Design Guidelines for Zoos

Rommel Mehta PhD
D. N. Singh PhD

School of Planning & Architecture, New Delhi

Central Zoo Authority, New Delhi

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FOREWORD

डॉ. हर्ष वर्धन
Dr. Harsh Vardhan

सत्यमेव जयते

भारत सरकार
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्री
GOVERNMENT OF INDIA
MINISTER OF ENVIRONMENT, FOREST & CLIMATE CHANGE

FOREWORD

The Central Zoo Authority was constituted in 1992 as a statutory body of the Ministry of Environment, Forest and Climate Change, Government of India to oversee the functioning of zoos in India and provide technical and other assistance to zoos.

It has been an endeavour of the Central Zoo Authority to have a comprehensive set of guidelines for the design in Indian zoos. The idea was to focus on the design aspects of various zoo components which could serve as reference and checklist to ensure that no aspect was overlooked in the design of a new zoo or up gradation of an existing zoo. This publication is an effort in that direction.

Over the years, the absence of any comprehensive reference material dealing with various aspects of designing of zoos has been felt by the Expert Group on Zoo Designing and the Technical Committee of the Central Zoo Authority. Therefore, the Central Zoo Authority with the help of the School of Planning and Architecture, New Delhi took up the responsibility to address the issue. This book is an attempt to serve as a manual for understanding the essential components and skills required for designing of zoos.

The information given in the book will ensure that no major aspect is overlooked while designing/upgrading a zoo. The publication is focussed towards planning, designing and construction aspects looking into the biology, behaviour and physical requirements of wild animals kept in captivity. It also deals with the requirements of human manpower mandated with the housing and upkeep of the animals in captivity. The requirements of the visitors to zoos have also been taken care of in the publication. The arrangement of texts also makes it convenient for reference and easy to use. This publication shall help in ensuring, quality control in all zoo related designs and construction.

This publication acknowledges the importance and close relationship between Wildlife Managers, Landscape Architects, Zoo Veterinarians and experts from other allied disciplines in designing of a zoo to be familiar with the design concerns.

Numerous illustrations from Indian context and the professional drawings add to the utility of this publication. I am sure that this publication shall be a milestone in the designing of zoos in India.

Harsh

Date:09.04.2018 **(Dr. Harsh Vardhan)**

PREFACE - 1

'Design Guidelines for Zoos' in India is written in response to a need for clarity and consistency in establishing recommendations, guidelines and principles to be followed in ensuring minimum planning and design standards for zoos in India. These guidelines explain the functional requirements as well as quality controls for comprehensive zoo design. The content of the book is specially directed to include Indian zoos. Certain ideas & planning details from international examples, which are suitable for Indian conditions, have also been adopted with appropriate modifications.

The primary objective of this book is to allow all those related in any way to zoo designing in India, to develop an understanding of the basic principles, spaces, elements and details involved in zoo design. This volume should prove to be useful for zoo related professionals, and many others in related disciplines like material suppliers and vendors, besides lay persons interested in zoos.

The preparation of these guidelines is intended to serve as a reference list for securing various zoo design related approvals by CZA and its various committees or any other concerned statutory authority.

The structure of this publication is organised under three basic segments of **site planning**; relating to large scale and overall considerations in layout in relation to site and climatic conditions, **drawings and documents;** to convey the designers intent for execution, methods and means of planning, graphic communication and execution of zoo projects and finally **design;** relating to project conceptualisation, sizes & locating of various zoo areas, enclosures, preparation of planting plans and design and construction details of all other elements. The text, drawings/ diagrams and pictures are intended for use by scholars concerned with creation & development of zoos and as desktop reference for zoo professionals engaged in designing or improvement of any specific aspect of zoo planning and design. These have been prepared in consultation with zoo professionals augmented by the authors personal experience. This has been further facilitated by listing bulleted items at the beginning of each chapter for each separate element of zoo planning and design. Checklists, under the head of 'Broad Guidelines' are given at the end of each introductory description for each item as ready reference. This listing is printed on the base colour for easy recognition. Further, a complete alphabetical compilation is given in the index. The book also contains examples of drawings to help zoo officials bridge the gap between their design intentions, terminology & representation used for drawing. It was realised, during the initial years of authors CZA membership of the 'expert committee' that such a gap existed and needed to be covered.

In the authors early interactions with zoo officials and members of various CZA committees, it was realised that all of them were very experienced, dedicated and well intentioned towards improving and creating modern 21st century zoos in India. This had become necessary after viewing the contrast between the existing facilities in Indian zoos and the advancement in zoo planning and design internationally. With the author being an architect & landscape architect with specialisation in site planning, landscape design and engineering, augmented the zoo official's specialisation in wildlife and related aspects. The objective of creating improved zoos in India was common, but the actual results on ground in terms of planning, design, construction management, detailing, selection & use of materials and execution was often different from what was intended. It was clear that there was a gap and that had to be bridged.

The author had to make a concerted effort, spread over a few years to understand the animal behaviour as related to zoo planning and enclosure design requirements. This inter disciplinary understanding resulted in much of what is written in the book.

The guidelines and examples in this book are carefully drafted to confine to design aspects and refrain from transgressing on specific information which can be referred from several other CZA publications/ standards. The objective is to provide zoo design initiatives and ensure that no aspect of planning and design is overlooked rather than being over, specific about, dimensions and materials, slopes etc. If this is done then local creativity & new initiatives in contemporary zoo design, by enterprising zoo directors and staff, will be restricted.

Beyond everything that is written in this book and every idea presented herein, it must be borne in mind that there will always be a creative extension of thought and intent which any zoo designer can explore and execute. This may include something which will be site specific or a creative draw out in the use of available material using the skills of local craftsman or an idea discovered by field experience. The designer should never hesitate to experiment and try out.

This being one of the first publications relating to zoo planning, design and construction related book in India, the possibility even with careful checking and double checking, that some errors will still remain and some aspects may have been overlooked. Questions about the text and possible errata should be directed to either CZA or the author.

Hopefully the context will be clear enough so that any such omission will not impede the textual flow on understanding of zoo planning and design guidelines being conveyed.

Prof. Dr. Rommel Mehta
Architect & Landscape Architect
Former Member CZA Expert Committee on Zoo Designing
myrmdesign@gmail.com

New Delhi, India
April 2018

PREFACE - 2

‘The Central Zoo Authority (CZA) is a statutory body created under the provisions of the Wildlife (Protection) Act, 1972 by the Ministry of Environment, Forest and Climate Change, Government of India. It came into existence in 1992 to oversee the functioning of zoos and provide them technical and other assistance.

The CZA, in fulfilment of functions assigned to it under the Wild Life (Protection) Act, 1972, has been publishing literature from time to time, for guidance of zoo personnel towards better management on scientific lines. In this direction, the present publication titled ‘Design Guidelines for Zoos’ is envisaged. The Recognition of Zoo Rules made under the Wild Life (Protection) Act, 1972 specify standard and norms for compliance by zoo operators with respect to schedules mentioned therein that include Animal housing, display of animals and animal enclosures. Besides, the CZA has issued guidelines on minimum prescribed dimensions of enclosures for various species.The present publication in that direction is long awaited. It helps zoo managers in comprehensive nature of designing the zoo.

Illustrations and drawings indicated in this publication enrich value of the publication manifold.

The Central Zoo Authority (CZA) had signed a Memorandum of Understanding (MoU) with the School of Planning and Architecture (SPA), New Delhi on 22nd March, 2006 for development of ‘Broad Guidelines on Principles of Zoo Designing for Zoos in India’, with financial assistance by the CZA. The work was supposed to be completed in eighteen months. However, it got delayed for varied reasons.

The CZApursued the matter proactively and I worked in close coordination with Prof. Dr. Rommel Mehta of the SPA. Once, draft copy of the publication was received, in order to expedite the process, the scientific staff of the CZA Secretariat reviewed it jointly with Prof. Dr. Rommel Mehta, Department of Landscape Architecture, School of Planning and Architecture, Delhi. Thus, the CZA ensured that this publication is print ready.

I am sure that this publication which is suggestive, acts as ready reference for stakeholders i.e. zoo operators/ managers, in comprehensive design of zoos including designing of animal exhibits and other aspects in a scientific manner. It would facilitate innovative designs of animal enclosures and other facilities in a zoo subject to the standards and norms laid down by the CZA.

New Delhi, India
April 2018

Dr. D. N. Singh
Member Secretary
Central Zoo Authority
cza@nic.in

ACKNOWLEDGEMENTS

I acknowledge with gratitude the contribution of institutions, individuals and animals who gave me an insight into the designing of zoos in India; which includes landscape planning & design, enclosure design, design of various zoo elements, zoo related services familiarity with the administrative structure of zoos.

I am indebted to Dr. D.N. Singh, I.F.S., present Member Secretary, Central Zoo Authority, whom I had the chance to be introduced to him during his tenure as the Director, National Zoological Park. His wide wildlife related and rich administrative experience was reflected in all our interactions. I thank him for helping and ensuring the completion of this publication.

I am especially thankful to Mr. B.N. Bonal, former Member Secretary, CZA, whose immense practical knowledge and empathy towards zoo animals and officials, was apparent in the numerous meetings chaired by him, which I attended.

Thanks are due to Dr. B.R. Sharma, previous Member Secretary, Central Zoo Authority, who guided me during the initial stages of the drafting of this manual through my regular interaction and discussions with him on all aspects of Indian zoos .

My knowledge about components of zoos and their working was provided & regularly augmented by Sh. S.K. Patnaik, (retd.) Addl. Principal Chief Conservator of Forest (Wildlife), Orissa. Continued contribution of Mr. S.K. Patnaik to my theoretical & practical knowledge, understanding and appreciation of animals was a unique experience of a professor being a student. I shall ever remember the time spent with him in and out of zoos. My respectful thanks to Sh. S.C. Sharma, Addl. DGF (WI), MOEF (Retd.) and earlier member secretary, CZA, whose practical & administrative experience and the ability to communicate with conviction transcends the normal.

Many thanks to Dr. Brij K. Gupta, Evaluation and Monitoring Officer, CZA, who was always helpful and a constant reference for me on various zoo related aspects and with whom I had travelled to various zoos and enriched myself with information about various aspects of zoos. His habit of constantly upgrading his knowledge is appreciable. Dr. Devender Kumar, Zoo Biologist and Scientific Officer, been a constant and valuable help in recent times. Over the years I was able to pick on the knowledge and experience of numerous I.F.S, officers, forest guards, and animal keepers with whom I interacted during my travels to various zoos in India and abroad. I remember them and gratefully acknowledge their contribution in building my zoo related knowledge even though I regret not being able to acknowledge them individually.

I thank the directors of all zoos I visited during the writing of this manual. Their experiences and wisdom refined the guidelines formulation.

Central Zoo authority, a statutory body looking after all aspects of Zoos in India deserves the credit for realizing the need for establishing comprehensive guidelines for zoo design. I express my gratitude to the School of Planning and Architecture, Delhi to which I am indebted for my development over the last 35 years and for the completion of the book.

I also wish to thank profusely my wife Sandhya and daughters Charvi & Suchitra who helped me in divergent ways and taught me how to embrace, persevere and complete a task.

I acknowledge the contribution of my old students Sh. Himanshu Ratan Singh & Sh. Imran Khan and Sh. Sohit, draughtsman, who helped in drawings and sketches, with good cheer and completed the illustrations and in addition made some other creative suggestions for improvement of the format.

Prof. Dr. Rommel Mehta

New Delhi, India
January 2018

ABBREVIATIONS AND SYMBOLS

Abbreviations / Symbol Expanded form

BOQ	Bills of Quantities
CCTV	Closed-Circuit Television
CLDP	Comprehensive Landscape Development Plan
cm	centimetres
CTA	Central Treatment Area
CZA	Central Zoo Authority
EIA	Environmental Impact Assessment
EOI	Expression of Interest
DPR	Detailed Project Report
ESS	Electric Substation
FPR	Food Preparation Room
IPC	Indian Patent Stone
ISSC	Information and Souvenir Sales Counter
mg/l	milligram per litre
M.S.	Mild Steel
NDMA	National Disaster Management Authority
PCC	Plain Cement Concrete
RCC	Reinforced Cement Concrete
RR	Random Rubble
STP	Sewage Treatment Plant
SOR	Schedule of Rates
WC's	Water Closets


Sakkarbaug Zoological Garden

CHAPTER 1

Introduction

The Prevailing Perception
Past and Future of Zoo Designing in India
Authors Intent and Thoughts

Zoo, in terms of design, is a comprehensive entity made up of various disciplines. It is composed of spaces and elements beginning from the 'approach & parking area' to 'enclosures and service buildings' besides services like plumbing and electrical. Yet conventional planning and design of zoos in India has concentrated on the shape and size of enclosures only. Construction details were generally ignored.

CHAPTER 1

Introduction

The Prevailing Perception
Past and Future of Zoo Designing in India
Authors Intent and Thoughts

1.1 THE PREVAILING PERCEPTION

It may seem strange, but very few Indian visitors to zoos are aware that zoos are comprehensively designed. In fact often no thought is given to zoo designing by most visitors. The visitors' imagination and information is limited to what is there for them to see and experience. Generally well designed Indian zoos, or well designed areas and enclosures within a zoo, are only experienced but their design is neither understood nor appreciated by the public. This is not because of lack of public intellect or interest but because design aspects of zoos have never been presented to them.

Visitors experience tiredness when they find the distance between enclosures unduly excessive, without any points of interest in the intervening space, or are affected by lack of public facilities. On the positive side they experience joy when they are able to relate well and enjoy the animals and the environment in an immersive exhibit. But most visitors will not be able to connect this to zoo design,

Fig. 1.1 Respect for existing environment and a thoughtful enrichment is evident in this enclosure in Gangtok, Sikkim.

let alone analyze and offer constructive suggestions for improvements in enclosure or circulation design. This is because most visitors are not aware that zoo is designed through a complicated sequential process like any building or institutional campus. In fact it requires a unique expertise because it relates to living animals and visitors and not only structures. Unfortunately what often gets prominence is an occasional accident which highlights design and management deficiencies. However, when one thinks about it zoos have logically evolved by learning from experience and failures and following specific design strategies based on human attitudes towards nature and wildlife. Science and technology has influenced zoo design in multiple ways. Scientific recording of animal behaviour within the cells, improvements in veterinary science & equipment and improved security systems are examples of recent development in zoos .

Design brief for modern zoos includes provision for proper animal upkeep, conservation initiatives, research on wildlife, educational aspects and information dissemination to public. Inclusive enclosures design has replaced cages, for example. Zoo design addresses and ensures visitors satisfaction and convenience for all categories of visitors including children and handicapped. To ensure this the size of zoo, its location, topography, and climate, human demography of the area, natural vegetation and existing drainage patterns, besides others are considered while designing the zoo. Presently, a conspicuous deficiency in zoo management is the lack of formalised methodology for visitors feedback and the assurance of authorities action thereafter. This will improve design if attended to properly

1.2 PAST AND FUTURE OF ZOO DESIGNING IN INDIA

The concept of modern zoos is based on animal welfare, conservation breeding, research and education. These are also the major goals of Indian zoos. Surprisingly the goals themselves can be in conflict. Part of the zoo design objectives is to resolve contradictions between local desires often expressed through animal collection lists and the realities of site in terms of location, topography, climatic etc. Local visitors may wish to see penguins in a semi-arid region zoo in India but it is not practically feasible and not a good idea from the animal display point of view.

Good design of zoos is important because design of exhibits or enclosures effects the animal perception of the visitor. This is realized by undocumented but careful observations of experts spread over many years in many zoos in India and abroad. Presently zoo design in India relies on personal observations and interactions with Indian wildlife experts and zoo persons. This is because of a serious dearth of formal documented research specific to zoo design and layout, while there is a huge body of information available on zoological & veterinary aspects..

Zoo, in terms of design, is a comprehensive entity made up of various disciplines. It is composed of spaces and elements beginning from the 'approach & parking area' to 'enclosures and service' buildings besides services like plumbing and electrical .Yet conventional planning and design of zoos in India has concentrated on the design of enclosures only. In fact it has dealt only with the 'layout' of enclosures (i.e. the placement of enclosures within the site) and not even with their design. The apparent reason for this is that the zoo directors or other animal experts are the only ones who are engaged in designing of zoos, though the situation is now improving. They focused on animal related aspects since they were experts in that field. Other aspects of design were dealt with an ad hoc manner, often at site. While infrastructural services were left to individual engineers. Essential co-ordination was not done as is necessary in contemporary project management. The design potential of various elements and their inter relationships were ignored and conventional materials and design were followed; unintentionally ignoring developments in materials and construction techniques. Aesthetic and design potential of various constituents of zoo such as road alignment and surface finishes, signage's and materials for outside and within enclosures is not fully explored.

Fig. 1.2 This enclosure takes advantage of the surrounding landscape to provide visual enrichment. An interesting idea.

The deficiency in this design approach was that while there was an 'administrative' leader, the 'design' leader was missing. A person leading the design team in contemporary terms is someone who is either well versed or at least familiar with all components which constitute the larger entity of zoo: the animal related considerations, the civil work, grading and storm water layout and engineering, the security systems layout, irrigation system layout and engineering and environmental aspects besides others. Such a person is able to co-ordinate, assess and dovetail functional and aesthetic aspects of various constituent elements into a 'whole zoo'. Such a system helps in bridging the gap between the ideas of the zoo director/ animal expert and the conversion of that vision into reality by appropriate design, material sourcing and execution.

Zoos have evolved globally over the years. During their transformation they have acquired various physical forms and changes in objectives and priorities. Indian zoos, beginning with the early 1800's, have also gone through changes. These changes were a result of the evolution of man animal relationship. Animal captivity 'areas' took various physical forms. Beginning with cages and evolving into the contemporary zoos. Development of larger cities and the consequent separation of wildlife from humans resulted in 'campuses' housing animals for viewing and study. The planning and design of zoos has been executed in India for the last approximately 200 years by the patron rulers and in most recent 100 years by foresters and wildlife experts. Zoo design during this period was based on the familiarity of the individual with animals and the local regional conditions. Specific scientific base data on animal behavior and living conditions in the wild or in captivity was either not available or was not site specific. Neither was any formal zoo planning nor design sequence followed. Individuals, generally with a background of zoo management (such as Zoo Directors or persons who had spent time in zoos in various capacities such

Fig. 1.3 Once inside the zoo it should be the animals, 'you' and nature. Every element in the zoo should essentially exude nature in terms of shapes, colour and texture.This path and the planting is a good example.

Fig. 1.4 South India Arignar Anna Zoological Park, Vandalur, Chennai

as veterinarians and curators) began to delve into zoo 'designing'. They were experts and knowledgeable in their field of animal sciences but were neither qualified academically or by experience to construction methods and management practices of buildings & infrastructural development.

Therefore innovation in these aspects was not their forte. Resulting in perpetuation of limited forms of circulation systems (often the ones carried on from past), enclosure designs, construction detailing, use of materials, infrastructure layout and non-scientific system of construction management. About 25-30 years back it became evident, that the above aspects could not be ignored in zoo design. Zoos areas are large spaces, generally close to settlements, towns and urban habitat areas. In such locations land values are high; often very high. This demands specialized comprehensive planning. With the zoos gradually acquiring larger responsibilities for wildlife conservation, research in captive breeding and evolving concepts of exhibiting animals, it became necessary that a format of zoo design be evolved.

This was to provide for all mandatory/ necessary sequences to be followed while allowing individual designers, located in various parts India, to exercise creativity in site specific zoo planning and design. This helped relate to the regional animal requirements and the local vegetation, geology, climate, topography, hydrological, demographic and social conditions and practices.

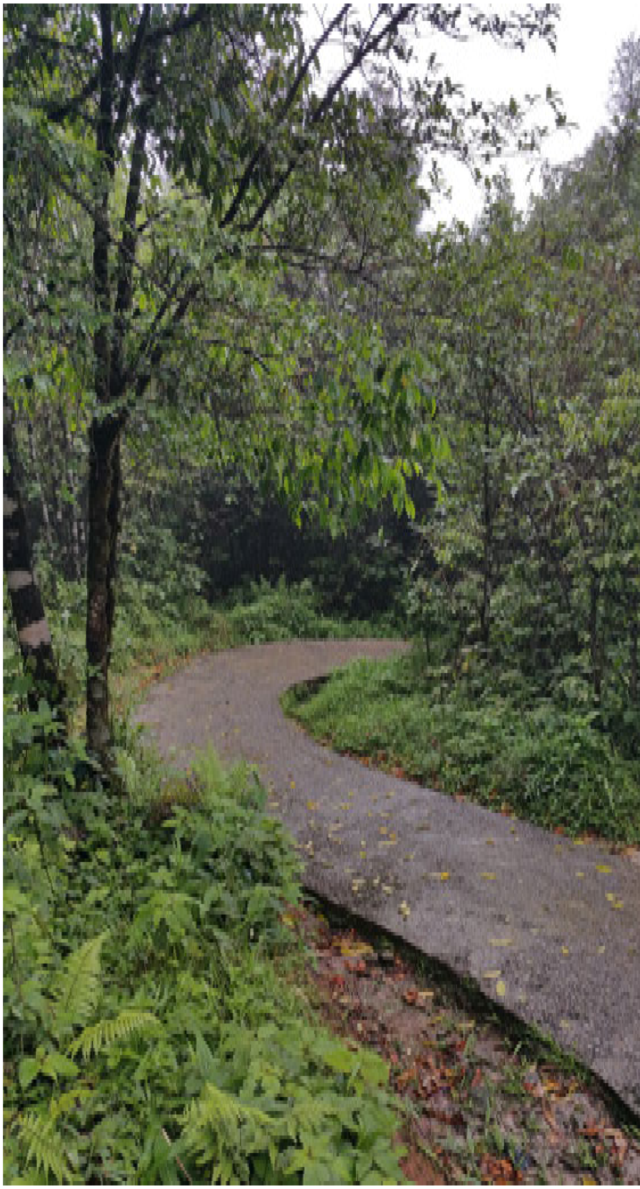


Fig. 1.5 This curvilinear road, through the existing indigenous vegetation, is a neat example of restraint often being the best design option in zoos. The alignment of the road with the slope of the land a design achievement.

During the last century various zoo design related disciplines have advanced

Fig. 1.6 Spacious entry area provides for better handling of crowds but it should be visually broken up with suitable planting so that the entire area is not visible as one large paved area.

Fig. 1.7 Large unused open spaces should be suitabaly planted or used for service structures and not left undesigned.

tremendously in terms of available information and studies. These disciplines include animal studies such as animal behavior, veterinary data, genetic engineering, captive breeding of animals and biotic and physical services. Alongside technology has also advanced to an extent where any design is now ‘possible ’. This includes technologies related to infrastructural development, innovative structures, materials and lighting. Design priorities now include sustainable development and limiting of carbon footprints.

This has resulted in a situation where comprehensive design can no longer be carried out in isolation by an individual. It requires a multidisciplinary team led by a team leader (preferably a person having knowledge and experience of animal behavior and landscape planning and design) driven by interest for zoo designing. A major step in protection of depleting number of some animal and bird species was the promulgations of the Wildlife (Protection) Act, 1972. Subsequently the act was amended in 1991 and a separate

Fig. 1.8 & Fig. 1.9 In most zoos small bird enclosures, rather cages, and blatant uninterrupted view of masonry and concrete require design improvement.

chapter was added to the Act for establishment of Central Zoo Authority. This provided for a unified authority for recognition of zoos in India. Concern for animal welfare, public awareness and education, captive breeding of endangered species and sensitivity towards the regional ecology will probably be prime concerns for designing of Indian zoos in future.

1.3 AUTHORS INTENT AND THOUGHTS

The present document intends to collect, compare, analyze various internationally available options and the author's experience and information relating to zoo design while contributing author's own experience and present them in a form which can provide guidelines for designing of zoos in India and abroad. It will ensure that no vital design parameter is lost sight of during the planning of a zoo.

For gathering information various important zoos in northern, eastern, western, southern and central parts of India besides some zoos abroad were visited. Discussions were held

Fig. 1.10 The good points of this barrier is the well maintained vegetation in the standoff barrier and the planted moat slope. The curve in the visitors viewing length is hiding much of the wall construction. The sharp ends of the chain link on the top bar of the fence should be avoided.

with forest officials, keepers, curators, visitors and others, related to various aspects of zoo designing and animal behavior. Experience and knowledge of other persons related to zoos was also drawn upon.

Throughout the book the text has been augmented intentionally with both types of examples - an appropriate example and examples indicating what should not be done. This has been done because, it was felt that at times, a negative example communicated more effectively towards making the reader understand the issue.

It has also been an endeavour in this book to introduce or at least mention new materials and technologies to upgrade the zoo design which has been stagnant over many decades and relied primarily on precedents. This needs a swift change if we in India are to achieve the contemporary world standards particularly in terms of animal comfort, maintenance, enclosure environment and security aspects; in fact on almost all aspects of zoo design.

During zoo visits and research the most heartening aspect, was the positive attitude & the zeal for change & improvement amongst all concerned. There was an abundance of available intellectual and physical resources along with rich wildlife and zoo related experience of persons concerned with zoos in India.

Fig. 1.11 The height of the plants selected for the standoff barrier should be able to hide the view of the moat construction. The drop at the edge of the path (oposite the stand off barrier) is an avoidable mistake which could lead to tripping and falls.

Dr. SPM Zoological Park, Surat

CHAPTER 2

Zoo Designing in India

Historical Development
The Recent History of Zoo Design
Development of Zoos in India

There is a continuing debate and difference of opinion whether to have regional animal species or exotic animals in a zoo. One line of thoght is to exhibit animals of the region because the animals will be easier to manage. The other point of view is to exhibit exotic animals from other regions or foriegn countries.

CHAPTER 2

Zoo Designing in India

2.1 HISTORICAL DEVELOPMENT

The word 'Zoo' is derived from a Greek word 'Zoon', which means 'Animal'. The origin of this word dates back to the year 1828 as an acronym of Zoological Garden - initially used for one of the early zoos in the world called London Zoological Garden. The first zoo was established for research at Regent's Park, London, with 500 animals including monkeys and various species of birds. Almost three decades later, it was opened for the public in 1857.

There are different claims about the first zoo in the world, but it is generally accepted that the first zoo was established by Queen Hatshetsut in 1500 BC in Egypt by collecting animals from all over Africa. Later, Emperor Wen Wang of China built a zoo to show his wealth and power, spread over 1500 acres before 1000 BC. It had animals from all over his empire and was named the 'Garden of Intelligence'. In ancient Rome, these animals were reserved for sport and exhibited in enclosures before being released for animal fights and hunting in the coliseum. However, over centuries, the concept of zoos has evolved significantly.

The oldest functional zoo in the world is Tiergarten Schonbrunn in Vienna, Austria, constructed by Adrian van Stkhoven in 1752. While the largest collection of species in the world was opened at the Berlin Zoological Garden in Germany. It is also believed the concept of zoos began in Mesopotamian times (3100 BC) where animals were housed and frequently displayed in private collections throughout the world.

Understanding the history of zoos vis-à-vis its phases of evolution will help experts and visitors better appreciation of the evolution of the housing of animals in present zoos. Most of physical layouts of the older zoos (including enclosures and buildings) have been upgraded gradually with the changing times inspite of limited space, resources and evolving understanding of animal behaviour. This was result of studies carried out on the behaviour of different species of animals in the world. The evolution of wild animals from being looked at as 'beasts' to as one of the species like human beings deserving our care and empathy coupled with thinking that they have also an equal right over the resources of earth to be shared with human beings. It has played an important role in evolution of the management of zoos worldwide. As a result, the global history of zoo may be looked at evolving through following three phases:

a) **End of 18th and 19th century:** Zoos designed as Confinements

b) **Early 20th century:** Modernisation of Zoos

c) **Late 20th century:** Zoos designed as Conservation and Education Facilities

2.1.1 Zoos Designed as Confinements

Late 1800s and early 1900s were marked as an era of enlightenment and romance, and consequently, focused on beauty. In this era, for the first time, the natural world was explored with respect to the scientific principles. The first Zoological Garden was also established in London during this period. Other examples of early zoos that were opened for public viewing are Philadelphia Zoo, Lincoln Park Zoo, Bronx Zoo, Chicago & New York USA, Whipsnade Park, United Kingdom.

Since, the focus during this era was on aesthetic appearance of the zoos, including animal enclosures, zoos were an architectural delight and cages were created and decorated as per the local architectural tradition of the country/ region from where the species originated. However, the down side was that the animals were confined in enclosures that were small and fabricated with grilles and iron rods not allowing them to engage in their natural behaviour. The housed animals were also classified into different categories and kept in separate enclosures.

2.1.2 Modernisation of Zoos

The period of 1900s, witnessed several wars including the World Wars. During this period scientific exploration of nature and animals were not given due priority as compared to military and medical advancements because the prime focus of humanity at that point of time was their survival or winning wars.

Even as the focus on nature was limited and the zoos were reduced to animal exhibits, the concept of modern zoos evolved with the conceptualisation of the Tierpark, Hagenbeck in Germany by Carl Hagenbeck, a prominent German Architect. His ideas and design contributed to radical changes in zoo architecture. He introduced the idea of large open dry moats made of steep artificial rocks, so that the animals could be viewed without any visual obstruction of bars or fences (Chrulew, 2011, Managing Love and Death at the zoo, The Biologies of Endangered Species Preservation Australian Humanities Review, Issue 50 May 2011). It was as revolutionary as somebody turning today's zoo concepts upside down. Using concrete to give it an appearance of natural rock was one of his significant

Fig. 2.1 Signages educate and also enable the visitors to guide themselves.

Fig. 2.2 Inspite of efforts being made to improve the enclosure design the inexperieced human hand is often visible.

Fig. 2.3 Some structures fit the theme; others require design input.

Fig. 2.4 Signages educate and also enable the visitors to guide themselves.

original contributions to zoo design which has been developed and refined over the years. These enclosures were inspired by romantic landscape paintings, but mostly inadequate for the housed animals. This technique became very popular and can be still seen in European, North American and Indian zoos. With advancement in medicine, emphasis was also on cleanliness and physical health of the housed animals.

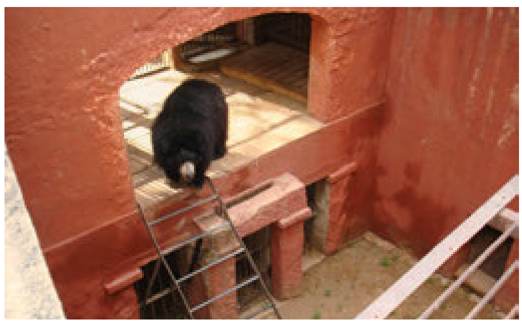


Fig. 2.5 Animals were caged, even until very recently, for human viewing without concern for animal comfort or habitat or cell enrichment.

2.1.3 Zoos as Conservation and Education Facilities

Starting from the middle of 20th century, our society has become conscious towards environment, human rights and animal rights. This change in the outlook of the society

Fig. 2.6 Recent design advances in Indian zoo design has resulted in ensuring enclosure enrichment resembling natural habitat & vegetation type.

towards animal rights has given birth to a new conception design of animal enclosures wherein enclosure enrichment and plantation was provided to create the natural habitat of the animal in the enclosures. The concept of 'Landscape Immersion' in zoo design developed simultaneously wherein, visitors are positioned to view the animals from a location in which they are one with the animal and its natural habitat and are not able to view any man made structure which are hidden by vegetation . Consequently, zoos are not only limited to exhibiting the animals but are places where visitors experience the natural habitat of the animals in terms of vegetation and enclosure enrichment. Woodland Park Zoo in Seattle, USA was one of the first zoos to adopt this style. Since then, this concept has become a rage, and today, is considered as an accepted norm for zoo design.

2.2 THE RECENT HISTORY OF ZOO DESIGN

There was a phase of stagnation in design and creative thinking related to Indian zoos for the last 50-60 years. During this phase design of new zoos laid stress generally on the physical aspects of zoos (barrier or enclosures dimensions for example). Other design parameters such as enclosure enrichment and convenience and experience of the visitors and animals was largely overlooked; probably inadvertently and out of ignorance of contemporary design information and travel opportunities for zoo officers and staff. The zoos and its infrastructure was being developed by the forest officials themselves based on their experience of working in the zoos and exposure to the development of zoo in different parts of the world through field visits. There were no specialised architectural professionals available in the country. After setting up of the Central Zoo Authority, qualified professional manpower from different fields including Animal Biologists, Landscape Architects, Engineers, Conservation Educationists and Zoo Managers were selected for comprehensive designing of the zoos and animal enclosures.

In India, the Central Zoo Authority has laid down standards and norms in 1992 for the operation of zoos in the country. Further, the Central Zoo Authority has also extended technical advice to the zoos in the country for their improvement. As a result of which many sub-standard zoos in the country have been closed and some of the old zoos located in the middle of the city having no space for its development, were relocated at new spacious locations. The Jaipur Zoo, opened to public in 1779 as a menagerie, has been relocated at its new location in Nahargarh with large, open, natural enclosures for animals and adequate amenities for the visitors. The old site of the Jaipur Zoo has been converted into a Bird Park maintaining its original architecture.

The animals were housed with little attention to their physical, biological and behavioural requirement. Their wellbeing, procreation and natural instincts were being compromised. Zoos try to preserve the physical wellbeing of the animals by maintaining and improving hygiene standards. Concrete and stone structures, glass, ceramic tiles, and steel have become popular for making of enclosures and its furnishing. Although, animal enclosures appear similar in their sterility on the inside, the architecture of most of the zoos is changing with changes in art and style.

Many of these exhibits tragically convey human dominance over animals kept in captivity and the needs and basic requirements of animals as visualised by its creator is being overlooked. With his book, 'Wild Animals in Captivity', Hediger, Heini, Butterworths Scientific Publications. 1950 set a bench-mark in the theory of zoo design in 1950. He pointed to the contradictions between animal behaviour and zoo facilities resulting in deficiencies and inadequacies. Unfortunately, behavioural problems of zoo animals are still acceptable in most places.

In 1976, Jones, Coe and Paulson (Jones et. al., 1976) introduced the concept of landscape immersion with their Long-Range Plan for Woodland Park Zoo. The idea of landscape immersion is to replicate the species' natural environment and to place the viewer within the animal's habitat. The concept reflects the increasing awareness of the interdependence of living creatures and their environment. The organization of the animal exhibits relates to zoogeography and takes the ecology of the site into account. Since advances in prophylaxis and medication allow the use of natural materials in animal enclosures, plants have become the major feature in this type of animal exhibit.

Additionally, synthetic fibres have become popular in zoo design. Moulds taken from natural forms are turned into naturalistic copies of rocks, plants or anything found in nature. Excellent examples can be seen in the Singapore Zoo. Both, natural and artificial materials can be used to replicate the natural habitat of the displayed animal as convincing as possible. Lately, designer have been emphasizing the relationship between traditional people and wildlife and arranging sequences of stories about it.

Since visitors often find it difficult to view the animals in spacious natural exhibits, various design techniques have been developed to provide positive incentives for the animal to stay in view. Enclosures are designed so that they are not abnormally deep or with enrichment (vegetation or rock outcrops) which the animal can use, at its sweet will, as its withdrawal area to hide itself whenever it is under stress due to presence of visitors or any other reason whatsoever, Yet the shape of the enclosure, the location of the night shelter and the length and positioning of the viewing area is designed to ensure privacy for the animal when required. Furthermore, audio-visual technology is used to provide memorable experiences for zoo visitors.

Today, the pace of evolution in zoo design is uneven. Some institutions are experimenting with more subtle barriers such as thin steel nets and light barriers. Others are stuck with the tradition of menageries. The concern of animal welfare and their ethical treatment, the rights of the each of the species of living form, and breeding of endangered animal species in captivity to serve as gene pool of their natural brethren will probably be the driving force for zoo design in the future.

Fig. 2.7 This drinking water facility could have been made to merge with the surroundings. The infringement of platform slope on to the main path is not desireable.

2.3 DEVELOPMENT OF ZOOS IN INDIA

In India, zoos originated with a collection of animals adjacent to parks by the kings of princely states or elite, often, for their personal pursuits as private collection and to entertain important visitors rather than for study or public viewing. Moreover, the princely states and individuals set up zoos in different parts of India in 19th century. The first zoo for public viewing was established in 1801 at Barrackpore. Sri Chamarajendra Zoological Gardens, originally referred to as the Palace Zoo, was established in 1892 in Mysore at the summer palace of Maharaja Shri Chamaraja Wodeyar. Similarly, public zoos in other princely states such Kolkota, Madras, Lucknow, Ahemdabad, Mumbai, Bikaner, Baroda, Trivandrum, Jaipur, Udaipur, Jodhpur, etc. came up. Apart from the kings and elite, zoos in India, like Maharaj Baugh (Nagpur),were also maintained by the local bodies.

Corresponding to the international trends in zoo designs in 18th and 19th century, the concept of zoo in the Indian context also evolved significantly underling the change in the perception of the zoo operators towards zoos. An overview of the evolution of Indian zoos in the 1900s is given below:

a) Early 1900s: Zoos were operated like parks with the primary objective to showcase animals for the purpose of recreation and entertainment.Little or no emphasis was given to the wellbeing and safety of the animals as they could be easily traded from within the county and procured from overseas. Animals were kept in small cage enclosures with fences, welded mesh or iron bars as barriers.

b) Mid 1900s: Post independence, the Government of India acknowledged the function of zoos as astorehouse of wildlife and centres for conservation awareness. Thus, introducing the concept of modern zoos wherein the zoo design focused on naturalistic enclosures that closely resembled the natural habitat of the housed animals. This lead to the creation of National Zoological Parl, New Delhi in 1957 with moated exhibits, both dry and wet, as barriers for displayed animals instead of cages. Thereafter, this modern concept of zoos also became popular in India and various zoos such as Nehru Zoological Park, Hyderabad, Nandankanan Zoological Park, Bhubaneswar, Arignar Anna Zoological Park, Vandalur, Chennai, Kanpur Zoological Park, Kanpuretc. have redesigned the animal enclosures to resemble the natural habitat of the retained animals.

   The recreation needs of large number of visitors lead to the establishment of various menageries and zoos across the country. Kamla Nehru Prani Sangrahalaya, Indore and V.O.C. Park Mini Zoo, Coimbatore, NawabWazid Ali Shah Zoological Garden, Lucknow are some examples of such zoos. However, unfortunately, the situation of these zoos was far from satisfactorydue to constraintsof space and resourcesas well as their location being in the middle of the city with hardly any space for its expansion. Like most of the other zoos, according to today's standards, the animal enclosures were inappropriate and poorly designed as the zoo authorities were unable to create moated structures as per the standard norms and had to look towards alternate solutions.

c) Late 1900: Subsequently, the development of zoos got a boost with the establishment of the Central Zoo Authority in 1992 which prescribed minimum standards and norms for operation of zoos in India, formulated National Zoo Policy, has been providing financial and technical support for improvement and up-gradation of zoos. More and more stress was laid on conservation, awareness, education, and research.

   CZA also organized many trainings / workshops/ seminars/ conferences involving different institutions, individuals and stakeholders from India and abroad, to sensitise themwith the latest developments and technology in the field of Zoo Designing.

   It has been made mandatory for a zoo to prepare Master Plan for its long-term development and get it approved from the Central Zoo Authority. This was done in order to ensure planned development to fulfil its objectives. Master plan of a zoo deals with appraisal of existing facilities, future action plan that includes Master (Layout) Plan, Animal Collection Plan and Management Plan which addresses the future budgetary requirement of the zoo.

2.3.1 Designed for Captivity

History, including Indian history, is replete with examples and stories wherein animals were captured from the wild and kept in cages until they died. There was no importance assigned to their procreation since the animals were available in wild in plenty and they used to be replaced in captivity from the wild population. The objective behind this cruel depiction was to express the dominance and power of the human beings over the 'ferocious' wild animals.It was display of a false and morbid sense of power used by rulers and noblemen as a means to convey their power and might to their subjects.

The animals were kept in small cages with little attention or considerations towards the climatic conditions of their natural habitats. The breeding of the animal in captivity was not a priority and animals were not housed in pairs because of lack of information about the ecology and biology of the species. These conditions often place the animals under severe stress leading to abnormal behaviour. The lack of information about the health and upkeep of animals also were responsible for their early mortality in captivity.

Fig. 2.8 Enclosure in contemporary zoos and those being presently developed, have progressively began, to be designed to appear like natural habitat rather than cages. This is an encouraging development.

Fig. 2.9 Zoos attract crowds and requiring paved areas. Yet such large pavements should be designed to enable greenery to predominate.

2.3.2 Designed for Viewing

In the middle of the 20th Century, in India, the animals were housed in the enclosures with fencing and cages. It was designed as per the available information about the animal and its behaviour based on the experiences of the zoo managers and local people living in the forests who were having exposure about the animal and its requirements in the nature. Here also, the physical, behavioural and psychological requirements of the animals kept in captivity was not given due importance because the prime concern was the visibility of animals to the visitors and the visitors' satisfaction was a major consideration. As is evident from above, even at this stage the layout was more from the point of view of the visitors with least concern about the comfort and concerns of the animals. The enclosure was essentially an enlarged cage.

There was hardly any space for animals to withdraw from the constant gaze and often physical disturbances caused by the unsensitized visitors. This stage in zoo planning and design in India extended for long period upto early 21st century. During this period zoo upgradation& improvements as well as layout & design of anew zoo was carried out by local zoo directors with help from wildlife experts available within the district or the state. Peer review of zoo designs, which was often in the form of hand drawn sketches, was unheard of. This resulted in a zoo design which was limited to the experiences and creativity of single individual. He would surely have experience and exposure in wildlife management but design and even professional views transcend intellectual and experiential boundaries. There are very often more than one solution and options for the design of the zoo or even an element within zoo. These elements include enclosures, roads, paths and even animals and waste disposal systems.

As a result while there was appreciable improvements, a slight improvement in zoo designs but a lot more considerations pertaining to animal comfort, welfare and enclosure enrichment were being overlooked. Since 1992, the year of the creation of the Central Zoo Authority, there was realization that the conditions of Indian zoos needed to be improved. This awareness dawned partly because of the evolution of the zoos worldwide.

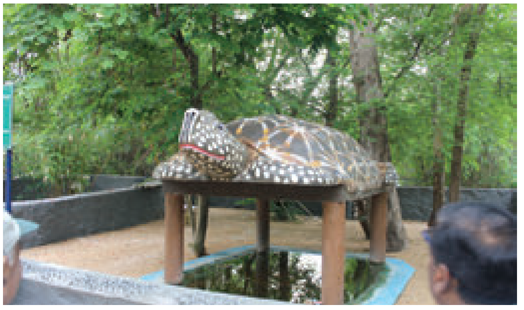


Fig. 2.10 This shelter has good craftsmanship but the placement and the design layout are not in sync with the zoos natural environment.

2.3.3 Designed for Education

After 1992, there was a perceptible improvement in the understanding, conceptualisation and planning and design of zoos, largely because of efforts of the CZA.

Drawings, however, incomplete and technically deficient, being received from the zoos which were often hand drawn sketches were examined by the Committee of experts in the CZA and approved with suggestions. The construction materials, estimates etc. were not fully defined and yet presented for approvals. Gradually on insistence and guidance of the CZA properly drawn drawings and documents began to become the norm. It was a significant period - continuing even now- in the design and development of Indian zoos.

There was a general, across the board, realisation of the fact that contribution from wildlife experts other than the zoo director or an individual contribution to improved zoo planning and design was need of the hour. The efforts of the Central Zoo Authority and the members of the Committee played an important and significant role to bring the changes in the zoo designing in India.

2.3.4 Designed for Conservation, Rescue and Empathy

Official status on zoo planning and design in today'scontext, is defined in the National Zoo Policy, 1998. Objectives specifically related to zoo designing and their strategy for achieving the same are described below:

a) To inspire amongst zoo visitors empathy for wild animals, an understanding and awareness about the need for conservation of natural resources and for maintaining the ecological balance.

b) Besides the aforesaid objectives, the zoos shall continue to function as rescue centres for orphaned wild animals, subject to the availability of appropriate housingand upkeep infrastructure. Where appropriate housing and upkeep is not available,State Government and the Central Government would ascertain setting up rescuefacilities in off-the-display areas of the zoo, subject to availability of land.

c) Every zoo shall maintain a healthy, hygienic and natural environment in the zoo, so that the visitors get an adequate opportunity to experience a naturalistic environment.

d) Every animal in a zoo shall be provided housing, upkeep and health care that can ensure a quality of life and longevity to enable the zoo population sustain itself through procreation.

e) The enclosures for all species display or kept in a zoo shall be of such size that all animals get adequate space for free movement and exercise and no animal is unduly dominated or harassed by another animal.

f) Each animal enclosure in a zoo shall have appropriate shelters, porches, withdrawal areas, wallow, pools drinking waterpoint, and such other facilities which can provide the animals a chance to display the wide range oftheir natural behaviour as well as protect them from extremes of climate.

g) The zoo shall encourage research on the biology, behaviour, nutrition and veterinary aspects of animals in their collection. They shall also endeavour for creation or expertise on zoo architecture and landscape designing, cooperation of recognisedinstitutions already working in relevant fields in this regard shall be taken.

h) The central theme of the zoo education programme being the linkage between the survival of various species and protection of their natural habitat, enclosures which allow the animals to display natural behaviour are crucial to zoo education. Zoo shall, therefore, display animals in such enclosures only where the animals do not suffer physiological and psychological restraint.

i) Attractive and effective signage methods and interactive display to explain activities of various species to visitors, published education materials and audio-visual devices are proven methods for driving home the conservation's message. A formal education programme should also be persuaded for strengthening the education message.

j) Zoo shall provide basic civic amenities to the visitors like toilets, drinking water points, shelters and first-aid facilities. Ramps shall also be provided for the benefit of visitors in wheel chair for approach to animal enclosure and other civic amenities.

k) Zoo shall not provide any infrastructure for recreation/ entertainment of visitors that is in consistent with the stated objective of zoos.

Improvements in zoo planning and design in India have made significant progress since inception of the Central Zoo Authority. Today, we have sufficient literature, information and professional manpower to take care of designing of the zoos and its animal enclosures keeping in view the safety and security of the visitors, captive animals and manpower mandated with the task of upkeep and healthcare of animals. There are professional and experienced manpower available within the country having knowledge and expertise in the field of animal behaviour, and allied disciplines such as civil engineers, plumbing, electrical, mechanical engineers, landscape architects and security experts. The availability of such a group of individuals is very necessary because zoo is a very complex entity which needs to be understood as a combination of buildings, structures and living animals who have the same requirements as that of humans.

In brief, india is now at a threshold where there is awareness, intention, understanding and available technology for creating modern zoos. What we require now is continuing education of zoo designers, persons with forestry & wildlife background and technology specialists and other allied disciplines so that new ideas and technologies in the field of zoo planning & design are available and evolve with the time keeping pace with the improvements in the technology and basic science of all related fields.

Fig. 2.11 The animal and the enclosure enrichment go well with each other in this enclosure in Sri Chamarajedra Zoological Garden, Mysuru

Chamarajendra Zoological Garden, Mysuru, Karnatka

CHAPTER 3

Zoo Components

There is a need for a comprehensive set of guidelines and checklist of all the components. This will ensure that no aspect, major or minor, is overlooked while planning and designing. Freedom of design exprssion should be ensured and encouraged to gain from the designers and zoo persons experience.

At present, in India, a zoological park has a different meaning and creates different images in mind of a lay person, a visitor, a wildlife expert and a zoo designer. Each is convinced that his description & concept constitutes the best definition of a zoo. The fact actually is that very often the zoo is something more than what any individual may imagine.

Otherwise the situation is much better now. Work is being done in project mode with requisite drawings and documentation. Although a deeper understanding and familiarity with animal behaviour and requirements needs to be aquired by the designers to create suitable and creative facilities for animals, visitors and staff.

CHAPTER 3

Zoo Components

3.1 INTRODUCTION

The basic components in a zoo, as far as the considerations for its designing is concerned, are animals, visitors, human manpower and infrastructure for housing, upkeep, healthcare of animals and basic facilities for visitors. In the designing of a zoo, highest importance and priority has to be given to the safety and security of the zoo animals, visitors and zoo personnel. These considerations, some of them often having conflicting requirements, need adequate attention to give equal importance to the necessities of each of them. This is what makes the design of zoo a very complex project. As is evident from the above, the components of zoo design consist of requirements of living elements and non-living elements. The 'living' part introduces the element of subjectivity and judgement. Meaning thereby that the same design situation will elicit different responses and design solutions based on the knowledge and experience of the concerned person. These variations are not a negative aspect. Infact on the contrary it is various options and differences in responses to design situations which encourage new ideas and experimentation; which are so essential for the design development of zoos.

The designing of a zoo requires expertise and knowledge in different aspects such as animal biology, behaviour, etc., visitors' expectation and satisfaction, zoo caretaker and managerial personnel requirements and understanding of the local climatic factors etc.

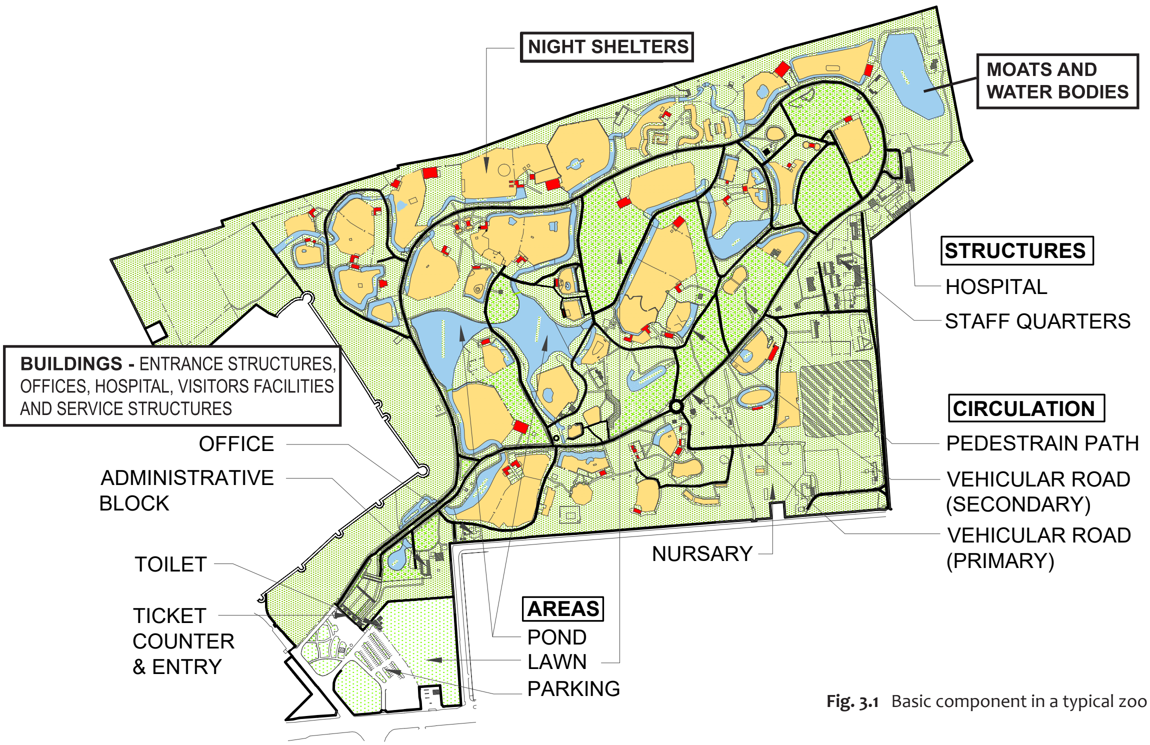


Fig. 3.1 Basic component in a typical zoo

This leads us to a situation wherein the inputs from different disciplines are required. It needs no convincing to accept that no one person can possibly be an expert in all aspects of zoo designing. It is evident that comprehensive zoo design is a multidisciplinary activity which requires creative and patient interaction amongst experts in various disciplines which relate to each component of zoo. Each expert should consider, if not fully accept, the inputs of others. The range of inputs can be that of animal behaviour & habits from a wildlife expert to the architectural detailing of the steel joints in enclosures and standoff barriers and the road edge details.

At present, in India, a zoological park has a different meaning and creates different images in mind for a lay person, a visitor, a wildlife expert and a zoo designer. Each is convinced that his description & concept constitutes the best definition of a zoo. The fact actually is that very often the zoo is something more than what any individual may imagine. By itself one may ignore this situation but while designing it becomes imperative that no aspect of a zoo is left out of consideration. Factors influencing zoo planning and design are animal specific and site dependent. The priority and significance of various zoo elements varies as perlocation of the zoo in a region of India. Therefore, design priorities are different for each zoo.

The suggestions and views on different aspects of the initial stages of zoo designing from experts from different fields may often lead to extended discussions and weighing pros and cons of each such suggestion and views. It may lead to arguments and consequent cost of time, but at the end, it is going to give an excellent output which would facilitate designing of a zoo taking into consideration aspects and requirements of each of the stakeholders. This healthy discussion based on differences in suggestions and views has to be accepted by a zoo designer.

Fig. 3.2 Additional greenery, strategically placed, and scaled down structures, would have added to the essential theme of a zoo entrance without compromising the desired 'grandness' .

Therefore, there is a need for a comprehensive set of guidelines/ checklist of all the components. This will ensure that no aspect, major or minor, is overlooked while planning and designing. It needs to be understood that there will be objective aspects and some subjective consideration in design. Size of enclosures as specified by the Central Zoo Authority or specifications for plantation of trees/ shrubs inside the animal enclosures or within the zoo premises are examples of objectives aspects which need to be mandatorily followed by all, while the design and type of enclosure enrichment may be based on a designer's opinion and may be termed as a subjective facet of design. The expression of subjective opinions should not be ignored. This kind of feedback may be coming from zoo employees or wildlife expertswho may not be very articulate in their verbal expression but the person may have valuable inputs and opinions for design of zoo based on their practical experiences. Freedom of suggestions in the initial design should be ensured and encouraged to gain from the designers and zoo manager's experience. This is vital facet of zoo planning and design. This ensures freedom of design and allows expression of designer's experience - a vital element in zoo planning and design. This also ensures an open avenue for design creativity and introduction of new technology and materials.

Presented hereunder, is an embracive list of components of a contemporary Indian zoo.

A contemporary Indian Zoo, as a comprehensive entity, constitutes of following components:

3.2 AREAS

Areas/ Landuse in the Vicinity of Zoo.

a) Front area outside the gate of the Zoo.

b) Main gate and entry area

c) Visitors parking

i. Outside the main gate

ii. Inside the main gate

3.3 CIRCULATION

a) Zoo Parking - inside the Zoo

b) Vehicular circulation

c) Pedestrian circulation

- Visitors & Staff
- Service Circulation for Access to Night Shelters and Kraals

Fig. 3.3 This sculpture, made of bronze is weather resistant and merges very well with the surroundings.

3.4 LANDSCAPE

a) Existing vegetation

b) Gardens,planting beds, trees,plantation

c) Vegetation buffers/ Screens (between spaces and between enclosures)

d) Peripheral planting
e) Landforms
f) Grade change devices (ramps, steps, stepped planters, etc.)
g) Green pavers areas
h) Landscape Art and Sculptures

Fig. 3.4 The location of this dinasaur replica is placed in a suitably scaled space with enrichment to match. The climate does not seem to damage the model but nourishes the vegetation.

3.5 ELEMENTS

a) Railings and Fences
  i. Along stand-off barriers
  ii. Along road and paths
  iii. For animal enclosures

b) Signage

  i. Information:signs conveying information about services and facilities, such as biological information of the species housed, maps, directional, or instructional signs.

ii. Directional: signs showing the location of services, facilities, functional spaces and key areas, such as sign posts or directional arrows.

iii. Identification: signs indicating services and facilities, such as room names and numbers, restroom signs, or floor designations.

iv. Safety and Regulatory: signs giving warning or safety instructions, such as warning signs, traffic signs, exit signs, or signs conveying rules and regulations.

Fig. 3.5 Glazed tile signage is not a viable option because it cannot be easily replaced in case of damage.

Fig. 3.6 Traditional stone signage can be replaced now by similar looking manufactured signages because original stone panels are not easy to replicate and fix.

3.6 ENCLOSURES

a) Animal Enclosures
   i. Paddock
   ii. Moat / Barrier
   iii. Kraal
   iv. Feeding cubicles / night shelter / retiring cell
   v. Stand-off barriers
   vi. Ancillary structures

Fig. 3.7 Enclosure enrichment in India requires extensive researched input because at present there are not many well designed situations.

3.7 STRUCTURES

a) Buildings/ Structures
   i. Interpretation Centre
   ii. Administrative offices
   iii. Veterinary Hospital
   iv. Quarantine / Isolationfacilities
   v. Visitors amenities - toilets, drinking water fountains & troughs)

b) Service Structures
   i. Electric sub station
   ii. Sewage treatment plant (STP)
   iii. Pumping station
   iv. Overhead/ underground water tanks

Fig. 3.8 Service buildings should merge with the surroundings in terms of colour and texture. The above is not the best of examples.

Fig. 3.9, Fig. 3.10 & Fig. 3.11 Structures of all types including butteresses, for example, should be elegently designed. No structure should be treated with disregard.

3.8 SERVICES

a) Services
   i. Storm water drains
   ii. Water supply pipes
   iii. Electrical cables
   iv. Secure digital communication
   v. Water retention pools
   vi. Recharge pits

Left over Areas - There are areas which may be small in dimensions, odd shaped or not easily accessible. This is nothing unusual or rare because this is something which happens in most layouts. This certainly does not imply that such areas are useless. Such areas can be used for buffer planting, location of Electric Substation (ESS), electrical pillars, stores or security cabins.

All the above components which combine to create a zoo need to be designed. There cannot

Fig. 3.12 Night shelter design and detailing has been one of the most ignored aspects. A comprehensive review is long overdue.

Fig. 3.13 & Fig. 3.14 All zoo structures including service buildings are function predominent and can be simple in form but should be made to merge with the environment in terms of colour, texture and form. This shold be the rule even if the area is out of bounds for visitors.

be specific instructions for design of every component because of the wide spread regional variation in climatic conditions, topography vegetation types, hydrological situation, availability of materials etc.

Guidelines are formulated to ensure the essential activities of a zoo are facilitated by creation of an improved zoo design. There are two types of activities:

a) Activities or design decisions which have specific solutions generally not given to opinion variation; e.g. the size of animal enclosure barriers or avoidance of any activity which is detrimental to interests of wildlife or inconsistent with the well- being of the animal. An example is the location of a children park in proximity of animal enclosures, which is not permitted.

b) Then there are decisions on which there can be more than one opinion. Examples are the selection of plants for immersion exhibits, or the type &

Fig. 3.16 Provision for services, such as stormwater drain, should be integrated with the overall zoo layout.

Fig. 3.15 Zoos are ideal areas for ground water collection and recharge because of their large areas. A facility at Sri Chamarajendra Zoological Park, Mysuru.

size of enrichment element, colour of enclosure walls or even the zoological park entrance design.

To summarize, there have to be controlling guidelines to ensure that the essential design intent and objectives are not lost. Guidelines can be categorized for functional and specific elements and others which are for subjective and are consequently dependent on the person executing them. For example the per capita consumption of water for human use is defined in the National Building Code while the material and finish of the masonry to be used for the feeding cubicle can be a matter of choice. Hence, the need and justification for forming guidelines. These guidelines will set the reasonable extent of variation and choice that can be exercised while designing a zoo. The Central Zoo Authority has framed guidelines for functional components (such as size and dimensions of animal enclosures and feeding cubicles). But other essential elements of a zoo are left entirely to the experience and judgment of respective zoo operator. As a consequence there is uncontrolled subjective variation. The guidelines will rectify this shortcoming. The Indian Zoos will acquire a minimum standard of functional correctness and aesthetics.

3.9 DISPLAY BASIS AND SEQUENCE

A component of zoo design, generally decided by the designer, is the basis of display of animals. There are at present no fixed rules, neither can there be, for the sequence and adjacency of the animal enclosures within a zoo. There are only suggestive methods which can be adopted for animal display. A few examples of the basis of display which continue to be used, both in India and abroad are based on:

a) Geographic condition
   i. African Savannah
   ii. Madagascar
   iii. Australian desert
   iv. Himalayan Foot Hills
   v. Western Ghats
   vi. Deccan Plateau, etc.

b) Eco system type
   i. Desert
   ii. Mangier
   iii. Wasteland
   iv. Rain forest etc. or there can be more specific reference to sites like:
      - Chilka/ Bharatpur ecosystem
      - Kanha Meadows
      - Sundervan Mangroves
      - Nilgiri Hills, etc.

c) Taxonomic classifications:
   i. Primates
   ii. Ungulates
   iii. Large carnivores
   iv. Small carnivores
   v. Bears
   vi. Marsupials
   vii. Reptiles
   viii. Birds (Aquatic and terrestrial)
   ix. Amphibians
   x. Insects
   xi. Fishes

The zoo management has to deliberate on which type of display shall be more desirable and convenient, based on ease of maintenance, availability or likely procurement of species, topography, visitor convenience health management and personnel request etc. Off display rescue centers, conservation breeding facilities etc. should not influence the above decision.

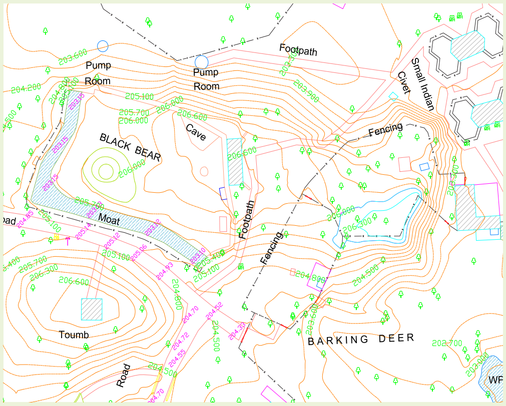
Fig. 3.17 Majestic but urban looking entry to the zoo. Addition of plants will enliven it.

Fig. 3.18 Storm water drain has two design aspects; the hydraulic design and the visual design. Both are equally important. This drain merges well with the zoo environment.

Sakkarbaug Zoological Garden, Junagadh, Gujrat

CHAPTER 4

Site Planning



The objective is to arrange the proposed uses of a new zoo by carefully selecting and analysing sites, generating land use plans, organising vehicular and pedestrian circulation, developing visual forms and materials concepts, readjusting the existing landforms by grading to facilitate the proposed activities, ensuring proper drainage and developing the construction details necessary to carry out the project.

CHAPTER 4

Site Planning

4.1 INTRODUCTION

When a zoo is established on a virgin site or by modifications to an existing site, there will be changes. After the changes, the remodelled site and new uses must mutually relate and complement each other. This must serve as the basis of the design of the zoo. What needs to be ensured is that the changes which are brought about in the existing environment are designed carefully to ensure that the existing natural systems are not disturbed. The activities and structures brought about by the establishment of the zoo are able to establish a symbiotic relationship. They should complement each other and sustain over time. This is achieved through the well-established process of **site planning.**

The objective is to arrange the proposed uses by carefully selecting and analysing sites, generating land use plans, organising vehicular and pedestrian circulation, developing visual forms and materials concepts, readjusting the existing landforms by grading to facilitate the proposed activities, ensuring proper drainage and developing the

Fig. 4.1, Fig. 4.2 & Fig. 4.3 When a zoo is established on a new site there will be changes. inspite of that after completion the site and the functions of the zoo must complement each other in such a way that the original visuals and the ecology of the site remains least changed.

construction details necessary to carry out the project.

In general, the primary objective of site planning is to make decisions about the use of resources with regard to the proposed activities and physical elements of the planned zoo. The problems and issues are diverse in both type and scope - ranging from flooding of areas after development where there was perfect natural drainage earlier to problems of poorly designed services resulting in extensive and avoidable damage to vegetation, drainage channels and top soil. Planning problems faced by most zoos in India today are complex and many are related directly to landscape. Most conflicts seem to result from mismatch between land use and environment. During the course of development of a zoo, changes in land use and the local ecology is inevitable. The change should be so planned and executed that it accommodates the requirements of the zoo without creating imbalance in the existing environment.

Prior to the design and development of a zoo, site information and design requirements have to be collected, organised (in the form of text and appropriate graphics) in such a way that it leads to a viable time bound design situation which should be practically executable. This should be done with a clear understanding of the management strategy over time. The final presentation should be in the form of scaled drawings, organizedsequentially to ease execution and management of the project. The information should be given in the form of drawings and documents.

Site planning for zoos will, principally involve five stages:

a) **Initial Decision Making:** Decision making process is carried out in conjunction with the local governmental authorities with regard to the location of the proposed zoo. It includes defining the issues and problems of concern including articulating the site specific zoo objectives, definition of alternative courses of action and organising of technical studies of the site/ alternate sites.

b) **Technical Planning:** The second stage involves detailed planning of various processes and services to support both decision making and design. Including but not limited to environmental inventories such as soil, existing vegetation, topographic surveys and assessing any heritage structures or structures of archaeological significance which will need to be integrated in the final layout of the zoo. This generally results in a Detailed Project Report (DPR).

c) **Landscape Planning and Design:** 'Planning' denotes activity zoning on the entire zoo site, while 'Design' refers to landscape decision on smaller areas and design of individual elements such as signage, railings, fences etc. After the decision making process and initial technical support studies work moves to design. Landscape design - mainly the domain of landscape architects but also indulged in by architects and planners - entails technical drawings showing uses, features, and elements that are to be built, changed, or preserved based on the earlier studies and the conclusions and recommendations there from.

   Subsequently, additional studies may be required. These may include storm water calculations, aquifer information and surface geomorphologic & sub-surface geologic conditions. As a result, site planning processes and the relationship among the three above mentioned activities is not a linear sequence but an interrelated activity requiring several iterations resulting in a check and balance relationship among the principle decision maker (the zoo operator the concerned government department/ municipal body or the zoo director), technical specialists (landscape architects, structural, electrical, security experts, veterinarians, zoo biologists, conservation educationists and specialist vendors) and most importantly the designer.

To initiate zoo planning and design, extensive and specific information about the site and all manmade structures on it is required to be collected. This is collected under the heads of 'Natural' factors and 'Manmade' factors on site. In both cases the information about the site of the zoo and its surrounding areas should also be recorded and shown on drawings.

The onsite and offsite data is systematically collected from primary and secondary sources depending on the site location and otherwise available site specific data. Once the data is collected it is organised in a form which makes it easy to refer during the zoo design process. Site related data is overlaid graphically on the site plan, each aspect wise. These base drawing are analysed and related aspects overlaid to arrive at site planning decisions. This process determines the most suitable location for each activity and structures.

Zoo activities include movement of visitors and their basic civic amenities. While zoo structures include enclosures, administrative and hospital buildings, roads, paths, etc. Every fresh activity and structure is an intrusion in the landscape. Therefore, all developments will entail changes in the existing ecology. The pros and cons of the intervention to the environment are evaluated and the actions which cause least damage to the environment while satisfying the design needs, form the basis of zoo layout.

The final zoo design is an outcome of accommodating the requirements of a zoo on the selected site. For this it is apparent that a thorough on foot reconnaissance is carried out andthe site is fully studied and understood in relation to ecological facts and aesthetic aspects. This requires the collection of data on all aspects of the site, gathered through a series of surveys about the following major and any other site specific informationincluding but not limited to:

i. History of the site

ii. Geology and Soils

iii. Vegetation

- Vegetation Character
- List of Existing Site Vegetation
- Native Vegetation According to Forest Type

- Administrative Status of Forest

iv. Hydrology
  - Drainage Characterises
  - Surface Water – Lakes, Streams, Rivers, Marshland
  - Sub Surface - Aquifer Information
  - Water Quality - physical and chemical characteristics

v. Topography
  - Landforms and Slopes

vi. Climatic Conditions
  - General Climatic Analysis
  - Site Microclimatic Analysis

vii. Existing Structures at Site
  - Service Lines
  - Drains, Manholes, Catch basins
  - Service Structures
  - Buildings, Roads and Paths etc

viii. Land Ownership Information

ix. Master Plan Regulations

x. Monuments/ Heritage Structures Within The Site (Or in Close Proximity)

After the data collection the site planning process will constitute of the following:

a) Determine the goals (vision documents) and objectives of the specific zoo
b) Data Analysis
c) Arriving at the problem statement
d) Reconciling conflicts
e) Conclusions and recommendations
f) Design Guidelines

This information is presented in a graphic form andsuitable scale for analysis. The analysis is pointedly directed towards the objective of relating the planned requirements of the specific site and the design brief as prepared by the client (zoo director and concerned persons). The design brief must be critically evaluated with respect to the site and discussed with the client to assess the design and cost feasibility. If the need be, specialists from varied scientific or professional fields may be consulted to arrive at a realistic programme.

Finally, a comprehensive design report is prepared which should serve as the base document for planning and design. The assessment study begins with the assembly of property information to describe both the zoo site and its relationship to surroundings and community.

At this stage a final 'Design Brief' is required from the client listing the requirements in terms of animal needs, needs for safety and security of animals, zoo personnel and visitors, the visitors' requirements; such as a detailed list of enclosures along with their sizes, physical requirements and all their ancillary spaces and structures. Besides, the basic requirements for effective scientific management of the captive animals within the zoo must be explained by the zoo managerial team.

This brief should include enclosure characteristics for particular animal species e.g. whether the animal requires level or undulating ground, a large water body (like in case of crocodiles or gharials) or any other specific vegetation type to satisfy the behavioural requirements of the particular species .

Once the site is selected and approved for a new zoo, or addition/ alteration are proposed for an existing zoo, the first step is to decide on the specific activities and enclosures that are required to be provided for according to procurement of animals based on the approved Collection Plan. The next stage is to decide on the placement of these activities and enclosures on the most suitable locations within the site. These decisions are to be taken on the basis of comprehensive study and analysis of site conditions as described above. The site conditions are then related to the project requirements in terms of available suitable areas, behavioural needs of the animal and the Central Zoo Authority standards. The conflicts are resolved on the basis of priorities to produce a concept plan. Concept plan is a full site document showing a comprehensive picture with regard to all aspects. The proposed grading, removal and addition of vegetation, showing alternate means of management of storm water if the natural drainage is disturbed.As a consequence, various elements such as roads, enclosures and structures are located so that they serve their function with minimum disturbance to the site environment and ecology. The information required to carry out site planning is listed further in this chapter.

Needless to add that there are formal and well established methods to collect, represent on drawings and analyse site data with respect to zoo activities and individual elements.

This procedure should be followed rigorously because it conveniently lead to results in terms of deciding location of enclosures, alignment of vehicular and pedestrian paths, on location service buildings and all other zoo requirements. Also because by following such methods any zoo designer will, reach more or less reach the same conclusions with regard to basic layout of the zoo at any specific location. For example, if a drainage pattern is shown on the survey plan no zoo designer will suggest to obstruct it with an enclosure.

The intention is to select areas from within the site which will accommodate the required enclosures/ roads etc. with minimum or no disturbances/ changes required to be made by way of remodelling of land, additional construction or cutting of existing trees/ or other vegetation. This will protect the ecology of the site and more importantly curtail avoidable expenditure.

Fig. 4.4

Fig. 4.4 & Fig. 4.5 Existing water bodies indicate two things; one that the area is a regional depression and second that the area provides a natural opportunity for water recharge and should be used for the purpose in the final layout design of the zoo.

4.2 SURVEY INFORMATION

Site surveys and the detailed information provides, comprehensive understanding of the zoo site. It helps in taking considered rational and data based design decisions which ensures sustainability after completion of the project. Besides the zoo planner and designer it is necessary that the concerned zoo director should have a clear overview of the information gathered through various surveys (even though the necessity for survey and the technical information required is determined by the designer and the consultant). This will ensure better understanding of the zoo design & execution process and will enable the zoo director to offer constructive suggestions.

A representative format for site data collection is given hereunder for use after applying site specific modifications.

4.2.1 Topographic survey

A typical list of information required from a topographic survey for a zoo is given here under. Additional information, as required for a specific site, may be asked for additionally.

a) Property Lines Data
   i. Alignment – either by triangulation or by angle measurement.
   ii. Boundary Dimensions.
   iii. Definition - Indication of how the boundaries are defined at site i.e., by wall(s), fence etc.

b) Bench Mark
   i. With respect to any existing structure at site.
   ii. Or with reference to the centre line level of the road at the centre of the road in front of the entry gate(s).

c) Spot Levels
   i. On a 5 mts. square grid. The grid should be aligned with any boundary wall. The grid size can vary and can be decided on the basis of the size of the zoo and the kind of landform within site. More the topographic variation smaller should be the grid size; say 5-15 mts. generally on ground level the grid size can be longer; say 15-20 mts.
   ii. Additional spot levels at all points where there is a sudden change in ground level of more than 0.5mts.
   iii. Centre line levels at every 5 mts. along the main road and along any other road.
   iv. Centre line invert levels, at 10 mts. centres, of:
   v. Drain, along the main road.
   vi. Drains, within the site.
   vii. Spot levels on grid upto 10 mts. outside the property lines on all sides of the property.

d) Orientation should be indicated by an angle in relation to any of the property lines.

e) Location/ Alignment/ Dimensions of the following:

   i. All existing structures on site along with their peripheral dimensions, plinth levels and top & bottom of all wall levels.

   ii. Locate all trees, with accuracy, in relation to the grid. Besides above, the location of all the trees having a trunk diameter of 20 cms. or above should be dimensioned on the survey plan along with the canopy size.

   iii. All constructed drains, if any, within the site.

   iv. Electric/telephone / any other type of posts / over-head and under-ground electric transmission or gas lines etc. along with the alignment of overhead lines within the site or along the main road.

   v. Location of existing lawn hydrants, sprinkler heads, catch basins, manholes etc., along with their invert levels.

   vi. Any other services within or adjacent to the site.

   vii. Right of Way and carriageway of main road and any other roads/ lanes, abutting the site.

   viii. Existing fences, walls & planters etc.

f) Area of the Site

The survey data/ drawing should be submitted as a soft copy by the surveyor using AutoCAD format along with 3 hard copies. Suggestions with reference to few important survey elements are:

4.2.2 Hydrological Survey

Large areas of zoos provide an ideal situation for water conservation. Large soft surfaces and easy collection of water from paved and other impervious surfaces can result in appreciable quantity of water being conserved. It should be realized that any expenditure incurred towards achieving efficiency in water conservation will always be more than adequately recovered in the long term.

Fig. 4.6 An example of an original site depression utilised as a design element to create a pool.

Water is required in large quantities for many zoo activities. As a result water management is of prime importance in the planning of a zoo. It may prove to be a key component in the ultimate success of a zoological park. Efficient planning and management of water has to be given high priority. To be able to place an efficient water management system in place, data relating to the existing water situation should be collected and represented in the form of figures and drawings. Water is required for the following purposes:

a) For animals - for drinking, for enclosure pools, for water animals for cleaning of enclosures, etc.

b) For staff and visitors - for drinking and use in toilets.

c) For landscape irrigation.

d) Water jets for emergency purposes including animal restraint and fire control.

e) For operation and management of various services

Water requirement in such large quantities is generally difficult to be served by municipal supply alone. As a result, water from surface water bodies or groundwater has to be extracted and used. This requires collection of existing groundwater and surface water data. This information will include the physical, chemical properties and the aquifer data. Large areas of zoos also provide an ideal situation for water conservation.

All zoo activities whether relating to visitors or animals will have to be located, avoiding areas susceptible to water logging. Adequate water availability of suitable quality will have to be ensured for visitor population and animals' needs. A representative inventory of water related information required for management of a zoo is given below:

Aquifer Information

Upto 200 ft. (minimum depth)

a) Identification of the drainage basin and water shed within which the zoo is located. (Should be marked on the contour plan)

b) High flood levels of stream or river in the vicinity of the zoo.

c) Water table depth and its seasonal variation.

d) Vertical and aerial extents of aquifer(s).

e) Groundwater flow direction.

