Third Edition

HAND-BOOK & GUIDE FOR

site supervision

By
SUDHAKAR DOKHANE
PAST PRESIDENT : PEATA (I)

Published by:

Practising Engineers Architects and Town Planners Association (India)

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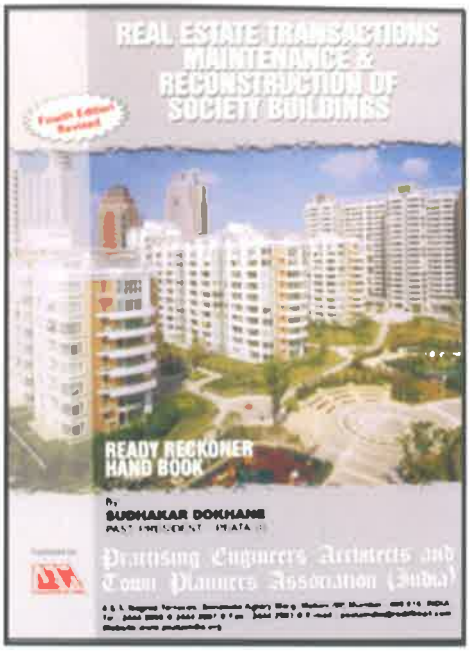

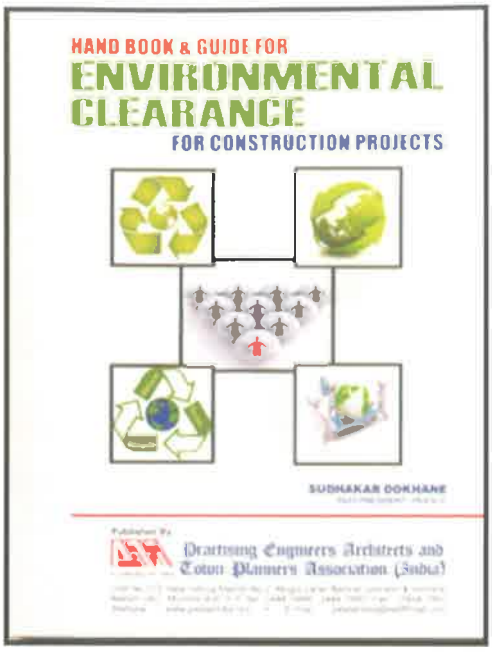

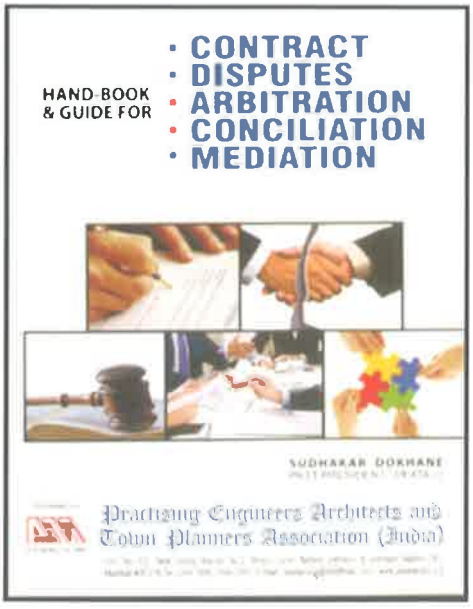

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By the same author:

- Real Estate Transactions & Reconstruction of Society Buildings.
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Dedicated to

Practising Engineers Architects and Town Planners Association (India)

PREFACE FOR 3RD (REVISED) EDITION

First edition (1000) of this -Hand Book, published in December 2002, was widely praised by many practising professionals, engineering students, statutory authorities as well as various professionals' institutions of repute. The assessment of this book made by eminent professionals and statutory authorities are worth reading which has given me over whelming pleasure and confidence too. The opinion and views of these authorities are reprinted in this edition for readers' information. The 2nd Edition of this Book (1000) was published in February 2006. Apart from Contractors and developers, the HODs' of many Civil Engineering Colleges emphasize the importance of this book to their staff and students respectively for their own benefit, on and off site activities.

For so many years due to our conservative national policies and unwarranted import-export restrictions, we were forced to adopt age old construction technology, and use of local materials with thesupport of traditional construction equipments. Once the gates were opened to Foreign Direct Investments (FDI) and liberalization in Import-Export policies the scenario of Indian construction industry was dramatically changed in last decade and half, mainly because of the use of innovative materials, equipments and modern technology. This modernization has increased not only the speed of work but have improved the quality of work substantially. Inspite of rapid modernization , our conventional construction methods are and will remain in use and operation for all the days to come because of its basic technique, texture and local requirements connected to our heritage and culture.

In view of modernization in construction activities and use of innovative materials and modern technology, it has become necessary to publish revised editionto cater the needs of component agencies in construction industry, as well as engineering students. In this 3rd (Revised) edition, one more chapter "Modernization of Construction Technology" is added with additional information about changing trend in use of innovative materials for pleasant building facades. The images of modern construction equipments presently in use are along with conventional equipments as well as illustrations of personal safety equipments are added in this edition for ready reference.

With immense pleasure I am presenting the 3rd (Revised) Edition (1000) of this most acclaimed book, to all the component agencies of construction industry as well as engineering students. I am sure that this edition also will be appreciated warmly by the readers.

Sudhakar Dokhane
Former President PEATA (I)

Mumbai

2015

FOREWARD FOR 3RD EDITION

This **"Hand-Book & Guide for Site-Supervision"** is well researched and time tasted hand book written by our former President– Shri. Sudhakar Dokhane, specially for Site Engineers and Site Supervisors, which gives precise details and check lists for all the operations at every stage of construction right from excavation to finish level. The check list of every item of operation gives adequate guidance and confidence to the site supervisor during the execution of the project at every stage.

The book is written in a very simple and lucid language so that it can be easily understood by non-technical person also. First & Second edition of this book has been already sold out, which proves as to how popular and useful this book is!

In this edition, the author Shri. Sudhakar Dokhane, has added one more chapter on modernization of construction technology, giving required information for the use of innovative materials, modern equipments and advanced construction technology. Fresh images of modern as well as conventional equipments in use, are added for desired clarity and benefit to every construction worker on site.

The author has dedicated all his earlier useful books, to PEATA(I), including this Edition, for which PEATA (I) will remain ever grateful to him. PEATA(I), in this Golden Jubilee Year, as a mark of respect, proudly publishes the **Third Edition** of this book with all praise and compliments that the author deserves.

I am sure that, this book will be a must possession for every agency in Construction Industry, and will be honorable addition to their personal library.

Manojkumar Dubal
President , PEATA(I)

Mumbai

2015

K. C. SRIVASTAVA
MUNICIPAL COMMISSIONER

OFFICE OF THE
MUNICIPAL COMMISSIONER
MUMBAI

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D. O. No. : CHE/1268/DPC/GEN
Date : 29-10-2002

FOREWORD

Sub: Publication of Hand Book for Site Supervisor.

Dear Shri Dokhane,

There is a little doubt that quality has become a buzzword in the Recent Globalisation and Liberalisation era. The meaning of the word quality is very much dependent upon the context in which it is used and the perception of the various people who will transmit and receive the message. It is therefore crucial that any construction organisation and the personnel working, reach a clear consensus and understand what quality means to them.

The site supervisor, the key person to any construction work, is the most effective person for upgrading the knowledge of staff working on site as well as to deliver quality services to achieve objectives of the construction organisation.

I heartily congratulate PEATA office bearers for their sincere effort in bringing out this useful document / handbook for "site supervisor" which will definitely helpsite supervisors to deliver the best quality constructions. Further, the topics covered by the Publishers such as Registration Procedure, Record Keeping, Checking Materials, Testing, Ready Mixed Concrete, Safety Codes, Electrical Installations, Fire Fighting etc. will help the supervisors in supervising the works more diligently.

I wish PEATA, a premier organisation of the Professionals a greater success for such contribution.

With regards,

Yours sincerely,

K. C. Srivastava

Date: 29/10/2002

Vishwas R. Kirtane

DIRECTOR
(Engineering Services & Projects)

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Date: November 15th, 2002

PREFACE

During early 90's, there were collapses of private buildings in Greater Mumbai, constructed hardly 15-20 years back. On account of this alarming situation the issue of such collapses in private sector due to the laxity of day to day supervision by the qualified personnel on the private construction site, was taken very seriously by the Municipal Corporation as well as by the State Govt. after much deliberations it was felt to make it obligatory on the part of private developers to appoint a qualified Site Supervisor for continuous supervision to ensure quality construction and desired durability to the structures. In order to make the appointment of registered Site Supervisor on each private site mandatory, with due sanction of the Corporation a circular was issued for the Registration and Appointment of site supervisor on 7.5.1991.

In the above backdrop and lack of specific training courses for the Site Supervisors, a need of a comprehensive Guide containing all required information and practical applications, was felt very strongly in the interest and benefit of private builders, connected professionals and consumers at large.

With this background it is heartening to note that Shri Sudhakar Dokhane, Past President of PEATA (I) has come out with such awaiting Hand-Book and Guide for the benefit of Site Supervisors and others connected to construction activities.

After having gone through it is seen that the Book is written in a simple language, covering all aspects right from the Registration of the Site Supervisor by the M.C.G.M. with information and check-lists of all the trades in civil engineering works required from commencement to completion.

Vishwas R. Kirtane

DIRECTOR
(Engineering Services & Projects)

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Tel. Nos. Office : 2262 13 87 (P)
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: Ext. 2300
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Apart from civil works the book covers information on water supply, drainage works, electrifications including planting of trees too. Besides from required text, theory and check-lists, this book has provided statutory formats, charts and graphics of construction equipments being used commonly.

This book has provided desired information at a glance for the conventional and improved system of building construction activities. The useful data provided in the book will be definitely beneficial and will assist the Site Supervisors, Architects, Consulting Engineers, Contractors, Builders etc. with detailed practical key notes for day to day building construction activities.

The book has 23 chapters and over 150 pages text, appended therewith graphical illustrations of construction equipments. However a chapter on estimation and costing, had it been added would have further enhanced the grace of this Guide.

I, thank Shri Sudhakar Dokhane, the author of the book for giving me an opportunity to write a Preface for this useful hand-book. I also congratulate Practicing Engineers, Architects and Town Planners Association (India), known for such regular useful publications in social interest, and also for taking the responsibility of publishing such long awaited Hand-Book.

Mumbai,

15th November 2002.

Shri V.R. Kirtane
Director (E.S. & P.)
Municipal Corporation of Gr. Mumbai

Regn. No. Bom. 32/1966, GBBSD
(The Society Regn. Act, 1860)
Regn. No. F-1388 (Bom.)
(Bombay Public Trust Act, 1950)

FOUNDED IN 1965

Practising Engineers Architects and Town Planning Association (India)

4 & 5, GR. FLR., NAGREE TERRACES, SODAWALA AGIARY MARG, OFF M. M. CHHOTANI RD., MAHIM (W), MUMBAI - 400 016. Tel.: 2444 5998 • 2444 2897
Fax : 2444 2983 • E-mail : peataindia@rediffmail.com

INTRODUCTION

Shri Sudhakar Dokhane, Past President PEATA (I), has written Books on various subjects that are of interest and usefulness not only to practicing Architects and Engineers but also serve builders / developers and all other component agencies concerned with development of properties in one way of the other, also for members of public who have occasion to transact/ develop or deal with maintenance, repairs or rehabilitation of structures.

This time he has chosen a subject that pertains to not only development of property, but all its details, correct procedures, use of materials, methods, and proper supervision on construction for safer and larger economic life of structures.

He has taken particular care to supply information in this book, appropriately titled "HAND BOOK & GUIDE FOR SITE SUPERVISOR", the duties and responsibilities, of mandatory requirement of appointing Licensed/Registered Site Supervisor for "Day-to-Day Supervision of Construction", of the Municipal Corporation of Greater Mumbai, vide its circular no. CHE/864/ D.P.B.P. dt. 7th May 1991.

The Licensed / Registered Site Supervisor's responsibility does not end at supervision during construction, but he has to submit his completion certificate to the Municipal Corporation regarding use of proper materials, workmanship, and execution of construction as desired for safer and economic life of the structure.

This book also helps supplement training and knowledge to Licensed/Registered Supervisor, in terms to step-by-step, stage-by-stage organizing construction work for early completion.

The book serves both as "Guide" and "Site Engineer's Filed Manual", for Civil, Plumbing, Drainage, Sewage disposal and Electrical installations.

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(The Society Regn. Act, 1860)
Regn. No. F-1388 (Bom.)
(Bombay Public Trust Act, 1950)

FOUNDED IN 1965

Practising Engineers Architects and Town Planning Association (India)

4 & 5, GR. FLR., NAGREE TERRACES, SOONAWALA AGIARY MARG, OFF M. M. CHHOTANI RD., MAHIM (W), MUMBAI - 400 016. Tel.: 2444 5998 • 2444 2897
Fax : 2444 2983 • E-mail : peataindia@rediffmail.com

This book surpasses all earlier books written on qualifications, registration, duties and responsibilities, preparing and submitting completion certificate of safe construction, as required under the said circular of Municipal Corporation of Greater Mumbai.

This book surpasses all earlier books written on qualifications, registration, duties and responsibilities, preparing and submitting completion certificate of safe construction, as required under the said circular of Municipal Corporation of Greater Mumbai.

Shri Sudhakar Dokhane has excelled himself by furnishing minutest details on each subject under one compilation, leaving nothing for the reader to refer to any other book for guidance nor tern to any other authority for clarifications for discharging the duties.

This Book will prove to be a Bible for Registered Site Supervisors, which in result will help to produce buildings of safer and longer economic life, ultimately benefiting most deserved occupants of the buildings.

It is hearting to note that the author has dedicated this Book also to PEATA (I), with all his copy rights. In recognition of his unquestionable commitment to the Association, PEATA (I) proudly publishes this most useful Book, with all the praise to the author he deserves.

Rajnikant C. Shah

Rajnikant C. Shah
President PEATA (I)

Date: 17th November 2002.

The Institution of Engineers (India)

(ESTABLISHED 1920, INCORPORATED BY ROYAL CHARTER 1935)

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Fort, Mumbai - 400 001.
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Fax 2652541
E-mail PATELND@usa.net

NDP/091/02-03

Date : 13th November 2002

My Dear Shri Sudhakar Dokhane,

Congratulation for conceiving an idea for "Hand Book & Guide for Site Supervisor" - a much needed book for site supervisor. You are also worthy for appreciation for sparing valuable time and taking pains to write the book. It indicates your devotion and desire to distribute your knowledge, experience and expertise to new bond.

In the book all necessary information required to know to by a Site Supervisor is covered in simple language with necessary pictures of machines. In fact, this will be a reference point for Site Supervisor.

A site supervisor is like a hinge of a door. As a hinge, though hidden silently converts two dimensional door shutter into three dimension in operation. Similarly a Site Supervisor converts two dimensional plan into three dimension building. Unfortunately practically no literature, training is available for such important skilled level job. Your book will provide one-window information and that is why your successful attempt to bring out this book will be unique great and worth appreciating.

Wishing you and the book all the success.

Yours Sincerely

(Narendra D. Patel)
Vice-President

Indian Concrete Institute

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Managing Director
Gilcon Project Services Ltd.

Shri E. J. Cassad
Consultant

No. ICI/ARJ/2002/11/ 12.11.2002

Dear Shri Sudhakar Dokhane,

I am in receipt of the Draft of your Book on Guidelines/Handbook for 'Building Supervisors'. I feel honoured that you have asked me to review the Draft and make suggestions.

The Rules for appointment of Building supervisors by Builders/ Developers, were made by B.M.C. few years before and PEATA had organized seminar under your leadership when system was to be introduced. I had also taken an active part in the said seminar. Many years have passed since then and really a sincere need was felt to have a Hand Book having the guidelines for Building Supervisors. I find that you have divided the book in two parts viz ;

[1] In the 1st part we find the Rules & Regulations of the BMC as well as the duties of Building Supervisor. Very rightly you have included various formats to be used in the works. Thus, all this information/formats at one place are readily available for reference and would be a great help to all concerned.

[2] In the 2nd part, you have dealt with Technical aspects which include properties of materials for various items of works, methodology, tests to be carried out and the most important 'Check Lists'.

All the above information has been presented in very simple language and in brief, without missing any important point. Therefore, without any difficulty Building Supervisors would be able to grasp the points. All the important aspects of R.C.C. work, Finishing Items, Sewerage, Water-Supply, Electrification

....2

etc. etc., have been covered. I am happy that temptation has been avoided to include theory and lengthy description, or else the Book would have become another Text Book.

I have already made some suggestions from my own experience and feel much happy that you have sportingly accepted the same. In fact all the way you came down to my residence on Sunday morning and discussed various chapters.

This prompt approach of yours demonstrates eagerness & great concern to make the Book as flawless as possible and more useful to users. As a matter of fact, I ask myself a question as to how very busy and renowned Architect like yourself could find time to compile and write down such a Book, but I also got the answer that this is not possible due to your commitment to the society at large and commitment to the profession you come from, i.e. the awareness of the Social obligation.

In conclusion, I would say that the efforts made by you are laudable and praiseworthy which will go a long way in improvement of quality of construction. I express my Best Wishes as also that of Indian Concrete Institute for success and wide acceptance of the forthcoming Hand-Book.

Once again with all my Best Wishes,

Yours sincerely,

12/11/02

A. R. Jambekar
Chairman,
Indian Concrete Institute

Shri Sudhakar Dokhane
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R. N. Raikar	Dr. S.K. Manjrekar	C.R. Raikar	B.V.B. Pal
President & Principal Coordinator	Past President	Vice President	Hon. Sec. & Treasurer

PEATA/2002/1795 18th November, 2002

My dear Shri Sudhakar Dokhane,

My hearty congratulations to you for compilation of the document "Hand - Book & Guide for Site Supervisor". The book would serve long awaited need of construction supervisors. Present construction activity lacks training facility / infrastructure. Therefore, this compilation would be of great utility to large number of construction supervisors. Wide circulation is therefore desired. This could be possible through support and participation of professional bodies such as yours, ours and many others.

While appreciating the contents of the book I feel the book has abrupt start. Opening chapter may be couple of pages to cover efforts made by PEATA for registration of construction supervisors by the Corporation and the need of such a document in the industry. This could add approximate lifeline to the entire document as a live communication.

You may be aware that IS 456 1964 has now revised to IS 456-2000 - Page 45.

It may be noted that construction management for construction supervisors need to have enough background preparations before the work is scheduled and particularly through drawings scrutiny which would go a long way for their efficient performance. This aspect may be covered in your next edition. If properly circulated and publicised the document will be always in short supply.

Once again our Chapter Board expresses their deep sense of appreciation for your commitment to the profession. No wonder PEATA is doing a great job as professional body. You are one of the important contributors to the glory of PEATA. Keep it up. Amen!

With warm regards,

Yours sincerely,

R. N. RAIKAR
President

Registered as Public Trust Registration No. E/13937 Mumbai [Contributions will qualify for deduction u/s 80G(1) of the I.T. Act, 1961]

Estd. 1941

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D.L. DESAI (SHANKARBHAI)
HON. GEN. SECRETARY

Ref: 387/S/2002-2003 dated September 19, 2002

Shri. Sudhakar Dokhane,
Past President,
Practising Engineers Architects & Town Planners Association (India)
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Off. M.M. Chhotani Road,
Mahim (West),
MUMBAI – 400 016

Dear Sir,

You were kind enough to send me two books titled (i) Real Estate Transactions Construction & Maintenance of House/Buildings (Second Edition), and (ii) Hand-Book & Guide for Site Supervisor, and sought my suggestions/comments before publication.

I have gone through **"Hand Book & Guide for Site Supervisor"** and spoken to you on telephone. I reiterate that, you have hardly left anything for me to make further suggestions. May please be noted that, this is for the first time this publication is being brought out.

Thanking you,

Yours Truly,

D.L. DESAI (SHANKARBHAI)
HON. GEN. SECRETARY
BUILDERS'S ASSOCIATION OF INDIA

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21st November, 2002

Hand-Book & Guide for Site Supervisor

The last three decades of the twentieth century was an era of sweeping changes and radical shifts in the social economical and political field. The technological innovations, research and development, improved ways and means of application of technical knowledge have compressed the decades into days. Things were considered unattainable, almost impossible and imaginary have become facts of life. Distances and communications have no more the same meaning as that in the past.

The construction of ownership buildings in private as well as public sector was also not an exception to this phenomenon. Construction in this field of the industry showed a rapid growth in the later part of 19th century. Today the construction of ownership buildings has earned a special place in building industry. The awesome factor in the past was bogging down the construction industry was the early deterioration of many buildings due to various reasons; one of them being a rather cool approach to quality control by far mainly due to ignorance.

A necessity of existence of a possible missing link between various component agencies of a building team was required to avoid pitfalls at various stages of construction work and to provide a proper and uniform co-ordination at sites. Keeping with its tradition, the Municipal Corporation of Brihan Mumbai came forward and took a lead in this respect in 1991 by creating a new cadre of qualified site-supervisors to provide this essential link. However the stipulations laid down for this

....2

purposes were mainly related to administrative process and the implementation part was not documented clearly.

This Manual is compiled and authored by Ar. Sudhakar Dokhane, Past President of PEATA (I), by collecting and putting most of the scattered data in one volume. The outline of the Manual and placing the various related subjects sequentially into chapters indicate skill, judgement, devotion and long professional experience of the author. Thus the Manual provides a complete guidance and information, which should bring in uniformity at all sites as a good construction practice.

The Manual literally walks the reader through the complete scenario that makes the site supervision work systematic from the foundation stage to completion. The most encouraging feature of this manual is in its stress on the importance of quality of the Structural Work and on the role of the Structural Engineer.

Though written for the benefit of the cadre of site supervisor, this Manual should be equally helpful to Architects, Structural Engineers, Contractors, Developers, Approving and Sanctioning Authorities, Engineering Colleges and all others who are connected to the construction all over the country.

On behalf of the 'Indian Society of Structural Engineers', I congratulate with admiration Ar. Sudhakar Dokhane and the Organisation of PEATA (I) for this excellent work and offer them good wishes to continue with their mission of "Knowledge-Documentation" that has been undertaken by them.

Prof. M. D. Mulay
President,
Indian Society of Structural Engineers

ACCOMMODATION TIMES

Fortnightly on A to Z of Real Estate

(Member : INS, IFSMN)

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Tel.: 2690 3470 Telefax : 2611 4221 E-mail : info@accommodationtimes.com Web : www.accommodationtimes.com

12th Nov., 2002

OPINION

In the well researched "Hand Book and Guide for site Supervisor" Shri Sudhakar Dokhane Past president PEATA (I) has made commendable effort to present the fundamental principals and time tested methods of supervision of the under construction projects. For the first time a publication on the most vital aspect of ongoing construction, gives complete and indepth systems, procedures and specifications for the site supervisors. The author have covered record keeping, terminology, material checking, field tests, concretisation and its components, construction specification and lot of other details for construction and repairs.

The book is an up-to-date guide and must for every site supervisor and all other concerned professionals in building construction industry.

M. Chaturvedi

Murari Chaturvedi
Editor
Accommodation Times

INDEX

CHAPTER - ONE

COMPONENT AGENCIES IN BUILDING INDUSTRY

The concept of one ownership building in developing urban areas and metropolis is now almost reduced, and hardly seen for last so many decades. The cost of land, increasing cost of construction and maintenance thereafter has gone beyond the reach of single owner. As such the construction activities, production and supply of housing stock resulted in multi ownership apartments constructed by the Developers, having transit financial interest in the project.

Under the circumstances a role of Site Supervisor has become very important to ensure quality construction, and for the purpose it is essential that the site supervisor should know all the component agencies involved in construction activities to enable him to discharge his duties more efficiently in professional manner.

The Following are essential component agencies related to successful execution and completion of a building construction project:-

A Developer
B. Consulting Architect / Licensed Surveyor
C. Consulting Structural Engineer
D. Consultants of other trades
E. Site Engineer / Supervisor
F. Contractor
G. Occupier

Description and role :

The description and role of each above component agency in short is explained as under : -

A. Developer :

Developer is a person who undertakes the development of land property in his capacity either as owner of the property or by acquiring development rights by means of Purchase, Lease, License or Power of Attorney. Developer undertaking construction, development and sale of premises, as a full time business, shall be duly licensed by Statutory Authority to carry on such business of construction activities.

B. Architect / Licensed Surveyor :

Architect / Licensed Surveyor, is a person having requisite qualifications and duly authorised by any law governing such profession including registration issued by Council of Architecture or any other license or registration issued by competent statutory local civic authority,authorizing such persons to undertake the professional assignment

involved in planning, designing and acceptance supervision of construction work and acts as chief coordinator of the project.

C. Consulting Structural Engineer :

Is a person having requisite qualifications to design structural components of construction projects, which is dulyrecognized or registered by the competent statutory civic authority / institutions to undertake such professional assignment.

D. Consultants :

Is a person having specialised knowledge and requisite qualifications of planning, designing and supervision in specialised aspects of construction such as Civil Engineering constructions, Electrical installations, Plumbing and Sanitary installations, Air-conditioning, and Mechanical installations etc.

E. Site Engineer / Supervisor :

Is a person possessing requisite qualifications and experience and having a license or registration from local civic authority to work as Site-Engineer / Supervisor and engaged on work for consistently supervising day-to-day construction activities at site in accordance with the plans, specifications and instructions of the Architect, Structural Engineer etc.

F. Contractor :

Is a person having requisite skill, knowledge, experience and capacity to carry out quality construction which he has undertaken to execute by providing all necessary materials, plant, methodology, equipments, skilled and unskilled labourers as required for due performance and discharge of his obligations as per the plans, designs, specifications and instructions issued by the architect and structural engineer from time to time.

G. Occupier :

Is a person lawfully using the premises exclusively for the purpose for which it is intended and approved, only after occupancy certificate has been granted by the local statutory authority with a responsibility to maintain the premises in good condition for all the time.

Roll of Site - Engineer / Supervisor :

The Site Engineer / Supervisor is a important link of all component agencies, who besides co-ordination is responsible for effective supervision and successful completion of project to the satisfaction of all said agencies.

All information, guide lines required for day to day execution of work, including his responsibilities, liabilities, scope of work and check lists for effective supervision on construction activities of all trades, are detailed in respective chapters appearing hereafter.

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CHAPTER - TWO

REGISTRATION OF SITE SUPERVISOR BY M.C.G.M.

(Extract from the circular issued by the Municipal Corporation of Greater Mumbai Vide No. CHE/864/DPBP of 7.5.1991)

In order to ensure reasonably good quality of work, in case of private buildings within the limits of Gr. Mumbai, the Standing Committee of the Corporation by their resolution No.: 890 dt. 25.10.1989 have accorded sanction under the provisions of section 356 of BMC Act 1888, for insisting upon appointment of SITE SUPERVISOR in case of construction of private buildings. Following are the guide lines, qualifications and scope of work of the Site Supervisor.

CIRCULAR - ANNEXTURE

(CHE/864/DPBP of 7.5.1991)

GUIDELINES / REGULATIONS FOR SITE SUPERVISORS

Constant supervision during the progress of building work by registered / licensed construction supervisor of appropriate category shall be compulsory on all construction works of buildings.

Proper arrangement for constant supervision shall be made for the following classification of work.

A. Minor Works: Means works up to the value of Rs. 4,00,000/- or 150 Sq. Mts. of development of individual span where storey height not exceeding 3.6 Mts. for flat roof / structure and individual span not exceeding 8.0 mts. and storey height up to 4.8 Mts. up to the level for sheeted roofs, the overall height of structure being up to 10 mts.

B. Small Works : Means works up to value of Rs. 7.50,000/- or development of area up to 300 Sq. Mts. with above mentioned parameter of spans and for flat and sheeted roof overall height of structure being up to 12.5 Mts.

C. Medium Works: Means up to value of Rs. 30,00,000/- or development or area up to 1500 Sq. Mtr. for individual span not exceeding 9 Mts. and up to 5 stories i.e. (Ground / Stilts + 4 Stories) in case of flat / slab or 20 Mts. span and storey up to 8 mts. for sheeted roof excluding development for commercial, educational or public assembly occupancy not confirmed to ground floor, height of structure being up to 12.5 Mts.

D. Major Works: All works not covered above.

1) Individual Building.

2) Multiple building on one project site.

Supervision for above work can be undertaken by following categories of persons subject to the restriction given as under :-

1) Licensed Surveyor
2) Architect
3) Consulting Structural Engineer
4) Structural Designer
5) Site Supervisor Grades I, II, III.

On specific appointment from DEVELOPER AND prior acceptance by licensed Surveyor / Architect / Consulting Structural Engineer / Structural Designer can undertake site supervision up to 5 works at any one time along with his primary design functions subject to aggregate maximum of 3000 Sq. Mts. of development and further subject to his submitting certificate of constant supervision restricted to only those works where he is connected with his primary design function.

Site supervision Grade III can undertake site supervision of maximum 5 MINOR WORKS at a time within any one Ward, having aggregate area of development up to 1000 Sq. Mts.