Water Tests

Water tests should include the following information on the physical characteristics and chemical constituents:

Physical examination	***Units***
Date of collection	
Date of examination	
Colour	
Odour	
Turbidity	NTU
pH value	
Electrical conductivity	mmhos/cm
Total dissolved solids	mg/l

Chemical examination	***Units***	***Chemical examination***	***Units***
Alkalinity	mg/l	Chloride	mg/l
Total alkalinity	„	Copper	„
Total hardness	„	Iron	„
Carbonate hardness	„	Fluoride	„
Non carbonate hardness	„	Chromium	„
Calcium hardness	„	Cyanide	„
Magnesium hardness	„	Arsenic	„
Ammonia	„	Aluminium	„
Nitrite	„	Phosphate	„
Nitrate	„	Residual chlorine	„
Sulphate	„		

4.2.3 Soil Survey

The significance of soil in the designing of zoo is three fold. Soil information is required for selection of planting material- trees, shrubs, ground covers & creepers planting in zoo. While observation of existing vegetation in the vicinity may give a fairly good idea about the plants which will do well in that area but site specific soil data is still required since the site may have different characteristics; sometimes significantly different. It may just be that the site may have been a landfill area or the geological horizons (the parent rock may have dipped or risen suddenly, thereby increasing, decreasing the soil depth available for planting. The planting design will relate to the depth and type of soil available. In relatively large areas such as that of a zoo, there is no possibility of replacing unsuitable soil with select earthin large quantities. Therefore, the plant selection will need to be such that it suits the existing soil.

The second reason for soil study will be to ensure that the soil has the bearing capacity and is suitable for building foundations. The soil should not be susceptible to any kind of erosion especially in undulating terrain. Thirdly soil texture and structure is significant because it affects the movement of surface water and contractsinfiltration besides determining the potential of zoo area for water harvesting; in the large context for water management.

There are three ways in which soil related information can be gathered: the state soil map, by site reconnaissance, and by soil testing at site.

a) State soil maps do provide a lot of information (such as soil type permeability, porosity, pH etc.) but on a state scale at the site scale the variations may significant. State level soil map information is indicative but not adequate enough for taking design decisions.

b) Site reconnaissance enables first hand physical inspection and assessment of the soil and other clues for soil evaluation. Use of ordinary equipment like soil anger allows the designer to obtain soil samples which enables preliminary determination of soil colour, texture, horizons and other characteristics. Field observations can give a fair idea above the soil texture class. Site or field observation entails reading of class. Soil clues may include vegetation species and their general health and evidence of soil prone to erosion etc. These clues also provide a check for the accuracy of the formal soil testing.

On site scale projects involving the construction of enclosures, barriers, night shelters, boundary wall and other architectural buildings, carried through working drawings require detailed soil testing, borings, test pits data beneath and around the structures. Soil testing, carried out by qualified persons/ institutions, include tests for strength, stability under loading, compactability, erodability, permeability, pH value and fertility. This is being mentioned here because soil testing requires time, attention and money. But it must still be carried out to achieve a successful final zoo project.

c) Soil tests should include the following information on the physical characteristics and chemical constituents:

Physical examination	***Units***
Soil texture	--
Soil porosity	%
Bulk density	gcm^3
pH value	--

Chemical examination	***Units***	***Chemical examination***	***Units***
Macro nutrients	mg/l	Micro nutrients	mg/l
Hydrogen	,,	Sodium	,,
Carbon	,,	Iron	,,
Oxygen	,,	Aluminium	,,
Phosphorus	,,	Silica	,,
Potassium	,,	Copper	,,
Calcium	,,	Molybdenum	,,
Magnesium	,,	Zinc	,,

Note: For both water and soil a minimum of 5 samples should be taken from the site. The number of samples should be decided considering the size of the site.The locations should cover the entire site.

To understand the site, full information regarding ‘Natural factors’,other than water, is required. It comprisesof various site-related landscape features relevant to a specific project location. These will comprise of (but not limited to) the data regarding the following:

4.2.4 Vegetation Survey

An exceptionally important prerequisite to zoo designing is the recording of information about the existing vegetation at site; particularly the trees. This is to ensure that the design is done to ensure that no tree will need to be cut; and if some trees are required to be removed then the design has full information about them to allow him to take the requisite statutory permissions for felling/ lopping of the tree as per the local rules/ guidelines/ instructions applicable in the area. No tree can be cut without the mandatory prior permission; whether the tree is located within public land or a private plot.

Vegetation survey can begin with examining the Google earth image of the site. This will providethe latest, authentic and good resolution image for getting preliminary information about site canopy coverage on site. This then needs to be followed up with site reconnaissance and formal vegetation survey. Vegetation survey begins with a quadrat/ transect survey of the site. Quadrat survey refers detailed surveys of small pockets within the site. A detailed explanation is not being provided here because the zoo director/ designer just need to be aware of this ‘stage’; the actual vegetation data collection will be done by the concerned consultant. A representative list of information gathered from the vegetation survey will include but may not be limited to the following:

a) Name of tree
b) Height
c) Girth
d) Canopy size (spread)
e) Frequency, density & ground coverage
f) Health condition - Diseases, pests afflicting the tree.

Existing vegetation can be divided into trees, shrubs, ground cover and creepers. Besides trees,comprehensive survey of herbaceous undergrowth is required to record the existingvegetation. Information relating to areas under tree canopy cover, shrubs, ground covers, vegetation type, condition (whether diseased etc), density will need to be co-related and analysed to come up with a design solution which will protect the existing vegetation. Well-formed or rare trees should be retained and protected, any poisonous species or species which may be harmful to the captive animal(perennially or seasonally) should be systematically removed from within the zoo area to protect the animals as well the visitors/ staff.

4.3 LAND OWNERSHIP INFORMATION

The following information needs to be collected:

a) Address/ local area map

b) Property description

c) Deed conditions, restrictions, or covenants that could affect future use and enjoyment of the property

d) Records of easements appurtenant (usually providing access to or through the property or adjoining properties)

e) Public road frontage and property access information

f) Contaminating conditions

g) Adjacent properties& their ownership, land uses and their proximity to zoo boundary

h) Probable off – site easements required for road and utility construction

4.4 MASTER PLAN REGULATIONS

In case the zoo site falls within urban limits or an area which is controlled by master plan regulations, it becomes incumbent on the designer to be aware of them and follow the statutory mandate.

Some related master plan information which will help the designer is:

a) Proximity of major travel and commuter routes, both existing and planned

b) Planning zoning and related development information

c) Aircraft flight paths / flight funnel area and noise contours

4.5 CLIMATIC AND MICRO CLIMATE DATA

Climate, in the form of precipitation, relative humidity, wind speed and direction, pressure and temperature, influences human and animal comfort, vegetation and activities. As zoo designer we are concerned with providing comfortable outdoor environment throughout the year for animals primarily, and also visitors. Cost of providing comfort within buildings by artificial means is prohibitive. Therefore zoos should be designed in the most comfortable environments, and if necessary the site should be modified to achieve comfort.

Fig. 4.7 Areas of such exposed rock outcrops will have much higher temperatures and radiated heat as compared to adjacent areas covered with ground vegetation and trees canopy. such area are unsuitable for enclosures - both because of heat/ cold and extreme difficulty in planting.

What is required to be focussed on is the micro climate of the site; i.e. the climate factors as they transform themselves at site. The values of microclimate may be at variance with the general regional values of climate components. This is because of the sites local topographic conditions, forests or wind breaks in the vicinity of the site and local situations which may affect reflectivity and radiated heat, in case the zoo is within an urban area. In such situations it will be the microclimate of the site which will influence layout and design of zoo.

The type of data gathered depend on the type an scale of project. For large zoo projects with sites having considerable topographic variation the designer needs to understand the landform thoroughly along with the wind speed and direction; along with vegetation masses and any other site conditions that may effect micro climate. Vegetation provides shade and can intercept the absorb 60% to 90% of incident solar radiation. Dense foliage, multiple foliage layers, or dense canopies obstruct solar radiation, whereas plants with open, loose foliage filter radiation. The surface temperature in shade (and consequent air temperatures) can be reduced significantly by shading. Oppressive levels of radiant heat are generated by such surfaces even after sunset. In addition to their ability to raise the temperature of the proximate air mass, can have a profound impact on perceptions of comfort.

The slightest change in microclimate may make the site unsuitable for enclosures or buildings. There was an instance when the entire design for a night safari was done and drawings prepared for execution based on relevant criteria. But the geomorphologic condition (Distributed areas of rock outcrops and the consequent radiated heat and severe reflection) was inadvertently overlooked. At the last stage just before execution on physical reconnaissance of the site, it was realised that the animals will be unable to survive on some of the areas that were delineated for enclosures. The design had to be modified. The site otherwise was visually beautiful and ideal for a zoo but a small slip resulted in a lot of reworking. This real instance is in support of the argument that microclimate aspects and site planning needs to be attended to very seriously.

4.6 MONUMENTS/ HERITAGE STRUCTURES WITHIN THE SITE (OR IN CLOSE PROXIMITY)

Many zoo sites may have monuments or heritage structures within the site or in close vicinity. If some of them are protected monuments then any development or construction will have to conform to the related laws. Otherwise these structures should be integrated in the layout of the zoo. Areas around the monuments which are within the site should be suitably designed so that the visitors are able to view them and learn about the historic context of the site. Those heritage structures/ monuments which are in visual proximity of the site should be integrated in the layout so that the monument integrates with the layout. Infact, if well designed, it should enhance the aesthetic value of the zoo when historic / heritage structure is made visible from various roads, paths and other open areas within the zoo.

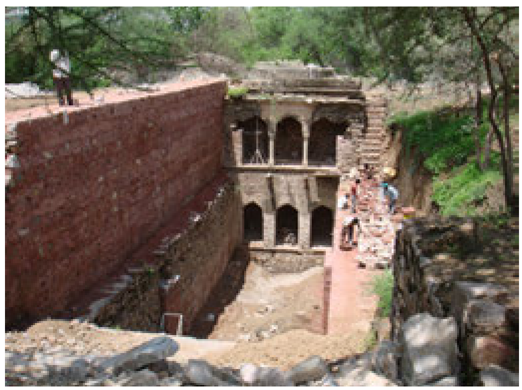



Fig. 4.8 & Fig. 4.9 All heritage structures, which will include specimen trees, of which there are many in Indian zoos, should be integrated with the zoo design.The above example is a part of the Nahargarh Biological Park, Jaipur

'Design' factors (alternatively referred to as 'Design brief') describe the functional and aesthetic design requirements.These will include but are not limited to the following:

a) Access
b) Surrounding landscape uses
c) Buildings and underground and overhead services
d) Visual character as influenced by the surrounding landscape and architectural development.

e) Vehicular, pedestrian circulation and parking requirements

f) Animal enclosure requirements

g) Open space activities

h) Visitors facilities

It needs to be understood that site planning has aspects which are objective and factual in nature and those which are subjective and experiential along. There are occasions when decisions are based on professional intuition. It the case of former the evaluation based on a fairly standardised methodology elicits more or less uniform responsesfrom all. In case of subjective aspects the response will obviously be based on the type and quality of the experience of the concerned specialist. But this input should not be underestimated because often it may be significant.

In conclusion, all site related information should be presented in the form of drawings, documents or diagrams. No information given in one drawing or document should be repeated in any other drawing/ document. This is to avoid confusion and misinterpretation. Documents contain information which cannot be presented in the form of drawings and vice versa.

This method avoids any missed information and provides easy reference. Further details on this aspect are exemplified in chapter no. 5

Environmental Impact Assessment (EIA)

Since natural resources are depleting at an accelerating rate it becomes incumbent that the use of natural resources is optimizes through internalising the environmental considerations in the design process and the execution methodology.

All zoo projects have a significant impact on the onsite environment. Existing landforms, drainage patterns, vegetation and even the animal and bird habitats are affected. Therefore it becomes morally and professionally incumbent on the designer to evaluate the consequences of the proposed changes on each element on the site.

a) Predict any change in each environmental constituent

b) Identify the scope of any change on each environmental descriptor

c) Determine the implications or significance of the anticipated change on each element.

As a result, whether mandatory or otherwise a comprehensive environmental impact assessment should be carried out. There are projects in which EIAis imperative as directed by the concerned legislation. It is advisable that appropriate action should be taken by the concerned zoo authorities as per the applicable Rules / Guidelines in the subject matter at that point of time and location of the site.

Fig. 4.10 In most places water is now a scarce resource, to be utilised with extreme restraint. Any place blessed with available natural water can utilise it to create a beautiful enclosure setting. In the above pic the edge construction could have been hidden to improve the enclosure appearance.

4.7 WATER RESOURCE MANAGEMENT FOR ZOOS: STRATEGIES & METHODS

The first step is to ensure the perpetuity of zoos by a self-sustaining design. Everything which hinders this objective will have to be addressed and resolved. The advantages of zoos for the regional ecology, for visitors & animals should be highlighted. Water is an ideal core subject around which we integrate so many important environmental issues.

There has over the last three decades, evolved a strong link between water management, conservation and zoological parks. Zoological parks can be utilised for water conservation for use of water for themselves and even conserve water for the use of areas outside its boundaries.

Zoological parks are almost always located within or near urban conglomerations. Yet large areas available within zoos can be used for effective water management & conservation practices after suitable treatment. Therefore the proximity of zoological parks and areas presents a symbiotic relationship. Urban Areas can provide visitors, earnings and easy access to technology & infrastructure while the zoological parks provides the ideal landscape and vegetation covered surfaces for conserving water and implementing water-harvesting schemes.

Earlier, in the context of zoological parks, water was thought of more in terms of ‘requirements’ and ‘disposal’. Disposal even now, has the same two aspects – the first, relating to large volumes of stormwater removal and the second relates to draining away of sewerage and waste water. Water requirements for zoos, have increased in recent times; largely in context of devising master plans enabling animals to be displayed in habitats that simulate the natural territoryand for providing water for pools for water related species.

Fig. 4.11 Biological treatment of water within the zoos should now gradually become the norm. Such storm water swales with suitable vegetation and gentle slopes (to reduce flow velocity) provide one method.

Water scarcity has become a serious contemporary concern. Earlier perceptions have changed drastically and water is now viewed as a holistic objective of management.There has been a significant change in the perception of water as a design element. Water disposal is taken as an opportunity for water management, conservation and harvesting. Now even sewerage & wastewater is being treated and recharged into underground aquifers or even reused. This has resulted in attention being focussed on the role of zoological parks as elements of utility rather than as large underutilized areas. In terms of zoo design this may result in zoos having sewage treatment plants as an essential requirement. Contemporary objectives onuses which are now being focused upon are for conservation, landscape and education.

In recent times there has been increasing interest and extensive discussion about the role of zoos in urban planning. The National Zoo Policy, 1998 has envisaged conservation education as one of the major objectives of the zoos in the country. Education has been recognized by the World Association of Zoos and Aquariums(WAZA) as a primary function of zoos. If the world and Indian zoos in particularare to be hospitable to the present diversity of life on earth, the world population of humans need to be bio literate and scientifically enlightened. Empathy towards animals and their habitats need to be ingrained through early education and exposure. Zoos can no longer be just collections of large and charismatic animals, otherwise critics will increasingly challenge their existence. They have to become a significant part of culture of conservation. Here, the water usage in the zoo can be utilized for conservation education to carry home the message of sustainable development.

Zoological parks will serve this purpose well since their area is large and water conservation will result in appreciable quantity of water being conserved. The strategy for water management and conservation will lie in well designed and suitably located water retention and detention structures for infiltration and on site use of water.

Water planning for zoological parts can be considered under the following heads:

a) Water Requirements
   - i. Potable water for
     - Animals
     - Staff
     - Visitors
   - ii. For existing vegetation
   - iii. For animal habitats
     - Essential
     - Non essential
   - iv. For amenity use

The above water requirements are fulfilled by Municipal water supply, groundwater extraction, water harvesting, and treated waste water.

Water management and conservation in zoos will relate to both the qualitative and quantitative aspects. Serious problems of contamination are not expected from zoological parks. Normal expected pollutants in zoo water should be treated within the zoo premises, either by bio treatment or the use of treatment plants, before being used or disposed.

Large areas, over which most zoological parts are laid out, may either have inherent water logging problem because of existing topography or may result in such areas after development. Landscape development and other construction activity during zoo construction or re development, effect surface changes which result in changes in alignment of existing water channels, water levels of surface water bodies such as streams, ponds, lakes, reservoirs and at occasionally of rivers. This is a result of modification of permeability, infiltration rates and runoff volumes and rates. The quantum of change depends on the intensity of development and how well water management has been addressed..

The quantity of surface runoff will be increased typically because of increase in area of pavements and reduction in vegetative cover from its original situation.

Another problem in zoos is that of disposal of waste water from wet moats. This could, with minimum treatment, (as required after testing), be used for irrigation since it will be rich in organic content.

Areas having high water table and those which are low lying can be managed by various means such as changes in landform and designed planting which will encourage a substantial increase in evapo-transpiration. In situations where ordinary approaches do not work the expensive alternate of sub surface drainage may be resorted to.

b) Planning & Technical Aspects Relating to Water Management and Conservation of Zoos Can be Listed as Follows:

i. Quantification
   - Water requirements.
   - Stormwater discharge.
   - Sewerage and waste water volumes with and without treatment.

ii. Quality standards for water which will be drained out so that there is no negative impact on the aquifers groundwater or surface water bodies. Particularly attention would need to be given to the water being received from animal cage hose down and moats so that it does not contaminate through high faecal coli form counts.

By way of storm water conservation zoological parks provide an ideal situation because of following reasons:

i. Large areas for receiving precipitation.

ii. The relatively dense vegetation particularly lower storey provides for reduced runoff velocities encouraging infiltrating of water into the aquifer.

iii. Space availability for first flush collection of stormwater and to provide flow equalisation when required.

iv. Opportunities for trade/ collected water for being used for a wide range of uses having varied quality requirements.

4.8 SITE PLANNING CHECKLIST

Site planning is an extensive exercise which requires authentic and comprehensive true to site data. Any deficiency in data can lead the designer to commit error in a design layout or may lead to actions at site which may damage the very character of the site for which the site was selected in the first place. Example of such an instance is where a wrong decision in cutting or filling could destroy vegetation and lead to large part of the site being left bare and deprived of all vegetation and topsoil for years together.

It is essential that data should be collected for all site specific aspects and no facet which may have an influence on the site design should be overlooked. It is precisely for this reason that there should be a compiled list of concernsto ensure that nothing, affecting the site, is overlooked.

A representative list for reference is given below:

1. Legal
    - i. Plot or boundary line survey
    - ii. Dimensions and alignments
    - iii. Easements
    - iv. Right-of-way lines
    - v. Acreage
    - vi. Oil and gas transmission lines
2. Restrictive covenants or deed restrictions
3. Existing land uses and buildings
4. Zoning (existing and proposed)
    - i. Permitted uses or special exceptions
    - ii. Density
    - iii. Setbacks/height limits
    - iv. Coverage
5. Planning Data
    - i. Adjacent land uses
    - ii. Utilities
        - Water
        - Sewer (storm and sanitary)
        - Gas
        - Electricity

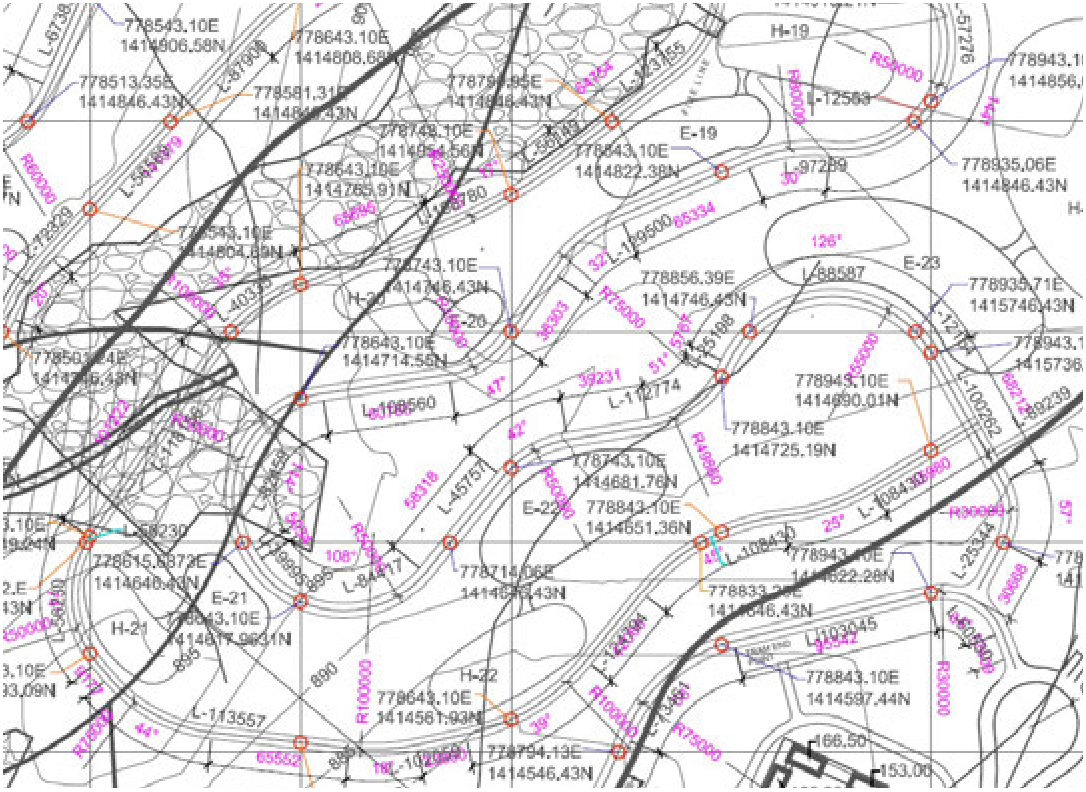
6. Roads, alignment and rights-of-way (existing and proposed)
    i. Major thorough-fares and free-ways
    ii. Primary arterials
    iii. Secondary collectors
    iv. Tertiary streets
    v. Service drives
7. Public parks, green areas and open spaces
8. Environmental
    i. Topography: minimal 2 ft interval
        - Slop analysis
9. Drainage
    i. Off-site considerations
        - Watershed: above and below site
        - Existing development in watershed
        - Proposed development in watershed
        - Potential impacts
10. On-site drainage characteristics
    i. Drainage patterns
    ii. Swales
    iii. Existing inlets, culverts, or drains
    iv. Areas of erosion or siltation
11. Hydrology
    i. Surface water
        - Existing and intermittent water courses
        - Floodplains
    ii. Subsurface: water table and aquifer
12. Vegetation
    i. Tree cover: types and species
    ii. Understory
    iii. Ground cover
    iv. Data regarding forest type

13. Geology and soils
    i. Surface soil characteristics noting high shrink/ swell soils or high water table
    ii. Subsurface geology: noting bedrock and depth to frost line
14. Climate
    i. Precipitation: annual rainfall and seasonal variations
    ii. Solar analysis
    iii. Wind: direction and velocities

The development of the data outlined above is critical to intelligent site planning and it will also be invaluable in the event of site-related litigation.

Fig. 4-12 This picture (from Rajasthan, India) effectively illustrates the significance of sub surface geology for load bearing structure and water retention capacities.

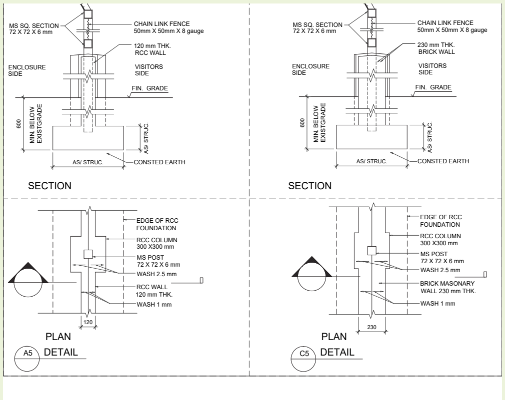
Fig. 4-13 This was the view of the site before zoo constrution and development began.
The view after completion should be very similar - that is the hallmark of good site planning. This can be achieved by adhering to the principles of site planning respecting the site conditions and resources.



CHAPTER 5

Drawings and Documents

Presentation Sequence
Drawings
Documents



Zoos in India had traditionally been developed and constructed on the basis of unscaled sketches, diagrams and personal instructions given at site by concerned individuals. Most zoos in India, in the last many decades, were created in this manner.

CHAPTER 5

Drawings and Documents

5.1 INTRODUCTION

Zoos in India had traditionally been developed and constructed on the basis of unscaled sketches, diagrams and personal instructions given at site by concerned individuals. The 'design persons' were generally those who were associated with zoos in some administrative capacity; generally serving or retired zoo officials. While they had the required knowledge about animals and zoo management they had no formal background, by way of qualification or exposure, with regard to technical drawings and numerous other professional disciplines which are required for a successful design, and construction of a large project such as a zoo. Most zoos in India, in the last many decades, were created in this manner.

As a result the site assessment was intuitive and not a result of scientific site data collection and analysis. As a result the information required for preparation of formal documentation with regard to items of work of various trades, the labour involved, quantities of material and precise specifications was based on an individual's intuitive perception and personal untested experience. Consequently, budgets and bill payments were imprecisely executed. In brief, there were no formal drawings or documents for the project to enable it to be properly budgeted, designed and executed.

This situation is now in transition. In contemporary professional state of affairs the number of specialized disciplines has increased and formal drawings and documents have become a necessity to secure against any subsequent queries or maintenance needs. Even otherwise drawings and documents are required if the design vision of the zoo designer is to be realisedand constructed on the ground. All zoo projects today are a result of an intense collective effort and specialized professional inputs even if the designer (a professional landscape architect/ architect) is an individual.

For every design communication formal true sketches and scaled drawings based on precise specifications are essential. This is for each specialized discipline involved in zoo design; enclosure & barrier design, architecture, storm water drainage, electrical, lighting, security services and all the rest.

While the project may be a zoo but the speciality disciplines required for design and execution of the project are the same as for any other engineering, architectural or landscape project. Such a project requires professional qualification, expertise and experience in many allied fields including quantity surveying. A quantity surveyor is responsible for preparation of essential documents such as Expression of Interest (EOI), Bills of Quantities (BOQ), specifications and agreement, tender drawings and documents. These documents maintain financial and project management control to ensure successful completion of the zoo project. All drawings and documents (and therefore the project) are based entirely on the original design brief of the client and the zoo director (in case he is not the primary client).

The process begins with the ‘in principle’ decision taken by the political leadership, concerned government/ municipality or an institutional developer to create a new zoo or undertake additions/alterations to an existing zoo. This can be termed as a responsive decision, in so far as it is in response to various political/ administrative/ environmental or wildlife considerations. This should be followed by what can be termed as an ‘envision document’. This document explains the idea, and the vision behind what is intended to be done. It will spell out what kind of zoo is conceived, which group of animals are proposed to be housed, is the primary purpose display or is it intended to have any other kind of design thrust(i.e the intention may be to have a state of art zoo with the latest design & technology inputs). Envision document will be an outcome based document, describing what should be the content and form of the desired result. The document will portray the quantitative and qualitative outcome of all aspects of the proposed zoological garden. Envision document becomes the base document for all subsequent, design, execution, policy and funding decisions in immediate and long term future. Any further review or restart of the project after a break (even of years) or decision of phasing will require reference to the envision document.

Next stage will spell out exactly and specifically the intended requirements of the proposed zoo. This is explained in the form of a design programme which will describe in detail the derivatives required from the project. These will include the following but may not be limited to the list below:

a) The physical requirements: The list of enclosures required for the animals as indicated in animal collection plan - may be with a provision for anticipated future expansion. The areas wanted to be provided for; this will be beyond the minimum specified by the Central Zoo Authority. The larger areas may be suggested because of site considerations related to topography or to present a more naturalistic enclosure design.

b) The qualitative requirements: These will indicate the exact location of various enclosures and other facilities on the specific site.

c) The attempt to make the zoo project green: Design to get green ratings from LEEDS or GRIHA.

d) The use of pollution less vehicles etc:

Subsequent to these basic directive recommendations the decision regarding the method of selection of an agency for awarding the project has to be taken. The options could be that the concerned government authority or the private zoo developer does it 'in house' or the project can be thrown open to public in a planned & sequenced manner to select an appropriate agency for executing the zoo project.

Thereafter, various options are open for proceeding with the work. These options include: an advertisement in the media inviting expression of interest from interested individuals, suitably qualified and experienced architects, landscape architectural firms or consortia, invitation to shortlisted professionals or the award of work to a suitable experienced government agency.

With the rapid technological development taking place in the world, various new materials are being introduced in the market, rapid development in animal care and fresh ideas being generated in the design fields including that of zoo's. It will,therefore, be desirable and progressive to throw an open competitive invitation for design addition/ alteration of zoos.

A brief explanation of the documents mentioned above may help in understanding and acceptance of the proposed sequence.

The process of selection of the zoo architect may constitute of a single stage or two stages. The selection in a two stage process will be done on an 'idea basis' and on 'experience basis'. This stage may be divided into two stages where initially only the concept is asked for. The submissions are then evaluated and shortlisted on the basis of the designers approach and the ability to satisfy the clients vision and site suitability. Persons whose concepts are shortlisted are asked to proceed with a detailed submission which will include the landscape layout along with the detailed layout of enclosures and other buildings within the zoo. The last submission will also include the general specifications, indication of materials and a preliminary budget estimate.

The EOI (Expression of Interest) notice serves to inform concerned professionals at large of the proposed project and is therefore likely to provide the maximum options for selection of the designers.

Any zoo project will require information for administrative approval, sanction and subsequent execution in the forms of graphic (drawings) and documents. After the short listing and selection of the zoo designer a series of interaction are carried out between the designer and the person/ organisation/ govt. who has initiated the zoo project. This is to ensure that the requirements of the client are unambiguously understood by the designer and the subsequent design work proceeds smoothly and there are no surprise deficiencies in the architectural design or landscape planning after it reaches an advanced stage.

This is ensured by breaking up the zoo design work in stages. Prior to this a design program is prepared which identifies the physical requirements and the requirements to ensure the maintenance of ecological balance and sustainability. At this stage a preamble is prepared detailing the expectations of the client from the designer the design thrust and priorities that are expected from him. For example the client's priority may be to protect the existing natural forest vegetation at site, to ensure the protection & conservation of existing water bodies or even to ensure that disturbing elements such as parking is not visible or heard from within the zoo.

At the end of this a detailed project report (DPR) is prepared which encapsulates the details of all aspects of the project which further ensure that such experience projects do not veer away from the original vision, which is often the case, as the project progresses through various stages of preparation of drawings/ documents and execution.

The documents are prepared by a quantity surveyor, of course under the supervision and responsibility of the concerned professional designer to whom the work is awarded. These are specialised texts having significant and extensive legal implications. This justifies and makes it mandatory to be undertaken in a formal way by qualified and experienced persons.

The zoo project will require other specific specialists which will in all probability form a part of the 'designers' company. These specialities will include veterinarian, zoo biologist, conservation educationist, electrical, plumbing & mechanical engineers, zoo security experts, groups specialising in electronic/computerisation of zoo management systems and daily and periodic collection and maintenance of records, professional photographers CCTV installation, management experts and ecologists. Besides specialists in sustainability, animal behaviour, genetics and bio chemists.

The Information from all the above specialists will again be required to be included as project information in the form of drawings, text documents and schedules/ tables.

On collection and analysis of data, the following sequence of drawings and presentation is followed:

5.2 PRESENTATION SEQUENCE

a) **Design Brief:** A design brief from the Zoo Director along with other officers concerned with the zoo establishment is obtained. The design brief should list the animal collection plan, space requirementsof structures and activities of animals, visitors & staff, other design ideas and avision/ concept statement (the real zoo as visualized by the client). (Refer CZA publication 'Zoos in India').

b) **Concept Plan:** Should include all design intentions with regard to layout including circulation and enclosures, planting materials, services, security system, disaster management and all aspects related to the specific zoo.

c) **Preliminary Plan:** This should show all what is shown in concept planin greater detail.

d) **Final Master Plan:** Should show everything indicated in preliminary plan accurately and to scale.

e) **Comprehensive Landscape Development Plan:** This will be a set of working drawings specifying the location and sizes of each landscape element.

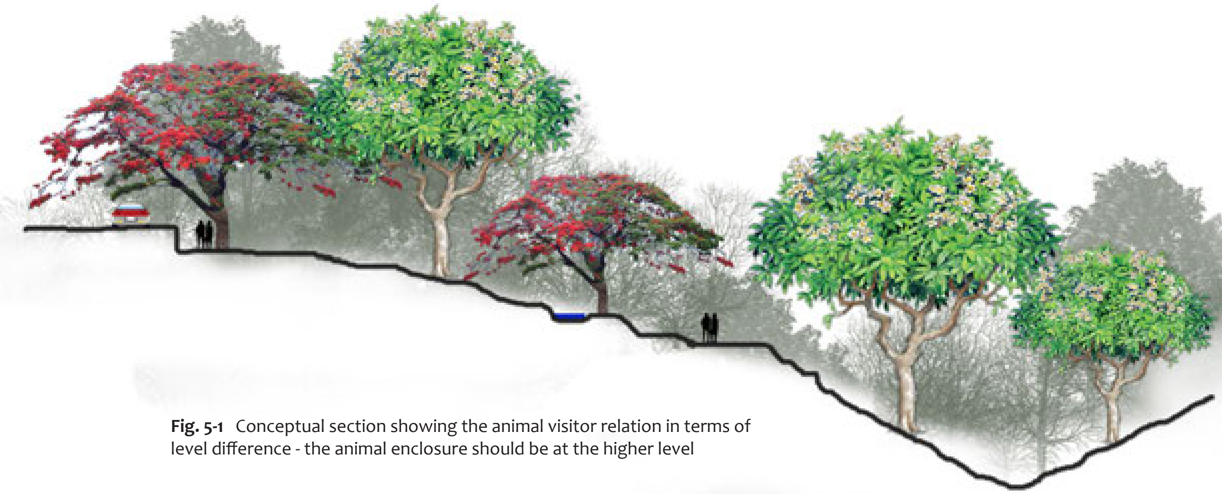


Fig. 5-1 Conceptual section showing the animal visitor relation in terms of level difference - the animal enclosure should be at the higher level

Fig. 5.2 Geodesic dome is a viable option for zoo structures with innumerable design possibilities. This structure covers the maximum volume with minimum weight of the structure. This large structure can be constructed in a short time with small structural elements.

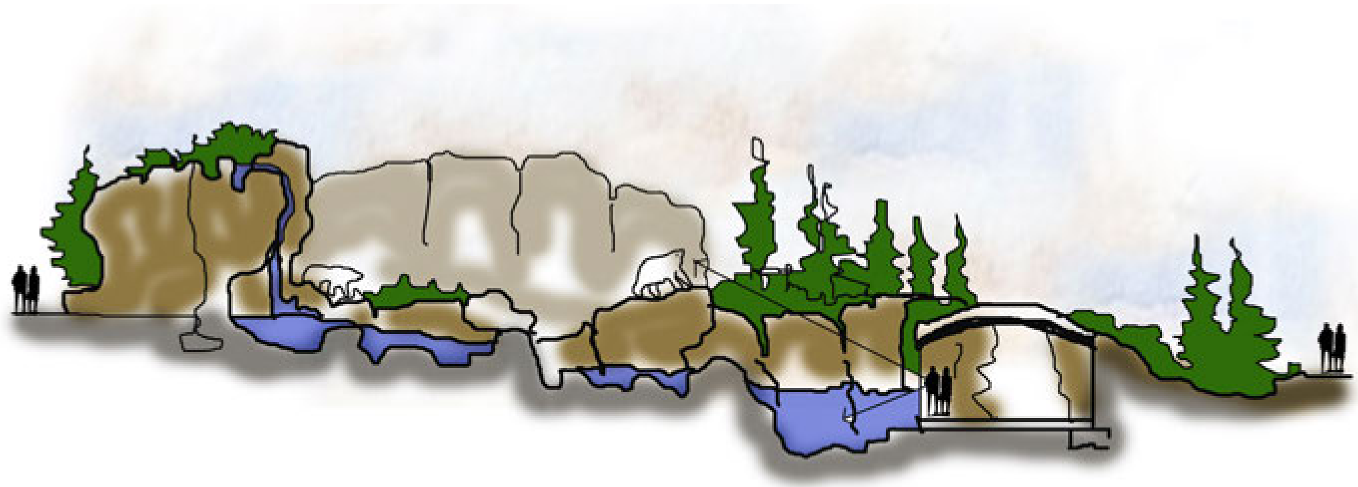


Fig. 5.3 Conceptual drawings should in scaled drawings showing actual condition in a presentation style. to be understood by a lay decision making authority.

Comprehensive Landscape Development Plan (CLDP) should include the following information in the form of a plan:

a) Updated base plan

b) Circulation

c) Vehicular

- Pedestrian Roads and Parking
- Trails

d) Cycle Track

e) Fire Tender Circulation

f) Service Circulation (Vehicular)

g) Vegetation Pattern & Layout

- Trees
- Shrubs
- Ground Covers

h) External lighting including electrical substation and service buildings

i) Open Spaces

j) Public Amenities - Toilets, drinking water points, food courts, kiosks etc.

k) Water Elements

l) Hardscape and Softscape areas

m) Street Furniture

n) Landscape Furnishings
o) Landscape Finishes
p) Grading & Storm water drainage
q) Site Sections

5.3 DRAWINGS

5.3.1 Architectural and Structure Drawings

Architectural drawings are means of communication by which the professional designing the zoo (landscape architect/ architect) conveys precisely what is to be executed/ built, method and sequence of building along with the specifications of materials, finishes and workmanship.

The architectural drawings show the layout (the location) and levels of all elements to be built. These elements include boundary walls, enclosures, roads, paths, drinking water facility, fences, all structures etc. Architectural drawings are technical drawings as distinct from sketches or diagrams. Set of architectural drawings is categorized as:

a) General
b) Plans
c) Elevations
d) Sections
e) Large scale views
f) Construction details
g) Schedules & diagrams

During the preparation and subsequently during co-ordination, all drawings of all disciplines; architectural, landscape, plumbing, electrical etc. are fine tuned to ensure that there is no ambiguity or contradiction anywhere in the set of drawings.

5.3.2 Interior Drawings

All buildings, such as interpretation centre, veterinary hospital, administrative offices, etc. Will require drawings showing the interior layout, wall finishes, flooring material and pattern, electrical/ planting layout, etc.

5.3.3 Landscape Drawings

Large percentage of all Indian zoos is 'open area'. The extent of open area in Indian zoos ranges from the minimum mandatory of 30% (as per the CZA norms) to any amount of open area left depending upon the situation of each specific zoo. A large area left open could be due to existing vegetation or forest cover or as a result of alignment of roads/ paths and enclosures. An abnormally large distances between enclosures and open area spread over the entire zoo, without any activity or special interpretative facility to engage the visitors in this stretch of green belt/natural landscape should be avoided, because it makes the visitors traverse longer distances and lead to boredom or alienation.

Generally one finds very large open areas in zoos whose topography, surface water bodies or source mandatory regulation do not allow additional development. Open areas fall under two major categories - natural open areas or designed open areas which form an integral part of the zoo planning and design. Natural open areas, such as forested areas or areas with dense shrubs, are protected to perform defined environmental functions (generally ecological in nature) while designed landscape spaces cater to the functional requirements. No specific drawings are required for areas under existing natural vegetation. Exception may be where method of planting is specified to add or augment planting in areas where vegetation has been eroded or cut by human interference.

The protection of natural areas and the design and development of all other open spaces require detailed technical landscape drawings to cater to various activities of the zoo. These drawings, specify to the minuets detail, the soft areas (landforms - lawns, planting etc.) and the hard areas (pavements and structures). The preparation of landscape drawings begins after the completion of data collection and analysis.

Landscape drawings, (all landscape drawings, without exception, should be to scale) in a typical zoo design project, should include information with regard to the following:

a) **Preliminary landscape development master plan:** and associated sections, elevations & general specifications (for initial approvals and sanction from competent authorities). This drawing should include the complete layout of the zoo including but not limited to the roads, visitors paths, enclosures, all buildings (administrative office, hospital, stores etc.), layout of major vegetation, service structures (electric sub stations etc.) and surface drainage channels. Generally this drawing should be colour rendered for clarity and easy understanding even by non-technical officials.

b) **Final landscape development master plan:** (This drawing should incorporate all suggestions and recommendations given by the evaluating committee and/ or competent authority). This forms the basis for all future design decisions over the entire extended period of the zoo development and construction.

c) **Layout drawings:** Showing, with dimensions, placement of landscape and architectural structures, roads, paths, parking areas, steps, pergolas, water bodies, planters, walls, fixed furniture etc. along with surface structures of underground services (manholes, catch basins, earthing pits etc).

d) **Grading plan:** Showing existing and proposed grades and levels.

e) **Storm water drainage layout:** Layout of surface structures of underground services such as catch basins, manholes, drain inlets, retention & detention ponds etc. (excluding the engineering information which is provided by the plumbing engineer as part of engineering drawing set.)

f) **Planting plan(s) & planting details:** Showing the pattern and types of trees, shrubs, creepers, ground covers, and lawns.

g) **External lighting & electrical layout:** Showing layout (position) and type of lighting fixtures, audio fixtures (for information dissemination and emergency warnings), closed circuit television system (CCTV), security systems, monitoring system, intercom etc.

The engineering information is provided by the electrical engineer as part of engineering drawing set.

h) **Irrigation system layout:** Showing irrigation system layout including co-ordination and checking with irrigation system consultants/ vendors. The engineering information is provided by the irrigation vendor/ plumbing engineer as part of engineering drawing set.

i) **Graphic design and signage:** Showing the layout/ placement of all kinds of signage (ref. 'Signage' in chapter 6 for details). 'Graphic design' is the artistic part as distinct from the content/ message of the signage. The shop drawings and engineering information is provided by the vendor/ fabricator as part of shop drawings.

j) **Landscape structures and features:** Showing the design and details of sculptures and animal forms (of stone, cement concrete, fibre glass, mild steel, brass etc.)

k) **Landscape drawings for co-ordination of all services:** Wiring and structures of all overhead and underground services constitute a dense network. This needs to be organised in a way where none of them interferes with the functional working of any other. The location of all surface structures of all services is co-ordinated and shown on the drawing.

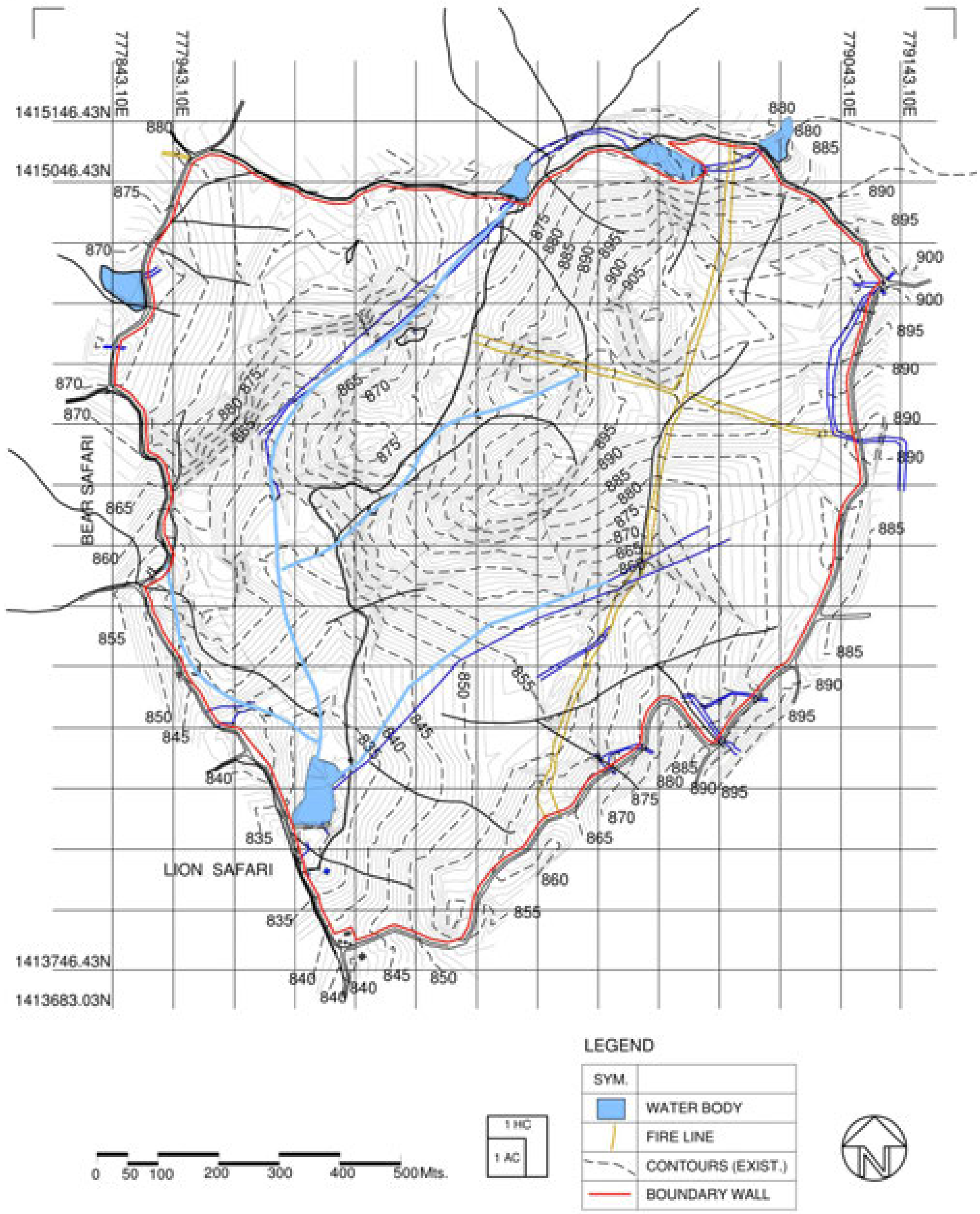


Fig. 5.4 (ILLUSTRATIVE DWG.) SURVEY PLAN

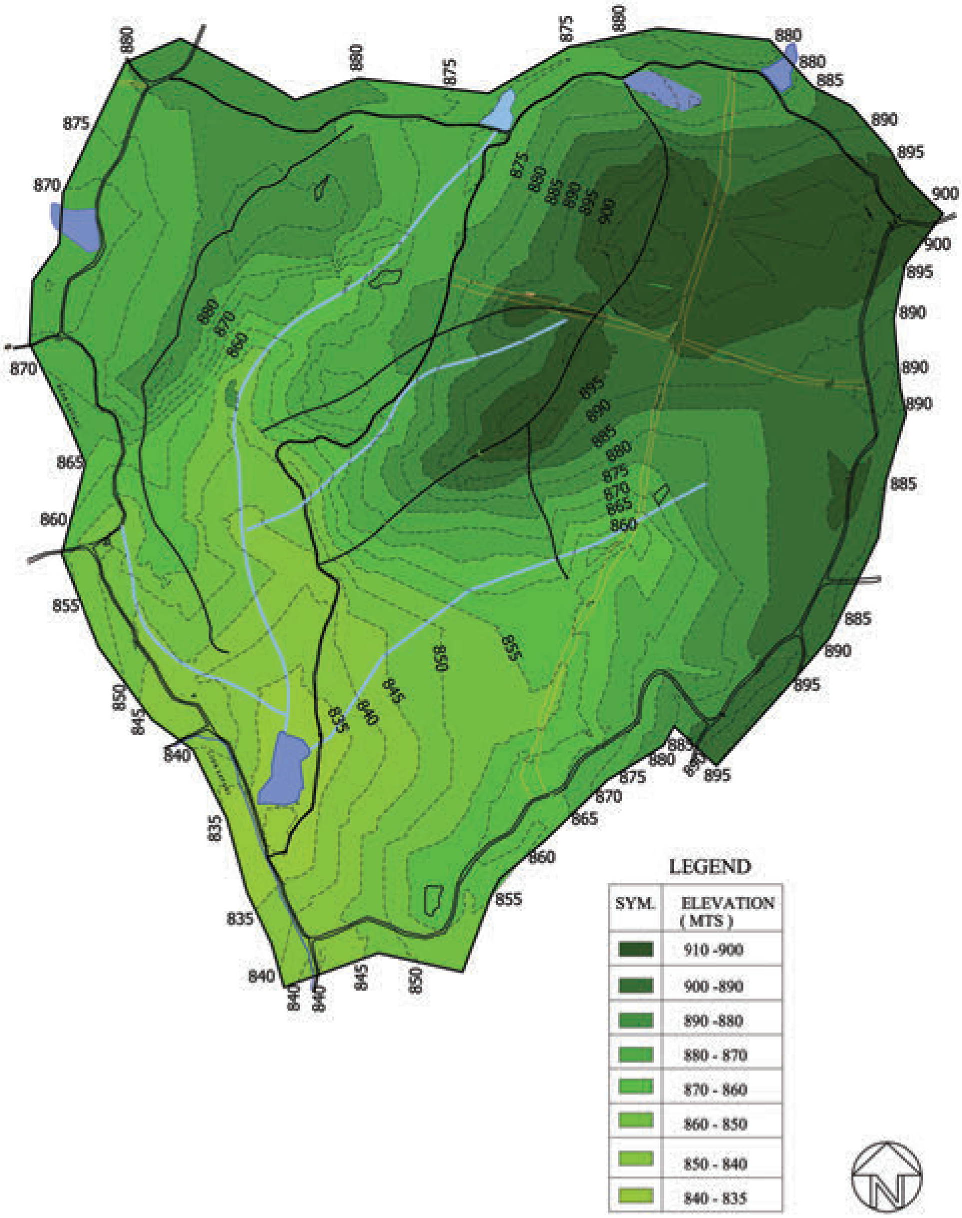


Fig. 5.5 (ILLUSTRATIVE DWG.) ELEVATION PLAN

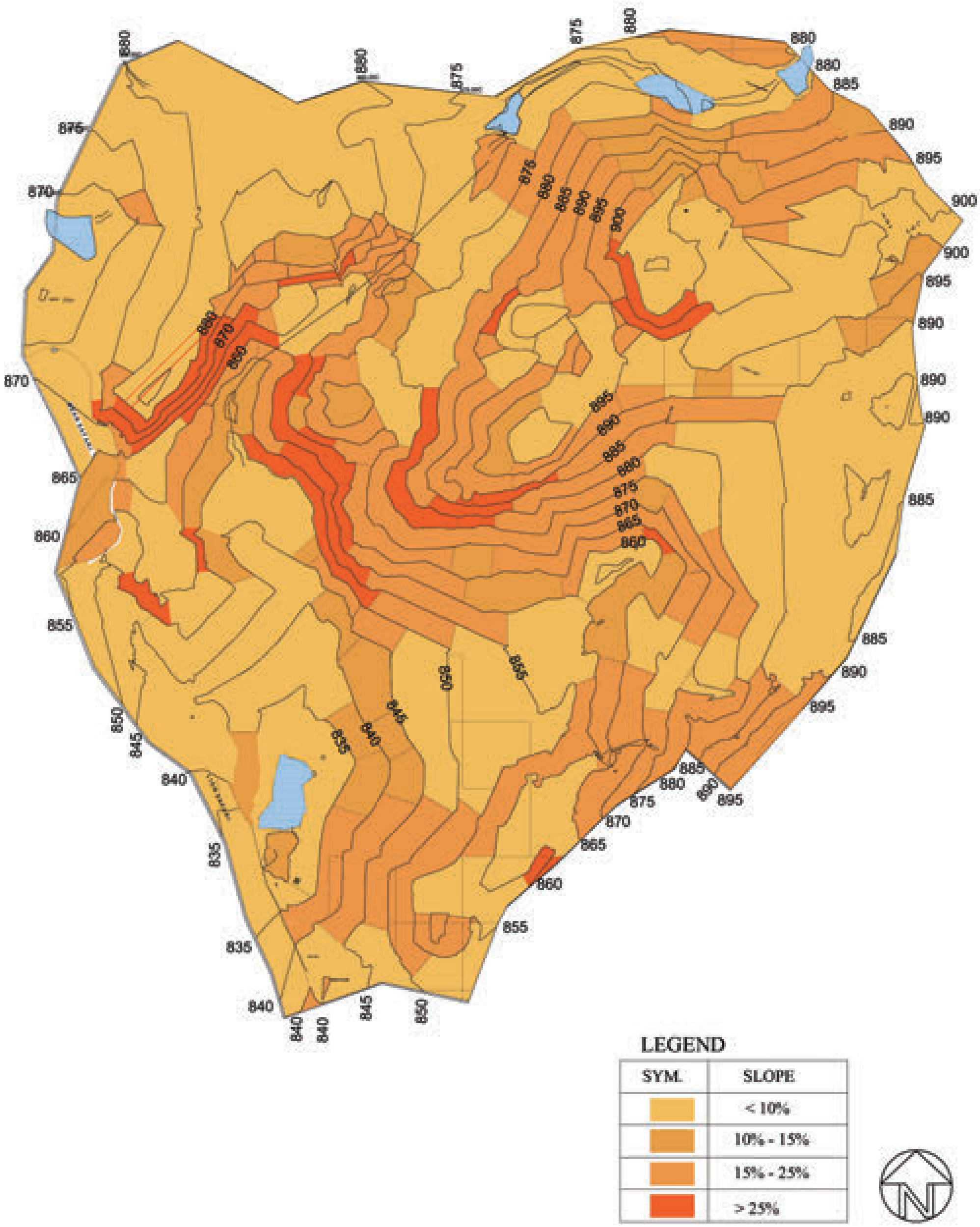
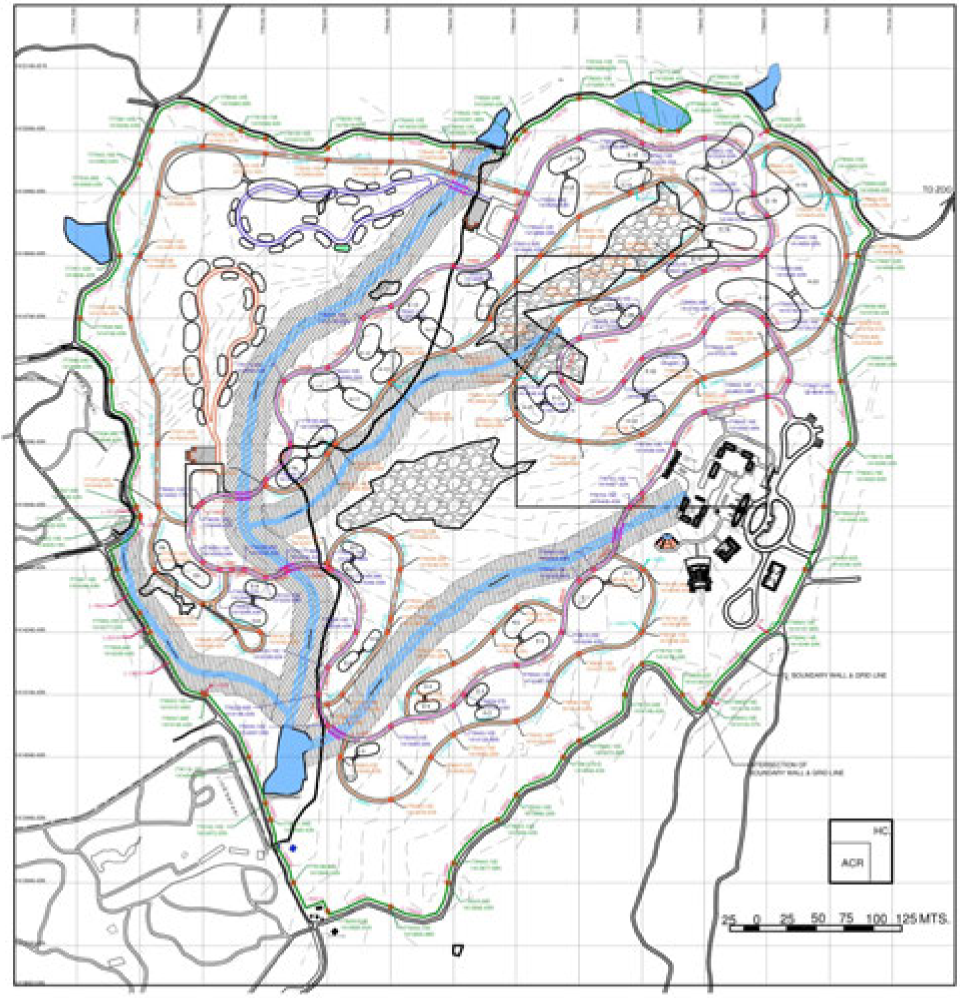


Fig. 5.6 (ILLUSTRATIVE DWG.) SLOPE ANALYSIS PLAN

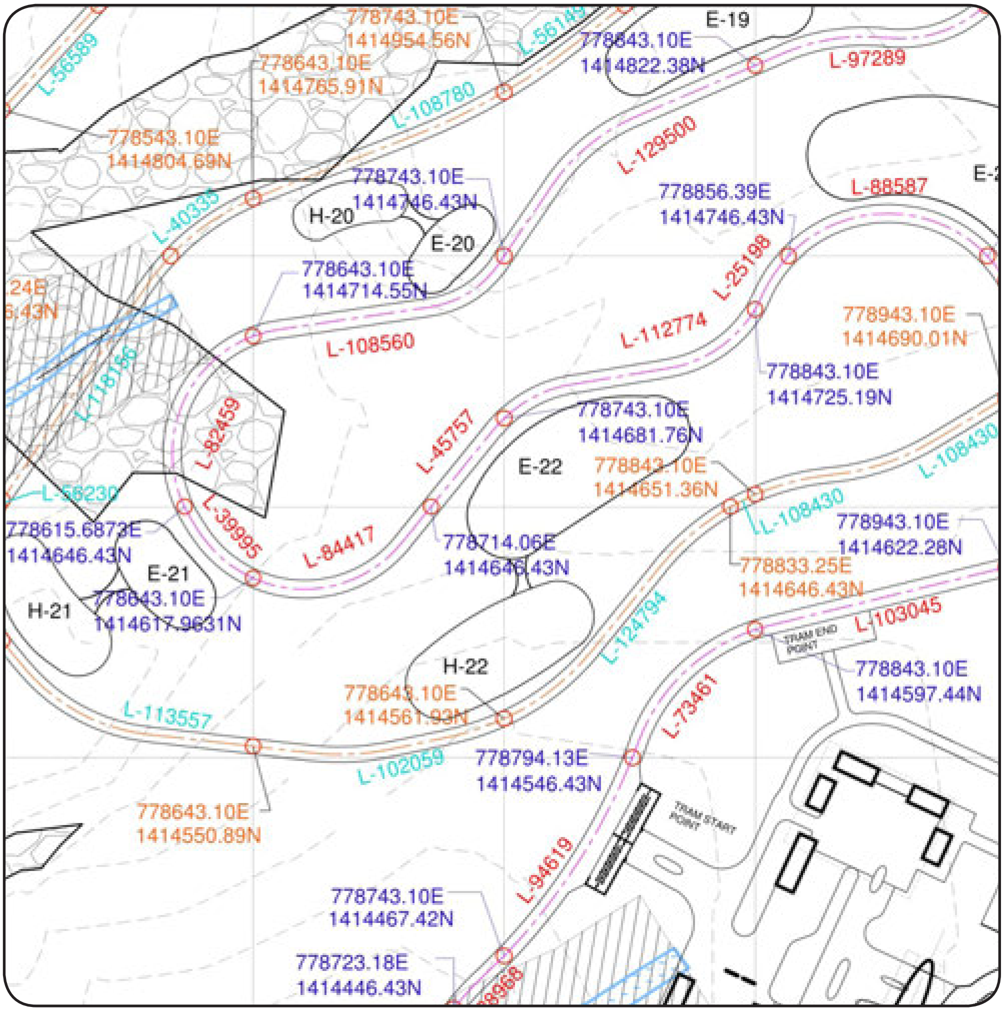


L-00000	BOUNDARY WALL LENGTH
L-00000	ROAD LENGTH
L-00000	SERVICE ROAD LENGTH
	BOUNDARY WALL
	ROAD
	SERVICE ROAD

TOTAL BOUNDARY WALL LENGTH	= 4715.33 Mts.
TOTAL ROAD LENGTH	= 4027.11 Mts.
TOTAL SERVICE ROAD LENGTH	= 3198.11 Mts.
TOTAL ENTRY ROAD LENGTH	= 880.35 Mts.
TOTAL RAGANTHATTU TRAIL LENGTH	= 847.22 Mts.
TOTAL SMALL CAT TRAIL LENGTH	= 660.15 Mts.

Fig. 5.7 (ILLUSTRATIVE DWG.) LAYOUT PLAN

Fig. 5.8 (ILLUSTRATIVE DWG.) MASTER SITE PLAN



L-00000	BOUNDARY WALL LENGTH
L-00000	ROAD LENGTH
L-00000	SERVICE ROAD LENGTH
	BOUNDARY WALL
	ROAD
	SERVICE ROAD

Fig. 5.9 (ILLUSTRATIVE DWG.) LAYOUT PLAN

5.3.4 Services Drawings

Services required in any zoo include the following (the list is representative and not exhaustive):

a) Plumbing
   i. StormwaterDrainage
   ii. Sewerage
b) Electrical
   i. Telecommunications
   ii. Audio Visual
   iii. Cable, Sound, P.A. System, Closed-Circuit Television (CCTV) Systems, etc.
   iv. Security
   v. Monitoring
   vi. Intercom
c) Fire Protection, etc.

Services drawings indicate alignment, sizes, invert levels, rim elevations, and layout & details of all related structures, relevant general and construction notes to ensure proper execution. Each service may require one or several drawings to be issued for purpose of execution.

Indian zoos should now look forward to introducing contemporary technology for maintaining the enjoyment and utility of visitors time spent at the zoo by use of specially designed applications (apps) based on android/ Microsoft/ Google platforms. These apps should be available to the visitors on their entering the zoo for use on mobile phones, pads or even laptops to guide them through their passage through zoo. These apps should be designed to provide the visitors a comprehensive information source about the zoo site layout, animals related information, enclosures, routes available within the zoo, location of public facilities, and the emergency protocol to be followed in case of an emergency happening, guide the visitors to gain most from their visit, and to apprise the visitors about the precautions and etiquette to be followed during their zoo visit.

5.4 DOCUMENTS

Documents are required to augment the drawings and complete the information required for effectual execution of project. Items in documents and the related specifications must relate totally to the design intent and drawings. The materials and finishes indicated in the drawings should be defined in the BOQ (Bill of Quantities) and specifications very precisely. Most of the items presented in Indian zoo estimates are the scheduled items from the Central Public Works Department or local government SOR's (Schedule of Rates). The kind of materials and finishes required for upgrading the design of Indian zoos are not listed in the scheduled items list. As a result detailed and precise items are required to be drafted and augmented by detailed specifications to achieve the desired design results and quality of all construction in the zoos. There are numerous construction and finishes materials now available in the Indian market and some which can be easily imparted. These items have been available since the last few years. Examples include weather resistant wood for external use to stainless steel meshes and finishes, electrical & plumbing installations etc which can be used very effectively in zoos. At present no serious attention appears to have been paid to such aspects as a result of which the traditional materials and methods of construction which have been in use for decades continue to be used. Once the tender is floated based on the prepared BOQ, the project is executed on the some basis and the result is very different from what some good zoo designer may have envisaged.

What is therefore required urgently is to revise and upgrade the zoo related items along with the required determination of rates based on the mandatory analysis of rates and either have the items incorporated in the SOR's documents (which is a lengthy process requiring numerous approvals etc.) or at least have a comprehensive documents (SOR) for use in zoo designing. This should include items and finishes required for zoo in all parts of India and should preferably be a national level zoo document.

After design decisions have been taken, information has to be communicated for floating tenders for execution and subsequent management of the project. Certain kind of information can be given in the form of drawings and other information requires to be given as documents. Both of them together will present a clear picture to the Zoo Director/ Zoo Project In-charge as conceived by the designer to all other concerned - the client, the contractor, the public and the approving and sanctioning authority.

The correctness of these documents is very essential,especially in case of zoo projects in India. The technically deficient document frequently leads to wrong construction details, suggesting in-appropriate materials and wrong service specifications. This is one major disconnect between the available professional reputed zoo managers and equally capable and expert zoo designers and the final outcome of the constructed zoo.

The general documents required for a conventional zoo project are:

a) **Tender Documents:**Tender documents are prepared for each discipline or type of work. Tender documentsinformthe contractor of the precise nature and quantum of work. The purpose of these documents is to enable the contractor(s) to quote his best price for the execution of work. Tender consist of the following set of documents:

b) **Invitation for Tender**

c) **Bills of Quantities:** Bills of quantities (BOQ) for each head of work

   This is a systematized list of items of work required for each discipline of work such as architectural, structural and services work.This enables the determination of estimates of cost and time

d) **Specifications:** Specifications for architectural work & workmanship.

e) **Terms and Conditions:** General conditions of contract

The preliminary plans are processed through all the affected agencies for approval. Most of the time, revisions are required before approval are granted by the concerned authority and the Central Zoo Authority.

Once all required approvals of the preliminary plan have been obtained, preparation of detailed construction plans can proceed. There may be several separate different plans or all may be included on one comprehensive set of drawings. Often water, sewer, electrical (including communications, security and biometric access systems) systems must be engineered separately and reviewed and approved by the approving agency or authority.

After the initial decision on the location of the proposed zoo the next step in the process usually involves hiring the services of a surveyor to do a boundary and topographic survey. The boundary survey is required to secure land and transfer title, while the topography survey is to accomplish design.

The planner, whether it be the architect, landscape architect, engineer, or zoo planner, (a qualified Landscape Architect with a basic degree in architecture i.e. architect/ landscape architect is an appropriate professional) will then proceed to do a schematic design of the proposed project, working closely with the Zoo Director and all members of the team.

The Master Plan is a comprehensive document to guide systematic and planned development of an existing and new zoo for a reasonably long period of 10 to 20 years keeping its land, financial, personnel, physical and aesthetic resources and constraints in view, in order to provide holistic nature conservation education with wholesome recreation. This document helps in optimum utilization of the zoo resources in a planned manner, without being affected by individual whims, peer or uniformed public opinion and serves as a document to guide annual budgeting and personnel planning.

THE FORMAT

Part – I

1. **Introduction** – (includes history, objectives, physical features like the topography of the area, geology, rock & soil, flora and fauna, climate, rainfall, season, approach, demography of the surrounding area, legal status of the land, sources of pollution, if any etc.)

   (for an existing zoo, the introduction section may also include, the present ground situation, layout, description of different facilities, difficulties faced in the management in the past and achievements)

2. **Appraisal of The Present Arrangement And Constraints:**

   a) Animal section, veterinary section, store and feed supply, section, sanitation section, maintenance section, security section, water supply section, disposal of solid waste & liquid waste – sewerage, visitors amenities, lawns and gardens-landscape section and any other section peculiar to the zoo
   b) Collection plan
   c) General Zoo administration section
   d) Research
   e) Conservation breeding
   f) Education and awareness
   g) Any other activity peculiar/ unique to the zoo

Part II

1. **Future objective including mission statement / theme**

2. **Future action plan**

   a) Proposed animal collection plan including population size and justification of keeping the endangered species.

   b) Description of the layout plan of the zoo –Layout map on scale:Layout map should be drawn on scale 1:1000 to 1:5000 depending on area of the zoo with contour interval to be between 1mts to 5mts., depending on the topography. Existing features like water bodies, precipices, forest patches, historical ruins, natural drainage, water channel, rock outcrops etc. should be depicted. North/south direction, visitor circulation and amenities, site for disposal of carcass, water and electricity supply lines, solid and liquid waste disposal, approach road to the zoo and paths, parking arrangement, gates and barriers, administrative buildings- [zoo office, ticket counter, veterinary hospital], housing colony, industries in the surrounding areas, rail, roads – sources of pollution (if any)]

      For an existing zoo, other than the above features the layout map should also show existing animal enclosures (black colour), enclosures to be modified(green colour) and the enclosures that need to be redone after demolishing the old structure (red colour). Proposed new enclosures may be in blue colour.

   c) Proposal to address the inadequacies and shortcoming identified in the appraisal report (as appraised in part I, 2 a). New activities if any, intended to be taken up.

   d) Depending on the local condition of the zoo, other-like off display Conservation Breeding Centre and Rescue Centre. Items not relevant can be deleted.

3. **Personnel Planning:** This will provide the proposed cadre strength to manage different works considering the activities indicated in the plan including phasing of their deployment, outsourcing etc.

4. **Disaster Management:** Plan to address problems faced during the natural calamities (Fire control, flood, cyclone situations, law and order break down, feed supply etc.)

5. **Contingency Plan:**
   a) Animal rescued from wild
   b) Escape of animals from enclosures
   c) Monkey and dog menace
   d) Arrangement of food in case of strike (non-supply by contractor)
   e) Snake bite
   f) Visitors getting injured/ visitors falling inside enclosure
   g) Fighting among animals
   h) Epidemics
   i) Breakdown of power supply

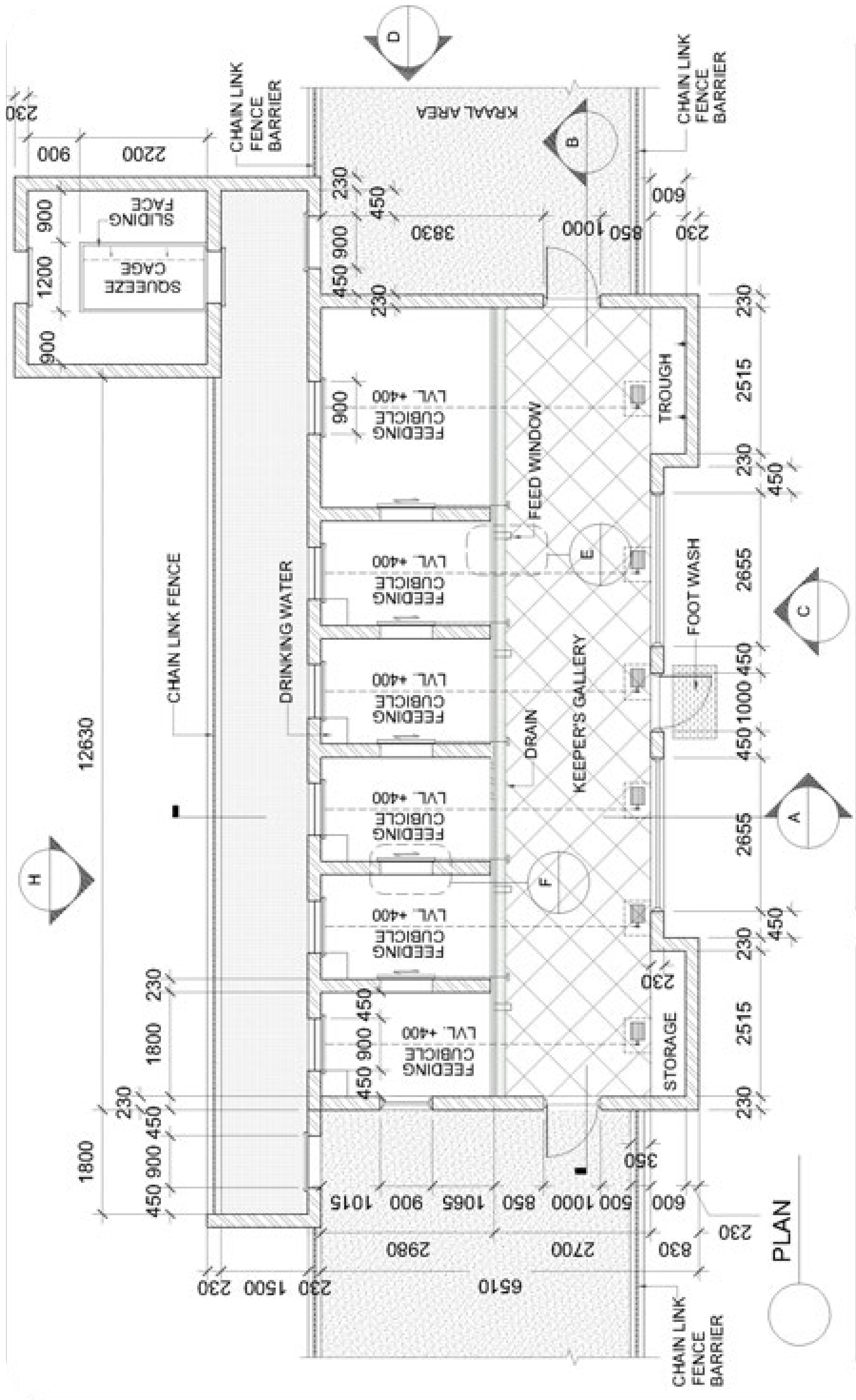
6. **Capacity Building:** Plan to upgrade skill of zoo staff, interaction with other zoos – regional cooperation.

7. **E-Governance**

8. **Broad Budget Analysis for Implementing The Plan:**
   a) Construction And Development
   b) Day To Day Maintenance

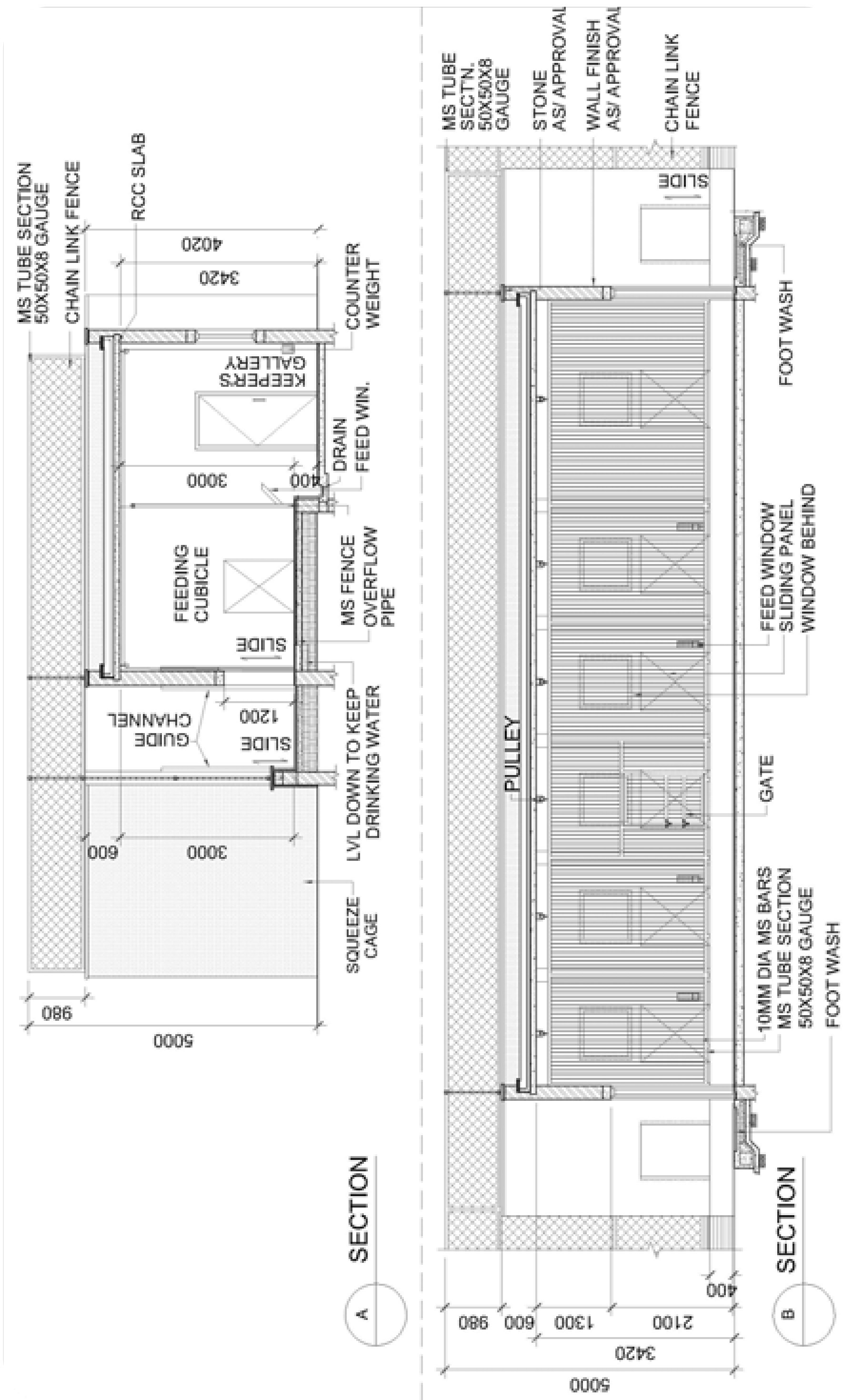
9. **Annexure to Master Plan:**
   a) Existing zoos requiring modernization:
      - Layout plan depicting the present setup (animal enclosures, administrative building, visitor amenities, road etc). Older maps, if available to indicate stages of development.
      - Existing animal collection plan/ inventory
      - Free living species occurring in the zoo campus Flora and Fauna
      - Present staffing pattern and position
      - List of buildings other than animal enclosures
      - Notification – creation of zoo society, acquisition of land etc., constitution of committees.

   b) For New Zoos: Site map, legal status of the land, proposed Collection Plan for animals (list of species).
      - Notification etc.
      - Proposed staffing pattern



TIGER ENCLOSURE

Fig. 5.10 (ILLUSTRATIVE DWG.)



TIGER ENCLOSURE

Fig. 5.11 (ILLUSTRATIVE DWG.)

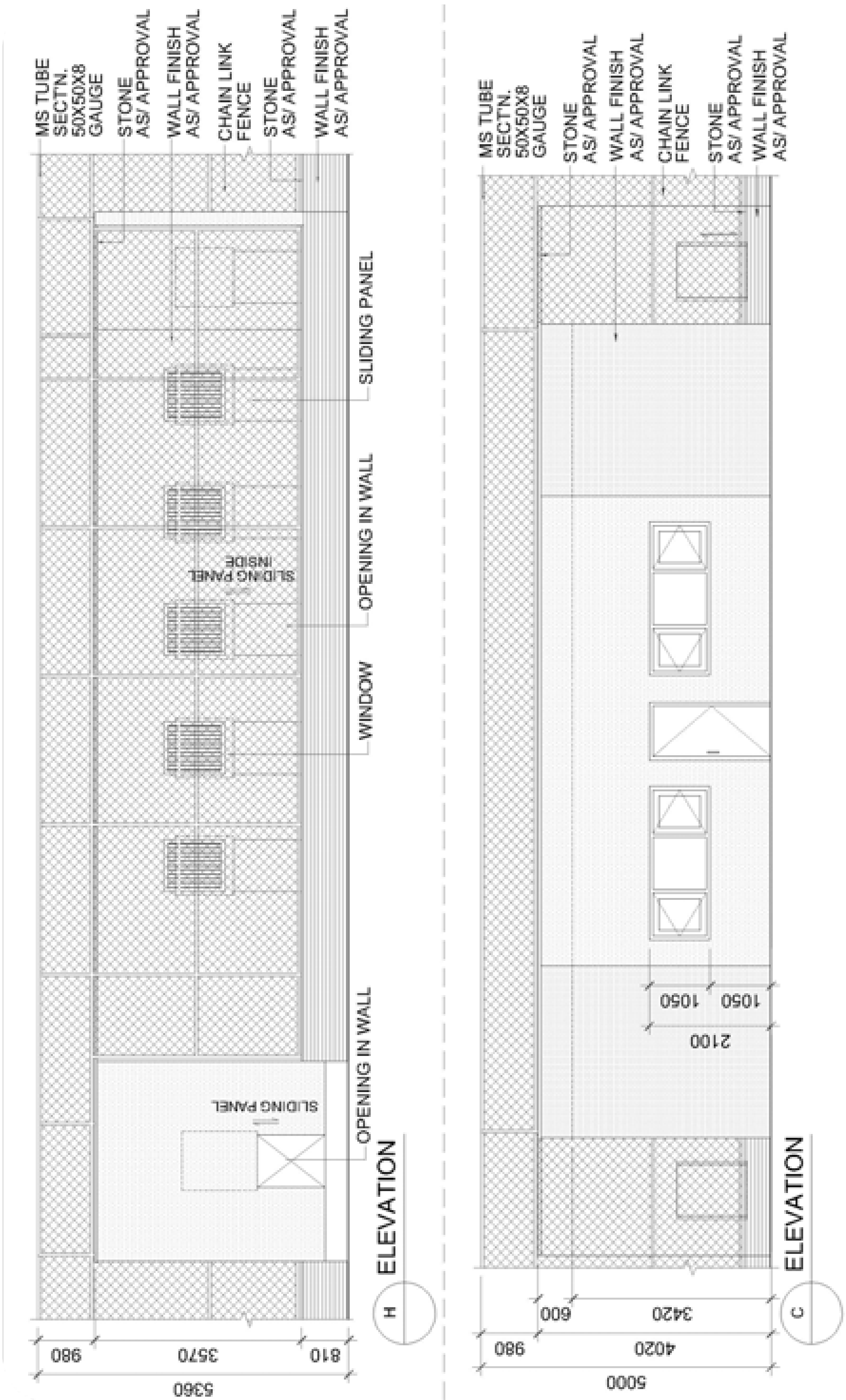


Fig. 5.12 (ILLUSTRATIVE DWG.)

TIGER ENCLOSURE

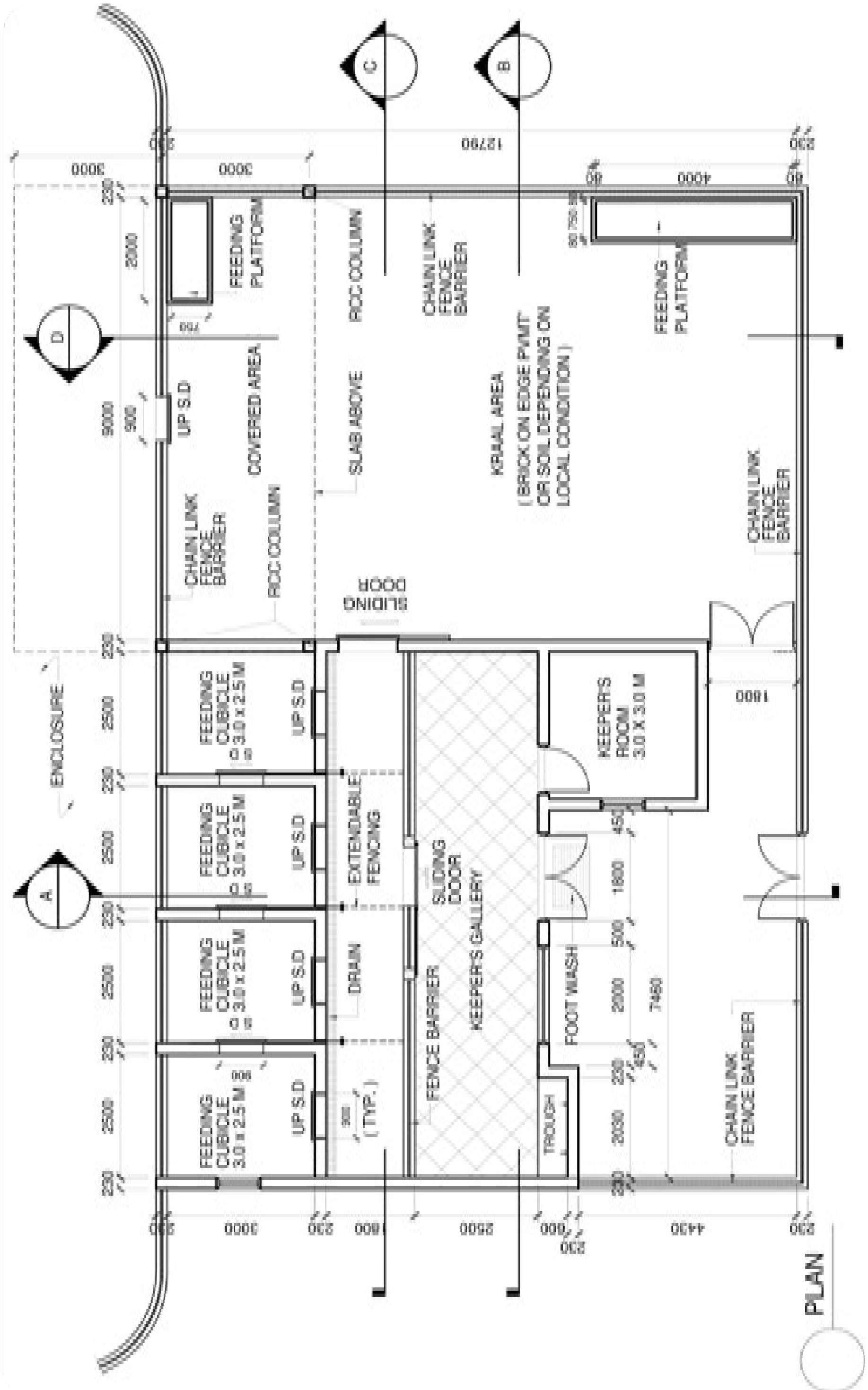
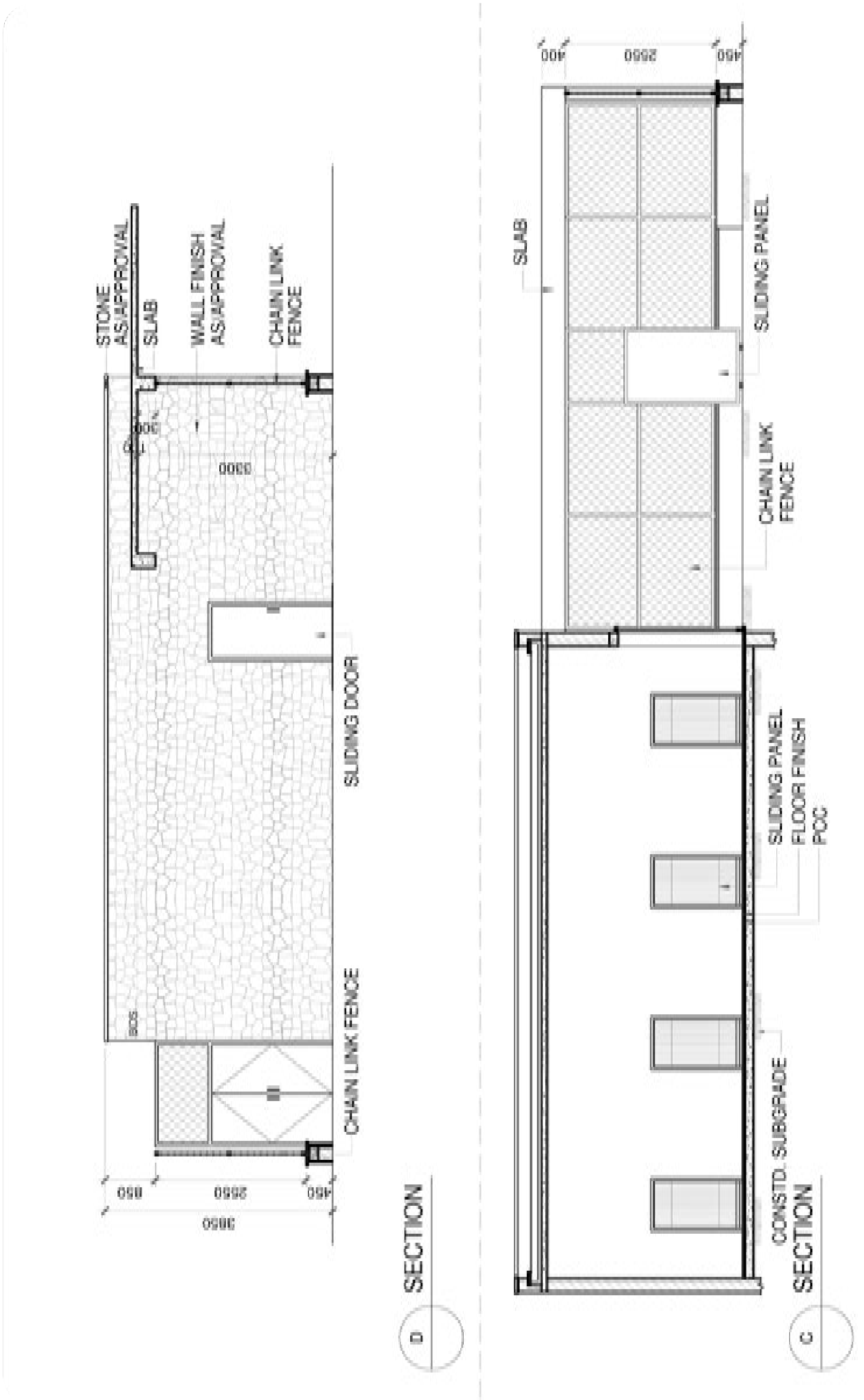


Fig. 5.13 (ILLUSTRATIVE DWG.)

BLACK BUCK ENCLOSURE



BLACK BUCK ENCLOSURE

Fig. 5.14 (ILLUSTRATIVE DWG.)

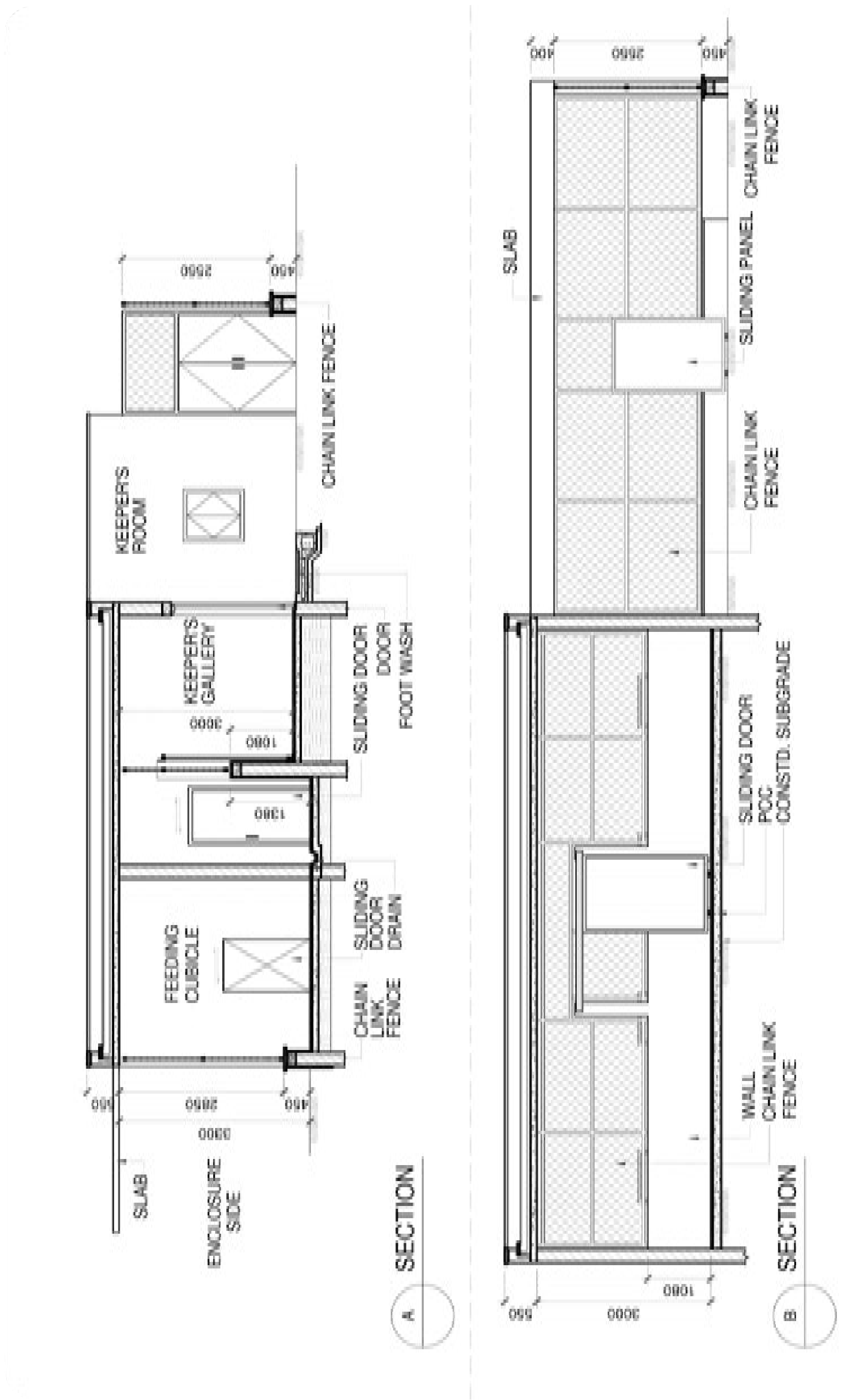


Fig. 5.15 (ILLUSTRATIVE DWG.) BLACK BUCK ENCLOSURE

TYRE WASH - PLAN

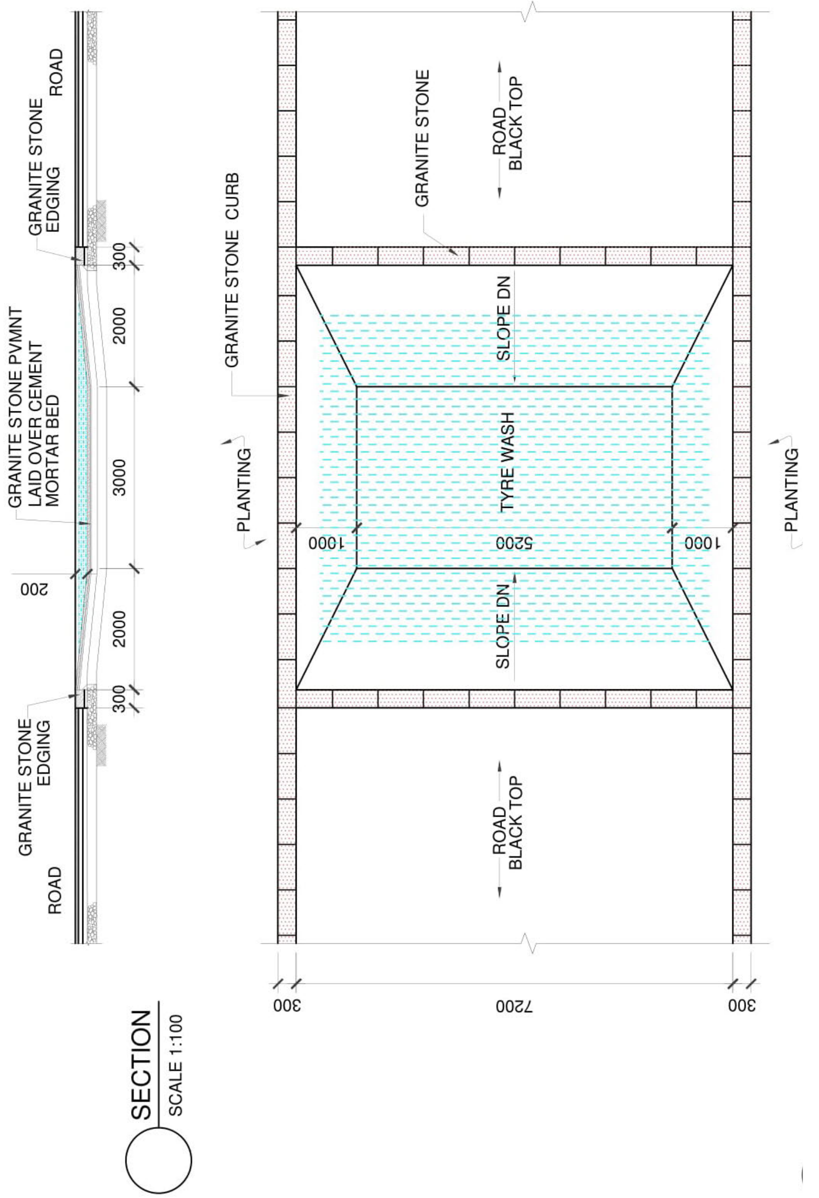
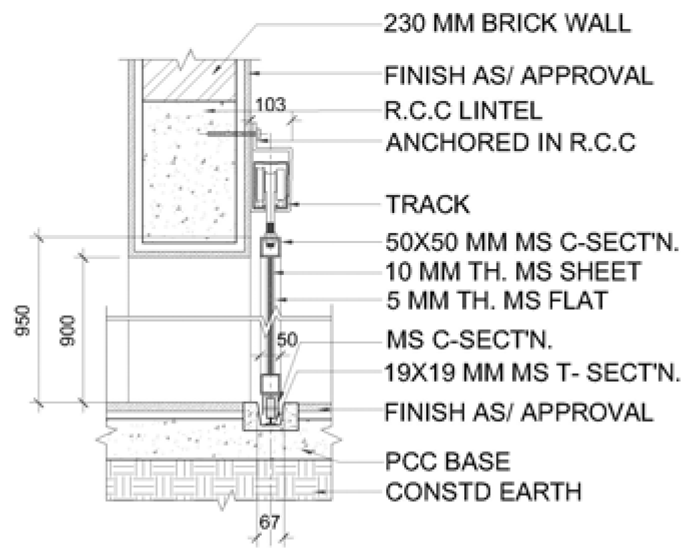
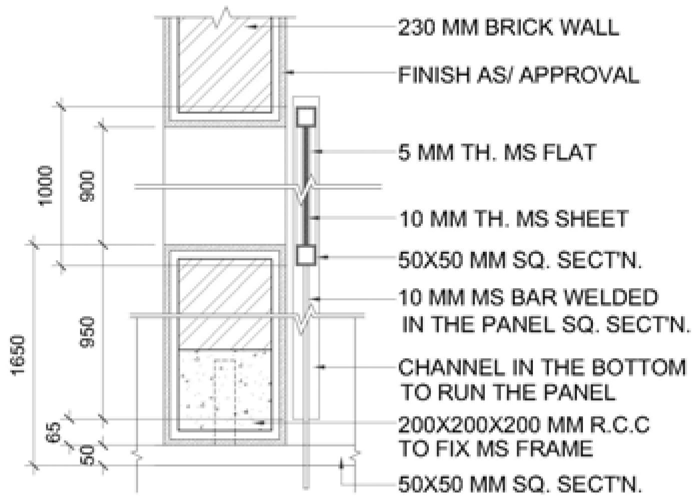


Fig. 5.16 (ILLUSTRATIVE DWG.)



F SECTION



F PLAN

Fig. 5.17 (ILLUSTRATIVE DWG.) TIGER ENCLOSURE DETAIL

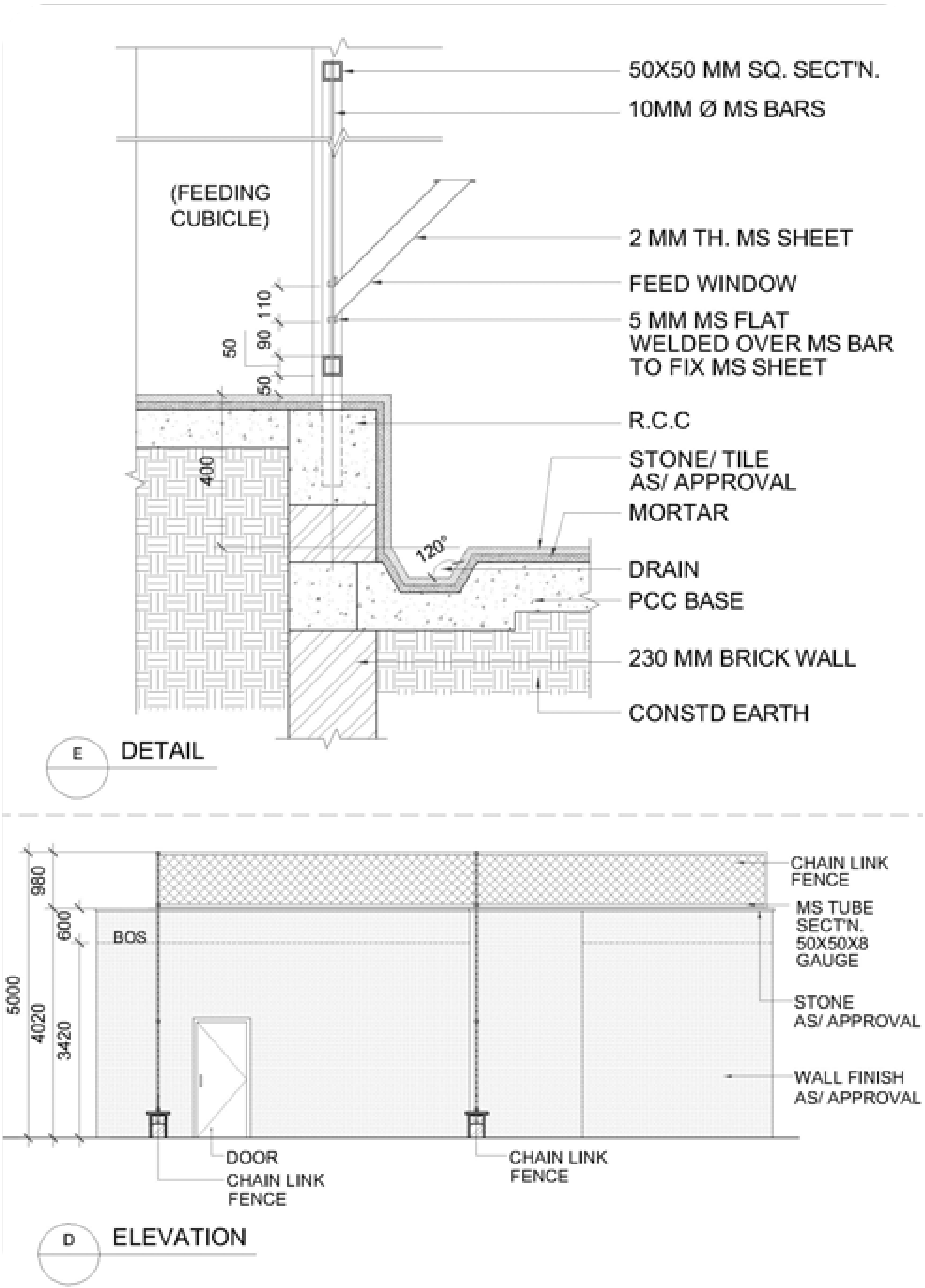
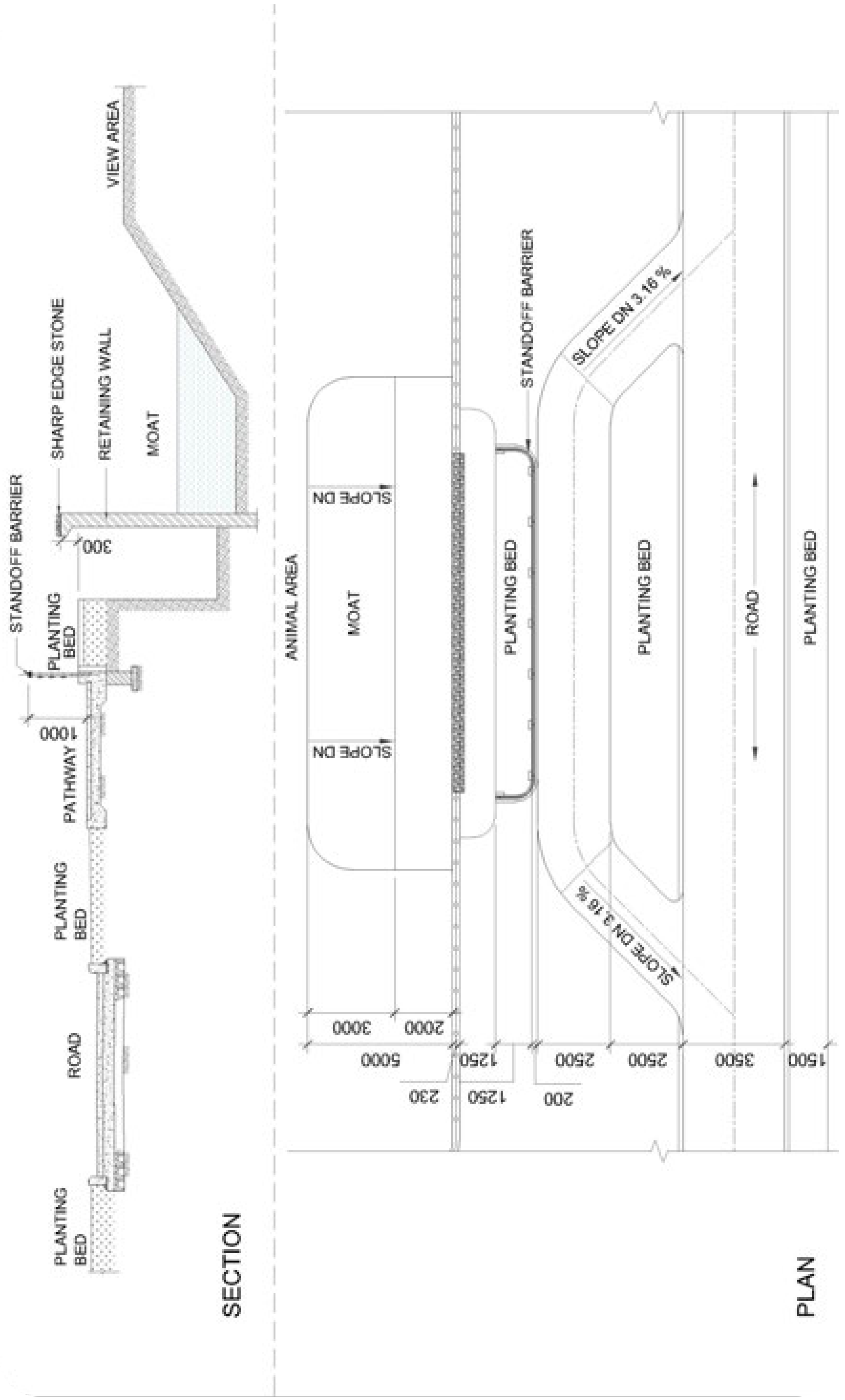
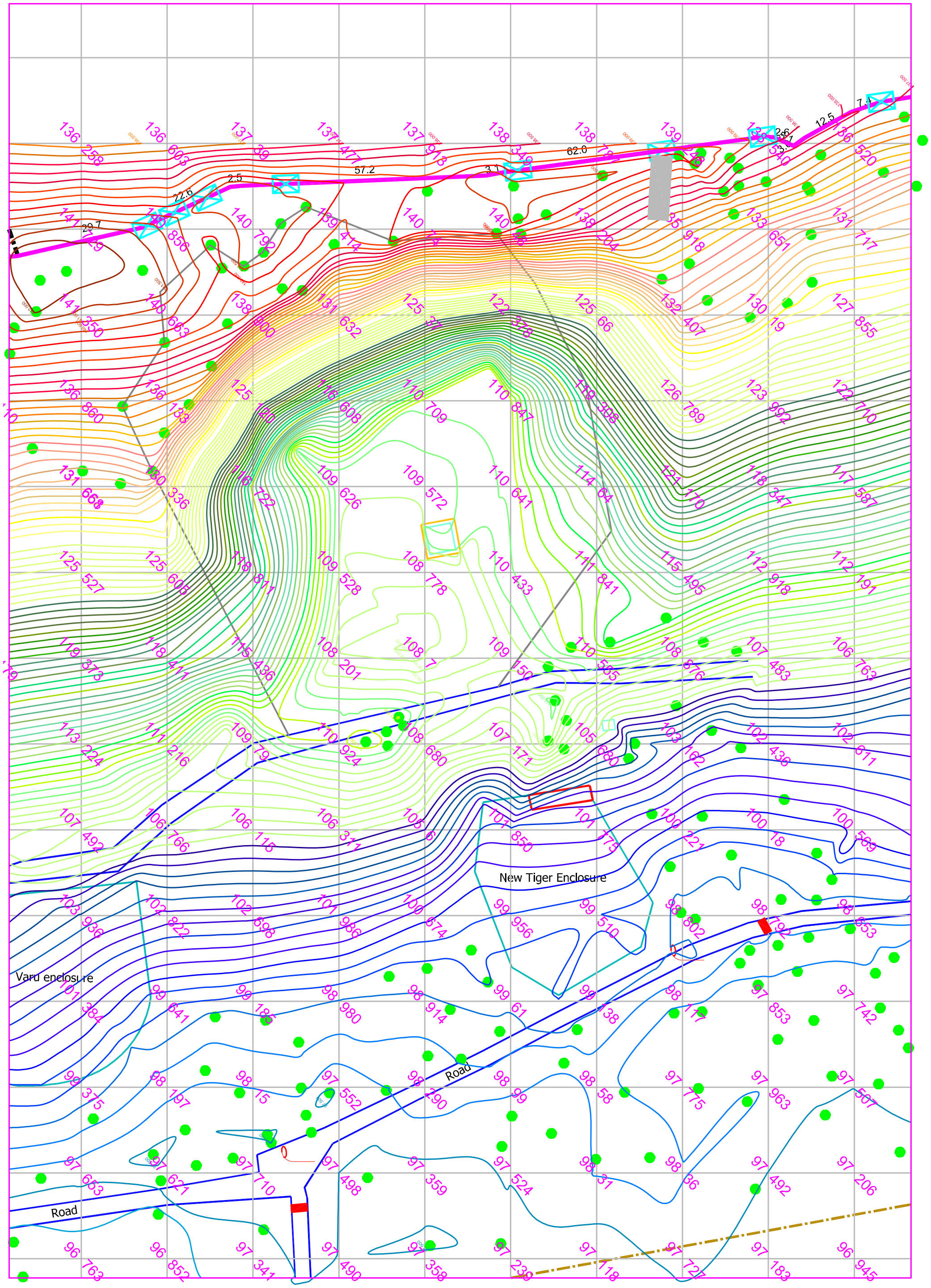


Fig. 5.18 (ILLUSTRATIVE DWG.) TIGER ENCLOSURE

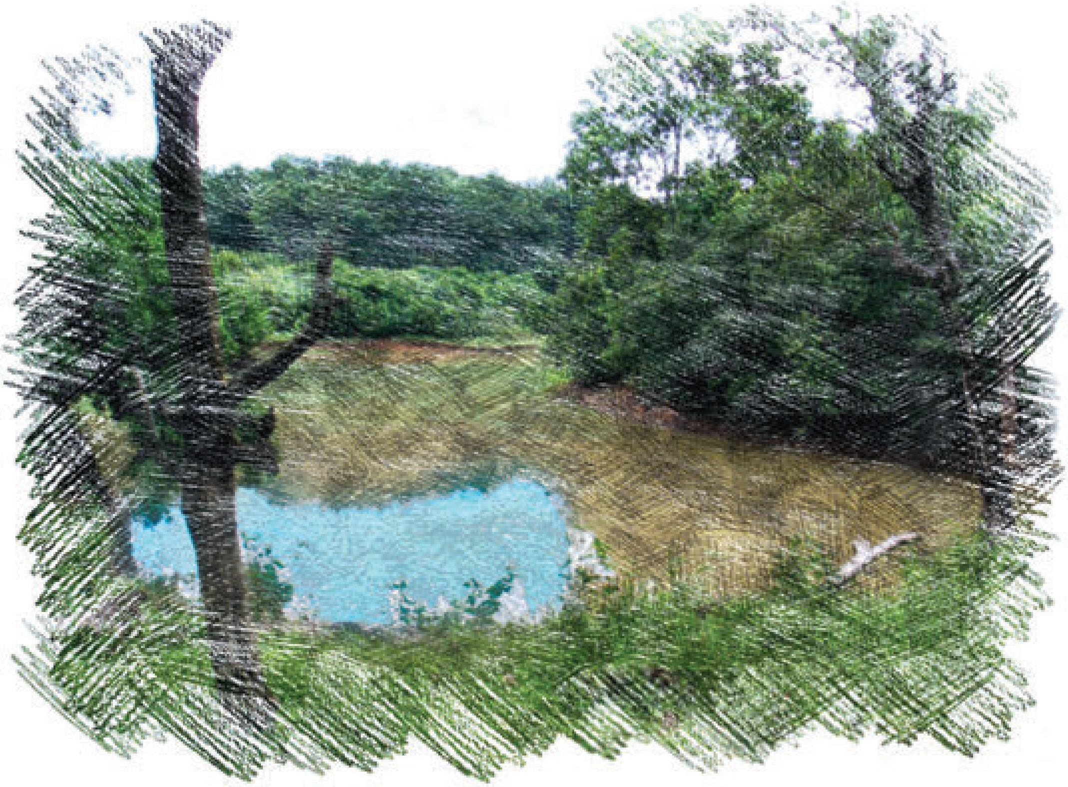


STAND OFF BARRIER TIGER

Fig. 5.19 (ILLUSTRATIVE DWG.)



An example of a typical survey drawing used for layout of enclosures and alignment of roads & paths within a zoo.



Sepahijala Wildlife Sanctury, Agartala, Tripura

CHAPTER 6

Design Guidelines

Zoo Spaces
Elements
Vegetation - Existing
Planting
Construction Materials
Signage
Services
Zone Separation
Facilities - Animals
Facilities - Visitors
Facilities - Staff

Zoo is a complex design entity. It has live animals accomodated within numerous zoo ‘spaces’. These spaces together must form a comprehensive whole, which forms the zoo. Good zoo design is the one in which the whole is designed as an integral of individual spaces and each space is designed as a functional component of the whole. Design Guidelines ensure that.

CHAPTER 6

Design Guidelines

6.1 ZOO SPACES

'Spaces' refers to locations within the zoo. some spaces are found in all zoos - such as the entry area, enclosures, administrative offices area etc. There are some spaces which will be found and required in some specific zoos only. These spaces may include a quarantine area, rescue centre, area for growing animal feed or a speciality facility for an animal species unique to a particular region. These spaces are physically separate. Some isolated instances require concentrated design inputs for each space. Not only that, but similar spaces may have completely different characteristics and requirements from one zoo to another depending upon the regional location, climate or the average number of visitors. Same spaces may have different sizes and design because of site specific reasons but should always have a definite sequential link with the other parts of the zoo.


Fig. 6.1 & Fig. 6.2 Entrance area in a zoo has to accommodate large crowds; both those entering and departing. It has to be designed and not ignored and left to be a part of the roadside at the entrance.

The complexity arises because of the fact that these individual spaces must merge together to form a comprehensive whole, which is the zoo. Good zoo design will be the one in which the whole is designed as an integral of individual spaces and each space is designed as a functional component of the whole zoo. As a result, the planning & design parameters and the design approach for each zoo will be very different and unique for that site.

To encapsulate; zoo is therefore a set of numerous spaces which need to be identified and designed with functional and aesthetic considerations peculiar to each zoo. No two zoos even with identical design brief and animal collection plan can have the same layout and design.

6.2 ELEMENTS

Elements are the next to 'spaces' in design hierarchy but no less important. Elements are smaller components of design. These include railings, bollards, stand-off barriers, waste bins, seats, pavements, toe walls & walls, gates, curbs, animal replicas etc. All such elements need to be designed primarily to fulfil the functional requirements but should also be aesthetically appropriate and merge with the location. The detailing and finishing should be of professional standard so that each element merges with the natural environment of the zoo and works perfectly in all seasons. Functional

Fig. 6.3 This fibre glass dinosaur is effective because it has been provided with space and good setting. Such elements placed abruptly and without context are a waste of expenditure.

requirements, for example could be that an entry gate should not allow a human intruder, feral animal including dog to pass through. Aesthetically the design should be such that scale, colour and texture merges with the surroundings. While detailing, should ensure that there is proper finishing and adherence to specifications. Detailing means focussing and sorting out each part of the element. Attending to function, aesthetics and detailing requires knowledge, experience and familiarity with contemporary construction materials & their characteristics including costs & local availability.

6.3 EXISTING VEGETATION

Every zoo in any location has some kind of existing natural vegetation at the site. The term 'vegetation' includes trees, shrubs, grasses and any other plant material. All these should be protected diligently from any kind of damage during construction, by providing whatever inputs that may be necessary by way of money, tender conditions and special instructions to all concerned contractors. All existing vegetation should be carefully protected from damage and removal during project execution and later.

6.3.1 Protection and Maintenance Measures

Protecting existing site vegetation should provide buffer zones, for visual and physical separation in the zoofrom outside.It helps stabilize vulnerable slopes, checks erosion, provides sediment control, helps in water management by maintaining water table and water quality besides providing aesthetic benefits which are so essential for restoring a natural ambience for a zoo. Preserving existing vegetation will be particularly useful in areas such as stream banks, wetlands, steep slopes and other areas susceptible to erosion where other structural erosion controls may be difficult

Fig. 6.4 & Fig. 6.5 Once planted, the planting should not be ignored. It requires regular unending maintenance not only by way of irrigation but also in terms of its appearance with mechanical or manual washing of foliage.

to establish or maintain. Existing vegetation can withstand higher discharges of storm water, has greater filtering capacity because of dense foliage and root system and requires minimal or no maintenance. Existing natural vegetation significantly provides areas where indigenous wildlife can remain undisturbed particularly during the construction period. Vegetation preservation and protection measures should be taken prior to clearing and construction activity at site (refer appendix D for measures and methods). An important precaution for preservation of existing vegetation is to maintain the existing grades at site, and particularly within the vicinity of existing vegetation to avoid exposing the roots or filling of earth around the plants above the existing original level. In many cases existing vegetation can serve as an ideal enclosure enrichment element.

Protection and preservation of existing vegetation requires an accurate survey plan and has to be planned and incorporated in drawings, in conditions of contract and in bill of quantities at the planning and design stage itself. This should be done much ahead of tendering and beginning of construction work at site. In fact, protection instructions with regard to existing vegetation should be in place prior to allowing access to site by anyone concerned with construction activity. Specific vegetation measures need to be incorporated as part of tender conditions to elucidate that the existing vegetation will not be allowed to be used for gathering fire wood or getting material for temporary shelter for labour or office hutments or even for picking fruits. Only after the project is completed should the existing vegetation be attended to for selective removal, pruning or arising of canopy height.

On relatively small sites, a balanced and considered view on protection of existing vegetation may have to be taken because of considerations of limited area for enclosures and ancillary buildings, because of the undulating topography of the zoo location, or because of the premium land values in the vicinity of the zoo site, there by making it uneconomical to leave large areas of existing vegetation at the cost of having more enclosures and facilities.

Preservation of existing vegetation should be a priority. There will obviously be a cost to it, like there is a cost for anything else. Time will also need to be allocated for it. Often there is unavoidable increase in project execution time and expenditure for preservation of existing vegetation. This should be included in the schedule and project budget at the beginning of the project. This will include expense on all protective measures around the area such as fencing or measures for erosion control, protection measures to prevent sediment laden surface run off flowing into the protected vegetation etc.

The costs incurred in the preservation of existing vegetation is often much less than the cost of its subsequent planting and also the cost to be incurred in future to provide and implement maintenance measures for erosion & sedimentation controls, provide screening vegetation and aesthetic enhancement at a later stage of the project.

Design Guidelines for Existing Vegetation

1. A comprehensive survey of existing vegetation, prior to the beginning of any activity at site, to determine the vegetation areas, genus/ species, density, age, diseases etc. of existing vegetation.

   All existing vegetation at site should be marked on the survey drawing. The information should include space wise distribution of vegetation, type (trees, shrubs and ground covers), genus & species, diseased plants (which can be removed if required), density and age of mature/ specimen trees which have to be retained and integrated in layout design of the zoo.

2. Special care should be taken during execution to ensure that no existing vegetation, trees, shrubs and ground covers should be damaged or removed. Any damage done to vegetation accidentally should be attended to immediately and should not be left to be taken care of at the end of the project.

3. Existing trees should not be cut or pruned without the formal permission of the appropriate authority. It is a cognizable offence in India and many other countries. All such trees should be Listed and permission from concerned authority should be taken before removal of limited selected existing vegetation. removal should be done only if absolutely necessary.

4. The areas to be preserved should be identified on the drawings and marked on the site before any activity is initiated.

5. All trees which are to be protected should be maked and it should be ensured that the area within the drip line is left undisturbed and no construction or storage of material is allowed.

6. Ensure that preservation measures are in place in areas where clearing and grubbing (removal of tree stumps and roots) activity is required. These are areas where there is no proposal for construction.

7. Site management in - charge and security should be given unambiguous instructions to guard existing vegetation.

8. Prevent disturbance or damage by not planning any activity/ construction on areas and within the drip line of existing vegetation.

9. Any damage to the roots, trunk or canopy of a tree(s), designated to be retained or repaired, should be attended to on priority.

10. Ensure that the surface runoff from construction activity at the sites is

redirected along designed temporary channels, with culverts if required, and not allowed over unprotected bare soil areas.The modified drainage should not be directed through or into an area of protected vegetation.

11. No vegetation should be removed from floodplains, stream banks, and steep slopes or wetlands existing within the zoo site.
12. Any existing large vegetated areas within the site which houses any kind of wildlife should be conserved.
13. All necessary regular maintenance requirements for vegetation preservation should be regularly carried out during the construction period. Restorative action should be taken in case of any damage or sediment build up.
14. Temporary storage of excavated soil or rock should be done in a location and with protective measures to ensure that the material is not in the vicinity of protected areas.
15. Protective fencing should be provided around any unique individual tree specimens.
16. There may be vegetation which may have been designated for removal but instead of removing it at the beginning of the project itself it may be used for erosion control or screening and later removed in phases.
17. Specific routes within the site should be designated and marked for movement of vehicles and temporary storage of material during construction.
18. Wind damage can result from exposure of vegetation to increased wind velocities, therefore this must be considered when removing adjacent vegetation.
19. Action should be taken on priority for treatment of damaged/ diseased trees which have been designated for protection.
20. Ensure that there are no grade change (cutting or filling) close to existing vegetation and if there is such a situation then ensure measure to prevent damage.
21. Equipment must be kept away from trees to be preserved to avoid trunk damage caused by equipment chipping or scarring the trunk.
22. Ensure provision of additional irrigation lines, as and if required to irrigate freshly planted saplings. These may augment the existing irrigation system

or part of it which is to be retained.

23. All protective measures for vegetation should be retained until three months or upto the next growing season (whichever is later) of the completion of the project.

6.4 PLANTING

For a pleasant zoo environment, for both animals and visitors, it is desirable to have minimum of built up area with large expanses of greenery, evenly distributed and spread over the zoo campus, in the form of lawns, gardens and groves of trees. The roads and path should be lined with adequate number of shady/ indigenous trees. Building and paved areas should be minimised and only provided if absolutely necessary. Maximum number of existing indigenous vegetation should be retained. All buildings and structures in the zoo may be suitably camouflaged with plantations so that the visitors to the zoo have bare minimum structures visible to them.

'Vegetation' pertains to the combination of existing and the planted vegetation. 'Planting' refers to proposed planting of trees, shrubs, creepers and groundcovers. It is imperative that at the start of design that an accurate survey of existing vegetation, in terms of location, canopy coverage and health condition should be carried out which, will influence and determine the design and type of each planting to be done.

Fig. 6.6 Well designed enclosure planting. Barrier needs to be designed better to prevent attempts to cross.

Planting design, like any other design, is based primarily on the functional and aesthetic considerations. Climate, soils, site slopes and irrigation provision are the other extremely important considerations in zoo planting. Ensuring visibility and camouflage as required at various locations within the zoo should also guide planting decisions. While designing proposed planting, it should be ensured that the existing plants are not damaged in short or long term. Where planting is proposed on vulnerable areas such as steep slopes or planting is carried out for densification of

Fig. 6.7 Concrete or any other pavement extending to the edge of tree trunk is an unpardonable sin. The cracks in concrete is proof of the struggle between the two. Minimum 1.5 mts soft space should be left around the tree base to enable it to survive. Space permitting soft area may extend upto the drip line.

an existing group of trees, existing vegetation should be protected, otherwise resulting damage will be uncontrollable. In such situation, the damage to existing plants can negate the very purpose for which additional planting was proposed and is likely to leave that area bare and susceptible to erosion for years.

Extreme care is required in selection, procurement and actual execution of planting of saplings. Plants should adhere to the specifications for plants & planting. A representative format is given in Appendix B. These specifications can be augmented or altered to suit various regional and local conditions. But there should not be any major compromise on this score. In old zoos, of which there are many in India, all old majestic specimen trees should be retained with adequate free space around them. This free space, should at least extend upto the spread of the canopy. Fresh planting should be maintained and pruned up to 3 to 5 years until they take root and their survival is assured. Pruning will also enable it to be given the required shape and canopy height.

6.4.1 Layout at Site for Planting of Trees, Shrubs, Creepers, Groundcovers, Lawns and Beds for Seasonal Planting

In a zoo project, planting is an important and essential component deserving of special attention. This is carried out on the basis of 'Planting Plan'.

Planting Plans are drawings which show the exact location (pattern of planting), genus & species and spacing of plants to be planted. The drawing also contains the total quantity (numbers) of each plant.

Planting process at site begins with what is known as the 'layout'. Each plant location (for trees, shrubs & creepers) is marked on the ground, while for ground covers, areas of planting, as precisely shown in the Planting Plan, are staked. These areas may be in any shape; rectangular, regular, multi sided or curvilinear. For each, an appropriate dimensioning method is used to ensure that layout is done as designed and nothing is left to the judgement of the person at site. The next step is to ensure that all locations and areas where planting is to be done are made up as per the proposed levels indicated in the grading drawings. This means that the earth (existing ground) should be filled, cut or left at the same level as required. This is to ensure that the soil level around the freshly planted saplings remains the same as it was in its original location in the nursery.

Thereafter, pits are excavated or areas prepared as indicated in the Planting Plan to receive the saplings. This part of the work should be carried out as in accordance with 'plants and planting specifications' (A sample format is given in the Appendix B).

To summarise, the planting layout is required to finalise the lines and levels of planting similar to marking of a building prior to construction.

Design Guidelines for Proposed Planting

1. Planting schedule should be decided prior to planting. This will include the procurement of plants, planting locations and timing with regard to season(s).

2. Procurement from nursery should be done stage wise as required according to the decided planting schedule because planting may be spread over months or even years. This will avoid maintenance responsibility and mortality replacement and expense.

3. During planting (which may spread over long duration) plants received received from nursery should be kept in a protected place, regularly irrigated as required and inspected for damage or disease.

4. Planting, which includes trees, shrubs, ground covers, should be done strictly according to the planting plan(s) drawing which indicates the pattern (position of each plant) and type (genus, species and variety) of each plant.

5. Entire area, on which planting is to be done should be cleared of debris, wild grasses etc. and the surface should be filled or cut (as required), and prepared (surface broken and manure/ fertilizer and pesticides added)to achieve the proposed grades (final levels).

6. Area should be cleared to execute planting. This includes removal of weeds and removal of trees (including stump removal in certain trees which are susceptible to coppicing) as required.

7. Any existing surface structures, such as drains, feeder pillars, disused walls/platforms, abandoned cables or earthing pits, which interfere with the planned planting should be demolished and debris removed from site.

8. All plant material received at site should be checked to confirm that the plants are healthy, free from diseases, well developed root system in an appropriate sized container or polythene bag.

9. Wherever the zoo site or part of it where planting is to be done is not fertile, fresh top soil should be procured for use in tree/shrub pits, planting beds and lawns.

10. All planting locations should be physically marked on site for adherence to drawing and final check before execution is started.

11. Planting should be done in the appropriate season and time to ensure that

saplings are irrigated by rain and are able to take root and sprout.

12. Regular and timely irrigation should be ensured for all new planting. This should be done either by using water from a natural surface waterbody or by providing irrigation lines before the planting is started.If this is not done then these are chances of avoidable losses by way of mortality. Plant replacement will offset any attempt at savings and conservation of effort.

13. All fresh planting should be protected by providing tree guards.

14. Proper soil preparation, rough grading, fine grading and consolidation should be done for laying and establishment of lawns.

6.5 FACILITIES FOR ANIMALS

6.5.1 Enclosures & Exhibits

Visitors to zoos generally desire to observe and interact with the animals in close proximity. This proximity and any kind of audio-visual or physical interaction with the animal is not desirable because it induces stress in most species and encourages teasing often leading to accidents. Animal - visitor interaction affects the behaviour of exhibited animals and consequently the exhibit design.

The contradiction lies in the fact that interacting with animals in close proximity without a visible barrier increases the appeal for public. However,it is not desirable. The public is prevented from interacting with animals which in some cases leads to decrease in the number of visitors thereby reducing public financial support in case of sponsorship. This is largely resolved by providing inclusive display enclosures, such as viewing through toughened glass.

Fig. 6.8 & Fig. 6.9 Both the outside and inside of the enclosure it should give a feel of unadulterated natural habitat setting with the use of carefully selected material and plants.

In recent past, in fact in many zoos even presently, animals are kept in captivity in cages or cage like structures. These are generally small structuresmade up of mild steel sections. The trend was to use heavy rods or heavy sections to guard against any misjudgement of animals strength or cunningness. Cages deprive the animal of normal exercise leading to deterioration in health. This also encourages teasing and attacks on the animal. Since the enclosure is made up of steel the environment inside becomes uncomfortably hot or cold for animals comfort. This also results in reduced visibility of the animal. Viewing the animal in a 'cage' is something in complete contrast to viewing the animal in natural surroundings.

Contemporary thought on enclosures favours naturalistic enclosures where barriers are hidden and animals are viewed amongst vegetation and enrichment elements.

There may be many interpretations to the understanding of what an 'animal enclosure & exhibit' may include in the Indian context. It definitely includes the barrier type from the viewing side as well as far from the non-viewing side. In the present write up, guidelines are offered only with regard to design aspects such as materials, textures, colours, methods and sequence of construction and detailing. Mandatory guidelines concerning the dimensions of barriers, i.e. width, depth and height are already issued by the CZA.

In contemporary scenario in India, enclosures and exhibits include the following:

Animal Exhibits

i. Open Air Moated Exhibits

Various kinds of exhibits have been designed and have evolved over the years. The improvements have been done based on animal comfort and visitors desire to feel one with the animal and experience the natural habitat of the animal. While exhibit designs and details are numerous, yet they fall essentially under few main categories.

In contemporary designs the moated exhibits with dry or wet moat as barrier is being widely adopted for all types of species. Of late dry moats (except where they are unavoidable) are being encouraged due to scarcity of water and contamination of water and algae growth due to prolonged stagnation.

But in few cases wet moats are provided where water is necessary to keep the animal confined to its display area, or is a part of its natural habitat. This is expensive and moats takes up a lot of land out of the enclosure area. The preference now is to use chain link mesh as barrier unless water is necessary, depending on species exhibited, whether climbing or not climbing, their jumping habit and physical strength. While wet moats necessarily have to be provided on the visitors' side it is optional along the rest of the enclosure perimetre.

ii. Open Air Exhibit With Water or Chain Link Mesh

Based on space or other consideration this type of enclosure is preferred. Ungulates and large flightless birds are generally kept in exhibits with chain link fencing with open top, saving lot of moat space. At the same time the visitors' area may have a moat for clear view. Wall as a barrier can also be provided in case of reptiles like crocodiles or monitor lizard. Sometimes snakes are also kept in enclosures with walls/ glass as barrier. But they remain vulnerable to attacks by predator birds. In case of leopards or other climbing cats, chain link mesh with slanting steel plates, slanting inwards can secure them effectively. Monkeys may also be kept in such enclosures when their jumping distance has been taken into consideration.

iii. Closed Enclosures

Despite contemporary preference for open exhibits keeping certain species in closed enclosures is necessary. Most birds need to be housed in closed enclosures or aviaries. They can be water birds or terrestrial birds. Quite often it is possible and safe to have leopards in closed enclosures with glass view. Nocturnal animals and fish are often kept in covered exhibits where viewing through glass can be a good option.

Viewing Concepts

Viewing the animal in its enriched zoo habitat without any visual barrier gives the feeling of being one with the nature. Hence most moated exhibits provide this opportunity. Some other viewing concepts are currently in use internationally and being introduced in India:

- Immersion exhibits: This sort of exhibit allows the visitor to feel like a part of the enclosure habitat taking him/ her almost inside the animal exhibit by and surrounding him with the enclosure and habitat vegetation and minimizing the view of the barrier.
- Viewing through glass barrier: Viewing through glass or other transparent materials of right strength can also provide visitor satisfaction while ensuring safety. Though it is quite common in case of aquariums and snakes this has still not become very popular in India as far as other animals are concerned and needs to be used more often.
- Piano string barrier viewing: Barrier with vertical piano string like wires when provided in birds enclosure it gives a visual feeling of 'no' barrier. Though this has been used extensively in different countries, it is yet to be used in India.
- Under water viewing: It is very interesting to watch activities of aquatic animals when they are in water. Some such exhibits have been created in India for crocodiles, beavers and terrapins. This can also be done with other terrestrial

animals that love water and spend time swimming.

- Depressed walls: Most ungulates are kept in chain-link mesh or welded mesh exhibits in India, which means visitors have to view through the mesh. To avoid this, ground level may be lowered to some extent along the visitor area and the visitor path can be laid above a retaining wall of appropriate height to prevent escape. There then shall be no viewing obstructions.
- Hot wire: 'Hot wire' is a term used for stretched wires having low voltage current which give a non-fatal shock whenever the animal attempts to escape. This develops a behaviour pattern which discourages and prevents the animal from escaping. Obviously it needs to be ensured that electricity is available without break. Solar powered or electric hot wires can prevent many species confined to the area allotted to it. Though this is not yet extensively used in the country, it has vast possibility and is quite economical. This provides unobstructed view of the animal.
- Vegetative barrier: Even thick vegetation or hedge can confine some animals like flightless birds and can merge well with nature.

Design Guidelines for Animal Enclosures & Exhibits

1. The first and the ideal attempt in enclosure design should be to analyse the existing landform and identify areas which are naturally shaped to form the barrier moat.
2. Enclosure's viewing side path should be separated from the primary or secondary circulation path by having a vegetation buffer. The vegetation buffer (a planting bed) should be at least 2 mts. wide and should have planting which will completely screen off the main path. The plants used should be such that the screen is perennial and does not shed leaves or reduce in foliage density with change in season.

   This can be achieved by branching a path off from the main circulation route and aligning it with the barrier edge and reconnecting it to the main route.
3. Clear width of the viewing path should be a minimum of 1.5 mts. wide but may be wider depending on the number of visitors during peak hours. The maximum width should not exceed approxivately 3.00 mts.
4. The level of the viewing path should be the same as the main circulation path.
5. If for some reason the level of the viewing path cannot be kept the same as the main path it should be connected by a ramp with a maximum gradient of 1:15.

6. Any ramp or platform having a vertical drop on sides should have a protective railing.

7. All construction of barrier walls, retaining walls, toe walls, or moat surfaces should be constructed using local material and finishes. This will ensure reduced costs and merge the constructed elements with surroundings.

8. Hot wire barrier (power fence) should be hidden by vegetation. If the height is more than 1.0mts then the hot wire can be placed in a moat like depression to make it less conspicuous.

9. The viewing side alignment and design should ensure that the animal is visible to the visitor wherever it may be sitting/ moving within the enclosure.

10. All constructed surfaces and animal forms, visible to the visitor, should be made to appear to be a part of the surrounding landscape or regional geomorphologic structure (rock type). This can be achieved by creating a surface in plain or reinforced cement concrete (PCC or RCC) or fibre glass.

11. It may be easier and economical to construct it in PCC/ RCC as compared to fiberglass will require trained artisans which are difficult to find except where such persons had been hired by the zoo and trained over the years. Often such skilled workmen are taken on 'loan' from another zoo or taken on contract.

12. Layout of enclosures should be organised according to the decided theme and not placed randomly.

13. Enclosures of animals which have a predator prey relationship should be separated by a suitable distance or elevation difference.

14. Each enclosure should be separated with a minimum gap of approximately 2 - 3 mts or more. The intervening space should be densely planted with suitable vegetation.

15. No existing tree should be removed to align the enclosure fencing or wall. The alignment of the enclosure perimeter should be done in way by which the existing trees are accommodated either within or outside the enclosure keeping in view the fact that it does not help the animal in any way to escape from the enclosure i.e., no tree should be in close proximity to the enclosure boundary.

16. Enclosures should not have acute corners, infact, they should preferably have obtuse or rounded corners.

17. The inside of the enclosures, as far as possible and by conscious design,

should be slightly higher than the visitors' side to avoid stress to the animal animalt feels insecure when the crowd of visitors is on a higher level.

18. Natural topography of the site should be used to achieve this level difference.
19. Enclosure enrichment should be designed according to the animal behaviour; the design of enrichment fixtures (benches, seats or swings) should not be of the kind that humans use.
20. No masonry structure should be visible within the animal enclosure.
21. No signage should obstruct or be seen from the viewing angle of the visitors.
22. No signage (or advertisement of sponsor) should be placed within the enclosure.
23. Night shelters should not be on the visitors viewing span. It should be located on the side in such a manner that it is least visible. The backside of the enclosure visible from the visitors' viewing area should have planting or elements to hide the enclosure barriers to give it a natural feel.
24. The enclosures should be immersion type where the visitors should have plants around them while viewing the animal. The visitor should not be exposed to any other view particularly any man made element either behind around, or in front of the enclosure.
25. The facade of the night shelter should be camouflaged with vegetation so that it should not be visible from the visitors' side in any manner.
26. The facade of the night shelter should be designed to appear as part of the natural environment. Textured stone, for example, can be used rather than coloured cement plaster surface.