Site supervisor Grade II can undertake site supervision of maximum 5 MINOR SMALL WORKS at a time within any one word having aggregate maximum area up to 1500 Sq. Mts.

Site supervisor Grade I can undertake site supervision of up to 5 MEDIUM WORKS within any one ward having aggregate maximum area up to 3000 Sq. Mts. or any single major work without restriction of size or value.

Provided that in case of projects involving development of multiple buildings under one developer and architect in a single layout of continuous building site the above specific requirements shall be deemed to have been met with provided suitable arrangements as to effective supervision or construction is made by providing licensed supervisory staff under him i.e. the site supervisor Grade I staff shall be intimated to architect and Corporation. When Grade II Supervisor work under overall control as above the restriction of type, area and value of work shall not apply.

QUALIFICATIONS :

Site Supervisor Grade I : B.E. (Civil) or B. Arch. or any other equivalent recognized qualifications with minimum 5 years experience after graduation, on execution of building.

OR

Diploma or Licentiate in Civil Engineering with minimum 7 years experience in construction or construction supervision.

Site Supervision Grade II: B.E. (Civil) or B. Arch or any other equivalent recognized experience of qualifications with minimum 3 years.

OR

Diploma or Licentiate in Civil Engineering with 4 years experience.

OR

Persons who has worked as supervisor and has minimum 10 years of experience and who in the opinion of the architect is capable of performing the duties given to him irrespective of his qualifications.

Site Supervisor Grade III: B.E. (Civil) or B. Arch or any other equivalent recognized qualifications.

OR

Diploma in Civil Engineering with 1 year's experience.

OR

Person who in the opinion of architect is capable of discharging his duties with practical experience of 5 years irrespective of his qualifications.

Notes:

1) *The Site Supervisor has to apply to the Municipal Corporation of Gr. Mumbai for Registration and obtaining License thereof.*

2) *The Site Supervisor has to submit his supervision memo to the Municipal Corporation of Gr. Mumbai through the architect before commencement of work.*

3) *The Site Supervisor has to submit his completion certificate at the end of work completed under his supervision, to the Municipal Corporation of Gr. Mumbai, through the Architect.*

4) *The simple formats for i) Application for Registration ii) Supervision Memo and iii) Completion Certificate are as appearing hereafter: -*

****

(FORMAT - A)

FORMAT APPLICATION

FOR REGISTRATION / UP-GRADATION OF SITE SUPERVISOR

To,

The Executive Engineer,
Building Proposal (City),
3rd Floor, Municipal E-Ward Office,
10 Shaikh Hafizuddin Marg, Byculla,
Mumbai - 400 008.

1. Full Name (in Block Letters) : _____

2. Full Postal Address : _____
(in Block Letters) _____
_____ Pin Code _____
Tel. No.: _____

3. Date of Birth : _____
a) Age : _____

4. Education Qualifications :
(a) As on the day he was first
Registered as site supervisor : i) _____ ii) _____ iii) _____
(b) As on the date of application : i) _____ ii) _____ iii) _____
(c) Training program attended : _____

5. Particulars of Experience :

S. No.	Period of Employment	Name & Address of Employer	Nature of Project	Designation & Responsibility

6. Sate if self employed: : Yes / No

7. Documents to be enclosed (True / Xerox Copies Only)
   a) Proof of Experience.
   b) Proof about date of birth (School leaving certificate / birth certificate issued by Municipal authority).
   c) Proof of educational qualifications and/or training.
   d) Two recent passport size photographs.

8. If application is for up gradation :
   a) Present registration No._____ Grade _____
   b) Grade applied for _____
   c) Training/ Experience completed : _____

I hereby declare that the particulars and information given above are true and correct to the best of my knowledge. I agree that false / incorrect information disqualifies me from being considered for Registration.

Yours faithfully.

Date: _____

Place: _____ (Name & Signature of Applicant)

(FORMAT - B)

(SUPERVISION MEMO)

From_____

_____

_____

Tel.:_____

Dated_____

To,
The Executive Engineer
Building Proposals, City/WS/ES,
Municipal Corporation of Gr. Mumbai,
Mumbai - 400 ___

SUPERVISION MEMO OF SITE SUPERVISOR
(Through Architect / Licensed Surveyor)

Dear Sir,

Sub: Proposed development on plot no. _____ CTS No. / C.S. No. _____ Village / Division _____ at _____ for _____

Ref.: Your No. EB/CHE/_____/BP/City/WS/ES/_____/_____.

I, the undersigned, a Registered Site Supervisor (Grade: _____) hereby agree to supervise day to day work of the above mentioned development, under the instructions of the Architect / Licensed Surveyor and Structural Engineer appointed by the Owner / Developer Shri _____ M/s _____ of the project

List of at present works under my Supervision: -

1) _____
2) _____
3) _____

Thanking you,

Yours faithfully,

Name & Signature
Registration No.: _____,Grade: ____

(FORMAT - C)

(COMPLETION CERTIFICATE)

From: _____,

_____,

_____.

Tel. No. _____

Date: _____.

The Executive Engineer
Building Proposals (City/WS/ES),
Municipal Corporation of Gr. Mumbai,
Mumbai.

Dear Sir,

Completion Certificate by Site Supervisor

Sub: Development on property bearing C.S. / Plot No./ CTS No., Division _____/Village _____at _____ Mumbai 400_____ for _____.

I, Shri/Smt._____, residing at _____ _____Mumbai 400 ____, have undertaken assignment as site supervisor on the work (Building No. _____) carried out on property bearing Plot No. _____, CTS No. _____, Village _____ as per design & plans prepared by Shri _____ / M/s _____ duly sanctioned by Municipal Corporation of Greater Mumbai under No. EB/CHE/_____/BP/WS/___/___ dated _____ for Shri _____ owner / C.A. to owner and M/s. _____ has been acting as contractors.

In addition to my site reports and certificates submitted from time to time to architects M/s. _____, I hereby certify that the entire work has been carried out under my personal supervision satisfactorily. I hereby certify that all materials used, workmanship and methodology employed for the construction at aforesaid premises, are as per prescribed standards. I further certify that applicable codes, instructions and directions of Architect, Licensed Surveyor, Consulting Structural

Engineer's or other Consultants have been followed to the best of my knowledge and the construction described herein after is completed in all respects to render it fit for occupation for intended use.

Description of work
i) Building No. _____ : _____
ii) Residential / Commercial/Industrial : _____
iii) No. of Floors : _____

Date : _____
Place : _____

Copies submitted to:

1 Architect / Licensed Surveyor
2) Consulting Structural Engineer

(_____))

Name & Signature
Registration No. _____
Grade : _____

****

CHAPTER - THREE

APPOINTMENT, SCOPE OF WORK, DUTIES, RIGHTS, RESPONSIBILITIES & LIABILITIES OF SITE SUPERVISOR

1) APPOINTMENT:

The Construction Supervisor shall be nominated or approved by the Architect / Licensed Surveyor, and appointed and paid by the Developer / Employer. He shall act as construction Supervisor for the Developer / Employer, under the over-all directions and control of the Architect and Structural Engineer and will be responsible to the Registering Authority, through the Architect / Licensed Surveyor.

2) ABILITIES :

The Site Supervisor being an important personnel on site should possess following abilities depending on the complexity and exigencies of the work involved on a construction site. To enable him to discharge his duties effectively, he should generally possess ability : -

a) To read and to translate tender documents, agreements of contracts.

b) To read plans and specifications and to translate and explain it in reality.

c) To determine well in advance any discrepancy or anomaly in drawings specifications and seek directions from Architect, Structural Engineer and other Consultants as the case may be.

d) To know correct gradation of all type of materials being used in constructions and its proper and quick assessment.

e) To know correct methods of stacking of cement, steel and other materials, as well as storage of water for construction activities etc.

f) To know workmanship of different trades involved in the building construction.

g) To take correct measurements and to check the centre line of different structural members and walls etc.

h) To identify Labour problems at site if any and to report the same to the employer / concerned agencies immediately.

i) To give report properly in writing to the architect and other consultants as per their requirements.

3) SCOPE OF WORK :

The scope of work of the Site Supervisor includes the following functions:-

a) Inspection and approval of all the material brought on site for construction.

b) Day to day complete supervision and control over the workmanship of different contractors and agencies connected with building construction.

c) On site and off site co-ordination between Architect, Structural Engineer, other Consultants, Contractors and Owner / Developer etc.

d) To arrange and obtain test results / certificates of materials that are necessary for the work, as directed by the Architect and other Consultants.

e) Performing such other functions as may be directed by the Architect and other consultants to ensure quality of the work and fulfillment of Architect's and other consultant's assignments.

f) To Submit his supervision memo along with commencement of work notice to Local Civic Authority through the Architect (Format - A).

g) To submit his Completion Certificate after the work is completed to the Local Civic Authority through the architect who is applying for Occupation Permission / Building Completion Certificate (Format - B).

h) To check and verify measurements and quantities of the running bills of contractor, and inform his comments, in writing to the Architect for issue of interim certificates for payments; in case of item rate contract.

i) In case of lump sum rate basis contract, to check running bills of contractor as to whether it is in conformity with the items and amount it is billed as per the provisions of contract; and after verification of completed stage of construction for which the bill is raised, recommend in writing to the Architect for issue of interim certificate for payment.

4) PRIMARY DUTY:

The Primary duty of the construction supervisor is to endeavor at all times, during his employment on a particular site, to ensure that the construction works are carried out in accordance with contract Document if there are any, or else in accordance with the good construction practice and specifications and such other written instructions as may be issued by the Architect / Licensed Surveyor and Consulting Structural Engineer from time to time. Unless otherwise authorised, he shall be constantly present on the site during normal working hours except when his duties require him to leave the site, and he shall also be present during overtime working hours of critical constructions, when so desired by the Architect / Licensed Surveyor. The Site Supervisor should insist for all drawings, documents, instructions, specifications etc. from the Architects and Structural Engineer in advance for study and ask for clarifications required if any thereof.

5) DETAILED DUTIES :

The basic detailed duties of the Construction Supervisor, subject to variation by the Architect / Licensed Surveyor will be as follows: -

a) Examine and be thoroughly familiar with the drawings, specifications, Bar charts etc. and refer any discrepancies or queries thereof to the Architect / Structural Engineer for determination.

b) Anticipate work to be put in hand, and endeavor to ensure that all necessary drawings and information are available at the site when required.

c) Report his comments to the Architect / Licensed Surveyor / Structural Engineer for any measures which he considers to be in the best interest of the work, and particularly measures to avoid faults and wastages.

d) Check the materials and workman ship to ensure that the standards required under the Contract / Specifications if there are any, or as per good construction practice, are maintained, and take samples and make tests as required.

e) Advise the contractor's site representative as soon as possible of any materials or workmanship which does not comply with the requirements of the contract or is otherwise unsatisfactory, and advise in writing, and obtain written directions from the Architect / Structural Engineer for the same and thereafter record when rectified.

f) Attend all site meetings dealing with the carrying out of the work, and act on behalf of the Architect / Licensed Surveyor when specifically authorised to do so.

g) Maintain a daily record (Job Diary) of actions taken in connection with the (a) to (f) above, and record in addition to of : -

   i) Significant deliveries of materials at the site.
   ii) Significant stages of the work commenced, in hand, or completed.
   iii) Dispute, accidents or other events which may later need to be recalled.
   iv) Significant Visitors to the site.

h) All oral directions given at site by the Architect / Licensed Surveyor or his consultants at the first opportunity, the Construction Supervisor shall obtain the confirmation of the Architect / Licensed Surveyor or other Consultants to such oral directions. Give any other information as the Architect and Structural Engineer may reasonably require.

i) Maintain Triplicate Book for site visit reports of Architects and Structural Engineer, and ensure follow-up of instructions issued thereof by them.

j) Maintain orderly records of all documents received relating to the works.

k) Make every effort to preserve an atmosphere of harmonious understanding and co-operation between all parties engaged on the works.

l) Make inspections of materials at site and insure its proper stacking in the construction yard or workshop and also to inspect any materials located off-site, as directed by the Architect / Licensed Surveyor.

m) The construction Supervisor shall, wherever possible, accompany the Architect / Licensed Surveyor or any authorised consultant and visitor on the site for inspection of work.

n) Maintain a checklist with all details recorded and signed as work progress for each stage and important items of construction work.

6) ADDITIONAL DUTIES :

In addition to the duties listed above the Architect / Licensed Surveyor shall be entitled to require the construction supervisor to :

a) Verify the setting out of works in relation to the boundaries of plot.

b Verify and record foundation conditions and foundation tests and with results, if performed.

c) Participate in and record any other tests of material or work at site.

d) Make site sketches to illustrate reports to Architect / Licensed Surveyor / Consulting Structural Engineer.

e) Record the position of drains and other sub-ground services.

f) Such other duties as are matter of understanding and contractual obligations on his appointment.

g) Allocate duties and generally direct the work of other assisting Construction Supervisors where they are separately employed.

7) RIGHTS :

a) The Construction Supervisor shall have right to have all working drawings, specifications, Municipal permissions and certified copies of Approved Drawings, and contract documents of the project, so long as he is in employment at particular site.

b) He shall have right to inform the Architect / Licensed Surveyor and Consulting Structural Engineer of the defects and / or variation in the work and/or materials of construction.

c) He shall have right to obtain clarifications or directions, from the respective agencies where he has doubts about quality of materials, construction and / or items of work etc.

d) Require the Contractor to carry out additional / extra work what may be reasonably implied from the Drawings and Specifications as the Architect and Structural Engineer may authorize from time to time.

8) RESPONSIBILITIES :

With due accountability in terms of (1) to (6) above, it will be responsibility of the Construction Supervisor to : -

a) Hand-over, on completion of work or on his termination, whichever is earlier, all records including all Reports, Instructions and Checklists duly filled in, recorded and signed by him for up to the stage of work supervised by him.

b) Issue Completion Certificate of Construction work in the event of completion or part completion, for the work carried out during his employment in the prescribed format.

c) Hand-over on his termination or completion of work whichever is earlier, original documents related to work including Original Reports, completed checklist, other drawings and instructions issued by Architect / Licensed Surveyor / Consulting Structural Engineer and other Consultants.

d) He shall be generally jointly responsible along with contractors of all trades for quality of all constructions done, save and except the design and details supplied by Architect / Licensed Surveyor / Consulting Structural Engineer and other consultants where applicable, including methodology of construction, workmanship employed and the finished construction, done under his tenure as Construction Supervisor till the defect liability period is over, and in no case beyond 2 years.

9) LIABILITIES :

The Site Supervisor is liable if he fails to exercise responsible skill, care and diligence in discharging his duties as appearing herein before. However his liabilities are limited to as stated below: -

a) The liability of the Site Supervisor does not cover cost/s of project, or any other financial liability connected thereto; including any liability for consequential damages etc.

b) The liability of Site Supervisor expires on the date of completion of defect liability period, and in no case beyond 2 years, from the date of virtual completion of the building / project.

c) The Site Supervisor has no liability whatsoever for any part of the work not carried out under his supervision.

d) The Site Supervisor has no liability for any damages resulting from an act of contractor/s supplier/s, designs and specifications prepared by professionals connected thereto and or any natural calamities whatsoever.

e) The Site Supervisor has no liability whatsoever for any part of the work for which liability rest with contractor/s, supplier/s or with any other agencies thereof.

f) The Site Supervisor has no liability whatsoever for violation of any legal and or technical provisions, or rights thereto in respect to the construction work, for which liabilities rest with other component agencies.

10) LIMITATIONS :

a) The Powers and/or Rights of Construction Supervisor shall be limited to those necessary to enable him to discharge the responsibilities set out herein above.

b) He shall not make any modifications to the works as designed.

11) INTERPRETATIONS :

a) In all questions of interpretations of these or any other instructions about the discharge of his duties, the Construction Supervisor should consult with the Architect / Licensed Surveyor / Structural Engineer, when in doubt.

b) He should obtain from the Architect / Licensed Surveyor, at the commencement of the project a clear understanding of the division of responsibilities, particularly where other supervising staff is employed.

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CHAPTER - FOUR

THE SITE OFFICE & RECORD KEEPING

A) THE SITE OFFICE REQUIREMENTS

The Site Supervisor should ensure that the Site Office is constructed at site by the contractor of required size at the location from where construction activities can be easily observed as approved by the Architect, before work is commenced. He should ensure that the Site Office is provided with : -

i) Sufficient number of windows, door/s with locking arrangements, telephone connection and a wall clock.

ii) Electric supply with sufficient light and Fan points with ceiling/ portable fan/s as required; and drinking water container/s; with glasses etc.

iii) Minimum one storage cupboard with locking arrangements with sufficient number of tables and chairs and required number of Display Boards.

iv) Required Stationary i.e. Measure tapes of different lengths, writing pads; pencils/sketch pens, scales, setsquare etc. and Site Visit Report-Books (triplicate page)for inspection reports of Architect and Structural Engineer.

v) Required number of Moulds for concrete cubes and glass tumblers / jars for checking Silt and Clay contents in sand.

vi) First-Aid Kit

vii) The Site Supervisor should display on Boards following : -

a) Approved drawings of layout of project and building/s under construction together with stage wise working drawings of architectural and structural works as well as other trades.

b) Work-progress charts of different trades.

Note: -

i) The drawings required for daily use be got laminated. The old drawings should not be destroyed and be kept as record in different files, unless permitted by the Architect / Structural Engineer.

B) RECORD KEEPING

The Site Supervisor should maintain various records at site for day to day work, which will assist him for inspection, verifications, references, and cross-references to co-ordinate in time with all component agencies thereof.

1) RECORD OF TECHNICAL DOCUMENTS:

The Site Supervisor should maintain up to-date records of following various technical documents in different files for ready reference at site :

i) Approved plans certified by the Architect.
ii) Development permission / C.C. certified by the Architect
iii) Structural drawings and details signed by the Structural Engineer
iv) Centre Line Plans prepared by Architect / Structural Engineer.
v) Set of Working Drawings of various items i.e.
    a) Elevation treatment
    b) Brick work & Plastering (External & Internal)
    c) Wood work i.e. Doors, Windows, Ventilators etc.
    d) Plumbing and Drainage Work. (External & Internal)
    e) Electrification Work.
vi) Contract documents and specifications thereof.
vii) Reports of soil investigation, Cube-test, Water-test etc.

2) RECORD OF VARIOUS COMPONENT AGENCIES :

For day to day co-ordination, the Site Supervisor should maintain record of following agencies, consultants and their representatives, comprising of their Name/s, Address, Profession, Designation, Telephone numbers at Office, Residence, Mobile, Fax, Internet / E-mail etc. of : -

i) Owner / Developer
ii) Architect / Licensed Surveyor
iii) Structural Engineer
iv) Contractors of Piling, Civil, Plumbing & Electrical works.
v) Consultants and Contractors of others installation agencies i.e. Lift / Elevators, Fire Safety, Water Proofing, Fabrication, Landscaping Glazing etc.
vi) Concerned MunicipalCorporators , Municipal Offices and its Officers, Police Station, Fire Brigade, Hospital and any other such authorities in the vicinity for emergency contact.
vii) Regular Material Suppliers.
viii) Material Test Laboratories and related Consultants thereof.

3) RECORD OF MEASUREMENTS & TESTS :

The site supervisor should maintain record of various test results and measurements i.e. :

i) Concrete cube tastes
ii) Measurements of Piles
iii) Measurements of Open Spaces
iv) Measurements of Plinth and Upper floors
v) Measurements of quantities when tender is on item rate basis.
vi) Statement of Carpet area and Built-up area.

4) RECORD OF MATERIALS :

i) In case if the work is to be carried out departmentally and the materials are to be supplied by the employer the Site Supervisor should maintain day to day Record of materials arrived at site. This should be two fold record wherein in first part, the Site Supervisor should record the quantity of various materials day to day brought at site i.e. Sand, Aggregate, Cement, Steel, Timber, Tiles and so on. The record should specify the name of supplier, truck number and quantity of materials delivered. The delivery challans of materials should be kept in the files of respective items, for cross verifications.

ii) In the second part he should maintain record of daily consumption of materials and places of construction where it is used. Even though it is difficult to ascertain exact quantity of used sand, aggregate, steel etc.; however quantity of Cement, Wood, Tiles etc. can be exactly recorded.

a) This record facilitates in making advance arrangements of materials to keep the desired speed of work. Based on the said records he can co-ordinate with the Owner / Developer / Contractor for necessary arrangements in time.

5) RECORD OF VISITORS :

i) The Site Supervisor should maintain day to day site visit records of concerned Consultants i.e. Architect / Licensed Surveyor, Structural Engineer, and Others Consultants or their representatives and study their site visit reports or instructions and co-ordinate with respective agencies for its compliance in time.

ii) Besides above, he should also record Name, Address, Designation and Telephone numbers of other Public Visitors i.e. Municipal Engineers, Public / Social Workers, Govt. Officers, Suppliers, Consumers etc.; and arrange to send their requests, instructions and requirements to the respective component agencies for their information and instructions if any thereof.

6) RECORD OF WORKERS AT SITE :

The Site Supervisor in consultation with contractor, should keep record of workers related to day to day work at site with following information : -

i) Number of skilled and unskilled Labourers / Workers with their names, addresses and photographs who will be residing in transit hutments at site and are to be retained through out the construction period.

ii) Workers' Insurance Policy with Numbers of skilled and unskilled workers insured, Amount of Insurance, and Period of Insurance. The Site Supervisor should ensure from time to time that the policy is in force through out the construction period.

iii) List of construction equipments (in working condition) at site i.e. mixtures, mechanical viabrators, water pumps, Concrete Lift and other such machinery / equipments etc. required for day to day work.

7) RECORD OF STOCK - TAKING:

The Site Supervisor should take weekly/fortnightly (or as directed by the Owner / Developer) inventory of all materials lying at site on such day, and prepare inventory report. He should send copies of inventory report to the Developer / Owner and respective Contractors to keep them aware for making advance arrangements of materials to maintain continuous speed of work.

****

CHAPTER – FIVE

BUILDING CONSTRUCTION - (PART - I)

TERMINOLOGY

Aggregate : Irregular pieces of crushed stone used in making of concrete. It should be hard, strong, non-porous and free from particles. The maximum / minimum size of aggregate is governed by the nature of work, generally termed as 'Metal'.

Bar : Steel reinforcement used in concrete.

Base : Bottom, Foundation, Foot-support on which Load ultimately rests.

Basement (CELLAR) : A lowest storey of a building beneath the principal one, below ground level fully or partially.

Beam : A main structural horizontal member between columns.

Bond : An arrangement of masonry units in successive courses to tie the masonry together, both longitudinally and transversely.

Brick : A rectangular block of baked or burnt clay with desirable approximate size generally is of 9" X 4.5" X 3". It should be hard, sound, free from cracks, and uniform in size, shape and colour i.e. deep red or copper.

Built-Up Area: A plinth area of any unit measured with out to out dimensions inclusive thickness of walls.

Bulging of Concrete : A swelling, sagging or increase in the form of set concrete resulted due to poor Form (centering) work.

Cantilever Projection: An unsupported projection from building line generally in the form of bracket to support hung projections of balconies, chajjas, cornices etc.

Carpet Area: An inner area of any room/s measured from inner surface of wall to wall, excluding thickness of walls.

Cavity Wall: A two sleeve wall built of arranged bricks or concrete blocks to provide air space within the wall. The width of cavity should not be less than 2" and more than 3" (i.e. 50 mm to 75 mm).

Cement : A product of Lime Stone in powder form, used to set / adhere two bodies together, i.e. mortar, concrete etc.

Cement Mortar : A mix of cement, sand and water in specific proportion.

Center Line Plan: A plan prepared by the architect / structural engineer specifying sizes of columns and its exact center to center distance at two directions at horizontal plane, with exact out to out dimensions of proposed structure.

Ceiling / Slab : The inner roof of a room.

Chhajja : A cantilever projection provided as weather shade over openings of windows, ventilators etc. or wherever required in external walls.

Chowk: A fully or partially enclosed space permanently open to sky within a building or at any level of building.

Column : A vertical load bearing supporting member, made of R.C.C. or Masonry.

Concrete : It is a mixture of sand, aggregate, cement and water in fixed proportion.

Construction Joint: A point left at already placed and hardened concrete to join with fresh / new concrete. The placing of such joint should be in such a way that the strength of member is not affected.

Coping : It is a horizontal covering course of masonry or concrete.

Corridor : A common passage, lobby or a circulation space within the building including a common entrance hall / foyer.

Cover Blocks: Small blocks of week concrete placed to achieve desired concrete cover to reinforcement.

Compaction : A process to press and consolidate the concrete; to expel air bubbles in the concrete mass entrapped during mixing. This can be carried out by- i) Hand Compaction by Roding, and by ii) Mechanical Vibrators.

Curing : A process of keeping laid concrete damp to facilitate completion of chemical reaction of cement and water to achieve desired strength, and to prevent loss of water from concrete during its early life.

Dado: It is a cladding of tiles provided to wall surfaces wherever required.

Dead Load: An unrelieved weight, and permanent compressive burden / load on a structure.

Dead Wall : A wall without any openings except for openings of ventilators not exceeding 60 cm. in height to be provided at beam bottom.

Dowel : A projected reinforcement for extension either vertically or horizontally.

Drip : A projected molding provided at to the edge of roof; or such projections; for throwing off rain water.

Excavation : A process of digging out soil from required depth and volume thereof for laying foundation.

Expansion Joint: This joint permits expansion and contraction in concrete due to changes in temperature and moisture contents; in reinforced concrete, provided to sub divide large continuous area. Generally expansion joints are provided wherever continuous length of building exceeds 40 Mtrs.

Eccentric : Any member departing from the centre, not having the same axis / centre as another.

Farma : A form-box to measure or to determine volume of sand and aggregate required for concrete mix. The Farma size is 30 cm X 30 cm X 37.5 cm (12" X 12" X 15") for 1:1:2 and 1:2:4 Mix. However for 1:1.5:3 Mix the size of Farma will be 30 cm X 37.5 cm X 45 cm (12" X 15" X 18").

Floor Height: A vertical distance of a room measured top to top between two floors.

Footing / Foundation: A spread constructed in brick work, masonry or concrete under the base of a wall or column for the purpose of distributing the load on large area.

Form Work : A frame/form work of steel or soft wood to provide support to R.C.C. members as per design of Structural Engineer popularly known as Shuttering or Centering.

Ground Level : The horizontal plane or line of solid surface of Land / Soil.

Guniting: A process in which mixture of cement, sand & water is forced through Cement-Gun and shot in to place by compressed air; generally adopted to repair and to reinstate old and deteriorated concrete in R.C.C. members; and also for water proofing of exposed concrete surfaces. This process is also known as ' Shot Crete'.

Grouting : Cementation carried out by forcing cement grout under pressure through drilled holes in members for repairing and restoring stability of structure.

Hacking : Roughening of concrete surfaces with hammer in workman like manner as soon as shuttering is removed to receive plaster coat perfectly.

Hold Fasts: These are long nails or steel strips (patties) fastened with door and window frames to be embedded in brick work to hold the frames firmly.

Honey Comb: A patch of loose concrete, generally occurred at the bottom and sides of R.C.C. beams, columns, joints and slabs etc.; formed due to improper compaction and or loss of cement slurry from the gaps of defective centering.

Jacketing: A process by which either cover or casing is provided to weak structural load bearing members. Generally jacketing is provided to strengthen the existing columns up to footings to maintain or increase structural stability of the building required for additions / alterations.

Lintel : A horizontal R.C.C. layer / beam provided at the top of window / door sills to accept wall load above.

Line-Out of Building : Physical marking of plinth line of proposed structure at exact location on site in relation to its distances / open spaces from plot boundaries as shown in the plans prepared by the Architect.

Load Bearing Capacity of Soil : A bearing capacity of soil which depends upon physical characteristic of the soil particles, moisture contents, and atmospheric influences. In general heavier the unit weight of soil the greater the strength.

Load Test: After concreting, if the strength of the member of a structure is felt doubtful, a test load can be applied on the member to verify its strengths / stiffness, under the instructions and supervision of Structural Engineer.

Load Bearing Wall: A wall designed to carry super imposed load. The thickness of load bearing wall should be sufficient at all points to maintain the stresses due to dead, live and other loads (for which the structure is designed) within prescribed limits.

Masonry : An assemblage of masonry units properly bonded together by mortar.

Open Space A horizontal distance measured at right angle from external face/s of building to the compound wall at each corner / offset.

Over Lap: When sufficient length of bar (dowel) is not available, two bars are finely wired overlapping each other. The overlapping length shall be as directed by the Structural Engineer.

Parapet Wall : A low height protection wall or railing built along the edge of roof.

Pile Foundation : A foundation made of piles; normally provided where the soil material under the base of structure has insufficient bearing power to take load of structure and soil near the ground surface is also incapable of supporting mat foundation.

Pile Caps: It is a R.C.C. Member block provided above cut-off level of piles connecting pile foundation with columns and tie beams, which transfers the load effectively to the pile foundation.

Plaster : A uniform layer/s of cement mortar applied over external and internal surfaces of structure; generally applied in two coats.