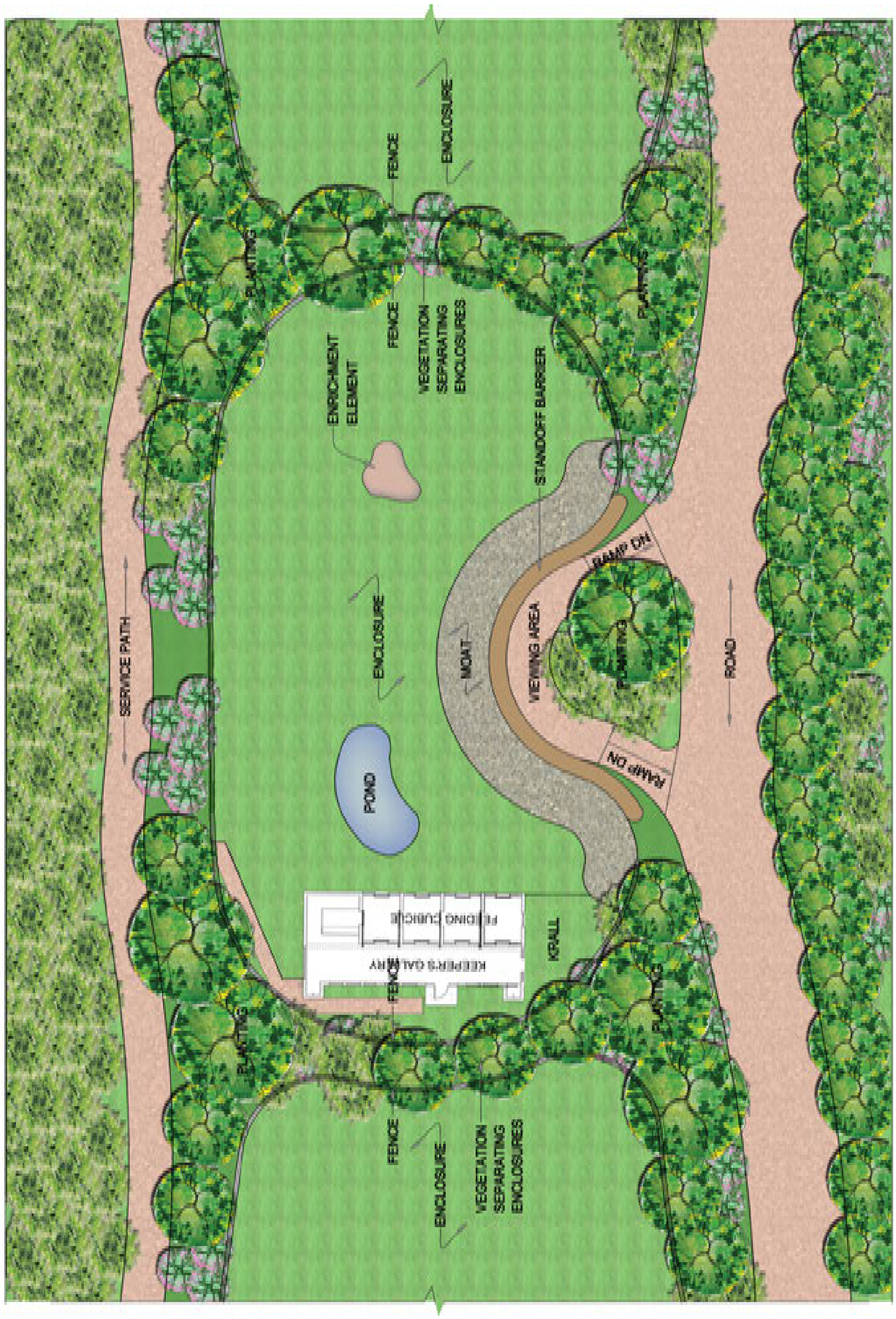


Fig. 6.10 (ILLUSTRATIVE DWG.) ENCLOSURE

Fig. 6.11 (ILLUSTRATIVE DWG.) PLAN & ELEVATION - EMU DRY MOAT BARRIER

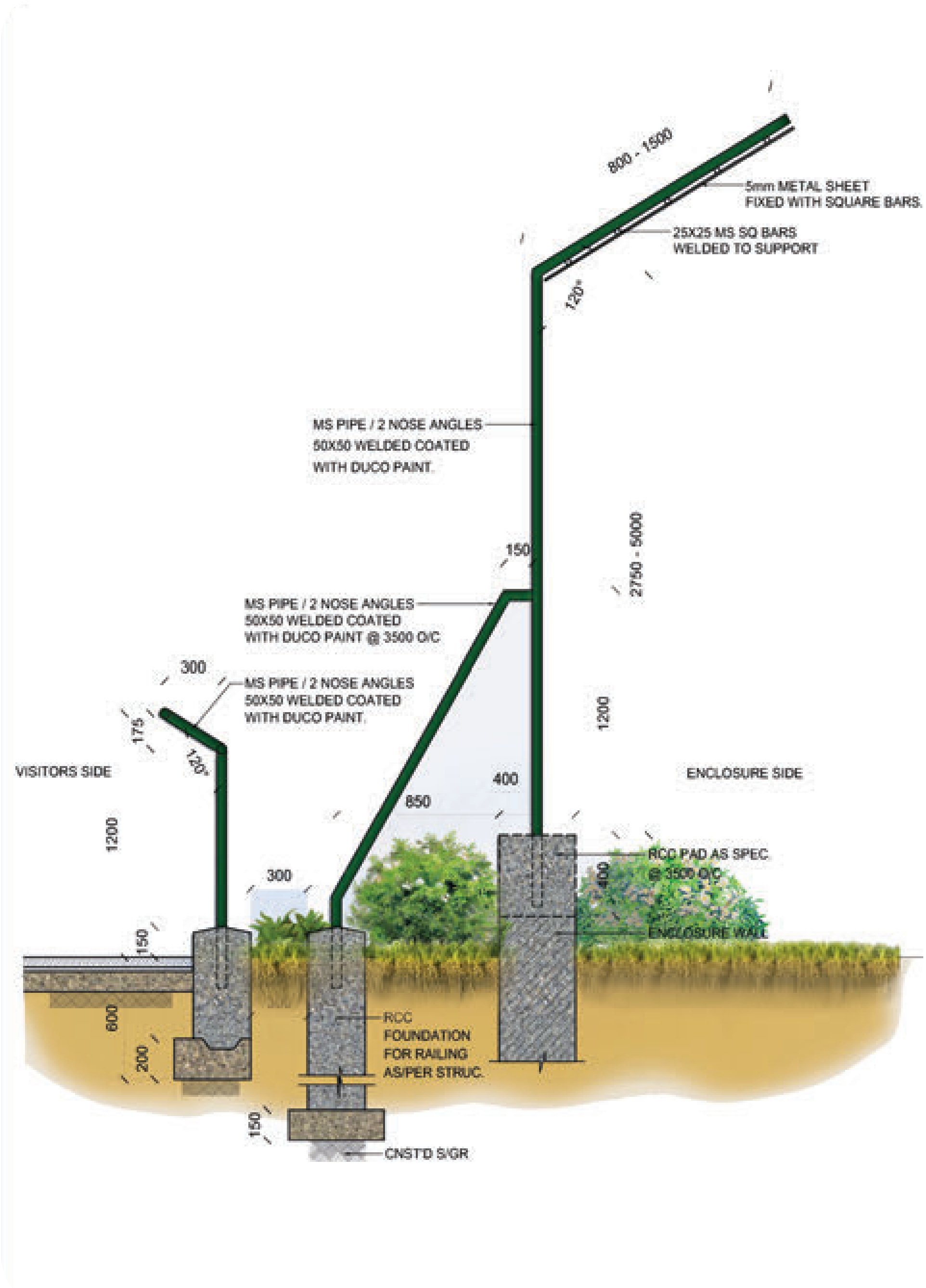


Fig. 6.12 (ILLUSTRATIVE DWG.) CHAINLINK FENCE DETAIL

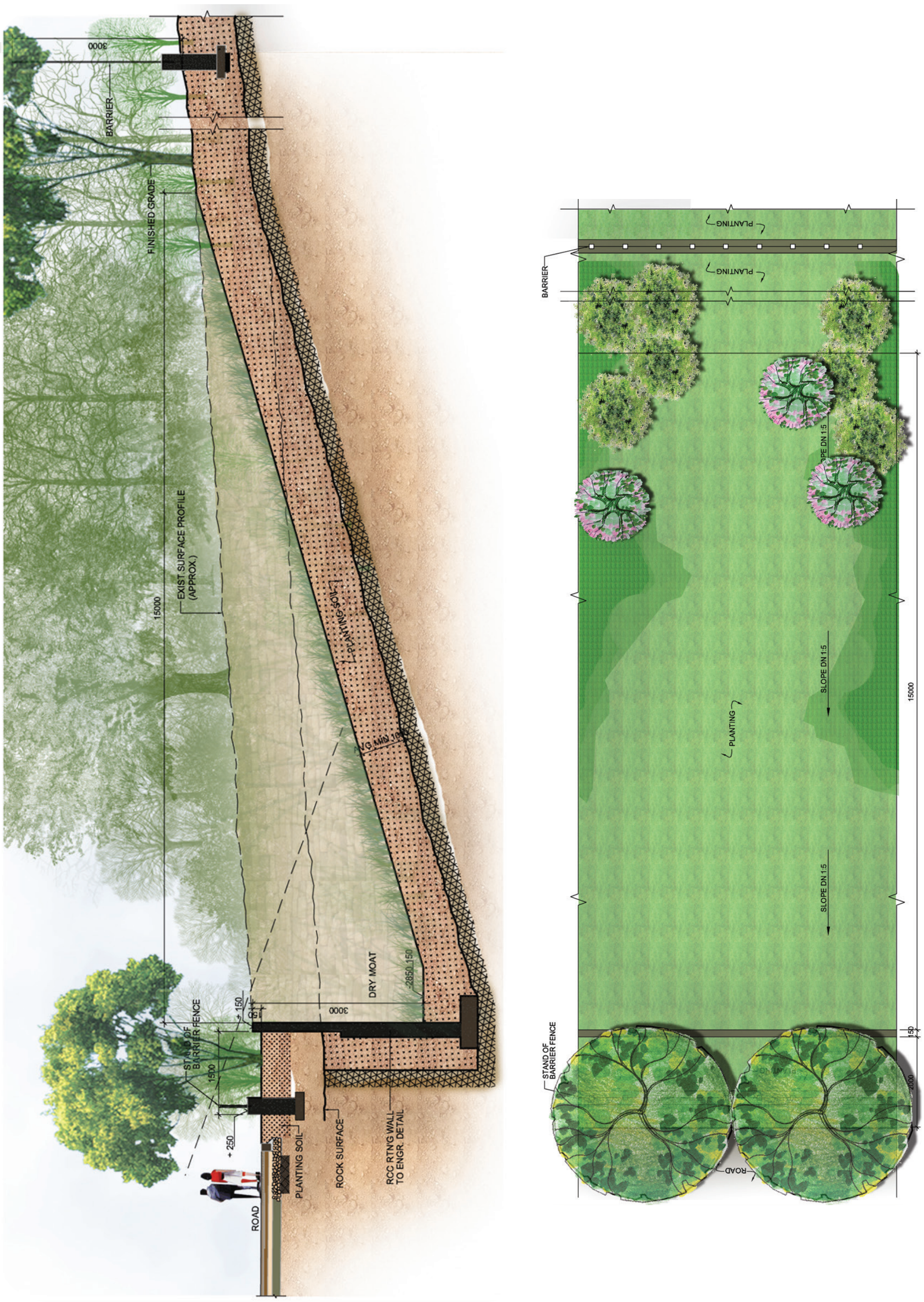


Fig. 6.13 PLAN & ELEVATION - BARKING DEER & SAMBHAR DRY MOAT BARRIER

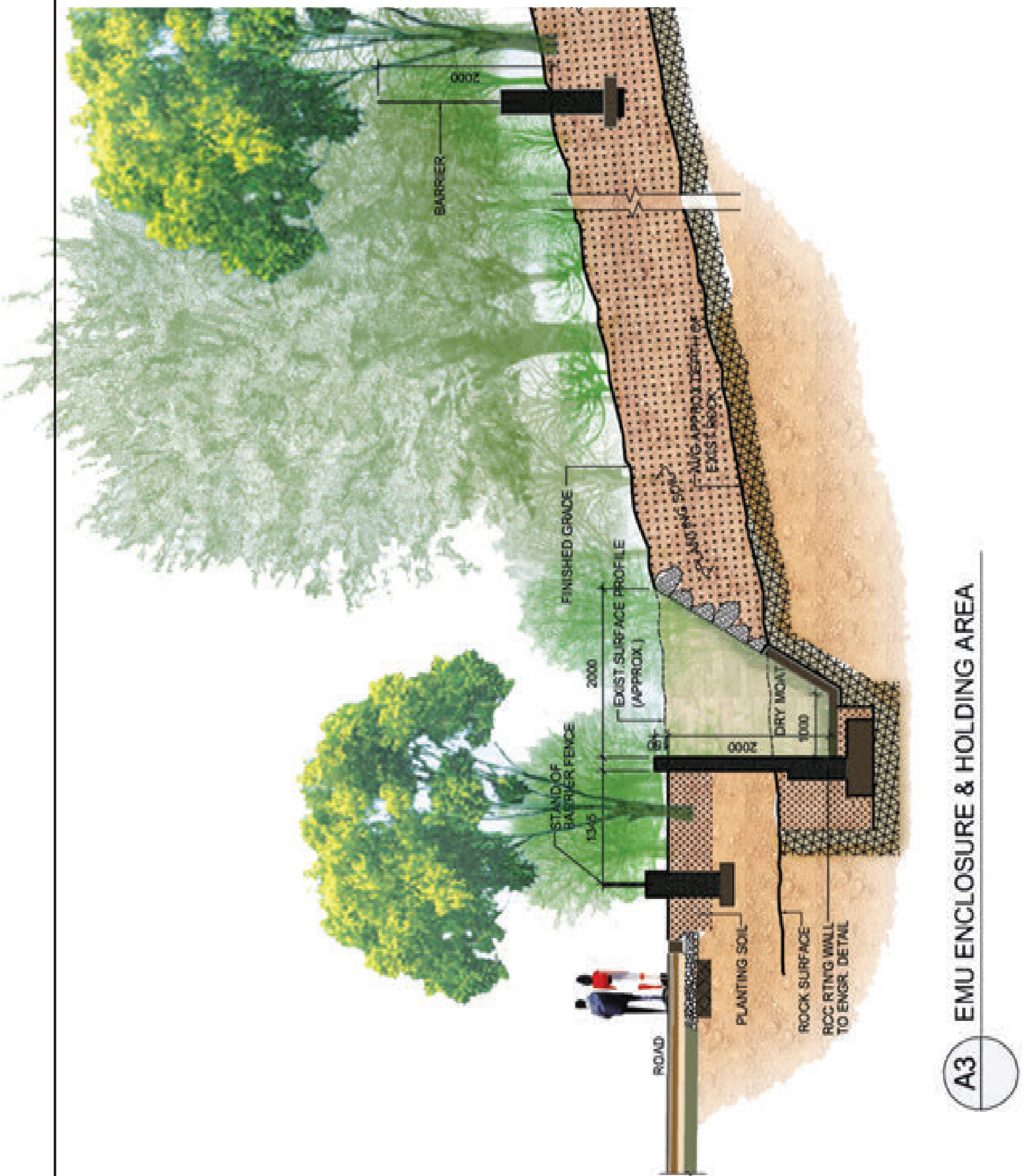


Fig. 6.14 (ILLUSTRATIVE DWG.) PLAN & ELEVATION - EMU DRY MOAT BARRIER

Fig. 6.15 PLAN & ELEVATION - ELEPHANT & GAUR DRY MOAT BARRIER

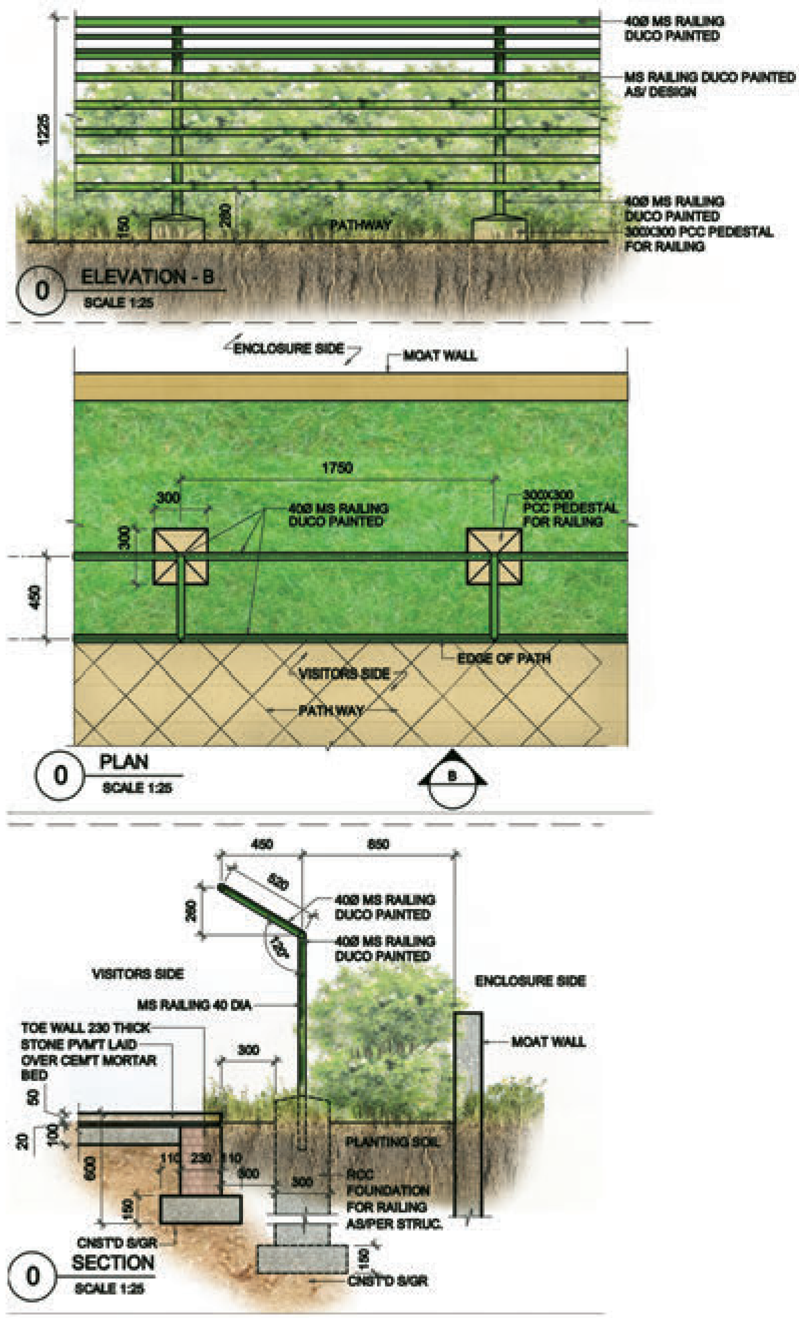


Fig. 6.16 (ILLUSTRATIVE DWG.) STAND OFF BARRIER RAILING 1

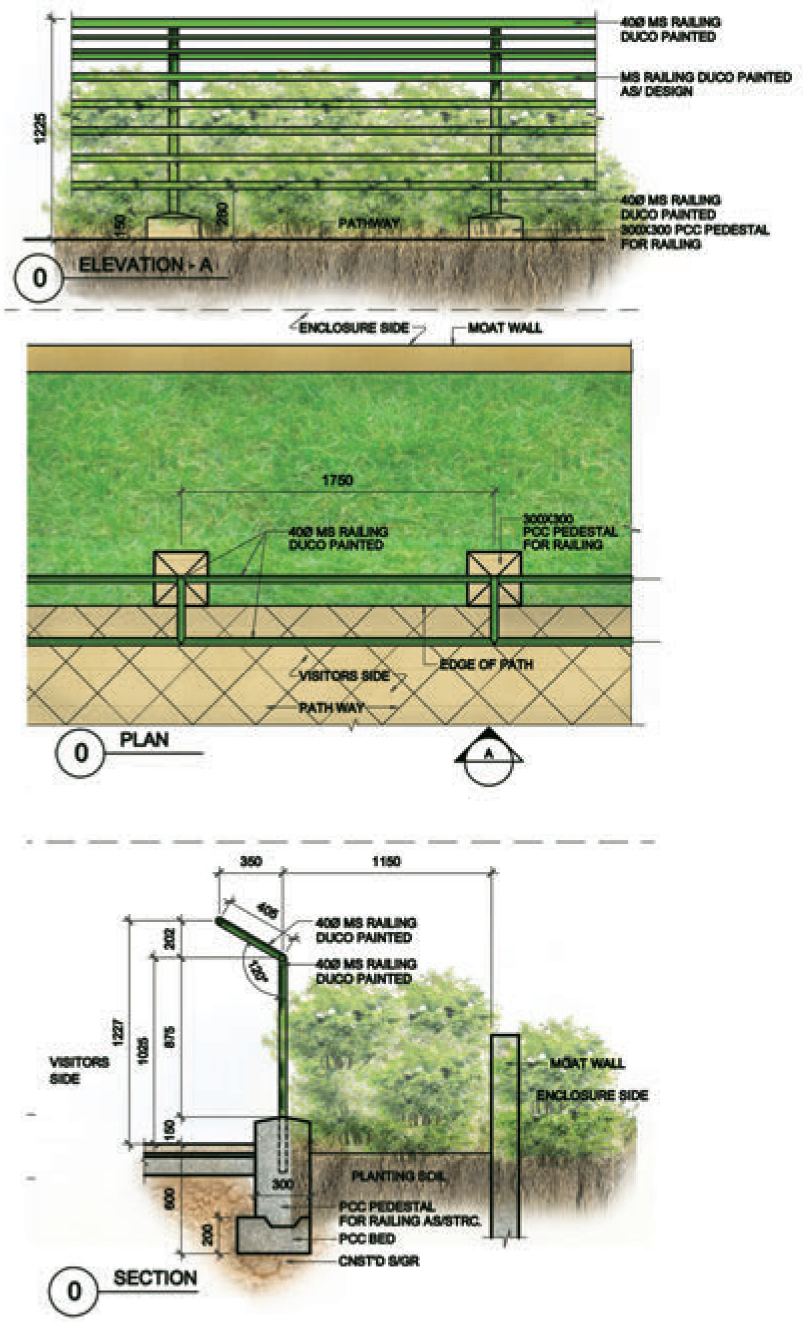


Fig. 6.17 (ILLUSTRATIVE DWG.) STAND OFF BARRIER RAILING 2

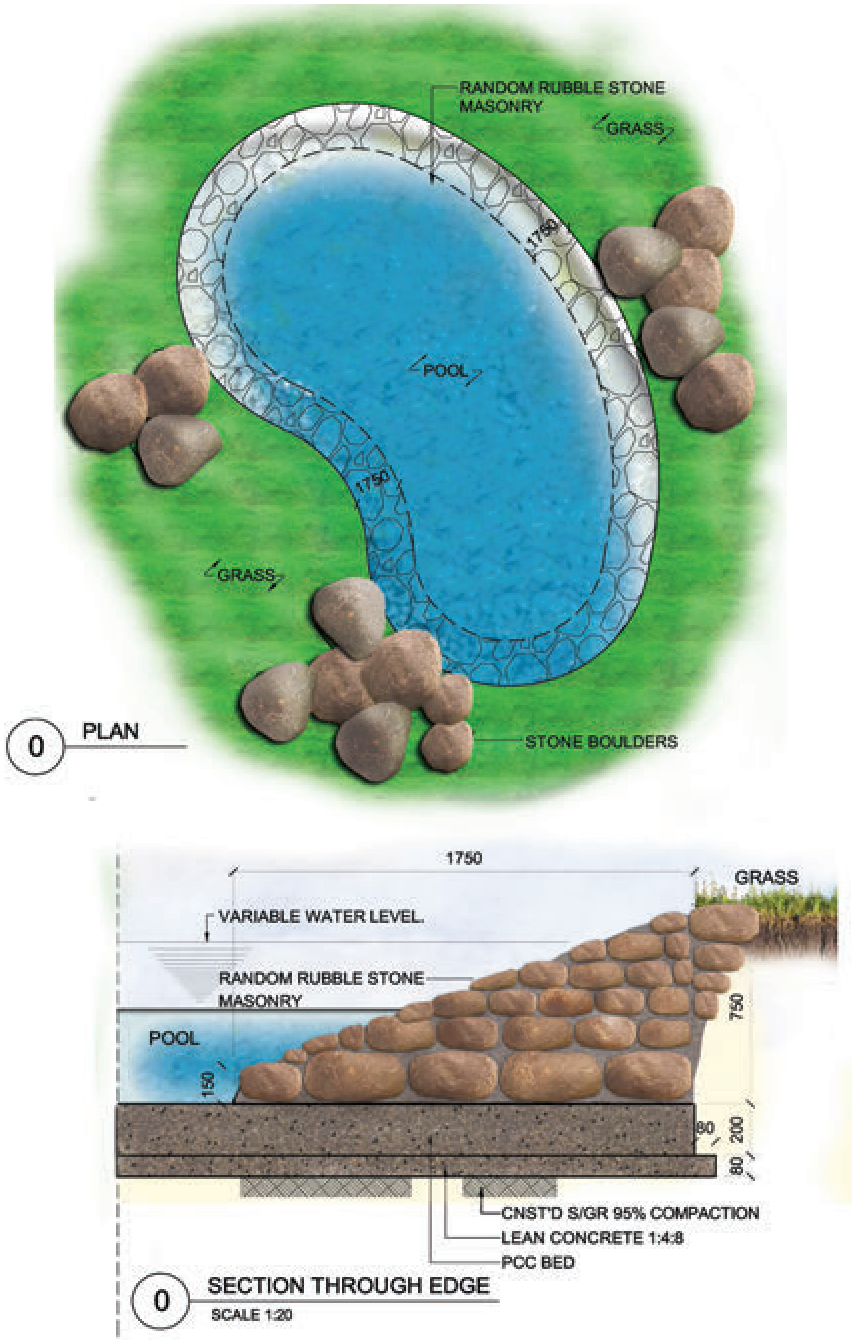


Fig. 6.18 (ILLUSTRATIVE DWG.) DESIGN OF POOL EDGE - INSIDE ENCLOSURE

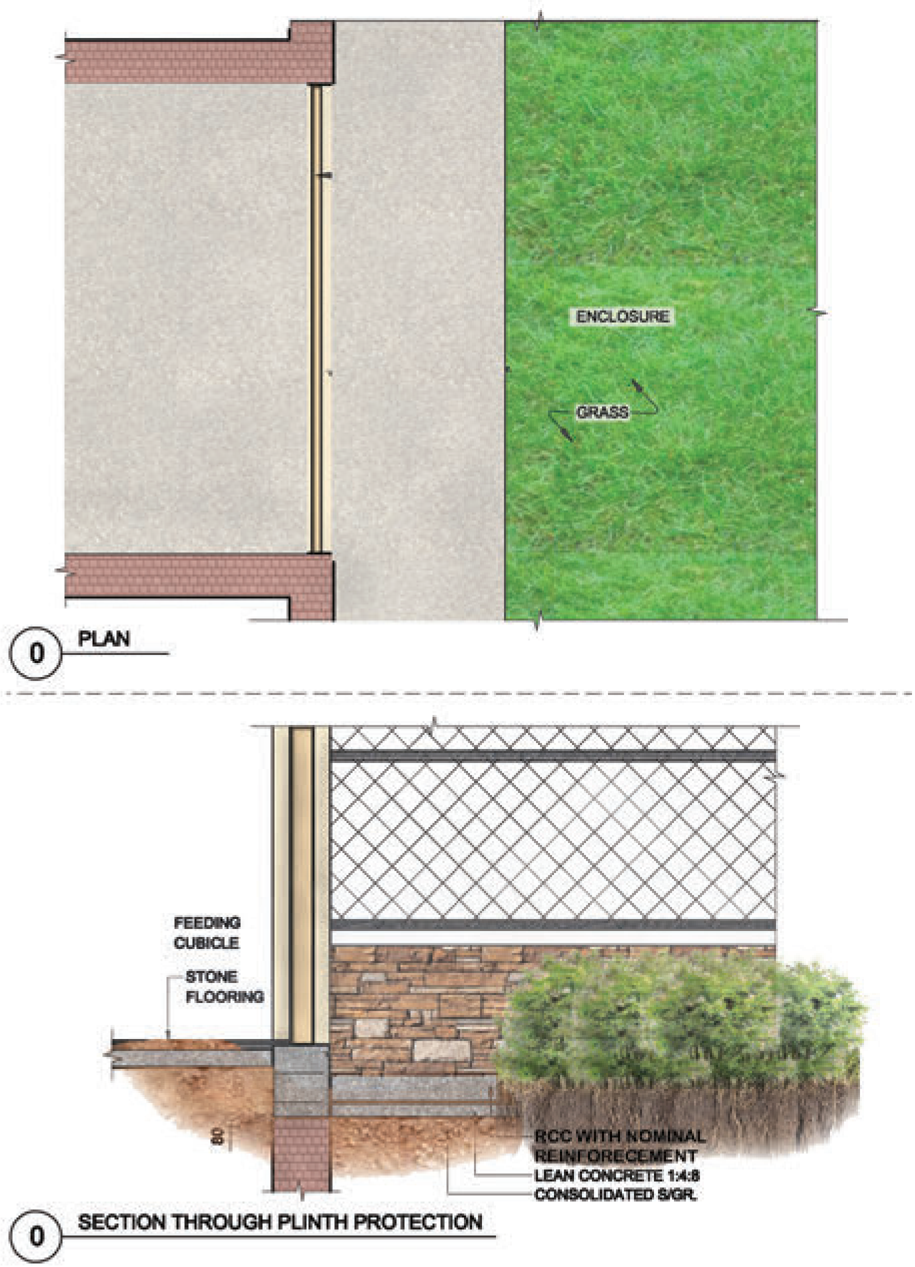


Fig. 6.19 (ILLUSTRATIVE DWG.) PLINTH PROAILTECTION DET

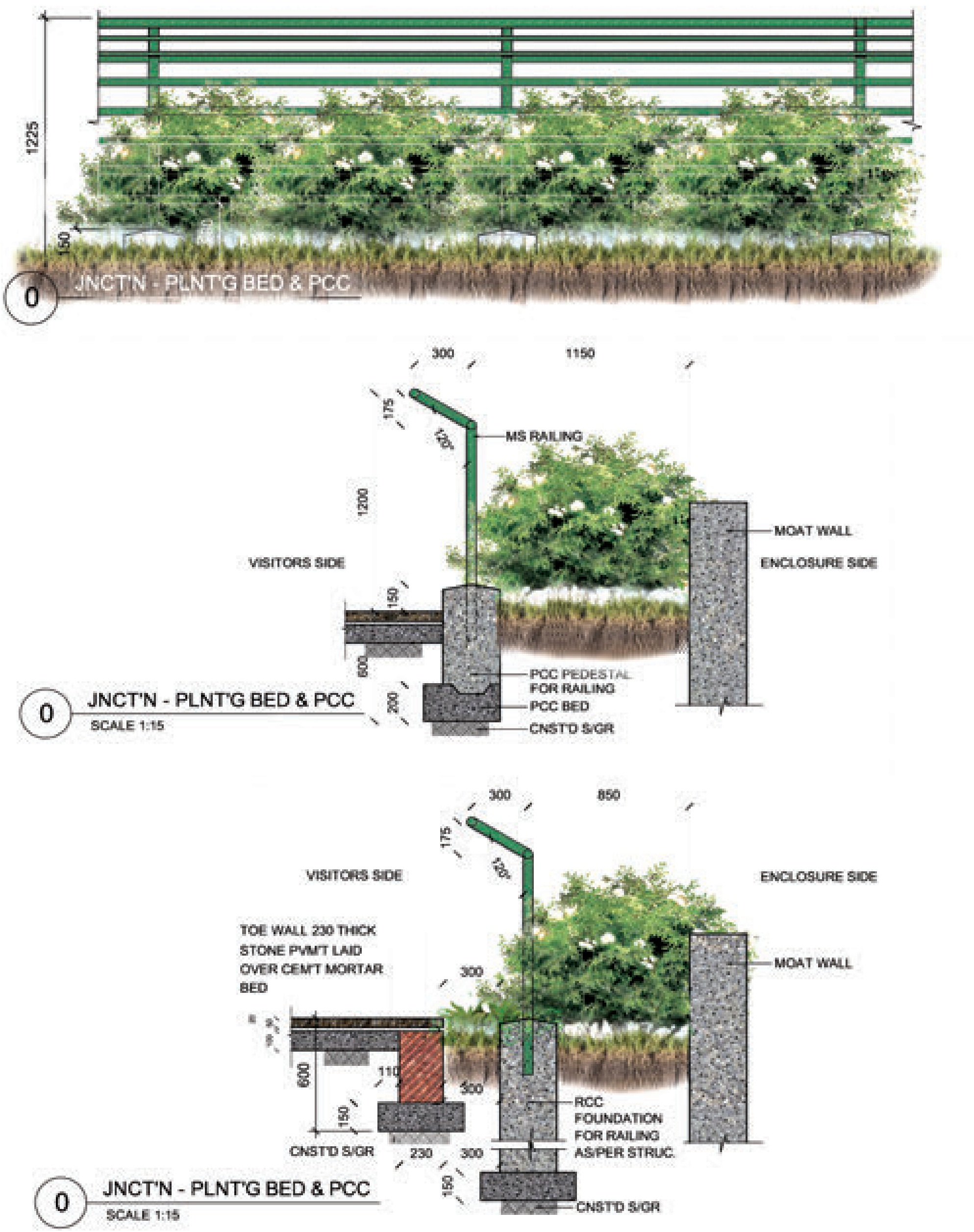


Fig. 6.20 (ILLUSTRATIVE DWG.) STAND OFF BARRIER RAILING

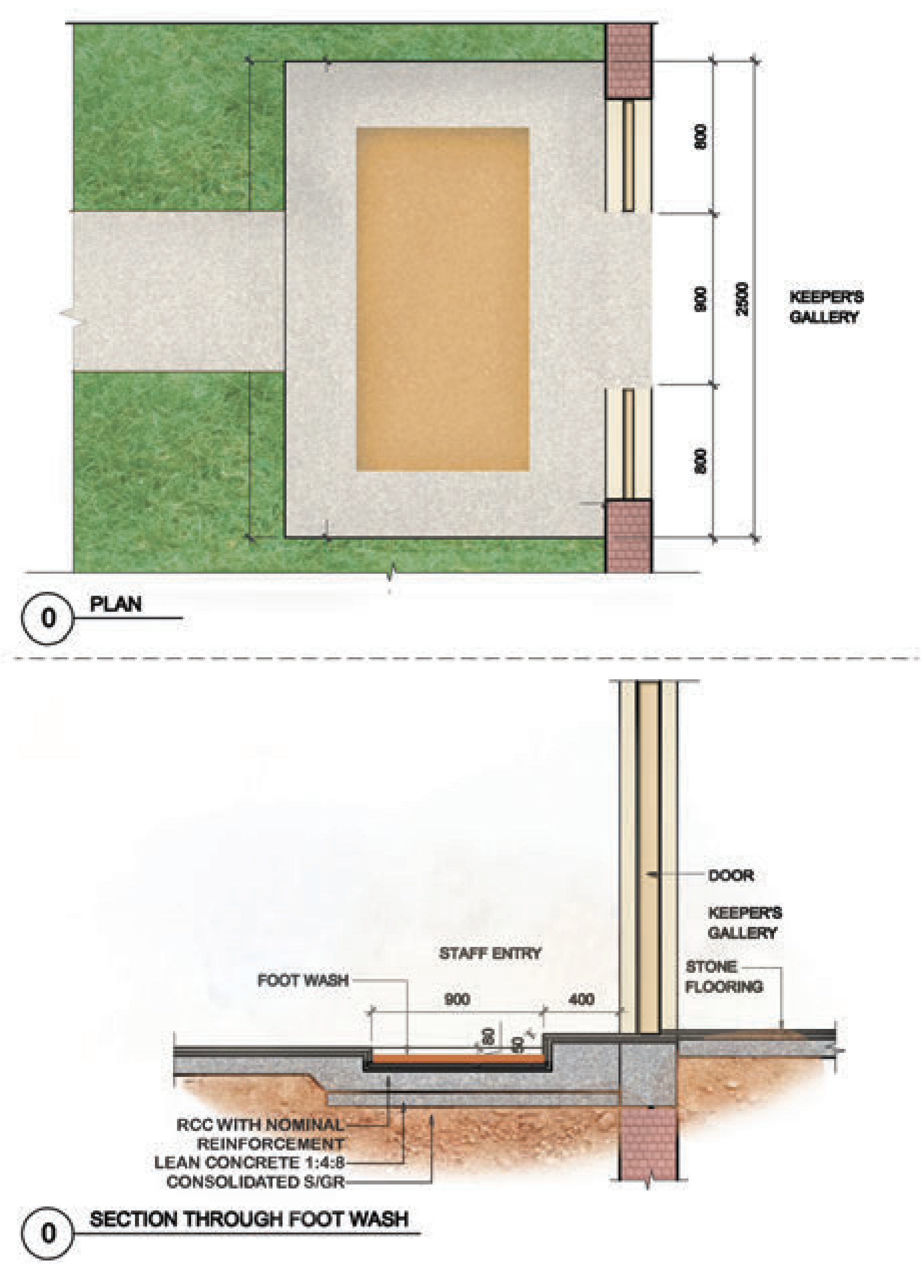


Fig. 6.21 (ILLUSTRATIVE DWG.) RETAINING WALL STAFF ENTRY DETAIL

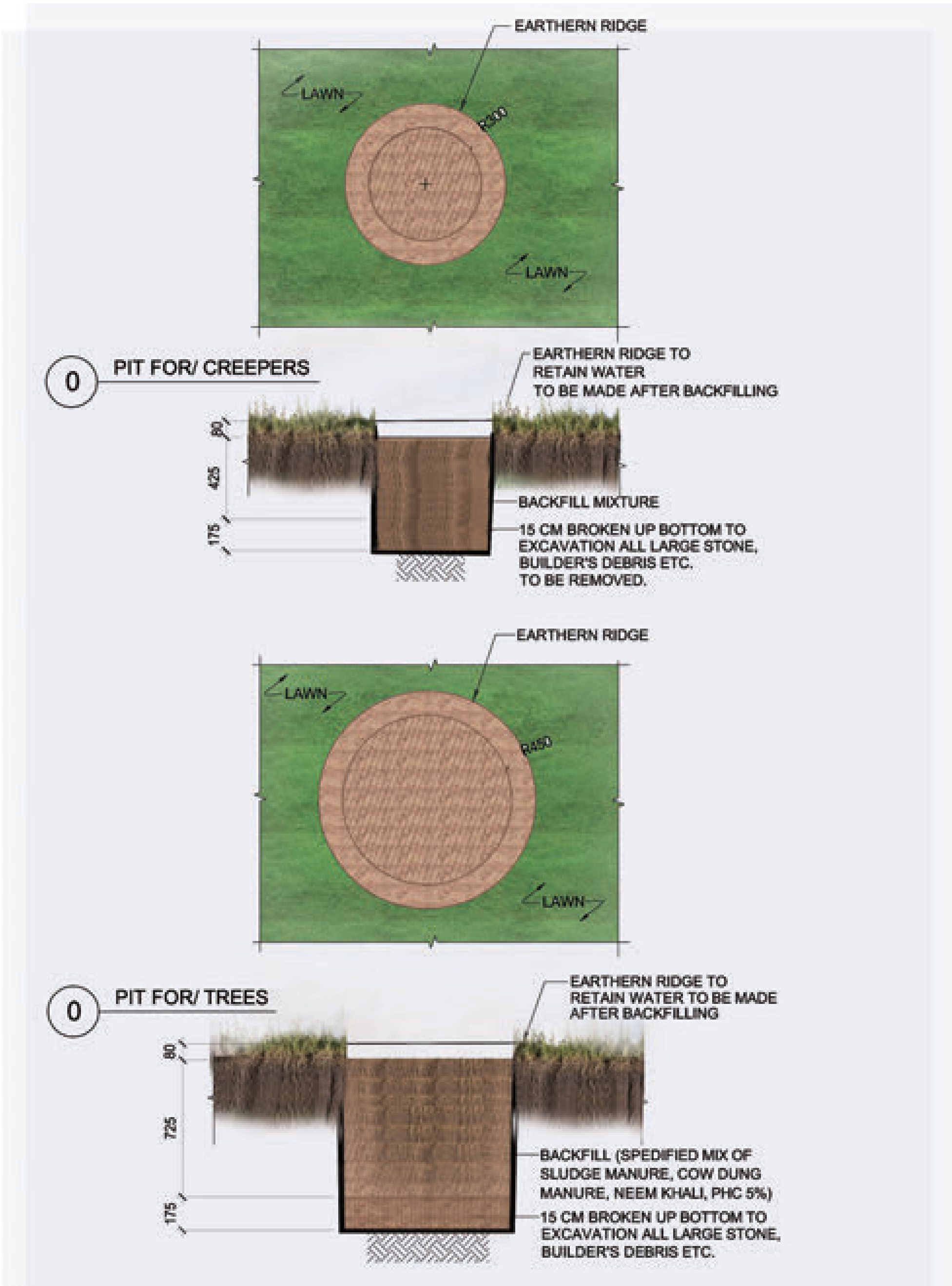
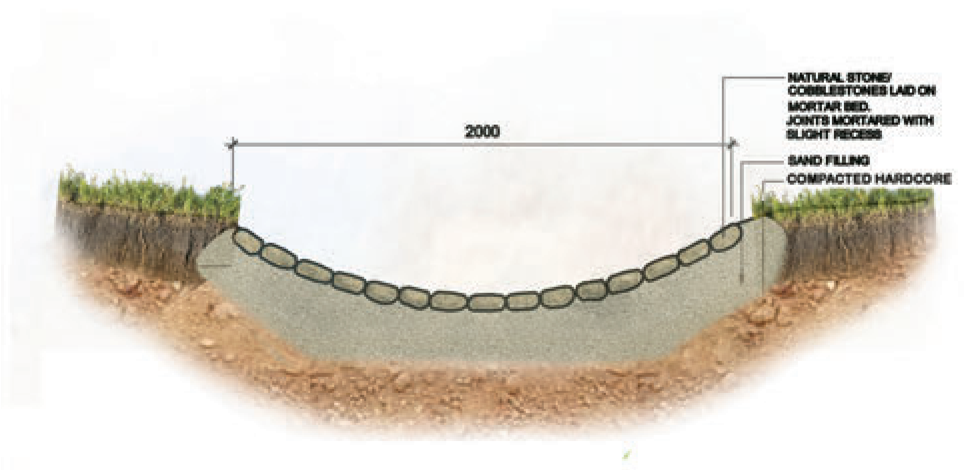
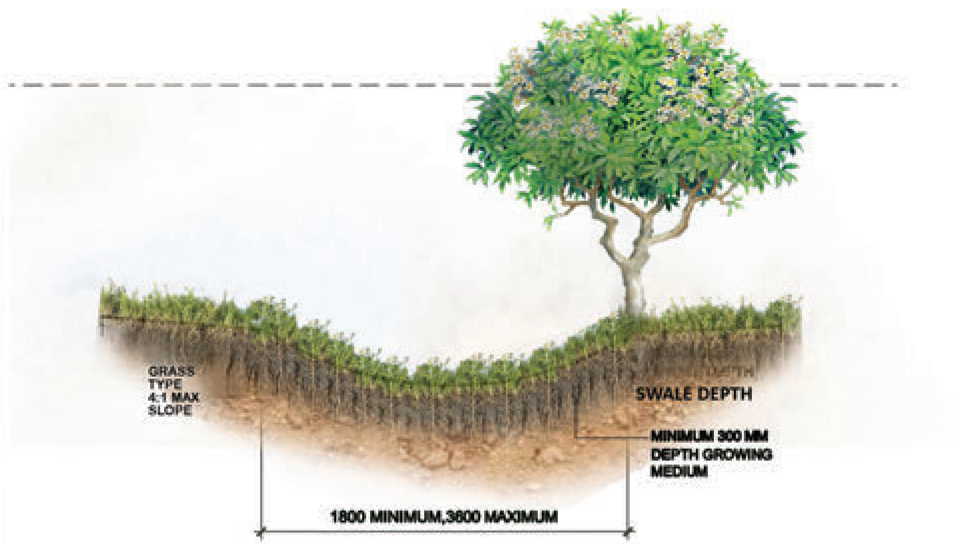


Fig. 6.22 (ILLUSTRATIVE DWG.) PLANTING PIT DETAIL



0 SWALE (COBBLES STONE SURFACE)



0 SWALE (NATURAL GRASS SURFACE)

Fig. 6.23 (ILLUSTRATIVE DWG.) SWALE SECTION

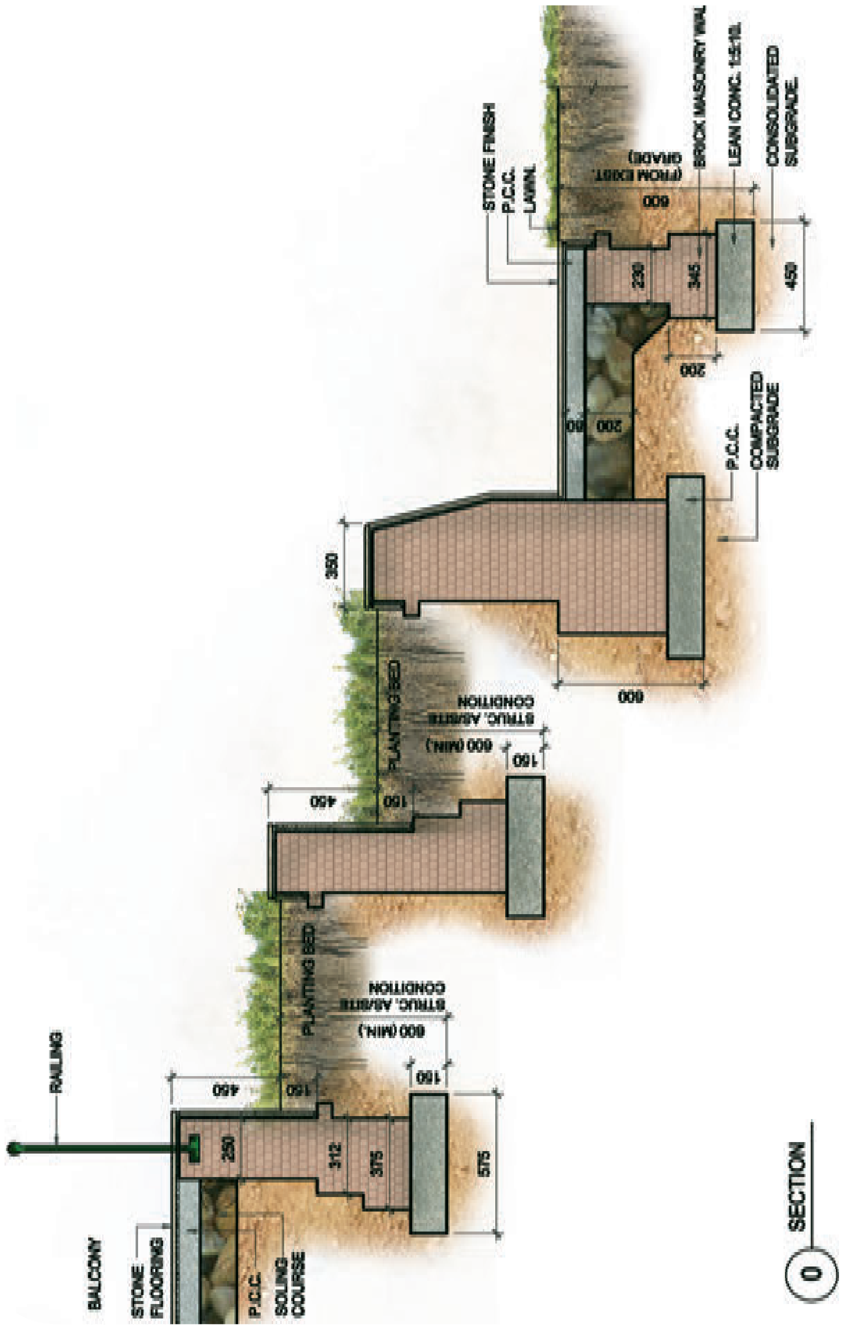
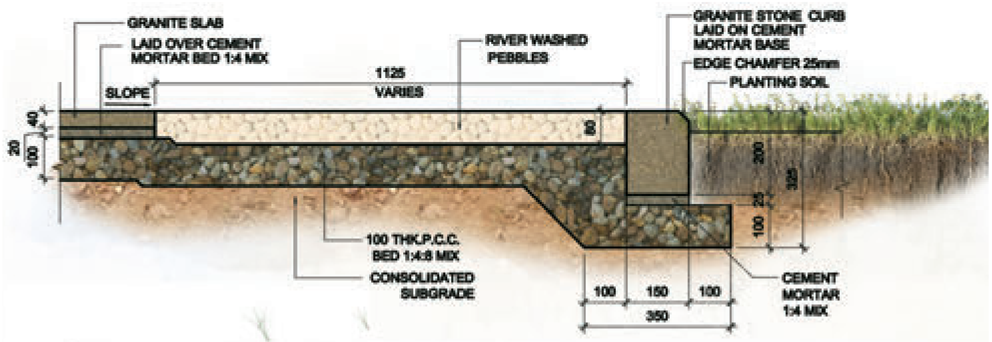
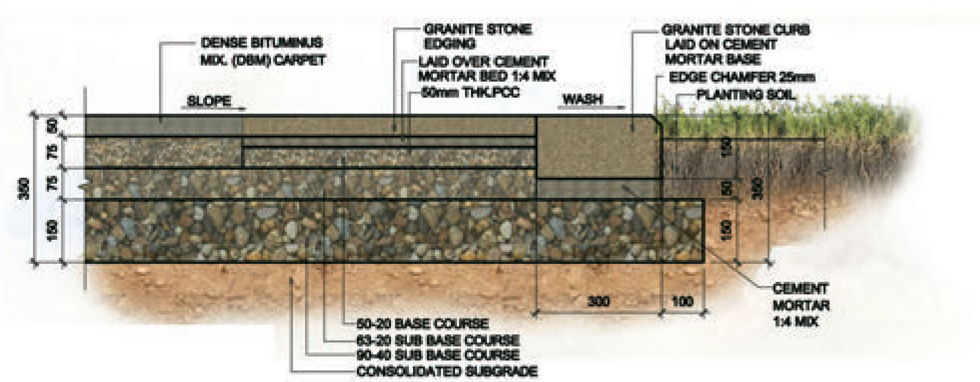


Fig. 6.24 (ILLUSTRATIVE DWG.) STEP PLANTER DETAIL



0 DETAIL-STONE & AGGREGATE PEDESTRIAN PATH



0 DETAIL - BLACK TOP & GRANITE STONE

Fig. 6.25 (ILLUSTRATIVE DWG.) JUNCTION CARRIAGE WAY

6.5.2 Enclosures Enrichment

A bare enclosure devoid of vegetation or other artefacts, to recreate the natural habitat of exhibited animal, appears very drab and boring for both the animal as well as the visitors. It is desirable to provide vegetation and other elements within the enclosure to recreate the original habitat of the animal. These include vegetation, enrichment elements, landforms for burrowing etc. This helps the animal to maintain its natural behaviour as well as provides the visitors with the view of the surroundings which are similar to the animals' natural territory. This is achieved by providing what are known as enrichment elements. Enrichment elements should provide for behavioural requirements of individual species to allow for activities like scratching, wallowing, burrowing, swimming, hiding and dust bathing etc.

It is desirable to provide artefacts like live trees, shrubs , caves, dens, soil for digging, trees, logs for scratching or climbing or discrete holes / burrows in them to look for food or vines to be used as swingsfor various animals who love such activities.

Animals in captivity in a zoo have plenty of 'free' time. In natural surroundings most of their time is spent in looking for food & mates and ensuring their survival which is automatically ensured in the zoo. In captivity, feed and water is available, grouping for social interaction and breeding are fairly stable, animals are secure from predator attack, territory is marked by enclosure fencing. Therefore, the captive animals are left with free

Fig. 6.26 A well enriched enclosure. All enrichment elements should be derived from the natural habits of the animal in the wild. Habits will include chewing, basking, climbing, digging, scratching, wallowing etc. Every enrichment component should cater to one or more habits of specific animals.

Fig. 6.26 & Fig. 6.27 High quality realistic animal enclosure enrichment is a very complex task which if not executed properly often appears amateurish. Effective enrichment requires deep knowledge of animal's native habitat, climatic conditions of the zoo location, plants & planting, fabrication & construction experience, high degree of concern for maintenance and finally patience to see the result unfold over time.

time which is not available to the animal in the wild. With time on hand, animal needs to be provided challenging exercises and enjoyment to keep them occupied. Otherwise, they display stereotypic behaviour. It is to counter that, that the enclosure enrichment is provided and should be designed accordingly.

The enrichment elements are species-specific and they vary in type and the size in as many ways as the number of different animals in the zoo. Design of enrichment should be decided to relate to specific animal's behaviour and life style and should ensure physical and mental stimulation for each type of species.

Enrichment can be in the form of placement of food and their distribution time. Instead of being left at one place at one time, food placement can be used to prolong the feed time

Fig. 6.28, Fig. 6.29 & Fig. 6.30 Enrichment can also be done effectively using natural on site materials such as rocks in their original form, indigenous plants and local rocks in a dressed form for stone masonry.

Fig. 6.31 & Fig. 6.32 Enrichment can use artificial materials like fibre glass rocks and logs in conjunction with integrated hot wires.

Fig. 6.33 Enrichment should be provided not only to be viewed but also to be used functionally to hide the barrier as in this enclosure.

to maintain their natural instinct. Fruits, vegetables, or meat can be left or hidden in small quantities at various location even at a higher level over a structure or net to encourage the animal to strive to reach it which will provide feed and exercise and also make the animal more inclined to interact socially.

Enrichment can be in the form of sensory inducement also. This will include touch, smell, sound, taste and sight. The olfactory inducement which uses sense of smell can be in the form of herbs etc. which can be located around the enclosure allowing the animal to reach for it. Cognitive enrichment should be of a type which substitutes for items in animal natural habitat to invoke behaviour pattern of the animal in the wild. Such items included bones, hoses, rope ladders, wooden logs etc. Cognitive enrichment provides mental simulation by hiding the food at different locations and within different objects to cause the animals to forage through the enclosure to reach the food.

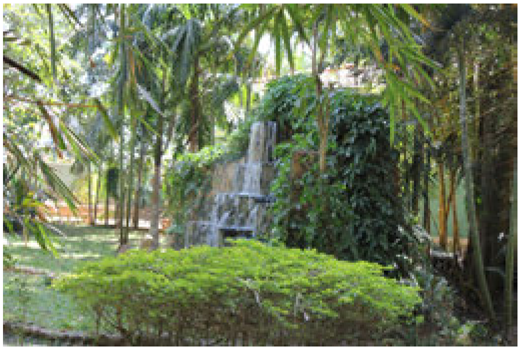


Fig. 6.34 Landscape elements such as this waterfall, can also serve as screens between two spaces.

Another creative enrichment of the 'social' type can be in the form of housing another species within the same enclosure which are naturally found in association with the species in the wild. This encourages healthy social behaviour. Lastly the physical habitat should have the surface conditions (such as rock outcrops, plain surfaces etc.) and community of various, plants. This helps in meeting the animals health needs and serve to create suitable enclosure conditions.

A final word, on what is commonly found, but should not be done. The enrichment should not be thought of and designed from the human point of view but should be designed from the view point of the animals, physical and mental needs. To encourage the animal to climb a tree or inclined logs may be provided and not a staircase! Neither is a seat required for the animal to sit! The authors have observed situations where if the enrichment inside the enclosure was lifted and placed outside it could have served as a children's play area!

6.5.3 Enclosure Finishes

Materials' texture and colour of the surfaces facing the enclosure side of the exhibit and seen by the visitor should be finished (surface material, colour, texture) to merge with the habitat type and enclosure design. Material, commonly used for enclosures, are mild steel chain fencing with M.S. pipe support and toe walls. The walls, depending upon the location, are either brick or stone masonry walls. Feeding cubicles walls facing

Fig. 6.35, Fig. 6.36, Fig. 6.37 & Fig. 6.38 The guiding principle for the selection of material colour & texture is that it should appear to be a part of the original habitat of the animal and should be indigenour to the region where the zoo is located. Construction detailing should help merge the enclosure with landscape in terms of colour and texture. Artificial landscape elements, such as these rocks, require specialised skill and expertise.

the enclosure side also form a part of enclosure view. Moat walls are also visible to the visitors, they also require a suitable finish and should not show up as a vast concrete surface. Enclosure finishes also depends upon the functional requirements. For some animals relatively plain finishes may be required so that they are not able to get a grip which will enable them to climb and escape – Sloth bear or Himalayan black bears are examples. For other animals rough to very rough random rubble (RR) stone masonry may have to be used. The material used for RR masonry in India is generally quartzite but in rare cases granite can also be used. This granite is of a type which cannot be used for slabs (available as granite hills in Bundhelkhand region near Mahoba, U.P. for example). It is used presently for general construction, but has still not been used in zoos where its colour and resistance to weathering can make it an ideal material.

The moat walls, including the inside of the moat wall, should appear to be a part of the naturalistic enclosure. It should either be built of stone etc. or should be finished to make it appear natural by imparting a texture on the concrete surface. In India, moat walls are finished with cement mortar generally finished with neat cement coat. The high reflectivity and light colour makes it conspicuous completely out of place in enclosures which are designed to be natural looking. Moat walls should be given special attention with regard to finishes because of their large surface area and visibility. Coarse sand cement mortar with dull dusty brown colour additive is another material and texture often used in Indian zoos which is quite suitable and merges well with colours of vegetation.

Another finish which can be used is fibre glass. Fibre glass can be cast in any shape, size colour and texture. It can be made to appear or copy any natural material very realistically. In case fibre glass is used, it will be generally desirable to use the same group of shape repeated randomly. This will reduce the cost considerably because more number of elements can be made from the same mould.

What have been described until now were lifeless surfaces. Another idea is to intersperse masonry materials with planting of vegetation in cavities created within the surfaces. Cavities can be filled with planting soil and planted with ground covers and vines. This vegetation will cover a large surface area and add to the overall natural appearance of the enclosure. Such planting requires minimum maintenance, if any. This makes it suitable for creative designing and extensive use.

6.5.4 Barriers

There is a barrier between the visitors and the animals (whose length by CZA recommendation, should not be more than 25% of the enclosure perimeter). The other barrier is the one separating the animal enclosure and outside area along the rest of the perimeter.

Fig. 6.39, Fig. 6.40, Fig. 6.41, Fig. 6.42 & Fig. 6.43 The design of barrier should be based on functional requirements to prevent animal escape (height and width) and good camouflage to ensure that it is not identifiable as a barrier because of visibility of plaster surfaces, exposed brick masonry etc. The visitors railing made out of artificial wood and stone is an acceptable option.

Barriers of each species should be structurally designed to withstand the thrust from the animal, and it should be high and wide enough to prevent escape of the animals so that they should not be able to climb or jump out of the exhibit. But species like pangolin, fox and hyena or porcupine can escape from under the ground. Masonry or concrete foundation should be deep enough to prevent such escape.

The key principle in designing of enclosures in zoos is to ensure a completely secure barrier, where the animal in the exhibit should be secure from visitors and the staff should be secure from the animals inside. It should be taken as an axiom that inspite of

Fig. 6.44 & Fig. 6.45 The barriers should serve as much to prevent the animal to escape as to allow the visitor any kind of access into the enclosure. This seems to be apparent but surprisingly often over looked.The lapse is generally a small design oversight (some corner where the barrier width is less or where the visitors railing allows the person to cross into the set back planting) which results in accidents.

the best of barriers designed, both the animals and visitors will come up with ingenious ways to beat the barrier. This implies that barrier design requires constant review, evolution and up gradation. Over the years, zoo standards and designs have evolved together. And with them have evolved the barrier designs; often through experience and lessons learnt from accidents. Inspite of that, in India as elsewhere, there is still much input required to ensure complete safety.

Earlier enclosures in zoos were like cages fabricated over sized steel sections (to secure against any unexpected accidents) are evolving into natural looking immersion exhibits providing the visitor with an environment where he is together with the animals. But a 100 % fool proof secure barrier which is invisible to the visitor between the visitor and the animal has still to be designed. This has resulted in design evolution of barriers which were either totally or partially camouflaged or the part which was visible merged with the surroundings in terms of design, colour, texture, scale and material appearance.

A basic design parameter for barrier (surprisingly overlooked in India and in zoo around the world) is that it should provide full security, whether it be an elderly person or a child who is barely able to walk. Some recent animal attacks and accidents in histories of zoos, even in accredited and respected zoos, have happened because the barrier design had not been viewed from the perspective of a child or from the outlook of a person given to irresponsible pranks. Barrier design has to cater to all ages as well as, handicapped persons and should be able to prevent against mischievous tricks by visitors. To summarise, children are an unpredictable variable in design and design has to cater to them.

Traditionally, in Indian zoos, barriers between the visitors and animals gave the impression of the visitor being 'out' and the animal being 'in', separated with a conspicuous fencing and set back planting. The back of the visitor is open to the visitor's circulation path and disturbing noises. The fencing is mild steel with wooden members or completely fabricated with mild steel sections painted with enamel paint.

With the development of zoo design in India and the exposure of zoo officials to evolution in zoo design in other parts of the world, the concept of immersion exhibit was introduced, in which the visitor, are expected to be a part of the enclosure and enclosure enrichment and they are screened off from other distracting views and disturbing

Fig. 6.46, Fig. 6.47 & Fig. 6.48 It should be ensured that the barrier design should cater to all age groups. In the pictures above children have a problem!

sounds of the zoo. This requires the barrier design to be camouflaged and subdued to the extent of being not visible. This is the contemporary expectation from good barrier design where the visitor is one with the animal and yet the animal cannot reach the visitor.

There is always a continuing debate amongst zoo professionals with regard to the type, and dimensions of barriers for enclosures of various animals. There is a general consensus and some standard guidelines are being followed based on the CZA guidelines. Yet there are variations within Indian and international zoos based on the personal experience and judgement of the zoo directors and other concerned with zoo designing. Such freedom, within self - imposed limits, should be encouraged to enable development and evolution of zoo designing. This also provides a sense of satisfaction derived from personal contribution to the project.

It needs to be pointed out here that the junctions between the visitors viewing stretch and the perimeter fencing is a vulnerable point. If barrier standards are not adhered to this location it can be a place for animal to escape.

More recently barrier design in Indian zoos has developed with the availability and use of new materials, technology and skills. There are some very natural looking barriers (particularly fencing) that are being created by using artificial, weather and vandalism resistant materials and paints now available in India.

6.5.5 Feeding Cubicles

a) Layout and Architectural Considerations

Food and security is a basic natural necessity of animals like it is for humans. In the wild, the animals find their own food. The herbivores get their food from the foliage. The carnivores kill animals to satisfy their hunger. Unlike herbivores, the carnivores do not have a fixed time or quantity by way of a meal. This is in contrast to the situation in a zoo where the animals are fed with the proper kind and quantity of diet. This is given to the animals ones or twice a day in the feeding cubicles. Feeding cubicles are also referred to as night shelters. This is an essential structure in all animal enclosures in a zoo. Feeding cubicles are small cabins attached to the enclosure. As the name suggests animals come to the feeding cubicles to receive their daily meal. This is also the place where the animals are housed for the night and secured from inclement weather and accidental attacks by street dogs, snakes etc. in an enclosed covered space.

Besides above, the feeding cubicles also serve as the area for treatment for minor injuries/ diseases of the animal (for major medical attention of animal is shifted to the zoo hospital). Feeding cubicle is also used for allowing the animals into the enclosure area on a rotational basis because some animals need to be kept separate because of infighting and cannibalistic behaviour.

This leads to the realisation that if a few of the animals have to be kept separated from the others for some days or weeks they still need an open space for normal daily exercise. This is provided in the form of a 'Kraal'. This medium sized open area is located adjacent to the feeding cubicles and connected to them. The size of kraal relates to the size and behaviour of the particular animal. Kraals have a direct passage/ opening from which the animal can be let out from the feeding cubicle cell and returned back. Kraal barrier should be the same in size and specifications as that of the enclosure area. No moat is used since kraal is off-display area. For this reason kraal should be kept screened and away from the visitors' circulation & access. Adequately sized water pointsare provided according to the requirements of the animal.

To manage the animals in the night shelters and to provide them food and treatment, animal keepers should have access to them. This implies that there should be a space for keepers. This space aligned along the entire length of the feeding cubicles is known as the keeper's gallery. This space requires easy movement, space for storage of equipment, and space for housing the mechanism for opening the gates between the night shelter cells and gates between the night shelter and the enclosure. Attached to the keeper's gallery is a keeper's room which serves as a small work space for the keeper to maintain records, to hang uniforms & night shelter keys and has provision for washing hands. Required furniture is provided to carry out the above duties.

Fig. 6.49, Fig. 6.50 & Fig. 6.51 In night shelters the design and dimensions should be appropriate for all animal related activities and ease of keepers. The squeeze cages and grilles in the cubicles can be improved on both counts.

The design should fulfil the purposes as mentioned above. Design of feeding cubicles should primarily provide following:

Fig. 6.52 Amazingly realistic stone appearance structure in Bangkok, Thailand, are actually night shelters for giraffes which vanish behind them.

Main components of feeding structure:

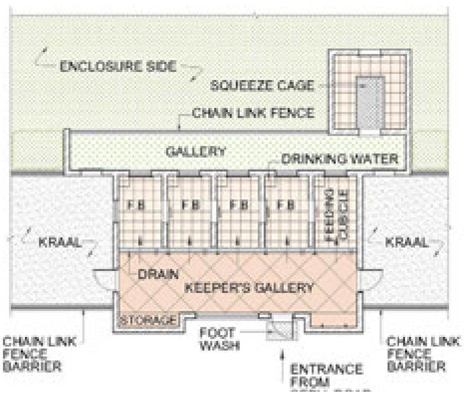


Fig. 6.53 Night shelter layout for blackbuck and tiger enclosure with separate animal gallery and showing typical relationship of various spaces

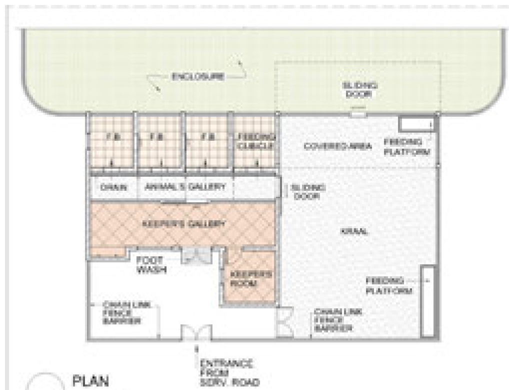


Fig. 6.54 Night shelter layout for blackbuck and tiger enclosure without separate animal gallery.

i. Cells to house the animals for feeding: The number of cells to be provided is decided on each zoo basis and depending on the Animal Collection Plan requirements.

ii. Keeper's Gallery: This provides access to keepers from the service road to the cell. This also is the storage area for equipment and linen used in management of cells. The water from washing of the cells is received in an open drain in the keeper's gallery from where it is drained out. The entry of the keeper's gallery from outside is through a foot wash to disinfect the shoes and prevent transfer of diseases from zoo areas to feeding cubicles. It is from this area that the doors separating cubicles and opening the cubicles to the enclosure side are operated. Therefore, the width of the keeper's gallery should be such that it allows the manual operation of closing and opening mechanism of the cell doors to be carried out conveniently. It has been found by experience that a clear width of minimum 3.00 mts. suffices; it may be increased for any site specific reasons.

iii. Squeeze Cage: Squeeze cage is required to ensure ease of capture, treatment and separation from other animals when required.

Animals requiring treatment are moved from the cubicle to a cage adjacent to the last cubicle. The squeeze cage has one side which can be moved to reduce the cage size to enable the animal to be held for access, examination and treatment. Squeeze cage has space around it (except on the side it is attached to the cubicle) for easy movement. The minimum dimension around it should be at least 1025mm and the clear height of a keeper gallery should be 2750 mm to allow for operation of interconnecting doors and hanging of ceiling fans.It is always a problem to move the animals into the squeeze cage because the animal relates it to an unpleasant experience. Therefore, to overcome this hesitation of the animal,the squeeze cage should be placed between the cells and enclosure so that the animal has to pass through it regularly and the animal does not have any inhibition in entering the squeeze cage.

b) External Finishes

External finishes of feeding cubicle building facing the enclosure side (or any part of it which are visible to the visitors) should be naturalistic finish (such as stone masonry) depending on the design and should relate to the enclosure enrichment elements in colour and texture.

The external finish on other walls of cubicle can be cement plaster, tiles or any other suitable material which should be able to protect the walls against climate. It should have colours which match the natural surroundings and should be non-reflecting so that it helps to merge the structure with the surroundings. Random rubble stone masonry, any other masonry using local stone, cement or sand plaster (textured or otherwise) painted with mat external paints or carefully selected terracotta/ vitrified tiles can be used. Any other material or finish which is not conspicuous and disturbing to the zoo environment can also be used.

c) Internal Finishes

The floor and walls of feeding cubicles and the related keeper's gallery along with the squeeze cage area should have a material which is mat, dull in colour and washable. Suggested materials will include, washable paint, granite/ kota stone or vitrified tiles for walls. Stone and vitrified tiles for flooring and drains. Surface materials, particularly for flooring, should not be slippery and should be a textured surface. Vitrified tiles with textured natural looking surface are available in fine and coarse textures. Various kinds of textures can be created in any stone whether it be an igneous hard stone such as granite or a sedimentary stone such as 'kotah'. Textures in use include sand blasted, shot blasted, chiselled etc. An economical, but no longer in conventional use, is the IPC (Indian Patent Stone) commonly known as cement flooring. It has the required quality to make it suitable for use except that skilled persons for execution are generally not available.

Design Guidelines for Feeding Cubicles

1. All tiles or stones on any surface of the cubicle should be firmly fixed to the surface (i.e. it should be properly detailed) to withstand scratching, hitting and all kinds of rough treatment by the animals and also be able to resist the water jet which may be used for washing.

2. All surfaces should be easily and repeatedly cleanable and washable with water and chemicals.

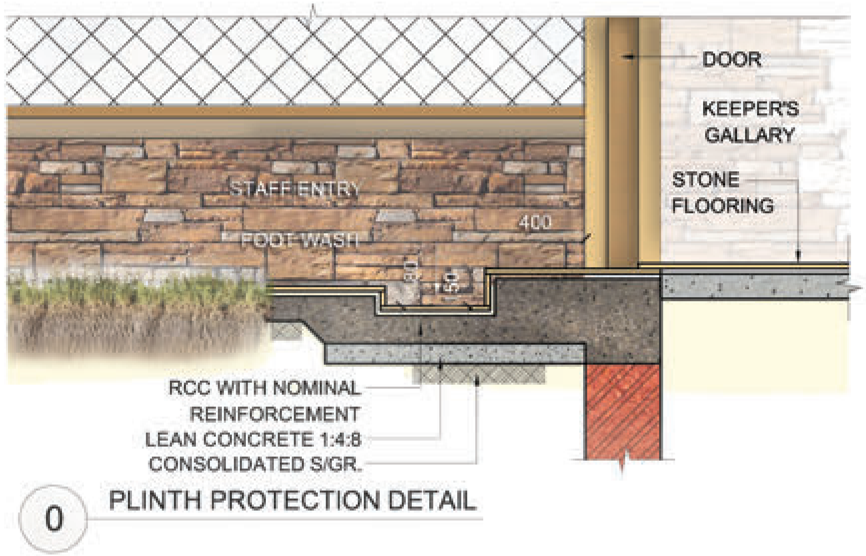
3. Wall surfaces may be glazed or textured tiles.

4. Flooring should be textured surface to enable the animal to have a grip.

5. Feeding cubicles should have minimum dimensions; length, breadth and height as per the CZA recommendations.

6. These should be densely camouflaged with vegetation or hidden by landform to screen it from the view of the visitors.

7. External walls of the feeding cubicles should be treated to merge with the surroundings. This can be done either by replicating the local geomorphologic structure or by having textures and colours which merge with the landscape. As an example an 'exposed aggregate' finish using aggregate of various subdued coloured stones



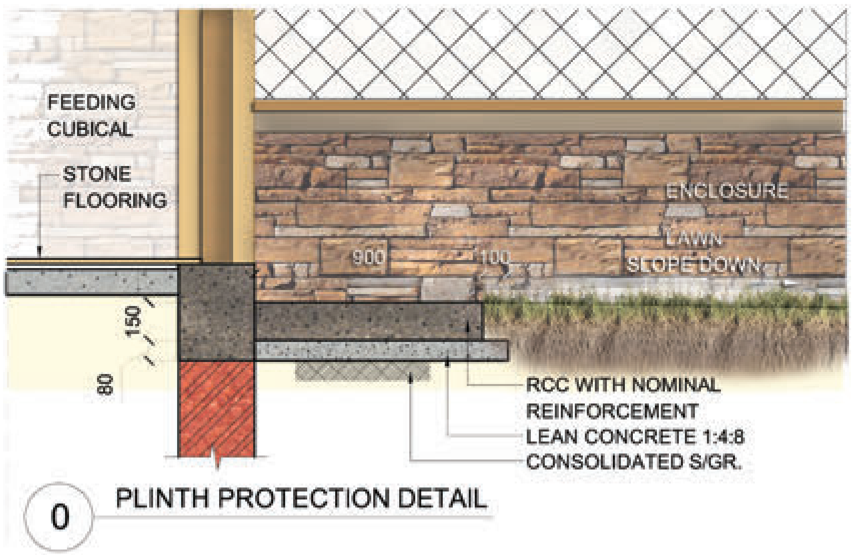


Fig. 6.55 (ILLUSTRATIVE DWG.)

FEEDING CUBBLE LION AND TIGER

Fig. 6.56 & Fig. 6.57 Both external and internal finishes should first conform to the functional requirements (is being easy to clean) and should also have a suitable external finish to match the zoo's natural environment. Both the above are not ideal examples!

The plastered walls are not easy to clean and the artificial stone masonary does not appear natural at all.

8. The flooring of feeding cubicles should be suitably sloped to ensure proper drainage.

6.5.6 Kraals

Design Guidelines for Kraals

1. Kraals should be located away from the visitors' side or visitors' vision.
2. Kraal should have entry points for animals from the night shelter and from the Keeper's gallery for its cleaning and maintenance.
3. Its substratum should be natural. Adequate drinking water and wallowing arrangement should be made for the animals.
4. There should be proper enrichment as in the paddock for the housed species.
5. The kraal should have adequate arrangement for animals as per weather conditions. For example, during summer months, the animals should not be continuously exposed to direct sunlight or during rains, it should have sufficient arrangement of rain shelter etc.
6. In case of herbivores, that are prone to injury being caused by crows etc., the kraal should be properly covered to prevent entry of such birds etc.
7. The sides of Kraals should be suitably proportioned. The Kraal should neither be very deep nor too shallow to give space to the animal to relax in a secure environment.

6.5.7 Space and Dimensional Standards

In any architectural or landscape design an important basis of conceptualising the layout are the areas and sizes that are required for various activities within the zoo. Areas are for spaces such as enclosures, hospital, Interpretation facility, resting places for visitors etc. whereas dimensions refer to the sizes of rooms, length and width of enclosures, width of roads and paths etc. Space and dimensions are decided on the basis of relevant standards along with general design guidelines. Comprehensive standards are available for buildings such as administrative office, veterinary hospital, public toilets etc. and various animal enclosures but standards and design guidelines for other spaces in zoos are not specified. This leads to tremendous variation in sizes and design based on the designer group or the individual - such as the zoo director - taking decisions based on personal experience. A stage has come where standards and dimensions are required to be decided and followed. This does not mean curtailing or discouraging innovation; not at all. All architecture in the world follows strict functional space and dimension standards not only for buildings but electrical, plumbing, air conditioning services as well and yet innovation and creativity flourish. Zoos are in need of comprehensive standards and where some standards are available they need to be augmented to have a complete set.

To summarise, space standards are required for all zoo components, elements, facilities for animals, visitors & zoo personnel, signage. For buildings such as offices, guard rooms, security offices, electrical and plumbing related buildings such as electric substations or sewage treatment plants - existing BIS and National Building Code standards should be used.

As an example, arrival space near/ adjacent to the entrance area inside the zoo should be sized and designed to accommodate the expected number of persons and the activity likely to take place. It should neither be under-sized nor over-sized. In case of situations where the number of users at peak time (certain days during the year) is substantially more, the space should be designed in such a way that the entire space is not visible in one glance but connects to an adjacent space (separated by elements or vegetation) to provide for extra space when required. This helps to scale the space so that a lesser number of persons feel as comfortable as the larger gathering which is accommodated by spreading to adjacent spaces.

The Central Zoo Authority has provided minimum exhibit space for each species. But this is just the minimum permissible. This may be increased depending on availability of space, topography, vegetation, animal behaviour requirements. A large space is good for the animals for viewing by visitors and maintaining the natural behaviour of particular animals. This decision with regard to increasing the enclosure or night shelter size should be decided judiciously by the designers. This should also be in harmony with size of other nearby enclosures of the zoo. Sometimes in large enclosures it is difficult to clean the enclosure or attend to any emergency situation related to animals.

a) Dimensions Of Night Shelters/ Feeding Cubicles

Minimum dimensions have been prescribed by the CZA but they can be increased to some extent in area and height to allow the greater comfort and manoeuvrability for the animal. Every set of such cubicles should have a squeeze cage or other restraining arrangement suitable for the species concerned to allow for treatment. The squeeze cage should allow the veterinary doctor to move all around the animal. Keeper's gallery isuseful for keepers in hot sun, rain or cold. Enclosures for animals may be required to be attached and adjacent to each other for segregating animals, as and when necessary, for treatment of the animals or any management purpose.

6.5.8 Hospital

There are no fixed space standards for hospital buildings in Indian zoos. Each zoo decides on the kind of building and spaces/ departments required for their own use depending on the size of the zoo and the animal collection. The zoo hospital/ veterinary facility should be located away from the enclosures and other zoo buildings such as the office, interpretation centre and any areas of public use etc. to keep the noise away from the animals under treatment. The term 'away' and 'close to' are not specified by any standards in terms of distance but should be followed in spirit & intent based on the size of the zoo and the experience of the zoo director.

The hospital should have separate areas for examination and treatment, surgery, quarantine, radiology, laboratory, storage of medicines also a safe lockable storage for narcotics based on the requirements of the concerned government department, area for food preparation, staff uniform storage & locker room with attached showers, reference library, in-patient and out-patient wards. Besides these areas, there should be adequate space for storage of capture and restraint equipment, surgical equipment, anaesthetic equipment, and autoclave facility. Essentially the animal holding areas must be completely separate from the personnel areas such as rooms of the veterinarian, store rooms, meeting & audio visual rooms or conference rooms etc. central air conditioning system (which excludes window or split units) should be separate for animal and veterinarians/ officialsrooms and spaces. Animal holding areas should be designed for adequate number of air changes per hour to remove odours and keep the areas fresh and free of disease. Circulation beginning from outside the hospital to areas within should be separate for animals and staff.Zoo hospital should be close to the boundary of the zoo, having separate entry and exit, other than the visitors' of the zoo.

Design Guidelines for Layout and Space Requirements for Veterinary Hospital

1. The hospital should be located in a separate area away from the anima enclosures and office buildings.
2. Zoo hospital should be close to the boundary of the zoo, having separate entry and exit, other than the visitors' of the zoo.
3. Veterinary hospital should be located in such a manner that it is at a suitable distance from the Quarantine Area,Rescue Centre, Post-mortem room and Incineration.
4. There should be adequate provision for parking of vehicles, two wheelers and ambulance.
5. There should be enough manoeuvring and parking space for a truck for

loading and cartage of animals.

6. In case the hospital is located away from the entrance then vehicular access should be provided which should be separate from the one used by visitors.

7. Veterinary Hospitals - Average Room Sizes For Recently Planned or Constructed New Zoo Animal Hospitals

S.No.	***ROOMS***	***SIZE Sq.mts***
1	Treatment	155
2.	Surgery	180
3.	Radiology	115
4.	Recovery	60
5.	Pharmacy	75
6.	Clinical Laboratory	145
7.	Necropsy	140

Total Clinic Area:		***870***
Wards		
1.	Inside Rooms	600
2.	Inside Stalls	175
3.	Outside Cages and Flights	310
4.	Outside Pens	560
5.	Food Prep	50
6.	Quarantine	550

Total Animal Area:		***2245***
1.	Office (average square feet per office)	45
2.	Medical Records	65
3.	Conference Room	115

Total Non-Clinical Non-Animal Area:		***225***
Grand Total:		***3340***

The following are the new zoo hospital facilities from which the above data was taken:

San Diego Wild Animal Park (planned), San Diego Zoo,
Baltimore Zoo, Calgary Zoo, Columbus Zoo,
National Zoo, Front Royal Conservation and
Research Centre, North Carolina Zoo, Philadelphia
Zoo, St. Louis Zoo, Woodland Park Zoo

Note: It is the authors' suggestion that the above areas be modified appropriately by zoo directors and others concerned with zoo designing based on their experience, professional judgement and local conditions.

6.5.9 Off - Display Conservation Breeding Centre

Wildlife habitat in India is under severe pressure from uncontrolled urbanization resulting in increasing incidents of man-animal conflicts precipitating into a large number of animal species becoming endangered. The zoos have not only to maintain the numbers of animals within zoo, but they also have the responsibility of augmenting the depleting population of endangered species in the wild. The objective is to scientifically breed a population of physically, genetically and behaviourally healthy specimens of endangered spices as a stock which can be released in case of species population depletion in the wild. It is with this in mind that the conservation breeding centres (or satellite facility in collaboration with scientific institutions) are established in zoos. CZA funds on a 100% basis the Conservation Breeding Programme for selected endangered species. These are off-display areas since visitors have nothing to do with it and the facility has to be closely monitored by zoo staff in an undisturbed environment. There are no codified building standards in India for the space or infrastructure requirements of a conservation breeding centre yet. Zoos, as part of their professional responsibility, ensure construction of appropriate enclosures for the selected animal species to fulfil their physical and behavioural needs. Standards for buildings, and spaces for scientific research of different species will vary. This variation will be in terms of cubicle sizes, room sizes, laboratory spaces and associated outdoor spaces & kraals. The cubicle sizes, enclosure design and size and materials will be similar to those provided for the same species in the main zoo. The off-display conservation breeding centre construction has to be simpler and functional as compared to the main zoo exhibit areas. Maintenance regime and daily use facilities of both animals and keepers should be formalised as documented procedure.

6.5.10 Quarantine Facility

No new animal received in the zoo is straightway taken to its enclosure. It is quarantined for a prescribed period, and observed to ensure that it is free from communicable diseases before it is displayed for visitor viewing. Many zoos in India receive injured or sick animals from outside which must be kept separate from animals within the zoo or those being transferred between zoos. Quarantine is a facility (a building physically separated from other structures within the zoo) which is a part of preventive medicine program in zoological parks for prevention of spread of disease to another animal collection. The quarantine facility should be isolated in all respects from all enclosures and buildings. Access should be restricted to prevent transport of infectious agents by zoo personnel. Quarantine, (quadrogita - Latin for forty) was the period for which human immigrants were kept away from general public to prevent spread of disease. The other purpose of quarantine is to establish the 'baseline' health status of new arrivals, not detrimental to the health and safety of others. The quarantine building is located and designed to achieve these requirements. The size of quarantine facility depends on the location of the zoo and the kind of animals that zoo generally services. It is neither possible nor required for all zoos to have a comprehensive quarantine facility which will cater to from jackals to giraffes. The general building components of a zoo quarantine facility are:

a) Quarantine compound
b) Entrance lobby
c) Lavatory
d) Anaesthesia/ treatment room
e) Recovery room
f) Animal enclosure
g) Space to accommodate mammals, birds, reptiles, amphibians and fish

There are no formal mandatory standards or guidelines in India for construction of quarantine facility. All quarantine facilities and services are being constructed based on the experience of the concerned zoo directors/ veterinarian and/ or on the recommendations of CZA. Formal introduction of mandatory guidelines by CZA will help standardise the facility in all zoos in India.

6.5.11 Animal Rescue Centre (Off-display Life Time Care Facility)

Diseased, injured animals rescued from various sources are brought to the zoo for care and treatment. Some of these animals may be released in the wild after appropriate healthcare. However, some of the animals arrive which are infant or seriously injured which cannot be rehabilitated in their wild habitat because it may endanger their life. Such animals cannot be displayed in the zoo, in case they are infirm. Therefore, the wildlife managers are required to take the lifetime care of such animals. Sometimes, they are accommodated in a zoo or separate lifetime care facility is to be setup for them. Animal Rescue Centres in zoological parks are built to provide life time care facilities. Sometimes, they may be used for Conservation Breeding. The location of animal rescue centre should be such that after entering the zoo, the rescued animals can be taken to animal rescue facility without having to pass through the main zoo enclosure area or any public area. The isolation of rescued animals is also necessary to keep them stress free by housing them away from other animals and vice versa depending on their mutual predator-prey relationship.

6.5.12 Laboratory

Every zoo should have a well-equipped veterinary hospital and research laboratory. The hospital should have the following basic components to be effective in achieving its objectives:

Fig. 6.58 & Fig. 6.59 A well equipped modern laboratory is an asset for the zoo. It is useful for staff training, diagnosis and generation of zoo specific data.

a) Central Treatment Area (CTA)

Generally this facility should be able to attend to all zoo animals except elephants, hippos, rhinoceros and giraffes that are generally treated in the open. CTA should have a radiology room, surgery area with scrub room and sterile preparation room.

Research laboratories ideally should be equipped for animal behaviour studies, vitro fertilization, semen analysis, nutrition studies etc. If not all, at least few zoos in India should have the capacity in terms of qualified staff and international standard equipment.

Finally, the veterinary staff should be equipped with a portable equipment bag to treat animals which can be easily treated in their cubicles.

(Ref: https://www.stlzoo.org/animals/veterinary hospital/)

- b) Research laboratories
- c) Clinical pathological laboratory
- d) Quarantine wing
- e) Administrative space

Diseases are a major impediment to wildlife conservation. Comprehensive diseases surveillance program, investigations into disease outbreaks and directed research into various common diseases found in Indian zoo require a modern cell equipped laboratory with ancillary anaesthesia room, specialised equipment, recovery room etc. Indian zoos lack this facility; except in a few cases where ill equipped, short spaced, short staffed laboratory exists but is not contributing in any significant way to its objectives of wildlife conservation.

Design Guidelines for Zoo Laboratory

1. Laboratories should be housed within the hospital or close to it but within the premises of the hospital.

6.5.13 Research Section

Zoos are ideal locationsfor conducting in situ conservation related research because of the availability of living animals. This research can be conducted by a zoo for its own wildlife conservation or towards a specific disease outbreak. The research may also be collaborative. The physical requirements and resources required for such research cannot be generalised but can only be organised on a case to case basis. The facility will generally contain the individual office, a hall with computer terminal facility along with internet connectivity for 4 to 8 researchers, a printing section, store, pantry and toilet facility.

6.5.14 Post-mortem Room

Death is a natural process. Death of animals in zoos may be due to diseases, old age or accident in captivity. If required, a complete investigation in to the cause(s) of death(s) should be carried out and recorded. For this a well-equipped post mortem room should be provided.

Design Guidelines for Post Mortem Room (PMR)

1. The size of the facility should be according to international or CZA norms.
2. It should be located close to the zoo hospital.
3. It should be away from the visitors' area. It should not be accessible to visitors or any unauthorised persons.
4. It should have sufficient natural light and ventilation. The PMR table should be raised having proper drainage facility.
5. It should have a wash basin.
6. It should have arrangement for the veterinarian to change his clothes and shower facility.
7. It may have proper animal carcass lifting and moving facility for handling of large dead animals.
8. The entry of the PMR should be such that the carcass of the animal can be brought easily to the PMR table.

9. Solid and liquid waste from the PMR should be disposed off in hygienic manner.
10. It should have a laboratory room for collection and storage of the samples.

6.5.15 Incinerator Room

Natural or accidental death of animals is an infrequent but unavoidable occurrence in any zoo. This requires a suitable disposal of the carcass. The disposal method should be in hygienic manner and ensure that there is no possibility of infection spreading to other animals or humans and the disposal method should ensure that no part of the body or skeleton could be accessed after disposal procedure is completed. This requires complete destruction of the carcass and if the disposal method requires gradual decomposition then the burial (burial ground) should not be accessible to any unauthorised persons. The most appropriate and hygienic method of disposal is by incinerator. This method prevents any kind of misuse or removal of any part of the dead animal.

6.5.16 Food Preparation Room (FPR)

All feed received and stored has to be prepared before it is delivered to the feeding cubicle/ area. This requires a space adjacent to the storage area. Food preparation room should be well ventilated (or conditioned). Preferably well lit by natural light with easily cleanable floor, platform and walls.FPR should be divided for separate storage and preparation of vegetarian diet for herbivore and non-vegetarian feed for carnivores. This area requires space for accommodating the following:

a) Preparation table or platform
b) Chopping and grinding equipment
c) Weighting machines
d) Small and large cleaning troughs
e) Deep freeze and fridge
f) Separate storage equipment and rooms for wet and dry articles
g) Raised platforms for storage of ration items.
h) Storage for separate clothing for FPRpersonnel
i) Storage for cleaning equipment and liquids of the FPR
j) Facility for proper washing of the feed items, utensils and equipments
k) Wash basin and soap for cleaning of hands and feet of the personnel

A most important consideration of FPR is an efficient and hygienic waste disposal facility including proper drainage. This is required to ensure that water from this frequently washed space drains off quickly and there should not be any areas which allow water logging or clogging.

Finally this area has to be rodent, cockroaches, other insectsand fly proof. Towards that objective, all design precautions should be taken. It should be ensured that the detailing and workmanship is such that there should not be any cracks or small openings in any of the walls, doors or windows. All drainage opening and drain inlets-outlet should have ideally stainless steel (preferred) nets to prevent the ingress of any rodent/ clogging of the drains. It should be noted that all the above are design related issues while other rodent pest control management measures shall be provided in addition to the above.

6.5.17 Store - Equipment and Space Requirement for Disaster & Emergency Management

Disaster and emergencies related to zoo can be animal related, concerning visitors and staff or concerning both. In terms of design and functional requirements a store (one or more as essential) will be required to house the equipment for emergency use. The architectural and storage design should ensure easy and instinctive reach because confusion may prevail during an emergency situation.The location of emergency store should be conspicuous to ensure quick approachability because disaster & emergencies can happen in unpredictable ways. The stores and equipment should be located at more than one location. Generally in case of animal related problems (largely concerning enclosures or visitors falling into the animal enclosures). The store requires to have basic capture and restraint equipment. Some pieces of equipment are common for all animals while animal specific equipment are required for various different animal types, such as large carnivores, small carnivores, hoofed stock, elephants, mammals, large and small primates, pinnipeds, reptiles, amphibians and birds.

There are at present no space standards for equipment storage of any kind for zoos in India. As a result the design of storage building(s) and method of storage is presently being decided entirely by a concerned individual without any research or assessment of the contemporary international storage methods and equipment.

Design Guidelines for Store for Equipment for Disaster & Emergency Management

1. The store should be centrally located so that it can be easily and promptly reached in case of emergency.
2. It should be accessible for vehicles such as tempos/ small trucks.
3. Since pole or any high intensity lights should be avoided at night time in a zoo. Emergency store should have low intensity glow lights embedded in the road surface or by the sides at curb height to enable the staff to reach it

in case of an emergency at night.

4. Storage within the store should be designed specifically to hold the equipment chemicals, medicines and other items required to be stored so that each item is easily accessible. It should not be a situation where several items may need to be removed to access the required article.

6.6 FACILITIES FOR VISITORS

6.6.1 Access and Approach (Area outside the Entry Gate)

Convenient and easy access to the zoo is a strong motivating factor for a visit. Often the access road is not under the administrative control of the zoo authorities. Therefore, the liaison has to be maintained with the concerned authorities to ensure a well maintained approach road and a clean area outside.

Fig. 6.60 The area immediately outside the main gate should be designed to have a suitable pavement, planting and visitors facilities and parking.

Fig. 6.61 & Fig. 6.62 Planting design for approach and entrance areas help gradually transform the outside environment to the naturalistic surroundings inside the zoo.

Design Guidelines for Access/ Approach to Zoos

1. The width of the road should be adequate to carry heavy vehicles.
2. It should conform to the fire tender requirements by way of clearances and road geometrics.
3. The right way (ROW) should provide for adequate planting and suitable pedestrian pathways.
4. The ROW should be free of encroachments.

6.6.2 Entry Area

a) Outside the Entrance

The area outside the entry gate receives visitors arriving by their own vehicles as well those who arrive by public transport and walk to the zoo entrance. This area should provide space

Fig. 6.63 & Fig. 6.64 Indian zoos should have some kind of parity in terms of entrance design to fulfil the minimum requirements of entrance area activities as well as visual appeal to welcome the visitor.

Fig. 6.65 & Fig. 6.66 Two viable examples of entrance areas contrasting in terms of planting and constructed elements.

Fig. 6.67 (above) This appears more like a mall than a zoo!
Fig. 6.68 (below) Entrance should be low key and planting should predominate

for such a temporary congregation. The number of persons increases and reduces during the day as well as depending upon the public holidays. The occurrence of such crowding is spread over the entire time during which the zoo is open but it may peak at certain times as well as on certain days during the zoo entry hours. The area should be designed (large enough with necessary facilities) to cater to such large crowds. It is advisable to have arrangement of visitors' management in such a way that they may be isolated and spread over in small groups to avoid congestion and any accident.

There should be sufficient arrangement at the entrance to vary the number of booking counters in operation as well as gates for entry in the zoo as per the number of visitors arriving at the entrance. Visitors to the zoo may come as individuals, as couples, as family groups or large groups of school children or an office group. The individuals or families will be entering and coming out of the zoo together. In case of larger groups, all of them will not act homogenously. A few may stay back or enter a little later. On return, the individuals in the group will in all likelihood return in small groups spread over a period of time. To cater to such a situation, adequate space suitably located should be provided to ensure that such groups do not obstruct vehicular or regular pedestrian movement in the vicinity of the zoo. Shade,

Fig. 6.69, Fig. 6.70, Fig. 6.71 & Fig. 6.72 The stretch inside the entry gage should serve as a buffer between the salubrious conditions inside the zoo and the activity hub outside. This can be achieved by improving the alignment and planting.

seating and drinking water facility should be a part of design where such group of visitors are likely to wait before departing.

There may be multiple entrances/ exits to a zoo but except for the main entrance, others are rarely used generally during emergencies. The problem spot is often the area just inside the main entrance. Area just inside the main entrance is a crowded place. There are visitors who are entering and those who are departing. There are vehicles of visitors, staff and service vehicles entering and leaving the zoo premises. Some order has to be established by suitable design rather than by management alone. Presence of staff or security personnel is not the answer. The entrance should be designed to infuse order. This is the area which makes the first impression on the visitor. The persons who are entering require to be provided with further directions for the visit. The visitors need to be informed of the layout of the zoo, and the discipline which should be adhered to during their zoo visit. This place should also apprise the visitors of the various pedestrian circulation ‘rings’. Some visitors may want to traverse the full route while others, including the infirm, or the research scholars may wish to take shorter routes and not go through the full zoo display and may wish to avoid the performance in the open air theatre or not want to visit the interpretation centre. Information to help the visitors decide on the routes and options is required to be made available at this area immediately

Fig. 6.73 This is a zoo entrance gate in Thailand. There may be divergent opinions on such a design but but design ideas should not be discouraged as long as they have relevance.

inside the main entry. Many visitors come with eatables, cell phones and plastic bags. Eatables, plastic bags etc. should be retained at the entrance to avoid the littering of such articles inside the zoo. It is advisable to have separate gates for entry and exit, with enough space in between to avoid mixing of the visitors entering the zoo from those coming out. Both entry and exit should be linked to the common parking area through separate routes.

Certain space and design requirements for this area become apparent and should be provided for if the above requirements are to be satisfied.

The above are the examples of functional requirements. An important conceptual function of this space is to serve as a transition space and buffer to enable the visitors to let go of the outside urban environment of buildings, roads, traffic and noise and enter the serene natural surroundings of the zoo inside.

In Indian scenario space outside the entrance includes the presence of unauthorized vendors who set up shop just outside the entry area. These include shops/ kiosks selling zoo or animal related literature, souvenirs and eating stalls. These establishments create a chaotic situation, disturbing pedestrian and vehicular circulation, hiding signage and generating litter.

Entry area to a zoo is an important area from the point of view of vehicular and pedestrian circulation, collection of people and for creating a first impression about the zoo in the minds of the visitors. The entry area will include the entry gate structure as well, which serves to convey a visual message about the zoo.

Parking in zoos have been provided both inside and outside the zoo premises. Parking areas immediately outside the main entrance should generally be avoided. Visitors' (which include adults, children and women) circulation from the parking area to the entry gate/ ticketing windows creates congestion and is an avoidable risk for pedestrians crossing the roads and obstruction vehicular traffic.

If in any situation this is unavoidable then it should be ensured that the visitors after disembarking from the vehicles are provided a safe passage (without crossing any vehicular road) via a well-designed and spacious pedestrian path.

Design Guidelines for Entry Area (In the Immediate Vicinity outside the Entry Area)

1. Entry area should have a large open space adjacent (inside and outside) to the entry gate. This is to provide for collection of visitors who come to the zoo using public transport. This space will also serve as a temporary waiting area for persons of a group who may have returned early or who decide to curtail the visit.
2. Should provide for sufficient street furniture (benches, waste bins etc.) and public facilities such as drinking water points.
3. Should have information boards and a layout plan of the zoo.
4. Should have directional signage at appropriate location.
5. Should provide a Divyang friendly access to the zoo entrance/ ticketing counters.
6. Unauthorized structures should be cleared regularly on their stationing their stalls from the area immediately outside the zoo by talking to vendors and by requesting the concerned municipality for their removal.
7. Display signage informing visitors about the availability of authentic literature and wholesome food at reasonable prices being provided inside the controlled area of the zoo.

b) Inside the Entrance

The area inside the entry gate should provide for both vehicular and pedestrian facilities.

Design Guidelines for Entry Area (In the Immediate Vicinity inside the Entry Area)

1 Separation of vehicular circulation from the pedestrian circulation is essential.

2 There can be one gate for the vehicles but ideally there should be separate smaller gates for entry and exit of pedestrians.
3 This area should be spacious to accommodate all activities which are to be provided for in this area.
4 This area functionally requires large paved surfaces but these should be designed in such a way that the large pavement is not visible to the visitors in a single view.
5 There should be a wide enough, safe, shaded and natural looking and well-designed pedestrian path leading to the zoo ticketing counter.
6 There should not be excessive distance (a maximum of approx. 200 mts.) between the entrance and the first 'place of interest' i.e.eitheranimal enclosure, an interpretation centre or a butterfly park for instance, otherwise it becomes tiring for the visitor and dampens his initial curiosity and enthusiasm.
7 A counter should be provided to receive and retain non bio-degradable plastic bags being brought in by the visitors and replace them with disposable paper bags to ensure the plastic material is not disposed of or littered within the zoo.
8 The passage from the entrance to the enclosures and beyond should be designed for the climate, suitably sized and having the necessary signage & seats and litter bins.
9 Semi enclosed spaces should be created using plants,waiting and resting spaces for group of visitors who may return earlier.

c) Non-Public Entry

Many zoos, particularly larger ones, and those located in urban areas tend to have multiple entries besides the main entry. This may be required for various reasons which are generally site specific and need not be discussed here. Besides any advantage that there may be, the disadvantage of multiple gates is that it adds to another point of security and surveillance. Such entries add to the risk of unauthorized access and pilferage.

Design Guidelines for Non Public Entry

1. All entrances, in case of multiple entrances, should have gates.
2. These gates should be electronically guarded by installation of CCTV cameras.
3. The gate at these entry points should be made operational from the central security control room only.

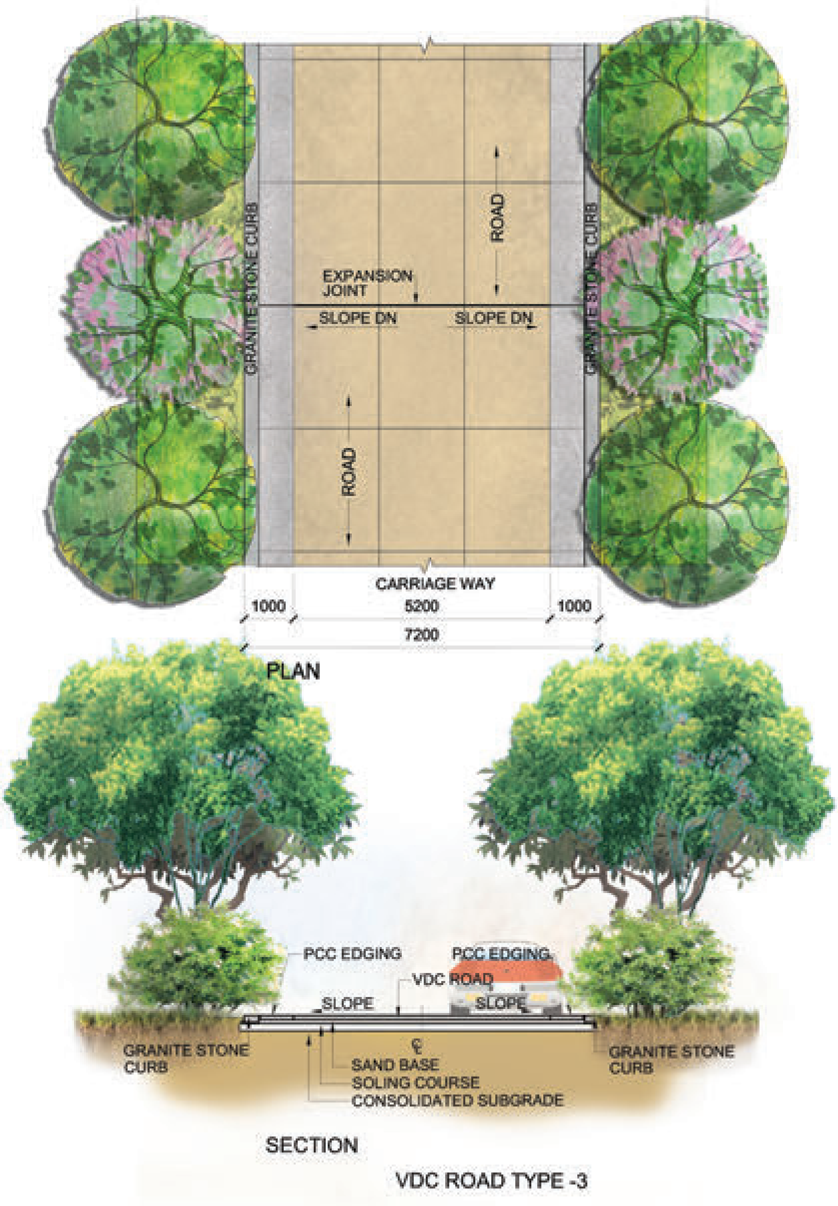


Fig. 6.74 (ILLUSTRATIVE DWG.)

VDC ROAD TYPE - 3

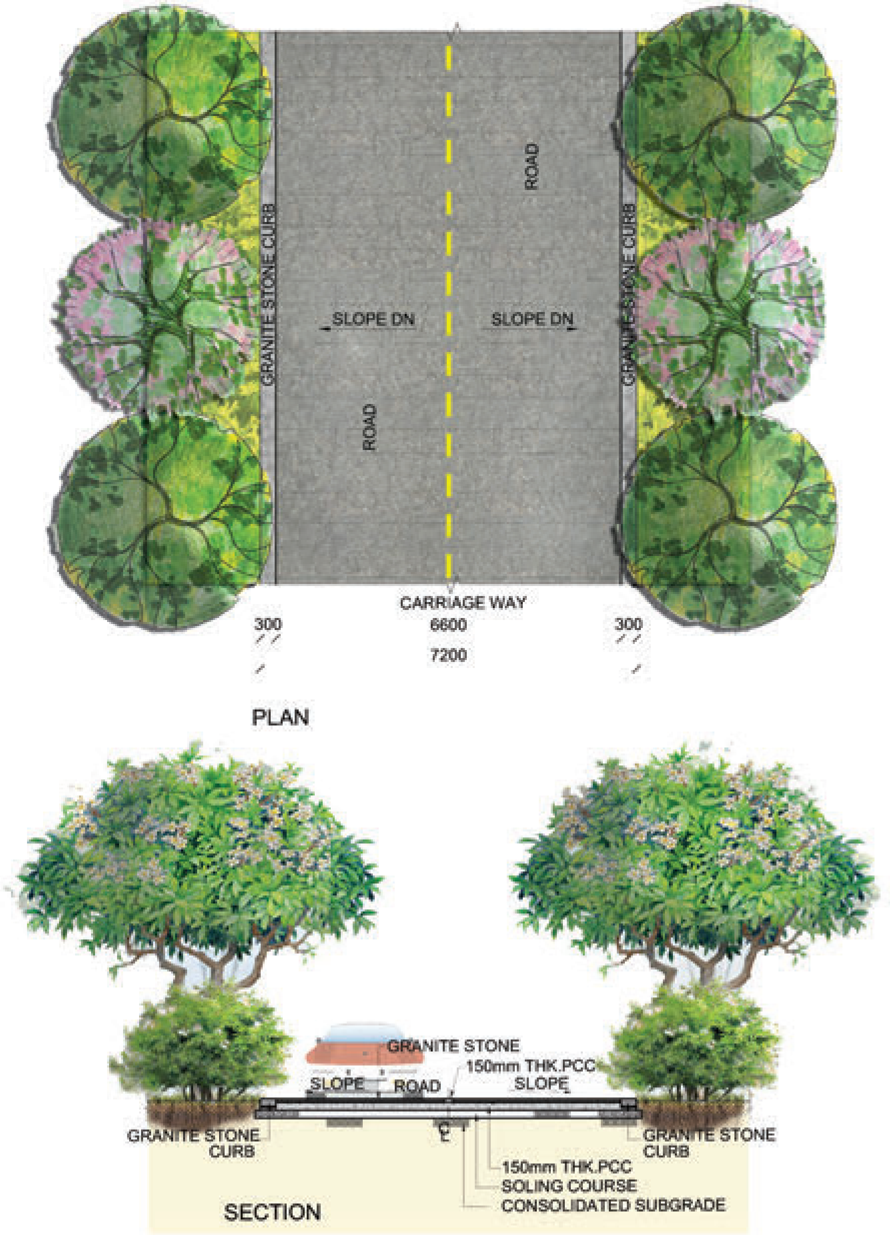


Fig. 6.75 (ILLUSTRATIVE DWG.)

GRANITE STONE ROAD TYPE -4

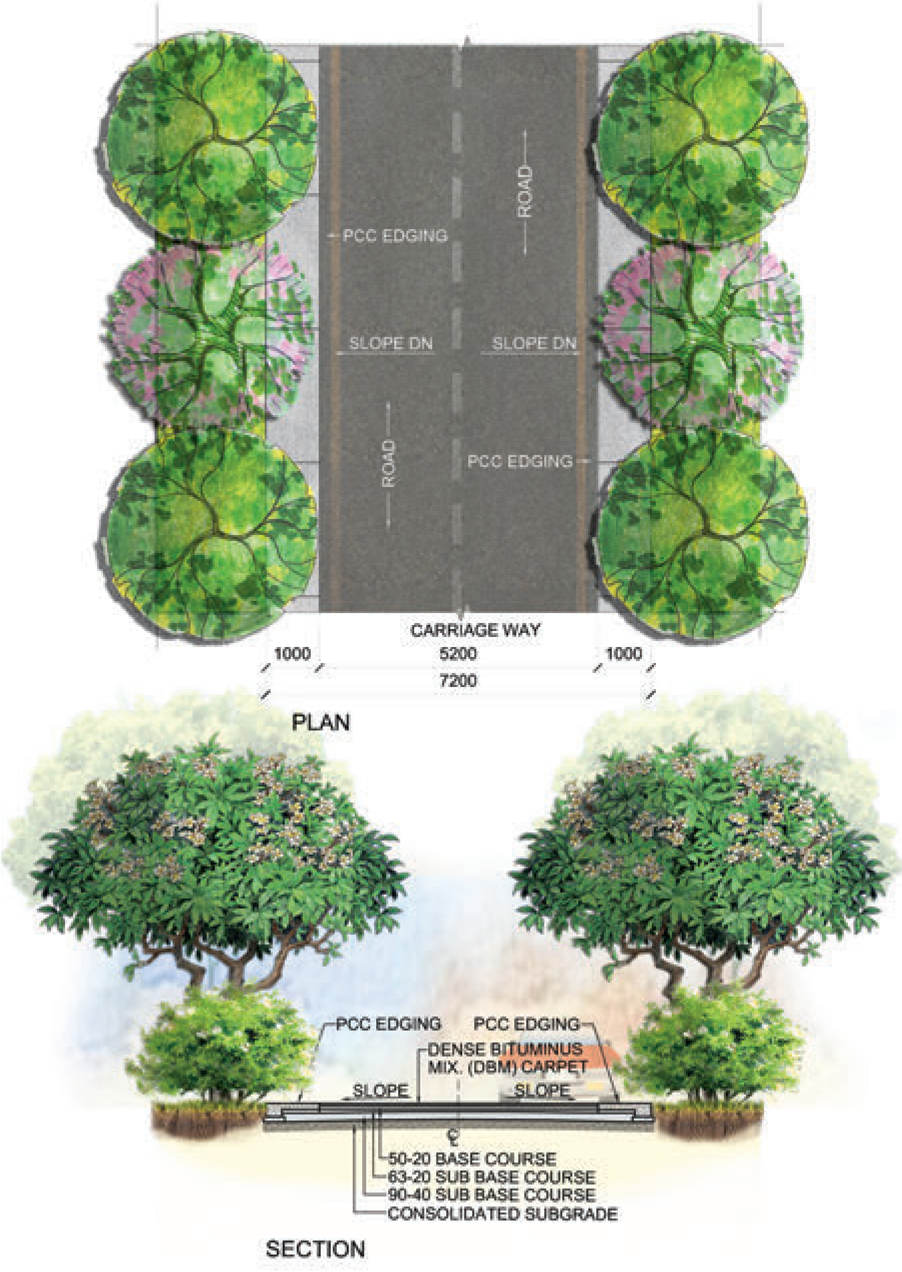


Fig. 6.76 (ILLUSTRATIVE DWG.)

BLACKTOP & PCC ROAD TYPE I

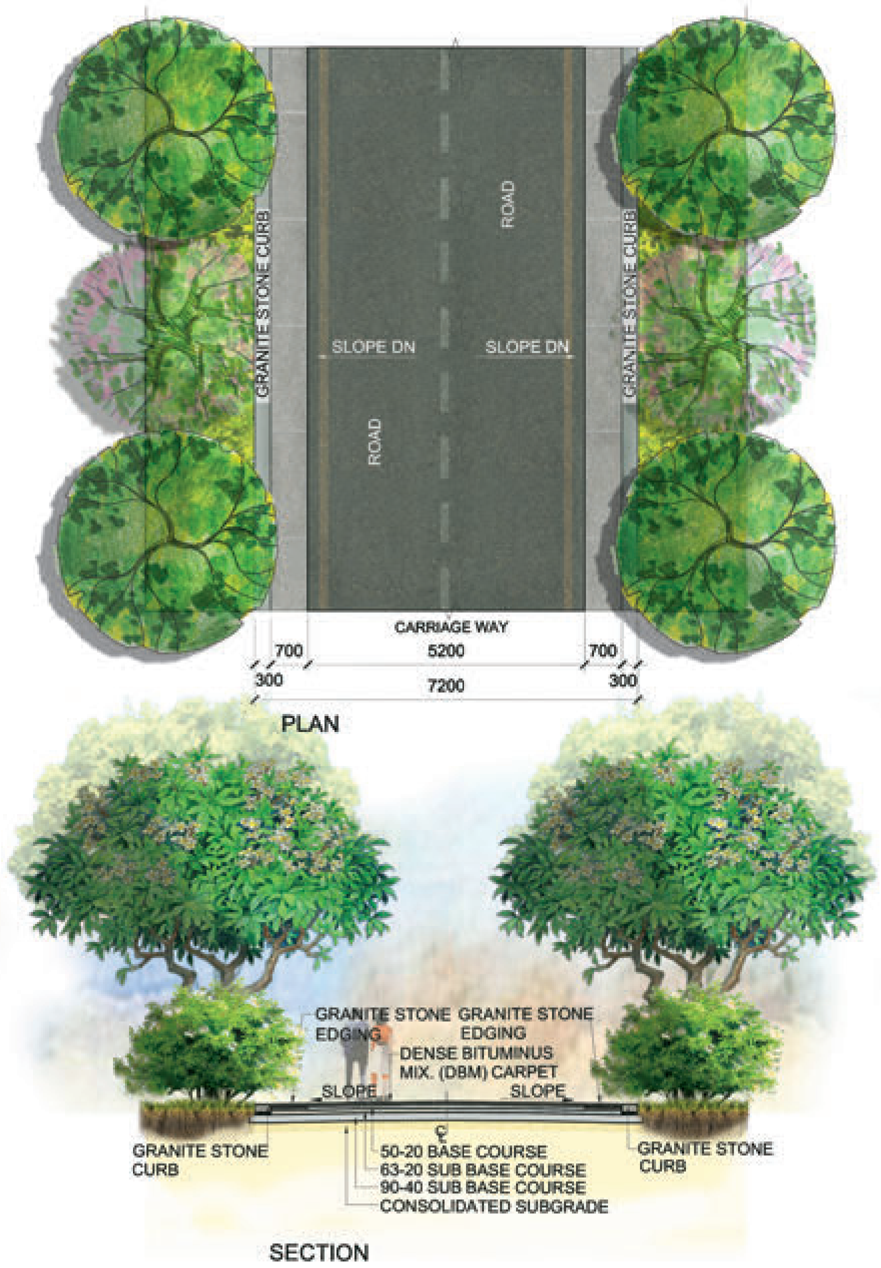


Fig. 6.77 (ILLUSTRATIVE DWG.)

BLACKTOP & GRANITE STONE ROAD TYPE II

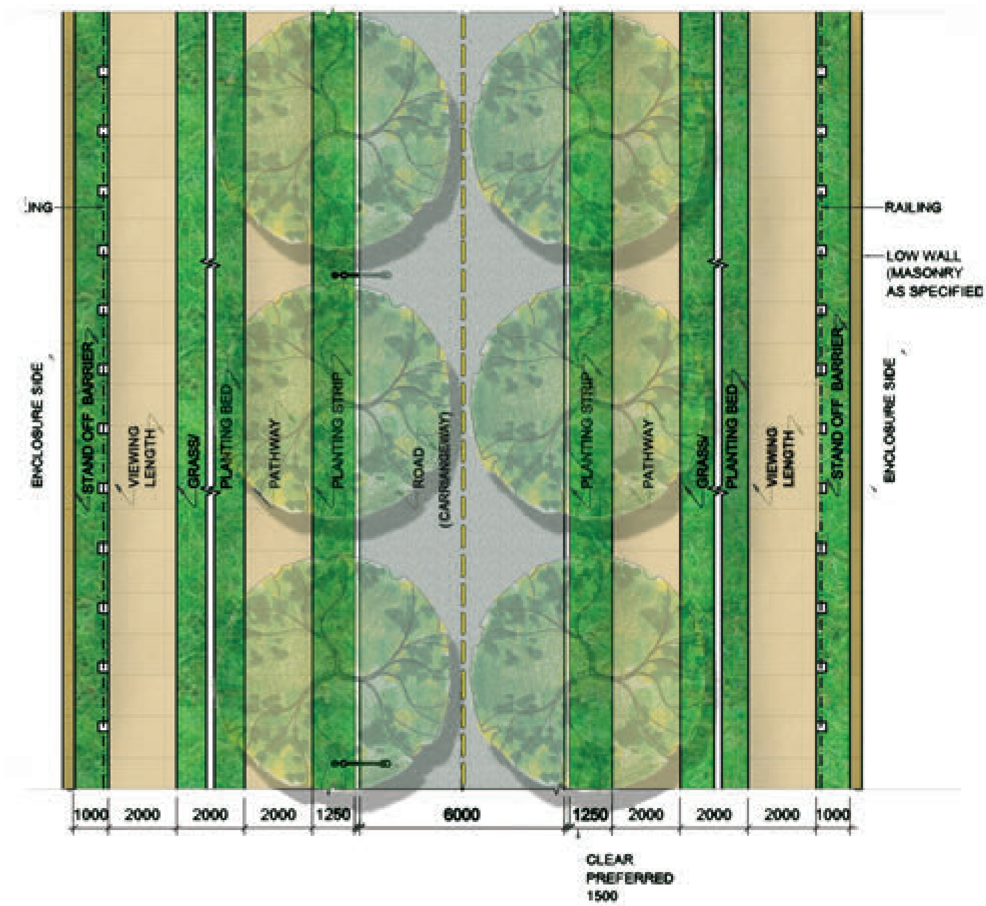


Fig. 6.78 (ILLUSTRATIVE DWG.)

ROAD TERMINOLOGY

4. These entries should be secured against escape of animals (by having enough height and design strength) who may have escaped from their enclosures and prevent any pilferage of material or unauthorised removal of animals. To ensure this the gates should have the requisite height and should be designed to be strong enough to resist any animal push

6.6.3 Parking

Parking areas are a necessary component of Zoos. Parking should have easy access on arrival of the visitors and should provide easy parking without the visitor having to go

Fig. 79 & Fig. 80 Parking requires professional design input which is often disregarded, this results in chaos at the entrance of most zoos.

back and forth trying to locate parking space or experiencing difficulty in manoeuvring. Parking area should have the correct dimensions of parking stalls and driveway width as specified in the standards and should have the correct geometry in terms of turning radii and comfortable slopes and horizontal curves in case the site is undulating. In case any one of the above is not properly designed it will result in traffic jams and reduced number of parking because of random parking of vehicles. This is a common occurrence Indian zoos. In some cases, it results in overflow of parking on to public roads. There should be separate entry and exit for the parking. The vehicle entering in the parking lot should not turn back at any place to access the exit of the parking. It would avoid cross-movement of the vehicles and resultant congestion in the parking area.

Parking requires expertise and experience in its layout and design. Parking should be resolved under the following heads:

1) Public Vehicles

   i) Autos

   i) Electric rickshaws

iii) Tourist and private buses

2) Private Vehicles

i) Car parking

Parking for self-driven vehicles

Parking for chauffer driven vehicles

ii) Tow wheeler parking - This will include scooters and motorcycles

Parking areas for zoos should be designed to relate to the natural environment inside the zoo. Parking should be designed to ensure that a vast paved area of a large number of vehicles are not visible at one glance. This can be achieved either by laying out the parking in a curvilinear alignment or providing level differences or both. Lot of trees and shrubs can help in providing shade and screening.The zoo parking should not look like an airport or commercial area parking which are designed to satisfy functional requirements with least consideration to aesthetics. The passage from the parking to the zoo gate and ticketing area should be pleasant and comfortable experience. It should have nodes (small spaces) for small groups to wait and should be designed with potable water dispensers. It is desirable to provide shade for the parked vehicles. This can be provided either by planting trees or by providing shade structures for sites having rain or snow for a major part of the year.

Suggested trees and shrubs suitable for parking lots is given in Appendix no. ---

Design Guidelines for Parking

1. The number of parking planned (i.e. the size of parking area) should relate to the maximum number of visitors expected to come on a day by cars and two wheelers. The total parking area can be arrived at by working out the Equivalent Car Spaces (ECS)or by arriving at an estimate based on the parking conditions in the last few years or by considering a similar zoo.
2. Parking for two wheelers, for cars, for buses and for any local transport mode may be located adjacent to each other or completely separate but should have a distinct well designed circulation which does not cross each other.
3. The zoo parking should not look like an airport or commercial area parking which are designed to satisfy functional requirements with least consideration to aesthetics. The passage from the parking to the zoo gate and ticketing area should be pleasant and comfortable experience. It should have nodes (small spaces) for small groups to wait and should be

designed with potable water dispensers. It is desirable to provide shade for the parked vehicles. This can be provided either by planting trees or by providing shade structures for sites having rain or snow for a major part of the year.

4. The parking area should be so located in terms of distance or location (so as to be separated by a level difference) that no disturbance in terms of noise or pollution, reaches the inner areas of the zoo, specially the enclosures.
5. The dimensions within parking areas should be according to standards.
6. The layout of parking area should relate to the site i.e. whether a strictly rectangular layout or a curvilinear one or a combination of both.
7. Sufficient number of parking should be provided for handicapped persons. This parking stall should have the required dimensions as per standards and should have signage which start from the parking area itself.
8. There should be suitable hard and soft pavement for all parking areas with adequate structure for taking vehicular load.
9. The pavement pattern should be designed to scale down the large area and make it aesthetically pleasing.
10. There should be no parking areas with bare soil as the surface.
11. Since the parking areas are large, the possibility of using material which will allow water infiltration such as grass pavers of PCCorHDVC should be explored.
12. Car parking should have access to a drop off point where chauffer driven passengers can be dropped off before the car is taken to parking lot.
13. The bus parking areas should have paved 'collection areas' for the group of visitors who return early and also to provide an area for visitors to group before they embark into the bus.
14. Parking areas should be provided with suitable shelters for protection against inclement weather.
15. There should be designed locations for tree and shrub planting. The trees will serve to shade the vehicles while the suitably located shrub planting will screen the parking from the entry and other areas.

6.6.4 Vehicular Circulation

Alignment - Vertical & Horizontal

Surface Materials

Edges

Fig. 6.81 Roads without curbs are perfectly acceptable in zoos since no rigid separation is required between vehicles and pedestrians. They also merge better with the landscape and don't require a designed storm water drainage system.

Fig. 6.82 Battery operated vehicles have proved to be a suitable means of transport in zoos requiring minimal maintenance.

a) Circulation

All parts of the zoo are required to be accessed by 'vehicles' and by 'pedestrians'. Vehicles include zoo vehicles, battery operated trolleys, and other visitors' vehicles (in some zoos) and pedestrians include the zoo staff and the public. This describes the circulation within the zoo. Circulation system or pattern is the interconnected web of various types of roads and paths. It provides access to animal enclosures, for keepers and sanitary staff to reach animal enclosures and getting the animals daily feed. The circulation also helps administrative and veterinary staff to reach the office, hospital buildings etc. and all other zoo staff to reach their work stations.

Roads vary in terms of carriageway widths, materials and detailing of edges and drainage systems. Paths differ depending upon the volume of expected traffic and the purpose for which it is intended to be used. For example, a path for use by visitors will be much wider and will have a surface material which will withstand intensive use than a path which is used by the keeper to reach the night shelter.

Zoo roads are primarily used for driving different kind of vehicles (such as cars including SUV's, trams, normal and electric buses and service vehicles such as small trucks and tempos). Vehicles are used for zoo related management and maintenance works and to transport visitors.

Zoo paths are used by the staff for their work and by visitors to view the animals.

Both roads and paths have stretches which are restricted to the staff only and out of bounds for visitors. The restricted sections of the vehicular circulation include the service road(s) which leads the back side of enclosures towards the feeding cubicles side and is used for carrying feed for animals and removal of garbage.

The second part of vehicular circulation is the service road which leads the back side of

Fig. 6.83 & Fig. 6.84 Vehicular circulation is an accepted fact in any zoo because of long distances required to be traversed by children, elderly and handicapped (which includes women carrying infants in their arms!).
Electric vehicles are now a norm to reduce noise and pollution and are very efficient even on fairly steep slopes.

Fig. 6.85, Fig. 6.86, Fig. 6.87 & Fig. 6.88 Roads, particularly, in zoos disturb the natural outlook. One way to tackle this is to align the roads in such a way that the paved view is limited and there is a predominance of vegetation.

Fig. 6.89 Creative representation of a zebra crossing in the main vehicular road.

Fig. 6.90 Visitors viewing area should be separated from the main pedestrian path because on the main path there is active circulation while in the viewing area pedestrians are either stationery or there is slow movement.

enclosures towards the feeding cubicles side and is used for carrying feed for animals and removal of garbage. On principle, service circulation (including service parking) should be completely independent of the visitors circulation. If at all the two are required to intersect, the crossings should be restricted to minimum.

'Vehicular' road or 'pedestrian' path relates to construction specifications as well as surface pavement materials and surface pattern. Meaning thereby, that the materials and thickness are able to take the anticipated load. Significant design fact is that surfacing on top can be given any appearance. A road can be paved with RCC, asphalt (black top) or even stone (with an attractive pavement pattern) depending on the overall design.

The principles of alignment and dimensions will remain the same for large, medium and small zoos. But may vary for mini zoos.

1. There should be the following hierarchy of road circulation within a zoo:

a) Primary Circulation

This is a wide road (with a minimum width of 6 mts.to 9 mts. generally) which makes a complete loop within the premises of the zoo and reaches all enclosures. This may consist of a single loop or multiple loops depending on the size and layout of the zoo. The surface materials (stone, asphalt, concrete etc.), the edge conditions (with or without curbs), the drainage system (surface or underground) and the related landscape features such as seats, drinking water and toilet facilities, waste bins etc. determine its design character.

b) Secondary Circulation

This road branches off from the primary circulation road to make a shorter loop and rejoin the primary circulation. This should have a minimum clearance of 6 mts. for fire tender access.

c) Tertiary Circulation

This in turn branches off from the secondary circulation road to make a shorter loop and rejoin the primary circulation. This may have a minimum clearance of 4mts. for service vehicle access.

All main roads designed for fire tender access should have a minimum clearance of 6 mts. 'Clearance' means a space without any obstructions. But in appearance it may be made to look less wide by clever use and mix of materials so that the central passage may of asphalt of course while the sides may be of stone, PCC pavement or grass pavers.

S. No.	Road Type	ROW (Right of way) Carriage way + Space on both sides	Carriage min. width	Pavement Type	Pavement Materials	Remarks
1	Primary	12 mts.	6 mts.	Vehicular	RCC, Asphalt stone	Preferred width 7.2 mts.
2	Secondary	10 mts.	6 mts.	Vehicular	RCC, Asphalt stone	
3	Tertiary	8 mts.	6 mts.	Vehicular	stone	

Circulation path alignment should be designed that it should be convenient for visitors to see all animals on display with ease without having to traverse the same stretch of road twice. In some cases, the roads are laid out haphazardly which makes the situation worse. Travelling on the same road twice results in crowding or missing certain exhibits all together or getting tired before viewing all exhibits.

Generally a loop type circulation alignment with and intermediate connection is appropriate. It will not be always possible to adopt this in all zoos particularly large ones. Hence the design can have a main loop(s) for main circulation and sub loops emanating from the main loop,to view animals. The sub loop will cover a related group of animal enclosures and return to connect with the main loop.

In small zoos with few exhibits multiple loops are not required. Only one path for both way movements will suffice.

Zoos are large campuses with fairly long distances to walk. Depending on the zoo topography, the walk may generally be on level ground or it may involve stretches with slope, sometimes fairly steep slopes. Even for a healthy person walking a long distance even with a 3% slope (which is considered to be shallow) can be tiring. For a handicapped person (which can be equivalent to a normal person not used to regular exercise traversing over even a lesser slope) is tiring. There are zoos in North Eastern India, Uttarkhand, Himachal, and even in Rajasthan having gradients beyond 10-15% over long and short distances. In spite of various such circumstances, everyone desires to visit the zoo. It is with this background that the need for a transport to travel within the zoo was felt. The two options being tried presently are to allow owner driven private vehicles to ply within the zoo or to provide zoo authorized buses/ trams for use by visitors. Both these options are prevalent not only in various zoos in India but abroad as well.

Movement of vehicles disturbs the animals. When private vehicles are allowed and are driven irresponsibly with horns blowing and being halted at unauthorized places, a chaotic situation develops. With zoo owned trams or buses driven by trained drivers, the situation is better.

Open CNG or electric buses/ trams have replaced the earlier polluting petrol driven vehicles. Very good quality electric &CNG vehicles are being produced in India, thereby reducing the cost and encouraging an increasing number of zoos to acquire such vehicles for the benefit of the visitors. Such vehicles can vary from small 4 seater to a 70 seater.

Design Guidelines for Transport for Visitors Circulation

1. Provide for a small kiosk at the entrance to serve as ticket counter. This will augment the sale of tickets for trams at the entrance ticket counter.
2. Place for visitors to collect/ wait before climbing on the bus/ tram. This area should be provided with the necessary visitors facilities, such as drinking water, trough for hand wash, toilet facilities and counter or dispensing machines for mineral water/ cold drinks.
3. Visitors'congregation/ waiting area should be paved.
4. The total tram route should be provided with stops at intervals. Theses stops should be located based on a maximum distance or close to a group of enclosures. These locations should be paved and identifiable by appropriate signage. The size of such 'drop off points' should be able to accommodate approximately 20-25 persons.
5. Tram/ bus stops should have seats, litter bins and water dispenser. Such stops should have a roof shelter with open sides to provide short time protection against inclement weather. This will also provide marginal protection to pedestrian visitors during rains.
6. Descriptive interpretive signage can be located at these locations.

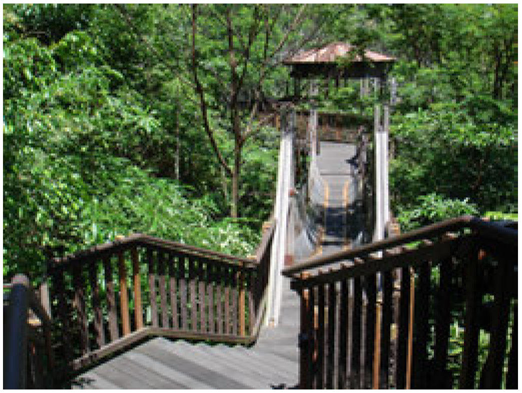


Fig. 6.91, Fig. 6.92, Fig. 6.93, Fig. 6.94 & Fig. 6.95 The area of pavement should be reduced visually by curvilinear alignment of path. This improves the aesthetics and reduces the radiated heat by shade of plants.

6.6.5 Pedestrian Circulation

Visitors walking the zoo are an important component. Zoo had to be traversed on foot to view and gain knowledge about animals housed there. Pedestrians have a clear advantage over visitors using vehicles. The leisurely pace helps them get a better feel of the larger environment of the zoo rather than just having a brief view of each animal and moving on the next enclosure. Pedestrians are able to feel and view the vegetation and hear the sounds of birds and animals as they move along. They are able to appreciate the design of surface textures and the use of materials and colours used for various zoo elements such as pedestrian path pavement materials and stand-off barrier designs.

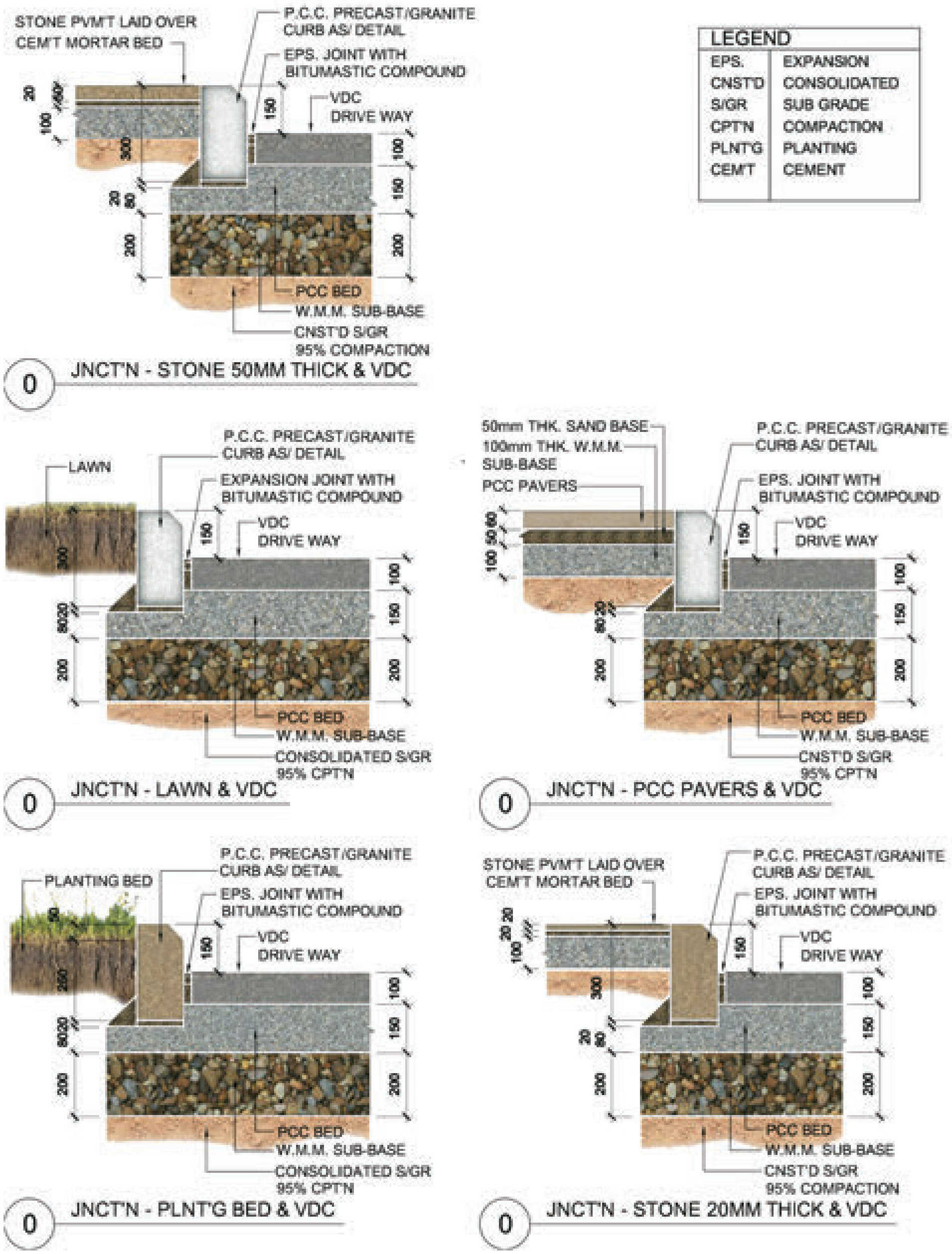


Fig. 6.96 (ILLUSTRATIVE DWG.)

VDC DRIVEWAY JUNCTION DETAIL

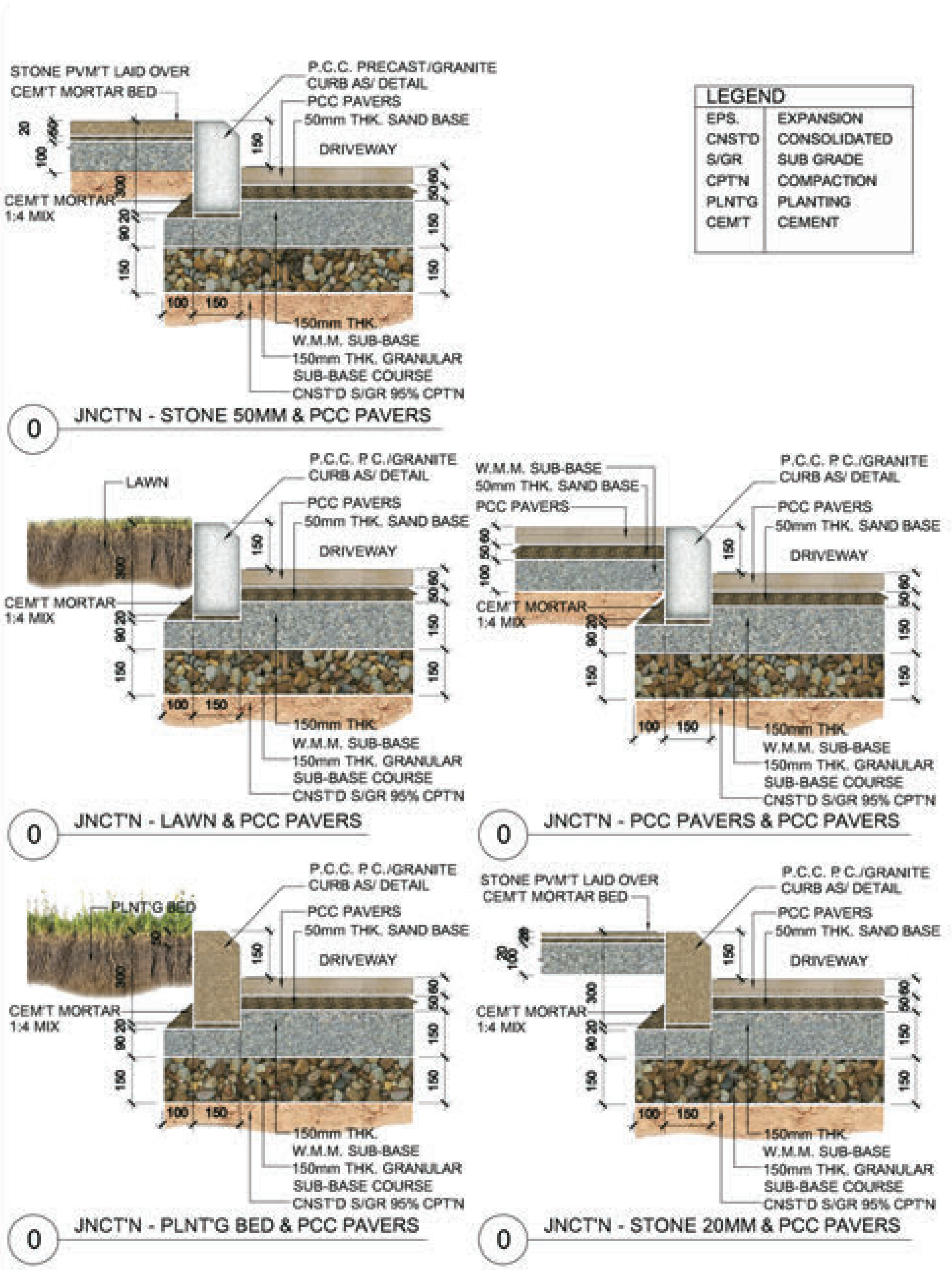


Fig. 6.97 (ILLUSTRATIVE DWG.)

VDC DRIVEWAY JUNCTION DETAIL

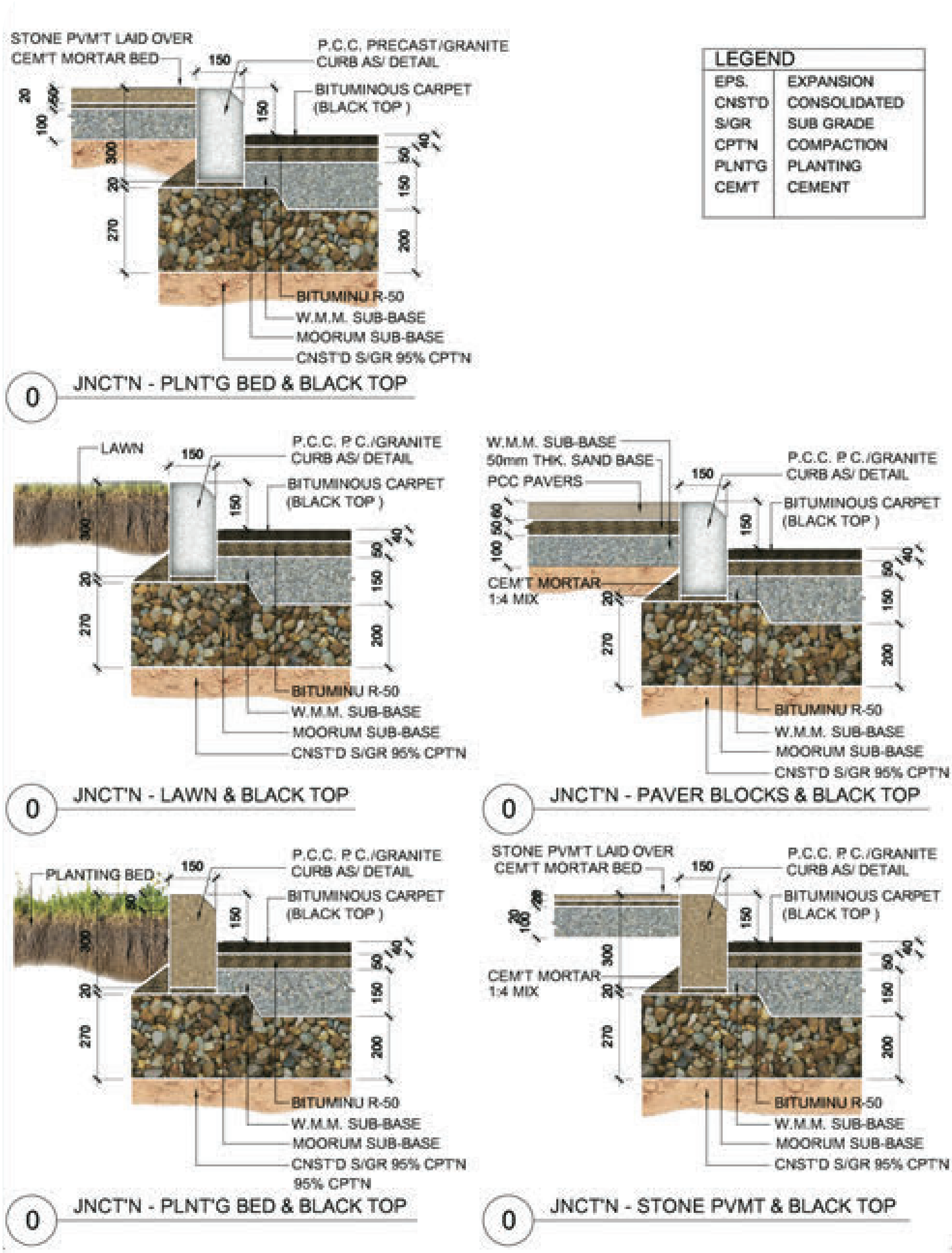
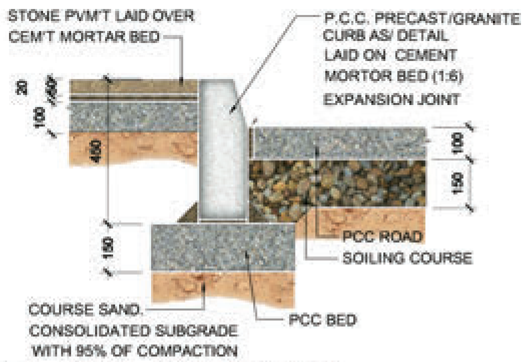


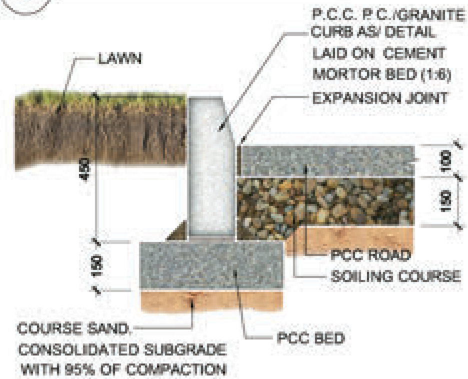
Fig. 6.98 (ILLUSTRATIVE DWG.)

BLACK TOP DRIVEWAY JUNCTION DETAIL

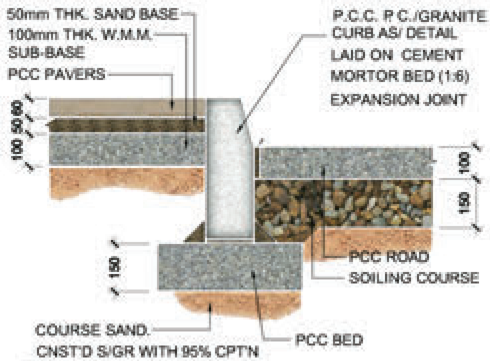


0 JNCT'N - PLNT'G BED & VDC

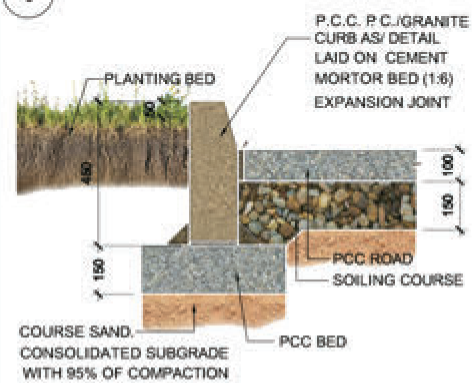
LEGEND	
EPS.	EXPANSION
CNST'D	CONSOLIDATED
S/GR	SUB GRADE
CPT'N	COMPACTION
PLNT'G	PLANTING
CEM'T	CEMENT



0 JNCT'N - LAWN & PCC



0 JNCT'N - PCC PAVERS & PCC



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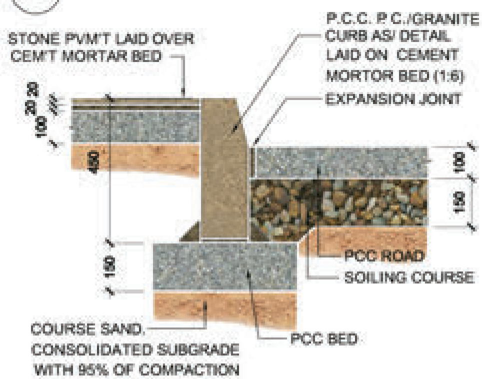
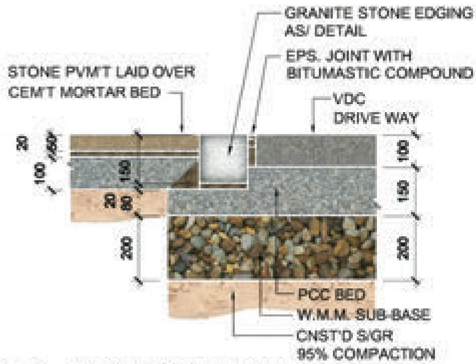


0 JNCT'N - STONE 20MM THICK & PCC

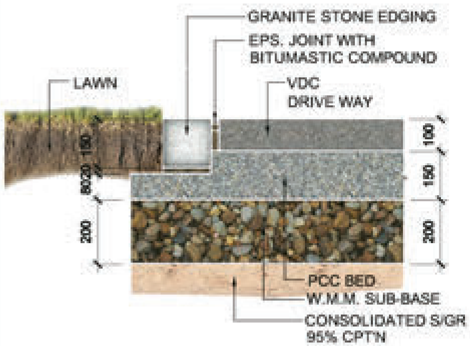
Fig. 6.99 (ILLUSTRATIVE DWG.)

VDC DRIVEWAY JUNCTION DETAIL

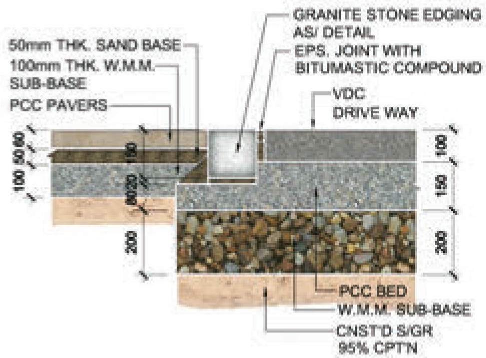
LEGEND	
EPS.	EXPANSION
CNST'D	CONSOLIDATED
S/GR	SUB GRADE
CPT'N	COMPACTION
PLNT'G	PLANTING
CEM'T	CEMENT



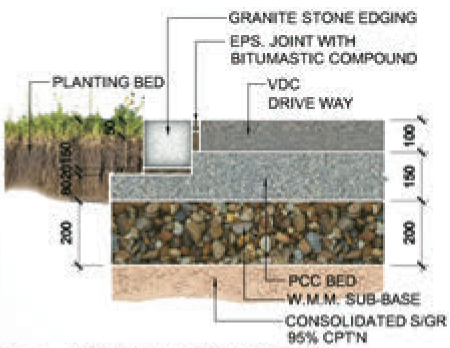
0 JNCT'N - STONE 50MM THICK & VDC



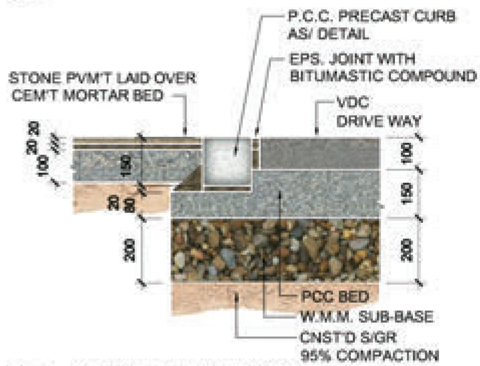
0 JNCT'N - LAWN & VDC



0 JNCT'N - PCC PAVERS & VDC



0 JNCT'N - PLNT'G BED & VDC



0 JNCT'N - STONE 20MM THICK & VDC

Fig. 6.100 (ILLUSTRATIVE DWG.)

VDC DRIVEWAY JUNCTION DETAIL

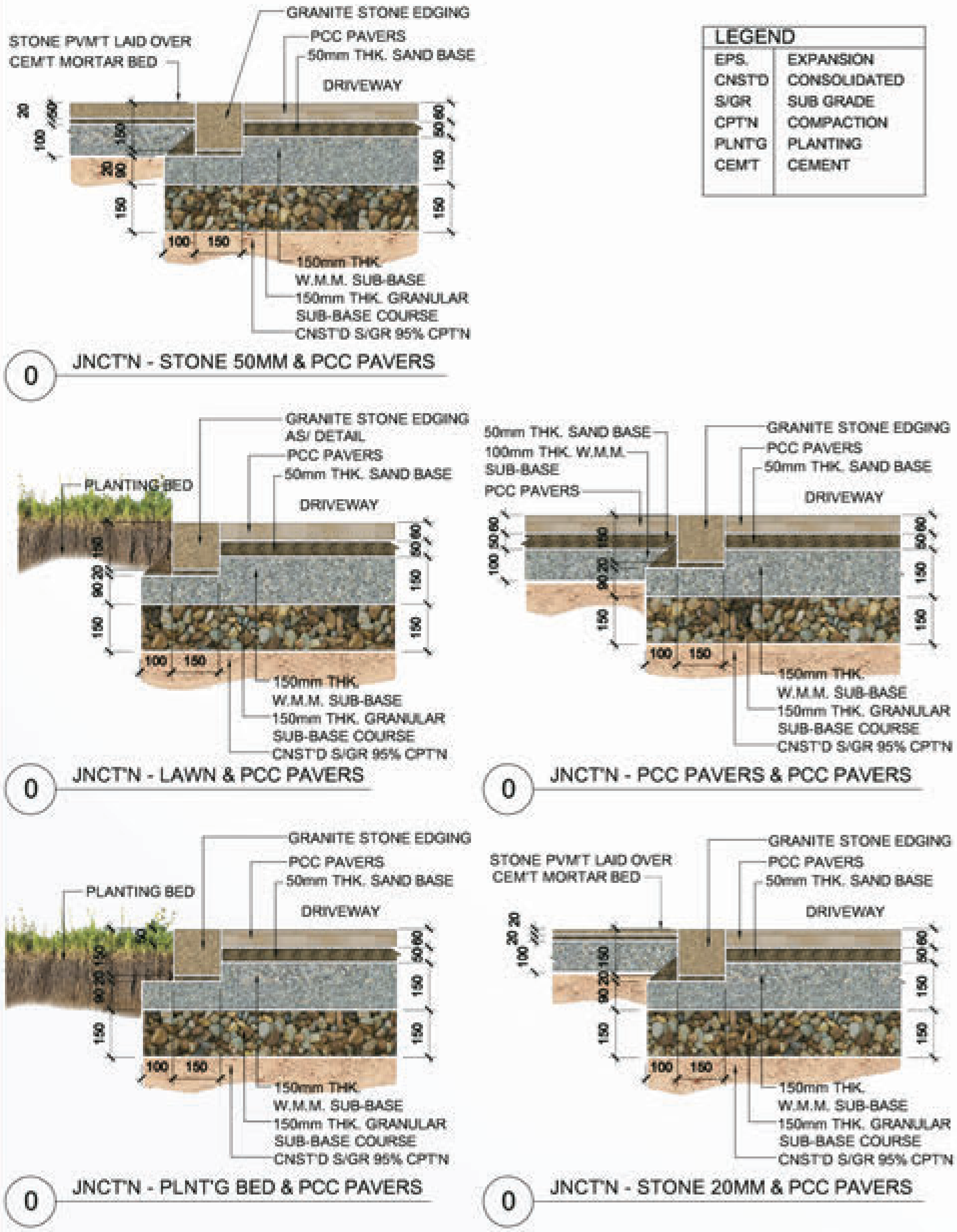


Fig. 6.101 (ILLUSTRATIVE DWG.)

PCC PAVER DRIVEWAY JUNCTION DETAIL

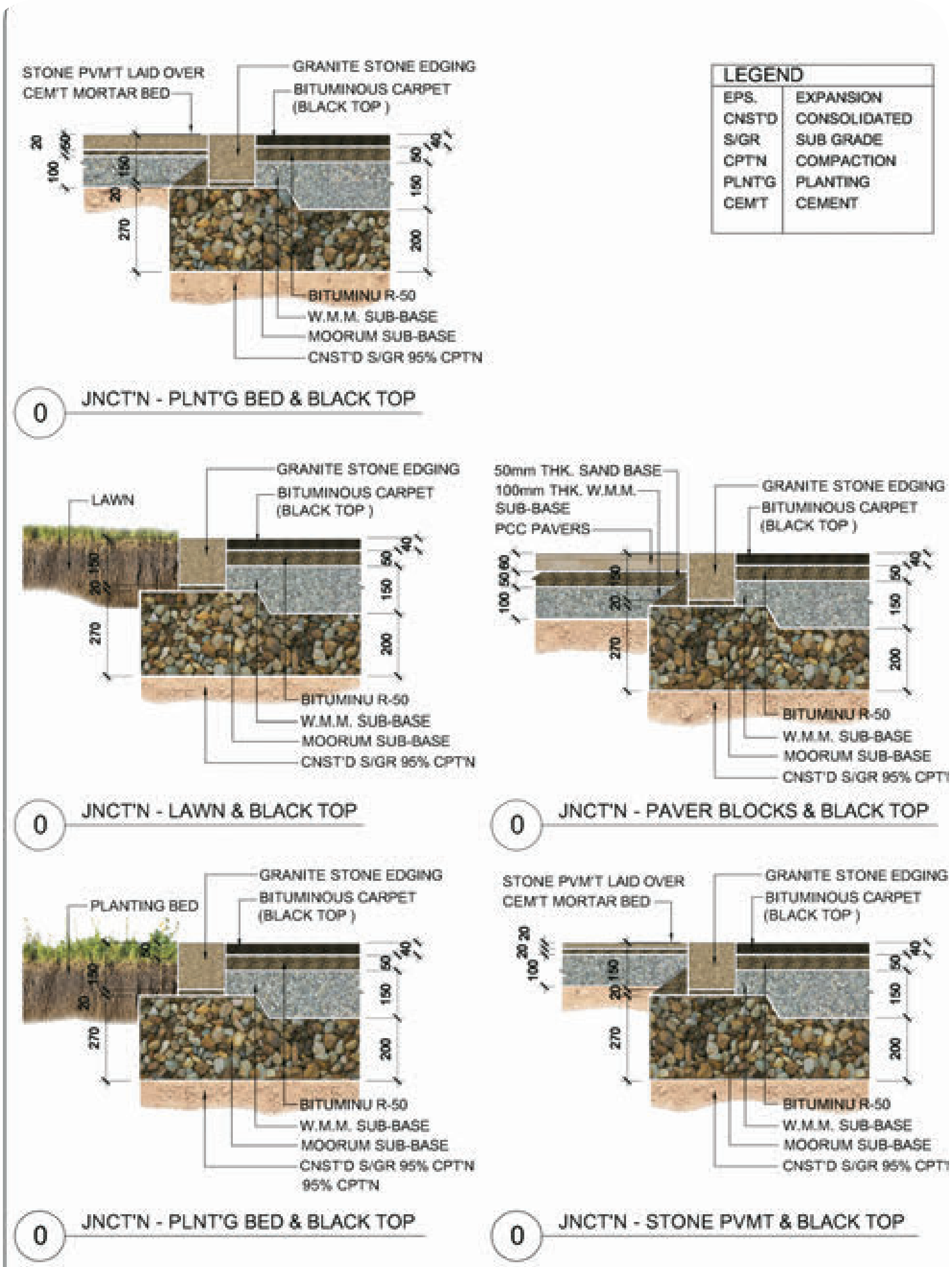


Fig. 6.102 (ILLUSTRATIVE DWG.)

BLACKTOP DRIVEWAY JUNCTION DETAIL

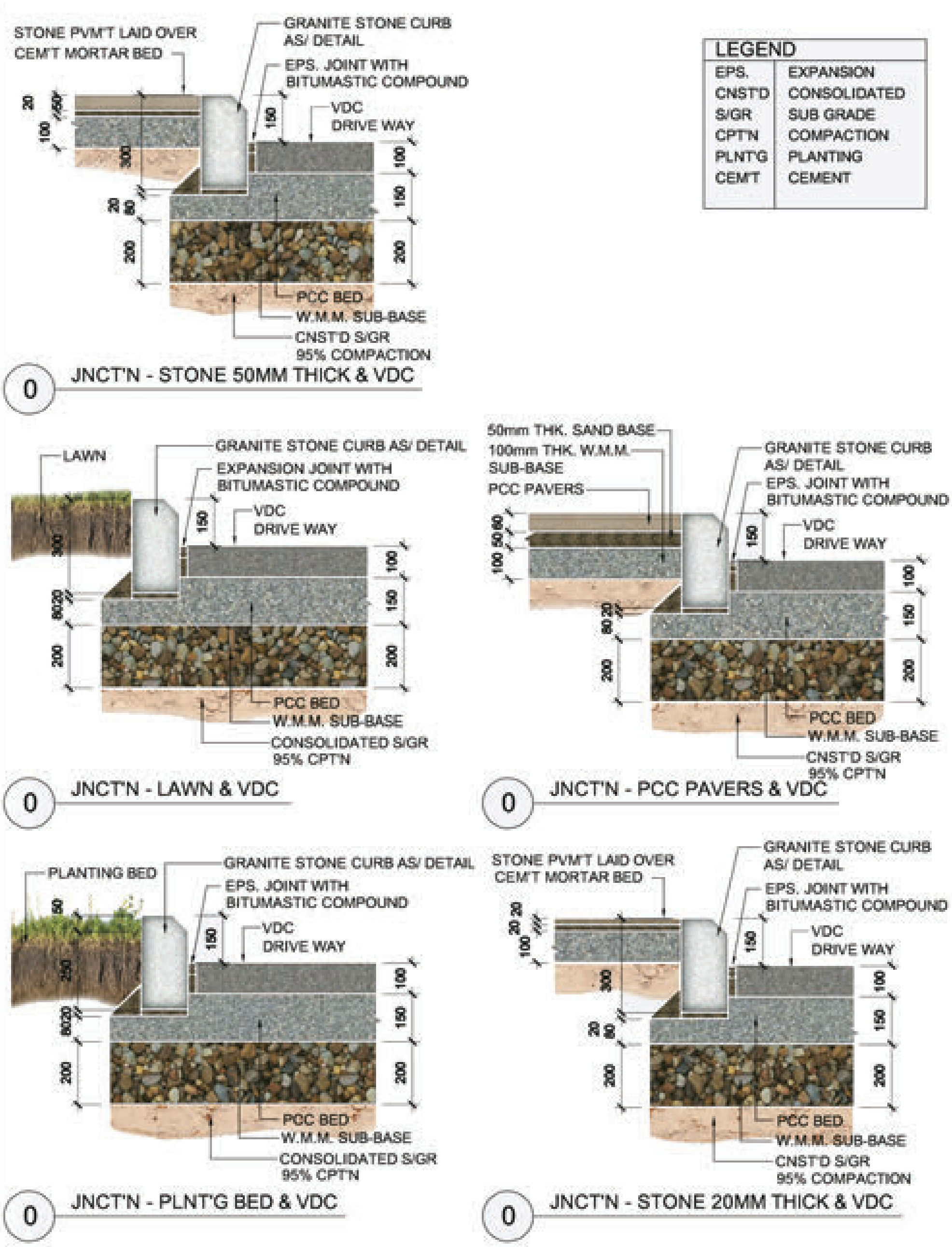


Fig. 6.103 (ILLUSTRATIVE DWG.)