Plinth : A portion of a structure between the surface of finish ground level and surface of the floor immediately above the ground.

Porch : A covered surface supported on pillars or otherwise for the purpose of pedestrian or vehicular approach to a building.

Pointing : Inserting mortar at face joints of masonry which can be either flush weathered or grooved.

Plumb : A heavy mass (as of lead / steel) hung on string used to measure vertical line of any member / surface.

Raft Foundation : A substructure supporting an arrangement of columns or walls in a row or rows transmitting the loads to the soil by means of continuous slab with or without depressions or openings.

Retaining Wall : A wall built in Masonry or R.C.C. to resist the pressure of earth filling of backing, deposited behind it after it is built.

Reinforced Cement Concrete(RCC): A combination of concrete with steel bars.

Ready Mix Concrete (RMC) : A concrete of required proportion made at R.M.C. plant and delivered at site in rotating drums / capsules mounted on vehicle with necessary mechanical equipments for laying / placing concrete at proper locations.

Sand : The Cohesion less aggregate of rounded, sub rounded, angular, sub angular or flat fragments of more or less unaltered rock or minerals.

Shear Wall: A wall design to carry horizontal forces acting in its plane with or without vertical imposed loads.

Spread Foundation : A foundation which transmits the load to the ground through one or more footings.

Striking of Forms: After the concrete has thoroughly set and hardened, it is a process of removing of shuttering / centering gradually and evenly so as not to cause any under shocks to concrete work.

Stilt : A ground floor of multistory structure with non habitable height used generally for parking of cars.

Water Cement Ratio : A ratio of the weight of water (exclusive of that absorbed by the aggregate) to the weight of cement therein, which is a most important factor for the strength of a concrete.

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BUILDING CONSTRUCTION - (PART-II)

(STAGE WISE CONSTRUCTION CHART)

A) R.C.C.

↓

Excavation for Foundation (Conventional)

↓

Rubble Packing, Compacting and Laying of P.C.C.

↓

Footings

↓

Columns Below Plinth Level

↓

Plinth Beams & Brick Work up to Plinth Level

↓

Rubble Packing, Filling & P.C.C. at Plinth Level

↓

Floor Columns

↓

Floor Beams & Slabs

↓

B) Brick Work & Plastering

↓

External Brick work with fixing of Door/Window Frames

↓

Internal Brick Work With Fixing of Door Frames

↓

External Plastering

↓

Internal Plastering

↓

C) Electrical Wiring

↓

Providing & Fixing of Conduits / Battens for Electrical Wiring
(Either Open or Concealed)

↓

Providing & Fixing Distribution Boards

D) Water Supply & Drainage Work

↓

Fixing of External Drainage Lines

↓

Fixing of External Water Supply Lines

↓

E) Water Proofing

↓

Terrace Water Proofing

↓

Water Proofing to WC, Baths, Toilets & Sinks Etc.

↓

F) Flooring

↓

Laying & Fixing Floor Tiles in All Rooms & Passages Except Toilet Blocks

↓

Polishing of Flooring

↓

G) Internal Plumbing

↓

Laying & Fixing of Plumbing Lines in W.C. Bath, Toilets & Kitchens

↓

H) Flooring & Cladding

↓

Laying & Fixing Ceramic Tile Flooring And Cladding to Walls of W.C. / Toilets

↓

I) Cooking Plat - Forms

↓

Construction of Cooking Platforms in Kitchens Including Sink

↓

Providing Ceramic Tile Dados Above cooking Plat-Forms

↓

J) Door & Window-Shutters

↓

Fixing of Door & Window Shutters

Providing Fittings & of Fixtures to Door & Window Shutters

↓

K) Electrical Fittings & Fixtures

↓

Fixing of All Electrical Fittings & Fixtures; including
Fixing of Consumer Meters

↓

L) Plumbing and Sanitary Fittings

↓

Fixing of All Plumbing Fittings & Fixtures; including Delivery Lines & Water Pumps and
Testing of Service Lines against Leakages

↓

M) Fabrication

↓

Fixing of M.S. Grills to Windows, Ventilators & Balcony Enclosures Etc.

↓

Hand Rails to Staircase, Balconies, Fixing of Compound Gates Etc.

↓

N) Storage Tanks

↓

Constructions of Septic Tank & Soak-Pit if any

↓

Construction of Suction Tank & Pump Room
(This can be constructed at initial stage also)

↓

O) Other Installations

↓

Lift / Elevator Installation

↓

Fire Fighting System

↓

P) Under Ground Water Supply & House Drainage Works

↓

Connecting Under Ground Water Supply Lines To Consumer Units

↓

Connecting Under Ground Drainage Lines to External & Internal Drainage System

Q) Paving / Compound Finish

↓

Providing & Laying P.C.C. for Compound Pavement up to Finish Ground Level Including Fixing of Surface Finish Materials

↓

R) Surface Storm Water Drains

↓

Providing & Laying Storm Water Drains for surface water disposal and its connection to Municipal S.W.D.

↓

S) Colouring

↓

External Cement Paint

↓

Internal Painting - Distemper / Colour Wash

↓

Oil Painting to Wood Work & Fabrication

↓

T) Service Connections

↓

Water Connection From Municipal Water Main

↓

House Drainage Connection to Municipal Sewer Main

↓

U) Landscaping / Tree Plantation

↓

Plantation of Trees Within Compound

↓

Landscaping of Garden Area etc.

↓

Virtual completion of project

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CHAPTER - SIX

CHECKING OF MATERIALS

The Site Supervisor should check all the materials brought at site before it is allowed to use in construction, as per following general check list for respective materials: -

1) SAND: -

Sand is an ingredient of concrete which fills the voids in coarse aggregates to produce dense concrete.

Sea sand should not be used in its natural state as salt attacks reinforcement. The high salt contents will retard setting and hardening of cement. Therefore sea sand should thoroughly washed and cleaned before it is allowed to use in production of concrete.

In the circumstances it is advisable to use river-bed or pit sand only, as sea sand contents salt and other impurities like chlorides which induces corrosion of steel bars and finally affects the strength of structure. The site supervisor should ensure that : -

i) The sand is clean, sharp, hard, durable, free from clay, mica and soft flunky pieces; silt and clay etc.

ii) The sand must be well washed and cleaned before use.

iii) The sand can be properly graded by passing it through mesh. The main object to use sand in mortar and concrete is : -

a To prevent excessive shrinkage and cracking of mortars / concrete in setting, especially in the case of fat limes which shrink very much while drying. Cement also shrink to some extent.

b. To improve strength and setting power of mortar as sand has greater crushing strength.

c. To increase the bulk and reduce the cost in case of cement mortar.

2) AGGREGATE:

The aggregate obtained from variety stones i.e. Basalt, Granite, Quartzite, Trap and those with rough and nen glossy surfaces are considered perfect for the use in concrete. For most of the reinforced concrete works, maximum size of coarse aggregate of 20 mm is generally suitable.

The coarse and fine aggregate should be used in proper proportions while batching for preparation of concrete. The Site Supervisor should check: -

i) That the aggregate is strong, non-porous and free from particles.
ii) The aggregate must be clean, and should be free from organic materials i.e. clay, loam, vegetable etc.
iii) That it should be thoroughly washed with clean water before use.
iv) The grading of coarse and fine aggregate as frequently as possible to ensure that the specified grading is maintained.

3) CEMENT :

As per the properties and chemical composition the cements are classified in different categories. Ordinary Portland Cement is most commonly used in general engineering works. Other types of cements i.e. Rapid Harding Cement, Quick-Setting Cement Blast-Furnace Slag Cement, Hydrophobic Cement, Low Heat Cement, Sulphate Resisting Cement etc. are used for specific purposes, and intended uses as recommended by the Structural Engineer.

Commonly used and available grades of cements are 43 and 53. Grade number is a compressive strength of mortar cubes at 28 days.

Cement of specified strength and brand should be used as directed by the Architect / Structural Engineer for the construction, as specified for respective items. The Site Supervisor should : -

i) Confirm in advance from Structural Engineer the type, grade/s and brand of cement before it is brought at site.

ii) Check at random the brand, grade and weight, ISI Mark, Date of Mfg., Etc. written on cement bag. When doubtful inform Structural Engineer / Architect and take instructions before it is allowed for use.

iii) Check that cement bags are completely dry, and do not contain any moisture.

iv) Allow to use cement in paper sacks than jute sacks.

v) Check that cement is stored in a dry room, preferably on wooden plat forms of 15 cm to 22.5 cm (6" to 9") above ground level and 30 cm (12") away from walls.

vi) Not to allow stacking of cement more than 10 layers in height (maximum 15'-0") to prevent bursting of cement bags in bottom layers.

vii) Check that the cement is used in rotation in sequence of arrival of stock.

viii) Before use in concrete production, check the initial and final setting time of cement.

4) ADMIXTURES:

The use of concrete admixtures specially chemicals in form of epoxy or polymer, improves the quality and life of structures; which gives protection to steel and concrete from rusting, sulphate attacks and effects of other adverse weather conditions.

The admixtures if used shall comply with IS 9103. Admixtures should not impair durability of concrete nor combine with the constituent to form harmful compounds nor increase the risk of corrosion of reinforcement. The workability, compressive strength and the slump loss of concrete with and without the use of admixtures shall be established during the trial mixes before use of admixtures.

The relative density of liquid admixtures shall be checked for each drum and should be compared with specified value before acceptance. The chloride contents of admixtures shall be independently tested for each batch before acceptance. If two or more admixtures are used simultaneously in the same concrete mix, data should be obtain to access their interaction to ensure their compatibility.

Mainly there are 3 types of admixtures: -

i) NSF : Naphthalene Sulphonated Formaldehyde.

ii) MSF : Melamine Sulphonated Formaldehyde.

iii) MLS : Modified Lingo Sulphonates.

Note: *- i) In Indian weather conditions use of admixtures in category 1 and 3 are more suitable.*

ii) Stiff Concrete can be made plastic by adding recommended plasticizers. However the use of admixtures shall always be as directed and specified by the Structural Engineer.

5) STEEL:

The most commonly steel used for reinforcement is either plain Mild Steel or High Tensile Cold Twisted deformed bars (Ribbed Tor steel), rolled and made from structural steel of reputed rolling mills, as specified by the Structural Engineer.

Mild Steel: Generally Mild Steel is used for all kinds of structural steel works. It is soft carbon steel and may contained 0.2 to 0.5 percent carbon. It is a elastic material possessing excellent ductility and can be easily cut, punched and drilled.

High Tensile Structural Steel : This is popularly known as Ribbed Tor steel, or high tensile cold twisted deformed bars. This has higher tensile strength and yield point. Deforming increases bond between steel and concrete where end hooks can be omitted. Due to its higher tensile strength it is most commonly used reinforcement.

The standard diameter of round bars commonly in use are of, 6, 8, 10, 12, 16, 20, 22, 25, 28, 32, 36, 40, 45 and 50 mm.

Note: *The used of Mild or High Tensile structural steel shall be as prescribed, specified and directed by the Structural Engineer.*

The Site Supervisor should:-

i) Ensure that the type and use of steel shall always be subject to the specifications and specific approval from the Structural Engineer.

ii) Ensure that there is TOR / Trade mark rolled on each meter length of high tensile reinforcement steel.

iii) Check that the structural steel is free from cracks, surface flaws, laminations, splits, rough, jagged or any other surface defects.

iv) Ensure that the steel stock is properly stacked in such a manner so as to avoid its ground contact.

6) BRICK :

The bricks are generally used for construction of walls / partitions, as per the size and thickness as shown in working drawings prepared by the Architect. The Site Supervisor should ensure : -

i) That the bricks are well burnt and uniform in colour and size.

ii) That the bricks are free from cracks and flows.

iii) That the surfaces are not too smooth otherwise mortar will not stick to it.

iv) That it should give metallic ring when struck with hammer or other brick.

v) That it should not break when struck with other brick or dropped flat on ground from height of about 3 to 4 feet.

vi) That it should have surface so hard that cannot be scratched by the finger nails.

vii) That it should not absorb water more than 1/6 of its weight i.e. 20% absorption, when immersed in water for one hour.

viii) That the bricks should not be allowed to use with lime or cement mortar unless soaked in water for at least one hour before use.

Notes: *1) The standard size of Brick (I.S. Modular) is 9" X 4 1/2" X 3".*

2) *The minimum crushing (compressive) strength of burnt bricks tasted flat wise prescribed are : -*

a) Common Building Bricks	:	*35 Kg. / Sq. Cm.*
b) Second Class Bricks	:	*70 Kg. / Sq. Cm.*
c) First Class Bricks	:	*105 Kg. / Sq. Cm.*

7) WOOD / TIMBER :

Well seasoned and sound teak wood shall be used of required sections as specified for respective items of wood work. The Site Supervisor should check and ensure that :

i) It should be dry, seasoned and free from moisture/ water contents.

ii) It is free from cracks, hollows, bad knots and such other defects.

iii) It should give metallic ring when struck with hammer.

Note: *Get the sample pieces approved from the Architect and keep at site office for random verification.*

8) FLOORING TILES :

Flooring work can be done by different types of floor tiles i.e. various type of stones i.e. Tandoor, Kota, Marble, Granite, Glazed and Ceramic etc. The Site Supervisor should check respective type of tiles brought at site before its use, as under : -

A) Tandoor / Kota :

i) It should be compact, non-porous, hard, free of cracks and uniform in colour; extracted preferably from one quarry.

ii) It should give metallic ring when struck by hammer or by other tile.

iii) Check the shades by spraying clean water. Light blue / gray shade stone tiles are hard & strong and commonly used for all type of occupancies.

iv) Reject the lot if soft tiles, (having yellow and brown shades); which are generally weak, and not recommended.

Note : *Keep approved sample in site office for random verifications.*

B) Marble :

It is a strongest variety of lime stone and one of the most durable of all stones; and available in different colour shades from white to black. The Site Supervisor should ensure : -

i) That it is uniform in colour, grains, thickness, free of cracks and obtained preferably from one quarry.

ii) That it should give metallic ring when struck by hammer or other stone.

Note : *Keep approved samples in site office for random verifications.*

C) Granite :

This is moststrongest and durable stone for flooring, and cladding, used at places subjected to heavy loads; and available in variety of shades. The Site Supervisor should ensure that :

i) It is uniform in colour, thickness and texture.

ii) It should give metallic ring when struck by hammer or other stone.

iii) It is fine grained, and preferably obtained from one quarry.

Note : *Keep approved samples in site office for random verification.*

D) Ceramic / Glazed Tiles :

These tiles are generally used for flooring and dados of Bath Rooms, W.Cs., Toilets and Kitchens, where water use is often. Now a days improved quality of ceramic tiles are used for regular flooring also. The Site Supervisor should ensure that: -

i) It is a product of reputed company and is of 1st quality.

ii) The tiles are uniform in colour, size, finish, thickness and having even edges; and shall be free form air bubbles, and any surface defects.

iii) It should give metallic ring when struck by hammer or other tile.

Notes: *i) 2nd quality tiles vary in colour, surface finish and posses air bubbles uneven edges, and such minor surface defects.*

ii) Keep approved sample tiles in site office for random verification.

9) FITTINGS AND FIXTURES:

A) Wood Work :

All fittings and fixtures for door, windows and for other wood work shall be got approved from the Architect. Generally fittings and fixtures are of brass, ironedoxidized, stainless steel or aluminum. The Site Supervisor should ensure that : -

i) The brand, weight, gauge, smooth finish is in conformity with approved samples.

ii) It should not have cracks, joints or such other surface defects.

Note : *Keep approved samples in site office for random verification.*

B) Water Supply, Plumbing and Drainage :

The Site Supervisor should ensure that all fittings and fixtures are approved by the Architect; and Licensed Plumber. He should : -

i) Check that G.I. pipes for water supply are of 'C' class; from reputed Mfg. Company, which has "Heavy" mark at every meter.

ii) Check that all pipes and accessories are of standard quality with ISI mark.

iii) Check that all sanitary wares i.e. W.C. Pans, Commodes, Wash basins, Urinals, Sinks etc. are of 1st quality; with smooth finish and free from surface defects; cracks, broken edges etc.

Note: *Keep approved samples in site office for random verification.*

C) Electrical Fittings and Fixtures :

All wiring materials, accessories, fittings and fixtures should be got approved from the Architect and Licensed electrical engineer / contractor. The Site Supervisor should: -

i) Check all the materials and accessories that are of quality and standard make of reputed company and possess ISI mark.

ii) Check at random that the accessories and fixtures are of smooth finish and are free from cracks, broken edges and similar surface defects.

Note : *Keep approved samples in site office for periodic verifications.*

10) COLOURS :

Generally the Water proof cement paints are used for painting external surfaces where as inner surfaces are finished with colour wash or distempers unless special type of paints are specified by the Architect. For external surfaces Sand tax (Mat), Acrylic and Polymer based paints are available. They are more durable and costlier than regular cement based paints. The wood work and fabrication are provided with oil paints. The Site Supervisor should ensure: -

i) That the cement paint brought at site is dry and packed in paper sacks.

ii) That the brand, weight, colour shade, ISI mark, etc. is in conformity with the specifications and approved samples.

iii) That the ready mix oil paints of reputed brand with ISI mark, of approved shades are permitted to be used, for wood work, fabrications and other surfaces as directed by the architect.

Note : *Colour shade cards of approved samples, of Cement and Oil paints shall be kept at site for verification of shades, brands, etc.*

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CHAPTER - SEVEN

FIELD TESTS OF CONCRETE MATERIALS

Various materials are used in construction. In R.C.C. frame structure aggregate, cement, sand, and steel are main components. Since the said materials are brought continuously at site in bulk, it is very difficult to check each and every item daily. As such, some common field tests are in use to check at random, the material lots which are described as under : -

1) AGGREGATE :

The testing of aggregate can be ascertain by sieve analysis. The materials retained on a 4.75 mm IS Sieve is classified as 'Coarse Aggregate', and below that it can be defined as 'Fine aggregate or Sand'.

Angular and roughly cubical particles are ideal, however river gravel make the best coarse aggregate. Roughly spherical (rounded) aggregates can produce most workable concrete when mix portion and water-cement ratio is well controlled. The voids in the mixed aggregate would be minimum, when sand is just sufficient to fill the voids in coarse aggregates. The volume of coarse aggregate is generally taken as twice that of fine aggregate. The grading of aggregates is most important since it can affect workability, density and strength of concrete, hence proper inspection of aggregate is essential before its use.

2) SAND :

a) **Presence of silt or clay**

i) This can be checked by rubbing a sample of sand between damp hands noting the discoloration caused thereof. Clean sand will leave the hands only slightly stained; which is a good sand for all ordinary purposes.

If hands stay dirty after the sand is thrown away, it indicates that there is presence of too much silt and clay.

ii) In another method, sand is filled up in a glass tumbler of its half capacity. A clean water is poured until the tumbler is three quarters full. Shake up the contents vigorously and leave it to settle for about an hour. Clean sand will be settled at bottom immediately and presence of clay will show the water muddy. Adding of one tea spoonful of salt will quicken the process, and clay or silt will settle in layer slowly on the top of the sand.

When thickness of silt layer exceeds one seventeenth, or 6% of that of sand below, such sand needs washing. This test is known as 'decantation test' and is not applicable to crushed stone sand.

Note: *i) A small presence of silt or clay not exceeding one to two per cent can be considered which improves the plasticity of a mortar to some extent. However an excess will cause reduction in strength of concrete.*

b) **Presence of organic impurities** :

In this test process the sand is mixed thoroughly in equal volume of a solution of caustic soda (100 gm. in 4 liters of water) in a glass bottle, and left it to settle for 24 hours. If the liquid above sand shows brown or yellow colour, it indicate the excessive amount of organic impurities.

Note: *i) Such organic impurities can be removed by washing the sand before it is allowed to use.*

ii) A certain per cent of impurities are inevitable in sand. Maximum 6 per cent of silt and 2 to 3 per cent of mica can be allowed / tolerated.

3) STEEL :

a) Cold Bend Field Test of Bars :

The test pieces of steel, should be cut lengthwise and crosswise from 'plates'; and lengthwise from 'Sections and Bars'. The test piece should withstand without fracture when doubled over either by pressure or by slow and steady blows of hammer, until the two sides of test pieces are parallel.

This bend test determines the metal is adequately ductile if : -

i) The internal radius of Bend is not greater than 1.5 times the diameter or thickness of the bars above 25 mm in diameter.

ii) The internal radius of Bend is not more than the diameter or thickness of bars which are less than 25 mm in diameter or thickness.

b) Tensile Test : It is generally carried out in labs. A test piece is stretched by gradually increasing load applied in apposite directions at its ends, until the test piece breaks. There is an elastic limit and yield point for steel under tension or compression.

c) Checking of Diameter of Bars : The Site Supervisor should be familiar and capable to check by visual inspection the diameters of various types of steel bars i.e. 8,10,12,16,20,22 mm etc. and he should ensure that the same are within tolerable limits. In case of doubts he can check diameter of bars by actual measurements, and or refer the matter to the Structural Engineer for instructions.

4) CEMENT

Accurate testing of cement requires practice and skill. Of the various field tests described a Test for 'Setting Time' may give some early indication as regards quality of cement, which is described as follows :

i) Make a stiff paste of neat cement and clean water after noting the volumes. Mould the paste into a pat 75 mm X 75 mm X 20 mm. The pat should commence to set in about thirty to sixty minutes. In 18 to 24 hours the pat should have hardened sufficiently and should make it impossible to scratch with thumbnail and it should be difficult to break the pat with the fingers after 48 hours.

ii) The commencement of setting of the cement can be roughly estimated by pressing the uncut end of a lead pencil into the mass. It will be found that the resistance to piercing increases suddenly when setting begins. The setting time should be counted from when water is added to the cement.

iii) The commencement of setting of cement can also be roughly estimated by holding vertically a jotter ball pen on mass. It will be noticed that under the weight of the pen, the projecting tip sinks slowly in the pallet. Make three such marks. Repeat the operation after 30 minutes. If the cement is of proper quality the tip will hardly penetrate in the pallet.

5) WATER

Besides Aggregates, sand and cement water is important component in production of concrete. The water to be used for concrete should be clean and free from oils, acids, alkalis, vegetable or other organic impurities. As such potable (drinking water) water is suitable for concrete.

i) Contents of excess alkalinity or acid in water can be tested by litmus paper. A rapid change of the litmus paper indicates dangerous amount of acid or alkali presence.

ii) Beyond a visual inspection for cleanliness a practical filed test to ascertain suitability of water for the use in concrete can be carried out by following method.

Prepare two identical pats of size 75 mm dia and 12 mm thick of neat cement paste, one with water of known suitability and other with water under test.

Place the pats on a clean non absorbent surface for 48 hours and observe setting and hardening times for both the pats.

If the pat made with water under test is not up to the standard of the other pat, then water under test is not suitable for the use in production of concrete.

6) TEST LABORATORY AT SITE :

i) Some time the above indicative tests may not be possible to carryout on site of smaller works, and in such cases it should be done at out-side labs of repute. The test reports should be forwarded to the Architect and Structural Engineer and obtain necessary instructions thereof if required so.

ii) For larger projects Field Test Lab should be established at site. Such site lab should be equipped with the following : -

i) Cube Testing Machine
ii) Sieve Sets
iii) Electric Oven
iv) Chloride and Phosphate Testing Kit
v) Rapid Moisture Meter
vi) Thermometer
vii) Sp. Gravity Bottle
viii) Balance
ix) Cube Moulds
x) Slump Cones
xi) Measuring Jars etc. etc. and any other apparatus required thereof.

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CHAPTER - EIGHT

TESTING OF CONCRETE CUBES

To ascertain the desired strength of concrete it is necessary to carry out cube tests regularly through out the period of concreting during construction. M.C.G.M. has made it mandatory to keep record of cube tests. The cube tests can be carried out by establishing a laboratory at site for major projects involving voluminous concreting. Alternatively such test reports can be available from professional test laboratories as per choice.

Note:- *For relatively small buildings / works in which quantity of concrete is less than 15 m^3, the strength tests may be waived at the discretion of the Structural Engineer.*

The Site Supervisor should study the text appearing hereunder carefully, and get himself familiar with all the exercises and methods to be adopted. Following information will give fare idea of all exercises required for the purpose:

1) **Sampling Procedure** :

A random sampling procedure shall be adopted to ensure that each concrete batch shall have reasonable chance of being tested i.e. the sampling should be spread over the entire period of concreting and cover all mixing units.

2) **Frequency**:

The minimum frequency of sampling of concrete of each grade shall be in accordance with the following: -

Quantity of Concrete in M^3	**Number of Samples**
1 - 5	1 (may be waived)
6 - 15	2 (may be waived)
16-30	3
31-50	4
51 and above	4 plus one additional sample for each additional 50 M^3 or part thereof.

3) Preparation of Specimens :

i) It is a good practice to prepare 6 (six) specimens. In order to get a relatively quicker idea of the quality of concrete, 3 specimens may be tested at seven days age. The remaining three specimens should be tested at 28 days age.

ii) Results of tests at 28 days age shall be the criterion for acceptance or rejection of the concrete. If however, from tests carried out in a particular job over a

reasonably long period, and if it has been established to the satisfaction of the Structural Engineer that a suitable ratio between the 28 days compressive strength at 7 days the Structural Engineer may suitably relax the frequency of 28 days compressive strength. The accepted ratio between 7 days and 28 days strength is 2 : 3.

4) Sampling:

i) A composite sample not less than 0.2 M^3 in volume is required for each test. When taken directly from the mixer the sample should be drawn in three increments by passing a clean and dry receptacle across the stream of concrete being discharged from the drum. The samples should be drawn when -one quarter, one-half and three quarters of the contents of the drum have been discharged.

ii) When taken at the time of deposition the sample should be collected from five different positions in the mass of concrete, avoiding edges where segregation may have occurred.

iii) The composite samples obtained by either of these methods should be mixed on a non-absorbent base with a shovel and should be used immediately for the test.

5) Moulding :

The samples obtained shall be cast in a steel mould, having accurate machined faces and strong enough to resist distortion. The mould should be capable to open in such a way that the specimen can be removed without damage.

6) Compaction :

i) The specimens shall be compacted either by hand or by vibration, depending upon the mode adopted in the actual construction as directed by the Structural Engineer.

ii) The compaction by hand is carried out by tamping each layer with a rod. Proper care should be taken to ensure that the stroke penetrates the underlying layer to its full depth for which a 16 mm diameter and 60 cm long bar with a bullet-nosed end should be used. The number of strokes to be applied to each layer is 35.

7) Curing :

i) The specimens should be cured under damp matting or sacks for 24 hours in a storage area, the temperature of which lies in the range of 22° C to 32° C.

ii) They are then immersed in clean water having a temperature of 24°C to 30°C until they are sent to testing laboratory.

iii) While being sent to the laboratory, the specimens should be packed in damp sacks, or similar material which would keep them in a damp condition during transport.

iv) On arrival at the laboratory they should be stored in curing water tank at a temperature of 25°C to 29° C.

8) Capping:

Prior to test, the specimens should be capped with either neat Portland cement paste, or a mixture of sulphur and inert filler, or by hard plaster.

9) The Compression Test :

i) At least three specimens, preferably from different batches, should be tested at each selected age.

ii) The specimens should be tested immediately after they are removed from the water curing tank.

iii) Before carrying out test, surface moisture, grits or slight projections if any should be removed.

iv) The Cubes should be placed in the testing machine in proper manner so that the load is applied to the opposite sides as cast, and not to the top and bottom as cast.

v) The rate of loading per minute for both cubes and cylinders should be approximately 140 Kg./cm.^{2}.

Note : *The compressive strength is calculated by dividing the load at failure by the cross sectional area of the specimen.*

10) **Standard of Acceptance** :

As already indicated, three test specimens are required to be made for test at each select age. The average of the strength of the three specimens may, in accordance with IS : 456-2000 be accepted as the compressive or tensile strength of the concrete provided that the difference between the maximum and minimum strengths of the three specimens dost not exceed 15 present of the average strength. 'Repeat - Tests' should be carried out unless the minimum strength exceeds that specified.

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CHAPTER - NINE

IMPORTANT OPERATIONS DURING R.C.C. WORK

The Site Supervisor should be familiar with various methods and operations of different trades, to be carried out during construction from commencement to completion of the work under the guidance of the Architect and Structural Engineer from time to time.

Before carrying out construction activities on the site compliance of following two basics preliminary requirements are made mandatory by the Municipal Corporation of Gr. Mumbai : -

A) DESIGNING OF EARTHQUAKE RESISTANT STRUCTURES :

After earthquakes at Killari (Maharashtra) and recently at Kuchh-Bhuj (Gujrat) the Municipal Authorities made it mandatory for the Structural Engineers and Developers to design and construct earthquake resistant structures respectively, within Gr. Mumbai limits.

As such the Site Supervisor should ensure and enquire from the consulting Structural Engineer, that the R.C.C. plans issued for executions are prepared taking into consideration the earthquake movements, and the structural designs are in accordance with the provisions of I.S. CODE - 1983.

B) SOIL INVESTIGATIONS / TEST REPORTS :

Now a days the Municipal Corporation of Gr. Mumbai insists for soil investigation report of every site wherever R.C.C. frame structure is proposed, before issue of development permission (commencement certificate), which earlier was applicable only for specific site conditions / topography.

Therefore the site supervisor should ensure that the soil investigation is carried out of the proposed site, and Geo technical Report based on actual soil investigation is obtained by the Owner / Structural Engineer, from the qualified Geo-technical consultant. A copy of such soil test report submitted to the Municipal Authority should be kept at site office records for reference.

Following is a text and check-list for some of the important methods, operations and exercises, which the Site Supervisor has to study, understand and keep him updated. These guide lines will facilitate and assist him to check, perform, observe and discharge his duties efficiently.

1) PRE-EXECUTION EXERCISES :

The Site Supervisor has to observe and confirm that : -

a The boundaries of plot should be got identified and demarcated from the Architect / Licensed Surveyor.

b. Peripheral Compound Wall or pucca fencing should be constructed / provided before carrying out Line-out of building on site.

c. The foot print of building should be marked on site by physical-line out of the plinth dimensions and open spaces from compound wall should be in conformity with the approved plans and get it checked and approved and / or obtain instructions regarding deviations if any, from the Architect.

d. The finish Ground level and Plinth level should be got confirmed from the Architect and its reference points should be properly marked at site.

e. The centre-line of each column should be marked on the peripheral side rails in conformity with the centre line plans prepared by the Architect / Structural Engineer.

f. After the plinth dimensions, open spaces, centers of columns and foot print of plinth and excavation trenches are checked by the Architect and Structural Engineer, the excavation for foundations should be allowed.

g. The location and size of water storage tank/s should be got approved from the architect and same should be constructed or temporary tanks should be provided at site for storage of water for construction and drinking purpose before work is started.

h. The Municipal water connection (for drinking purpose) should be installed at site if permitted through the Licensed Plumber, before any work is commenced.

i. The locations of temporary hutments for workers, storage tanks and godowns should be decided in consultation with the Architect and to get it completed from the contractor to avoid inconvenience to proposed construction.

j. Temporary toilet facility at appropriate location should be got constructed by the contractor for workers at site.

k. To make arrangements for temporary electric supply for construction purpose through the Licensed electrical contractor.

l. To ensure to obtain Soil Test Report from reputed Lab. before the commencement of work, and to submit the same to the Structural Engineer and obtain necessary instructions / drawings thereof.

m. To display a board at site giving details of project, professionals etc.

2) OPERATIONS DURING CONSTRUCTION :

Excavation for Foundation (Conventional)

i) Initially at least 4/5 trial pits at different locations should be excavated as directed by the Architect / Structural Engineer. The size and minimum depth of excavation should be as per the instructions of Structural Engineer; which will facilitate him to decide the bearing capacity of soil for preparing structural designs and calculations.

ii) After carrying out excavation of trenches to required depth, check the compaction of soil strata by piercing solid angular steel rod (paraee) in excavated surfaces as initial exercise before calling Structural Engineer for inspection; and approval thereof.

iii) After the depths and levels of foundation trenches are finally decided by the Structural Engineer, and approved thereof only then the contractor should be allowed to lay P.C.C. for foundation of required thickness and size as per the specifications / instructions of Structural Engineer; and not otherwise.

iv) It is obligatory that NO concreting should be permitted for any R.C.C. work through out the construction, without written permission from the Structural Engineer.

3) FORM WORK-SHUTTERING / CENTERING:

i) General :

a The form work shall confirm to the shape, lines and dimensions of R.C.C. members as shown on the Structural plans.

b. Water proof plywood / soft timber used for formwork should be of such quality and dimensions so as to remain sufficiently rigid and unyielding during laying, compaction and setting of concrete.

c. It shall be sufficiently strong enough so as not to deform and warp excessively when wetted or not to shrink which may create large gaps in or at the joints.

d. The forms shall be sufficiently tight to prevent loss of mortar from concrete.

e. In case of height more than 4 meters, props should be provided with special cross bracings as directed by the Structural Engineer. However number of jointed props shall not exceed 20%.

f. Any specialised form-work should be carried out under the guidance and instructions of the Structural Engineer.

ii) Board Sizes :

The recommended sizes of boarding of Form Work for various uses shall be as follows : -

For	:	Size of Boarding
a) Slab Panels	:	25 mm. with joists @ 600 mm. c/c.
b) Joists supporting slab boards	:	75 mm. X 50 mm @ 600 mm. c/c.
c) Sides of Beams	:	25 mm. with stiffeners 50 mm. X 50 mm.
d) Bottom of Beams	:	32 mm. with joists @ 600 mm. c/c.
e) Column Boxes	:	32 mm. with Yokes @ 600 mm. c/c.
f) Walls	:	25 mm. with Yokes @ 600 mm. c/c.

iii) Props :

a. Bullies used as props shall be of teak or similar strong and hard quality wood and its diameter shall not be less than 100 mm. and shall be in one length for work up to 4m. height.

b. The props shall be adequately stiff and properly braced; and shall not rest on loose or made up ground. For height more than 3 Mtr. bracing must be provided as directed by the Structural Engineer.

c. Spacing of props shall not be more than 450 mm. centre to centre for medium size beams.

d. There shall be minimum 12 props for slab per 10 Sq. Mrts. of area.

e. If thinner props are used they shall be braced laterally in both directions at mid height of props and in such cases the number of props should be increased as directed.

f. If Steel plates and tabular props are used for formwork and centering it shall be as per manufacturer's specifications and as directed by the Structural Engineer.

g. All props shall be truly vertical and should be supported on double wedges. While removing the props wedges should be gently eased.

iv) The general arrangement of Form work shall comply with following:

a. All pieces and panels shall be easily removable without causing disturbances to other members.

b. One side of column moulds shall be left open in case of columns higher than 2.5 to 3m. The open side shall be successively filled in as the concrete is placed and consolidated.

c. Wedges and clamps shall be used wherever practicable in lieu of nails to facilitate easy striking of form work.

d. All props shall be supported on double wedges. While removing the props these wedges should by gently eased out.

e. Adequate camber shall be provided in beams and slabs. Various pieces of formwork shall be fixed together with nails, screws, bolts, wire ties, clamps etc. Bolts and rods shall be preferably used for internal ties in case of heavy beams, walls etc. Wire ties for light and medium type of work may be used.

v) Treatment of Forms:

a. The inside of formwork shall be coated with non staining mineral oil or any other approved material. The coating should be as thin as possible and any excess should be wiped off before the reinforcement is placed.

b. Temporary openings shall be provided at the base of column boxes and wall forms and at other places wherever necessary to facilitate cleaning and inspection prior to laying of concrete.

c. All rubbish particularly chippings, shavings, sawdust, mortar pieces etc. shall be removed from the interior of forms before concrete is placed.

d. Formwork for heavy works and works at heights shall be as designed, detailed, and approved by the Consulting Structural Engineer.

4) STRIKING OF FORMS :

In normal circumstances (generally where temperature is above 20° C) and where ordinary Portland cement is used, forms may be struck after the concrete is fully set and hardened only after the minimum period have elapsed as directed by the Structural Engineer as indicated below : -

(a) Removal of props of walls, columns and vertical sides of beams		:	After 24 to 48 hours
i)	Soffit formwork to slabs	:	After 3 days
(b) Removal of props to slabs			
i)	Spanning up to 4.5 m (15'-0")	:	After 7 days
ii)	Spanning over 4.5 m (15'-0")	:	After 14 days
(c) Removal of props to beams bottoms			
i)	Spanning up to 6 m (20'-0")	:	After 14 days.
ii)	Spanning over 6 m (20'-0")	:	After 21 days.

(d) Removal of props to cantilever members

i)	Up to 1.5 M long	:	After 14 days.
ii)	1.5 M to 3 M long	:	After 21 days.

Notes:

i) Striking of forms shall start from the free end only.

ii) Special care shall be taken while striking the formwork of cantilever members.

iii) Supports shall not be released till the span behind the cantilever members is fully released.

iv) Moreover, before supporting any formwork for members coming above cantilever members, the whole member shall be supported and not only free end.

v) However, centering for slabs and beams can be struck at the end of above periods subject to cube crushing strength of concrete so cast have achieved at seven days age at least 66% of its final cube crushing strength. In the event of such cube strengths being lower, it shall be reported to the Structural Engineer for obtaining his recommendations before striking of centering.

vi) *If any honeycombs / defective concrete is detected after de-shuttering, it should be brought to the notice of the Structural Engineer, and such defective portions should be repaired strictly as per his instructions; immediately.*

5) REINFORCEMENT :

i) The type of reinforcement as specified by the consulting Structural Engineer shall conform to relevant codes. The rolled steel and sections made from structural steel shall conform to IS : 226 : 1975.

ii) The sizes and placing of bars, stirrups, hooks etc. for all R.C.C. members shall be strictly as per the design and specifications of Structural Engineer.

iii) All the reinforcement shall be clean and should be free from loose mill-scales, dust, rust, coats of paints, oil, mortar, which may destroy or reduce bond.

iv) Generally by and large cutting, bending and straightening of steel bars is done manually. However use of new equipments / machines for the said purpose can do the job much faster, giving better quality and economy. For simple handling the cutting area should be as close as possible to the steel storage.

v) All the hooks and bends in bar should be made before the bars are placed in position in form-work.

***Note**: No Concreting should be permitted unless reinforcement is checked and approved in writing by the Structural Engineer.*

6) PROVISIONS OF CONCRETE COVERS, CHAIRS, INSERTS, POCKET, SLEEVES ETC.

A) Covers :

Cover is provided for protection of reinforcement against corrosion and to withstand fire effects.

The reinforcement shall have adequate thickness of concrete cover, as specified by the Structural Engineer. However general norms for providing minimum thickness of covers are as shown in the following table : -

	Location	Required thickness of cover
i)	Foundations	: 40 mm.
ii)	At the ends of reinforcement	: Min. 25 mm and Not less than twice the diameter of bar.
iii)	For Longitudinal reinforcement i.e. piles	: Min. 40 mm and Not less than the diameter of bars.
iv)	For Columns	: Min. 25 mm up to 200 mm side Min. 40 mm above 200 mm side; and Not less than diameter of bars.
v)	For Beams : Sides, Top and Bottom	: Min. 25 mm and Not less than the diameter of bars.
vi)	For Thin slabs and walls	: Min. 20 mm
vii)	For Water Storage Tanks	: 35 mm with rich concrete and 40 mm with 1: 2: 4 mix.

Notes : *i) The above coverings are beyond stirrups and binders and exclusive of plaster or any decorative finish.*

ii) Increased cover thickness may be provided as directed by the Structural Engineer when surface of concrete members are exposed to harmful actions of chemicals, acid-vapor, sulphurous smoke, saline atmosphere etc. beyond the figures given above.

iii) Refer I.S. Code 456 / 2000 for additional information.

B) Chairs :

The M.S. Chairs are provided to support the top reinforcement of slabs. The size and locations of chairs shall be as specified by the Structural Engineer.

C) Inserts, Pockets, Sleeves etc.

i) All inserts for subsequent connections to concrete.

ii) Pockets for fixing any accessories to R.C.C. members.

iii) Openings for pipes, sleeves etc.

All inserts, pockets and opening including its sizes and locations etc. for the above purpose shall be provided in consultation with the Architect and as directed by the Structural Engineer while preparing form work.

Notes:

i) Detailed drawings and instructions must be obtained from other agencies i.e. Plumbers, Electrical Contractor etc. and such provisions should be made prior to concreting of R.C.C. work.

ii) In NO CASE cutting of holes, chase cut, making of grooves or any other cutting in R.C.C. work shall be allowed after concreting.

iii) Extreme care should be taken to- pre locate such provisions before laying concrete for R.C.C. members.

7) PRODUCTION AND CONTROL OF CONCRETE :

a) **Concrete Grades:**

Grade / Designation	Specified characterising compressive strength at 28 days N/ mm^2
M 15	15
M 20	20
M 25	25
M 30	30
M 35	35
M 40	40

Notes *:i) In the designation of concrete mix letter 'M' refers to the mix.*

ii) The number to the specified characteristic compressive strength of 15 cm cube at 28 days expressed in N/mm^2.

b) Normal Mix Concrete : Normal mix concrete may be used for concrete of grades M 10, M 15 and M 20. The corresponding proportions of concrete materials for normal mix and its grades as designated below : -

Grade of Concrete	Normal Cement: Sand: Aggregate	Max. quantity of water in liters per 50 kg. of cement
M 10	1 : 3 : 6	34
M 15	1 : 2 : 4	32
M 20	1 : 1.5 : 3	30

M 25 & M 30 : As per mix-design, as directed by Structural Engineer.

***Notes**: i) Normal mix means a volumetric mix wherein the cement shall be measured by weight.*

ii) For the purpose of durable concrete, the water-cement ratio shall be restricted to values as specified in I.S. 456 / 2000.

8) MIXING OF CONCRETE : PROCEDURES

a) Machine Mixing :

Normally concrete shall be mixed in a mechanical mixer. There are two types of machine mixers i.e. Continuous and Batch. The Continuous mixer can produce continuous flow of concrete and are used for works involving large mass of concrete. The portable Batch mixers either tilting or non-tilting type are commonly used for normal works. However the tilting drum mixer is more suitable for stiff work abilities as the entire mix can be easily emptied or discharged by tilting the drum. For machine mix concrete, following instructions shall be observed for desirable results: -

i) The coarse aggregates should be placed in the hopper first, followed by sand and cement. A small quantity of water should be poured in drum before dry materials are put in, to prevent the accumulation of cement paste around the blade roots. The required quantity of water for concrete mix can be poured simultaneously along with dry materials.

ii) Confirm that the drum is not over loaded, otherwise the mixing of concrete will not be efficient and materials will overflow while mixing.

iii) It is always observed that some cement and sand from the first batch of concrete will stick to sides and blades and as such the first batch becomes short of sand and cement. This harsh and stony concrete while placing will segregate and result in honeycombing and poor finish.

Therefore it is essential to have additional sand and cement, batched in first mix, due to this, the first mix will also require more water. However water-cement ratio of the mix would remain unchanged. It is recommended that around 10% increase in the sand and cement or reduction of coarse aggregates by about 20% can improve the first batch.

iv) The concrete shall be mixed continuously until there is uniform distribution of materials and the mix becomes uniform in colour and consistency. In NO CASE mixing be done less than 3 (Three) minutes.

Note: *10% increase in sand and cement can improve the first batch of concrete.*

b) Hand Mixing :

When hand mixing is permitted by the Structural Engineer it shall be carried out strictly as per his instructions. Following procedure should be adopted for manual mixing of mortar and concrete :-

i) Spread out the required quantity of sand evenly on the watertight mixing platform. Unload the cement on the sand and spread it uniformly over the sand layer.

ii) Mix the sand and cement with shovels (phawdas). Turn the mixture over and over, till it becomes of even colour throughout and free from streaks of brown and gray. (Presence of streaks indicate that materials are not yet mixed properly). Then the measured quantity of coarse aggregates should be uniformly spread over the sand-cement layer.

iii) Mix the dry materials in required proportion for minimum Two minutes, with a shovel from centre to side and then from side to centre and back to side, by turning it over and over, until the materials are blended properly. The mixture thereafter be further spread / arranged for making a hollow in the centre of the heap to receive water.

iv) 75% of the total water requirement be poured into the hollow portion and simultaneously. The mix should be turned towards the centre from sides over and over with the shovel. The wet mix then should be gradually turned and mixed with remaining quantity of water.

v) The wet mass should be turned over minimum 5 to 7 times and should be thoroughly mixed until concrete becomes uniform in colour and consistency.

Note: *10% more cement should be added in hand mixed concrete over and above specified proportion.*

9) TRANSPORTING & HANDLING OF CONCRETE :

After mixing, concrete shall be transported to the formwork as quickly as possible, in such a manner and methods which will prevent segregation and or loss of any of the ingredients or ingress of any for foreign materials and water. This is essential to maintain the required workability of concrete.

During hot and cold weather conditions the concrete shall be transported in deep containers. Suitable methods of transport as directed by the structural engineer may be adopted to reduce the loss of water by evaporation in hot weather and heat loss in cold weather conditions.

10) WATER-CEMENT RATIO :

Water-Cement Ratio is a ratio of the water in a mix (excluding water already absorbed by the aggregate) to the weight of cement therein. Water-cement Ratio is a most important factor in production of concrete which governs the strength of concrete. Less the water the concrete is more impervious and stronger. Hence control of water in concrete production is very important.

For making concrete more workable with reduction of use of water, now a days, water reducing super plasticizers are available, which can be used as directed by the Structural Engineer.

For immediate reference following table will give information on maximum free water cement ratio, with relative exposure, minimum cement content and minimum grade of concrete as specified in IS 456-2000:

TABLE

MINIMUM CEMENT CONTENT & GRADE OF CONCRETE AND MAXIMUM WATER-CEMENT RATIO FOR DIFFERENT EXPOSURES, WITH NORMAL WEIGHT AGGREGATES OF 20 MM NORMAL SIZE.

Sr. No.	Exposure	IS 456-2000		
		Minimum Cement Content Kg / m^3	Maximum Free Water-Cement Ratio	Minimum Grade of Concrete
1	Mild	300	0.55	M20
2	Moderate	300	0.50	M25
3	Severe	320	0.45	M30
4	Very Severe	340	0.45	M35
5	Extreme	360	0.40	M40

11) PLACING OF CONCRETE :

The Stage of placing and compacting concrete is the due point of the whole operation of concrete. Skilful methods will prevent segregation.

Before starting with the placing of concrete, the position of the construction joints should be predetermined so as to stop the concrete at the end of day's work. The positions of the joints should also be identified and be kept ready for consideration in case of failure of the concrete mixer or due to unforeseen stoppage of concrete by any other reason.

A) Manual Placing of Concrete :

While placing concrete following precautions should be taken :

i) While depositing the concrete, care should be taken that the particles do not segregate while placing.

ii) The concrete should not be thrown from a height, when brought in basket / ghamelas. The lowering direction of its fall shall be always vertical. The height of fall shall not be more than 1 to 2 Mtrs.

iii) The concrete in columns and beams should be deposited in centre to avoid possibility of coarse aggregate getting between the form work and stirrups, thereby obstructing flow and compacting of concrete.

iv) The runways for concreting gangs shall not be allowed to rest on reinforcement.

v) The Concrete must be deposited near its final locations. The corners and ends of form should be concreted directly.

vi) While concreting the foundations the practice of dropping the concrete in pits by chutes directly from the mixer is common, but the provision of baffle would prevent segregation.

vii) When depth of foundations are more, it is advisable to use trickles instead of chute for placing of concrete.

viii) While placing concrete in foundation pits where the water table is high, placing of concrete should not be done in such conditions as far as possible. It will be a good practice to provide a sump from where the water is pumped away to keep the pits as dry as possible. Quick setting compounds are effective in such cases. However the concreting in such areas shall be as per the instructions of the Structural Engineer.

B) Placing of Concrete with use of Machines :

Now a days use of R.M.C. is becoming very popular because of its advantages. In such cases concrete is placed at exact locations as required, more efficiently by the use of placer machines i.e. : -

i) Concrete Pumps.

ii) Placer Booms.

12) PROVISION OF STARTERS :

To ensure proper stiffness and grip to column form-work at all places, the starters can be provided strictly as per the specifications and instructions of the Structural Engineer.

However before concreting the starters, it is essential that at least 20 mm base concrete, inside and around such columns, should be carefully scraped and cleaned and then re-packed with 1:1:2 concrete mix. The re packed portion should be cured for at least 3 days before allowing concreting of starters.

13) COMPACTING OF CONCRETE : METHODS

The concrete will develop its full strength only if it is thoroughly compacted, by expelling voids and air bubbles in the concrete mass entrapped during mixing. The compaction can be carried out by hand or by mechanical vibrators. The concrete should be well compacted before setting commences, and should not be disturbed subsequently.

a) **Hand Compaction** :

This can be done either by roding, tamping, hammering or ramming on out side of the form work during setting of concrete.

i) Roding consists of inserting steel bar/s vertically into the concrete moving it up and down until the concrete is deposited in its placeRoding is used only for vertical sections, and corners.

ii) For slabs, compaction by tamping is the best method. This can be done by small wooden mallets which also can serve for finishing of concrete.

iii) Ramming is used for compacting heavy masses of plain concrete.

Note: *Hand compaction is preferred only in emergencies, if permitted.*

b) Compaction by mechanical vibrators:

Concrete compaction by mechanical vibrator (needle type) shall be carried out very carefully and strictly as directed by the Structural Engineer. The Site Supervisor should ensure that : -

i) The vibrators to be used are in working conditions, and there should be at least one or two extra for stand by service.

ii) The concrete so wet and plastic which can be easily compacted by hand (125 mm or more slump) should not be vibrated as the same will result in segregation.

iii) The vibrators can be used to make harsh and stiff concrete mix with a slump of 40 mm or less.

iv) The vibration can be easily workable where concrete is as dry as is practicable.

v) The vibrator in operation should be immersed vertically in concrete slowly and withdrawn more slowly, other wise gaps may be left in stiff concrete.

vi) The locations of insertion should be staggered to ensure that every bit of concrete is well compacted.

vii) Avoid touching of vibrators to the form work and reinforcement which will cause damage to the needle and form work and also will disturb placing of reinforcement.

viii) Do not use vibrator continuously. Intermittent rest is necessary.

ix) Over vibration should be avoided. The vibration should be stopped immediately when scum appears on surface.

Note: *Compaction by mechanical Vibrators will always give better results.*

14) TROWELLING FLOOR SURFACES :

a) Floor Surfaces : -

Wherever directed by the Architect and Structural Engineer floor surfaces can be trowelled to a smooth and hard finish with a wooden float and steel trowel. The first trowelling should be done after an hour or two, as soon as surface is sufficiently hardened; and excess water is disappeared from the surface. The final trowelling should be finished before initial set takes place.

b) Sunk portions of toilets, kitchen etc. : -

It is advisable to finish sunk portions of toilets, kitchen etc. to help it to become water tight at initial stage itself.

A cement slurry prepared in proportion of 2.2 kg. of neat cement for per square Meter of floor area, mixed with water should be spread over the surfaces, sides and joints while the concrete is still green.

The second coat of slurry should be applied when concrete starts setting. It should be ensured that the surfaces, sides and joints are properly trowelled to smooth finish. This process is generally termed as "Ghutai" by the contractors.

For curing the areas, as soon as the surfaces are dried up, the sunk portion should be filled-in with water for minimum required time as suggested by the Architects / Structural Engineer to achieve desirable results.

15) CURING OF CONCRETE :

When concrete is laid its water content is rapidly lost by evaporation occasioned by the action of sun, wind and also heat generated during setting of cement, unless

proper precautionary measures are taken. To prevent such loss of water from concrete during its early life, process of keeping set concrete damp is known as 'Curing'. Cement sets very fast in the initial stages unless kept damp to avoid loss of strength in concrete. Minimum 10 days of curing gives good results.

Effective curing can be done by following methods :

i) Vertical surfaces of concrete i.e. columns walls etc. can be covered by wet sacks or Hessian or similar absorbent materials; and can be effectively cured by continuous sprinkling of water by pipes. Alternatively by keeping pots full of water on their tops with dripping pin holes at their bottom also can give good results.

ii) Horizontal surfaces i.e. slabs etc. can be effectively cured by ponding system commonly used. After 24 hours of laying of concrete earthen or week mortar mounds in Squares of 30 to 50 mm on entire surface area shall be provided, and be kept full of clean water all the time therein; for at least 10 days.

iii) The curing by continuous spray / sprinkling of water on laid concrete for minimum period as directed by the Structural Engineer should be observed.

iv) Now a days curing compounds also are available and can be effectively used for inaccessible areas or wherever required; under the direction of Structural Engineers.

16) CONCRETING AT CONSTRUCTION JOINTS :

Concreting shall be carried out continuously upto construction joints the position and arrangement of which shall be predetermined by the Consulting Engineer. The concreting at construction joints is to be carried out very carefully as under : -

When the work has to be resumed on a surface which has hardened, such surface shall be roughened, and after removing all loose aggregates it shall be swept clean, and thoroughly wetted for about an hour by water. Cement slurry composed of cement and sand in the same ratio as the cement and sand in the concrete mix shall be applied followed by 15 mm layer of cement mortar in 1:2.

When the concrete is partially hardened, all laitance shall be removed by scrubbing the surface with wire or bristle brushes, very carefully to avoid dislodgement of particles of aggregate. The surfaces shall be then coated with neat cement grout. The first layer of concrete shall be well rammed against old work, by giving particular attention to corner and edges.

17) REPAIRING OF DEFECTIVE CONCRETE (HONEYCOMB ETC.):

For repairing of honeycombed and other defective concrete, loose aggregate shall be removed down to sound concrete. If chipping is necessary the edges shall be perpendicular to the surface or slightly undercut. No feather edges will be permitted. The area to be patched, an area at least 15 cm. (6") wide surrounding shall be dampened to prevent absorption of water from the patching mortar. A bonding grout shall be prepared using a mix of approximately 1 part fine sand passing a No. 30 mesh sieve mixed to the consistency of thick cream, and then well brushed into the surfaces.

The patching mixture shall be made of the same material and of approximately the same proportions as used for the concrete except that the coarse aggregate shall be omitted and the mortar shall consist of not more than 1 part cement to 2 parts of sand by damp loose volume. The quantity of mixing water shall not be more than necessary for handling and placing. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulations with a trowel, without addition of water, until it has reached the stiffest consistency that will permit placing.

After surface water has evaporated from the area to be patched, the bond coat shall be well brushed into the surface. When the bond coat begins to loose the water sheen, the premixed patching mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, it should be left undisturbed for at least 1 hour before being finally finished. The patched area shall be kept damp for 7 days.

18) IMPORTANT NOTES FOR CONTRACTORS

A) Reinforcement :

i) Reinforcement is represented diagrammatically and not necessarily shown in true projection in structural plans.

ii) Reinforcement shall not be bent after embedded in concrete.

iii) Laps in reinforcement shall be allowed only with the prior approval of the Structural Engineer and the lap length shall be provided as specified.

iv) Welding of reinforcement will not be permitted under normal circumstances unless directed by the Structural Engineer and same should be carried out strictly as per instruction.

B) Concrete:

i) Concrete shall be carried out continuously.

ii) Concrete shall be machine mixed, shall be placed and compacted before setting commences and shall not be subsequently disturbed.

iii) Concrete surface shall be kept constantly wet for seven days from the date of placing.

iv) Concrete shall not be placed during rain.

v) Water used for both mixing and curing shall be free from injurious / deleterious materials.

vi) If construction joints are necessary, their position shall be as determined by the Structural Engineer.

vii) Immediately after removing formwork any honeycombed and defective concrete is detected it shall be brought to the notice of the Structural Engineer and shall be repaired as stated above or as directed.

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CHAPTER - TEN

PRECAUTIONS FOR CONCRETING DURING HOT & WET WEATHER CONDITIONS

A) HOT WEATHER CONDITIONS : -

During summer months, high temperature combined with high wind velocity and or low humidity increase the rate of evaporation of the water and enhance the rate of hydration of cement, resulting reduction in setting time of concrete which effect adversely the properties of hardened concrete.

When temperature exceeds 38 deg. C. it is advisable not to concrete in such weather conditions. For concreting in hot weather conditions following precautions should be taken: -

i) Aggregates should be stacked under shade and should be sprinkled with cold water immediately before use.

ii) Mixing should be carried out under shade.

iii) Mixing time should be minimum as far as possible that will ensure quality of concrete.

iv) Control and lessen the time between mixing and placing.

v) Protect the placed concrete from the expose of sun and winds, with wet gunny bags or hessian cloth as early as possible.

vi) Horizontal surfaces can be easily protected by tarpaulins or straw-mats, supported on gabled frame work.

vii) Cold water should be used for concreting in hot weather.

viii) Avoid use of rapid hardening cement during hot weather conditions.

ix) Water curing should be started as soon as possible.

B) WET WEATHER CONDITIONS: -

During rainy season the concreting work should be carried out very carefully. It is advisable not to carry out concreting work during rains. However concreting can be done during dry-spells.

Following precautions should be taken for concreting in wet weather conditions :

I. Concreting work should not be carried out during rains.

II. Aggregate should be stacked under covered shed wherever possible; and its should be ensured that the same is free from heavy moisture / water contents before its use.

III. Control mixing and placing of concrete during dry-spell.

IV. Protect the placed concrete from expected rains / showers, by covering it properly by tarpaulins or plastic sheets supported on gabled frame work in such a way that rain water will not mix-up with placed concrete.

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CHAPTER - ELEVEN

READY MIXED CONCRETE (RMC)

As defined in IS 4926 1976, Ready Mixed Concrete is :- " A concrete delivered at site or in to the purchasers vehicles in plastic condition, and requiring no further treatment before being placed in the position in which it has to set and harden."

This is a specialised product which is batched and mixed in exact proportion at a central plant away from site and transported by rotary mixer drums, which can be placed at desired location on construction site.