VDC DRIVEWAY JUNCTION DETAIL

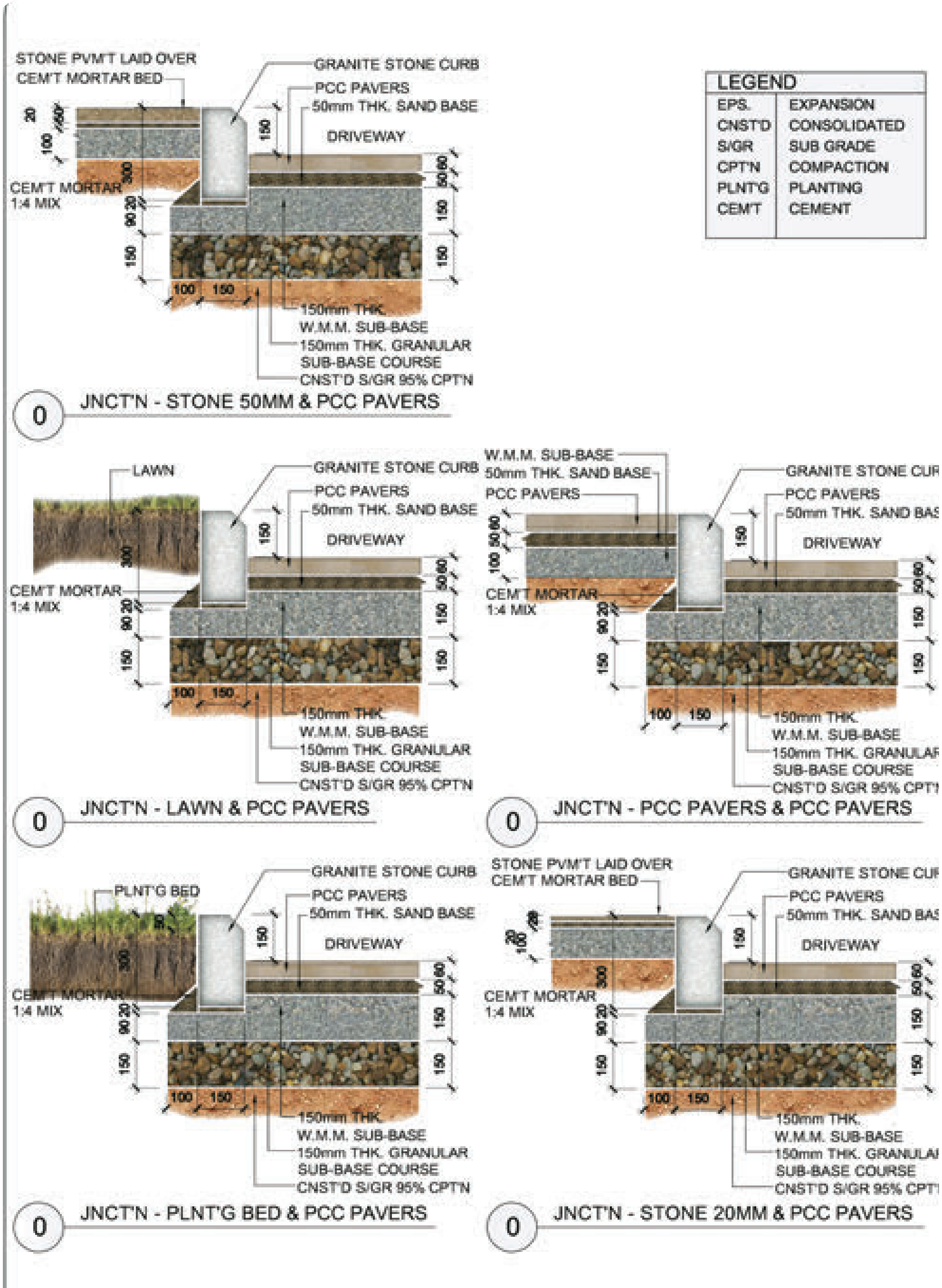
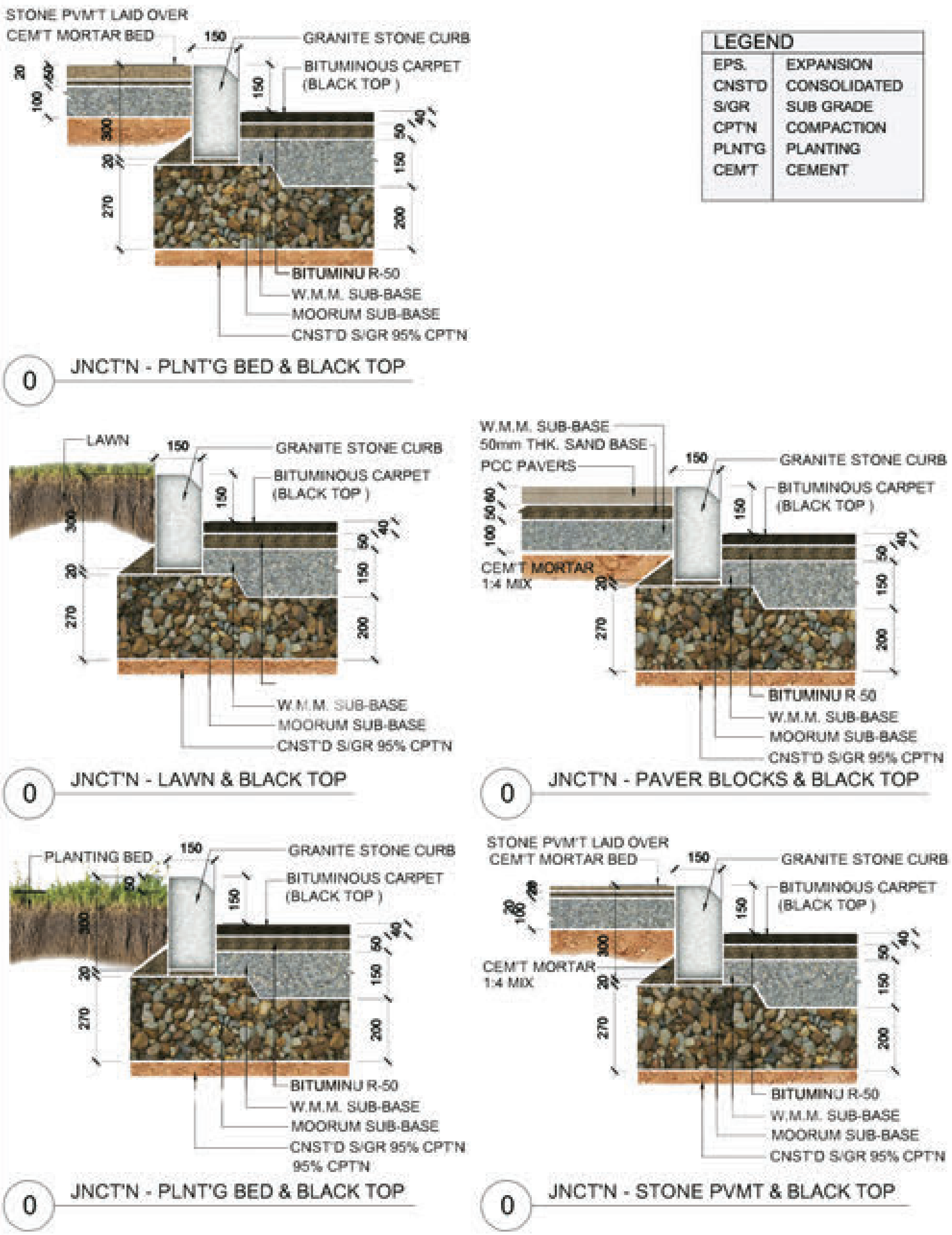


Fig. 6.104 (ILLUSTRATIVE DWG.)

PCC PAVER DRIVEWAY JUNCTION DETAIL

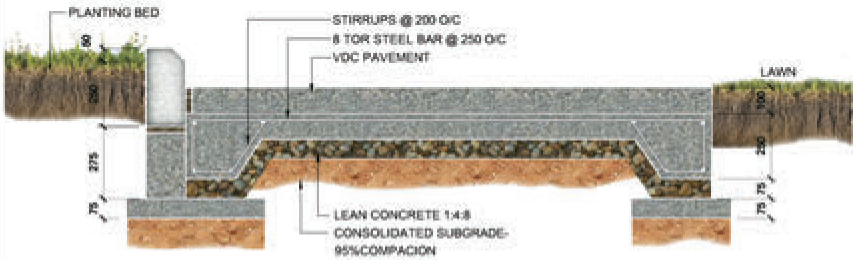


LEGEND

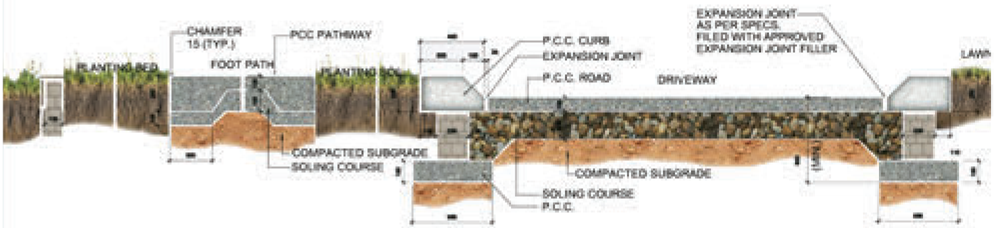
EPS.	EXPANSION
CNST'D	CONSOLIDATED
S/GR	SUB GRADE
CPT'N	COMPACTION
PLNT'G	PLANTING
CEM'T	CEMENT

Fig. 6.105 (ILLUSTRATIVE DWG.)

BLACKTOP DRIVEWAY JUNCTION DETAIL



0 STRUCTURE ON FILLED SOIL



0 JNCT'N - PLNT'G BED & PCC

Fig. 6.106 (ILLUSTRATIVE DWG.)

BLACKTOP DRIVEWAY CURB DETAIL

Fig. 6.107 It is essential that connecting paths should be as well designed and detailed as any other part of the zoo.

To achieve all this, every aspect of pedestrian circulation within the zoo are designed with attention and care. These primarily include alignment (the route) of the path, the experience the visitors are offered while moving from the one enclosure to the next and the experience the visitors are required to have while viewing the animals and the security and safety of the pedestrians during their zoo visit.

The alignment refers to the changes in horizontal direction (which may be fairly straight or curvilinear) and the grading (up and down slopes) planned for the pedestrians as they walk the zoo. The experience of walking between enclosures should offer interesting close or distant views carefully fitted in with the design to ensure that visitors remain focused on the zoo rather than getting distracted into irrelevant chatter.

This can be achieved by suitable planting design, by locating sculptures relating to zoo or animal aspects and be providing a visual composition (a designed scene) of all the above. Another method of maintaining the pedestrian interest could be to have interesting signage and fascinating railings which hold the interest of all age groups. The visitor experience while actually viewing the animals can be enhanced by providing a view which exhibits

Fig. 6.108 Visitors path should be laid out to provide interest and pleasant surprises for the visitors so that they don't feel the distance walked.

the animal in its natural habitat (by providing the right kind of terrain and plants) and by segregating the viewer from the noise and views of the general public and other animals besides the ones which is being viewed. Pedestrian security is an extremely important aspect of pedestrian circulation. The security and safety is not restricted to attacks by animal or a times deranged persons. Security has to be viewed holistically in terms of any element which may lead to an accident or hurt to a pedestrian visitor. This includes poorly designed uneven pavements, open manholes & drains, sharp edges in standoff barriers, sudden drops in levels, slippery stretches of polished stone or tile pavements, or even low tree branches requiring pruning which may hit a pedestrian. Pedestrian should be secured against free ranging animals and snakes.

All necessary facilities like drinking water, shelters to provide protection from sun, rain or snow, toilets should be available at convenient locations. In case of very large zoos, some eco-friendly transport like battery operated vehicles should be an added advantage. Facilities for physically challenged individual should also be available. The circulation should be so arranged that a person should cover minimum path on foot to see all the exhibits. In brief, due care should be exercised to ensure that their movement on foot, within the zoo is smooth and pleasant and they should receive the right educational input like any other visitor.

In a well designed zoo, the above parameters and considerations should form the basis of visitor pedestrian circulation design.

The visitors' circulation is generally restricted to daylight hours and therefore does not require lighting except maybe alarm related warning lights. There is the other aspect of staff, security personnel and keeper related circulation which often extends to beyond the daylight hours. This requires suitable various types and illumination levels of lighting as required at various locations within the zoo. The lights for this purpose will essentially be for specific activities such as delivering feed, reaching enclosure or night shelter to attend to animal requirements, general movement within the zoo for inspection and emergency purposes or for within the zoo and perimeter security. The detailed discussion regarding zoo lighting is taken up in sub head 6.11.5 (Lighting - External).

6.6.6 Special Provisions for Divyang (Handicapped) Persons

It is now a socially accepted fact that persons with physical disabilities have the same desires as others and should be provided with the facilities which will enable them to access and enjoy the provisions which any normal person is able to, including an independent visit to the zoo and every area within it. This is also a statutory requirement.The guidelines given hereunder will enable a person with disability to enjoy all facilities as a normal person would.

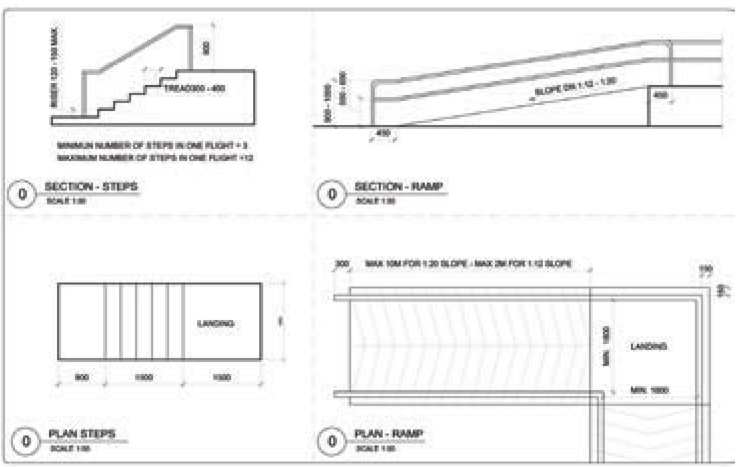


Fig. 6.109

A visitor using a wheelchair or someone who is handicapped otherwise, should be able to access all visitors' areas within the zoo without help. Beginning from the parking area including the enclosures, the toilet and other visitor facilities, the refreshment areas, aviaries, safari's and busesand access to interpretation equipment within interpretation centres, ramps and use of counter heights of ticket and information booths.

This requiresstrict and statutory adherence to standards specified for handicapped.

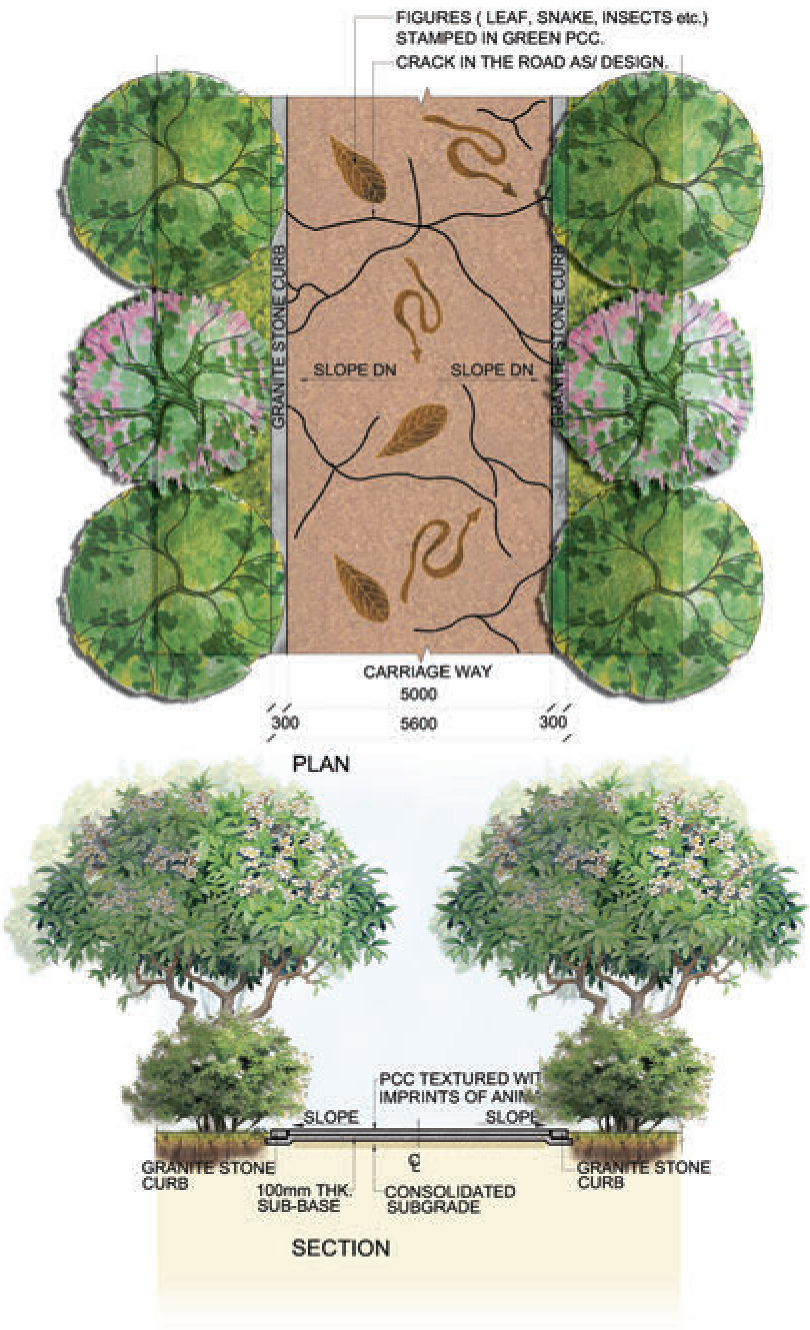


Fig. 6.110 (ILLUSTRATIVE DWG.)

PCC PEDESTRIAN PATH

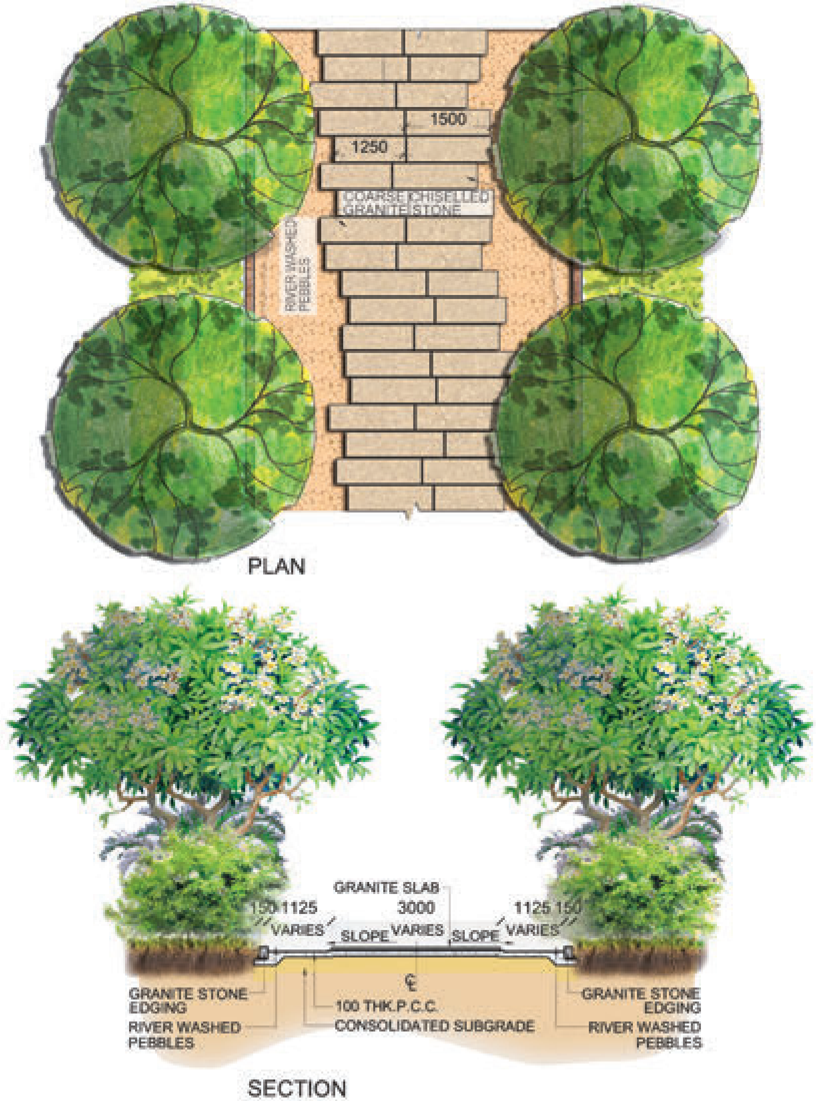


Fig. 6.111 (ILLUSTRATIVE DWG.)

PEDESTRIAN PATH - TYPE I

Design Guidelines for Divyang (Handicapped) Persons

1. Parking

a) Parking for Divyang vehicle should be located within 30m of the main entrance of the zoo campus/ building entrance.

b) Two accessible parking lots with overall minimum dimension 3.6m x 0.80m, should be provided.

c) It should have the international signage painted on the ground and also on a signpost/ board put near it.

d) There needs to be directional signs guiding people to the accessible parking.

e) Wheel stoppers to be provided to avoid vehicles to occupy space on the pedestrian pathway.

2. Signage

a) Signage should include direction and information signs, warning signs, road/paths names, maps etc.

b) All signs should be visible, clear (easy to see and to understand), concise (simple, short and to the point) and consistent (signs meaning the same thing should always appear in the same manner) and properly lit if the zoo remains open upto late evening. Adequate information (both written and pictograms), should be provided which benefits all, including persons with hearing impairment.

c) External signage: Should be mounted above 2.0m from the floor level. Font sizes between 0.10m and 0.71m mm are recommended in order to be easily distinguishable at a 3 meters distance. The smallest letter type should not be less than 0.15 m.

d) Internal signage: Should be mounted on the wall, between 14m and 17m from the floor level. The individual characters between 0.15 m- 0.50 m tall, raised by 1 – 1.5 mm, bold & colour contrasted with their background and also in Braille. Accessible places and facilities should be clearly identified by the International Accessibility Symbol.

3. Pathway/ Pavement

a) Must be easy to follow, obstruction-free for the convenience of all users.

b) Surface should be smooth and level, continuous, firm, non-slip and even.

c) Every change in level on the pathway (a step, curbs or road-works) should be made clearly visible through the use of bright contrasting colours.

d) The minimum width of a clear unobstructed path should be 1.2m.

e) Obstructions should be placed outside the path of travel, preferably along a continuous line and should be easy to detect.

f) Resting Places should be provided along travel routes.

g) Protruding elements should be avoided.

h) Bollards should be painted in a contrasting colour or in coloured strips with clear minimum gap of 1.2m.

i) Pathway dimensions: minimum width of a two-way wheel-chair traffic passage should be 1.8m.

4. Ramps

a) The slope should be gentle: 1:12 max.

b) There should be landing: every 750 mm of vertical rise.

c) Width: 1200mm or more.

d) Handrails to be on both sides at a height of 0.85m – 0.90m.

e) Both ends to be rounded and grouted and extend 300mm beyond top and bottom of ramp.

f) Surfaces (ramp + landing) should be slip resistant.

g) A ramp should be accompanied by a flight of easy going steps.

5. Steps and Stairs

a) Uniform riser: 0.15m and tread: 0.30m

b) Stair edges should have bright contrasting colours: 50mm

c) The maximum height of a flight between landings to be 100mm

d) Landing should be 1.2m deep, clear of any door swing.

e) The steps should have an unobstructed width of at least 1.2m.

f) Have continuous handrails on both sides including the wall (if any) at 0.85m – 0.90m.

g) Warning strip to be placed 0.30m at the beginning and at the end of all stairs.

h) Nosing should be avoided.

6. Tactile Surface

a) Ground surface of a different texture allowing for guiding/ warning by tactile signal for persons with vision impairment.

b) Line-type blocks indicate the correct path/ route to follow.

c) Dot-type blocks indicate warning signal, to screen off obstacles, drops-off or other hazards, to discourage movement in an incorrect direction and to warn of a corner or junction. Should be placed 300mm at the beginning and end of the ramps, stairs and entrance to any door.

7. Circulation Area

a) Corridor should have an unobstructed width of 1.80m and to do well lit.

b) Level differences should be bevelled.

c) Thresholds and gratings should not be more than 10mm.

d) Protruding objects (more than 0.10m from the wall) to be placed either on a niche or above 2.0m from the floor.

e) Spaces below ramp and stairs should be blocked out completely by protective guard rails, raised curbs or marked with a tactile surface.

8. Handrails

Handrails should be circular in section with a diameter of 40-50mm, at least 45mm clear of the surface to which they are

attached, at the height of 0.85m - 0.90m from the floor, extend by at least 0.30m beyond the head and foot of the flight and ramp, in the line of travel and grouted in the ground or in the wall.

9. Curbs

a) Width should not be less than 1.2m. If width is less than 1.2m, then slope of the flared side shall not exceed 1:12.

b) Useful for a smooth transition, specifically at pedestrian crossings and in the vicinity of building entrances.

c) Pavement should be dropped, to be a flush with roadway, at a gradient no greater than 1:10 on both sides of necessary and convenient crossing points.

d) Warning strip to be provided on the curb side of the slope, so that persons with vision impairment do not accidentally walk onto the road.

10. Doors

a) Should provide a clear opening of 0.90m.

b) Be fitted with lever, action locks and 'D' shape handles of circulation section, between 0.85m and 1.1m from floor level

c) Also be fitted with vision panels at least between 0.90m and 1.5m from floor level.

d) Be colour contrasted with the surrounding walls and should not be heavier than 22N to open.

e) A distance of 0.45m to 0.60m should be provided beyond the leading edge of door to enable a wheelchair user to manoeuvre and to reach the handle.

f) Kick plates are recommended 0.30m from the bottom, to resist wear and tear.

11. Accessible Toilets

a) A minimum of and toilet compartment should have enough floor space for wheelchair users to enter and exit.

b) Clear floor space 2.0m long and 1.75m wide.

c) Level differences should be bevelled.

d) Thresholds and Gratings should not be more than 10mm.

e) Protruding objects (more than 0.10m from the wall) to be placed either on a niche or above 2.0m from the floor.

f) Spaces below ramp and stairs should be blocked out completely by protective guard rails, raised curbs or marked with a tactile surface.

12. Washbasins

a) Be of dimensions 0.52m and 0.41m, so mounted that the top edge is between 0.70m-0.80m from the floor have a knee space of at least 0.76m wide by 0.20m deep by 0.65m – 0.68m high.

b) Lever type handles for taps are recommended.

c) Mirror's bottom edge to be 1.0m from the floor and the mirror may be inclined at an angle.

13. Water Closets (WC's)

a) An unobstructed space 8.9m wide should be provided from the edge of the

WC to the side wall to facilitate side transfer, together with a clear space of 1.2m in front of the WC.

b) Be located between 0.46m to 0.48m from the centre-line of the WC to the adjacent wall.

c) The top of the WC to be 0.475m to 0.49m from the floor.

d) Have a back support.

e) Grab bars should be provided. On the transfer side movable type and on the wall side L-shape grab bar is preferred.

6.6.7 Ticketing Counter Vicinity

On reaching the zoo either by public transport or after parking ones vehicle, the visitor is required to buy the tickets - entry ticket, bus ticket for travel within the zoo or tickets to access other areas, such as the aquarium,within the zoo. For convenience and easy movement of the visitors the location and passage to the ticketing counters should enable the visitors to reach it easily.

Ticketing counter areas in India are found to be generally crowded areas resulting in long disorganized never ending queues. There are many zoos where visitors waste substantial time to buy tickets. Ticketing counters area should have a large enough space to accommodate the crowd. While one person out of the group is waiting in the queue to buy tickets the rest should be provided with enough space to wait and engage themselves in gathering information about the zoo and its layout with the help of signage, mobile apps. and brochures. This area should be secure for visitors and should not be an extended part of the vehicular road (which unfortunately is the situation in many zoos).

The ticketing window, in many Indian zoos, opens outside the boundary of the zoo. Expecting visitors to use public space (public pedestrian paths and even part of vehicular road) to wait in order to buy tickets. This has gone on for so long that people accept this without protest and without realizing that it is the responsibility of the zoo authorities to provide space and suitable environment to procure tickets.

Size of ticketing area and the number of ticketing windows will depend on the expected number of visitors and the maximum number per day or during a certain period or specific season. There should be adequate and proper facilities to provide ease of access and cater to public requirement. The visitor should not be made to spend more than a few minutes to buy tickets in any situation. Author had observed an extreme situation of mismanagement where visitor had to stand in a long queue to buy a ticket (because the number of ticket counters was less than required to cater to the average number of visitors) and after buying the tickets visitors had to join another long queue to enter the zoo!

Fig. 6.112 Ticketing counters are an important part of the zoo; counters and the related activities should not spill on to public road.

Fig. 6.113 In the above pic in Thailand, ticketing counter have been appropriately designed and provided a suitable space.

Design Guidelines for Ticketing Area

1. The ticketing area should be easily accessible from the parking area. It should be connected to the parking area by a suitable and secure walk way where visitors, including children and women are able to reach by walking the shortest possible distance.

2. The walk way connecting the ticketing areas to the parking area should not cross vehicular traffic. If this is not possible than the crossings should be restricted to a preferably not more than one.

3. The pedestrian path leading to the ticketing area should be suitably paved.

4. The approach to the ticketing area should avoid too many steps to access it or to exit it.

5. There should be a provision to increase the ticket counters as and when the visitors increase.

6. Ideally the visitors should be able to get ticket by electronic means - may be - insertion of their Aadhar or I/D card.

7. The height of the counters should be convenient for an adult as well as a child. Separate counters can also be provided for adults and children/ handicapped.

8. Layout should ensure that the visitors are able to buy tickets easily in the shortest possible time.

9. Ticketing area should be covered to provide shelter from inclement weather.

10. There should be seats, waste bins and clean drinking water facilities available for the waiting public in vicinity of ticket counters.

6.6.8 Interpretation Centre

Interpretation in the context of the zoo, can be explained as an activity to inform & educate the visitor and get him interested to understand the animal life and behaviour, wildlife conservation and concepts of ecological sustainability in which animals play a significant role. Zoological park offers a unique opportunity where the interpretation activity can be carried out as a first - hand experience using actual objects (such as the horns or jaws of various animals, habitat timber samples etc.), illustrative & scientifically correct modern models or audio visuals with living animals in the zoo to relate them with the living animals in the zoo. Interpretation Centre is a building or an open space in which elements used for interpretation of animal characteristics and behaviour are kept. Otherwise interpretation by itself is also done with the help of signage, leaflets, brochures and nature trails. These are outdoor elements while Interpretation Centre per se is a covered space - often with audio visual facilities. Various methods, equipment

Fig. 6.114, Fig. 6.115 & Fig. 6.116 Interpretation centres should be a thrust area for zoos where information and display should exercise the mind and senses of the visitor. It should have a focussed program initiatives to involve visitors using digital means, should offer engaging literature and have naturalistic presentations of models and replicas.

and infrastructural facilities are used in an interpretation centre in a zoo. Interpretation Centre is meant to serve as a classroom for all age groups and gender mix of visitors to the zoo.

It will not be proper to offer specifics regarding architectural design and sizes of rooms/ halls and audio visual facilities to be provided in Interpretation Centres in zoos because it will restrict region and animal specific imaginative layouts and designs. India still does not have more than a few innovative examples to emulate. Good international examples should be referred to.

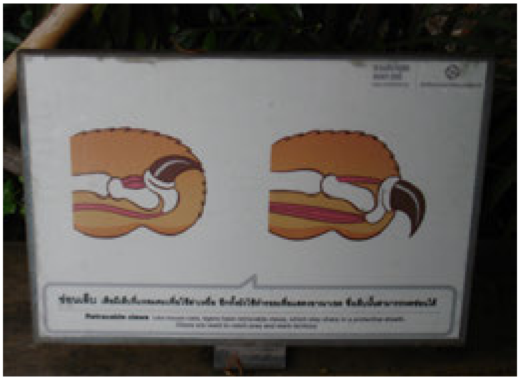


Fig. 6.117 & Fig. 6.z Interpretation can be offered separately or as a part of the enclosure area.

6.6.9 Information and Souvenir Sales Counter (ISSC)

An information dissemination and souvenir facility is a part of almost all zoos in India. Presently in India the quality and size varies from a small window with one counter for storage to a small room with minimal, often outdated, material with an unattractive display. ISSC facility apparently, has been long ignored. In fact it is generally the vendors outside the zoo who offer substandard mementos which are unrelated to the zoo theme. The consequence over the years has been that the visitors visit to the zoo ends in 'viewing and enjoying' the animals rather than making the visitors any wiser about the animal behavioural characteristics and its habitat. The lack of information and souvenir facility has resulted in the zoo visit being forgotten almost immediately after leaving the zoo. Present visitors to zoo look for such material and are even ready to pay for it but do not find good commemorative items to take home. The present available information is in the form of a poorly produced brochure(s) or a booklet with a few lines of information on a few animals. This usually serves the most uniformed visitors but there is nothing to serve the knowledge appetite of an informed curious visitor or student of animal behaviour and someone keen to know about other aspects of zoo.

In sharp contrast, the better zoos abroad have extremely well equipped information & souvenir shops for visitors with material of all information levels, age groups and interests. Such material is knowledge for visitors and earning & advertisement for zoos.

There is hardly any information material in any zoo in India which is worth sharing as reference material. Neither with regard to animals, nor with regard to plants and nor relating to geology, geomorphology or soils or any other aspect of the zoo history.

Design Guidelines for Information & Souvenir Sales Counter

1. There should be well equipped, well designed information and souvenir shop/ counter which should be attended to by trained and knowledgeable staff.
2. The size of ISSC will depend on the location of zoo and number & cross section of visitors and their paying capacity. A minimum size approximately 18 – 20 m^2 should be maintained. The upper limit can be decided for each zoo and expected sales volume.
3. The location and design of ISSC should ensure that the resultant activity and noise does not go beyond the ISSC area and certainly should not disturb the enclosure area.
4. The information should be available in printed form (well produced brochures and books), in digital form (information CD's, maps movies) as well as in the form of innovative toys , badges, utility items such as mugs, stationary item all of which should be of superior quality.
5. ISSC should be located to enable the visitor to conveniently visit it both before and after the visit to the enclosures.
6. The theme and design of souvenirs may reflect local arts and culture but should not exclude modern creative designs.
7. The material and hardiness of souvenirs should be such that they do not wither away or lose shape too soon. Souvenir should be well manufactured and of lasting material.
8. Without compromise on the quality, souvenirs should be available for all income groups of visitors since all children by nature have the same interests and desires!
9. The exterior and interior design of ISSC should be colorful and be able to attract the visitors.
10. ISSC should have suitable screening – either masonry or vegetative to restrict its activity and view.

6.6.10 Children's Play Area

Children's play areas are now a common feature of most Indian zoos. Presently these are in the form of a few lawns (often bare soil because of dismal maintenance) and a few randomly selected play equipment. These are often used for rest and play by children and persons accompanying them generally on their way out after visiting the animal enclosures. Such areas may be adjacent to the zoo but have to be separated from the main zoo premises since it is not allowed to be a part of the zoo as per the Central Zoo Authority norms.

Children of all ages form a substantial percentage of the visitors to Indian zoos. They can broadly be categorised into two groups - those who accompany their family and those who come as part of school visits. All tend to use the play areas.

Children play area, like other areas of the zoo, should have a core theme related to zoo animals, enclosure design or zoo etiquette. Whereby the layout of the play area informs the children about the layout of the zoo enclosures or play models of enclosures and stand off barriers. Play areas should have elements to help inform the children about the safety aspects, discipline and precautions to be taken while viewing the animals. Children's play within a zoo should not be similar to a public park outside the zoo.

Children play area should be located so that it does not disturb the zoo activities or the zoo environment. The area should not be prominently visible to the visitors since it is not a core element of the zoo. It should be ensured that sounds of play should not reach the animal enclosures or other areas of the zoo.

It should be designed as an area where children, and even the accompanying adults, are introduced to interesting information about zoo animals - such as their physical dimensions, behaviour, jump characteristics etc. - as part of play. Visitors can be introduced to the sounds of animals & birds can be to enhance their knowledge of animal world. Hoof marks laid on ground can form a part of recognition competition for the visitors. The intention behind this is that if an individual concentrates on something (in this case the footmarks , the jump distance etc.) even if it is for a few minutes it will be remembered and enhance the public awareness about wildlife in general and zoo in particular.This space should be use innovative ways and designs to inform the visitors about the conduct rules to be followed during the zoo visit.

Children play areas can be used to display design elements which familiarise the user about the plants in the zoo. These plants should be the ones which are a part of the natural habitat of the animals in the zoo. The element should help the visitor understand the physical characteristics (height, spread, bark texture, foliage colour etc.), the liking of the animal to the specific part of the plant (such as the foliage, the fruits or the suitability for nesting).

Another idea could be to create full scale models of animal habitats showing the natural habitat vegetation and showing animals sharing the same habitat and existing in a symbiotic

Fig. 6.119 & Fig. 6.120 Children's play area should not be allowed as part of zoo premises. In some cases such play areas are located adjacent to but technically just outside the 'boundary' wall of the zoo since children seem to need this activity area.

ecological relationship. The children can then move through these environments and experience the animal & birds sounds and even feel the artificially created rain and humidity of a tropical forest and get a feel of the natural habitat of the animals.All this will help children in understanding wildlife which is the purpose for which the people & children in particular, visit the zoo.

In brief, children play area of a zoo deserves serious attention with regard to its purpose which is significantly different from a children's play area in the normal sense. Adequate budgetallocation should be made at the design stage and should be treated as an integral part of the whole zoo design and not as compulsory and necessary adjunct.

There are now many company's manufacturing very interesting and safe play equipment which can be used. Some equipment can be constructed to integrate with the layout and planting design of the specific play area.

6.6.11 Landscape Furniture

There are numerous individual utility items used in the open spaces of a zoo for the convenience of the visitors. These include seats, waste bins, cycle stands, bollards, barriers, sculptures, litter & recycling receptacles, sunshades, drinking water fountains etc. Earlier in India these were constructed in brick masonry with neat cement finish or stone cladding or metal in simple, functional and traditional designs borrowed from what were there earlier. The product design component was entirely missing. Often the design was not integrated with the surroundings and as a result, it became unsuitably conspicuous in terms of colour, material, form and size. This disturbed the natural look which should be the hallmark of zoo environment. There have recently been individual attempts at design of these elements but these still remain unrefined and lack modern product design finesse.

The basic design requirement of landscape furnishings should be that they should be convenient to use and should merge in a mature way (not by juvenile interpretation)

Fig. 6.121, Fig. 6.122, Fig. 6.123 & Fig. 6.124 Visitors facilities including drinking water fountains (a part of landscape furniture) are now available in a wide range of proprietary designs available of the shelf and can be placed in an easily accessible but non conspicuous. location in the zoo

Fig. 6.125 Selection of materials is important to create a natural appearance in a zoo, If this seat or signage was stainless steel it will compromise the ambience.

with the surroundings in terms of colour and design. Presently there are numerous companies manufacturing ready to install furniture in materials ranging from cement concrete to stainless steel, wood and even stone (granite and others). It is advisable to select appropriate items from the ones available in the market rather than attempting to design and construct in situ. The advantage of procuring furniture from the market will be timely delivery, easy installation and good detailing. There will not be any sharp edges, the paint will weather longer and will generally be well designed. The only effort should be to select the items which are appropriate for zoo use in terms of colours and textures which merge with the zoo vegetation. The vendors may even be willing to manufacture specific designs (of the kind which one may come across from other international zoos) if orders are large enough.

Design Guidelines for Landscape Furnishings

1. The selection or design of various items such as waste bins should be such that they are easy and large enough to use.
2. Waste bins should be located at a maximum distance of approximately 200 to 250 mts apart and at all other functionally suitable locations.
3. Seats should be comfortable to sit i.e. they should not be either too hot or too cold for the use in all seasons, even in inclement weather.
4. All landscape furnishings should be installed/ placed at locations where they are easy to access and use. Visitors should not be required to jump over drains or go around planting to use any utility item.
5. Waste bins or any other utility item should never be nailed to trees.

6.6.12 Resting Structures - Pergolas & Gazebos

Visitors of all age groups in the form of individuals, families and groups of school children or tourists visit Indian zoos. As a result of walking long distances, even in an average zoo, all visitors, whether elderly or children, require to rest for a while before continuing to other enclosures or prior to departure after they have completed the zoo visit.

Resting structures cater to this requirement. The primary functional requirement of such structures is to provide shade (from sun, rain or inclement weather) and to provide for comfortable sitting.

The design aspects will include the size (so that the structure is large enough and has an adequate extension to provide protection against sun & rain), and a suitable colour and texture to merge with the surroundings (which should not be conspicuous and contrasting with the surroundings). These structures can be either constructed at site or

Fig. 6.126, Fig. 6.127, & Fig. 6.128 **Waste management requires immediate improvement in collection methods, infrastructure and disposal. Mechanisation will enhance the system.**

manufactured ones. Modern tensile structures in innumerable designs, colours and sizes are now freely available commercially.

Design Guidelines for Resting Structures - Pergolas & Gazebos

1. Such structures should be located to be easily accessible for the public generally adjacent to visitors' circulation path.

2. Resting structures can either be fully visible or can be partially screened so as not to disturb the natural environment of the visitors' circulation design. In this situation clear signage should indicate the location so that the users are aware of the facility.

6.6.13 Public Toilets

A large number of visitors come to the zoo every day. They need to be provided with basic civic facilities of which toilets and drinking water fountains are basic and necessary.

1. Toilet facility should be available near the parking area, in the vicinity of the ticketing counters.

2. These should be evenly spread out in the zoo area along the main visitor's path, at the distance of approximately 500 mts. between two.
3. These facilities should be close to the visitors' path but completely camouflaged with suitable vegetation and yet identifiable by directional signage.
4. The location should not be visible to visitors' walking on the main pedestrian route.
5. The structure and colour and texture of external finishes should merge with the surrounding vegetation i.e. should not be conspicuous by colour or size.
6. Wherever possible the built up part should be kept minimum. For example while toilet will require a built up area the drinking water fountain need not have a cover. It can be a well-designed functionally as an efficient small element.

6.6.14 Drinking Water Fountains

Thirst is a normal body demand during the long walks in a zoo. Drinking water facilities should be made available at convenient intervals. These can be in the form of small elements such as 'fountains' (where at the press of a button throws up a small water jet) or a larger structure with a trough where more number of persons can avail of the facility at the same time.

Fig. 6.129 & Fig. 6.130 Public facilities should be placed at short distances, suitably camouflaged with vegetation yet visible and easily **accessible.**

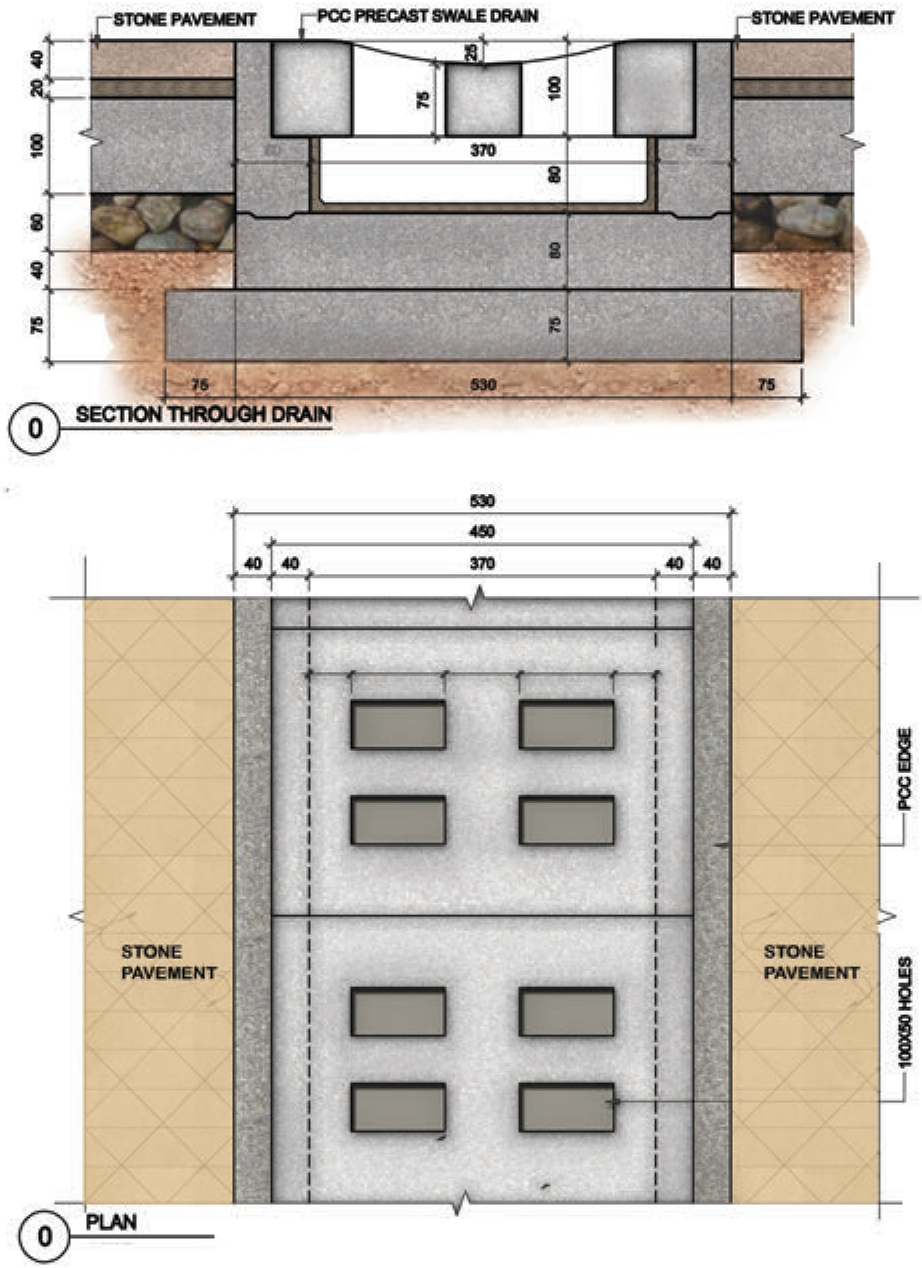


Fig. 6.131 (ILLUSTRATIVE DWG.)

DETAIL- DRAIN ALONG PATHWAY

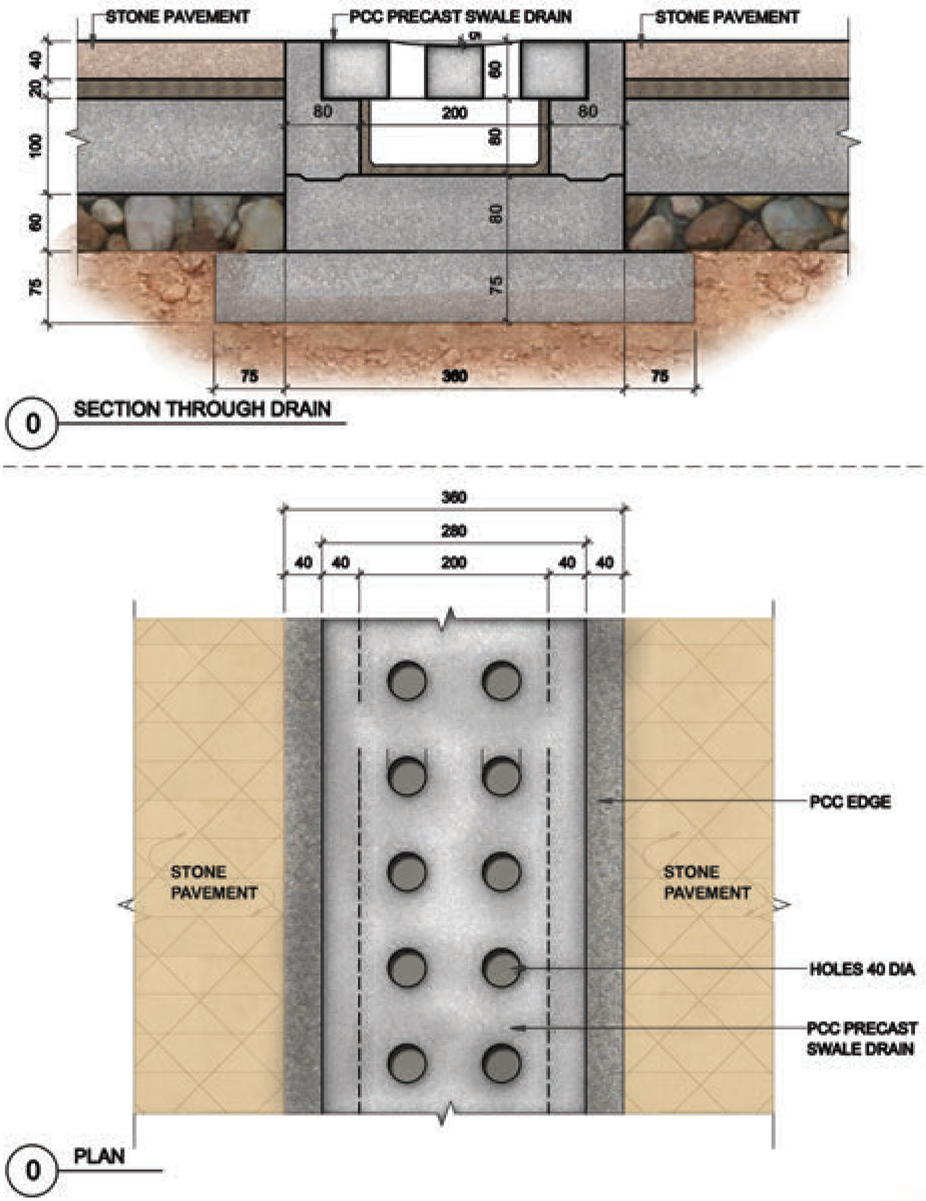


Fig. 6.132 (ILLUSTRATIVE DWG.)

DETAIL- DRAIN ALONG PATHWAY

6.6.15 Kiosks/ Food Court/ Restaurants

In India, very often, reaching a zoo is an effort which is time consuming, tiring and expensive. Visitors to Indian zoos by and large are from the lower income and middle income group. Some use self-owned and driven vehicles and many others use public transport ending in short and long walks, to arrive at the zoo. This results in a need for refreshments before entering the zoo.

Most zoos involve long walks and therefore generate the urge for frequent refreshments, except maybe for the exceptionally healthy. In Indian context this need is catered to in a disorganized, non-formal manner by the vendors outside and inside the zoo premises. The zoo authorities often play no role except granting formal or non-formal permission to vendors inside the zoo. Such vendors are generally selling edible items in most unhygienic conditions. Menu of course is no body's business! No formal studies have been conducted or data collection done to establish the visitor or data profile in any of the zoos in India. Therefore, the food preferences, type and qualities are not based on any scientific data but is decided by the vendor.

Fig. 6.133 Food courts/ restaurants generate noise and waste and therefore should be located, physically and visually, far away from enclosures.

Design Guidelines for Kiosks/ Food Court/ Restaurants

1. There should be suitability located refreshment facility immediately adjacent and / or within the zoo.
2. The size and menu of such facility or more than one facility will depend, for the present on the assessment of the zoo authorities.

3. The facility should be located so as to be easily accessible but should be designed not to be conspicuous.
4. The design should ensure that the activity does not overflow outside the specified area.
5. The facility should have adequate number of litter bins located at appropriate locations.
6. The facility should be provided with a very efficient garbage removal system. This system should also have closed temporary garbage storage for the day.
7. The facility, if within the zoo premises, should be placed away from the primary circulation route only; with a short connecting path. This facility should not be placed along secondary or tertiary circulation paths and of course never along the service road.
8. The visitors should not be allowed to take out any food item outside the restaurant/ cafeteria boundary.

6.6.16 Amphitheatre and I-MAX Theatre

One of the main objectives of zoos is to disseminate information by various means of communications. Amphitheatre - described as an open air venue for performances and entertainment, is one means of imparting the message of zoos to the public. These performances are controlled performances directed towards specific objective of educating visitors and but the habits and conservation aspects of animals in captivity as well as in the wild. Presentations are made to explain to the visitors the methods and techniques of animal management and research. The size of the amphitheatre should be decided on the basis of the likely number of visitors and the size of the particular zoo. Amphitheatres are built with a central stage for performance and with a series of wide steps around it to accommodate the viewers. Apparently one way of achieving this is to build this situation artificially by construction. If built on a flat ground the back of the steps end in a high wall. Ideally amphitheatres should be built on a suitable natural slope available at site.

Fig. 6.134 The use of artificial thatch minimizes maintenance. Maintenance considerations are of prime importance in a large area like a zoo.


Fig. 6.135 & Fig. 6.136 The OAT inside the zoo should conform not only to the sitting standards (width and height of the seats) but should have a design and look to merge with the surroundings with all weather seats.

It is best to use a natural slope of approximately 1:4 or 25% from within site. The steps/ risers for sitting and access steps and ramps should be added by construction. Amphitheatre will have also associated small service structures. These will include preparation rooms, change rooms, projection rooms, a back wall etc. Amphitheatres will also require suitable audio visual, lighting, electrical and plumbing services.

I-MAX is an acronym for image maximum; a projection system introduced in 1971. This system is capable of high resolution projection on a screen much wider than the conventional cinemas. The sound system gives a realistic feel with a surround sound effect. I-MAX has a six channel system locked to the picture. Compared to the conventional manic system I-MAX is expensive but presents wildlife and related aspects in a way which connects every visitor to realistic of wildlife. At present there is no I-MAX theatre in any zoo in India but it will prove to be a most innovative addition in modernisation of Indian zoos.

6.7 FACILITIES FOR STAFF

6.7.1 Zoo Administrative Offices

All zoos require space to house staff and equipment for administration and management of the zoo. It may be a single building, in a small zoo or a complex/ group of buildings (generally within an enclosed compound) in case of large zoos or as per the requirement of a specific zoo.

Administration offices control the entire working of the zoo and therefore need to be easily accessible and secure. There should be separate and well-designed rooms and storage spaces to enable all levels of hierarchical offices and staff to work in.

Administrative and security aspects are the most important and elements of any organization. But both of them, especially in case of a zoo, should be low key in terms of their architectural appearance. In most Indian zoos the administrative buildings do not have a suitable architectural design and are often located wrongly. Architectural design is not only restricted to the appearance but should also ensure that the building is located suitably to reduce unnecessary circulation and wastage of areas.

There are no standards for providing room/ space sizes to be followed by zoo in India. Suggested minimum sizes, which should enable comfortable working, are provided further herewith.

Design Guidelines for Zoo Administrative Offices

1. Administrative office with its attendant buildings should be planned toaccommodate the spaces given further hereunder; the size of certain spaces will vary according to the size and location of the zoo.
2. All spaces should have a minimum height as specified by local bylaws otherwise a minimum clear height of 2.85 mts. This height is sufficient to hang a ceiling fan and hanging lights but additional clear height is required to accommodate air-conditioning ducts etc.
3. If the buildingsare single storied then they should have roof insulation to ensure comfortable temperature inside.
4. Attempt should be made to achieve GRIHA/ LEEDS rating to make the building energy efficient.
5. The area around the administrative office should be suitably landscaped.

Open air theatre, Zoo Negara, Kaula Lumpur, Malyasia

Zoo Administrative Offices - Design Requirements

Zoo Administrative Offices - Design Requirements					
S.No.		**Space**	**Design Requirements**	**Area (m^2)**	**Remarks**
1		Common parking area for all building in the administrative office complex.	Shall be surface parking @ 23 **m^2**/ ECS should be hidden from the entrance and other		Nos. of car parking spaces will be decided as per the requirement of each zoo.
2		Drop-off area (Porch)	Should be able to park 2 cars		
3		Entrances lobby	Should be able to provide setting for 4-8 persons	20.0-30.0 **m^2**	
4		Director's Room	Should be a minimum area of 35 m2 dimensions of approx. 4m x 5m. Should have meeting area with appropriate space for furniture, for seating 5-8 persons. Should have a TV screen		
		Deputy Director's room		Min. 20 **m^2**	
	4.1	Attached toilet	WC, wash basin chamber	2.5 x 1.75 **m^2**	Should have stone or vitrified flooring and wall cladding
	4.2	Store/ strong room		Min 4.5 **m^2**	
5		Conference meeting cum audio visual room	Should have a seating capacity of 15-20 persons Min.	2.5**m^2**/ person Min.	
	5.1	Attached office		9.25 **m^2**/ person Min.	
	5.2	Attached toilet			
6		Administrative office			
	6.1	Administrative officer's room		16.5 **m^2**(avg)	
	6.2	Toilet	Existing local bylaws - depending upon no. of uses.		
	6.3	Record room -1			For hard copy records. Records room vary considerably in size & shape as the data contained within them.

	6.4	Record room -2			For electronic data storage
7		Curators room		20m^2 Min.	
8		Computer & research facility			
9		Library		15.0 -40.0 m^2	
Facilities Lunch Room 1.5 m^2/person **Mail Room 2.45-2.75 mts wide, length depends upon usage**					
10		Feed supply section			
11		Central security control room		20m^2	
12		Security office room		10 m^2	
	12.1	Staff room for security personnel			Depends upon the number of security staff
	12.2	Attached toilet	WC, wash basin, urinal		Should be separate for men & women depending on number of persons
13		First aid room	16.5-18.0 m^2		
Infrastructure Services					
14		Landscape development services			
	14.1	Maintenance sewerage office			
	14.2	Maintenance staff room	16.5 m^2 (Avg)		
	14.3	Maintenance store	Approx. 18.0 m^2		Depends entirely on the requirements of the zoo and the facilities/ services it provides

Directors Office

Staff Room

Record Room

Curators Office & Records

Publication Room

Note:

1. All the above areas are an average for efficient functioning. These may decreased slightly or increased as required in the particular zoos.
2. All rooms should have a minimum height as specified by local by-laws otherwise a minimum clear height of 2.85 mts. This will accommodate a ceiling fan or any hanging lights.
3. If the building is single storied it should have roof insulation.
4. Attempt should be made to achieve GRIHA/ LEEDS rating to make the building energy efficient during construction and during its life.
5. The area around the administrative office should be suitably landscaped.

6.7.2 Maintenance Store and Maintenance Yard

All zoos are large areas with extensive equipment, landscapes, enclosures, barriers, kraals, electrical and plumbing system etc. It is obvious that such a campus with require extensive regular maintenance. Various kinds of maintenance and large and small equipment to capture wildlife required to be stored in a zoo. From ropes to sten guns and from landscape maintenance equipment take mechanised lawn mowers to barrier repair welding equipment etc. All equipment specific storage spaces for easy and emergency access.

Hence the need for maintenance store(s); one or multiply, depending upon the area and specific requirement of the zoo. The area and design of the store will again depend to the requirement of each zoo. Therefore, adequate thought and planning will need to be

done before deciding on the size and the storage system within the store. There are at present no mandatory or even recommendatory space or specification standards (except CZA area standards) for zoo in India.

This needs priority attention. This situation results in each zoo and individual zoo official having a subjective opinion which has precipitated in a wide range of sizes, locations and design of maintenance stores in Indian zoos. A maintenance yard; a large open area with water and electricity connection is always required adjacent or in close proximity to the maintenance store. This serves as space for large equipment repairs, drying, inspection of new material & feed items received and even temporary storage.

6.8 SIGNAGE

One of the most conspicuous and important elements of a zoo are the signage. Signage can be described as any kind of visual graphics to present information to the visitors and staff in a zoo. Signage is extensively and uniformly spread out within the zoo. Starting from the zoo parking areas to individual enclosures. A full drawing of the entire zoo indicating the exact location of each signage along with legend of the signage type is an imperative requirement.

Each signage is designed & located to serve a specific purpose, each has its own viewing distance, each is used for a specific purpose and each has its own appropriate orientation(facing north/south/east or west). Design and location means its colour and text size is decided depending upon whether it is for general public or for specific group of people while location is decided considering that if it is a warning sign it has to be bold and conspicuous but if it is an enclosure signage then it should be so placed that while the visitors should be able to read it but it should not obstruct animal view. In many cases the direction (orientation) of the signage becomes important because it becomes unreadable with the sun shining on it or if the viewing is through glass than the glass reflection completely obliterates the signage. In such cases care is required to place the signage at an appropriate angle to ensure its legibility.

Almost all zoos are complex physical environments not given to easy way finding. Most zoos clear site lines because of extensive vegetation and without the prompts one is used to when finding directions in a city or a building. There is a unique requirement for the visitors to continuously orient themselves with regard to their location and intended movement to be able to enjoy the zoo experience. This will help the visitors to access the enclosures easily without getting lost and exhausting themselves.

A zoo visit comprises of a series of events within zoo: arrival of vehicles, parking, buying tickets, orientation in the interpretation centre, moving on to various zones within zoo such as animal enclosures, other visitor facilities such as food kiosks, meeting & rest areas and toilets.

After entering the zoo the visitors have numerous choices. There could be upward of 200-300 destinations of animal displays in various thematic zones and areas within a zoo. Finding ones way and organising the day upon arrival is a daunting task. This demands that the visitor plans the visit carefully if the idea is to see the entire zoo or a part of it which can only be made possible with the help of large easy to read site map at various appropriate location within the site beginning from the entry. It may be a good idea to make the visitors learn how to read the site map. Many, in fact most, visitors are not able to use the map.

As the visitor proceeds inside, he is sure to have to take decisions as to which path to take and which enclosure/ places to visit which can be facilitated with signage in the form of text and other graphic forms of communication. All these should result in a co-ordinated, well designed and suitably located signage, maps and graphic displays. These may be augmented with audio messages and touch screen displays. Zoo maps should be simple in design and should have maximum clarity. Signage designer should be free to include diagrammatic enhancement and artistic inputs to enhance readability and understanding. A primary objective of zoo signage design should be to project the complex spatial layout so that the visitors quickly come to understand the layout and use it with ease.

The tools for designing signage can be colour, font, font size, texture and shape. The communication will include names, locations, nomenclature, numbering system and design with reference to the zone theme. Signage should clearly convey the specific purpose for which it has been displayed and should be placed considering the viewing distance & the direction (to take care of the glare which often obliterates the signage entirely).

Different categories of signage are listed below:

a) **Information:** Provides information about enclosures locations, facilities and instructions regarding the visitors conduct/ behaviour during the zoo visit.

Fig. 6.137, Fig. 6.138 & Fig. 6.139 There can be innovative ideas for zoo signage in which shape, colour, location and material can vary but in all cases they should be weather resistant and readable.

b) **Direction:** Provides directions to facilities, public conveniences, zoo offices, emergency services with the help of directional arrows and site maps.

c) **Identification:** Identifies the services and facilities by name, numbers or graphic images.

d) **Safety and Regulatory Signage:** This provides warnings against wrong actions which may be harmful for either the animals or visitors.

e) **Signage for Visually Handicapped and Differently Enabled:** This is a specialised item often using Braille and sound effects.

f) **Emergency direction signage:** This signage should very prominently provide the direction to be followed in case of an emergency evacuation. Distinction must be made between a warning signage and an emergency signage. Warning signage is to inform the persons to avoid an emergency whereas an emergency signage is to inform what to do after an emergency has occurred.

Obviously the visitors, unlike trained staff, cannot be trained for emergency evacuation or emergency response procedures. Yet it is the visitors who are most likely to be affected in case of an emergency. In such a situation one way out is to considerably increase the frequency of visibility of 'emergency signage' all over the zoo. It is to create a situation where the visitor subconsciously reacts to an emergency situation because of having read the emergency signage frequently during his walk in the zoo. Emergencies often happen without warning. In a zoo a most likely emergency may be that of an animal having escaped from its enclosure. It is in such situations that the visibility and repetition of emergency signage will help.

Besides the design aspects the most important consideration is the fabrication/ construction and the use of suitable materials to ensure that the signage is able to weather the open locations in all kinds of climate. It should not wear or discolour. At present, signage is often either bent, broken, discoloured or even warped. Enamel painted mild steel sections (pipes or rectangular) are commonly used for signage. The text/ information on sign boards are generally painted. In most zoos this method still continues. The paint quality and the application technique & equipment has improved over the years as a result of which if the signage structure is professionally detailed the mild steel and enamel/ duco paint method can still work effectively. For example, everything else being correct if the joint between two members of the frame is not properly welded it cannot be painted properly as a result of which it rusting starts from that point.

It is time though that Indian zoos introduce and experiment with new materials which have been introduced and are now in use across the board. These include aluminium and stainless steel in the form of sheets, textured sheets and nets. The higher initial cost of contemporary materials has to be viewed in terms of long term savings, considering its longer life and almost zero regular maintenances and absence of all problems associated with rusting.

Presently ceramic tiles are also in use for signages, but are still not very popular. These do not last long and are vulnerable to damage besides being costly because limited numbers required in a single zoo have to be printed specially.

Finally, the design of the base structure on which the signage is fixed, (generally of cement concrete) should be done by a qualified engineer. The design of the foundation is not uniform and will depend on the size, height & weight of the signage and the soil condition.

Broad Guidelines for Signage

1. All signage in a zoo should be weather proof, meaning thereby, that the base material and the support/ fixing assembly should not rust or otherwise deteriorate over time or reduce in visibility.

2. The support or frame material should be either of stainless steel/ aluminium or it should be painted with duco paint or superior grade enamel paint.

3. All signage should have suitable text size to be easily readable from the distance they are supposed to be read.

4. The colour contrast of the text/ graphic and background should be adequate for clear visibility reading.

5. The placement and of various types of signage should be carefully done to ensure that they serve their purpose i.e., the intention should be as follows:

a) Information signage should be seen together with the object or animal they provide information for. The person should not be required to turn around to see the signage.

b) Direction Signage should:

- Be provided for vehicular routes, pedestrian paths, service roads and emergency vehicles such as fire tender.
- Indicate the direction and the destination it leads to
- Signage should start from parking lot and continue to direct visitors to various sites within the zoo.

c) Should be placed at all locations where the visitor will have to decide which direction to take e.g. at all junctions and change in alignment. This should be done with the help of sign posts and directional arrows

d) Indication signage should be able to identify unambiguously the location of all services and all zoo facilities.

e) Safety and Regulatory signage - signs giving warning or safety instructions, such as warning signs, traffic signs, exit signs, or signs conveying rules and regulations - should be placed at close distances (approximately 100-150mts) and at locations where there is likely hood of the 'wrong actions' by visitors and caution has to be conveyed. Signage which has to direct the visitors & staff in case of an emergency should be placed prominently with clear visibility because it will have to guide visitors when there is a state of panic and confusion.

6. It should be ensured that signage does not get hidden by any obstruction including plant foliage.

7. All signage should be clear, legible and merge with the natural colours of the zoo and should not have bright colours which disturb the naturalness of the zoo environment. English and local vernacular language should be used on all signage. Both these should be on the same face of the sign board and not on two opposite sides of the sign board.

8. The use of maps, photographs and symbols may be encouraged to be used for conveying message in the signage to cut across language barriers.

6.9 CONSTRUCTION MATERIALS

The criteria for selection of materials palette for construction depends on six primary considerations:

a) Functional
b) Structural
c) Aesthetic
d) Cost
e) Local availability
f) Availability of skilled labour for specific type of construction/ fabrication

The above criteria are applicable unless there is a situation where a specific material (such as chain link fence) has to be used even if it is not available in the region. In which case, it has to be procured, whatever the cost and effort, even if many of the above criteria have to be ignored.

There are unlimited types of construction materials, techniques and methods of detailing. Suitability criteria of construction materials for zoos is not common to all zoos in India or elsewhere in the world. Yet there are some universal qualities and characteristics which are appropriate for use in zoos to achieve the natural environment of animal habitat and behaviour. The selection and decision of materials should not be allowed to be based simply on the whims or personal liking of an individual.

Some desirable general material qualities are as follows:

a) The materials should not be brightly coloured and should be subdued. These qualities and basis of selection must relate in type, texture colour, fragrance, fruiting and flowering season.

b) Use of local material should not be understood to mean exclusion of innovative and modern materials such as stainless steel and aluminium sections and meshes, toughened and laminated glass, and vitrified textured tiles.

c) Use of modern technology, wherever possible, should be explored, sourced and used for camouflaging it, wherever necessary.

d) Local/indigenous/ regionally available materials should be used for pavements and masonry works for buildings and enclosures. These materials should be using indigenous finishes. Tools and techniques can be used for better and more efficient cutting and detailing. Local skills and craftsman should be used for providing surface textures etc.

e) All finishes, structural elements; including walls, retaining walls, toe walls, service buildings, enclosure structures, platform, steps, paths and roads should generally conform to relevant Schedule of Rates (SOR) items and specifications, unless there is a need to use better quality material or finishes which are available but are not included in the SOR. Use of better standards and specifications suitable for zoos should always be encouraged. There should be no attempt to deviate or lower from the SOR items or compromise on the specifications or good construction practicesin an attempt to 'save'. This ultimately leads to serious problems of management, excessive expenditure on maintenance and aesthetically poor overall appearance.

f) All elements of design should conform to relevant standards. These include parking areas – for two wheelers, cars and buses, steps, besides others.

6.10 ZONE SEPARATION

Zones in the context of zoo may not only be to with reference to physical areas, but may even be based on managerial budgetary considerations. Zoos are generally large and often very large areas ranging from a few acres to a few hundred acres (for example the Nehru Zoological Park, Hyderabad is spread over 380 acres, ArignarAnna Zoological Park, Vandalur, Chennai is 602 Hcs). It makes design and management sense to break them into manageable parts for the following reasons which are very different from each other and require different design guidelines:

a) Management control from the point of view of animals, visitors, facilities and maintenance of landscape forest areas.

b) Animals' enclosures animal enclosure zones based on geomorphological distribution.

c) Zones to be operated to secure & separate areas within the zoo during emergencies.

Fig. 6.140, Fig. 6.141, Fig. 6.142, Fig. 6.143 & Fig. 6.144 Innovative and creative designs, textures and materials for pedestrian and vehicular pavements add immensely to a natural zoo ambience.

During the period of construction, which may extend to a few years, temporary zone separation based on construction phasing may be required.

Zoning based on management controls refer to situations where within the zoo there are areas which require various & different types of managerial, administrative and design inputs. Example could be where there are considerable variations in slopes along with associated dense vegetation cover and or there could be situations (there are many such instances in Indian zoos) where parts of zoo open into surrounding built up areas which result in disturbing views for zoo visitors and expose the animals to stress and teasing. Even attacks from adjacent areas. In such cases area wise zones are identified for appropriate design inputs.

Animal distribution & enclosure layout can lead to creation of zones based on water quantity and water treatment requirement in case of crocodiles, hippopotamus or beavers for example. Such zones require different services layout, different cleaning methods and frequency. This results in diverse budgetary inputs which are higher as compared to the average of other areas within the zoo.

There is probably no example in Indian zoos where different areas are separated from each other to avoid cross infections. These zones are created by having a depression in the roads & paths so that any vehicle, staff or visitor moving though the zoo passes through a wheel wash or foot wash thereby minimising the chances of infections travelling across the zoo areas.

Emergencies of various kinds are unavoidable in any zoo. Emergencies caused by deficiencies and omissions in landscape or architectural design and detailing of the zoo require design solutions as opposed to management solutions for management problems. Sometimes management solutions augment design but they should not substitute design related issues.

One method of dealing with animal escape from enclosure is to ensure that the animal is restricted within a certain physical zone and prevented from roaming all over the zoo and also to prevent its escape from the zoo. This will help in protection of visitors/ staff and quicker capture of the escaped animal. This can be achieved with camouflaged physical barriers, such as fences, which should be hidden amongst vegetation with least visibility to visitors. Each such zone houses a group of enclosures. The area of each zone may range from a few acres to a few hectares depending upon the surface conditions (presence of valleys, channels or rock outcrops), accessibility (presence of steep slopes and deep valleys etc.) Such zones will also be delineated considering whether the areas are visitors access areas or not. Such zones may have permanent fencing to decide areas or may, in specific locations such as paths & roads, have retraceable barriers which in normal conditions remain in underground housing and emerge above surface in case of an emergency. Such retractable systems will be similar to retractable bollards or retractable stripes seen close to places of high security areas.

Since construction of a new zoo or additions/alterations in an existing zoo are likely to take a few years, it is an accepted practice that the work and work areas are divided into phases based on time and other considerations. In physical terms these phases are converted on zones to areas or zones. Zones based on construction are temporary selected and cease to exist on completion of construction. It implies, therefore, that the methods & materials used for marking such zones are of a temporary or reusable nature. Such zones may be transient in nature but are a necessary in the development of a zoo. Temporary or otherwise all such elements require separate adequate budgetary provisions.

In almost all Indian zoos such ‘zones’ are created without being specific and without any formal notifications. This unintentional vagueness creates confusion down the hierarchy.

Design Guidelines for Zone Separation

1. Zoo should be divided into separate physical areas (Zones) with several similar types of animal enclosures in one zone to ensure isolation of an area in case of an emergency.
2. The zones can be from a few acres to few hectares.
3. Sometimes zones will have to be created on the basis of natural surface conditions at site such as topography, existing water bodies, areas of rock outcrops or densely vegetated areas.
4. Fencing or walls should be used to enclose each zone. Whatever means are used to divide zones the structure should be hidden or camouflaged to ensure that it is not visible to visitors and does not visually disturb the natural ambience of the zoo.
5. Each zone should have a separate set of CCTV cameras connected to at least two separated control rooms.
6. Entrance/ Exits to every zone should have a depression filled with anti-infection chemical to prevent infection from one zone to travel to the adjacent zones.
7. Gate pillars of each zone should have an alarm and a warning light to inform the visitors and staff about the zone in which the emergency has occurred.

6.11 SERVICES

Services are as important in a zoo as in any other modern architectural or landscape project. In fact services are the key component for the survival and maintenance free running of a zoo. The different services underground above ground and over-head include storm water drainage, sewerage (both human and animal excreta),water supply, lighting, security, & surveillance, digital data services, air conditioning, heating etc. All services must be designed & co-ordinated at the drawing stage much before actual execution. This will ensure efficiency of services and cleaner pedestrian and vehicular movement areas with no disturbance to vehicles, pedestrians or maintenance staff.

Fire, lighting (including emergency lighting) and electrical barriers (such as hot wire fencing etc.) and other emergency services within the zoo must be designed to be disaster proof. All disaster proof services within the zoo must be checked and recharged regularly at pre-determined frequency. This is to ensure that they remain operational even during the worst disaster because that will be the time when emergency services will be most required. The chances are that emergency proof services (lighting, drainage, pumps etc.) will be located underground either in embedded or in disaster proof chambers. This is achieved by hiring the services of a professional consultant in contrast to getting advice from a vendor who will suggest suitable detailing and the right specifications.

Design Guidelines for Services in General

1. All services, above ground and underground, should be designed by qualified engineers/ specialists in accordance with mandatory national norms (e.g., BIS Standards, National Building Code, CPWD specifications or any applicable local codes).

2. All services should be executed/ installed by qualified and government approved contractors by qualified/ skilled labour.

3. All documents and calculations on which the basis of which services have been designed should be procured from the consultants prior to execution and peer reviewed to ensure that calculations are correct and no aspect has been overlooked. This will also ensure greater commitment by consultants since they will know that their work will be vetted and checked.

4. All documents and records of technical calculations for design of services along with 'as built' drawings should be retained by the zoo authorities for their records to ease future maintenance.

5. It should be ensured on drawings and during execution that service line alignments or service structures (manholes, catch basins, earthling pits, feeder pillars etc.) do not intrude into visitors' circulation paths, vehicular roads, enclosures, night shelters or any other public areas.

6. Alignment and levels of all underground and over ground service lines should be flag marked and inspected and corrected prior to execution of work.

7. Location and levels of all services related structures such as pumping stations, feeder pillars, earthling pits, manholes, catch basins etc. should be checked prior to execution of work.

8. All stretches and locations of services lines and services structures should be graded to proposed grades before starting work. All areas of filling should be suitably consolidated.

9. Lighting drawing - indicating the location, type of lights, switch board/ MCB location and circuit diagrams - should be evaluated for zoo use before procurement and beginning of work. Samples should be called for and assessed for suitability in zoos. Suitability in specific terms include type, intensity and aesthetic of light (which includes the colour, intensity i.e., wattage and type i.e., LED, sodium vapour, halogen, mercury vapour etc. and aesthetics which includes the size, shape and fixture colour).

10. Low energy consumption lights (such as LED's) should be used except in situations such as spot lights or security lights.

11. Cost effective latest equipment should be used for all services particularly for garbage collection and disposal and all security related situations (such as digitized automated systems).

12. Cutting edge technology should be used for cleaning and maintenance of feeding cubicles and enclosures.

6.11.1 Storm Water Drainage

Zoos are large areas under single ownership and are ideal for all inclusive storm water management and water recharge systems. The primary commitment should be to integrate water management systems and sustainability. Storm water has three components; collection, transportation and disposal. Each of these stages requires calculations, design, engineering and landscape and construction detailing. Engineering design will determine the pipe sizes and surface drain dimensions while landscape considerations will decide whatever is seen on the surface - for example the alignments, materials and location of related structures such as man holes, catch basins etc. As a general principle it is good practice to have small siltation cum recharge chambers within the drains restrict the silt and other debris such as dead leaves, twigs and waste paper from reaching the main recharge wells. These siltation chambers can be periodically cleaned. The storm water drainage term refers to the water generated on the zoo site as a result of rain, snow hail etc. This water is required to be collected from all pockets (technically known as catchments) within the zoo into surface drains or an underground system of storm water drains and discharged in any one, or a combination of the following ways:

a) Drained out of the site into a lower area or connected to the city's storm water system.

b) Recharge into ground through a detention chamber or a detention area
c) Treated for reuse.

The principle is that in nature, each area with its natural surface is optimised for minimum runoff but with development and increase in impervious surfaces the runoff from the site increases which ideally require measures to maintain the site runoff discharge at the original rate. This prevents flooding downstream. We have in fact now reached a stage where aim should be to achieve zero runoff rather than minimise it.

Water management strategy should provide ideas and opportunities for water reuse. This would decide the treatment requirements and protocols for using treated water for different purposes.

Sewer water and waste water is different from storm water and should not be mixed. The two should be discharged separately. In case of a zoo the sewerage water will include, besides the very limited quantity of water from WC's, the water from the wet moats and particularly the water from the hippopotamus tanks. The most efficient system will be to separate sewerage and waste water if it is to be treated in sewage treatment plant (STP) for reuse. In the above three situations the treatment required for re use of storm water will be the least complicated and least expensive, whereas it will be maximum for treatment of sewerage if it is to be reused. The only slight advantage in the latter case will be the resultant useable manure from the treatment process which can be used for horticultural purposes or in areas of feed production farms.

The storm water/waste water and sewerage master plan (often referred to as water management concept plan) can be organised under the following three heads:

a) Separation of storm water, sewerage and waste water.
b) Storm water management
c) Water treatment and reuse.

The above has two aspects to it: the design aspect (e.g. the location of treatment facilities and the alignment of surface drainage channels and bio swales design) in which the recommendations of the designer are necessary and the engineering aspects (calculation of discharge, channel sizing and other hydraulic aspects besides sizing of STP) which should be left to the engineer.

The proper method of sewerage removal is by means of a separate underground pipe. The storm water meanwhile can be removed either by open drains or by underground pipes. Open drains are preferred because the discharge volume is large (underground pipes will be expensive except for small catchments) and more importantly open channels/ swales can be integrated with siltation chamber/ plants to reduce silt and include recharge pits to encourage maximum recharge within the site and thereby reduce load on municipal storm water systems.

Fig. 6.145, Fig. 6.146, Fig. 6.147 & Fig. 6.148 Drain design requires hydrological and hydraulic inputs and an essential design input to make it less conspicuous and merge with the overall design.
Attention to design, colour and construction detailing has made this storm water drain in Singapore zoo an element of appreciation. It can be otherwise to as can be seen from the examples given above!

6.11.2 Sewerage

Sewerage is collected from the toilets along with the sewerage water from wet moats and tanks (such as Hippo enclosure) and discharged to the municipal sewer line or to the STP. The sewerage should never be combined with storm water/ waste water for discharge. This will help to reduce the process for treatment and will also reduce the volume to be treated.

6.11.3 Sanitation and Garbage Disposal

Sanitation within a zoo is of absolute prime importance. It is as vital as sanitation is in case of a hospital. Lack of sanitation can lead to a potentially disastrous situation. There can be cross infection and diseases can spread amongst animals. Lack of hygiene can cause spread of zoonotic diseases as well. Management aspects apart, some design inputs which can add to maintenance of general sanitation in a zoo can be viewed under two heads based on the areas which are in direct contact with animals- enclosures, kraals shelters, quarantine building, hospital, post mortem room etc. including but not limited to the entry areas, landscaped areas and all other areas. These two overall areas should not have roads, paths, public amenities etc. but should have completely different hygienic regimes; and consequently separate equipment and periodicity of cleaning procedures. This requires designed storage spaces and adequately sized areas for cleaning and sanitizing of equipment.

Fig. 6.149 Waste management requires attention towards design & infrastructural improvements and mechanisation.

6.11.4 Water Supply

Zoos are generally large areas with extensive water demands for animals, staff, visitors, operation of different activities in the zoo and vegetation.

India is a vast country, many regions having different rainfall characteristics. The rainfall intensity and durations vary over India, with the annual average rainfall ranging from 0-20cm to 800-1000cms. This results in a wide range of irrigation and animal related water requirements. Not only does the volume vary but the frequency of use and replenishment also various from animal to animal and between various regions where the zoos are located. All this clearly establishes that there cannot be specific rules for water with pan India applicability. And yet, the principles of conservation, water management and water requirements for specific animals are the same in any zoo anywhere in India.

Conservation of water and its judicious use is not only an Indian but universal priority. The result of this is that there is no thumb rule to arrive at a water supply demand; every zoo will be specific case with the water requirement to be calculated uniquely for that zoo.

Water supply requirement to zoos can be categorised under the following heads along with the frequency of use:

S.no.	Water Use For	Average Frequency
1	Potable water for human consumption, staff and visitors	Daily
2	Water for drinking by animals	Daily
3	Water for filling wet moats	Once a month (Avg.)
4	Water for animals tanks and water bodies (example being the hippo tanks, water tanks for the other animals, the water bodies in tiger enclosures, for crocodiles & gharials)	Uses from once every two days to once daily (varies seasonally)
5	Water for irrigation	Daily (distributed area wise)
6	Water requirement for cleaning/ washing of enclosures and night shelters.	Daily

Managing naturalistic environments within and in some instances around our Indian zoos requires substantial amount of water usage. This demands intelligent management of available water and a commitment to minimise water consumption while maintaining diverse natural environments for Indian zoos.

The following suggestions can serve as guiding principles to conserve water in zoos:

Design Guidelines for Water Conservation

1. Ideally it should be ensured that there is no discharge of water from the site to outside whether into the municipal drainage or any other natural water body.
2. The discharge from wet moats or animal enclosures such as hippopotamus, beavers etc. should be treated through sewerage treatment plant and

treated water should be reused for horticulture or fodder irrigation.

3. Storm water discharge should be collected and recharged through a designed system of recharge pits.
4. Make every zoo site a zero discharge area by harvesting rain water on site.
5. Use water saving plants for landscaping and enclosure enrichment. This can be achieved by sustainable planting design.
6. Use environmentally friendly detergents and reuse of waste water in the garden.
7. By proper designing of gardens and reflecting plants requiring less water.
8. A rain garden takes advantage of rainfall and storm water runoff in its design and plant selection. It is designed to withstand extremes of moistures and concentrations of nutrients particularly nitrogen and phosphorous.
9. Use automated irrigation systems with timer devices.
10. Use existing water more efficiently by preventing overuse, misuse and preventing leaks.
11. To modify or reduce the need for water.
12. Use water falling on the site it effectively and efficiently.

    Planted areas should be used as a water collector. The surface planting should prevent rapid runoff and allow for percolation of the falling water into the soil. This is the surest, least expensive and most environmentally correct strategy to conserve water and to use available water most efficiently.
13. Use drought resistant or drought tolerant vegetation:

    Basically the purpose is to replace excessive water requirment plants in the landscape with those which require less water and irrigation.
14. Leave plants in a stress condition: This strategy involves just barely watering the landscape plants enough to keep them alive, but not enough for them to grow and flourish.
15. Erecting wind barriers: The concept should be that by reducing wind speed less of the available water will be transpired out of the plant into the atmosphere.

16. Redesign or innovate to reduce water requirements: Specific plants which require too much water, whether it be a tree, a shrub, ground cover or even a turf variety, may have to be replaced in times of extreme water shortage.
17. Soil Modification: An ideal soil for conserving water or using water most efficiently would be one with a high percentage of organic matter and which is a deep friable loam.
18. Expand the use of mulch: Mulches are effective in helping to conserve existing water supplies and to use the rain and irrigation water more efficiently.
19. Use of anti - transpirants: To reduce evapo - transpiration from plants anti-transpirants will lock in whatever moisture is already in the plants
20. Re-use of water: The utilization of waste water is a re-use of what would otherwise be wasted water for irrigation of landscape plants in the ground areas.
21. Establishing water priorities: A series of priorities which determines what, when, how much and how to irrigate plants with limited resources.
22. Alter or adjust irrigation practices: The sole criteria in determining how to irrigate needs to be that site specific method or technique which is most effective and most economical in the use of water.
23. Use irrigation water more efficiently: Everyone, at all levels, in the zoo should be familiarised with all of the alternatives which are possible in using water more fully and more efficiently and applying the same in daily use.

6.11.5 Lighting - External

Lighting in a day zoo is a very complex and requires specialised design input. A basic design presumption, which appears to be contrary to the general lighting design principles, is that the most ideal situation in a zoo at night should be complete darkness because that is the natural condition of the animals in the wild. It is difficult for humans to understand how all animals are able to manage and survive the darkness of a forest night but for animals that is normal. Animals have their instinct and other senses to manage the night hours. This fact leads to a basic design principle for lighting in zoos; and that is, keep the zoo area as dark as possible unless required otherwise for specific locations and functional reasons. This will keep animals free of stress. The above principle also implies that areas which need to be lit should have lighting designed in such way that the light and glare does not spill over to enclosures or to areas beyond where it is required. Lights can be provided to operate only when required strictly on a need basis. For example, security lighting is not required to be switched on throughout the night; it should be designed in such a way that in case of a security breach it should be possible to switch on the security lights either automatically or manually from the central security hub.

Zoo lighting can be designed based on the following considerations:

Zoo lighting can be categorised under:

a. Which will be required throughout the hours of darkness that will vary with the season.
b. Lights which will be required during the initial hours of sunset when the public may still be within the zoo premises.
c. Emergency lighting: which should be available (either with manual or automatic switching) during an emergency.

Lighting design and illumination levels should be considered under the following heads:

a. Lighting at the main gate and at all other gates in the zoo
b. Footpath and amenity lighting
c. Lighting along vehicular road
d. Lighting in enclosures - regular or operational during emergency
e. Lighting in night shelters - regular and during child birth in some animals such as tigers.
f. Security lighting for the entire zoo area
g. Security lighting along the boundary of the zoo

Light at the gate should illuminate 8-10 mts. outside and inside the gate. Footpaths within the zoo should be illuminated with bollards or LED underground embedded lights enough to show the path alignment. Service buildings such as the generator room and the electric sub-station should be lit up adequately (with minimum glare) both within and the immediate vicinity. Visitor paths & service roads require just enough illumination to see their direction at night. These lights will provide very low illumination levels generally in the range of 20 - 50 lux.

Full night lights will include the stations of the night security guards quarters/ offices, and the residential quarters of the zoo director or the zoo staff.

Lights required for few hours generally after sunset will include service roads leading to the feeding cubicles and the vicinity of the feeding cubicles.

Fig. 6.150 It is time that every bit of work in all disciplines related to zoo (architectural, landscape, structural, fabrication, security systems etc.) are done professionally otherwise the attempt to economise may result in major expense later. The pic is an example of unacceptable work.

Emergency lighting should be provided for the entire zoo. This lighting should be designed on sectoral basis and should be able to illuminate any part of the area of the zoo or the entire zoo, if required. The purpose of emergency lighting, is to provide floodlight type of lighting in case of night situations such as escape of animals from enclosures, attempt to enter the zoo premises or in natural disaster situations such as flooding, earthquake or fire emergency. Lighting may also be required in case of wild animals or feral animals entering into the zoo at night.

Emergency lighting should be organised in such way that each 'control' lights up a particular section of the zoo. The number of sections in each will depend on the total area and the layout/ master plan of the zoo. It will also depend on the topography and the existing & planted vegetation. All the above will determine the spread of light from each light fixture. In other words even if a light fixture by its photometric and lux rating capable of lighting a certain square metres of area it may not serve its purpose because of obstructions caused by vegetation or landform and may require additional light fixtures.

Maintenance Considerations

Many modern technologies and lighting systems are now available for use in modern zoo design. Maintenance will need to be regular and sustained. Without such assurance selected conventional and less ambitious installations shall have to be used. It is intended to use materials which require minimum or almost no maintenance after the initial installation. Such material for infrastructure and fixtures includes stainless steel, moulded aluminium and stone.

Vandalism

Vandalism and theft are always problems with lighting installations, and in isolated areas extra precautions to protect fittings may be needed. In case of a zoo, where pedestrian penetration is extensive, special attention is required to prevent vandalism through proper selection of vandal resistant light fixtures.

Light Controls and Light Fixtures

Placement of light controls switches and mini circuit breakers need to be designed on a case to case basis within various zoos. Major considerations in deciding on the location of controls will be easy and 24x7 accessibility, particularly during emergencies. Even if it requires additional expense (in terms of cable lengths etc.) functional appropriateness should be the deciding basis.

Since any type of emergency may happen at any time, it should be ensured that the access to emergency lighting controls have access passage even in case of a disaster. One way to ensure this is to have controls & feeder pillars at multiple locations within the zoo. Such emergency controls should also be located at all sub stations spread with in the zoo besides other designed locations. Zoo directors, deputy directors, security office and the administrative office should all have access and control to emergency lights. All light fixtures within the zoo, which are accessible at human height level (such as bollards, garden lights etc.) should be designed to run on low voltage with the use of a step down transformer. This is to ensure that in case of damage to the fixture any visitor or staff does not suffer a fatal shock.

Pole lights or any light which spreads at night generally disturbs the animals and should be avoided.

Types of light fixtures which are likely to be used in zoos will include the following:

i. Pole light - 3.5 to 6 mts high

ii. Bollard lights

iii. Underground uplighters

iv. Wall lights - generally embedded in wall

v. Bracket lights - fixed on the wall

vi. Strip lights - located under seats or within recesses

Generally the illumination levels of external lighting will be within 5 to 200 lux depending on the location, activity and purpose for which the light is being provided.This illumination range will be exclusive of the security and emergency lighting which will have higher illumination levels.

Design Guidelines for Zoo Lighting

1. All lighting should be on generator to ensure that at no time, especially during emergencies, is the zoo without electricity.
2. Lighting controls should be distributed all over the zoo by being located on the feeder pillars, sub stations and at the central security office/zoo director's office/ central administrative building so that the lights and the alarm system could be operated from anywhere in case of emergency.
3. The electrical circuits should be designed to ensure that electricity to various points within the zoo is maintained from more than one source.
4. Light fixtures should be vandal proof in terms of design and should be located and placed at a height which makes it difficult to access by visitors and other un-authorized persons.
5. All lighting should be LED inspite of the fact that its initial cost is higher. This will help conserve energy in the long run specially in large areas that most zoos occupy.
6. The design and colour of light fixtures should merge with the predominantly vegetated natural ambience of the zoo.
7. Light fixtures should never obstruct the visitors' circulation paths or the view of the animal enclosures.
8. Remote or digitally controlled lights and specially emergency lights can be considered since the technology is commercially available. These can be operated through the net or mobile application.
9. Care should be taken to especially light steps and ramps with low level footpath lights, particularly in enclosed viewing areas such as underwater viewing of otter, beaver or alligators or in case of enclosed areas such as the nocturnal animal and reptile houses.
10. Generator should be located at such a place which is not prone to water logging or flooding and disruption due to cyclone, earthquake etc. It should not be adjacent to large trees, uprooting of which due to any reason whatsoever, may damage the generator or supply cables.

6.11.6 Security and Surveillance

The concept of security and preventive surveillance in a zoo is apparently different from the conventional interpretation of these aspects. In a zoo almost every one, has to be secured against everyone else. Animals have to be secured from humans and humans have to be secured from animals. Property has to be secured from both animals and humans. It is seemingly a bizarre situation but it is extremely important that security concerns in Indian zoo are designed with extreme diligence. Any lapse can lead to very serious consequences to life and property and even severe punishment to the designer or concerned staff. Understandably security will have both design and management related considerations. It is only the design considerations that shall be discussed here.

There is no Indian zoo presently which has a comprehensive installed security or CCTV system for monitoring animals in their enclosures or to monitor visitors. This is becoming increasingly necessary because of large areas under zoos and the consequent difficulty of monitoring and securing the entire area. Increasing, often regular by instances of pilferage of animals, birds and reptiles, instances of mischief and intrusions by visitors now require continuous monitoring and recording which can only be achieved by a comprehensive electronic surveillance & security system.

Security in zoos has multiple interpretations. As a result, security related design aspects have to be viewed from different perspectives and designed accordingly. Zoo security can be perceived and listed under the following heads:

a) Security of animals
- in the enclosures
- in the kraal
- in the night shelters
- in the qurantine area and the hospital

b) Security of visitors
- in the general zoo area
- in the viewing area adjacent to enclosure
- in case of a visitor entering into an enclosure

c) Security of staff & keepers
- in the night shelter
- during transfer of animals from outside
- within the general zoo area during performance of routine duties
- within the enclosure during an emergency

d) Security of property and other assets
- Buildings
- Animal feed
- Medicines and equipments
- Horticultural maintenance equipment

e) Security of Computer Networks

a) Security of Animals

While the animals in the enclosures should be secure from visitors and from being hurt by poorly designed landscape enrichment elements. Animals should particularly be protected from poorly designed any badly detailed enclosure fencing.

The barrier between the enclosure and the viewing side should be designed to prevent visitor from entering and from throwing elements into the enclosure, from feeding the animals and from positioning themselves in a way which stresses the animals. Landscape elements should be so designed that the animal does not get scratched/ hurt or falls into a pit or a moat from a vertical edge.

In a kraal there should not be any possibility of visual or physical interaction between the visitors and the animals.

Security of animals while they are within the night shelter is a prime concern any kind of injury should be prevented by appropriate design, good architectural detailing, use of suitable materials, regular garbage removal and efficient drainage. Design should prevent the visitors being able to throw any object into the enclosure and should also ensure that they are not able enter the enclosure in any way.

b) Security of Visitors

Visitors to the zoo are not a homogenous group. Visitors include infants (carried by elders), children of all age groups, healthy adults - both males and females, unhealthy adults and handicapped persons (handicapped by any of the sense; a lady carrying child in her lap or an elder helping aged person should also be considered as 'handicapped' for that duration). All such visitors should be secured against attacks by animals and also by unruly or deranged visitors.

A potentially most dangerous person is the one who is mentally unstable or a psychologically disturbed individual. Such persons have often been the cause of most zoo accidents and security lapses. Security lapses referred to above are not caused by any security personnel or design deficiency but because of the abnormal behaviour of the deranged visitor. Prevention of such incidents is almost impossible because design can only take care of anticipated irresponsible behaviour but not of irrational behaviour.

c) Security of Staff & Keepers

Zoo staff and keepers are the key stone of a zoo. They have hands on experience of working with animals and are most aware of the strength and weaknesses of the zoo layout and design. Their security and safety should be one of the most important concerns in zoo designing. Zoo keeper and animals do not share the same space without some form of adequate safety barriers between them; even that is also based on strict protocol. The attack on the safety of staff & keepers could come from numerous directions - from agitated animals, from unruly visitors, from bad detailing of enclosures within the night shelters and even from outside the zoo in case the zoo is within a forested area. Good design should take care of a most parts of the security while management aspects, equipment and safety protocols will take care of the rest.

a) Security of Property and Other Assets

As in other campuses, the security of zoo building properties and of all other fixed and loose assets is of prime importance. Vandalism, mischievous and unintentional damage to public furniture, fences, various landscape art displays and sculptures, scratching, & writings on walls and even trees and throwing of garbage in open drains and more seriously to electrical & other service lines can be termed as attacks on property and assets. One parameter for design of zoo properties and other elements should ideally be to prevent and at least to deter all attempts at disfigurement, damage and destruction of zoo properties. These attempts may come primarily from the visitors but unfortunately at times come from within the zoo establishment; from the officers and staff in the form of serious pilferage of restricted drugs and thefts of zoo articles. It is very obvious that security network should not be limited to the apparent aspects but should also take into consideration the entire physical and human resource structure of the zoo as indicated by the above example.

b) Zoo Surveillance is as Necessary as Security

All kind of activities within a zoo should be monitored, throughout 24 hours for the purpose of management, security, animal research and prevention and investigation of crime or accident. It needs to be carried out by each one of the zoo staff in addition to electronic surveillance with the help of CCTV cameras and sensors.

Biometric surveillance at specific points of duty can prove to be of immense help in managing Indian zoos. Indian zoos should now graduate to surveillance with the help of commercially available drones which is now an increasingly popular means of surveillance and prove to be exceptionally useful in monitoring and recording activities within the zoo and in its immediate vicinity along the boundary.

c) Security of Computer Networks

At present computer network security is not a commonly used or understood concept in Indian zoos. But very soon this will not only a desirable requirement but should become mandatory as part of the design.

The computer network security concept covers the security & safety networks and the information/ data networks. Security networks will cover the communication between the main security office, the guard rooms at all entrances and exits of the zoo (and safaris as well). Sturdy passwords, fingerprint and iris recognition should be mandatorily be incorporated for access to computer rooms and software storing zoo and network related information. Added advantage of such systems will be that manipulation of records will not be possible since the dates and time will be permanently recorded.

This will facilitate the information transfer from all enclosures & night shelters (and any other visitor or staff accessible locations) to the main secure computer information room within the administrative office or the zoo Director's office.

In near future, information transfer from all enclosures is very likely to be digitised and passed over the designated network to the cloud or a designated server. It is then that the problem of routing is considered. In a situation where a sophisticated adversary randomly penetrates parts of routing infrastructure and attempts to disrupt routing

Fig. 6.151 Security, particularly in zoos which have wilderness outside require visible security structures.

it should be ensured that there is at least one non faulty path that exists between all important sources and destinations.

This should be planned and all physical infrastructures required for computer rooms, cables etc. should be designed as professionally advised.

Design Guidelines for Zoo Security

1. In a perfect situation, all areas of zoo should be under surveillance throughout the day and night even if is not security covered.
2. Surveillance and security should definitely extend to visitor areas, animal enclosures and night shelters and all buildings (offices, hospitals, stores etc.)
3. Electronic surveillance should be preferred over human surveillance. It is certainly more reliable and ensures implementation in areas which may be difficult to access because of vegetation or terrain.
4. Manual surveillance should augment electronic surveillance in difficult sites which may at times require taking decisions in emergency; such as peripheral areas align boundary where there are chances of animal escape or human intrusion.
5. Surveillance should include CCTV cameras and alarms.
6. Manual security should include wireless contact and manual electrical alarms.
7. Manual alarms should include drums or gongs, in case all else fails.
8. Fire hydrant systems should be installed to cover all vulnerable areas.
9. There should be fire extinguishers in close proximity (as specified by fire consultant). Fire suppression systems should be installed. In areas of high risk where at times keepers or personnel may not be present such as night shelters during night. This system control should be able to control fire without human intervention e.g. fire sprinkler system, gaseous fire suppression and condensed aerosol fire suppression.
10. There should be provision for storage of security equipment such as ropes, ladders, pressure water hoses, crackers etc. near visitors viewing area at every enclosure.
11. Security of computer networks and other networked electronic equipment should be covered by use of firewalls antivirus software and anti-hacking software to ensure the integrity of the zoo computer systems

12. Security of the computer systems should be ensured by making the data and access available to personnel on a need based basis and strictly according to hierarchy and protocol.

6.12 Elements within the Zoo Area but Physically Separated from Zoo

There are certain parts of the zoo which are a ‘part’ of the zoo and are required to be in the closest proximity of the enclosures but are still required, according to CZA norms, to be physically separated from the inner zoo premises. In other words persons, unless on duty, will not have unrestricted access to the enclosure area beyond office hours. Such components are normally kept separate either by a wall or a short distance. The requirement being that in case of an emergency the zoo Director, security officer and staff should be able to reach the zoo within the shortest possible time.

Design Guidelines for Elements within the Zoo Area but Physically Separated from Zoo

1. The Director’s and the staff residences should preferably be attached to the zoo but should be separated either by a wall of minimum height of 2 mts., or by a plantation buffer at least 20 mts. wide or by a distance. In all cases it should be ensured that the disturbance by way of noise, light and pollution of any kind does not reach the animal enclosures area.
2. There should not be any entry/ exit or any other kind of opening directly between the ‘separated’ area and the zoo.
3. The distance between the two areas should not exceed approx. 1.50 kms.to ensure that in case of emergency the zoo can be reached within approximately 5-7 minutes.

Fig. 6.152 Representive Conceptual Design Section - drawn to scale

Fig. 6.153 Representative Conceptual Design Sections - drawn to scale

Fig. 6.154 Representive Conceptual Design Sections - drawn to scale

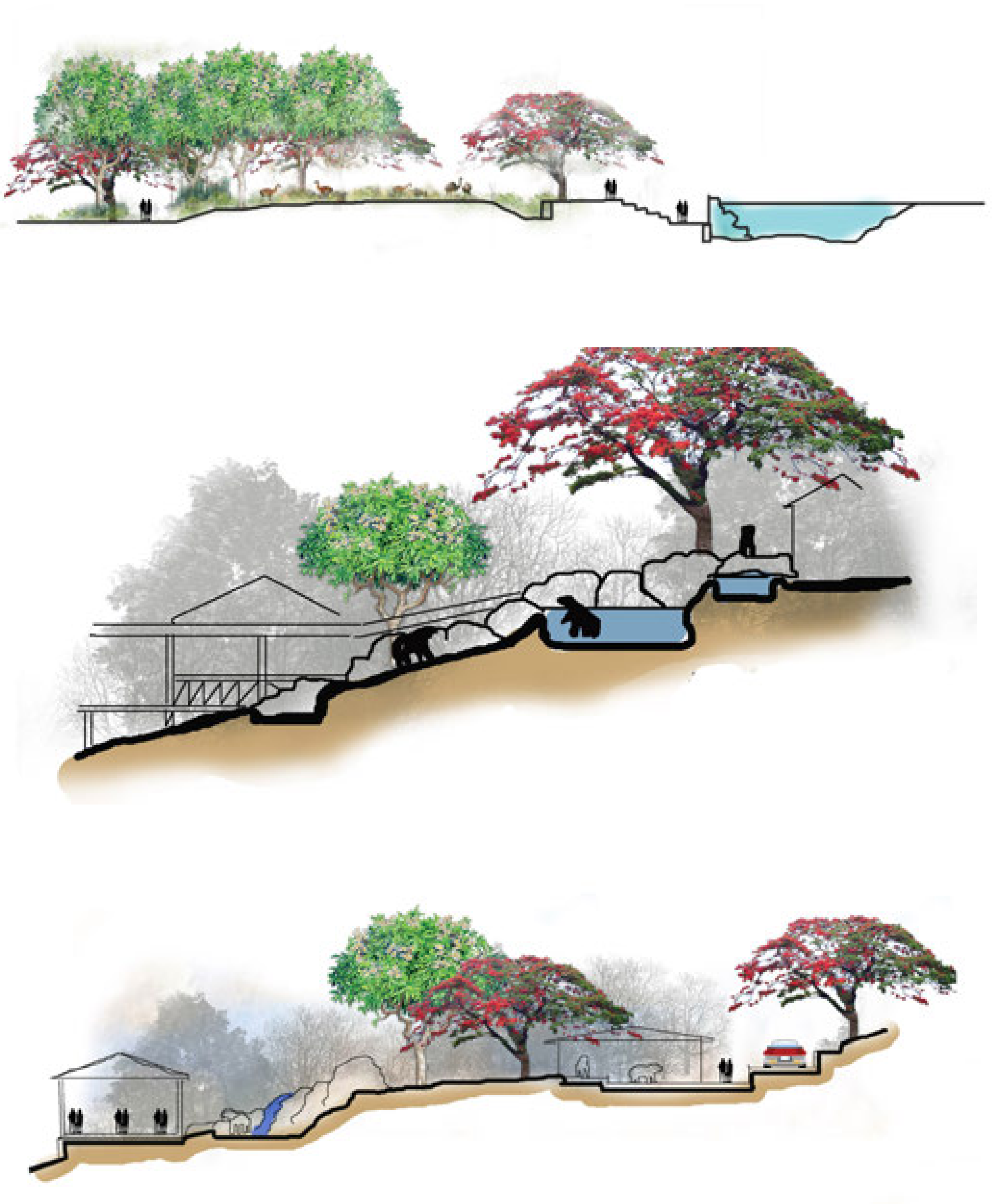


Fig. 6.155 Representive Conceptual Design Sections - drawn to scale

Fig. 6.156 Representative Conceptual Design Sections - drawn to scale

Design features in Zoo Negara, Malaysia

CHAPTER 7

Precautionary Measures

Disaster Management Design Measures
Contingency Plan and Measures
Measures to Prevent Intra Animal Conflict
Prevention of Visibility Between Enclosures
Prevention of Rodent Infiltration in Enclosures
Infiltration of Animals and Intruders From Outside
Prevention of Escaped Animals From Inside the Zoo to Outside

No formal records are available in public domain cataloguing disasters relating to Indian zoos. Therefore, a unique aspect of Indian zoo disaster management is that it may be difficult to find disaster management examples and precedents which are unique to zoos and which often lead to finding creative and unique site specific solutions.

,ICHAPTER 7

Precautionary Measures

7.1 DISASTER MANAGEMENT DESIGN MEASURES

Inspite of all possible precautions, disasters happen. They have to be dealt with post occurrence. The range in terms of type of disasters and their scale is very wide. There are disasters common to any location or type of institution including zoos. These include damage due to earthquake, civil disturbance, cyclone, floods, tsunami, cloud burst or high speed winds. If such an incident happens zoo will be affected like any other location. In such a situation the disaster management protocol will be same as given in the National Disaster Management Authority (NDMA) Guidelines. Besides the general NDMA guidelines each institution, which includes the Indian zoos should have location specific, animal specific and administration specific disaster management guidelines and program. Location specific aspects refer to zoo disasters which are related to regional locations. These may include landslides, insurgent related problems, overflowing of rivers or water logging. Animal specific disasters are those which can be expected in a zoo housing specific species. For example accidental dangerous attacks on humans can be expected in the zoo has in its collection carnivorous animals such as tigers, leopards or bears or even herbivores such as hippopotamus. Primarily it is the zoo administration which will be responsible for organising the response whatever may be the cause. At present, there are no specific NDMA guidelines for disaster management of Indian zoos. The Central Zoo Authority has got prepared a model Disaster Management Plan under its Research Project Scheme for adoption by zoos in India. As a result, each zoo must draft a Policy and guidelines for zoo specific disaster management. This Plan will be site-specific in response to the threat perception based on the likely regional threats, from natural and man made causes, in which zoo is located. This is already a part of the mandatory CZA requirement submitted as part of the Master Plan for long-term development of each Zoo.

Since there are 'live' animals and visitors present in a zoo, there is a strong possibility of disaster related to biological aspects. A zoo may have to deal with a disaster which may have its origin outside the zoo. Obviously the approach to tackling biological disasters will have to be dealt with in a carefully controlled manner according to a planned standard operating procedure led by veterinary and medical teams and personnel. Biological disasters may require long time periods to bring the situation back to normal. Other types of physical disasters (such as damage due to earthquake, floods or civil strife) will require immediate inputs to salvage life and property and a different methodology to their amelioration for which the zoo should be prepared with a plan and equipment.

As an overview, disaster management guidelines and measures will relate to the following:

A. Natural causes
    i. Flood
    ii. Cyclone
    iii. Tsunami
    iv. Earthquake
    v. Forest Fire
    vi. Cloud burst / heavy downpour
    vii. Snow fall

B. Man-made causes
    i. Zoo animals - animal escape / free ranging or stray animals etc.
    ii. Humans – Visitors / Zoo personnel
    iii. Property
    iv. Enclosures – Buildings / Roads
    v. Services - Overhead services / Underground services
    vi. Law and Order - Bomb or terror threat, civil strife including, rioting & curfew, etc.
    vii. Strikes in the zoo by employees or suppliers etc.
    viii. Dislocation in zoo essential supplies

No formal records are available in public domain cataloguing disasters relating to Indian zoos. Therefore, a unique aspect of Indian zoo disaster management is that it may be difficult to find disaster management examples and precedents which are unique to zoos and which often lead to finding creative and unique site specific solutions.

Guidelines for Disaster Management

1. There should be effective communication means between the zoo management and local disaster management authority as well as Police Station.
2. The area size and type of structures will vary and should be carefully assessed. A permanent communication line with suitable specifications should be installed and protected to ensure it remains operational for communication during disaster(s) and to restore normalcy within the shortest possible time.
3. Areas within the zoo which are susceptible to major 10 yearly and 5 yearly flooding in the past should be identified and marked at site.
4. Annual high flood levels should be marked on enclosures and buildings and disaster management provisions should be made for all such susceptible areas.

a) Undertake grading (ground level modification) to provide for collection of water at a predetermined location and installation of the pump at lowest area to pump out water.

b) Provision of elevated areas for animals (within enclosures) staff and officials to survive until rescue or draining of water.

c) Provisions of fire extinguishers at accessible locations which should not be the first to be affected by disasters.

d) Equipment which are resistant to inundation and fire should be aquired and kept ready.

e) Designing of construction details which do not succumb to flooding or fire. Pedestrian path with loose aggregate surface is an example.

f) All materials used in areas of expected annual floods should be such that power and water supply is not affected.

g) Provide an inbuilt disaster resistant warning, speaker/ communication system within the zoo premises as part ofinfrastructure layout.

h) Provide for creation of 'secure areas' (areas which will not be during disasters) within zoo as part of initial layout.

i) Provide for dividing the zoo into smaller 'sections' by providing boundary fencing to secure a group of enclosures within the zoo, to divide the zoo into smaller sections (number of sections will depend on the specific zoo) which can be cordoned off with retractable gates in case of an emerging. This will ensure restricting the area of the escaped animals.

j) Distinctive disaster signage (identifiable by colour or shape) should be located at all areas within the zoo. These should by text or graphics indicate the basic response from the public in case of a disaster.

k) Provision of CCTV coverage of zoo areas visited by public. The specifications and designof CCTV system should be disaster resistant or that during disaster. The system should be installed from the day of zoo being opened to public.

l) Providing buffer between enclosures (a space to physically separate i.e. not to have a common fence) to present inter animal conflict, spread of diseases, etc.

m) Suitable disaster resistant storage should be provided at appropriate locations to ensure maintenance of:

- Animal feed stock for emergency purposes, for 15 days at least
- Disaster management equipment and medicines- such as generators & fuel, drinking water, food, first aid,torches, stoves etc.

n) There should be provision for security check of each visitor at the entry gate.

o) There should be a separate gate for entry of staff and officers through biometric security.

p) Red lines may be painted on curbs/ road to provide direction during emergency evacuation. There should be rooms along this path to enable the visitors to be safely locked inside while being evacuated in case of escaped animal being in vicinity and it is not possible to reach the zoo exit in time.

Fig. 7.1 Disasters in zoos can happern because of reasons related to layout of the zoo or because of bad constrution/ detailing and execution of which above pic is an example. Any animal enclosure having such details is inviting injury to animals.

7.2 CONTINGENCY PLAN AND MEASURES

Inspite of all precautions and due diligence, there is a high possibility of unforeseen contingencies occurring within a zoo or areas in proximity to zoos. This is because each visitor to the zoo is a unique individual having a unique behaviour pattern and habits and therefore has an unpredictable response to situations. A well designed stand-off barrier may prevent all except that one disturbed visitor who may still find a way to jump across into the animal enclosure! Each animal also is an individual and is equally unique in its physique, behaviour and response to situations. A standardised moat dimension or barrier height/ design may suffice for all animals except for the 'one' who somehow will manage to escape! These kinds of situations result in contingencies. The nature of contingencies is such that in almost all cases the response will have to be swift and effective. It implies that the tools, at least the minimum required, should be available at site of the contingency. Herein lies a contradiction because to provide the tools at the site of contingency the location and time of contigency occurrence should be known, but that thought is against the very definition of contingency! In terms of design and guidelines it implies that such tools should be provided all over the zoo area. These must be located on the basis of experience and professional judgement. Example of such a situation is a visitor falling or entering an animal enclosure. Since this is a situation which is likely - even with extreme infrequency - a rope ladder and a pressure hose pipe should be provided at a suitable location in each dangerous animal enclosure. The next stage response to such a contingency should be the arrival of a trained zoo staff with a tranquilizing gun - within a pre-determined response time.

Guidelines for Contingency Plan and Measures

1. There should be small stores/ open water proof structures spread (the distance between each to be decided on the basis of a few minutes access time) over the zoo area. The store/ storage structures should be of adequate size to store the following:

a) Tranquilizer gun
b) Blow dart
c) Jab sticks
d) Nets and ropes
e) Protective gear for staff
f) Poles and staffs
g) Bags of toughened material etc.

2. The above mentioned storage could be independent structure or a part of another structure such as the drinking water fountain or even sitting platform or seats.

7.3 MEASURE TO PREVENT ANIMAL CONFLICT

In natural habitat, animals are separated by regions or marked territory, providing sufficient space to be used for escape from the predators. These include the desert areas, rain forests, dry deciduous forests, riverside stretches etc. within each region animals mark their territories and maintain the natural distance and separation for their safety with regard to the predator prey considerations. This is not possible for the animals in captivity within the zoo where animals are not allowed to follow their natural instincts. In zoos proximity relationship of enclosures is decided by the designer and not by the natural instinct of the animal. It is extremely important that placement of enclosures is done with extreme care, sensitivity and full knowledge and experience of animal behaviour. Otherwise, if wrongly placed, animals may remain under continuous stress (affecting their health and breeding and resulting in abnormal behaviour) and worse still may result in animal conflict. Animal conflict happens if a wrong group of animals is housed in the same enclosure or if the enclosures are attached together without the necessary buffer between the same.

7.4 PREVENTION OF VISIBILITY BETWEEN ENCLOSURES

It has often been experienced that when the enclosures are adjacent to each other and have a common fence (generally chain link fence) there exists a real chance of the animals attacking each other. Often the tail or any body part of one animal is scratched and bitten by the other. This may lead to further management complications.

When the adjacent animals are not comfortable being near to each other, the situation is worsened when the adjacent animals are able to view each other. In this condition, it is desirable to at least prevent visual contact, even though the animals are able to sense the close presence of each other. The simplest method is to have green buffer to obstruct visibility as well as access between the enclosures. The other, successful prevalent method is to have a gap of about 1.5 mts or more which should be planted with dense indigenous evergreen foliage species to prevent visual contact between adjacent enclosures.

7.5 PREVENTION OF RODENT INGRESS INTO ENCLOSURES

In any enclosure there is a possibility of the confined animal escaping or a rodent or a reptile entering the enclosure by burrowing. Both situations are dangerous and need to be prevented. The most used and time tested method is to create an underground barrier approximately a metre deep by extending the barrier toe wall (or wall depending on the size of the enclosures). The second method frequently adopted and which has been found to be effective is to have a concrete floor with wire-mesh reinforcement, the top of which is filled up with the suitable substratum.It would prevent any ingress of rodents from below or escaping of animal by burrowing. It should be ensured that such preventive construction is undertaken at the time of initial construction because it becomes very difficult and expensive to undertake preventive measures later.

7.6 INFILTRATION OF ANIMALS AND INTRUDERS FROM OUTSIDE

Indian zoo are situated in numerous different kind of locations ranging from urban areas, to suburban areas, forested areas and different kinds of topographic situations. Understandably the zoo has to be secured from wild (and even domestic/ feral) animal as well as from human intruders. The perimeter can be in the form of boundary wall or fencing depending on the kind of protection required. For example, if the zoo is within or close to a forest and the protection is required against ingress of elephants and tigers then the wall has to be strong enough and designed to resist any impact from a charging elephant and high enough to prevent a tiger or a leopard from climbing or jumping in. The perimeter can be constructed totally with masonry (brick masonry, stone masonry, granite masonry, cement concrete etc.) or it can be a combination of masonry wall with fencing on top (barbed wire or concertina wire). In other words the functional requirements must be fulfilled with any suitable local material.

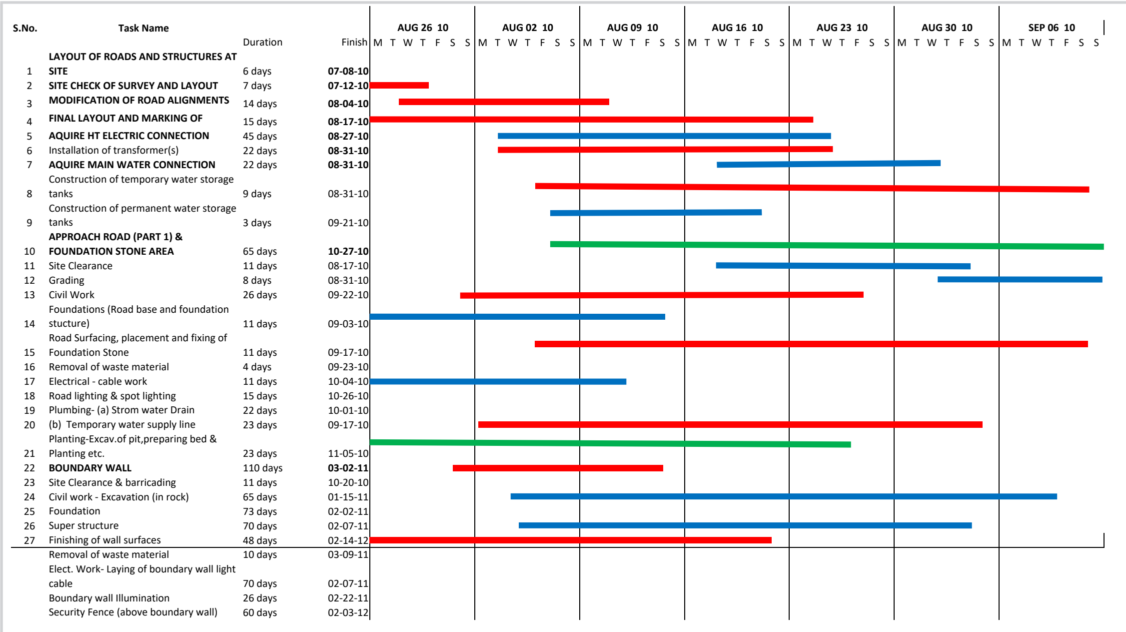
Besides the above it is necessary that the material used for boundary protection should be able to resist weathering / erosion and should have excellent workmanship to ensure long term security and prevention of accidents.

7.7 PREVENTION OF ESCAPED ANIMALS FROM INSIDE THE ZOO TO OUTSIDE THE ZOO CAMPUS

No amount of thought or design and management precautions can prevent a situation wherein and animal escapes from its enclosure and then attempts to escape from the zoo premises itself. Such occurrences, rare as they may be, have to be attended to by prior installation of preventative measures. The measures should include design measures to restrict animals within a pre-determined section/ sector/ area of the zoo after the escape alert has been sounded. This can be achieved by closing the gates and isolating the sector in which the animal has escaped. These gates are the gates of individual sectors into which the zoo has been divided and fenced. The isolated sectors could be a single sector or a few sectors within which the animal is lilely to be present in. An associated design aspect is the immediate evacuation route for visitors to secure them, preferably in a secure building constructed within each sector.

Each sector should be isolated with a fence or a combination of fence and wall. The fencing ideally should be of a height which can prevent a high jumping animal (such as tiger or a leopard) from escaping. In case the animal escapes from a sector then it will either enter the adjacent sector or reach the boundary. Preventive measures as the boundary wall include a high wall with mild steel or concertina wire fencing on top. In addition, electronic surveillance with CCTV cameras and sensory devices can further strengthen perimeter defence. A driveway along the boundary can help in locating the escaped animals. There should not be any plantation along the boundary wall, so that the animal is not able to climb a tree or a shrub to escape over the wall.

Fig. 7.2 A common occurance in zoos is the entry of rodents and other predators into the enclosure by burrowing. The above holes in the soil (in Patna zoo) bear testimony to authenticate the fear. The stand off barrier railing design needs improvement to ensure that the visitor does not cross over but this should not be at the cost of seriously injuring the visitors - particularly the children.



CHAPTER 8

Project Management and Implementation

Methodology
Environmental Considerations During Execution
Advisory Committee
Use of Internet and Modern Technology
Disposal of Dead Animals
Environmental Enrichment
Disposal of Garbage

Any zoo project requires a very strict and detailed project management protocol. First, during its planning and later on during implementation. Generally such projects are not undertaken in one go, but are constructed and landscaped in phases. Therefore, project management requires to be suitably envisaged and phased in terms of works and landscape to be executed.

CHAPTER 8

Project Management and Implementation

Zoo projects are generally large and complex projects; a mix of structures, animal enclosures and landscape areas. Zoo projects are also 'sensitive' projects because living animals and regional ecology is involved.

In most other projects the consequences of anything going wrong during execution or subsequently does not affect life. In case of a zoo project, any slip at the time of execution of the works in the field may endanger the life of an animal, and in a worst case scenario, may even endanger the life of the zoo personnel or the visitors. If any lapse in project management & execution results in the escape of an animal, it will endanger the life and property of the public and property in the vicinity of the zoo. This effectively underscores the importance of project management of zoo projects. It is for these reasons that the costs of the zoo projects may, occasionally be on an average, higher than the unit cost of similar sized less complicated projects. Both the initial investment as well as the running maintenance cost later on may be high or in some items extremely high. This may be because of alternate materials, better detailing or improved technology for a specific work or item.

Any zoo project requires a very strict and detailed project management protocol. First, during its planning and later on during implementation. Generally such projects are not undertaken in one go, but are constructed and landscaped in phases. Therefore, project management requires to be suitably envisaged and phased in terms of works and landscape to be executed.

All construction should ensure that the areas and enclosures are designed in response to the topography of the site. Minimum cut and fill should be attempted. Where necessary the cut and fill should balance within the site itself instead of importing or exporting soil.

8.1 METHODOLOGY

The methodology and principal stages for implementation of a typical zoo project in India is proposed as under:

i. Discussions and planning of the project to arrive a final conceptual plan/ proposal.
ii. Preparation of conceptual drawings and preliminary estimates.
iii. Interaction with concerned government/ municipal officials/ NGO's and discussions with wildlife experts and peers.
iv. Finalization of project by consultants and obtaining clients approval.
v. Preparation of Detailed Project Report (DPR).
vi. Preparation of drawings and documents.
vii. Securing of approvals and sanctions from municipal/ government agencies and funding organizations.
viii. Implementation of preparatory operations and activities.
ix. Layout of roads and structures at site.
x. Site check of survey and layout.
xi. Modification of road alignments, building locations, enclosures etc., if required.
xii. Final layout and marking of roads, buildings, services structures, enclosures etc.
xiii. Acquire electric HT connection from concerned authorities.
xiv. Acquire main water connection from concerned authorities.
xv. Up gradation of approach road (if required) from the main road & installation of foundation stone.
xvi. Construction of boundary walls.
xvii. Construction of Main gate, emergency gate and any other gates on the boundary.

xviii. Construction of Entry area structures (ticketing counters, security check posts .etc.), parking areas for buses, private cars, taxis, private two wheelers and auto & E- rickshaws.

xix. Construction of Administrative wing.

xx. Construction of roads within the site.

xxi. Construction of veterinary treatment unit with operation theater.

xxii. Construction of Post mortem unit.

xxiii. Construction of Caracas Disposal Unit (including incinerator).

xxiv. Construction of Service road(s).

xxv. Construction and completion of Phase I - roads, paths, trails, enclosures, barriers, moats, night shelters, rest area and all other necessary constructions and laying of related services to ensure thatphaseI becomes operational and open to visitors.

xxvi. Procurement of animals.

xxvii. Dry run.

xxviii. Installation of security infrastructure.

xxix. Procurement of equipments, furniture, furnishings.

xxx. Procurement of vehicles.

xxxi. Establishment of administrative setup.

xxxii. Recruitment and training of administrative and technical staff.

xxxiii. Final opening.

Subsequently construction and completion of Phase I, II, III etc - roads, paths, trails, enclosures, barriers, moats, night shelters, rest area, and all other necessary constructions and laying of related services to ensure that phase I becomes operational and open to visitors.

8.2 ENVIRONMENTAL CONSIDERATIONS DURING EXECUTION

It is often the case that in spite of all good intentions, during the course of execution of zoo project, considerable and irretrievable damage is done to the environment. This is generally because of weak tender conditions and lack of protective & preventive systems in place to ensure its protection. Properly detailed and site specific tender conditions and specifications would ensure that the site is not 'lost' at the 'cost' of the project. The natural assets of the site which may include the existing (for which the site was probably selected in the first place) are not obliterated during execution. However, unfortunately this is a common occurrence. Healthy existing trees are cut, surfaces are damaged by disposal of construction debris at site which is never removed and establishment of labour camps at site, including rampant removal of fire wood, causes long term and irretrievable damage, which has been an important initial reason for site selection.

All precautions with required budget allocations should be taken to ensure complete protection and conservation of the site and vegetation at site. This will include priority enforcement of precautionary systems to maintain the site, in the same environmental and visual state, as it was before the execution of the project.

Representative list of conditions which should be enforced as part of tender conditions are:

a) No labour camps should be allowed within the site during construction.

a. Temporary labour accommodation, if possible shall be provided at location(s) close to the parking area near the existing zoo.

b. Contractors shall be given access to and allowed to operate in clearly marked limited minimum areas required for the execution of specific activity.

b) It will be ensured that the required construction material is bought to site in limited batches and downloaded within the 'operational' area allowed to each separate contractor. It will also to ensure that there is no 'spilling' of building material within the site during cartage and use.

c) All construction debris shall be removed at short intervals from the site.

d) No removal of firewood, fruits or any other forest produce shall be allowed for use by contractors labour or for use as shuttering / scaffolding.

e) No excavation of any material, particularly rock, from the site should be allowed to provide material for construction of walls or any other construction.

f) The work shall be organized/ co-ordinated to ensure that there is no repeated excavation for laying of various service lines etc.

g) No construction work should be allowed in the vicinity of the water bodies or water channels.

h) Strict time schedules for work execution shall be maintained to limit the time period during which labour and equipment is present at each work location.

i) Precaution shall be taken to ensure that no intentional or unintentional damage is inflicted on the existing vegetation at site. This will include using trees for 'pegging' or draining/ washing of waste over the site into the channels, etc.

j) No modification of landform shall be allowed to facilitate construction. Temporary small structures shall be built to ensure movement of men and material over the undulating parts of site and to ensure that the natural drainage is not disturbed.

k) Any other conditions(s) to protect the site and environment, as required, specific to the site situation.

It is evident that the above will require specific budgeting allocation. Permission for the same should be secured beforehand. In the present zoo construction scenario in India, this is unheard of and may be termed as redundant and avoidable expense. But it is not true. This aspect is ignored in almost any case of zoo construction/ addition/ alteration in India. This is a singular most important reason for Indian zoos not achieving highest standards in design and construction quality. The advantages and natural assests of the site are destroyed during the construction period itself.

8.3 ADVISORY COMMITTEE

It has been observed that generally, in the design of Indian zoo, it is an individual who decides on almost all requirements, animal collection, plan and even the layout. This severely restricts generation of creative ideas, introduction of new approaches in zoo design and update on latest available materials and fixtures all of which are now available in amazing variety. On principle, no individual, however experienced, can outdo collaborative effort.

This leads to the idea of constitution of an 'Advisory Committee' (or by any other name one may wish to call this group). The persons who constitute this committee should be from various disciples relating to different aspects of zoos - such as wildlife experts, veterinarians, landscape architects, civil engineers specially experienced in zoo design, project management experts, persons relating to accounts and of course representatives of the 'client' (i.e. municipal corporation, state governments/ ministry/ department of wildlife or the central ministry). This committee or group should be constituted 6 months or even earlier prior to the proposed date of announcement of the competition for zoo or if design is proposed to be done departmentally, then the date when the zoo design is to begin. This group should have a clearly defined mandate empowering it to deliberate and advise on all aspects of the designing, execution and administrative procedures for the design of the proposed zoo. Also ensure that the entire project is completed without any unforeseen hurdles and delays.

8.4 USE OF INTERNET AND MODERN TECHNOLOGY

With modern technology infiltrating all areas of life and with infrastructure keeping pace it is not only necessary but also very beneficial to extensively use all internet tools in the design of Indian zoos. This will help project management at all stages.

The use of available technology should begin with creation of a web site dedicated to the zoo project, before the stage when the zoo is proposed to be thrown open to the public. It may be done as a competition project, or for project designed in house departmentally, at the stage of inviting expression of interest from interested contractors/ project management companies. The utility of this web site will be immense, which may include but not limited to the following:

a) Informing a larger group of interested designers with the intent to elicit ideas and suggestions.
b) For dissemination of information regarding terms and conditions of the design of specific zoo.
c) For providing design brief and technical requirements, particularly the transfer of graphic materials such as site & topographic plans, photographs to show the intent/ specific requirement of the client.
d) This will help in easy dissemination of videos, which the client may want to show the competitor designer to convey for inclusion in the proposed zoo.
e) This will eliminate the possibility of any personal human interference in the procedures associated with zoo designing, either in the initial stages or during execution.
f) Creating a website for inviting zoo designers is the most inexpensive form of disseminating textual and graphic (drawings, charts, diagrams etc.) information. It is also the fastest way to communicate. Thereby, sometimes saving months of project time.

8.5 DISPOSAL OF DEAD ANIMALS

All dead animal carcasses shall be incinerated through an appropriate incinerator close to the P.M. room and all large cat carcasses shall be disposed off in accordance with the strict CZA guidelines. No body parts of dead animals should be sold or removed from the zoo except on strict scanning and by prior adminsistrative approval of the competant authority for research by recognized institutions.

8.6 ENVIRONMENTAL ENRICHMENT

Animal enclosures and kraals should not be devoid of any enrichment. By contemporary design opinion, the enclosures should have various elements to cater to the behavioural need of the species for stimulating the animal and to infuse interest and avoid monotony both for the animal and the viewer. Enrichment elements should provide creative design use of existing vegetation, rocky outcrops with logs, small water ponds, aerial roots, logs, branches, small tunnels etc. All these should be real or absolutely natural looking artificial duplicates. Such duplicates as artificial plants & vines and thatch are now commercially available. Tunnels and artificial stones and stone cladding can be created by skilled workers/ artists or with the use of fibre glass. Any surface or three dimensional objects can be produced out of fibre glass with suitable moulds. Artificial artefacts used for enrichment should be periodically changed in type and placement, to maintain interest and variety. A significant design input should ensure that the enrichment objects should blend seamlessly with the natural surroundings.

Interestingly, an entirely overlooked aspects is the enrichment within the night shelter cubicles. It is a fact that animals spend more time inside the night shelter than in the open enclosure. It is obvious that the cubicle interiors need to have creative and functionally effective enrichment elements to keep the animals active and devoid of stress. These elements should be designed to encourage the animals natural behaviour e.g. to make the monkeys jump and engage in activity which is not a part of the natural behaviour of big cats. Enrichment elements within the cubicles will vary considerably from species to species and also from animal to animal.

8.7 GARBAGE DISPOSAL

All biodegradable garbage collected during routine cleaning, dumped by visitors and food leftovers may be converted to compost and used for gardening. Non degradable items, should be collected for recycling.

Garbage disposal is as important, or maybe more important, within the zoo as for the areas outside the zoo. The description of 'garbage' in the context of the Indian zoos is wide. There are various types of garbage requiring different types of treatment and disposal methodology.

Garbage may be listed essentially in terms of garbage generated:

a) By the visitors: Loose pieces of paper, paper & polythene bags, chewing gum etc.
b) From the administrative building/ Directors office: Paper, leftovers, tea, disposable glasses etc., - largely biodegradable.

Conventionally the separation of garbage is done on the basis of biodegradable and non degradable wastes. Included in the above are several other kinds of wastes generated which have to be carefully treated before being disposed off into the municipal waste system or at times may have to be separately disposed off suitably and appropriately to avoid spread of infection, chemical harm or contamination of natural water bodies or soils. Disparate examples of such garbage/ waste includes the waste from the zoo kitchen to the waste coming from the hippopotamus pool; both requiring completely different methods of treatment and disposal.

The various types of garbage generated within the zoo are:

a) Organic wastes:
    i. Animal waste - includes liquid and solid waste and large volume waste such as cleaning and refilling of hippo pool.
    ii. Animal by products.
    iii. Human waste - Waste water and sewerage generated from public conveniences etc., zoo administrative offices and the residential quarters.
    iv. Slaughterhouse waste.
    v. Generated from the store, where daily animal feed is prepared.

b) Inorganic Waste
    i. Litter generated by visitors.
    ii. Paper waste generated from ticketing & administrative offices and the residential quarters.
    iii. Chemical waste from the zoo hospital and post mortem room.
    iv. Bio medical waste from the zoo hospital.
    v. Construction and demolition waste.

The garbage and waste generated in a zoo, depending on the type, may have to be removed on an hourly basis, daily, weekly, fortnightly, quarterly or even twice a year. Process of garbage removal has to be given attention at the design to provide for the spaces, structure and independent roads/ paths for garbage removal.

APPENDIX A

Guidelines On Minimum Dimensions Of Enclosures For Housing Exotic Animals of Different Species

S.No	Species	Minimum Size of Outdoor Enclosures (Sq.m)	Number of Animals/ Birds to be Housed (M:F)	Size of Feeding Cubicles/ Night Shelters (length x breadth x height, each in metres) for each animal or bird	Minimum Size of Water Body (if required) (Sq. m)
1	Flightless birds, emu, cassowary	500 (up to 10 birds)	1:1	3 × 2 × 2.5	--
2	Exotic pheasants	80 (with the minimum dimensions of the aviary being 3 m × 3 m × 6 m)	1:3		--
3	Flying birds	80 (with the minimum dimensions of the aviary being 3 m × 3 m × 6 m)	2:2	Height of the aviary should be 6 m	--
4	Parrots, macaws, cockatoos, conures, rosellas	80 (with the minimum dimensions of the aviary being 3 m × 3 m × 6 m)	2:2	Height of the aviary should be 5 m	--
5	Baboons, capuchins, lemurs, exotic monkeys	500	1:1	2 × 1.5 × 2.5	--
6	Marmosets, squirrel monkeys	50	1:1	1 × 1.5 × 2	--
7	European bear	1000	1:1	2.5 × 1.8 × 2.5	--
8	Cape buffalo	1500	1:1	3 × 2 × 2.5	--
9	Chimpanzee, orangutan, gorilla	1000	1:1	2.75 × 1.8 × 3	--

S.No	Species	Minimum Size of Outdoor Enclosures (Sq.m)	Number of Animals/ Birds to be Housed (M:F)	Size of Feeding Cubicles/ Night Shelters (length x breadth x height, each in metres) for each animal or bird	Minimum Size of Water Body (if required) (Sq. m)
10	Fallow deer, sika deer and lechwe	1000	2:3	3 × 2 × 2.5	--
11	African elephant	5000	1:1	8 × 6 × 5.5	--
12	Giraffe	1500	1:1	8 × 5.5 × 6	--
13	Hippopotamus	1000	1:1	5 × 3 × 2.5	--
14	Jaguar	500	1:1	2 × 1.8 × 2.5	--
15	African lion	1000	1:1	2.75 × 1.8 × 3	--
16	African rhino/white rhino	2000	1:1	5 × 3 × 2.5	--
17	Tapirs	500	1:1	2.5 × 1.5 × 2.5	--
18	Tigers (other than bengal tiger)	1000	1:1	2.75 × 1.8 × 3	--
19	Zebras	1500	1:1	3 × 2 × 2.5	--
20	Wallabies	300	1:1	2.5 × 1.5 × 2.5; the floor should be provided with a ramp	
21	Crocodiles/ Alligators: African dwarf alligator, American, alligator, Australian alligator, False gavial, Morelet's crocodile, Nile crocodile, Siamese crocodile, Slender-snouted crocodile, West African dwarf Crocodile, Spectacled caiman, Yacare caiman and Dwarf caiman	500	1:1	Note: Sufficient amount of sane should be provided for basking.	200 (with a depth of 2 m)
22	Iguana	100 (covered partly by chain link)	1:2	1.0 x 0.75 x1.5	Reptile house/glass terrarium type enclosure may also be provided.
23	Giant Aldabra tortoise	200	1:1	Area 20 m2 (to provide shelter from rain and heat)	
24	Small aviary birds (love birds, finches, lorikeets, Java sparrow, munias, budgerigars	15	2:3	Earthen pots of appropriate size for nesting and shelter should be provided	

MINIMUM PRESCRIBED SIZE FOR FEEDING/ RETIRING CUBICLE FOR IMPORTANT MAMMALIAN SPECIES OF CAPTIVE ANIMALS

Name of the Species	Size of the feeding cubicle/ night shelter for each animal (meters)			Name of the Species	Size of the feeding cubicle/ night shelter for each animal (meters)		
	Length	Breadth	Height		Length	Breadth	Height
Tiger, Asiatic lion	2.75	1.80	3.00				
Common leopard, Clouded leopard & Snow leopard	2.00	1.80	2.5	Musk deer, Nilgiri tahr, Chinkara, Four horned, antelope, Bharal, Goral, Wild sheep and Markhor	2.5	1.5	2.5
Small Cats	1.8	1.50	2.0	Mouse deer	1.5	1.0	1.5
Sloth bear, Himalayan black bear, Brown bear and Malayan sun bear	2.5	1.8	2.5				
Monkeys and Langurs	2.0	1.5	2.5				
Civets, Binturong, Otters, Retel, Hogbadger, Martens, Red panda, Wolf, Jackal and Wild dog	2.0	1.5	2.5				
Elephant	8.0	6.0	5.5	Slow loris and Slender loris	1.0	1.0	1.5
One-horned Indian Rhinoceros	5.0	3.0	2.5				
Wild buffalo, Yak, Indian gaur and Wild ass	3.0	2.0	2.5				
Brow antlered deer, Hangul & Swamp deer							

MINIMUM PRESCRIBED SIZES FOR OUTDOOR OPEN ENCLOSURES FOR IMPORTANT MAMMALIAN SPECIES IN CAPTIVITY

Animal/ Species	Minimum size of outdoor enclosure (per pair) (Square meters)	Minimum extra area per additional animal (Square meters)
Tiger and Lion	1000	200
Panther, Clouded leopard and Snow leopard	500	100
One-horned Indian Rhinoceros	2000	400
Brow antlered deer, Hangul, Swamp deer	1500	100
Wild buffalo, Indian bison and Wild ass Bharal, Goral, Wild	1500	200
sheep and Serow	500	100
Sloth bear, Himalayan black bear, Brown bear and Malayan sun bear	1000	100
Red panda, Jackal, Wolf and Wild dog	400	100
Monkeys and Langurs	500	100

MINIMUM PRESCRIBED SIZES FOR OUTDOOR ENCLOSURES FOR IMPORTANT BIRDS IN CAPTIVITY

Animal/ Species	Minimum size of Aviary (Square meters)	Minimum height of Aviary (Square meters)	Minimum size of the water body within Aviary (Square meters)
Birds of prey	300	8	10
Pheasant *	80	3	3
Water birds (mixed species enclosure)	300	8	60 (with a depth of 1.5m)
Flying birds (mixed species enclosure)	300	8	20
Flying birds (single species)	80	6	2

* In case of Peafowl the aviary size should be kept 160 sq. m.

MINIMUM PRESCRIBED SIZES FOR OUTDOOR ENCLOSURES FOR IMPORTANT BIRDS IN CAPTIVITY

Animal/ Species	**Minimum size of outdoor enclosure (per pair) (Square meters)**	**Minimum extra area per additional animal (Square meters)**
Crocodile/ Gharial	400	150 (with a depth of 2 meters)
Python	80	6
Cobra, Rat snake, Vipers	40	4
Sand boas	40	4
Monitor lizards *	80	6
Chameleons and Small lizards	40	4
Tortoises	40	4
Turtles	80	40 (with a depth of 2 meters)
Amphibians	10	4 (with a depth of 0.5 meter)

* In case of water monitor lizard the size of water body should be kept at 40 sq.meters with a depth of 1.5 meters.

NOTE

1. The dimensions have been given only in respect of the species, which are commonly displayed in zoos.

2. No dimensions for outdoor enclosure have been prescribed for Chinkara and Chowsingha because of the problem of infighting injuries. The enclosure for these species could be a group of small sized enclosures with fewer animals in each. Care should be taken to ensure that there should be no competing mating males in each small enclosure.

3. The designs of enclosures for endangered species, not covered by this Appendix, should be finalized only after approval of the Central Zoo Authority.

Annexure adopted from:

Bonal, B.S. (2012). Guidelines on Minimum Dimensions of Enclosures for Housing Exotic Animals of Different Species. Central Zoo Authority. pg 4-8.

APPENDIX B

Suggested List Of Plants For Various Locations And Uses

(Adopted from 'Trees for Drylands' edited by Drake Hocking. Pulished by Oxford & IBH Publishing Co. Pvt. Ltd.)

RATING OF TREES FOR VARIOUS USES

(Higher the number (range 1 to 10, the better it is and the higher the quality for that use, relative to other trees.)

S. No.	Botanical Name	Fodder	Growth rate	Erosion protect
1	*Acacia albida*	8	6	5
2	*Acacia aneura*	3	4	6
3	*Acacia auriculiformis*	2	7	8
4	*Acacia catechu*	5	5	3
5	*Acacia ferruginea*	6	4	5
6	*Acacia holosericea*	3	4	6
7	*Acacia leucophaloea*	6	4	4
8	*Acacia nitotica*	7	6	5
9	*Acacia senegal*	2	3	7
10	*Acacia salicina*	5	5	4
11	*Acacia seyal*	7	8	6
12	*Acacia tortilis*	5	7	6
13	*Ailanthus excelsa*	6	9	4
14	*Albizia amara*	7	8	5
15	*Albizia lebbek*	4	7	4
16	*Anacardium occidentale*	2	4	4
17	*Anogeissus pendula*	5	4	7
18	*Anona squamosa*	1	6	5

S. No.	Botanical Name	Fodder	Growth rate	Erosion protect
19	*Azadirachta indica*	6	6	4
20	*Balanites aegyptica*	6	3	6
21	*Bauhinia varigata*	8	7	5
22	*Borassus flabellifera*	1	3	1
23	*Boswellia serrata*	5	4	5
24	*Butea monosperama*	4	5	4
25	*Capparis decidua*	2	3	8
26	*Cassia fistula*	3	7	5
27	*Cassia siamea*	4	8	5
28	*Casuarina equisetifolia*	3	7	8
29	*Celtis austrails*	5	6	5
30	*Colophospermum Mopane*	8	8	7
31	*Commiphora caudata*	6	4	8
32	*Commiphora wightii*	7	3	7
33	*Cordia dicholoma/ rothii*	5	4	6
34	*Dalbergia latifolia*	5	6	2
35	*Dalbergia sissoo*	3	6	2
36	*Dendrocalamus strictus*	7	8	7
37	*Dichrostachys cineraria*	6	6	10
38	*Diospyros melanoxylon*	4	6	4
39	*Emblica offcinalis*	4	5	4
40	*Erythrina indica*	7	8	7
41	*Eucalyptus camaldulensis*	1	9	5
42	*Eucalyptus tereticomis*	1	9	4
43	*Ficus bengalensis*	6	7	6
44	*Ficus religiosa*	7	8	6
45	*Grewia tenax*	8	6	3

S. No.	Botanical Name	Fodder	Growth rate	Erosion protect
46	*Hardwickia binnata*	9	6	5
47	*Holoptelia intgrifolia*	3	5	6
48	*Leucaena leucocephala*	10	10	7
49	*Madhuca latifolia*	5	4	6
50	*Melea azedirach*	5	8	5
51	*Moninga oleifera*	7	10	1
51	*Morus alba*	8	6	5
53	*Ougenix oojeinensis*	6	6	4
54	*Parkinosonia aculeata*	1	8	9
55	*Pithecelobium dulce*	1	2	2
56	*Phonenix dectylifera*	8	8	6
57	*Pongamia pinnata*	6	6	5
58	*Prosopis cineraria*	10	3	4
59	*Prosopis juliflora*	5	9	8
60	*Rhus mysorensis*	6	5	6
61	*Salvadora olecides*	4	4	7
62	*Santalum album*	2	8	3
63	*Sesbania grandiflora*	8	10	5
64	*Syzygium cimini*	7	6	4
65	*Tamanindus indica*	8	2	2
66	*Tamarix aphylla*	2	4	8
67	*Tecomella undulata*	3	6	5
68	*Terminalia alata*	4	6	3
69	*Terminalia arjuna*	4	7	4
70	*Terminalia bellerica*	4	8	3
71	*Wrightia tinctorica*	5	5	7
72	*Zizyphus mauritiana*	6	6	5
73	*Zizphus nummularia*	8	7	7

RATINGS OF TREES FOR FROST AND FIRE HARDINESS

(Higher the number the more hardy it is relative to other trees.

10 = Unharmed by several degrees of frost; mature trees unharmed by ground fire of high intensity.

1 = Killed by the litest frost; or by slight ground fire.