The truck mounted transit mixers has now replaced the dumpers and agitator cars which earlier were used to transport fresh concrete from batching plant to the site. The mixer trucks are now available with conveyor belt to place the concrete up to a distance of 10 to 12 mtrs. at the rate of 45 CuM/hr. Besides the conveyor belts the transit mixers are also available equipped with Placing Boom and Concrete Pump arrangement also. In this equipment, different range of capacities are available i.e. :-

a.	Mixer Drum Capacity	-	6 to 9 CuM
b.	Vertical Reach of Placing	-	16 to 20 M.
c.	Pump output	-	40 to 60 CuM/hr.
d.	Water tank Capacity	-	600 to 650 Ltrs.

The Ready Mixed Concrete can be classified in three categories : -

i) **Central Mixed** : In this category the mixing of concrete is carried out at central plant, and such mixed concrete is delivered at site in an agitator truck / transit mixer which continuously rotate slowly to prevent segregation and undue stiffening, which keeps the mix in an agitated conditions.

ii) **Shrink Mixed**: In this case concrete is partially mixed at central plant and further mixing process is completed en route.

iii) **Transit Mixed** : The concrete materials batched at a central plant are mixed in a transit truck mixer before the same is delivered and discharged at site.

This is a product with service with use of modern technology by RMC companies who can assure quality product where concrete strength is guaranteed. Even though it is more costlier than the site mixed concrete, considering its advantages its use has became more popular in construction activities : -

a) **Advantages of RMC :**

i) It produces consistency as compared to site mixed concrete.

ii) Voluminous concreting can be done at site at faster rate.

iii) Its use can keep construction site as open as possible for other activities, which otherwise is required to be used for storage of sand, aggregate and cement.

iv) RMC company can deliver quality product of required grade and quantity where concrete strength is guaranteed.

v) It increases speed of construction thus can save completion time of project to great extent.

vi) In this product there is flexibility of using different grades and types of concrete.

vii) The supervising on concrete production and checking quality of ingredients can be eliminated.

viii) It canminimize pilferage and wastage of raw materials i.e. cement etc. and concrete.

ix) No chance of concrete getting mixed with earth, mud etc., as against site mixed concrete.

x) Labour cost can be reduced.

xi) It can be placed at exact location at construction site.

xii) It is ideal to use at congested site, where open spaces are limited.

xiii) RMC management has legal and professional obligation to deliver the product which will render a target performance.

xiv) The contractor becomes free of hassle of procurement of cement, sand, aggregate etc. and as such his administrative charges and inventories are reduced.

b) Dis-advantages of R.M.C. :

i) It is costlier than Site Mixed concrete by 15% to 20% mainly due to taxation.

ii) It takes hours for transit mixer to reach the construction site barely away from central plant due to traffic congestion, which difficulty does not occur in Site mixed concrete.

iii) The contractor on site has to make complete arrangements required for handling and placing of concrete.

iv) Once RMC is delivered at site and if not placed in stipulated time, the concrete is likely to set and harden.

v) It is advisable to use for mass concreting.

CHECK LIST

In comparison, it can be seen that RMC has more advantages over site mixed concrete. Therefore it is a duty of Site Supervisor to encourage owner / contractor to use RMC wherever advisable as per the instructions of Structural Engineer and Architect. For effective co-ordination and before calling RMC at site the Site Supervisor should : -

i) Study well in advance the terms and conditions of contract executed with RMC company.

ii) Ensure that the entire reinforcement is completed in all respects and checked and approved by the Structural Engineer before calling RMC for placement.

iii) Keep record of grade and volume of concrete delivered at site including departure and arrival time of each trip.

iv) Ensure that the RMC management is placing and laying concrete at desire location in perfect and workmanship like manner by using proper equipments, etc.

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CHAPTER - TWELVE

CHECK-LIST FOR CONSTRUCTION ACTIVITIES

(I) PRE-CONSTRUCTION ACTIVITIES

a) Check Plot Boundaries
b) Check Site Dimensions
c) Set-out Plinth
d) Erection of Site Rails
e) Mark Centre-Lines of Columns
f) Get Centre-Lines Checked from Architect / Structural Engineer
g) Check open spaces (Margins) as per approved drawings.
h) Get clarification from Architect if open spaces are deviating.
i) Allow Excavation for foundation if (a) to (g) are checked and found correct.

(II) FOUNDATION WORK (CONVENTIONAL)

a) Excavate up to at least 1.5 m or up to hard strata as directed.
b) Get foundation strata checked by Structural Engineer
c) Get approval from Structural Engineer before laying P.C.C.
d) Get revised Drawings for foundation if necessary from Structural Engineer
e) Check quality of sand, stone metal and cement
f) Check mixing water is suitable for construction
g) Check soil stabilization is properly done if so required.
h) Check the pits are complete dry, prior to laying P.C.C.
i) Ensure proper thickness of concrete laid
j) Ensure the top of concrete laid is in level and of required thickness and size.

(III) FOUNDATIONS (PILING) (If Applicable)

a) Obtain approved specifications for piling from Structural Engineer.
b) Record name and address of piling contractor.
c) Get piling Lay-out approved from Consulting Structural Engineer.
d) Check adequacy of bentonite slurry and other adequate facilities established by the piling contractor.
e) Check correctness of Rig erection at required centers for each and every pile.
f) Obtain from Structural Engineer instructions / details of records to be kept.
g) Check chisel is of adequate size, weight and cutting edge being in order.
h) Get founding strata checked and approved for resting of piles by Consulting Structural Engineer.
i) Get instructions from Structural Engineer for founding of piles.
j) Maintain records for every pile work proceeds including chiseling hours, samples of rock strata of each pile etc.

k) Ensure intermittently the adequacy of bentonite as to specific gravity and proper recycling.

(IV) FOUNDATION CONCRETING (CONVENTIONAL)

a) Mark actual centres of columns on P.C.C.
b) Check correctness of reinforcement cage before lowering.
c) Check correctness of placement of reinforcement Cage of each footing and
d) foundation column thereof.
e) Check column centres again after placement of reinforcement cages.
f) Check quality of sand, stone metal and cement.
g) Check mixing water is of acceptable quality.
h) Check reinforcing steel is of required quality.
i) Check proper covers are provided to reinforcement.
j) Clean top of P.C.C. with splash of water.
k) Ensure proper mixing of concrete and its transport.
l) Ensure proper placing of concrete to required size, depth and profile.
m) Ensure that pit is kept de-watered till initial setting of foundation concrete.
n) Prepare concrete cubes with concrete drawn from actual concrete being placed and install identification marks.

(V) PILE FOUNDATION CONCRETING

a) Check if reinforcement steel is of required quality.
b) Ensure that the length of reinforcement cage is adequate for the final bore length.
c) Check that the reinforcement is provided with adequate cover.
d) Check quality of sand, stone metal and cement.
e) Check mixing water is of acceptable quality.
f) Ensure that the bore is cleaned of all loose materials.
g) Ensure proper mixing of concrete and its placement.
h) Ensure that bottom of tremie pipe has adequate embedment in concrete as concreting proceeds.
i) Prepare concrete cubes with concrete drawn from actual concrete being placed and install identification marks.

(VI) COLUMNS BELOW PLINTH

a) Ensure proper erection of shuttering for foundation / plinth columns.
b) Ensure stiffness of column formwork.
c) Ensure proper cover to reinforcement bars.
d) Check quality of sand, stone metal and cement.
e) Check mixing water is of acceptable quality.
f) Ensure top of footing area for seating of ground floor columns is cleaned by splash of clean water.
g) Ensure proper mixing of concrete including the water / cement ratio.
h) Ensure proper transport and placement of concrete, compaction and maintain record of quantity of concrete consumed.

i) Ensure that the pit is kept dewatered till initial setting of concrete.
j) Prepare concrete cubes with concrete drawn from actual concrete being placed and install identification marks.
k) Get the concrete cubes tested at specified ages, record its results and intimate the results to consulting Structural Engineer and Architect.
l) Ensure proper curing of concreted work for minimum required period.

(VII) PLINTH BEAMS

a) Check actual centres of columns as concreted as required by centre-line drawing.
b) If there is discrepancy in (a) above, obtain further instructions from Architect and / or Structural Engineer.
c) Check quality of shuttering.
d) Ensure proper closing of gaps in :
    i) Side shuttering
    ii) Side and Bottom Junction
    iii) Column Caps
e) Check quality of reinforcement steel
f) Ensure proper cutting, bending, binding and placing of reinforcement steel.
g) Check proper cover to reinforcement steel.
h) Get preparatory work checked and approved from the Structural Engineer.
i) Check quality of sand, stone metal and cement.
j) Check mixing water is of acceptable quality.
k) Ensure cleaning of inside of formwork of all loose foreign materials.
l) Ensure proper mixing of concrete including the water / cement ratio.
m) Ensure proper transport and placement of concrete including its compaction.
n) If there is water logging ensure dewatering till initial setting of concrete.
o) Prepare concrete test cubes with concrete drawn from actual concrete being placed and install identification marks.
p) Cure the test cubes as per requirement.
q) Get the concrete cubes tested at specified ages, record its results and intimate results to consulting Structural Engineer and Architect.
r) Ensure proper curing of the work concreted for minimum required period.

(VIII) PILE-CAPS AND TIE BEAMS

a) Check and record actual centers of each pile as concreted.
b) Report the actual data to consulting Structural Engineer and obtain from him any revisions in design of pile caps and tie-beams if required.
c) Ensure cutting of pile heads to required level as directed by the Structural Engineer.
d) Check quality of shuttering for pile-caps and tie-beams.
e) Check quality of reinforcement steel.
f) After erection of column reinforcement cages, check column centres and ensure that it is in conformity with as specified in the centre-line drawings.

g) Check mixing water is of acceptable quality.
h) Check quality of sand, stone metal and cement.
i) Ensure proper preparation of bedding under pile-caps and tie-beams.
j) Ensure proper sealing of junction of side shuttering with bottom to prevent loss of cement slurry.
k) Check proper cover is provided to reinforcement bars.
l) Get preparatory work checked and approved from Structural Engineer prior to concreting.
m) Ensure top of P.C.C. bedding cleaned with splash of water.
n) Ensure proper mixing of concrete and its placement.
o) If there is water logging, ensure that the pit is kept dewatered till initial setting of pile-caps and tie beams.
p) Prepare concrete cubes with concrete drawn from actual concrete being placed and install identification marks.
q) Get the concrete cubes tested at specified age, record its results and inform to the Structural Engineer and Architect.

IX) COLUMNS AT GROUND & UPPER FLOOR LEVELS

a) Ensure proper erection of shuttering for columns on true centres.
b) Ensure stiffness of column formwork.
c) Ensure proper cover to reinforcement bars.
d) Check quality is of sand, stone metal and cement.
e) Check mixing water is of acceptable quality.
f) Ensure top of plinth area for seating of ground floor columns is cleaned by splash of clean water.
g) Ensure proper mixing of concrete including the water / cement ratio.
h) Ensure that the bottom junction of formwork has no gaps to prevent loss of cement slurry.
i) Ensure proper transport and placement of concrete including compaction and maintain record of quantity of concrete consumed.
j) Ensure that the columns are cast exactly up to beam soffit level.
k) Prepare concrete cubes with concrete drawn from actual concrete being placed and install identification marks.
l) Get the concrete cubes tested at specified ages, record its results and intimate the results to consulting Structural Engineer and Architect.
m) Ensure proper curing of concrete work and test cubes as required.

Note: Ensure and observe above check-list for upper floor columns.

(X) SLAB AT FIRST FLOOR & UPPER FLOOR LEVELS

a) Check actual centres of columns as concreted as required by centre-line drawings.
b) If there is discrepancy in (a) above, obtain further instructions from Architect and/or Structural Engineer.

c) Check quality of Shuttering Materials.
d) Check adequacy and quality of materials of centering, i.e. props, bracings
e) Ensure proper closing of gaps in shuttering at :
    i) Beam sides and Beam-column junctions
    ii) Beam bottoms
    iii) Column caps
    iv) Slab bottoms and beam sides
    v) Slab shuttering
f) Check quality of reinforcement steel.
g) Ensure proper cutting, bending, binding and placing of reinforcement steel.
h) Ensure proper cover to reinforcement steel.
i) Ensure cleaning of formwork of all foreign materials.
j) Ensure that any disturbance if detected to reinforcement steel caused by other sub-contractors is set right.
k) Ensure that conduit pipes for electrical mains, sleeves, inserts, from hooks are installed at required locations prior to placement of concrete to avoid cutting into final set concrete at future date.
l) Ensure that upper floor column dowel bars are tied with rings
m) Ensure that, before lowering beam reinforcement cages down in beam form work, specially at 1st and 2nd floor level, the assembly of steel is checked and certified by the Structural Engineer.
n) Get the preparatory work (after ensuring all the above) checked and approved from consulting Structural Engineer.
o) Check mixing water is of acceptable quality.
p) Check quality of sand, stone metal and cement.
q) Ensure proper mixing of concrete including the water / cement ratio.
r) Ensure proper transport and placement of concrete including its compaction.
s) Ensure that sunk portions of Kitchen, W.C., Bath rooms, Toilets etc. are provided with thin layer of plaster of fine cement mortar (ghutai) mixed with water proofing compound, immediately after the concrete is set initially, and shall be filled in with water for at least 15 days to check leakages if any.
t) Prepare concrete test cubes with concrete drawn from actual concrete being placed and install identification marks.
u) Ensure proper curing of concrete work and test cubes for minimum period as required.
v) Get the concrete cubes tested at specified ages record its results and intimate to consulting Structural Engineer and Architect.
w) Ensure proper hacking in good workmanship manner of exposed faces of concrete immediately on removal of formwork to ensure proper keying and bond of later finishing. (Not if architect has specified exposed concrete)

Notes:

i) For all concrete works bulk of sand should be checked carefully and accordingly sand quantity can be increased and as such water quantity may be reduced proportionately as directed by the Structural Engineer.

ii) It is advisable to use Damp Proof Cement, and application of anti-termite treatment and a coat of coal-tar and or epoxy paint to concrete surfaces below ground level. The plinth protection concrete for better durability should be provided as directed by the Structural Engineer.

XI) BRICK MASONRY WORK

a) Check quality of bricks.
b) Check quality of sand and cement for mortar preparation.
c) Ensure wetting of bricks at least one hour prior to its use in masonry.
d) Ensure application of rough dash of cement mortar on faces of concrete to which brick masonry will abut.
e) Ensure that masonry units are placed as near to (d) above so as to have minimum thickness of jointing mortar at those junctions.
f) Ensure that all vertical joints are staggered.
g) Ensure proper mix of jointing mortar.
h) Ensure proper bedding at every course or masonry.
i) Ensure provision of stiffening bands either in R.C.C. patli or flat arched masonry (karanja) at required heights as directed by the architect.
j) Ensure control of raising of masonry in one operation.
k) Ensure proper alignment and plumb control of masonry from both faces.
l) Ensure erection of door and window frames in positions including holdfasts and other inserts and see that the frames are firmly fixed.
m) Ensure that as masonry is reaching ceiling, the last three to four courses are so adjusted that the joint at ceiling abutment will have minimum thickness.
n) Ensure that the joints are tooled by raking only after initial mortar is set.
o) Ensure proper curing of Constructed Masonry for required period.
p) Ensure that no additions or alterations in brick work should be permitted once R.C.C. frame work is completed, unless permitted in writing from the Architect and Structural Engineer.

(XII) CONCRETE BLOCK MASONRY

a) Check quality of concrete blocks.
b) Check quality of sand and cement.
c) Ensure wetting of blocks for minimum required time prior to its use in masonry.
d) Ensure application of rough dash of cement mortar on faces of concrete to which block masonry will abut.
e) Ensure that masonry units are placed as near to (d) above so as to have minimum thickness of jointing mortar at those junctions.
f) Ensure that all vertical joints are staggered.
g) Ensure proper mix of jointing mortar.
h) Ensure proper bedding at every course of masonry.
i) Ensure provision of stiffening bands either in R.C.C. patli or as specified by Architect at required heights.

j) Ensure control of raising of masonry in one operation.
k) Ensure proper alignment and plumb control of masonry.
l) Ensure erection of door and window frames in position including holdfasts and other inserts and see that the frames are firmly fixed.
m) Ensure that as masonry is reaching ceiling the last three to four courses are so adjusted that the joint at ceiling abutment will have minimum thickness.
n) Ensure that the joints are tooled by raking only after initial mortar is set.
o) Ensure proper curing of constructed masonry for required period.

(XIII) INTERNAL NEERU FINISHED PLASTER

a) Ensure scrapping of any loose mortar at junction of walls with ceiling.
b) Ensure that any gaps at masonry wall junction with ceiling are filled with a dry-pack like fresh mortar.
c) Ensure repeating of (a) & (b) above, at side junctions with R.C.C. Members.
d) Ensure provision of guide blocks (Dhadas) for ensuring control of plumb and alignment.
e) Check quality of sand, cement and neeru.
f) Ensure proper mix of mortar for plastering.
g) Ensure that mortar spilling which have initially set are not re used or re-mixed in fresh mortar.
h) Ensure that finished surfaces are in line, level and plumb.
i) Ensure that the final surface to receive neeru or other finish is tooled by thoroughly combing with wavy lines about 12 mm apart and 3 mm Deep.
j) Ensure that prior to applying neeru (lime putty) the back coat is hardened.
k) Ensure that the neeru is well rubbed onto the backing by repetitive working in with trowels.
l) Ensure proper curing of plaster for required period.

(XIV) EXTERNAL SAND FACED PLASTER

a) Ensure scrapping of any loose mortar at junction of wall with ceiling.
b) Ensure that any gaps at masonry wall junction with ceiling are filled with a dry-pack like fresh mortar.
c) Ensure repeating of (a) & (b) above, at side junctions with R.C.C. members.
d) Ensure provision of guide blocks (Dhadas) for ensuring control of plumb and alignment.
e) Check quality of sand and cement.
f) Ensure proper mix and proportion of sand and cement for preparing of mortar.
g) Ensure that a water proofing compound in power from of reputed make is thoroughly mixed (in specified proportion) in mortar before it is used for plastering.
h) Ensure that mortar spilling which have initially set are not re used or re-mixed in fresh mortar.
i) Ensure that finished surfaces are in line, level and plumb.

j) Ensure that the final surface to receive second coat of plaster is tooled by thoroughly combing with wavy lines about 12 mm apart and 3 mm deep.
k) Ensure that prior to applying finishing coat the back coat is hardened.
l) Ensure that the sand for use in final coat is properly screened for desired grains in finish.
m) Ensure that the base coat is cured for at least two days prior to applying the finishing coat.
n) Ensure that the finishing coat does not exceed 8 mm in thickness.
o) Ensure that the final finished surface is in line, level and plumb with required enrichment as per details like bands, grooves, drip moulds etc.
p) Ensure proper curing of plaster for required periods.

(XV) CEMENT / MOSAIC TILE FLOORING

a) Ensure that the area to receive tile flooring is cleaned of all loose foreign materials including oily and greasy surfaces.
b) Check quality of lime and sand for bedding.
c) Check quality of cement.
d) Ensure provision of guide blocks (Dhadas) for proper levels and slopes as required.
e) Ensure proper proportion of mixing of bedding material.
f) Ensure that the final top surface of bedding laid is in conformity with desired levels of flooring.
g) Ensure that soupy mortar is not used for filling of large depressions in bedding.
h) Ensure proper consistency of cement slurry being used for bedding and fixing the floor titles.
i) Ensure proper levels of tiling from time to time as work proceeds.
j) Ensure that there is no wide variation of levels at individual joints that may require excessive scrapping while polishing.
k) Ensure that the joints are properly pointed and sealed after laying.
l) Ensure that mechanical polishing is allowed only after the tiles have finally set.
m) Ensure proper polishing to give smooth finish.

(XVI) CERAMIC TILE FLOORING

a) Ensure that the area to receive ceramic tile flooring is cleaned of all loose foreign materials including oily and greasy surface.
b) Check quality of lime and sand for bedding.
c) Check quality of cement.
d) Ensure provision of guide blocks (Dhadas) for proper levels and slopes as required.
e) Ensure proper provision of mixing of bedding material.
f) Ensure that the final top surface of bedding laid is in conformity with desired levels of flooring.
g) Ensure that soupy mortar is not used for filling of large depression in bedding.

h) Ensure proper consistency of cement paste being used for bedding and fixing the tiles.
i) Ensure proper levels of tiling from time to time as work proceeds.
j) Ensure that there is no variation of levels at individual joints.
k) Ensure that the joints are pointed with neat cement of matching colour.

(XVII) CERAMIC TILE DADO

a) Ensure that the area to receive ceramic tile cladding is cleaned of all loose foreign materials including oily and greasy surface.
b) Ensure that all concealed piping, spouts etc. are installed.
c) Check quality of cement.
d) Ensure provision of guide blocks (Dhadas) for proper levels as required.
e) Ensure proper proportion of mixing of backing materials.
f) Ensure that the final surface of backing laid is in conformity with desired line, level and plumb.
g) Ensure that soupy mortar is not used for filling of large depressions in backing.
h) Ensure proper consistency of cement paste being used for bedding and fixing of the cladding tiles.
i) Ensure proper levels of tilling from time to time as work proceeds.
j) Ensure that there is no variation of levels at individual joints.
k) Ensure that the joints are pointed with neat cement of matching colour.

(XVIII) TOILETS' WATERPROOFING

a) Ensure that all pipes and sleeves are installed prior to carrying out work of water proofing.
b) Ensure that all internal water supply and drainage lines for concealed plumbing are laid, installed and tested prior to applying water-proofing treatment on walls.
c) Ensure that during final installation of sanitary fixtures, the water-proofing is not damaged.
d) Ensure proper repairs to water-proofing if damaged during (c) above.
e) Ensure testing of all joints of sanitary fixtures installed, for any leakages and their sealing, prior to being finally covered / embedded.
f) Test efficiency of water-tightness and water-proofing by artificial flooding.
g) Injection grouting to concrete walls / slabs may be carried out before starting water proofing treatment wherever directed by the architect.

(XIX) TERRACE WATER-PROOFING

a) Obtain detailed specifications from the agency for water-proofing treatment.
b) Ensure that the top surface to receive the water-proofing treatment is cleaned of all loose foreign materials, oil, grease etc.
c) Ensure that the base course is laid to required slopes.
d) Ensure that all pipe out-lets are installed in position while finishing the treatment.
e) Ensure that the final finished surface including golias with proper slope is provided as required.

f) Ensure proper curing for required period.
g) Check the efficiency of the waterproof treatment by artificial flooding.
h) If defects noticed during (g) above get rectification done immediately.
i) Ensure that during laying further final finishing on top, the water-proofing is not damaged.
j) Obtain the guarantee in writing if promised, from water-proofing contractor.

Imp. Notes:

i) In case pile foundation work is carried out, the Site Supervisor should ensure to obtain "The Performance Guarantee" of pile foundation from the Piling Work Contractor who have executed the job in the format as appearing hereafter. (Format - D)

ii) When the work is completed in all respects the Site Supervisor should ensure to obtain the necessary completion certificate from the Contractor who had executed the construction, as well as "Completion Certificate" from the employer i.e. Developer / Owner in the format as appearing hereafter. (Format - E)

iii) The Site Supervisor should handover the copies of Completion Certificates from the Contractor / Developer, and the Performance Guarantee Certificate from the Piling Contractor, to the Architect.

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(FORMAT-D)

(On the Letter Head of Piling Contractor)

Ref: Date:

PERFORMANCE GUARANTEE OF PILE FOUNDATION WORK

NAME OF THE PROJECT : _____
LOCATION OF PROJECT : _____
ARCHITECT : _____
CONSULTING STRUCTURAL ENGINEER : _____
PROJECT ENGINEER : _____
OWNER / DEVELOPER : _____
TYPE OF PILE : _____
DATE OF COMMENCEMENT : _____
DATE OF INSTALLING LAST PILE : _____
CEMENT (TYPE) USED : _____
STEEL USED : _____

We hereby certify that we have carried out the work of installation of pile foundation work for the subject work at the location as described above as per the drawings and specifications provided by the Consulting Structural Engineer.

We hereby further state that the minimum socket length in bearing strata was ___ mm and that the average depth at which boring strata was available was form ____ Mtrs. to ____ Mtrs. below original ground level.

We further certify that the minimum safe load capacities of various diameters of pile installed are as under : -

Diameter of Bore	Diameter / Size of Pile	Minimum assured safe load carrying capacity in Tons.
a) ____ mm Dia.	_____ mm Dia.	_____ Tons
b) _____ mm Dia.	_____ mm Dia.	_____ Tons

We further state and confirm that the entire work of installation of piles as described above, was carried out in conformity with required codes and standards and that the instructions and or specifications as specified by the Structural Engineer / Consultant are not deviated.

(_____)
Name & Designation of
Authorised Signatory

(FORMAT - E)

COMPLETION CERTIFICATE TO BE ISSUED BY BUILDING CONTRACTOR / DEVELOPER

Completion Certificate (Contractor / Developers)

I/We _____ having our office at _____ _____ have undertaken the work of development on property bearing _____, as per architectural designs and plans prepared by M/s _____ the Architects and structural designs and plans prepared by M/s _____ duly sanctioned by Municipal Corporation of Mumbai under No. _____ dated _____.

I/We hereby certify that all materials used in the construction are of good quality. The workmanship and methodology employed in the construction, described hereunder at aforesaid premises, are as per prescribed standards.

I/We further certify that stipulations of applicable codes, rules, regulations and Architect's Consulting Structural Engineer's or other Consultant's instructions have been followed and observed to the best of my/our knowledge and the construction described herein after is completed in all respects to render it fit for occupation for the intended use.

Description of work : i) Property : Plot No./CTS No. _____
Village _____, Dist. _____

ii) User : Residential / Commercial / Industrial

iii) Type of Construction : _____

Name & Signature of Contractor/Developer
Authorised Signatory
(Partner/Director/Proprietor)

Date: _____
Place _____

Copies submitted to
1) Architect
2) Consulting Structural Engineer

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CHAPTER - THIRTEEN

BEFORE CALLING STRUCTURAL ENGINEER ON SITE FOR INSPECTION

It is general experience that the Structural Engineers are called on site by contractors for inspection of reinforcement without doing complete home work, resulting more unnecessary visits, when work is not completed. Therefore it is essential that Before calling the consulting Structural Engineer for inspection the site supervisor should ensure that the : -

a) All the props are of full height single piece of minimum average diameter of 100 mm for timber props, in proper alignment and plumb and not more than 20% jointed props.

b) Additional props for slabs / beams shall be provided with long double planks under.

c) All the props are properly stayed by providing wedges and cross bracings.

d) All shuttering gaps are properly closed giving particular attention to column caps, beam junctions, beam side to slab bottom junctions and beam side to beam bottom junctions.

e) The formwork is cleaned of all loose foreign materials.

f) Sides of Beams, columns and R.C. walls are properly aligned, plumb, stayed and stiffened to achieve even and plumb face.

g) All cantilever projections are provided with a runner member under shuttering and props are provided under this runner / chavi, to ensure even level soffit of projection ends.

h) The reinforcement of slab is in proper alignment and the slab bar bends must be lifted up to give a bend-up height of 1/2" less than the slab thickness specified.

i) Proper cover to reinforcement are provided to slab bottom, beam bottom and sides, sides of columns and walls.

j) M.S. chairs are provided in slab reinforcement, to achieve requirements of (h) above.

k) Dowels from old concrete are cleaned properly of mortar, rust and other impurities.

l) Columns are cast exactly up to beam soffit level.

m) Reinforcement bars are cleaned of oil, rust etc. if any.

n) Reinforcement is assembled and tied as per drawings and details.

o) Column dowels projecting above slab to be cast are properly tied with rings.