S. No.	Botanical Name	Common Name	Frost	Fire
1	*Acacia albida*	Siris/siras/kalshish/tantia	6	5
2	*Acacia aneura*	Mulga	10	8
3	*Acacia auriculiformis*	*Australian babul*	1	3
4	*Acacia catechu*	Kaggali, Bevu	9	7
5	*Acacia ferruginea*	Safed khair, kaigar	1	6
6	*Acacia holosericea*	Strap wattle	6	5
7	*Acacia leucophloea*	Naibela, Ronjh/rini/kareer/nimbar	8	8
8	*Acacia nitotica*	Babool/gum/kikar	9	7
9	*Acacia senegal*	Kher, Gum acacia	8	7
10	*Acacia salicina*	Black Wattle	10	10
11	*Acacia seyal*	Shittim, red acacia	7	
12	*Acacia tortilis*	Israeli babool	8	10
13	*Ailanthus excelsa*	Tree Of Heaven, Maharukh, mahaneem	5	5
14	*Albizia amara*	Krishna Siris	1	8
15	*Albizia lebbek*	Lebbeck, Black Shirish	8	6
16	*Anacardium occidentale*	Cashew nut	2	5
17	*Anogeissus pendula*	Kardhai	6	8
18	*Anona squamosa*	Sharifa, Sugar apple	7	7
19	*Azadirachta indica*	*Neem*	3	6
20	*Balanites aegyptica*	Desert date	5	10
21	*Bauhinia varigata*	Kachnar	3	5

S. No.	Botanical Name	Common Name	Frost	Fire
22	*Borassus flabellifera*	Wine palm, doub palm	8	8
23	*Boswellia serrata*	Sambrani	6	7
24	*Butea monosperama*	Flame of the forest	8	8
25	*Capparis decidua*	Bare Caper	6	8
26	*Cassia fistula*	Amaltas/girmala	2	6
27	*Cassia siamea*	Kassod	1	5
28	*Casuarina equisetifolia*	Casurina, Australian Pine	1	4
29	*Celtis austrails*	European nettle, honeyberry	10	7
30	*Colophospermum mopane*	Mopane, Balsam tree	8	9
31	*Commiphora caudata*	*Khejri*	4	6
32	*Cordia dichotoma*	Lasora,bhokar	8	8
33	*Dalbergia latifolia*	Beete, Indian Rosewood	4	5
34	*Dalbergia sissoo*	Shisham	4	3
35	*Dendrocalamus strictus*	Bidiru	5	5
36	*Dichrostachys cineraria*	Pink Brush Acasia	8	8
37	*Diospyros melanoxylon*	Ebony	8	8
38	*Emblica offcinalis*	Nelli, amla	5	7
39	*Erythrina indica*	Indian coral tree	3	6
40	*Eucalyptus camaldulensis*	River red gum	6	6
41	*Eucalyptus tereticomis*	Forest red gum	8	7
42	*Ficus bengalensis*	Banyan tree	8	8
43	*Ficus religiosa*	*Peepal*	8	8
44	*Grewia tenax*	White Crossberry, Phalsa Cherry	6	7
45	*Hardwickia binnata*	*Anjan*	5	6
46	*Holoptelia intgrifolia*	Indian elm*, chilbil*	2	5

S. No.	Botanical Name	Common Name	Frost	Fire
47	*Leucaena leucocephala*	*Subabul*	2	4
48	*Madhuca latifolia*	*Mahua*	2	8
49	*Melia azedarach*	Chinaberry tree, Pride of India,	4	5
50	*Moninga oleifera*	Drum Stick	1	5
51	*Morus alba*	*Shahtoot*	3	5
51	*Ougenix oojeinensis*	Sandan	2	5
53	*Parkinosonia aculeata*	Jelly bean	6	8
54	*Pithecelobium dulce*	Jungle jalebi	10	10
55	*Phonenix dectylifera*	Khajoor,	3	7
56	*Pongamia pinnata*	Karanj, Indian beech tree	5	8
57	*Prosopis cineraria*	Khejri, Jhand, kanda, khar	9	9
58	*Prosopis juliflora*	Kikar	7	8
59	*Rhus mysorensis*	*Dasni*, Dansara,	5	8
60	*Salvadora olecides*	Arak, Mustard tree	7	8
61	*Santalum album*	Srigandha	1	6
62	*Sesbania grandiflora*	Gaach-munga	1	5
63	*Syzygium cimini*	*Jamun*	2	5
64	*Tamanindus indica*	Imli	1	6
65	*Tamarix aphylla*	Smoke Bush	10	10
66	*Tecomella undulata*	Desert Teak, Honey Tree	10	10
67	*Terminalia alata*	Asan, sain, saj	3	5
68	*Terminalia arjuna*	*Arjun*	5	5
69	*Terminalia bellerica*	Baheda, bharla	2	6
70	*Wrightia tinctorica*	Sweet Indrajao	2	5
71	*Zizyphus mauritiana*	Jujube, Indian plum	8	8
72	*Zizphus nummularia*	Jar ber	10	10

TREES FOR ALKALINE SOILS

S. No.	Botanical Name	Common Name
1	*Acacia aneura*	Mulga
2	*Acacia salicina*	Black Wattle
3	*Acacia nilotica*	Babool, Gum, Kikar
4	*Acacia tortilis*	Israeli babool
5	*Albizia lebbek*	Lebbeck
6	*Balanites aegyptica*	Desert date
7	*Butea monosperama*	Flame of the forest
8	*Capparis decidua*	Bare Caper
9	*Casuarina equisetifolia*	Casurina, Australian Pine
10	*Colophospermum mopane*	Mopane, Balsam tree
11	*Dalbergia latifolia*	Beete, Indian Rosewood
12	Emblica officinalis	*Amla*
13	*Eucalyptus camaldulensis*	River red gum
14	*Ficus bengalensis*	*Banyan*
15	*Leucaena leucocephala*	*Subabul*
16	*Madhuca latifolia*	*Mahua*
17	*Pithecellobium dulce*	*Jungle jalebi*
18	*Prosopis cineraria*	*Khejri*
19	*Prosopis juliflora*	*Kikar*
20	*Salvadora persica*	*Arak*, Mustard tree
21	*Tamanindus indica*	*Imli*
22	*Tamarix aphylla*	Smoke Bush
23	*Tecomella undulata*	Desert Teak, Honey Tree
24	*Terminalia arjuna*	*Arjun*
25	*Zizyphus mauritiana*	*Jujube*, Indian plum
26	*Zizphus nummularia*	*Jar ber*

TREES FOR SALINE SOILS

S. No.	Botanical Name	Common Name
1	*Acacia aneura*	Mulga
2	*Acacia holosericea*	Strap wattle
3	*Acacia salicina*	Black Wattle
4	*Albizia lebbek*	Lebbeck, Black Shirish
5	*Anona squamosa*	Sharifa, Sugar apple
6	*Balanites aegyptica*	Desert date
7	*Butea monosperama*	Flame of the forest
8	*Capparis decidua*	Bare Caper
9	*Cassia siamea*	Kassod
10	*Casuarina equisetifolia*	Casurina, Australian Pine
11	*Colophospermum mopane*	Mopane, Balsam tree
12	*Dalbergia sissoo*	Shisham
13	*Ficus bengalensis*	Banyan tree
14	*Moninga oleifera*	Drum Stick
15	*Phonenix dectylifera*	Khjoor
16	*Pithecelobium dulce*	Jungle jalebi
17	*Pongamia pinnata*	Karanj, Indian beech tree
18	*Prosopis cineraria*	Khejri, Jhand, kanda
19	*Prosopis juliflora*	Kikar
20	*Salvadora persica*	Kharijal, Toothbrush three
21	*Tamanindus indica*	Imli
22	*Tamarix aphylla*	Smoke Bush
23	*Tecomella undulata*	Desert Teak, Honey Tree
24	*Zizyphus mauritiana*	Jujube, Indian plum
25	*Zizphus nummularia*	Jar ber

TREES FOR FODDER

S.No.	Botanical Name	Common Name
1	*Acacia albida*	Siris/siras/kalshish/tantia
2	*Acacia aneura*	Mulga
3	*Acacia ferruginea*	Safed khair, kaigar
4	*Acacia leucophaloea*	Naibela, Ronjh, Kareer, Nimbar
5	*Acacia nitotica*	Babool, Gum, Kikar
6	*Acacia senegal*	Kher, Gum acacia
7	*Ailanthus excelsa*	Maharukh, Mahaneem
8	*Azadirachta indica*	Neem
9	*Balanites aegyptica*	Desert date
10	*Bauhinia varigata*	*Kachnar*
11	*Colophospermum Mopane*	Mopane, Balsam tree
12	*Commiphora caudata*	*Khejri*
13	*Commiphora wightii*	Gugal, guggul
14	*Dendrocalamus strictus*	Bidiru
15	*Dichrostachys cineraria*	Pink Brush Acasia
16	*Erythrina indica*	Indian coral tree
17	*Ficus bengalensis*	*Banyan*
18	*Ficus religiosa*	*Peepal*
19	*Grewia tenax*	White Crossberry, Phalsa Cherry
20	*Hardwickia binnata*	*Anjan*
21	*Leucaena leucocephala*	*Subabul*
22	*Moninga oleifera*	Drum Stick
23	*Morus alba*	*Shahtoot*
24	*Ougenix oojeinensis*	Sandan Sandan SandansSna
25	*Pithecelobium dulce*	*Jungle jalebi* Jungle jal Jungle jalebi
26	*Pongamia pinnata*	*Karanj*, Indian beech tree

S. No.	Botanical Name	Common Name
27	*Prosopis cineraria*	Khejri ,Jhand, kanda, khar
28	*Rhus mysorensis*	*Dasni*, Dansara,
29	*Syzygium cimini*	*Jamun*
30	*Tamanindus indica*	*Imli*
31	*Zizphus nummularia*	Jar ber

TREES FOR SANDY SOILS

S. No.	Botanical Name	Common Name
1	*Acacia albida*	Siris/siras/kalshish/tantia
2	*Acacia aneura*	Mulga
3	*Acacia ferruginea*	Safed khair, kaigar
4	*Acacia holosericea*	Strap wattle
5	*Acacia leucophaloea*	Ronjh/ rini/ reru/ kareer
6	*Acacia senegal*	Kher, Gum acacia
7	*Acacia salicina*	Black Wattle
8	*Acacia tortilis*	Israeli babool
9	*Balanites aegyptica*	Desert date
10	*Borassus flabellifera*	Wine palm, doub palm
11	*Boswellia serrata*	*Shallaki*
12	*Butea monosperama*	Flame of the forest
13	*Capparis decidua*	Bare Caper
14	*Cassia siamea*	*Kassod*
15	*Casuarina equisetifolia*	Casurina, Australian Pine
16	*Colophospermum mopane*	Mopane, Balsam tree
17	*Commiphora caudata*	Hill mango
18	*Dalbergia sissoo*	*Shisham*

19	*Dichrostachys cineraria*	Pink Brush Acasia
20	*Hardwickia binnata*	*Anjan*
21	*Moringa oleifera*	Drum Stick
22	*Morus alba*	*Shahtoot*, Mulburry
23	*Phoenix dactylifera*	*Khajur,* Date palm
24	*Prosopis cineraria*	*Khejri*
25	*Prosopis juliflora*	*Kikar*
26	*Salvadora olecides*	*Jal, Pilu*
27	*Tamarix aphylla*	Smoke Bush
28	*Tecomella undulata*	Desert Teak, Honey Tree
29	*Zizphus nummularia*	*Jar ber*

TREES FOR SHALLOW, ROCKY SOILS

S. No.	Botanical Name	Common Name
1	*Acacia holosericea*	Strap wattle
2	*Acacia leucophaloea*	Naibela
3	*Acacia senegal*	Kher, Gum acacia
4	*Acacia salicina*	Black Wattle
5	*Anacardium occidentale*	Cashew nut
6	*Anogeissus pendula*	Kardhai
7	*Anona squamosa*	*Sharifa*, Sugar apple
8	*Azadirachta indica*	*Neem*
9	*Balanites aegyptica*	Desert date
10	*Borassus flabellifera*	Wine palm, doub palm
11	*Boswellia serrata*	Sambrani
12	*Butea monosperama*	Flame of the forest
13	*Capparis decidua*	Bare Caper

S. No.	Botanical Name	Common Name
14	*Cassia siamea*	*Kassod*
15	*Celtis austrails*	European nettle, honeyberry
16	*Commiphora caudata*	*Khejri*
17	*Cordia obliqua*	Clammy Cherry
18	*Dendrocalamus strictus*	Bidiru
19	*Eucalyptus tereticomis*	Forest red gum
20	*Grewia tenax*	White Crossberry, Phalsa Cherry
21	*Hardwickia binnata*	*Anjan*
22	*Holoptelia intgrifolia*	Indian elm*, chilbil*
23	*Madhuca latifolia*	*Mahua*
24	*Parkinosonia aculeata*	Jelly bean
25	*Pithecellobium dulce*	*Jungle jalebi*
26	*Pongamia pinnata*	Karanj, Indian beech tree
27	*Prosopis juliflora*	*Kikar*
28	*Rhus mysorensis*	*Dasni*, Dansara
29	*Wrightia tinctorica*	Sweet Indrajao
30	*Zizphus nummularia*	*Jar ber*

FAST GROWING TREES

(In approximate order of growth rate, on good sites)

S.No.	Botanical Name	Common Name
1	*Ailanthus excelsa*	Tree Of Heaven, Maharukh, Mahaneem
2	*Albizia lebbek*	Lebbeck, Black Shirish
3	*Albizia amara*	Krishna Siris
4	*Bauhinia varigata*	Kachnar
5	*Acacia auriculiformis*	Black Wattle

S.No.	Botanical Name	Common Name
6	*Acacia seyal*	Red acacia, Shittah tree
7	*Cassia siamea*	Kassod
8	*Acacia tortilis (Sym. Vachellia tortilis*	Umbrella thorn
9	*Dendrocalamus strictus*	Bidiru
10	*Erythrina indica*	Indian coral tree
11	*Eucalyptus camaldulensis*	River red gum
12	*Eucalyptus tereticomis*	Forest red gum
13	*Ficus bengalensis*	Banyan tree
14	*Ficus religiosa*	Peepal
15	*Leucaena leucocephala*	Subabul
16	*Melea azedirach*	Pride of India,
17	*Moninga oleifera*	Shahtoot
18	*Parkinosonia aculeata*	Jelly bean
19	*Pithecelobium dulce*	Jungle jalebi
20	*Prosopis juliflora*	Kikar
21	*Santalum album*	Srigandha
22	*Sesbania grandiflora*	Gaach-munga
23	*Terminalia arjuna*	Arjun
24	*Terminalia bellerica*	Baheda, bharla
25	*Zizphus nummularia*	Jar ber

TREES FOR DRYLANDS

S.No.	Botanical Name	Common Name
1	*Acacia albida*	Siris/siras/kalshish/tantia
2	*Acacia aneura*	Mulga
3	*Acacia auriculiformis*	Australian acacia
4	*Acacia catechu*	Kaggali
5	*Acacia ferruginea*	Safed khair, kaigar

S.No.	Botanical Name	Common Name
6	*Acacia holosericea*	Strap wattle
7	*Acacia leucophaloea*	Naibela
8	*Acacia nilotica*	Babool,gum,kikar
9	*Acacia salicina*	Black Wattle
10	*Acacia senegal*	Kher, Gum acacia
11	*Acacia seyal*	Shittim, red acacia
12	*Acacia tortilis*	Israeli babool
13	*Ailanthus excelsa*	Maharukh, mahaneem
14	*Albizia amara*	Mulga
15	*Albizia lebbek*	Lebbeck
16	*Anacardium occidentale*	Cashew nut
17	*Anogeissus pendula*	Kardhai
18	*Anona squamosa*	Sharifa, Sugar apple
19	*Azadirachta indica*	Neem
20	*Balanites aegyptica*	Desert date
21	*Bauhinia variegata*	Kachnar
22	*Borassus flabellifera*	Wine palm, doub palm
23	*Boswellia serrata*	Sambrani
24	*Butea monosperama*	Flame of the forest
26	*Capparis decidua*	Bare Caper
27	*Cassia fistula*	Amaltas, Shower Of Gold
28	*Cassia siamea*	Kassod
29	*Casuarina equisetifolia*	Casurina, Australian Pine
30	*Celtis australis*	European nettle, honeyberry
31	*Colophospermum mopane*	Mopane, Balsam tree
32	*Commiphora caudata*	Khejri
32	*Commiphora wightii*	Gugal, guggul

S.No.	Botanical Name	Common Name
34	*Cordia rothii*	Kabula
35	*Dalbergia latifolia*	Beete, Indian Rosewood
36	*Dalbergia sissoo*	Shisham
37	*Dendrocalamus strictus*	Bidiru
38	*Dischrostachys cineraria*	Pink Brush Acasia
39	*Diospyros melanoxylon*	Ebony
40	*Emblica officinalis*	Amla
41	*Erythrina indica*	Indian coral tree
42	*Eucalyptus camaldulensis*	River red gum
43	*Eucalyptus tereticornis*	Forest red gum
44	*Ficus bengalensis*	Banyan
45	*Ficus religiosa*	Peepal
46	*Grewia tenax*	White Crossberry, Phalsa Cherry
47	*Hardwickia binnata*	Anjan
48	*Holoptelia integrifolia*	Indian elm*, chilbil*
49	*Leucaena leucocephala*	Subabul
50	*Madhuca latifolia*	Mahua
51	*Melea azedirach*	Chinaberry tree, Pride of India,
52	*Moringa oleifera*	Drum Stick
53	*Morus alba*	Shahtoot
54	*Ougeinia oojeinensis*	Sandan
55	*Parkinosonia aculeata*	Jelly bean
56	*Phoenix dectylifera*	Khajur, Date palm
57	*Pithecelobium dulce*	Jungle jalebi
58	*Pongamia pinnata*	Karanj, Indian beech tree
59	*Prosopis cineraria*	Khejri
60	*Prosopis juliflora*	Kikar

S.No.	Botanical Name	Common Name
61	*Rhus mysorensis*	Dasni, Dansara
62	*Salvadora oleoides*	Jal, Pilu
63	*Santalum album*	Sandal Wood, Chandan
64	*Sesbania grandiflora*	Gaach-munga
65	*Syzygium cuminii*	Jamun
66	*Tamarindus indica*	Imli
67	*Tamarix aphylla*	Smoke Bush
68	*Tecomella undulata*	Desert Teak, Honey Tree
69	*Terminalia alata*	Asan, sain, saj
70	*Terminalia arjuna*	Arjun
71	*Terminalia bellerica*	Baheda, bharla
72	*Zizyphus mauritiana*	Jujube, Indian plum
73	*Zizyphus nummularia*	Jar ber

APPENDIX C

Recommended Specifications for Plants and Planting

a) Trees

b) Shrubs

c) Ground Covers

d) Creepers and Vines

e) Grass

General:

Scope: Contractor to furnish all materials labour and related items necessary to complete the work indicated on drawings specified herein:

Related Work: EARTHWORK

MINERIALS

1.1 **Plants materials**

Plant materials shall be well formed and shaped true to type, and free from diseases, insects and defects such as knots, sunscald, windburn, abrasion or disfigurement.

All plant materials shall be healthy, sound, vigorous, free form plant diseases, insects, pests or their eggs, and shall be healthy, with well-developed root systems. All plants shall be hardy under climatic conditions similar to those in the locality of projects. Plants shall be freshly dug, nursery grown stock. All plants supplied shall conform to the names listed on the plants list. Botanical names shall govern plant selection. Common names are given for references only. No plant material shall be accepted if branches are damaged or broken, or the top of the root ball is loose. All materials should be protected from the sun and the weather until planted.

All nursery stock shall be inspected for the type and quality and approved by the Landscape Architect or specialist retained by the client. All plants shall be between two to four years in age and all tree saplings should be at least 45 mm high and well branched at the time of arrival at site.

All plants shall conform to the requirements specified in the plant list. Except that plants larger than specified may be used if approved by the contracting, but use of such plants shall not increase price, if the use of such larger plant is approved, the spread of roots or ball of earth shall be increased in proportion to the size of plant.

Plants delivered at site shall have legible identification labels.

Plants of the same species planted in close proximity shall be of uniform size and appearance.

1.2 Topsoil

Topsoil of the locality containing at least 2% of decayed organic matter (humus). It shall be taken from a well-drained arable site. It shall be free of subsoil, stones, earth, clods, sticks, roots, or other objectionable extraneous matter or debris. It shall contain no toxic materials. No topsoil shall be delivered in a frozen or muddy condition.

1.3 Fertilizers and Manures

Commercial fertilizer shall be used in planting and shall be delivered mixed as specified in original, unopened containers, dry and free flowing. Fertilizer shall contain 10% nitrogen, 6% phosphoric acid, and 4% potash by weight for free planting and ground cover beds. Equivalent quantities or manure or other organic fertilizer maybe substituted subject to prior approval of Landscape Architect.

Apply fertilizer at the following rates during planting operation: Shade and Ornamental Trees - 1.5 – 2 kg/ tree pit and 750 gm per shrub and creeper pit – ½ pound per shrub.

Well decomposed cow dung manure of not less than one-year decomposition, sludge, compost or any balanced complete Orin manure shall be used for planting of trees, shrubs, groundcovers, creepers and vines.

Manure used shall used in the ratio of 1:3 (1 part of stacked volume of manure after reduction by 8% and 3 parts of stacked volume of earth after reduction by 20%) per each tree, shrub and creeper pit and in the same ratio of the excavated volume of soil for ground cover beds.

1.4 Mulch

Shredded bark shall be used in mulching operation. Samples shall be submitted to the Landscape Architect for approval prior to installation. Install to depths shown on the drawing.

2.0 DEFINITIONS

The following definitions shall apply:

Tree: A woody perennial with a distinct stem

Shrub: A woody perennial, usually of less size than a

tree, with several stems from or near ground level.

Climbers: Plants, which have special structure to climb on supports.

2.1 Origin

Trees and shrubs shall be true to name. Those, which are normally propagated vegetatively, shall, if grown from seed, be stated to have been so produced.

If subjects have been budded or grafted this shall be stated, and the name of the rootstock shall be supplied if requested by the purchaser.

If high-worked this shall be stated.

2.2 Root System

The root system shall be conductive to successful transplantation. Where necessary, the root ball shall be preserved by support with hassein or other suitable materials. On soil where retention of a ball is not possible, the roots should be suitably protected in some other way, which should not cause any damage to roots. Larger trees shall be wrapped with burlap and tied with twine (balled and burlaps) as noted on the plant list. Twine and burlap shall be organic and able to readily decompose after planting.

2.3 Conditions

Trees and shrubs shall be free from pests and diseases, and shall be materially undamaged. Torn or lacerated roots shall be pruned before dispatch. No roots shall be subjected to adverse conditions, such as prolonged exposure to drying winds or subjected to water logging, between lifting and delivery.

3) TREES

1.1 Orientation

Before lifting is started a mark should be made on the stem to indicate the approximate north side so that the tree may be finally planted with the same orientation as that when growing in the nursery.

1.2 Plant Material

1.2.1 Supply and Substitution

Upon submission of evidence that certain materials including plant materials are not available at time of contract, the contractor shall be permitted to substitute other materials and plants, with an equitable adjustment of price. All substitutions shall be of the nearest equivalent species and variety to the original specified and shall be subject to the approval of the Landscape Architect.

1.2.2 Packaging

Packaging shall be adequate for the protection of the plants and such as to avoid heating or drying out.

1.2.3 Marking

Each specimen of tree shrub, or each bundle, shall be legibly labeled with the following particulars:

a) Its name.
b) The name of the supplier.
c) The date of dispatch from the nursery.

1.2.4 Protection

Trees should be supplied with adequate protection as approved. After delivery, if planting is not to be carried out immediately, balled plants should be placed cheek to cheek and the ball covered with sand or moist peat to prevent drying out. Bare-rooted plants can be heeled in by placing the roots in a prepared trench and covering them with earth, which should be watered in to avoid air pockets round the roots.

3.3 Digging of Pits

Tree pits shall be dug in a minimum of three weeks prior to backfilling. The pits shall be 90 cm in diameter and 90 cm deep or as shown on the plans. While digging the pits, the topsoil upto a depth of 30 cm may be kept aside, if found good (depending upon site conditions), surmised with the rest of the soil.

If the soil is bad below, it shall be replaced with the soil mixture as specified further herein. If the soil is normal it shall be mixed with manure while river sand shall be added to the soil if it is heavy.

The bottom of the pit shall be forked to breakup the subsoil. In case the soil is clay a layer of broken bricks and stones shall be covered over dried leaves or straw.

In case the site is infested with white and the sides of the pits shall be brushed with a mixture of B.H.C. (10% concentration) and water in a proportion of 200 gm of B.H.C. mixed in 5 liters of water. Special care is need in lawns or areas recently planned planted with grass to insure that soil removed from the pit does not damage the existing grass, and that foot damage is mitigated by the use of planting boards.

3.1.1 Backfilling

The soil shall be backfilled, watered through and gently pressed down, a day previous to planting the soil shall be pressed down firmly by treading it down, leaving a shallow depression all round for watering.

3.4 Planting

No tree pits shall be dug until final tree positions have been pegged out for approval of the Landscape Architect. Care shall be taken that the plant when planted is not buried deeper than it was in the nursery.

Planting shall not be carried out in water logged soil.

It is most important to plant trees at the original soil depth; the soil mark on the stem is an indication of this and it should be maintained on the finishing level, allowing for settling of the soil after planting. All plastic and other imperishable containers should be removed before planting. Twine and burlap from balled and burlap trees shall be removed from the top 1/3 of the root ball. Any broken or damaged roots should be cut back to sound growth. The bottom of the planting pit should be covered with 50mm to 75mm of soil. Bare roots should be spread evenly in the planting pit: a small mound in the center of the pit on which the roots are placed will aid an even spread. Soil should be placed around the roots, gently shake the tree to allow the soil particles to sift into root system to ensure close contact with all roots and to prevent air pockets. Backfill soil should be firmed up as filling proceeds, layer by layer, care being taken to avoid damaging the roots. Organic material should be applied, according to soil requirements. Apply fertilizer as specified.

3.5 Requirements

Newly planted trees must be held firmly although not rigidly by staking to prevent the pocket forming around the stem and newly formed fibrous roots being broken by mechanical pulling as the tree rocks.

3.6 Watering

The Landscape Contractor shall allow for the adequate watering in of newly planted trees and shrubs immediately after planting (particularly when planting takes place in spring) and he shall, during the following growing season, keep the plant material well watered until acceptance by the Landscape Architect.

All shrubs, which are supplied pot grown, shall be well soaked prior to planting.

Watering in and subsequent frequent watering of summer planted container grown plants is essential.

3.7 Maintenance

The landscape contractor shall maintain all planted trees areas within the landscape contractor boundaries until the area is handed over in whole or in phases. Maintenance shall include watering, weeding, cultivating, control of insects, fungus and other diseases by means of spaying with an approved insecticide or fungicide, pruning adjustment and repair of anchors and wires, repair of minor washouts and horticulture operations necessary for the proper growth of the plants and for keeping the landscape sub-contract area near in appearance.

3.8 Pruning and Repair

Upon completion of planting work on the landscape sub-contract all trees should be pruned and all injuries repaired when necessary. The amount of pruning shall be limited to the minimum necessary to remove dead or injured twigs and branches and to compensate for the loss of roots and the result of transplanting operations. Pruning shall be done in such a manner as not to change the natural habit or special shape of trees. All cuts should be made flush leaving no stubs. On all cuts over 75mm diameter and on bruisers or scare on the bark, the injured cambium shall trace back to living tissue and removed. Wounds shall be smoothed so as not to retain water and the treated area shall be coated with shellac or an approved tree-wound paved.

3.9 Tree Guards

Where tree guards are necessary, care should be taken to ensure that they do not impede natural movement or restricted growth.

3.10 Nursery Stock

Planting should be carried out as soon as possible after reaching site. Where planting must necessity be delayed, care should be taken to protect the plants from pilfering or damage from people or animals. Plants with bare roots should be healed-in as soon as received or otherwise protected from drying out and other set closely together and protected from the wind. If planting is to be delayed for more than a week packaged should be unpacked. The bundles opened up and each group of plants heeled-in-separately and clearly labeled. If for any reason the surface of the roots become dry and the roots should thoroughly soaked before planting.

4.0 SEASON AND WEATHER CONDITIONS

4.1 Season

Most deciduous shrubs to be lifted from open ground should be moved in the dormant period, which is normally between October and April inclusive. Herbaceous plants must be moved September to October and March to April.

5.0 PROTECTED FENCING

According to locate environment shrubs must have to be protected adequately from vandalism until established.

6.0 SHRUBS

Tall shrubs may need staking; which shall be provided if directed by the Project Manager depending upon the conditions of individual plant specimen.

6.1 Shrubs in Beds

Exact locations and edges of shrub beds shall be approved by Project Manager prior to planting operation.

Position of shrubs to be planting should be marked out in accordance with the planting plan. When shrubs are set out, precautions should be taken to prevent root drying. Planting holes 60 mm dia. and 60 cm deep should be excavated. Polythene and other non-perishable containers should be removed and badly damaged roots carefully pruned. The shrubs should then be set in holes so that the soil level, after settlement, will be at the original soil mark on the stem of the shrub. The hole should be backfilled to half its depth and firmed by trading. The remainder or the soil can then be returned and again firmed by treading. Apply fertilizer as specified.

6.2 Ground Cover Shrubs

Low growing ground cover shrubs may be planted as for herbaceous plants. If climbers, such as *Ilamanda cathartica* are used for ground cover planting, the cane, which is usually supplied with the plant, should be carefully removed and the stems pegged out to encourage growth in the required directions.

6.3 REQUIREMENTS

6.3.1 Pruning

Prune existing trees as required to permit erection of building. Pruning shall be conducted in such a way as to prevent hazard to workmen.

Prune all existing trees damaged in any way by construction as required to compensate for such damage. Pruning shall be conducted as soon as extent of damaged can be adequately assessed.

All pruning shall be done by qualified professional arborist horticulturist or tree surgeon.

All work shall conform to commonly accepted horticultural trade standards.

All work shall be co-ordinated with the project manager or specialist prior to execution.

6.3.2 Removal and Diseased Wood

All existing seriously diseased trees or parts of trees shall be removed. Diseased wood shall be disposed of off the site and shall not be burnt with in the site.

Evaluation of the trees and determination of extent of weak or diseased wood to be removed shall be made by a qualified horticulturist.

6.3.3 Deweeding

Periodic (as required seasonally and depending on the type of weed) removal of all unwanted plants from the freshly planted areas and immediate daily removal and destruction (by burning or otherwise) of the same from the site.

7.0 Guarantee

All labour and plant materials shall be guaranteed for 1 year after final acceptance by the project manager. This will be an unconditional guarantee and the contractor shall replace, free to charge, ant plant materials, which die during this period under the same conditions as, described before. At the end of the guarantee period, any material not showing definite and satisfactory life growth shall be guaranteed for one full season from date of planting. Repair damage to other plants, or facilities during plant replacements at no cost to the owner.

7.1 Plant replacements

All replacements shall be plants of the same kind and size as specified in the plant list .1. They shall be furnished and planted as specified under Planting Operations. The cost shall be borne by the contractor expect for possible replacements resulting from removal, loss or damage, due to occupancy of the project in any part, vandalism or acts of neglect in the part of others, physical damage by animals, vehicles, fire, or losses due to curtailment of water by local authority, or to “ Acts of God”.

7.2 Maintenance

Maintenance during planting operations shall begin immediately after each plant is planted and shall continue until the installation of planting is complete. Plants shall be watered, mulched, weeded pruned, sprayed, fertilized, cultivated and otherwise maintained and protected until acceptance. Settled plants shall be reset to proper grade and position after it becomes apparent and weather and season permit. Upon completion of planting and prior to provisional acceptance, the contractor shall remove from the site excess soil and debris and repair any damage to structures, etc. resulting from planting operations.

8.0 GRASSING

8.1 Preparation

During fallow period prior to planting the tilth shall be maintained free from weeds. Whatever the nature of soil the complete surface shall be trenched over to a death of 45-60 cm. Grading and final leveling of the lawn shall be completed at least three weeks prior to the actual sowing. Regular watering shall be continued until sowing by dividing the lawn area into the portions of approx. 5 mts. Square by constructing shall bunds to retain water. These bunds shall be leveled just prior to sowing of grass plants. At the time if actual deservation at site, that the soil has completely settled.

8.2 Soil

The soil it shall be ensured to the satisfaction of contracting Officer to be a good fibrous loan, rich in humus.

In case the soil has to be imported, it shall be ensured to be free of other seeds, weeds and stones, and shall be enriched with adequate dressing manure. The quantity and composition of the manure shall be specified by the Landscape Architect on the basis of the existing site conditions and soil analysis.

If fresh mould cannot be introduced, the top-soil, if heavy, shall be well broken up, weeds and stones must be removed and with it should be incorporated plenty of finely-sifted ashes or well decomposed cow dung manure or vermiculite, to render the soil porous and enable the roots to penetrate through it. If the soil is too light well-decayed, manure and leaf mould shall be added, until the top 250 cm of the compost consists of one part of these ingredients to four parts of soil. In any event, 1.5 cum to the acre, should be incorporated with the top spit of soil and should not lie more than 10 cm below the surface. In case lime is found to be lacking, powdered lime must be dug in at rate of 210 gm/m^2. If this preparation is made during September to November the ground should be allowed to lie fallow through the winter. In the spring surface should be again carefully tested for level with a straight edge and spirit-level, so that any inequalities may be made up, the upper 4 inches of the soil is then made as fine as possible by repeating rakings and through rollings, until the surface is firm.

8.3 Sowing of grass roots

Grass roots (Cynadon dactylon or a local genus, approved by the Landscape Architect) shall be obtained from a grass patch, seen and approved beforehand by the contracting officers. The grassroots stock received at the site shall be manually cleaned of all weeds and water sprayed over the same after keeping the stock in a place protected sun and dry winds.

8.4 Execution

Small roots shall be dibbled about 15 cm apart in to the prepared grounds.

Grass areas will only be accepted as reaching practical completion when germination has proved satisfactory and all weeds have been removed.

8.5 Maintenance

As soon as the grass is approximately an inch high it shall be rolled with a light wooden roller- in fine, dry weather- when it has grown to 5 – 8 cm above the ground weeds must be removed and regular cutting with the scythe and rolling must be begun A top- dressing of an ounce of guano to the square yard on well decomposed well broken cow dung manure will help on the young grass. The scythe must continue to be used for several months until the grass is sufficiently secure in the ground to bear the moving machine. It should be possible to use the mower in September, but the blades must be raised an inch above the normal level for the first two or three cuttings. That is titnches, the grass should be cut so that it is from 2.5 to 5 cm in length, instead of the 1.5 to 2.0 cm of an inch necessary for manure grass.

In the absence of rain, the lawn shall be watered every five to ten days heavily, soaking the soil through to a depth of at least 25cm.

Damage, failure or dying back of grass due to neglect of watering specially for seeding out of normal season shall be the responsibility of the contractor.

Any shrinkage below the specified levels during the contract or defects liability period shall be rectified at the contractor's expense.

The contractor is to exercise care in the use of rotary cultivator and moving machines to reduce to minimum the hazards of flying stones and brickbats. Al rotary mowing machines are to be fitted with safety guards.

8.6 Rolling

A light roller shall be used periodically taking care that the lawn is not too wet sodden.

Rolling shall not be restored to, to correct the levels, in case certain depression are formed due to watering.

8.7 Edges

These shall be kept neat and must be cut regularly with the edging shears.

8.8 Fertilizing

The lawn shall be fed once a month with liquid manure prepared by dissolving 45 grams of ammonium sulphate in 5 liters of water.

8.9 Watering

Water shall be applied at least once in three days during dry weather. Water whenever done should be thorough and should wet the soil at least up to a depth of 20 cms.

8.10 Weeding

Prior to regular mowing the contractor shall carefully remove rank and unsightly weeds.

APPENDIX D

Recommendations on preparatory operations

1. Site Enclosure

All fencing should be maintained in good and effective condition until the work is completed. The type of fencing used all depend on a number of fencing used will depend on a number of

factors, e.g. the location of the site. the likelihood of vandalism by children or other, and the degree of danger to persons accidentally trespassing. Urban sites are more likely to need protection than rural ones, and in some cases the latter may not need fencing at all. The following types of fence are considered suitable:

(1) 1.20m to 1.80 Shisham or Teak fencing

(2) 1.20m to 2.10 chain link fencing complying with, Part 1.

2. Existing Services

The location of all service runs, such as water supply, gas, electricity(overhead or groundwater), telephones and drainage should be ascertained before work is started and marked up on a plan, giving position, size and depth. Where they will affected by excavation, or where machines may be working nearby, they should be carefully sealed off, protected and diverted. In most cases it will be necessary to obtain the approval and assistance of the statutory undertakings and local authorities concerned.

3. Existing Vegetation

Protection

Where book is carried out near existing vegetation which is to retained it should be protected from damage with 1.20m cleft chestnut fencing or similar. This should be maintained in good and effective condition until the work is completed. Fencing to protect trees should coincide, as far as is practicable, with the spread of the branches, or in the case of fastigiated trees with a radius of half the height of the tree. Material should never be stacked with in the root spread of trees. Normal maintenance should be carried out within fenced areas during the execution of the work. Areas of grass to be cut for turf should be treated during the growing period with weed-killer and should be kept well mown before filling. Where work is done by contract, a penalty clause should be inserted to cover damage done to trees and shrubs.

Remedial Work

Existing plants and grass included in the landscape plan, which have been neglected, should be restored to a healthy condition and shapely habit. Accidental damage which occur during the execution of the work should be carefully repaired. Tree work described in.

Preparation for moving

Trees and large shrubs which are to be transplanted normally require preparation some time in advance. Advice on this subject is given in. Turf to be stripped for use elsewhere be left in situ and not lifted until the site on which iris to be laid has been prepared; the area of turf to be lifted should be divided into parallel strips 300mm wide with a half -moon edging iron or turf race. Each strip is then divided in the same way into suitable lengths (usually 1m) for lifting with a turf lifting iron. Alternatively, for large areas, turf may be cut with a turf cutting machine. The aim should be to produce a turf 25mm or 40mm thick, and of even thickness throughout. If hand lifting, it is better to take up a thicker turf which can subsequently be reduced in thickness in a turf gauge box. The turves can then be rolled or folded and stacked ready for moving.

Vegetation to be cleared

Long grass and weeds should be cut, and trees, hedges and other plants not required should be cleared and the roots grubbed out. The material arising should be burned clear of existing trees and the ash spread on site, or carted away if burning is not permitted (or practicable). Clearance f tree stump is described in.

4. Stripping

In certain cases it is necessary to strip the topsoil. This will occur when the area is to be occupied by buildings, roads of other hard surfaces, when major changes of level are required, or when the soil is likely to suffer damage from building or engineering activities. In such case the full depth of topsoil should be carefully stripped and strict precaution taken to prevent it becoming mixed with subsoil or other deterious materials. While topsoil is stacked, measures should be taken to ensure that weed control by spraying with total or appropriate selective weed killers is carried out during the growing season to prevent weeds seeding. Alternatively the appearance of heap may be improved, and weeds suppressed, by sowing a short-term crop of Italian rye grass.

5. Existing Artefacts

To be retained

If work is to be undertaken close to existing building, paved area and special structures to be retained, they should be protected from damage with 1.20 m Shisham or Teak fencing.

Materials For Reuse

Before starting demolished, any stone, brick, clay tiles, paving slabs, granite sets or other materials suitable for reuse should be carefully taken up and stacked on site until required or removed by agreement.

Demolition

Building, walls, roads foundation, disused drain, manholes and any other construction not required should then be demolished and removed to the following minimum depths below finished levels:

Grass area	450 mm
Ground cover perennial planting area	450 mm
Shrub planting area	600 mm
Tree planting (within 2 m of tree station)	900 mm

All unwanted material should be off site. Below the depths given, concrete slabs or other impervious layers should be broken up to allow free drainage. When sub soiling and drainage operations are to be carried out involving depths below those mentioned above, then consideration should be given to the need to demolish to lower levels.

Rubbish

All rubbish should be collected and disposed of either by burning 10 m clear of the spread of existing trees or any areas to be grassed down, or by carting off site.

ADDITIONAL SPECIFICATIONS FOR PREPARATORY OPERATIONS

Site Enclosure

Temporary fencing

Allow for providing temporary fencing if required to enclose any portion of the site during the carrying out of the work with gates in same, as necessary; alter and adapt from time to time and remove at completion.

Most landscape work can be satisfactorily protected by cleft chestnut pale fencing, and extracts from the British Standard are given later. When higher security measures are required chain link fencing should used; because of its more permanent nature and the extra expense involved, it should where possible be sited so as to from the permanent perimeter fence.

7. Existing Services

Not with standing any information which the landscape architect may make available to the contractor, either verbally or by the production of record plans purporting to show the position of existing water, gas, cable TV, electricity and post office mains, service connections, private pipelines etc., it shall be the responsibility of the contractor to satisfy himself by his own independent observation and enquiries as to any omission from or the accuracy or otherwise of the information provided, in so far as it affects his contract area.

The contractor shall make all the necessary arrangements for the diversion, if necessary, of any such existing services required for the purpose of the contract, or otherwise, and shall allow for upholding and temporarily supporting, repairing and maintaining any such service, if and as encountered during the progress of the works, pending the decision of the employer concerned as to their diversion or otherwise as may be appropriate. No Scaffolding, props, staging, ropes, supports other than required for the temporary support of such services, shall be fixed or attached to them and the contractor shall accept responsibility arising from the presence of such main, cables etc.

Any damage to service caused by the contractor or his subcontractors in the course or in consequence of the contract operation shall be made good at the expense of the contractor.

In the event of existing work being disturbed through any cause whatsoever, the contractor shall immediately draw the landscape architect's attention verbally, and subsequently in writing, to the nature of this disturbance in order that the employer may be informed forthwith.

8. Temporary Works

The contractor shall provide, maintain and remove on completion of the works all temporary works for carrying out the contract, including roadways, sleeper track, staging etc. over roads, footpaths, cycle tracks, streams or unstable ground, fencing, hoardings, footways, guard rail, barriers, gantries and the like, and shall make them safe and suitable in every respect to carry all plant required for the work or for providing access and to secure adequate protection of the public in their legal use of the adjacent paths, roads, pavements and buildings and to comply with the applicable bylaws, regulations or instruction of any authority concerned. All temporary work shall be constructed and maintained to the satisfaction of the landscape architect.

9. General Protection And Reinstatement

The contractor shall allow for safeguarding and protecting against damage due to the carrying out of the contract all existing and completed works (by others on the site such as fences and gates, paving, manhole covers and kerbs. In this connection the contractor should particularly note, when visiting the site, the width and construction of any existing carriageways and the nature and construction of any other existing works. The contractor will be held responsible for maintaining the nature of existing verges, embankments, cutting, terraces and the like. Should any damage or loss be caused to any existing or completed works due to or arising from the performance of the contract then the contractor will be required to reinstate and make good such damage or loss at his own expense and to the satisfaction of the landscape architect.

All fences, walls, footpaths, or other routes which may be injured during the execution of the work shall be properly restored to the satisfaction of the landscape architect, at the expense of the contractor.

The contractor shall avoid nuisance to neighbouring owners and occupiers by keeping the amount of noise to a minimum and confining it to reasonable hours. He shall also reduce the amount of dust by suitable timing of his operation and/or by keeping the site watered, as and when necessary.

Wherever ground is temporarily disturbed by the contractor during the course of his contract operations it shall be restored by him to its original state and form, or to such other appropriate state and form as shall be approved by the landscape architect.

10. Existing Vegetation

Protection

No existing trees, shrubs or other plants shall be removed or cut without specific instructions. The landscape contractor shall take all precautions to protect, in the course of his work, all existing plant materials from malicious or accidental damage and shall ensure that no branches shall be lopped and no roots over 50 mm diameter shall be served from growing trees, without express prior permission.

No soil, spoil, constructional materials or rubbish shall be stored or tipped within the spread of existing trees, shrubs or hedges and no bonfires shall be lit in any situation where they can cause damage to existing trees, shrubs or hedges. The landscape contractor must cover up and/or protect from injury from any cause, all new work, materials and plants. He must also supply any other requisite protection for the whole of the works executed, whether by himself or special tradesmen or subcontractors, and any damage caused must be made good by the landscape contractor at his own expense.

Remedial work and liability to damage

Should any tree which it is intended to preserve be uprooted, destroyed, or in the opinion of the landscape architect be damages beyond reasonable chance of survival in its original shape owing to the contractor's negligence, then the contractor shall without charge to employer provide and plant suitable replacement trees or shrubs of a similar type and age. If such replacement trees or shrubs are not obtainable other trees or shrubs, selected by the landscape architect, shall be provided and planted. The contractor's liability shall continue until the replacement trees and shrubs have survived the winter following the planting and have completed satisfactorily the following summer's growth.

Vegetation to be cleared

When burning of vegetation is not permitted, all material is to be carried away to a tip provided by the contractor.

Felling shall be the complete removal of a tree, including the removal of the stump to a specified depth below ground by hand or machine hacking, grubbing out, or(in exceptional circumstances and with prior permission) burning. it shall include the chemical killing of any stump or roots remaining. It shall include the careful taking down in sections of any large trees in confined spaces, or near to buildings or to other trees which are to be retained.

Grubbing shall include the complete removal of tree stumps and roots over 100 mm diameter by hand or machine excavation, winching or other mean. It shall include the chemical killing of any stump or roots which require such treatment.

Scrub clearance shall be the removal of scrub, bushes undergrowth, saplings and seedling from a specified area of the site by hand or mechanical means. It shall include the grubbing up of all stumps and roots run which can be taken out without undue removal of top soil. It shall be taken to include also the partial clearance of an area in which selected saplings, bushes, shrubs are to be retained. In such case the selected plants to be preserved shall have clearly marked or otherwise indicated on site.

11. Soil Stripping

Topsoil and subsoil shall be stripped to a total depth of 900 mm and each stacked separately in the area directed by the landscape architect.

Topsoil shall be stacked in spoil heaps not more than 1.25 m high and shall not remain unused for more than 12 month unless work is undertaken to turn the soil over to prevent it becoming stale. Weed growth on topsoil heaps shall be controlled by mechanical or approved chemical mean, to prevent soil becoming polluted with weed seeds.

12. Existing artefacts

Preservation of features

The contractor shall allow for taking all reasonable and necessary precautions to safeguard existing features. He shall make good at his own expense and reinstate or restore to the satisfaction of the landscape architect, any damage done to existing structures, path, fences and natural feature on or off the site, in the course of executing the contract.

Material for possible reuse

Any stone, brick, clay pavers, granite sets or other surfacing materials shall be taken up, wheeled and stacked on site for possible reuse. No such materials, at whatever stage they are found, shall be removed from the site without written permission from the landscape architect.

Materials arising from site works

Should suitable sand, gravel, hardcore or aggregate be found in the excavation, the landscape architect may require the contractor to use the same in the work in substitution for material the contractor would otherwise have provided. In this event the material shall be paid for by the contractor at an agreed price.

The employer reserves the right to dispose of any surplus sand, gravel, hardcore, aggregate or topsoil in any way he wishes, or to direct the contractor to deal with it as ordinary excavated material for disposal on site.

13. Rubbish

All rubbish, including that of subcontractors and special tradesmen, is to be immediately cleared and carted away as it accumulates during the progress of the contract. At completion the site is to be left in a clean and tidy condition.

All materials condemned by the landscape architect are to be removed immediately at contractor's own expense.

The contractor shall be responsible for providing a temporary tip and for meeting all costs arising there from.

No temporary spoil or rubbish heaps are to be formed over the rooting area of trees or shrubs.

The location and timing of the burning of rubbish in bonfires shall be subject to the landscape architect's approval. Bonfires shall not be situated on the windward side of trees, or any closer than 18m to the outmost spread of tree branches.

B. Restrictive covenants or deed restrictions

APPENDIX E

LIST OF ANIMALS FOUND IN INDIAN ZOOS

MAMMALS

S. No.	Common Name	Scientific Name
1	African Cape Buffalo	*Syncerus caer*
2	African Elephant	*Loxodonta africana*
3	Antelope, Four Horned/Chowsingha	*Tetraceros quadricomis*
4	Asian Elephant	*Elephas maximus*
5	Asiatic Wild Ass	*Equus hemionus khur*
6	Bear, Himalayan Black	*Selenarctos thibetanus*
7	Binturong Or Bear Cat	*Arctictis binturong*
8	Black Bear	*Ursus americanus*
9	Black Buck / Krishna Mrig	*Antelope cervicapra*
10	Bonnet Macaque	*Macaca radiata*
11	Brown Capuchin	*Cebus apella*
12	Cat-Golden	*Catopuma temmincki*
13	Cheetah	*Acinonyx jubatus*
14	Chimpanzee	*Pan troglodytes*
15	Chinkara	*Gazella bennetti*
16	Civet, Common Palm / Cat Toddy	*Paradoxurus hermaphroditus*
17	Civet, Small Indian	*Viverricula indica*
18	Common Otter	*Lutrinae*
19	Deer Barking-Muntjac (Kakkar	*Muntiacus muntjak*
20	Deer- Swamp / Brasingha	*Cervus duvauceli*
21	Deer, Brow Antlered / Sangai	*Cervus eldi*
22	Deer, Mouse	*Tragulus memmina*
23	Deer-Sangai	*Rucervus eldii eldii*
24	Dhole Or Indian Wild Dog	*Cuon alpinus*
25	European Brown Bear	*Ursus arctos arctos*
26	Fishing Cat	*Prionailurus viverrinus*

S. No.	Common Name	Scientific Name
27	Fox Common	*Vulpes bengalensis*
28	Gaur	*Bos gaurus*
29	Giant Fruit Bat	*Pteropus giganteus*
30	Giraffe	*Giraffa camelopardalis*
31	Goral	*Nemorhaedus goral*
32	Greater One Horned Rhinoceros	*Rhinoceros unicornis*
33	Hamadryas Baboon	*Papio hamadryas*
34	Hare Indian	*Lepus nigricollis*
35	Hedge Hog (Asian)	*Erinaceinae*
36	Hippopotamus	*Hippopotamus amphibius*
37	Hog Deer	*Axis porcinus*
38	Hoolock Gibbon	*Hylobates hoolock*
39	Hyena	*Hyaenidae*
40	Indian Gaint Squirrel	*Ratufa indica*
41	Indian Porcupine	*Hystrix indica (Vulpes bengalensis)*
42	Jackal	*Canis aureus*
43	Jaguar	*Panthera onca*
44	Jungle Cat	*Felis chaus*
45	Langur-Common	*Presbytis entellus*
46	Leopard / Panther	*Panthera pardus*
47	Leopard Cat	*Felis bengalensis*
48	Leopard Cat	*Prionailurus bengalensis*
49	Lion Asiatic	*Panthera leo persica*
50	Lion Hybrid	*Panthera leo*
51	Lion Tailed Macaque	*Macaca silensus*
52	Loris Slow	*Nycticebus*
53	Macaque- Stump Tailed	*Macaca arctoides*
54	Macaque-Assamese	*Macaca assamensis*
55	Mangoose Common	*Herpestes edwardsi*
56	Marmoset White Eared	*Callithrix jacchus*
57	Monkey Squirrel	*Saimiri sciureus*
58	Mouse Deer	*Tragulus kanchil*

S. No.	Common Name	Scientific Name
59	Nile Hippopotamus	
60	Nilgai / Blue Bull	*Boselaphus tragocamelus*
61	Nilgiri Langur	*Trachypithecus johnii*
62	Olive Baboon	*Papio anubis*
63	Orang Utan	*Pongo pygmaeus*
64	Otter Smooth Indian	*Lutrogale perspicillata*
65	Pangolin	*Manis crassicaudata*
66	Pig Wild/Wild Boar	*Sus scrofa*
67	Pigmy Hippopotamus	*Choeropsis liberiensis*
68	Porcupine	*Hystricidae*
69	Ratel	*Mellivora capensis*
70	Rat-White	*albino*
71	Red Lechwe	*Kobus leche leche*
72	Red Patas Monkey	*Erythrocebus patas*
73	Rhesus Macaque	*Macaca mulatta*
74	Rhinoceros	*Rhinocerotidae*
75	Royal Bengal Tiger	*Panthera tigris tigris*
76	Royeal Bengal Tiger (White)	*Panthera tigris tigris*
77	Sacred Baboon	*Papio hamadryas*
78	Sambar Deer	*Cervus unicolor*
79	Savanna Baboon	
80	Sikka Deer	*Cervus nippon*
81	Sloth Bear	*Melursus ursinus*
82	Slow Loris	*Nycticebus coucang*
83	Spotted Deer Or Chital	*Axis axis*
84	Striped Hyena	*Hyaena hyaena*
85	Stump Tailed Macaque	*Macaca speciosa*
86	Sun Bear	*Helarctos malayanus*
87	Swamp Deer	*Rucervus duvaucelii*
88	Thamin Deer	*Rucervus eldii*
89	White Buck	*Antilope cervicapra*
90	Wild Dog	*Lycaon pictus*

S. No.	Common Name	Scientific Name
91	Wolf	*Canis lupus pallipes*
92	Zebra	*Equus burchelli*
93	Zebra Grant	*Equus burchellii bohmi*

LIST OF ANIMALS AND BIRDS FOUND IN INDIAN ZOOS

BIRDS

S. No.	Common Name	Scientific Name
1	Adjutant Stork	*Leptoptilos dubius*
2	Budgerigar	*Melopsittacus undulatus*
3	Buzzard	*Buteo buteo*
4	Canary	*Serinus canaria*
5	Cassowary	*Casuarius*
6	Cassowary, Southern (Double Wattled	*Casuarius casuarius*
7	Cattle Egret	*Bubulcus ibis*
8	Cockatiel	*Nymphicus hollandicus*
9	Cockatiel, White/ Cinamon Pears Pied	*Nymphicus hollandicus*
10	Cockatoo	*Cacatuidae*
11	Cockatoo Moluccan /Salmoncrested	*Cacatua moluccensis*
12	Cockatoo, Lesser Sulphur Crested	*Cacatua slphurea*
13	Connure Brown Throated	*Eupsittula pertinax*
14	Connure Jandaya	*Aratinga jandaya*
15	Conure Pine Apple	
16	Conure Sun	*Aratinga solstitialis*
17	Conure Yellow Sided	
18	Coot	*Fulica*
19	Crane -Common	*Gruidae*
20	Crane Sarus	*Grus antigone*
21	Darter Or Snake-Bird	*Anhinga*
22	Demoiselle Crane	*Grus virgo*
23	Dove	*Columbidae*
24	Dove Barbary	*Spilopelia chinesis*

S. No.	Common Name	Scientific Name
25	Dove Laughing	*Spilopelia senegalnesis*
26	Dove, Diamond	*Geopelia cuneata*
27	Dove, Emerald	*Chalcophaps indica*
28	Dove, Ring Necked	*Streptopelia capicola*
29	Dove, Spotted	*Spilopelia chinesis*
30	Duck - Brahmini	*Tadorna ferruginea*
31	Duck Moscovy	*Cairina moschata*
32	Duck, Mandarin	*Aix galericulata*
33	Ducks	*Anatidae*
34	Eagle Crested Serpent	*Spilornis cheela*
35	Eagle Stappee	*Sp*
36	Eagles	*Haliaeetus leucocephalus*
37	Egret Large	*Cosmerodius albus*
38	Egret Little	*Egretta garzetta*
39	Egret, Median	*Egretta intermedia*
40	Egrets	*Ardea alba*
41	Emu	*Dromaius novaehollandiae*
42	Falcated Duck	*Anas falcata*
43	Finch, Bengalese/ Society	*Lonchura striata*
44	Finch, Long Tailed	*Poephila cincta*
45	Finch, Star	*Poephila ruficauda*
46	Finch, Zebra	*Poephila guttata*
47	Gadwall	*Anas strepera*
48	Geese	*Branta canadensis*
49	Goose- Domesticated	*Anser anser domesticus & Anser cygnoides domesticus Linnaeus*
50	Goose-Bar Headed	*Anser indicus*
51	Grey Heron	*A rdea cinerea*
52	Grey Partridge	*Perdix perdix*
53	Helmet Guinefowl	*Numido meleagris*
54	Heron Grey	*Ardea cinerea*
55	Herons	*Ardeidae*
56	Hombill - C0mm0n Grey	*Bucerotidae*

S. No.	Common Name	Scientific Name
57	Horn Bills	*Bucerotiformes*
58	Hornbill -Great Indian/Great Pied	*Buceros bicornis*
59	Hornbill Grey	*Ocyceros birostris*
60	Hornbill -Indian Pied	
61	Ibis, White	*Threskiornis aethiopica*
62	Indian Peacock	*Pavo cristatus*
63	Kite	*Milvus migrans*
64	Kite - Black Winged	*Elanus caeruleus*
65	Kite Black	*Milvus migrans*
66	Kite Bramhiny	*Haliastur indus*
67	Kite -Common Pariah	
68	Koel	*Eudynamys scolopacea*
69	Lbis - Black	*Pseudibis papillosa*
70	Lesser Adjutant	*Leptoptilos javanicus*
71	Little Cormorant	*Microcarbo niger*
72	Lories	*Loriini*
73	Lorikeet - Blue Faced	*Trichoglossus haematodus enetermedius*
74	Lorikeet, Swainson's	*Trichoglossus haematodus moluccanus*
75	Lorry Red Chattering	*Eos bornea or Eos rubra*
76	Lorry Yellow Backed	*Lorius garrulus flavopalliatus*
77	Love Bird, Fischers	*Agapornis fischeri*
78	Love Bird, Masked	*Agapornis personatus*
79	Love Bird, Peach-Faced	*Agapornis roseicollis*
80	Love Birds	*Agapornis*
81	Macaw	*Ara ararauna*
82	Macaw - Blue & Yellow	*Ara ararauna*
83	Macaw - Green Winged	*Ara chloroptera*
84	Macaws	
85	Mallard	*Anas platyrhynchos*
86	Moor Hen- Indian	*Gallinula chloropus*
87	Munia Black Headed	*Lonchura malacca*
88	Munia Green	*Estrilda formosa*
89	Munia Red	*Estrilda amandava*

S. No.	Common Name	Scientific Name
90	Munia Spotted	*Lonchura punctulata*
91	Munia, Spotted / Nutmeg Mannikin	*Lonchurapunctulata*
92	Mynah Hill	*Gracula religiosa*
93	Night Heron	*Nycticorax nycticorax*
94	Ostrich	*Struthio camelus*
95	Owl Barn	*Tyto alba*
96	Owl Great Horned	*Bubo bubo*
97	Owl- Screech	*Megascops asio*
98	Owl, Brown Fish	*Bubo zeylonesis*
99	Owl, Oriental Scops	*Outs sunia*
100	Owl-Indian Great Horn	*Bubo bengalensis*
101	Owls	*Strigiformes*
102	Parakeet- Blossom Headed	*Psittacula roseata*
103	Parakeet Large Indian	*Psittacula eupatria*
104	Parakeet Red Breasted	*Psittacula krameri*
105	Parakeet, Alexandrine	*Psittacula eupatria*
106	Parakeet, Blossom Headed	*Psittacula cyanocephala*
107	Parakeet, Mostach / Indian Red Brested	*Psittacula alexandri*
108	Parakeet, Rose Ring	*Psittacula krameri*
109	Parakeets	*Melopsittacus undulatus*
110	Parrot African Grey	*Psittacus erithacus*
111	Parrots	*Psittaciformes*
112	Partridge Grey	*Francolinus pondicerianus*
113	Peafowl, Indian	*Pavo cristatus*
114	Peafowl, Indian White	*Pavo cristatus*
115	Pelican Grey/Spot Billed	*Pelecanus philippensis*
116	Pelican Rosy / White	*Pelecanus onocrotalus*
117	Pelicans	*Pelecanus*
118	Pheasant Kaleej	*Lophura leucomelanos*
119	Pheasant Silver	*Lophura nycthemera*
120	Pheasant Yellow Golden	*Chrysolophus pictus mut.*
121	Pheasant - Golden	*Chrysolophus pictus*
122	Pheasant - Lady Amherst	*Chrysolophus amherstiae*

S. No.	Common Name	Scientific Name
123	Pheasant - Reev's	*Syrmaticus reevesii*
124	Pheasant - Ring Necked	*Phasianus colchicus*
125	Phesant Kalij Indian	*Lophura leucomelana*
126	Pigeon - Common Green	*Columbidae*
127	Pigeon Nicobar	*Caloenas nicobarica*
128	Pintal Northern	*Anas acuta*
129	Pochard	*Aythya ferina*
130	Pochard Red Crested	*Netta rufina*
131	Pond Heron	*Ardeola*
132	Red Jungle Fowl	*Gallus gallus*
133	Rosella - Eastern	*Platycercus eximius*
134	Shikra	*Accipiter badius*
135	Sparrow Java	*Padda oryzivora*
136	Spoonbill	*Plataleinae*
137	Spoonbill White	*Platalea leucorodia*
138	Spoonbill White Eurasian	*Platalea leucorodia*
139	Stork Black Necked	*Xenorhynchus asiaticus*
140	Stork Lesser Adjutant	*Leptoptilos javanicus*
141	Stork Open Billed	*Anastomus oscitans*
142	Stork Painted	*Ibis leucocephalus*
143	Stork Painted	*Mycteria leucocephala*
144	Stork - Black Necked	*Ephippiorhynchus asiaticus*
145	Stork - White Necked/Wooly Necked	*Anastomus oscitans*
146	Storks	*Ciconiidae*
147	Swan Black	*Cygnus atratus*
148	Swan Mute	*Cygnus olor*
149	Temminck's Tragopan	*Tragopan temminckii*
150	Turaco, Living Stone's	*Turaco living stonii*
151	Turaco - Violet	*Musophaga violacca*
152	Vulture Cinereous	*Aegypius monachus*
153	Vulture Long Billed	*Gyps indicus*
154	Vulture White	*Neophron percnopterus*
155	Whitebacked Or Bengal Vulture	*Gyps bengalensis*
156	White - Crested Cockatoo	*Cacatua alba*

APPENDIX F

Equipment for Disaster & Emergency Store

1. Equipments required for dealing with the disaster:

    a) Alarm system

    b) Public address system

    c) Radio communication

    d) Rubber boots/gloves

    e) Helmets

    f) Shovels

    g) Pick Axe

    h) Welding cutting machine and gas cutter

    i) Portable chain saw

    j) Portable generator

    k) Portable pumping set

    l) Ropes & nets

m) Portable cages

n) Construction material

o) Chain link, angles, clamps, iron rods and cement

p) Tractor-trolley and portable earth removing equipment

q) Fire-proof dress and goggles

r) Wooden planks, poles & bamboos

s) Torches and search lights

t) Consumables like diesel oil/petrol, batteries etc.

u) First aid equipments and drugs etc.

v) Spread out in multiple numbers at suitable locations.

APPENDIX F

List of Approved Manufactures

For Civil Works

Specifications /brands names of materials (Refer materials, whichever are applicable for the scope of work) and finishes approved by the engineer in charge are listed below. However approved equivalent materials and finishes of any other specialized firms may be used, in case it is established that the brands specified below are not available in the market and subject to approval of the alternate brand by the Engineer in charge.

S.no	Description Of Items	Approved Manufacturer.
1.	Cement	A.c.c, Ultra Tech, Gujrat Ambuja, Vikram, Jp Rewa, Shree Cement, J. K. Cement.
2	White Cement	J.K. Birla
3	Chlorpyriphos	De Nocil, Aimco
4	Water Proofing Compound (Liquid)	Pidlite, , Fosroc, Snowcem India, MYK Schomburg, Basf
5	Reinforcement Steel	Tisco, Sail, Rinl, Jindal
6	Structural Steel	Tisco, Sail, Rana
7	Stainless Steel	Salem Stssl, Jindal, Sail
8	Friction Stays	EBCO or Equivalent
9	Non Shrink Grout	Bal Endura, Pidilite, Fosroc
10	Pigment	Sudershan Chemical Industries Ltd. Tata Pigment

S. No	Description Of Items	Approved Manufacturer.
11	Hardeners	Ironite, Ferrok, Hardonate
12	Interlocking Paver Blocks	KK,Unitile, Swastik, Nitco, Nimco
13	Reflective Hard Coated Glass	Glaverbel, St.gobain
14	Plywood	Archid, Kitply, Green Ply, Century, Sarda Plywood/ Duro Ply (Mr Grade)
15	Aluminium Hardware	Earl Bihari, Ecie, Crown, Savex
16	Stainless Steel Screws	Kundal, Arrow
17	Hardware & Brassware	Shalimar, Indo-Brass, Amarbhoy Dossaji, Earl Bihari, Savex
18	Float Glass	St. Gobain, Modiguard, Hindustan Pilington
19	Distember & Paints	Ici, Asian Paints, Berger Paints, Nerolac
20	Putty	Goldsize Putty By Shalimar Paintsm Ltd./Asian
21	Kerb Stone	Kk, Nitco, Swastic, Unitile
22	Upvc Stone / Pve Pipe	Finolex, Kisan, Supreme, Prince, Polypack
23	Anchor Fasteners	Hilti, Fischer
24	Ceramic Glazed Tiles	M/S H.r. Jonson (I) Ltd, M/S Oarasyran Oittert Wirk, M/S Jaharua Ceranuc, M/S Rogancy Cermamic
25	Vitrified Tiles	M/S H. R. Jonson (I) Ltd – (Marbonite) & M/S Bell Ceramic Ltd.-(Marbogranit)
26	Polycarbonate Sheet	Ge, Danpal
27	Aluminium Extrusions	Hindalco, Jindal Industries
29	Glass Brick	Poesia Glass Ltd, Mouk Colour Glass Pvt. Ltd & Matrix Ceramic Industry
30	Glass Mosaic Tile	Palladio, Bizzaza
31	Precoated G.i. Sheet	Tata Blue Scope , Colour Roof India Ltd,Loyd Insulations (India) Ltd

S. No	Description Of Items	Approved Manufacturer.
32	M.s. Pipe	Tata, Jindal Hissar, Surya
33	Sports Flooring	Parquet Furnishers Pvt. Ltd, Surface India Flooring Pvt. Ltd, Exotic Décor Pvt. Ltd., Bvg Industries Ltd.
34	Expansion Joint System	Sanfield
35	Floor Springs, Frameless Glass Fittings, Handles	Doorset, Dorma & Trium
36	Panic Latch	Briton
37	Fire Rated Shutter	Navair
38	Laminated Partical Board	Mdf, Novapan, Archid Ply

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List of Indian Zoos

Sl.	Zoo Name	City	State	Category
1	A.N. Jha Deer Park	Hauz khas (New Delhi)	Delhi	Mini Zoo
2	Adina Deer Park	Malda	West Bengal	Mini Zoo
3	Agra Bear Rescue Facility	Agra	Uttar Pradesh	Rescue Center
4	Aizawl Zoo (Mizoram Zoo)	Aizwal	Mizoram	Small Zoo
5	Alipore Zoological Garden	Kolkata	West Bengal	Medium Zoo
6	Ambardi Wildlife Interpretation Zone (Ambardi Safari Park)	Amreli	Gujarat	Mini Zoo
7	Amirdhi Zoo	Vellore	Tamil Nadu	Small Zoo
8	Amtes Animal Ark	Gadchiroli	Maharashtra	Rescue Centre
9	Arignar Anna Zoological Park	Vandalur, Chennai	Tamil Nadu	Large Zoo
10	Assam State Zoo Cum Botanical Garden	Guwahati	Assam	Large Zoo
11	Aurangabad Municipal Zoo	Aurangabad	Maharashtra	Small Zoo
12	Bannerghatta Biological Park	Bengaluru	Karnataka	Large Zoo
13	Bardhaman Zoological Park (Ramnabagan Mini Zoo)	Burdwan	West Bengal	Small Zoo
14	Bellary Childrens Park-Cum-Zoo (Bellary Zoo)	Bellary	Karnataka	Small Zoo
15	Bhagwan Birsa Biological Park	Ranchi	Jharkhand	Medium Zoo
16	Bijni Deer Park	Bongaigaon	Assam	Mini Zoo
17	Biological Park, Chidiyatapu	Port Blair	Andaman & Nicobar Islands	Small Zoo
18	Biological Park, Itanagar	Itanagar	Arunachal Pradesh	Small Zoo
19	Birsa Mrig Vihar	Kalimati	Jharkhand	Mini Zoo
20	Bondla Zoo	Usgao	Goa	Small Zoo
21	Centre For Bear Rehabilitation And Conservation	Pakke	Arunachal Pradesh	Rescue Centre
22	Centre For Wildlife Rehabilitation And Conservation	Golaghat	Assam	Rescue Center
23	Ch. Surinder Singh Elephant Rescue Centre	Bansantour	Haryana	Rescue Centre
24	Chennai Snake Park Trust	Guindy, Chennai	Tamil Nadu	Small Zoo
25	Children Park & Binkadakatti Zoo (Gadag Zoo)	Gadag	Karnataka	Small Zoo
26	Childrens Park	Guindy, Chennai	Tamil Nadu	Medium Zoo
27	Deer Park At Shri Kshetra Sogal, Soudatti	Belgaun	Karnataka	Mini Zoo
28	Deer Park At Udhagamandalam (Ooty)	Udhagamandalam	Tamil Nadu	Mini Zoo
29	Deer Park, Bir Moti Bagh (Patiala Zoo)	Patiala	Punjab	Small Zoo
30	Deer Park, Bir Talab	Bhatinda	Punjab	Mini Zoo
31	Deer Park, Chittoor	Chittoor (East) Division	Andhra Pradesh	Mini Zoo
32	Deer Park, Cuttack Municipal Corporation	Cuttack	Odisha	Mini Zoo
33	Deer Park, Hissar	Hissar	Haryana	Mini Zoo
34	Deer Park, Kandaleru	Kandaleru	Andhra Pradesh	Mini Zoo
35	Deer Park, Kesoram Cement	Basant nagar	Telangana	Mini Zoo
36	Deer Park, N.M.D.C. Ltd.	Donimalai	Karnataka	Mini Zoo
37	Deer Park, Narain Tewari Dewal (Almora Zoo)	Almora	Uttarakhand	Mini Zoo
38	Deer Park, Neelon	Ludhiana	Punjab	Mini Zoo
39	Deer Park, NFCL Green Belt	Kakinada	Andhra Pradesh	Mini Zoo
40	Deer Park, Papadahandi	Nawarangpur	Odisha	Mini Zoo
41	Deer Park,Jawahar Lake Tourist Complex	Shamirpet	Telangana	Mini Zoo
42	Deer Park,Thenzawl	Thenzawl	Mizoram	Mini Zoo
43	Dhauladhar Nature Park	Gopalpur	Himachal Pradesh	Small Zoo
44	Dr. K.Shivarma Karanth Pililkula Biological Park	Mangalore	Karnataka	Large Zoo
45	Dr. Shyamaprasad Mukharjee Zoological Garden	Surat	Gujarat	Medium Zoo
46	Gandhi Zoological Park	Gwalior	Madhya Pradesh	Small Zoo
47	Gar Chumuk (Ulughata) Deer Park	Howrah	West Bengal	Mini Zoo
48	Gharial Research & Conservation Unit	Tikarpara	Odisha	Mini Zoo
49	Harinalaya at Eco Park (Nature Park At Taratola Road)	Kolkata	West Bengal	Rescue Center
50	Harishankar Deer Park	Balangir	Odisha	Mini Zoo
51	Himalayan Nature Park	Kufri	Himachal Pradesh	Small Zoo

Sl.	Zoo Name	City	State	Category
52	Himalayan Zoological Park, Bulbuley	Gangtok	Sikkim	Small Zoo
53	Indira Gandhi Park Zoo	Rourkela	Odisha	Small Zoo
54	Indira Gandhi Zoological Park	Visakhapatnam	Andhra Pradesh	Large Zoo
55	Indira Priyadarshini Sangrahalaya, Anagodu	Davangere Taluk	Karnataka	Mini Zoo
56	Indroda Nature Park	Gandhi Nagar	Gujarat	Medium Zoo
57	Jammu Zoo	Ramnagar (Jammu)	Jammu & Kashmir	Mini Zoo
58	Jawaharlal Nehru Biological Park	Bokaro	Jharkhand	Medium Zoo
59	Jungle Mahal Zoological Park	Jhargram	West Bengal	Medium Zoo
60	Kakatiya Zoological Park (Vanavigyan Kendra)	Warangal	Telangana	Small Zoo
61	Kamla Nehru Prani Sanghrahalaya Zoo	Indore	Madhya Pradesh	Medium Zoo
62	Kamla Nehru Zoological Garden	Ahmedabad	Gujarat	Large Zoo
63	Kanan Pandari Zoo	Bilaspur	Chhattisgarh	Medium Zoo
64	Kanpur Zoological Park	Kanpur	Uttar Pradesh	Large Zoo
65	Kapilash Zoo	Dhenkanal	Odisha	Small Zoo
66	Karimnagar Deer Park	Karimnagar	Telangana	Mini Zoo
67	Kinnerasani Deer Park	Kinnersari	Telangana	Mini Zoo
68	Kittur Rani Chennamma Nisarg Dhama Mini Zoo	Belgaum	Karnataka	Mini Zoo
69	Kodanadu Zoo	Kodanadu	Kerala	Mini Zoo
70	Kota Zoo	Kota	Rajasthan	Small Zoo
71	Kuanria Deer Park, Nayagarh Forest Division	Nayagarh	Odisha	Mini Zoo
72	Kurumbapatti Zoological Park	Salem	Tamil Nadu	Small Zoo
73	Lady Hydari Park Animal Land (Meghalaya Zoo)	Shillong	Meghalaya	Mini Zoo
74	Leopard Rescue Centre	Manikdoh	Maharashtra	Rescue Centre
75	Lion Breeding Centre and Multiple Safari Park, Etawah	Etawah	Uttar Pradesh	Mini Zoo
76	Lion Safari - Vasona	Vasona	Dadra & Nagar Haveli	Mini Zoo
77	Lion Safari Park At Nayyar Dam (Nayyar Mini Zoo)	Thirunvananthapuram	Kerala	Mini Zoo
78	Ludhiana Zoo	Ludhiana	Punjab	Small Zoo
79	Machia Biological Park (Jodhpur Zoo)	Jodhpur	Rajasthan	Small Zoo
80	Madras Crocodile Bank Trust/Centre For Herpetology	Mahabalipuram	Tamil Nadu	Medium Zoo
81	Maharaja Martand Singh Jedeo White Tiger Safari and Zoo, Mukundpur	Satna	Madhya Pradesh	Mini Zoo
82	Maharaja Shahaji Chhatrapati Zoo	Kolhapur	Maharashtra	Mini Zoo
83	Maharajbag Zoo	Nagpur	Maharashtra	Small Zoo
84	Mahatma Gandhi Rashtriya Udyan Zoo	Solapur	Maharashtra	Small Zoo
85	Mahendra Chaudhury Zoological Park	Chhatbir, Chandigarh	Punjab	Large Zoo
86	Maitri Baagh Zoo	Bhilai	Chhattisgarh	Medium Zoo
87	Malsi Deer Park (Dehra Dun Biological Park)	Dehradun	Uttarakhand	Mini Zoo
88	Manipur Zoological Garden	Iroisemba	Manipur	Medium Zoo
89	Marble Palace Zoo	Kolkata	West Bengal	Small Zoo
90	Marudhara Biological Park (Bikaner Zoo)	Bikaner	Rajasthan	Small Zoo
91	Miao Mini Zoo	Miao	Arunachal Pradesh	Mini Zoo
92	Mini Zoo A. M. Gudi Balvana	Chitradurga	Karnataka	Mini Zoo
93	Mini Zoo At Gendekatte	Hassan	Karnataka	Mini Zoo
94	Mini Zoo Cum Children Park	Gulbarga	Karnataka	Mini Zoo
95	Mini Zoo, Bhiwani	Bhiwani	Haryana	Mini Zoo
96	Mini Zoo, Pipli	Pipli	Haryana	Mini Zoo
97	Mini Zoo, Roing	Roing	Arunachal Pradesh	Mini Zoo
98	Nagaland Zoological Park, Rangapahar	Rangapahar	Nagaland	Medium Zoo
99	Nahargarh Biological Park (Jaipur Zoo)	Jaipur	Rajasthan	Medium Zoo
100	Namadachilume Deer Park	Tumkur	Karnataka	Mini Zoo
101	Nandankanan Biological Park	Bhubaneshwar	Odisha	Large Zoo
102	Nandanvan Jungle Safari (Naya Raipur)	New Raipur	Chhattisgarh	Medium Zoo
103	National Zoological Park	Delhi	Delhi	Large Zoo
104	Nawab Wazid Ali Shah Zoological Garden	Lucknow	Uttar Pradesh	Large Zoo
105	Nawabganj Deer Park	Unnao	Uttar Pradesh	Mini Zoo
106	Nehru Park Zoo, Danakgre,Tura	Akhongini Tura	Meghalaya	Small Zoo
107	Nehru Pheasantry	Manali	Himachal Pradesh	Rescue Centre
108	Nehru Zoological Park	Hyderabad	Telangana	Large Zoo
109	Nisargakavi Bahinabai Choudhary Pranisangahalaya	Chinchiwad, Pune	Maharashtra	Small Zoo

Sl.	Zoo Name	City	State	Category
110	North Bengal Wild Animals Park	Jalpaiguri	West Bengal	Mini Zoo
111	Padmaja Naidu Himalayan Zoological Park	Darjeeling	West Bengal	Medium Zoo
112	Parassinikkadavu Reptile Park	Kanur	Kerala	Small Zoo
113	People For Animals - Rescue Centre	Bengaluru	Karnataka	Rescue Centre
114	People For Animals, Shelter House	Wardha	Maharashtra	Rescue Centre
115	Pillalamarri Deer Park	Pillalamarri Complex, Mahabub Nagar	Telangana	Mini Zoo
116	Pt. Govind Ballabh Pant High Altitude Zoo	Nainital	Uttarakhand	Small Zoo
117	Rajiv Gandhi Zoological Park And Wildlife Research Center	Pune	Maharashtra	Medium Zoo
118	Rajkot Municipal Zoo	Rajkot	Gujarat	Medium Zoo
119	Rasikbeel Mini Zoo	Cochbihar	West Bengal	Mini Zoo
120	Renuka Mini Zoo	Sirmour	Himachal Pradesh	Mini Zoo
121	Rescue And Rehabilitation Home	Tutikandi	Himachal Pradesh	Rescue Centre
122	Rescue Centre At Gorewada	Nagpur	Maharashtra	Rescue Centre
123	Rewalsar Mini Zoo	Mandi	Himachal Pradesh	Mini Zoo
124	Rohtak Zoo	Rohtak	Haryana	Small Zoo
125	Sajjangarh Biological Park (Udaipur Zoo)	Udaipur	Rajasthan	Small Zoo
126	Sakkarbaug Zoo	Junagarh	Gujarat	Large Zoo
127	Sanghi Deer Park	Sanghi Nagar	Telangana	Mini Zoo
128	Sanjay Gandhi Biological Park	Patna	Bihar	Large Zoo
129	Sanjay Gandhi National Park And Zoo	Borivali	Maharashtra	Small Zoo
130	Sarahan Pheasantry	Sarahan	Himachal Pradesh	Mini Zoo
131	Sarnath Deer Park	Varanasi	Uttar Pradesh	Mini Zoo
132	Sayaji Baug Zoo	Vadodara	Gujarat	Medium Zoo
133	Sepahijala Zoological Park	Sepahijala, Agartala	Tripura	Medium Zoo
134	Shivganga Garden Mini Zoo	Thanjavur	Tamil Nadu	Mini Zoo
135	Snake Park, Malampuzha	Malampuzha	Kerala	Mini Zoo
136	Snake Park, Shikshan Mandal	Kolhapur	Maharashtra	Mini Zoo
137	South Khairbari Rescue Centre	Madarihat	West Bengal	Rescue Center
138	Sri Chamarajendra Zoological Gardens	Mysuru	Karnataka	Large Zoo
139	Sri Venkateswara Zoological Park	Tirupati	Andhra Pradesh	Large Zoo
140	State Museum & Zoo	Thrissur	Kerala	Medium Zoo
141	Sundarban Wild Animal Park, Jharkali	Dist.24 Parganas South	West Bengal	Mini Zoo
142	Sundervan Nature Discovery Centre	Jodhpur Tekra (Ahmedabad)	Gujarat	Mini Zoo
143	Surulia Mini Zoo, Purulia	Purulia	West Bengal	Mini Zoo
144	Taptapani Deer Park	Parlakhemundi	Odisha	Mini Zoo
145	Tata Steel Zoological Park	Jamshedpur	Jharkhand	Medium Zoo
146	Thiruvananthapuram Zoo	Thirunvananthapuram	Kerala	Large Zoo
147	Tiger & Lion Safari	Shimoga	Karnataka	Small Zoo
148	Tungabhadra Dam Mini Zoo	Bellary	Karnataka	Mini Zoo
149	V.O.C. Park Mini Zoo	Coimbatore	Tamil Nadu	Medium Zoo
150	Van Prani Udyan, I.V.R.I.	Izatnagar, Barelly	Uttar Pradesh	Mini Zoo
151	Van Vihar National Park Zoo	Bhopal	Madhya Pradesh	Medium Zoo
152	Veermata Jijabai Bhosale Udyan & Zoo	Mumbai	Maharashtra	Medium Zoo
153	Vinod Van Mini Zoo, Ramgarh (Gorakhpur Zoological Park)	Gorakhpur	Uttar Pradesh	Mini Zoo
154	Vulture Conservation Breeding Centre	Pinzore	Haryana	Rescue Centre
155	Wild Animal Conservation Center	Mothijharan, Sambalpur	Odisha	Small Zoo
156	Wildlife Rescue Centre	Gurugram	Haryana	Rescue Centre

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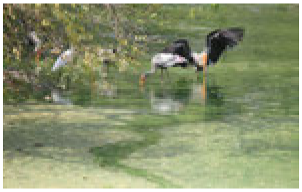

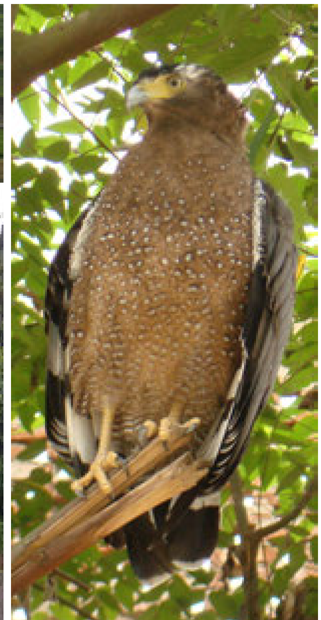

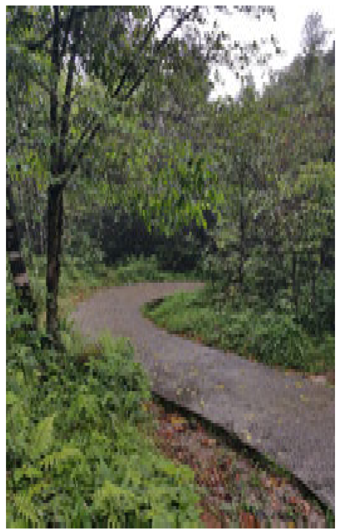

Prof. Dr. Rommel Mehta graduated in Architecture in 1975, completed his post graduate in Landscape Architecture and his PhD in 'Ground Water and Landscape Planning.' He is the former Head of the Department of Landscape Architecture in the School of Planning and Architecture, Delhi, where he taught for 34 years. He has been associated with the Central Zoo Authority of India as a member of the expert group on zoo designing for the last many years. His avid interest in wildlife and zoos has resulted in this publication with the support and encouragement of the Central Zoo Authority, India.

Dr. D N Singh, IFS is a distinguished Indian Forest Service officer with an uncommonly rich administrative and field experience related to wildlife. He is presently the Member Secretary, Central Zoo Authority of India - an autonomous apex statutory body which has been constituted under the Wild Life (Protection) Act. . He had also served as Director, National Zoological Park, New Delhi. His experience ranges pan India.