Note: *For any doubts regarding the quality of materials and or work carried out, the Site Supervisor should inform the Architect and or Structural Engineer, and obtain suitable instructions for remedial measures thereof from time to time.*

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CHAPTER - FOURTEEN

SAFETY CODE : PROVISIONS & PRECAUTIONS

The Site Supervisor should ensure that the contractor shall at his own expenses, arrange for the safety provisions incorporated in safety code hereinafter or as required by any Law for the time being in force in respect of labour directly or indirectly employed for the performance of the work and shall provide all facilities in connection therewith. Precautions in the safety clauses are the minimum necessary and shall not prevent the Contractor taking additional safety precautions as may be warranted for the particular type of work. Also mere observance of these precautions shall not absolve the Contractor of his liability in case of loss or damage to property or injury to any person, including Contractor's labour, Employer's Supervisor or any member of the Public or resulting into any casualty. The Site Supervisor should ensure provisions of following safety measures:-

Safety Measures : -

A) SCAFFOLDING, PLATFORMS, LADDERS ETC.: -

i Suitable scaffolds are provided for workmen for all works that cannot safely be done from the ground, or from solid construction except such short period work as can be done safely from ladders. When a ladder is used, an extra mazdoor (helper) shall be engaged for holding the ladder and if the ladder is used for carrying materials as well, suitable footholds and handholds shall be provided on the ladder and the ladder shall be given an inclination not steeper than 1/4 to 1 (1/4 horizontal and 1 vertical).

ii. Scaffolding or staging more than 3.25 meters above the ground or floor, swung or suspended from an over head support or erected with stationary support, shall have a guard rail properly attached, bolted braced and otherwise secured at least 1 meter high above the floor or platform of such scaffolding or staging and extending along the entire length of the outside and ends thereof with only such openings as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened so as to prevent it from swaying from the building or structure.

iii. Working platform, gangways, and stairways shall be so constructed that they do not sag unduly or unequally, and if height of a platform or gangway or stairway is more than 3.25 mtrs. above ground level or floor level, it shall be closely boarded, have adequate width and be suitably fenced, as described in (ii) above.

iv. Every opening in floor of a building or in a working platform shall be provided with suitable means to prevent fall of persons or materials by providing fencing or railing with a minimum height of 1 meter.

v. Safe means of access shall be provided to all working platforms and other working places. Every ladder shall be securely fixed. No portable single ladder shall be more than 9 meters in length. Width between side rails in a rung ladder shall in no case be less than 30 cms. for ladders upto and including 3 meters in length. For longer ladders this width shall be increased at least 6 mm for each additional 30 cm of length. Uniform step spacing shall not exceed 30 cm.

vi. All scaffolds, ladders and other safety devices mentioned or described herein shall be maintained in a safe condition and no scaffold, ladder or equipment shall be altered or removed while it is in use. Adequate washing facilities shall be provided at or near places of work.

B) EXCAVATION AND TRENCHING :

i. All trenches, 1.5 meters or more in depth, shall at all times be supplied with at least one ladder of each 3 meters in length or fraction thereof. Ladder shall be extended from bottom of trench to at least 1 meter above surface of the ground.

ii. Sides of a trench which is 1.5 meters or more in depth shall be stepped back to give suitable slope, or securely held by timber bracing, so as to avoid the danger of sides collapsing.

iii. Excavated material shall not be placed within 1.5 meters or edge of trench or half of depth of trench, whichever is more.

iv. Cutting shall be done from top to bottom. Under no circumstances undermining or undercutting shall be done.

C) OTHER SAFETY PRECAUTIONS:

1) Adequate precautions shall be taken to prevent dangers from electrical equipments.

2) No materials on any of the Sites shall be so stacked or placed as to cause danger or inconvenience to any person or the public.

3) The contractor shall provide all necessary fencing and lights to protect public from accidents and shall be bound to bear expenses of every defense suit , action or other proceedings at law that may be brought by any person for injury sustained owing to neglect of the above precautions and to pay any damages and costs which may be awarded in any such suit, action or proceedings to any such person or which may with consent of the contractor be paid to compromise any claim by any such person.

4) **Demolition** : Before any demolition work is commenced either prior to or during the progress of the work : -

i. All roads and open areas adjacent to the work site shall either be closed or suitably protected;

ii. No electric cable or apparatus, which is liable to be a source of danger, shall remain electrically charged;

iii. All practical steps shall be taken to prevent danger to persons employed from risk of fire or explosion.

5) Necessary props should be provided to the structure to be demolished for systematic and safe demolition. No floor, roof, or other part of a building shall be so overloaded with debris or materials as to render it unsafe.

6) All necessary personal safety equipment as considered adequate by the Engineer - in-Charge shall be available for use of persons employed on the Site and maintained in a condition suitable for immediate use; and the contractor shall take adequate steps to ensure proper use of equipment by those concerned.

7) The Workers employed on mixing asphaltic materials, cement and lime mortars / concrete etc. shall be provided with protective foot wears and hand gloves.

8) The workers engaged in handling any materials or instruments i.e. welding etc. which are injurious to eyes shall be provided with protective goggles and eye shields.

9) The workers engaged in stone breaking shall be provided with protective goggles and protective clothing.

10) When workers are employed in sewers and manholes, which are in use, the Contractor shall ensure that manhole covers are opened and are ventilated at least for an hour before workers are allowed to get into them. Manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent accident to public.

11) The contractor shall not employ men and women below the age of 18 on the work of painting with products containing lead in any form. Whenever men above the age of 18 are employed on the work of lead painting, the following precautions shall be taken: -

a. No paint containing lead or lead products shall be used except in the form of paste or ready mixed paint.

b. Suitable face masks shall be supplied for use by workers when paint is applied in the form of spray of a surface having dry lead paint to be rubbed and scrapped.

c. Overalls shall be supplied by the contractor to workmen with adequate facilities to enable working painters to wash during and on completion of work.

12) When work is to be carried out near any place where there is risk of drowning, all necessary equipments shall be provided and kept ready for use. All necessary steps should be taken for prompt rescue of any person in danger and prompt first aid treatment should be provided for the injuries likely to be sustained during the course of work.

13) **Hoisting Operations** : Use of hoisting machines and tackle including their attachments, anchorage and supports shall conform to the following: -

a. These shall be of good mechanical construction sound material and of adequate strength and free from patent defects and shall be kept in good repair and in good working order.

b. Every rope used in hoisting or lowering materials or as a means of suspension shall be of durable quality and adequate strength and free from patent defects.

c. Every crane driver or hoisting appliance operator shall be properly qualified and no person under the age of 21 years shall be in charge of any hoisting machine including any scaffold winch who can not give signals to operator.

d. In case of every hoisting machine and of every chain ring, hook shackle swivel and pulley block used in hoisting or lowering or as means of suspension, safe working load shall be ascertained by adequater means. Every hoisting machine and all gear referred to above shall be plainly marked with safe working load. In case of hoisting machine having a variable safe working load, the conditions under which it is applicable shall be clearly indicated. No part of any machine or of any gear referred to above shall be loaded beyond safe working load except for the purpose of testing.

e. In case of use of any company machines, a safe working load shall be notified by the Engineer-in-Charge. As regards Contractor's machines the Contractor shall notify safe working load of each machine to the Engineer-in-Charge whenever he brings it to site of work and get it verified.

f. Motors, gearing, transmission, electric wiring and other dangerous parts of hoisting appliances shall be provided with efficient safeguards. Hoisting appliances shall be provided with such means as will reduce to minimum risk of accidental descent of load. Adequate precautions shall be taken to reduce to the minimum the risk of any part of a suspended load becoming accidentally displaced.

g. When workers are employed on electrical installations which are already energized, insulating mats, working apparel such as gloves, sleeves and boots, as may be necessary, shall be provided. Workers shall not wear any rings, watches and carry keys or other materials which are good conductors of electricity.

h. The above safety provisions shall be brought to the notice of all concerned by display on a notice board at a prominent place at the works spot. Persons responsible for ensuring compliance with the safety code shall be named therein by the Contractor.

i. To ensure effective enforcement of the rules and regulations relating to safety precautions, arrangements made by the Contractor shall be open to inspection by the Engineer - in charge or his representatives.

j. To ensure that all labourers employed are adequately insured by the respective contractors through out during the coarse of construction.

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CHAPTER - FIFTEEN

TOLERANCES

Tolerance is a specified permissible variation from lines, grade or dimension given in drawings. The Site Supervisor should study following text and incase of any doubts obtain necessary clarifications / instructions from the Structural Engineer. Unless otherwise specified, the following tolerances are permissible.

A) Tolerances for R.C.C. buildings :

1. Variation from the plumb :

a) In the lines and surfaces of columns, piers, walls and in arises 3mm per 2.5 m but not more than 10 mm.

b) For exposed corner columns and other conspicuous lines,

In any bay up to 5 m maximum	:	5 mm
In 10 m more	:	10 mm

B) Variation from the level or from the grades indicated on the drawings:

a) In soffits of slab, ceilings, beam and in arises

In 2.5 m	:	5 mm
In any bay up to 5 m maximum	:	8 mm
In 10 m or more	:	10 mm

b) For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines,

In any bay 5 m maximum	:	5 mm
In 10 m or more	:	8 mm

C) Variation of the linear building lines from established position in plan and related position of columns, wall and partitions :

In any bay up to 5 m maximum	:	5 mm
In 10 m or more	:	10 mm

D) Variation in the sizes and location of sleeves, openings in walls and floors :

5 mm (except in the case of and for anchor bolts).

E) **Variation in cross sectional dimensions of columns and beams and in the thickness of slabs and walls :**

: - 5 mm
: + 10 mm

F) **Variations at Footings :**

a) Variation in dimension in plan : - 5 mm
: + 50 mm

b) Misplacement or eccentricity : 2% of footing width in the direction of misplacement but not more than 50 mm.

c) Reduction in thickness : 5% of specified thickness subject to a maximum of 50 mm.

G) **Variation in Steps :**

			Rise	Tread
a)	In a flight of stairs	:	3 mm	5 mm
b)	In consecutive steps	:	1.5 mm	3 mm

H) **Tolerances in other concrete structures :**

1. a) Variation of the constructed linear outline from established position in plan.

In 5 m : 5 mm
In 10 m or more : 10 mm

b) Variation of dimensions to individual structure features from established positions.

In 20 m or more : 25 mm
In buried construction : 50 mm

c) Variation from plumb, from specified batter or from curved surfaces of all structures.

Up to 2.5 m : 3 mm
2.5 m to 5 m : 8 mm
5 m to 10 m or more : 12 mm
In buried construction : Twice the above.

d) Variation in cross sectional dimensions of columns, beams, buttresses, piers and similar members : - 5 mm
: + 10 mm

e) Variation in the thickness of slabs, walls, arch sections, and similar members : - 5 mm
: + 10 mm

2. Footings for columns, piers, walls, buttresses and similar members:

a) Variation of dimensions in plan : - 10 mm
: + 5 mm

b) Misplacement or eccentricity : 2 % of footing width in the direction of misplacement but not more than 50 mm.

c) Reduction in thickness : 5% of specified thickness subject to a maximum of 50 mm.

Reference : IS 456-2000.

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CHAPTER - SIXTEEN

IMPORTANT I.S. CODES FOR REFERENCE

1)	IS 13920/1993	:	Ductile detailing of Reinforced Concrete Structures
2)	IS 456-2000	:	Plain & Reinforced Concrete.
3)	IS 383	:	Coarse Sand for Concrete.
4)	IS 2386	:	Methods for test of Aggregates (Part I & II).
5)	IS 3025	:	Tests for Water.
6)	IS 4031	:	Methods for physical tests for Cement.
7)	IS 8112	:	43 Grade Portland Cement.
8)	IS 9103	:	Admixture for Concrete.
9)	IS 12269	:	53 Grade Portland Cement.
10)	IS 432	:	Mild Steel & Medium Tensile Steel Bars.
11)	IS 1786	:	High strength / tensile deformed (TOR) Steel Bars.
12)	IS 3696	:	Safety Code for Scaffolds.
13)	IS 6313	:	Code of practice for Anti-termite measures.
14)	IS 1237	:	Code of practice for Marble Mosaic (M.M.) Tiles.
15)	IS 1542	:	Specifications for Sand for Plaster.
16)	IS 3068	:	Testing of Bricks.
17)	IS 651	:	Specifications for salt glazed S.W. Pipes.
18)	IS 458	:	Specifications for Concrete Pipes.
19)	IS 226	:	Structural Steel.
20)	IS 1893	:	Structural Design of Earthquake Resistant Structures.

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CHAPTER - SEVENTEEN

WATER SUPPLY & DRAINAGE WORKS - (PART- I)

TERMINOLOGY

• PLUMBING

Bib Tap : A valve with a suitable means of connection for insertion in a pipe line for controlling or stopping flow of water.

Bottle Trap : A device connecting wash basin and waste line; provided with a clearing plug either at side or bottom to facilitate removal of clogging.

Consumer Line : A down take water supply line to individual units from the over head water tank.

Delivery Line : A water supply line from suction tank to overhead tank.

Foot Valve : A valve with a non returned device fixed at the end of delivery pipe connected to water pump, which remained immersed in water stored in suction tank.

Flush Valve : A device which discharge predetermined quantity of water to fixtures for flushing purposes attached by direct water pressure. These valves are generally used for water closets and urinals, to flush water again and again without storage tank.

Flushing Cistern : A storage tank of limited water capacity used for flushing purpose; of urinals, Indian water closets and European water closets (commodes).

Hydrant : A valve or Faucet drawing water from a pipe. Usually this is a outside installation for supplying large quantity of water for sprinkling, watering, fire protection and similar purposes.

Nipple : A short piece of pipe with outside threads used for connecting pipes or fittings, in threaded joints.

Nozzle : A outlet from a faucet or at the end of pipe line or hose so designed that the issuing stream of water is thrown in a shape or size different from the diameter of the pipe.

Overhead Water Storage Tank : A two compartment water tight storage tank for domestic and flushing use, made either of R.C.C., steel or plastic etc.; placed on at least

4'-0" (clear) above terrace level of the building; wherein water is pumped from the under ground storage tank;

Pipe Connection Fittings : This includes Nipples, Tees, Elbows, Couplings / Unions, Unions caps, Male & Female Adapters, Plugs etc.

Pillar Tap : A draw off tap with a vertical inlet and up-tilted or horizontal free outlet.

Pump Room : A small covered room constructed on suction tank, wherein set of water pumps are installed to eject the water from underground to overhead storage tank.

Self Closing Tap : A draw off tap which remains in 'open' position so long lever handle is kept pressed up, down or side ways.

Sink : A rectangular shallow receptacle used in kitchens, laboratories and wash areas of factories, hospitals etc.; which is a one piece of construction and provided with or without rim, and generally made of glazed fire clay, earthen ware, vitreous china, enameled steel, stainless steel, aluminum, fiberglass etc.

Shower : A fitting provided for spray of water for bathing from pipe connection.

Stop Valve : A valve with a suitable means of connection for insertion in a pipe line for controlling or stopping flow of water.

Suction Tank: A partially under ground, water tight tank to store water from the direct water supply from Municipal Connection; generally made of R.C.C. or Masonry.

Supply Line : A pipe line to carry water supply within compound, from Municipal connection to suction tank.

Washer : An annular disc of leather, rubber, plastic etc. usually placed between flanges of abutting pipes beneath the plunger of bib tap etc., to prevent leakages.

Wash Basin : A waste fixture used for ablution purpose located inside or outside toilet blocks; either fixed on cantilevered brackets or pedestal.

Water Closet : A sanitary fixture, designed and installed to receive human excreta and to discharge it effectively to the drainage system.

- **DRAINAGE**

Anti siphon vent or back vent : Any vent pipe from an individual trap to the open air or to main or branch vent pipe, provided for the prevention or breakage of water seal in the trap.

Bedding : A layer of concrete or other suitable material on the trench floor to provide continuous support for the pipes.

Benching : The sloped floor of a manhole or an inspection chamber on both sides and above the top of the channel.

Chair : A bed of concrete or other suitable material on the trench floor to provide a support for the pipes at intervals.

Channel : The open waterway through which sewage, storm water or other liquid wastes flow at the invert of a manhole or an inspection chamber.

Cleaning Eye : An access opening having a removable cover to enable obstruction to be removed / cleared by means of a drain rod.

Combined Waste Pipe : Any pipe which received the discharge from both the soil and waste fixtures and conveys the same directly to the drain, which is used only in connection with one pipe / single stack system.

Depth of Manhole : The vertical distance from the top of the manhole cover to the outgoing invert of the main drain channel.

Diameter or bore or size: The nominal internal diameter of any pipe.

Drain : A line of pipes including all fittings and equipments such as manholes, traps, gullies and floor traps used for the drainage of a building / number of buildings or yards appurtenant to the buildings, within the same premises. This shall also include open or buried channels used for conveying surface water, sewage or any waste water.

i **Sub-soil Water Drain** : A drain conveying sub-soil water.

ii. **Surface Water Drain** : A drain conveying surface water including storm water.

Drainage : The removal of any liquid by a system constructed for the purpose.

Drainage Work: The design and construction of a drainage system.

Drop Connection : A manhole incorporating a vertical drop for the purpose of connecting a sewer or drain of high level to one at low level.

Drop Manhole : A manhole installed in a sewer where the elevation of the incoming sewer considerably exceeds that the outgoing sewer wherein vertical water way outside the manhole is provided to divert the water from the upper to the lower level so that it does not fall freely into the manhole.

Effluent : The supernatant liquid discharge from a septic tank.

Fixture Unit : A quantity in terms of load producing effect of different kinds of plumbing fixtures on plumbing system.

Hunching : Concrete bedding with additional concrete at the side of the pipe.

House Gully: A passage common to a group of premises which is used for laying common drains.

Invert : The lowest point of the interior of a sewer or drain at any cross section. In a manhole or inspection chamber, it is the lowest point of the channel in the floor.

Inspection Chamber : A water-tight chamber constructed in any house-drainage system, which takes wastes from gully traps and disposes of to the manhole with accesses for inspection and maintenance.

Licensed Plumber: A person licensed by the Civic Authority to carry out plumbing and drainage works.

Manhole : A built -up opening by which a man can enter or leave a drain, sewer for inspection, cleaning and maintenance of sewer line fitted with suitable cover.

Municipal Sewer : A network of sewerage system, constructed, maintained and owned by the Municipal Authority.

PH (Potential of Hydrogen ions): The reciprocal of the hydrogen ion concentration. It signifies the amount by weight of hydrogen ion, in ion form in grams per litre of solution, as determined by procedures / outlines in 'Standard Methods'.

Septic Tank : A water-tight single storied tank in which sewerage is retained for sufficiently long time to permit sedimentation.

Sewage : A liquid waste of house hold or community including human excreta.

Sewer : A closed drain carrying night soil and other water borne-waste.

Sewer trap or Intercepting trap : A trap situated in the last chamber or manhole between the Municipal Sewer and the House drain within the property of the owner, for the purpose of preventing the passage of air or gases from the Municipal sewer into the house drain and equipped with a fresh air inlet on the upstream side of the trap.

Soak way / PIT : A pit suitably prepared to receive soil waste water or partially treated sewage for seepage into the surrounding ground.

Soffit / Overt: The highest portion of the interior of a sewer or drain at any cross section.

Soil pipe : A pipe which receive the discharge from soil fitments, such as water closets, urinals, slop sinks etc.

Soil waste : The discharge from water closets, urinals, slop sinks, or similar appliances.

Stack : A vertical line of soil, waste / combined waste or vent piping with its offsets, if any.

Storm Water Drain : A open water-way through which storm water flows. It is generally provided along road side plot boundary, where surface water from the compound is discharge. The size and construction shall be as specified by civic authority.

- **SYSTEMS:**

i. **Combined System** : A system in which foul water and surface water are conveyed by the common drain.

ii. **Separate System** : A system in which foul water and surface water are conveyed by separate sewers and drain lines.

iii. **Partially Separate System**: A modification of the separate system in which part of the surface water is conveyed by the sewers.

iv. **Two-pipe System** : The system of plumbing in which soil and waste pipes are distinct and separate, where the soil pipes are connected to the house drain directly and waste pipes through a trapped gully. Traps of all appliances are completely ventilated in this system.

v. **One pipe System**: The system of plumbing in which the waste connections from sinks, baths, wash basins and soil pipe branches are all collected into one main pipe., which is connected directly to the drainage system. Gully traps of water closets, basins etc. should be completely ventilated to preserve the water seal.

vi. **Single stack System**: One pipe system without trap ventilation pipe work. The traps of water closets, sinks, basins etc. are directly connected to the single stack. Single stack system shall comply with the following: -

a. The vertical distance between the waste branch (from floor trap to the individual appliance) and the soil branch shall not be less than 20 cm.

b. If appliances like wash basins and sinks are directly connected to the stack, they shall have a 7.5 cm deep water seal trap. However, if they are connected through the floor trap to the stack, the individual appliances need not have water seal trap. The floor trap shall have atleast 35 mm. water seal. The conventional 50 mm water seal of W.C. are satisfactory. The branches from W.C.s. and floor traps shall be 100mm. and 75mm. dia. respectively.

c. The branch pipes from all appliances shall fall gradually and continuously in the direction of flow and shall have slope of 1:10 to 1:50.

Additional requirements: The pipes shall be laid in straight lines as far as possible in both the vertical and horizontal planes. Any thing that is likely to cause irregularity of flow, such as abrupt change of directions shall be avoided. No bends and junctions whatsoever shall be permitted in sewers except at manholes and inspection chambers.

vii. **One pipe system partially ventilated** : A via-media between the one pipe system and single stack system. There is one soil pipe into which all water closets, baths, sinks and basins discharge. In addition, there is a relief vent which ventilates only the traps of water closets.

THD : Levels of various works under the jurisdiction of the Corporation are with reference to Mumbai Town Hall Datum (THD) which is 24.46M or 80.257 ft. below the mean sea level (MSL). The bench mark is fixed on the north side of the main entrance of Town Hall and is marked as G.T.S.O.B.M. Its value is 30.48 M or 100 ft. above THD.

Trade Effluent : A Discharge or liquid waste from any manufacturing or other process other than domestic sewer.

- **TRAPS:**

i. **Trap** : Any fitting designed to retain a quantity of water for the purpose of preventing the passage of air or gases through such fittings.

ii. **Gully Trap** : A trap used in the two pipes system for isolating or disconnecting waste pipes from the drain and for providing inlet ventilation to the waste pipes discharging into it. This fitting also facilitates removal of accumulated grit.

iii. **Gully Chamber** : A chamber built of masonry around gully trap for housing the same.

iv. **Grease Trap** : A trap which is used to intercept grease present in the discharges, before it enters into drain pipe.

v. **Nahani Trap**: A trap provided at the outlet of sanitary fittings in baths, sinks etc. which retains sufficient water to prevent smell or gases from the waste pipe or drain from escaping and entering the premises.

Waste Pipe : Any pipe which conveys the discharge from any fixtures, other than water closets, slop sinks, urinals, mortuaries or operation theatres, to the trap gullies in case of separate pipe system.

Combined Waste Pipe: Any pipe which receives the discharge from both soil and waste fixtures and conveys the same directly to the drain used only in connection with the one pipe system / single stack system.

Waste Water : Spent water from baths, wash basins, sinks and similar appliances, which does not contain human or animal excreta.

Water seal / Trap seal : The vertical distance between the soffit of the dip and the crown of the weir of a trap.

Vent pipe : A pipe line installed to provide flow of air to or from a drainage system or to provide circulation of air within such system to protect trap seals from siphoning and backflow.

Ventilating Pipe : The pipe which provides a safe outlet into the atmosphere for the foul gases from the drain or sewer

WATER SUPPLY & DRAINAGE WORK - (PART - II)

(EXECUTION)

Summary of Work

This chapter is limited to general Planning, Designing, Execution and specially Supervision of water supply-plumbing and Drainage system mainly in residential and semi-commercial and Commercial buildings only. Following is a brief summary of its planning, designing and execution etc.; to give fair idea of each system for effective supervision.

Planning & Designing :

As per the provisions of BMC Act, 1888 any work related to plumbing water supply and drainage shall be carried out by and under the supervision of the Licensed Plumber.

The Licensed Plumber has to prepare plumbing and drainage layouts based on the plans prepared by the Architect / Licensed Surveyor; taking in to consideration all requirements and specification prepared thereof. Stage wise exercises and operations are detailed below:

Pre-Execution Exercises :

1) The Licensed Plumber has to prepare proposal of drainage layout of project including house drainage arrangements etc. and has to get it approved from the Municipal authority before commencement of work.

2) The plans should consists of vertical external drainage work including storm water drains and underground house drains system; and its connection to Municipal Sewers or to Septic Tank as the case may be.

3) After scrutiny of plans and verifications of documents submitted, M.C.G.M. approves the plans of drainage layout and water supply requirements by issuing 'P' form (by M.C.G.M.); approving water connection for construction purpose.

4) Before execution of work the Licensed Plumber should obtained from the architect following drawings and guide lines :-

   i Details working drawings of plumbing and sanitation.

   ii. Details about plumbing system i.e. open type or concealed.

   iii. Brand and types of various fittings and fixtures to be installed.

   iv. Detailed specifications for water supply and drainage work to be executed.

   v. Terms and conditions / contract documents.

During Execution:

1) The entire plumbing and drainage work should be carried out strictly as per approved plans and in according to the rules and regulations of Local Municipal authority.

2) After the work is completed, the Licensed Plumber has to submit his completion certificate (Format-F) for drainage work executed and has to obtain Drainage Completion Certificate (Format-G) from Municipal Authority and has to obtain permanent water and drainage connections from the Municipal main service lines for the building. The formats F & G are as appearing hereafter.

3) The Licensed Plumber should hand over to owner and architect copies of plumbing and drainage layout plans according to which the work is completed; together with the copies of approved plans and completion certificates etc. for future record.

For effective execution and supervision thereof a check-list for water supply and drainage work is given hereafter : -

WATER SUPPLY & DRAINAGE WORK - (PART - III)
CHECK-LIST FOR EXECUTION

The Site Supervisor have to study following check-list and correctly observe the instructions stated therein to facilitate smooth working of all component agencies at site.

PRE-EXECUTION : -

1) To identify source of water supply from the Contractor / Owner for Construction and drinking purpose whether it is available from : -

   a. Municipal Water Supply
   b. Open Well Water Supply
   c. Bore Well Water Supply
   d. Tanker Water Supply

2) To identify the location for construction of water storage tank in consultation with the Architect.

3) To make arrangement of water storage at site by providing R.C.C. Masonry, Steel or Syntex Tanks with pumping arrangement through the Contractor.

   Note: To avoid double expenditure on storage tanks, it is advisable to construct suction tank (undersigned water storage tank) of required capacity of building as per Municipal requirements in consultation with the Licensed Plumber and Architect through Contractor.

4) To ensure that the Municipal water connection is available for Drinking purpose for Staff at site, as well as for construction through Licensed Plumber.

5) To make temporary toilet accommodation for workers at site; in consultation with Licensed Plumber. The location should be got approved from the Architect.

6) To ensure provision of temporary office at site.

DURING EXECUTION: -

1) To check and ensure that the conduits / pipes of required capacity and quality are provided for drainage, water and electric supply and or other such services, Below Plinth, when such supply Lines are to be connected to main lines from inner part or chowks of building. This work should be carried out before filling up, compacting and concreting of plinth.

2) To check-up at every slab level as to whether the required sunk is provided in Centering / Form work, for Bath, W.C. Toilets & Kitchen etc.

3) To ascertain as to whether sufficient space is available for taking / fixing vertical drainage and Water Supply lines, when such lines are proposed very close to chajjas, Windows, ducts etc.

4) To ascertain from the Structural Engineer that inverted beams are provided on each floor wherever sunk is proposed for W.C. / Toilet blocks, to avoid

unnecessary breaking or making holes in brick work or R.C.C. beams; before 1st slab is concreted.

5) After R.C.C. overhead water storage tanks are concreted, it should be ascertained that necessary- In let and Out-let pipes are grouted as per requirements of Licensed Plumber before carrying out internal and external plastering of overhead water tank.

Notes:

a. It should be ascertained that the internal plastering of over head storage tank, shall be completed before concreting top slab.

b. It should be ascertained that the circular openings of 18"/20" diameter for receiving manhole covers, are provided in form work / centering before concreting top slab of over head and suction tank.

6) To ascertain as to whether necessary openings / holes are provided at terrace level at proper locations as per the instructions of Licensed Plumber and Architect, to connect / fix pipes for rain water disposal.

EXTERNAL WATER SUPPLY & DRAINAGE SYSTEM:

1) To call for plumbing contractor for carrying out work of external vertical drainage and water supply system, only after the external plastering is completed.

2) To check from time to time that the plumbing and drainage work materials brought at site including Pipes, Fittings and Fixtures, are of standard make with ISI mark, before permitting use of such materials.

3) When external vertical water supply and drainage system work is completed, check-up following as to: -

a. Whether all supply lines are in PLUMB.

b. Whether joints are properly fixed and connected.

c. Whether the required number of clamps to each pipe are provided and are fixed / nailed to hold the pipes properly/firmly.

UNDER GROUND WATER SUPPLY AND DRAINAGE SYSTEM: -

1) To decide finished ground level in consultation with Architect and Licensed Plumber, before starting the underground water and drainage system work.

2) To checkup as to whether adequate slope is provided / maintained in drainage system by pouring water in first chamber (Sewer trap chamber); and its

discharge in last chamber as well as to ascertain whether manholes are properly plastered.

3) To check as to whether all branches from i) W.C., ii) Bath room and Kitchen lines, are connected properly through gully trap to manholes.

4) To confirm that all the covers of required strength for the Manholes and Inspection Chambers are provided flushed with finish ground level.

5) To checkup and ascertain that the direct water supply line within the compound up to suction tank is provided with water meter and its meter chamber.

6) To ascertain that adequate size and number of steel covers with locking arrangements are provided to Suction Tank and Over head Water storage Tank/s.

7) To ascertain that the set of pumps with proper foundation is provided along with delivery lines for ejecting water supply to over head water tank/s.

INTERNAL WATER SUPPLY AND DRAINAGE SYSTEM: -

1) To ascertain as to whether necessary pipe connections are provided for connecting Nahani Trap of Kitchens and Baths, and 'P' Trap is provided for W.Cs. / Toilets.

2) To ascertain as to whether W.C. Pans (Indian Style) are fixed correctly on 'P' traps with its flush pipes properly embedded in walls.

3) To ascertain as to whether Out-let pipes are provided up to Nahani Traps in kitchen and bathrooms / toilets.

4) In case of concealed plumbing, to ascertain that the water supply lines are properly jointed and tested for leakage and to check-up as to whether all concealed pipes are fixed properly in walls and provided with anticorrosive paint and covered with hessian cloth (Bardan) and grooves are properly plastered before permitting ceramic tile cladding to walls.

5) To check that the Nahani Traps are fixed before permitting flooring (tile) work to bath rooms, toilets and kitchens.

6) To check that the necessary spouts are provided for brass fittings at proper locations in bathrooms / toilets etc. before permitting ceramic tile cladding to the walls.

7) To permit to fix sanitary fixtures i.e. Wash Basins European style W.C. (Commodes), Flushing (cistern) tanks and fittings i.e. Taps, Geysers, etc., only

after entire work is completed in all respects and locking arrangements are provided to the premises to avoid thefts, damage or misuse of the fixtures.

8) To checkup entire water supply and drainage system completed, by releasing water supply from over-head tanks; to check leakages if any and to ascertain as to whether all the fittings and fixtures of water supply and sanitary wares are properly functioning.

9) To inform the Licensed plumber, if any defects or leakages are traced, and see that such defects are immediately rectified properly by the plumbing contractor.

10) Arrangement of chambers for house drains :

a. Ensure that the distance between two chambers is not less than 1.5 Mtr. and is not more than 7.5 Mtrs.

b. Ensure that the following gradient / slope is maintained :

i) House drain lines : 1 : 80 to 100

ii) Branch Connections to chambers : 1 : 40

****

(FORMAT - F)

(Drainage Completion Certificate to be issued by Licensed Plumber)

From:
Shri / Smt. _____
M/s _____
Licensed Plumber/s
Address _____
Mumbai - 400 _____.

Dated _____.

To,
The Assistant Engineer
Building Proposals _____
Municipal Corporation of Gr. Mumbai
Mumbai - 400 _____.

Sub: Drainage Completion Certificate for building No. (_____) on plot No. _____; bearing CTS /CS Nos. _____, Village _____, at _____ Mumbai 400 _. For Shri / M/s _____.

Your Ref.: ES/CE/CHE/_____/BP/_____ dated _____.

Dear Sir,

I do hereby certify that all vertical and underground drainage including of main lines branch lines, inspection chambers, gully trap chambers etc. for above building has been completed under my supervision, to my entire satisfaction and that the workmanship and whole of materials used are of good quality and no provision of Bye Laws, Acts and no requisition made, conditions prescribed or order issued, has been transgressed in the course of works. I have carried out the smoke test for the vertical drainage lines, and no leakages were traced / found while testing.

Thanking you,

Yours faithfully,

(Name & Signature of Licensed Plumber)
License No. _____

(FORMAT - G)

(D.C.C. Acceptance Letter by M.C.G.M.)

MUNICIPAL CORPORATION OF GRATER MUMBAI

No: CE/CHE/_____/BP/_____ of 20_____.

Office of the
Executive Engineer BP/___/
_____
_____
Mumbai _____.

Dated _____

To,
Shri _____
M/s _____
_____
_____

With reference to your letter dated _____ regarding drainage work of premises _____ _____ belonging to _____ _____ and works mentioned therein,

I have to state that the drainage work mentioned in requirements of this office letter under No.: ES/CE/CHE/_____/ dated _____200__; have been carried out / complied with.

Yours faithfully,

Executive / Assistant Engineer
Building Proposals
Ward _____.

Copy forwarded to owner
Shri / M/s _____
for information.

CHAPTER - EIGHTEEN

ELECTRICAL INSTALLATIONS - (PART - I)

TERMINOLOGY

Accessory : Any device, associated with the wiring and electrical appliance of an installation, for example, switch, fuse, plug, socket, outlet, lamp-holder, ceiling rose etc.

Alternating Current (A.C.) : A current which alternatively reverses its direction in a circuit in a periodic manner. .

i A complete set of these changes is called 'cycle'.

ii. The member of times, the current goes through these changes during each second is called the 'Frequency' of so many cycles per second.

Ampere (amp.) : It is the unit of electric current or quantity flowing. A current of one amp. flows when a potential difference of one volt is applied to a resistance of one ohm.

Apparatus : Electrical apparatus includes all machines, appliances and fittings in which conductors are used or of which they form a part.

Appliance : An energy-consuming device or equipment (other than a lamp) fixed or portable, in which the electrical energy is converted into light, heat, motion or any other form of energy or substantially changed in its electrical character.

Cable: A length of single insulated conductor (solid or stranded), or two or more such conductors, each provided with its own insulation, which are laid up together. The insulated conductor or conductors may or may not be provided with an overall mechanical protective covering.

Cable Armoured : A cable provided with wrapping of metal (usually in the form of tape or wire) serving as a mechanical protection.

Cable-Flexible : A cable containing one or more cores, each formed of a group of wires, the diameters of the cores and of the wires being sufficiently small to afford flexibility.

Cable-Polythene-Insulated : A cable in which the insulation of the conductor or conductors is a polythene compound.

Cable-PVC-Insulated : A cable in which the insulation of the conductor is a polyvinylchloride compound.

Candle Power: It is the strength or intensity of a light source, but not a direct measure of the light output.

Circuit : An arrangement of conductor or conductors for the purpose of conveying energy and forming a system or a branch of a system.

Circuit Breaker : A device, capable of making and braking the circuit under all conditions, and unless otherwise specified, so designed as to brake the current automatically under abnormal conditions.

Conductor (Arial) : Any conductor which is supported by insulators above the ground and is directly exposed to the weather.

Conductor of a Cable or Core : The conducting portion consisting of a single wire or group of wires, assembled together and in contact with each other or connected in parallel.

Conduit : This is a channel or pipe conveying or covering electrical wires, made of steel, plastic, etc.

Connector : A mechanical clamp shrouded in insulating material for connecting the conductor of a cable or of a flexible cord to that of another cable or of another flexible cord.

Connector Box or Joint Box : A box forming a part of wiring installation, provided to contain joints in the conductors of cables of the installation.

Consumer Terminals : The ends of the electrical conductors situated upon any consumer's premises and belonging to him at which the supply of energy is delivered from the service line.

Cord-Flexible : A flexible cable having conductor of small cross-sectional area. Two flexible cords twisted together are known as twin ' flexible cord'.

Core of a Cable : A single conductor of a cable with its insulation but not including any mechanical protective covering.

Current : A flow of electricity.

Cut-Out : Any appliance for automatically interrupting the transmission of energy through any conductor when the current rises above a pre determined amount, for example, fusible cut-out.

Direct Earth in System : A system of earth in, in which the parts of an installation are so earthed as specified but are not connected within the installation to the neutral conductor of the supply system or to earth through the trip coil of an earth leakage circuit-breaker.

Direct Current (D.C.) : A current flowing in one direction only and of uniform strength free from pulsation.

Dis-connector : A device used to open or to close a circuit when either negligible current is interrupted (or established) or when the significant change in the voltage across the terminals of each of the pole of the dis-connectors occurs. In the open position it provides an isolating distance between the terminals of each pole.

Distribution Fuse Board : An assemblage of parts including one or more fuses arranged for the distribution of electrical energy to final sub-circuits.

Earth : A connection to the general mass of earth by means of an earth electrode. An object is said to be 'earthed' when it is electrically connected to an earth electrode; and conductor is said to be 'solidly earthed' when it is electrically connected to an earth electrode without a fuse, switch, circuit-breaker, resistance or impedance in the earth connection.

Earth Electrode: A metal plate, pipe or other conductor electrically connected to the general mass of the earth.

Enclosed Distribution Fuse Board: An enclosure containing but-bars, with fuses for the purpose of protecting, controlling or connecting more than one outgoing circuit, fed from more than one or more incoming circuits.

Fitting, Lighting : A device for supporting or containing a lamp or lamps (for example, fluorescent or incandescent) together with any holder, shade, or reflector, for example, a bracket, a pendant with ceiling rose, or a portable unit etc.

Fuse: A device that, by the fusion of one or more of its specially designed and proportioned components, opens the circuit in which it is inserted when the current through it exceeds a given value for a sufficient time. The fuse comprises all the parts that form the complete device. It is a safety device for protecting conductors against over load and fire.

Fuse-Element : That part of a fuse which is designed to melt and thus open a circuit.

Fuse-Switch: A composite unit, comprising a switch with fuse contained in or mounted on the moving member of the switch.

Horse-Power : It is a rate of expenditure of energy.

Insulated : Insulated shall mean separated from adjacent conducting material or protected from personal contact by a non-conducting substance or an air space, in either case offering permanently sufficient resistance to the passage of current or to disruptive discharges through or over the surface of the substance or space, to obviate danger or shock or injurious leakage of current.

Installation (Electrical) : All the electrical wiring, accessories, fittings, consuming devices, control and protective gear, and other apparatus associated with the wiring

situated in any premises in which electricity is supplied or is to be supplied through any one service connection to consumer(s).

Linked Switch : Switches linked together mechanically so as to operate simultaneously or in definite sequence.

Lumen: This is a unit used to measure the rate of flow of light.

Multiple Earthed Neutral System: A system of earth in, in which the parts of an installation specified to be earthed are connected to the general mass of earth and, in addition, are connected within the installation to the neutral conductor or the supply system.

Ohm: It is the electrical resistance of a conductor in which a constant current of I-amp. flows under a constant voltage of I-volt.

Plug : A device carrying three metallic contacts in the form of pins, intended for engagement with corresponding socket contacts and arranged for attachment to a flexible cord or cable.

Point : A point shall consists of the branch wiring from the branch distribution board, together with a switch as required, and including the ceiling rose or socket-outlet or suitable termination. A three-pin socket - outlet point shall include, in addition, the connecting wire or cable from the earth pin to the earth stud of the branch distribution board.

Service : The conductor and equipment required for delivering energy from the electric supply system to the wiring system of the premises served.

Short Circuit: An accidental connection between positive and negative conductors due to which the current is cut short and does not complete its circuit.

Single-Phase System: A system in which power is sent out from one circuit of the generator with A.C. System for domestic consumers.

Socket-Outlet : A device carrying three metallic contacts designed for engagement with corresponding plug pins and arranged for connection to fixed wiring.

Switch : A manually operated device for closing and opening or for changing the connection of a circuit.

Switch-Board : An assemblage of switchgear with or without instruments but the term does not apply to a group of local switches on a final sub circuit where each switch has its own insulating base.

Switchgear : Main switches, cut-outs or fuses, conductors and other apparatus in connection therewith, used for the purpose of controlling or protecting electrical circuits or machines or other current using appliances.

Three-Phase System: This is universally employed system wherein it has three circuits wherein three or four wires are used. Three-phase service is provided for larger power consumers.

Transformer : An instrument for reducing or transforming a high pressure to a low one by induction.

Volt: The practical unit of electric pressure, the force that would carry one ampere of current against one ohm resistance.

Voltage-Low : The voltage which does not normally exceed 250 volts.

Voltage-Medium : The voltage which normally exceeds 250 volts but does not exceed 650 volts.

Voltage-High : The voltage which normally exceeds 650 volts but less than 33 kV.

Watt: It is a unit of power and is equal to I volt X I amp. i.e. watts/volts = amperes.

ELECTRICAL INSTALLATIONS - (PART -II)
(STAGE WISE EXECUTION CHART)

Planning & Designing

↓

Lay Out & Working Drawings

↓

Application to Electric Supply Company for Granting Estimated Load Supply, & Requirements of Sub-Station / Transformer Etc.

↓

Laying Conducts for Under Ground Supply Lines if any before concreting and completing of Plinth work.

↓

Laying Conduits in Each Slab & Beam Reinforcement, Fixing of Fan Hooks / Boxes in Slab reinforcement for main Supply to Consumer Units / Premises

↓

Physical Marking of Layout of Wiring in All Units / Rooms.

↓

Fixing of Conduits/Casing battens on Walls in case of open wiring or embedding the same in walls in case of Concealed Wiring

↓

Fixing of Junction Boxes, Panels, Boards and Such Fixtures

↓

Providing & Laying Complete Wiring

↓

Fixing of All Fittings & Fixtures & Complete Electrical Installation

↓

Testing of Installations

↓

Providing Consumer Meters

↓

Submission of Test Reports to Electric Supply Company and application for Supply Connection after obtaining NOC from PWD, in Case of Building Exceed 15 Mtrs. Height.

↓

Checking of Electrical Installation by authorised officer of Electrical Supply Company before passing & sealing of Meters

↓

Permanent Electric Supply Connection to Building & Consumers Thereof

ELECTRICAL INSTALLATIONS - (PART - III)

DESIGN & PLANNING :

1) The design and planning of an electrical installation is governed by the type of user of the building and requirements of the consumers thereof. Therefore it is essential to consult competent electrical engineer / Licensed Electrical Contractor at the planning stage for providing and planning electrical installations which should be safe and efficient in its use and adequate for its intended purpose.

2) For Designing layout of electrical installations for specific requirements of power use it is essential at planning stage that the Architect in consultation with Structural Engineer, Electrical Engineer and Owner / Developer to decide about following : -

   i) Needed accommodation for making provisions of Sub station, Meter Room, Switch Room, Service Cable ducts, Rising Mains and Cables, Opening and Chases required in floors and wall for intending electrical installations.

   ii) Total load requirements i.e. lights, fans, power etc.

   iii) Anticipated future increase in power consumption.

   iv) Requirements of Electric Supply company including location and distance of main supply connection point.

v) Layout of wiring installation whether open (in conduits) or concealed.

vi) After collecting necessary information, and suggestions from other consultants the architect shall prepare detailed working drawings of complete electrical installation in consultation with Licensed Electrical Contractor and also shall prepare necessary specifications of work including terms and conditions of contract.

EXECUTION :

1) The execution of entire electrical installation shall be carried out under the guidance and supervision of competent Electrical Engineer / through Licensed Electrical Contractor; in accordance to the design and specifications provided in the tender and strictly as per rules and regulations of Electric Supply company.

2) The Electrical contractor should decide his sequence of work in consultation with the Architect, in such a manner that it will not affect / conflict with working of other agencies and it will allow other service agencies to work smoothly and simultaneously without any interruption.

3) The Electrical Contractor should get approval for all the materials including fitting & fixtures to be used from the architect before commencement of work.

4) The Electrical Contractor should remain in co-ordination with the architect and other agencies through out the work.

5) The Contractor should arrange temporary electrical supply for construction purpose; before project work is commenced.

6) At the end of work the electrical contractor should check and test the entire electrical installation work and get it approved from the electric supply company.

7) The electrical contractor should submit his test reports and completion certificate in required format of Electric Supply company or as per Indian Electricity Act (Format Enclosed hereafter) together with NOC from P.W.D. Department incase height of Building is more than 15 Mtrs. and arrange for consumer meters and permanent electric supply connection to the building.

8) The Electrical Contractor should handover plans and diagrams of electrical installation; with copies of his test reports and completion certificates to the Architect and owner / developer for future reference.

CHECK LIST

Pre-Execution : The Site Supervisor should: -

1) Study all the working drawings of Electrical Installations, and obtain necessary instructions / guide lines from the architect before electrical work is commenced.

2) Keep record of all agencies and persons related to electrical installation work i.e. Electric Supply company, Electrical Engineer & Licensed Contractor, his assistants, wiremen etc. with following information : -

   a. Name, Address and Telephone numbers of company / agency appointed.

   b. Name, Address of Licensed Electrical Contractor and his assistants including their telephone numbers.

   c. Name, Address and Telephone Numbers of consulting Electrical Engineer appointed.

3) Ensure temporary electric supply for construction before work is started.

4) Ensure location of sub-station and transformer to be installed if any.

During Execution

1) Get all the materials including fittings and fixtures to be used, approved from the architect and keep samples of all items at site office for cross check.

2) Ensure that necessary number of unbreakable conduits of required gauge, size and capacity are provided below plinth level when electrical supply is passing through inner parts of building to be connected to main supply.

3) Ensure that the unbreakable P.V.C. conduits of specified gauge and diameter are provided and fixed with slab and beam reinforcement properly before concreting. Also ensure that the conduit pipes are properly joined with coupling and sealed with PVC solution so that pipe joint shall remain intact during concreting.

4) Ensure that the conduit pipe ends are properly capped immediately after concrete is set in slabs and beams to avoid blocking of conduit pipes; and also check by steel wire that the passage is clear for wiring.

5) Check materials to be used from time to time and ensure that it is of standard make, quality and are in conformity with the specifications recorded in tender / contract and approved samples.

6) Ensure that copper wiring is used for electrical installation unless approved and specified otherwise by the Architect.

7) Ensure that the electrical contractor has taken care of all safely provisions required during installation; and has provided with all essential safely devices thereof.

8) Ensure that the chases / openings provided in walls and floorings etc. are properly sealed after fixing of conduits.

9) Ensure that minimum 14 SG. copper wires are used for earth-in and 12 SG wire of aluminum and cheek that the earth in work is carried out as per requirements of PWD.

10) Ensure that conduits, battens, boards and such accessories should be permitted to fix only after the plaster is set and hardened properly.

11) **Open Wiring** : (PVC casing capping / conduits) :-

i. Ensure that the conduits are fixed with clamps at required intervals, in a proper line and level vertically and horizontally.

ii. Ensure that conduits or casing battens are not fixed on R.C.C. members continuously except at bends or crossing of columns and beams. In such cases conduits / casing battens are properly secured by drilling holes in R.C.C. member up to minimum required depth to fix with screws as directed by the structural engineer.

iii. In no case nailing by hammer should be permitted.

iv. Ensure that bends provided shall have minimum radius of 7.5 cm.

v. Ensure that all wiring whether concealed or open type, should be fixed as near the ceiling as possible.

12) **Concealed Wiring:**

i. Ensure that the grooves in partition walls are chiseled mechanically by notching machine (cutter) for required depth in length and width to accept conduit pipes and other accessories, in good workmanship line manner.

ii. Ensure that conduits are properly fixed and secured and such grooves and openings are sealed by mortar and finished by plastering in line and level, immediately.

13) Ensure that sufficient safe distance for wiring is maintained from water and gas supply lines.

14) Ensure that the wiring should be continuous between two connecting points without any joint in between; except looping is permitted for neutral.

15) Ensure that operational fittings i.e. Buttons, Regulators, Switches etc. shall not be fixed at height less than 1.5 Mtr. from floor level, unless specified, with safety devises.

16) Ensure that light holders bulbs, shades, florescent and such light fittings are fixed at height not less than 2.5 Mtr. from floor level.

17) Ensure that distribution boards, panels, fuse boxes and other safety devises etc. are fixed at proper location as near the ceiling as possible.

18) Ensure that the required fan points, light points, plug points and domestic power point of 15 amps. for geysers and kitchen appliances are provided; in each unit / premises as specified.

19) Ensure that the electric supply is connected, and installed with starters etc. for operation of water pumps.

20) Ensure that electrical installations for lifts and water pumps is carried out as per requirements and specifications of P.W.D.

21) Ensure that the No Objection Certificate is obtained by the Licensed Electrical Contractor from P.W.D. for entire electrical installation for multi-storied building exceeding 15 Mtr. height as applicable in the State of Maharashtra.

22) Ensure to obtain from Licensed Electrical contractor copies of test reports P.W.D. N.O.C. and work completion certificate as well as all electrical layouts, diagrams, etc. after permanent main supply is connected by the Electrical Supply Co. and should be handed over to the Architect and Owner / Developer for future reference.

****

FORM OF COMPLETION CERTIFICATE

I / We certify that the installation detailed below has been installed by me/us and tested and that to the best of my/our knowledge and belief, it complies with Indian Electricity Rules 1956.

Electrical Installation at _____

Voltage and system of supply _____

Particulars of Work :

a) Internal Electrical Installation

	No.	Total load	Type or system of wiring
i. Light Point			
ii. Fan Point			
iii. Plug Point			
3-pin 5 A			
3-pin 15 A			

b) Others	Description	hp/kw	Type of starting
1) Motors :			
i.			
ii.			
iii.			
2) Other plants :			

c) If the work involves installation of over head line and / or underground cable.

1) i) Type and description of overhead line.
   ii) Total length and no. of spans.
   iii) No. of street lights and its description.

2) i) Total length of underground cable and its size.

ii) No. of joints:

End joint

Tee joint

Straight through joint

Earth-in

i) Description of earth-in electrode

ii) No. of earth electrodes

iii) Size of main earth lead

Test Results :

a) Insulation Resistance

i) Insulation resistance of the whole system of conductors to earth ..... Megohm

ii) Insulation resistance between the phase conductors and neutral

Between phase R and neutral ..... Megohm

Between phase Y and neutral ..... Megohm

Between phase B and neutral ..... Megohm

iii) Insulation resistance between the phase conductors in case of poly phase supply

Between phase R and phase Y ..... Megohm

Between phase Y and phase B ..... Megohm

Between phase B and phase R ..... Megohm

b) Polarity test :

Polarity of non-linked single pole branch switches

c) Earth continuity test :

Maximum resistance between any point in the earth continuity conductor including metal conduits and main earth-in lead ..... Ohms.

d) Earth electrode resistance :

Resistance of each earth electrode

i) ..... Ohms.
ii) ..... Ohms.
iii) ..... Ohms.
iv) ..... Ohms.

e) Lighting protective system.

Resistance of the whole of lighting protective system to earth before any bonding is effected with earth electrode and metal in / on the structure ..... Ohms.

Signature of Supervisor	Signature of Contractor
Name and Address	Name and Address
.....	.....
.....	.....
.....	.....
.....	.....

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CHAPTER - NINETEEN

LIFT / ELEVATOR PROVISIONS

Multi storied and high rise apartment buildings are now commonly constructed in any urban development with lift/s provisions, taking in to consideration of total occupancy load and number of floors to be served. The provision of number of lifts and its capacities are different depending upon the users of building i.e. Residential, Commercial or Industrial.

Requirements:

For any types of building, MCGM insists for minimum provision of lifts, governed by the height of the building as under: -

Minimum Requirement	Height of Building
One Lift	For residential building above Gr + 4 upper floors or height between 15 Mtrs. to 24 Mtrs. (Gr and 7 upper floors considering floor height 9.5 Ft. with 2 Ft. plinth).
Two Lifts	24 Mtrs. of height and above.

Note: However there is no restriction for providing lift/s for any type of building even for lower height structures below 15 Mtrs. irrespective of its users if required by the owner / occupants.

Designing, Planning & Execution :

The Architect has to plan and decide the provision of number of lifts taking into consideration the user of such building, based on number of floors, and occupancy load depending upon functional requirements.

The minimum size of lift well / shaft, is depending upon the required capacity of persons in lift car, for the respective users in Residential, Commercial, Assembly and Hospital buildings etc. The Lift manufacturing companies provide ready information, plan, charts and various details such as lift shaft, speed of lift, location and size of the machine room etc. prescribed as per minimum standards.

The installation and erection of lifts is carried out by Lift Manufacturing Company. The developer / owner has to enter into an agreement with the lift manufacturing company which consists of total cost, period / time for installation, warranty period,

specifications, design of lift car including fittings and fixtures, and necessary facilities required during construction for erection and installation of lift/s.

At the end of installation the Lift Mfg. Company has to obtain completion certificate from Lift Inspector for satisfactory installation, and permission to use and operate the lift/s.

CHECK-LIST

For effective installation of lift in any type of building the Site Supervisor should :

i. Study plans and terms and conditions of contract executed by the developer / owner with the Lift Mfg. company including the specifications and the manner in which the work is to be carried out and completed.

ii. Study the drawings prepared by Architect and Structural Engineer for lift pit, lift shaft and lift machine room with its floor height from terrace top level.

iii. Ensure that the water tight lift shaft is constructed strictly as per structural designs and specification absolutely in plumb line for unobstructed travel of lift car.

iv. Ensure that the necessary door frames of required size are embedded properly in R.C.C. / Brick wall as specified in drawings at each floor level where lift opens, as per the requirements of the Lift Mfg. Company.

v. Ensure that the machine room of required size and capacity is constructed normally straight above lift shaft. The floor height of lift room above terrace level shall be as specified in the drawings.

vi. Ensure that the entire electrical installation is carried out by the Licensed Electrical Contractor as per the specifications and requirement of the Lift Mfg. company.

vii. Check that the lift machine, motor and other equipments are provided with necessary foundation at lift machine floor level as required by the Lift Mfg. Co.

viii. Ensure that all necessary openings at proper locations are provided of required size in lift machine room floor slab, for unobstructed operation of lift cables.

ix. Ensure that all the materials brought at site by the contractor is of standard quality and specifications mentioned in the contract document.

x. Ensure that the entire installation work is completed strictly as per specifications and requirements thereof.

xi. Arrange for test operations after the installation is completed in all respect, before calling Lift Inspector for inspection.

xii. Ensure to obtain a completion certificate and permission to use and operate the lift from the Lift Inspector a competent authority appointed by the State Govt.

xiii. Verify the bills of contractor against the completion of respective items for payment as agreed in payment schedule of contract, and recommend the same to the Architect for issuing interim certificate and releasing payment thereof.

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CHAPTER - TWENTY

FIRE SAFETY IN HIGH-RISE & SPECIAL TYPE OF BUILDINGS - (PART - I)

TERMINOLOGY :

Automatic Fire Detection and Alarm System: Firm alarm system comprising components for automatically detecting a fire, initiating an alarm of fire and other actions as appropriate.

Note: *The system may also include manual fire alarm call.*

Automatic Sprinkle System : Means an arrangement of pipes and sprinklers, which automatically get operated by heat and discharging water on fire, simultaneously setting an audible alarm.

Combustible Material : Means that material which when burnt adds heat to a fire tested for combustibility in accordance with the IS: 3808-1966 'Method of test for combustibility of Building Materials', National Building Code.

Down Comer: Means a arrangement of fire fighting within the building by means of down comer pipe connected to terrace tank through terrace pump, gate valve and non return valve and having mains not less than 100 mm internal diameter with landing valves on each floor / landing. It is also fitted with inlet connections at ground level for charging with water by pumping from fire service appliances and air release valve at roof level to release trapped air inside.

Dry Riser: Means a arrangement of fire fighting within the building by means of vertical rising mains not less than 100 mm internal diameter with landing valves on each floor / landing which is normally dry but is capable of being charged with water usually by pumping from fire service appliances.

Draught Lobby : Means a lobby on entrance at floor connected to a corridor on one side and to the open air on the other.

Enclosed Staircase : Means a staircase separated by fire resistant walls and doors from the rest of the building.

Escape Route: Means any well ventilated corridor, staircase or other circulation space, or any combination of the same, by means of which a safe place in the open air at ground level can be reached.

Exit : Means a passage, channel or means of egress from any building, storey or floor area to a street or other open space of safety. The horizontal, outside and vertical exits having meanings at (i), (ii) and (iii) respectively as under : -

i. "Horizontal Exit" means an exit which is a protected opening through or around a fire wall or bridge connecting two or more buildings.

ii. "Out side exit" means an exit from a building to a public way, to an open area leading to a public way or to an enclosed fire resistant passage leading to a public way.

iii. "Vertical Exit" means an exit used for ascending or descending between two or more levels, including stairways, smoke-roof towers, ramps, escalators and fire escapes.

Fire and / or emergency alarm system: Means an arrangement of call points or detectors, sounders and other equipments for the transmission and indication of alarm signals working automatically or manually in the case of fire or other emergency.

Fire Lift : Means a special lift designed for the use of fire service personnel in the event of fire or other emergency. The speed of the fire lift shall be such that it can reach to the top floor from ground level within ONE MINUTE.

Fire Proof Door (F.R.D.): Means a door or shutter fitted to a wall opening, and constructed and erected with the requirements to check the transmission of heat and fire and shall have fire resistance of not less than two hours.

Fire Pump: Means a machine, driven by external power for transmitting energy to fluids by coupling the pump to a suitable engine or motor, which may have varying outputs/ capacity but shall be capable of having a pressure of 3.2 kg / cm^2 at the topmost level of a multistoried or high rise building.

Booster Fire Pump : Means a mechanical / electrical device which boosts up the water pressure at the top level of a multistoried / high rise building and which is capable of a pressure of 3.2 kg / cm^2 at the nearest point.

Fires Resistant : Means the time during which a fire resistant material i.e. having a certain degree of fire resistance, fulfills its function of contributing to the fire safety of a building when subjected to prescribed conditions of heat and load or restraint. The fire resistance test of structures shall be done in accordance with IS÷ 3809 1966-'Fire Resistance Test of Structure'.

Fire Separation : Means the distance in meters measured from any other building on the site or from another site, or from the opposite side of a street or other public space to the building.

Fire Service Inlet: Means a connection provided at the base of a building for pumping up water through inbuilt firefighting arrangements by fire service pumps in accordance with the recommendations of the Chief Fire Officer.

Fire Tower : Means an enclosed staircase which can only be approached from the various floors through landings or lobbies separated from both the floor area and the staircase by fire-resisting doors and open to the outer air.

Hazardous Material : Means -

i. Radio active substances;

ii. Material which is highly combustible or explosive and/or which may produce poisonous fumes or explosive emanations, or storage, handling, processing or manufacturing of which may involve highly corrosive, toxic or noxious alkalis or acids or other liquids;

iii. Other liquids or chemicals producing flames, fumes explosive, poisonous, irritant or corrosive gases or which may produce explosive mixtures of dust or fine particles capable of spontaneous ignition.

Pressurisation : The establishment of a pressure difference across a barrier to protect a stairway, lobby, escape route or room of a building from smoke penetration.

Pressurisation Level : The pressure difference between the pressurised space and the area served by the pressurised escape route.

Smoke-stop Door : Means a door for preventing or checking the spread of smoke from one area to another.

Tower-like Structure : Means a structure in which the height of the tower-link portion is at least twice the width of the broader base.

Travel Distance : Means the distance from the remotest point on a floor of a building to a place of safety be it a vertical exit or an horizontal exit or an outside exit measured along the line of travel.

Venting Fire : The process of heat and smoke to leave a building as quickly as possible by such paths that lateral spread of fire and heat is checked, fire fighting operations are facilitated and minimum fire damage is caused.

Wet Riser : An arrangement for fire fighting within the building by means of vertical rising mains of not less than 100 mm internal diameter with landing valves on each floor / landing for fire fighting purposes and permanently charged with water from a pressurised water supply.

FIRE SAFETY IN HIGH-RISE & SPECIAL TYPE OF BUILDINGS - (PART - II)

PROVISIONS :

As per provisions of D.C. Regulations 1991 (Rule 43) It is mandatory to obtain N.O.C. / clearance from the Chief Fire Officer of Mumbai Fire Brigade for construction of High Rise and Special Type of buildings as listed below: -

1) High Rise Buildings :

i. Any building having height 24 Mtrs. and above.

2) Low - Rise / Special type of Buildings : -

i. Industrial Estate Buildings.

ii. Service Industrial Estate-Buildings.

iii. Factory Buildings.

iv. Storage Buildings.

v. Warehouse Buildings

vi. Cinema / Theatre / Assembly Halls.

vii. Shopping Centres.

viii. Residential Hotel Buildings.

The Developer / Owner has to provide fire safety installations as specified in the permission / NOC granted by the Chief Fire Officer (CFO), under the supervision of competent fire fighting consultants through contractors of repute.

After completion of work, the Architect / Owner has to obtain final clearance / NOC from the Chief Fire Officer. After inspection the C.F.O. will ensure that all required precautions and fire safety devices are installed satisfactorily, and there after the C.F.O. issues its clearance for operations; without which occupation permission can not be granted by the Municipal Corporation.

CHECK-LIST

For effective installation of fire fighting system and provision of equipments thereof, the site supervisor should : -

i. Study floor layout plans showing fire fighting systems and installations thereof as specified and approved by the C.F.O.

ii. Study terms and conditions of No Objection / Clearance issued by the C.F.O. and check that the same are incorporated correctly in the contract with fire fighting contractor for execution of work.

iii. Collect detailed list of materials, equipments and devices to be used in installation work from the consultant / contractor.

iv. Check that all materials to be used are of standard and good quality of reputed make; and get it approved from the fire safety consultant and architect before it is allowed to be used.

v. Check that the contractor has provided entire installation of fire fighting system including automatic sprinkler system, wet risers, dry risers, down commers, fire alarm and all such devices, and all fittings and fixture work is carried out properly; as specified in the first N.O.C. / clearance of C.F.O.

vi. Ensure that the contractor has provided Fire Proof Doors (FRD), Fire pumps, Additional storage tanks for fire fighting of required capacity, Fire lift etc. as per specifications required by C.F.O. and get it checked and approved from the fire safety consultant and architect.

vii. Get the entire installation checked / tested under the supervision of fire safety consultant and contractor and get defects rectified if any, before calling Fire Officer for inspection for issue of final N.O.C.

viii. Ensure that a set of plans showing fire fighting installations as executed on site, are handed over to the Architect / Owner and Consumer for permanent reference.

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CHAPTER - TWENTY ONE

PAINTS & PAINTING WORKS

Painting is one of the important finishing item for protecting the exterior and interior surfaces from water leakage, seepage, and deterioration from all kinds of whether effects. For the purpose it is classified in two categories i.e. i) Cement Paints and ii) Oil Paints respectively.

1) CEMENT PAINTS :

The quality cement paints are generally based on white Portland cement with additives that enhance ease of application and water repellency. The cement paints to external surfaces provides a hard, durable and water proof surface which resists penetration of moisture in wet climate conditions. If applied strictly as per instructions it can give best results and can not be rubbed, flake, peel-off; or can be easily washed off. The light bright shades can act as excellent light reflector.

A) Application of Cement Paints to exterior surfaces : For effective and desired results the cement paints should be applied to exterior surfaces in following manner: -

i. Clean all the external surfaces thoroughly and make it free from dust, dirt, oil etc. Wash the surfaces with clean water using water spray till the absorption of water is stopped; and surface remains wet for at least for 6 to 8 hours.

ii. Apply base / primer coat prepared either from pure solution of cement mixed with sodium silicate and water or with cement primer compound in liquid form mixed with equal quantity of water after the surfaces are thoroughly dried up.

iii. After the primer / base coat is fully dried up (usually after 24 hours in normal climate conditions), 1st coat of cement paint should be applied. After the first coat dried up it should be cured with clean water for at least 6 to 8 hours.

iv. After 1st cement coat is fully dried up and cured, the second coat should be applied in similar manner as stated in item iii) above.

B) Colour wash / Distempers :

i. In the newly constructed buildings the inner surfaces of walls, ceiling etc. shall be provided with colour wash (lime base) or cement based distempers in three coats.

ii. The preparation of surfaces and application of colour coats are identical as to the application of cement paint as described herein above.

CHECK-LIST FOR CEMENT PAINT

The site supervisor should study the specifications and colour scheme for painting exterior and interior surfaces as prepared by the Architect, before commencing of painting work. For effective results the Site Supervisor should : -

i. Ensure that the cement paint to be used is a quality product of reputed company.

ii. Ensure that the painting contractor has provided necessary scaffolding, strong enough to take load of working painters and materials thereof.

iii. Ensure that all the exterior surfaces are thoroughly cleaned and washed before primer coat is provided.

iv. Ensure that the samples of approved colour shades are displayed at site as required by the Architect. .

v Ensure that the quantity / volume of water and cement paint is maintained strictly as specified by the Cement Paint Mfg. company.

vi. Ensure that the paint is well stirred and mixed to uniform consistency before its use. No dilution of paint should be permitted thereafter.

vii. Ensure that each coat of cement paint is as per finally approved shade (first and second) is applied only after the earlier coat is fully dried up.

viii. Ensure that each coat is thoroughly cured with clean water at least for six to eight hours after each application depending upon the climatic conditions. If required repeat curing for proper setting.

ix. Ensure that the curing is carried out from bottom to top with fine water spray.

x. Ensure that Cement paint to external surfaces should not be applied during rains.

2) OIL PAINTS:

The oil paints are commonly applied to prevent wood and fabrication works and any other inner surfaces from climatic effects, wherever specified by the Architect. The paints generally consist of following materials: -

i. **Base** : This is a principal constituent forming the body of paint wherein white lead, red lead, zinc oxide, iron oxide, etc. are used.

ii. **Vehicle** : The liquid vehicle acts as a binder for the base and pigments which helps in forming a tuff elastic film when dried. The liquid vehicle helps to spread the base and pigment over the surface to be painted. Linseed oil is mostly used vehicle for all common oil painting works.

iii. **Solvent or Thinner** : A liquid thinner is commonly used to thin the prepared paint to desired consistency to make it work more smoothly and evenly, which effectively penetrates in porous surfaces. Spirits of Turpentine is most widely used as excellent thinner.

iv. **Drier**: A drier helps in quickening the drying of vehicle in the paint for setting a hard film and should be used under the supervision of competent painting contractor, as drier has tendency to destroy the elasticity of paint if used unnecessarily or in excess.

v. **Pigment**: The pigments are available either in powder or in liquid form and should be thoroughly mixed in paint to achieve desired colour shade.

Application of Oil Paints to : -

a) Wood Work :

Before application of oil paint it is essential that all the surfaces of wood work are rubbed down by fine grade sand paper and are made perfectly smooth. The Painting should be carried out in three coats :-

i. Primary coat: It is first coat to be applied with primer to fill up the pores of wood or any inequalities on the surface to be painted.

ii. First Finish Coat: This is a second coat of desired colour shade which shall be applied only after primary coat is fully dried up.

iii. Second Finish Coat: The third and final finish coat should be applied with desired colour shade and pattern, only after first finish coat (second coat) is fully dried up.

Note: *Generally thin coats of oil paints should be applied as the thicker coats take longer time to dry up and has tendency to flake off after some time.*

b) Fabrication / Iron work :

To protect iron and steel from corrosion and rust, all the fabrication work should be painted in three coats. Before painting ensure that the rust scales and dirt is thoroughly removed by scrapers or iron brushes. The coats shall be applied as under: -

i. Primer Coat : An anti rustic / anti corrosive paint commonly known as 'Red oxide' shall be applied as primer / base coat. This is generally provided by the fabricating contractor as soon as the product is ready in workshop itself, before its delivery at site.

ii. Second and Third coat : The second and third coat of desired colour shade shall be applied only after the earlier coat is fully set and dried up as stated in a) above.

CHECK-LIST FOR OIL PAINTING

The site supervisor before and while carrying out work of oil painting, should ensure that :

i. All the materials i.e. base, vehicle, thinner, drier, pigment, ready mixed packed oil paints are of good quality and standard make of reputed company.

ii. The surfaces are clean and free from dust, dirt, grease, oil, rust, moisture and loose particles, etc.

iii. All the defects in wood work i.e. nail holes, cracks, gaps and such other inequalities are properly filled in by ordinary putty to bring the surfaces in level only after the primer coat is applied and dried up.

iv. All the wood work surfaces are rubbed down by fine grade sand paper and made perfectly smooth before application of second and third coat.

v. The desired colour shades are prepared and samples are displayed at site by the painting contractor before its application as per colour scheme decided by the Architect / Owner.

vi. All the paints and other materials are stored in cool and dry place and away from children and sources of ignitions.

vii. The paint containers are tightly closed after use.

viii. The painters are using 'dust nose pads' while rubbing the surfaces.

ix. The painters are using nose mask, eye protections and gloves during the application of respective paints.

Notes :

i. Do not allow to apply any colour coat unless earlier coat is fully dried up.

ii. Do not allow to throw left over paint into drains to avoid its blocking.

iii. Specially for the external painting work of a multistoried buildings, ensure that the painting contractor has insured the painters working at site properly.

iv. The Site Supervisor should obtain the copy of Insurance Policy and keep it in record, with necessary intimation to the Architect and Owner / Developer thereof. The site supervisor should ensure that the policy is in force through out the painting work.

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CHAPTER - TWENTY TWO

GLASS & GLAZING

Glass is a product of oxides of silicon and normally used for desired transparency in door and window shutters. Good quality glass should be hard, transparent, smooth, clear and without any surface or other manufacturing defects.

The thickness of glass to be used is determined based on the size of aperture. Generally in building construction, following types of glasses are used depending upon its requirements :-

i. **Crown Glass** : - It is a cheapest quality of glass and generally used for window panes of smaller sizes.

ii. **Sheet Glass** : - For pane sizes below 36" X 36", the sheet glass is commonly used for window and door shutters in residential and commercial buildings. It has desired hardness and transparency.

iii. **Plate Glass** : - It is more stronger and transparent than sheet glass; and used for large size (more than 36" X 36") glass panes for shop fronts, show rooms, fully glazed-doors in one piece for commercial establishments, dining tables etc.

iv. **Wired Glass** : - Wire-netting is embedded in plate glass while rolling. It resists heat and fire better than plate glass, and if fractured it does not fall to pieces; often used for steam bath cubicles and other such places.

v. **Glass Crete** : - Small square pieces of tough glass set in steel or concrete frame are used for light in basement. Semi-prisms are made on underside of the glass pieces to collect light and project it in to basement.

Fixing of Glass: -

i. The glasses are cut to required sizes depending upon the opening. The glass panes for doors and windows are secured in place by means of putty or wooden moulds; as specified. The glass panes are cleaned properly before and after fixing.

ii. The Non-transparent glasses are generally used for window/ventilators of W.C., Bath and toilets where transparency is not desired. In old days the glass sheets were grounded uniformly with fine sand to remove transparency. However non transparent glass sheets now are manufactured with self design. The fixing procedure is identical to as described in a) above.

CHECK – LIST

The Site Supervisor should : -

i. Ensure that the product is of reputed company. The samples should be got approved in advance from the Architect and should be kept at site for cross-check.

ii. Ensure thickness and transparency of glass sheets.

iii. Ensure that the glass sheets are stacked vertically supported by inner surface of walls on wooden platform to prevent damage to surfaces and edges.

iv. Ensure that the glass panes are properly secured in place by wooden moldings, and nailed properly; with line and level in wooden frame shutters and fixed by putty in steel frame shutters.

v. Ensure that hand gloves are used by workers while cutting and fixing of glass.

vi. Ensure that at the end of the day work, left over cut pieces of glass and glass dust etc. is removed and disposed off in dustbin.

vii. Ensure that glass panes are cleaned from both sides after application of paint to frames and shutters.

viii. Ensure that all the materials i.e. channels, sections, ball bearings, handles, P.V.C. moldings, areof best quality, gauge, and finish, required for aluminum sliding shutters for balcony enclosures or wherever such large openings are proposed to be closed by glazing.

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CHAPTER - TWENTY THREE

PLANTING OF TREES

i) Planting of Trees (Requirements):

It is mandatory to plant certain number of trees in compound as per the provisions of D.C. Regulation 1991 (Rule 23(f), before Occupation permission is granted to any new building as under: -

a. In layout plot, 5 trees per 100 Sq. Mtr. or part thereof in a Recreational Open Space of layout / sub-division i.e. Layout R.G. Area.

b. 1 tree per 80 Sq. Mtr. or part thereof in a plot for which layout / sub division is not necessary i.e. where plot area is less than 2500 Sq. Mtrs.

Minimum number of trees as specified above shall be planted peripherally along compound wall (Except on road side) and to grow to its minimum height as specified in Tree Act.

After planting of trees, necessary certificate / clearance shall be obtained from the Superintendent of Gardens / Tree Authority of MCGM before occupation permission is requested from the building proposal department.

ii) Cutting of Trees :

It is mandatory to obtain tree cutting permission (within M.C.G.M. jurisdictions) from the Superintendent of Garden / Tree Authority of the of the Municipal Corporation when existing tree/s affects proposed construction. The tree authority usually grants such permission after inspection of site either for cutting or transplantation, depending upon norms laid down in Tree Act. The application should be made in proforma including diameter, number and name of each tree to be cut and the same are distinctly shown on plans.

It is to be clearly understood that cutting of tree without permission is criminal offence and person can be charged with penalty and or imprisonment. The Architect has to obtain prior permission for cutting of such trees affecting construction in writing from the tree authority before work is commenced.

iii) Preserving Existing Trees :

It is mandatory to preserve the existing trees at site, not affecting proposed construction. Such trees should be provided with numbers, and should be well protected and maintain during and after construction.

iv) Method of Planting the Trees:

a. Generally in smaller independent plots, trees should be planted in small trenches specially provided along compound wall except on road side, at required distance centre to centre. The trench should be reasonably wide depending upon the open spaces around the building and required clear paved area. The trenches should be protected by 9" bund wall; to protect the plants, as well as to protect spilling of earth filling on paved areas.

b. The trenches should be excavated at least 2' to 3' deep as required. The excavated soil should be removed and shall be filled with clean soil suitable for planting of trees mixed with manure in proportion. The surface should be leveled properly up to finish ground level only; to have clear protection of 9" bund wall to plantation.

v) Types of trees for plantation :

a. Trees specially of vertical growth which remain ever green and shady through out the year, and which will cause minimum nuisance when fully grown up, are excellent for planting in compound area, such as : -

b. The flowery or leafy short growth plantation should be provided between two major trees, to keep entire compound lush green.

c. The plantation of trees in larger open space areas (layout R.G.) where landscaping is required, the same shall be carried out under the guidance and supervision of Landscaping Consultant through professional contractors.

Note:- *The plantation of trees of larger vertical and horizontal growth such as Mango, Neem, Pippal, Baniyan, etc. should be avoided in compound as it will cause inconvenience to building residents, when fully grown up.*

CHECK-LIST

For effective plantation of trees in building compound the Site Supervisor should : -

i. Check that the trenches for plantation are provided with 9" bund wall duly plastered from both the sides.

ii. Ensure that necessary weep holes are provided in compound or bund wall wherever required; to discharge excess water.

iii. Ensure that water taps at specific locations are provided for watering the plants.

iv. Check the proportion of mix of soil and manure, and ensure filling of prepared soil in layers in the trenches up to required level.

v. Ensure to obtain fresh saplings of uniform height and growth for plantation from reputed nursery.

vi. Ensure to start planting of trees at least 3/4 months in advance prior to completion of building work so that the trees can grow up to reasonable height and shape, before occupying the premises.

vii. Ensure that the tree plantation and landscaping of larger open space i.e. Layout R.G. shall be carried out under the supervision of Landscaping Consultant / Architect through the competent contractor.

viii. Ensure that the locations of larger open spaces as stated in vii) above, should be got demarcated properly on site in consultation with project Architect before commencing tree plantation thereof.

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CHAPTER - TWENTY FOUR

MODERNISATION IN CONSTRUCTION TECHNOLOGY

For years together, by and large in our country, majority construction activities were being carried out in usual conventional manner. We were far behind advanced technology in comparison with other developed / developing countries, who had brought effective and radical changes in construction activities in their own nations. Due to age old conservative national policies and unwarranted Import-Export restrictions, India could not achieved recognition in the construction sector for decades together.

However, in last decade and half, due to encouragement of Foreign Direct Investment (FDI) in Real Estate and liberalization of import - export policies by the Union Government, the construction scenario in our country is improved dramatically.

Once doors were opened for foreign investments in real estate, use of modern construction equipments clubbed with innovative materials and technology, it has given complete facelift to construction industry in India. With the result a healthy competition was started in real estate sector, to give best possible products to the consumers. Now a days mega construction projects are undertaken with regular use of innovative materials and modern technology, therefore the construction quality is improved to a great extent. Mega constructions of functional modern and eco friendly high rise buildings has definitely changed the skyline of Mumbai, Delhi, Bangalore, Chennai etc. at par with any other metropolis in the world.

The Chapters 1 to 23, of this book describes that, how in the past, the materials, equipments and construction technology was adopted in traditional manner in our country. After the new wave of modernization in construction technology it has changed overall perspective of Real Estate in India considerably.

In the circumstances it has become obligatory for the Site Supervisor to get and keep himself updated about the information regarding the use of innovative materials, modern equipments and continuous improvement in construction technology throughout the world on day-to-day basis.

Following is the fundamental information about some of the modern equipments, innovative materials presently in use and construction technology adopted, which has not only increased the speed of construction but has improved quality of construction to the satisfaction of all players in real estate and specially of the consumer too.

In view of above, in this 3rd edition, we have added new illustrations of modern construction equipments for the ready reference and information of the Site Supervisor as well as for interested readers.

Modern Construction Equipments & Innovative Materials :-

- **Excavators & Hammer Breakers** :- Innovative excavation equipments are in frequent use for speedy excavations at project sites for desired depth. Bulldozes are supported by the Bucket Loaders, Front End Loaders and Backhoe Loaders which gives effective results in minimum time frame.

  For rocky soils, different types of hydraulic hammer breakers are used to drill and remove the rocky areas effectively. The Truck mounted hydraulic hammer breakers are also available in different sizes & forms, according to requirement of project.

- **Earth Removers** :- Specially designed hydraulic Dump Trucks has given great relief to the contractors in removing excavated earth from the site within shortest possible time. For different requirements and specific site conditions. The use of Forklift Trucks, Transfer Dump Truck and Side Dump Trucks for lifting and placing of debris materials at desired spot and location has become much more easy now a days.

- **Cranes** :- Use of different types of cranes for lifting and placing construction materials on higher levels of construction sites, has become inevitable, which has given great relief to construction workers and saving of man power. You can see that the Tower Cranes, Mobile Cranes and Telescoping Cranes are in regular use at construction sites of skyscrapers having different floor plates.

  The cranes are also available in various forms and sizes i.e. Truck Mounted Cranes, Mobile Cranes, Loader Cranes etc. are preferred for specific locations where desired mobility is required.

- **Processed Steel** :- Apart from standard Tor Steel (which by and large is used in standard construction), a trend is changing to use 'Specially Processed Tor Steel', and or 'Preservative Coated Processed Tor Steel' for the specially designed mega constructions and infrastructure projects. It is possible that in near future, steel frame structures will be used for commercial buildings as in practice in many western countries.

- **Cutting & Bending Bar Machines** :- Special machines are introduced for cutting and bending of steel bars, as per specifications and structural requirements of the building. Special cutters are also available for cutting of marbles, flooring stones, ceramic tiles, wooden, and steel plates etc. in required sizes. This has definitely improved the quality of workmanship, and has provided great help and relief to skilled and unskilled construction workers.

- **Concrete Mix, Placement & Compaction** :- Developers generally prefer their own batching plant on site for their mega projects wherever possible. Ready Mix Concrete (RMC) has given great relief to all concerned specially in respect to water cement ratio and grade of concrete mix etc. which has not only assured quality of concrete as well as saving of man power resulting into speedy construction. It has

also become possible to place the concrete at higher levels with help of truck mounted pump unit and placing booms. Use of specially designed Compactors and effective mobile Vibrators has given great contribution to the placement and quality of concrete.

- **Shuttering :-** Long back, usual conventional wooden plank shuttering is replaced by heavy duty smooth plywood shuttering, resulting in perfect size, plumb and smooth surfaces of respective R.C.C. members including slabs which can give honeycomb free finish to R.C.C. frame work. Fabricated steel plate shuttering is also used depending upon site conditions specifications and specific requirements of the project.

- **Scaffoldings :-** A desired awareness has been created considerably amongst all component agencies connected to construction activities regarding safety and security for construction workers at project site. To avoid accidents, and or injury to workers/public during the construction, special scaffolding materials are in use such as tabular pipe frame scaffoldings, Agro safety net curtains around buildings, as well as use of cantilevered M. S. framed scaffolding with double agro safety nets for high rise / multistoried construction sites, specially proved effective for vertical extensions in crowded locations.

- **Suspended Work Platforms :-** As per Occupational Safety and Health Act and other similar provisions, it is mandatory for the employers to provide fall protection equipments i.e. suspended work platforms for the safety of the construction workers working at great heights particularly at skyscrapers involving high risk. These are specifically used for cleaning of window panes, glass curtain walls, cladding, plastering and painting of external surfaces of the high rise buildings. Besides above suspended platforms, tabular frame scaffoldings are used for similar operations at external face of buildings.

- **Special Elevation Treatment / Curtain walls :-** To make building elevation elegant and eye catching a trend of providing structural glass curtain walls to exterior faces, specifically for commercial buildings, is increasing day-by-day in all cities of our country. This type of facade gives very eye pleasing look to the building if it is designed properly.

  In the similar manner specially designed Aluminum foil elevational features for the external face of the building can give equally pleasant look to the buildings. This can effectively give new look to old buildings very successfully.

- **Personal Safety Equipments :-** During the course of construction, the use of personal safety equipments and accessories, for the construction workers on site, has been made mandatory throughout the world. In our country, it is also made compulsory for the construction workers to use & wear following safety equipments as required before he starts the work :-

  (i) Heavy duty safety Footwear/Boots,

(ii) Hard Hats and Eye Protectors (Goggles),

(iii) Hand Gloves,

(iv) Knee Caps,

(v) Tool Kit and

(vi) Safety Vests etc.

Making provision of First Aid Kit, Masks for workers and Fire Extinguishers are now made compulsory for the safety and security of construction workers on every construction site. These equipments gives reasonable protection to workers when if met with any unfortunate event/accident.

Notes :

1) *The Site Supervisor has to ensure that each construction worker is wearing/using aforesaid safety equipments before he is permitted to proceed with actual work at site.*

2) *The images of aforesaid innovative construction equipments are displayed hereafter for the ready reference of the site supervisor and reader also.*

****

MODERN EQUIPMENTS

Bulldozer

Compact Excavator

Front Loader

Backhoe Loader

Hydraulic Hammer Breaker

Truck Mounted Hydraulic Hammer Breaker

Dump Truck

Forklift

Mobile Concrete Mixtures

Truck Mounted Mixer Drum

Truck Mounted Placing Boom & Pump Unit

Concrete Vibrators

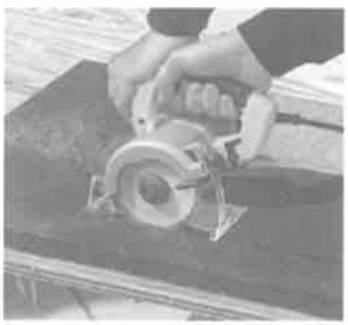
Block Making Machine

Concrete Vibrators

Block Making Machine

Floor Polishing Machines

Bar Cutting & Bar Bending Machines



Different Cutters

Wooden & Steel Floats

Drilling Machines

Telescopic Mobile Crane

Mobile Crane

Tower Crane & Truck Mounted Crane

Suspended Work Platforms & Tabular Frame Scaffoldings

Personal Safty Equipments

Personal Safety Equipments

CONVENTIONAL EQUIPMENTS

Trowel

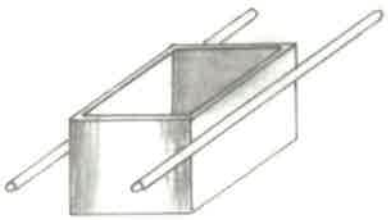
Gauging Trowel

Floating Rule

Ghamela

Wooden Float

Measure Box

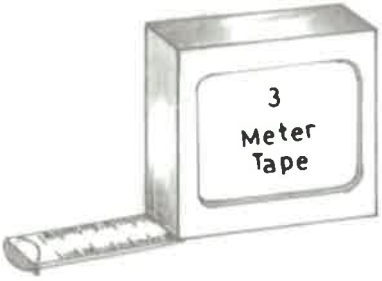


Metal Float

Tread (Line Dori)

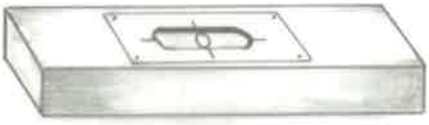
Wire Brush

Set Square (Katkona)



Measure Tape

Plumb (Olamba)



Level Bottle

Water Tube (For Levels)

Spirit Level

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Notes

Notes

I heartily congratulate PEATA office bearers for their sincere effort in bringing out this useful document / hand-book for "Site Supervisor" which will definitely help Site Supervisors to deliver the best quality construction.

---Shri K. C. Srivastava
Municipal Commissioner-Mumbai

This book has provided desired information of all the trades at a glance for the conventional and improved systems of building construction and will be definitely beneficial to the Site Supervisors, Architects, Consulting Engineers, Contractors, Builders etc.

---Shri V. R. Kirtane
Director (E.S. & P.), Municipal Corporation of Gr. Mumbai

This book will prove to be a bible for Site Supervisor which in result will help to produce buildings of safer and longer economic life.

---Shri Rajnikant C. Shah
President, PEATA (India)

In this book all necessary information required to know by a Site Supervisor is covered in a simple language. To bring out such book is unique and worth appreciating.

---Shri Narendra Patel
Vice President, The Institution of Engineers (India)

All information is presented in a simple language and in brief, without missing any important point. The efforts made are laudable and praiseworthy which will go a long way in improvement of quality construction.

---Shri A.R. Jambekar
Chairman, Indian Concrete Institute (Maharashtra Centre)

The Manual literally walks the reader through the complete scenario that makes the site supervision work systematic from the foundation stage to completion. The most encouraging feature of this manual is in its stress on the importance of quality of the structural work and on the role of the Structural Engineer.

---Prof. M.D. Mulay
President, Indian Society of Structural Engineers

The book is an excellent on the spot guide, for efficient supervision and contains a great amount of relevant information for the technical staff managing the project site.

---Shri S.C. Srivastava
Registrar, The Indian Institute of Engineers (India) (Maharashtra State Centre)

Present construction activity lacks training facility / infrastructure. This book will serve long awaited need of construction supervisors. If properly circulated and published the document will be always in short supply.

---Shri R.N. Raikar
President, Maharashtra India Chapter of American Concrete Institute

The author have hardly left anything for me to make further suggestions. This is for the first time such a publication is brought out.

---Shri D.L. Desai (Shankarbhai)
Hon. Gen. Secretary, Builders Association of India

In this well researched book, the author has made commendable efforts to present fundamental principals and time tested methods of supervision on construction projects, and is must for every Site Supervisor and other concerned professionals in building industry.

---Shri Murari Chaturvedi
Editor, Accommodation Times