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Sanjay Pant
S. Arun Kumar — National Building Code of India 2016– The Building Code for the Nation

V. Suresh — National Building Code of India 2016– Comprehensive Guiding Framework for Safe and Sustainable Built Environment

Dr. K. M. Soni — Repair, Rehabilitation and Retrofitting

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K.N. Agarwal — Haryana PWD Code 2009 - A Review

Focus on Built Environment

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IBC Journal
December 2018
FOCUS ON
BUILT ENVIRONMENT-NBC 2016

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Scientist D (Civil Engg), Bureau of Indian Standards — **1**

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From

Editor-in-Chief's Desk

The National Building Code of India 2016, is a single document in which, like a network, the information contained in various Indian standards and other information is woven into a pattern of continuity and cogency with the inter dependent requirements of parts sectors of the code carefully analy ed and tted in to make the whole document a cogent continuous volume. It gives all the information required by Architects, Engineers, Services Engineers and other professionals from the early stages of planning to translating the building on to terra rma. Immediately after this code was published, all related professionals were interested to understand the provisions of this code so that they work according to norms set in the code.

Indian Buildings Congress showed keen interest for propagating the code and in February 2018, arranged two days conference, along with CPWD and BIS at Vigyan Bhawan, New Delhi. It was highly successful and appreciated by all professionals. Later on IBC also arranged conferences on NBC-2016, at other places including Gwalior and Raipur. In view of importance of NBC-2016, it was decided to publish IBC Journal, dedicated to this code. Our purpose is to give the comprehensive review, as also see what more is required beyond NBC.

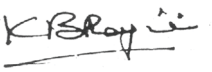
The project of comprehensive revision of the code was taken up under the aegis of National Building Code Sectional Committee CED 46 of BIS and its 22 expert panels, involving around 1000 experts. As a culmination of the project, the revised NBC 2016 was brought out. Shri H.S.Dogra, Head of Civil Engineering Division Council played the important role. The person who put untiring e orts for publication of this code is Shri Sanjay Pant, Director Civil Engineering Division of BIS. It was therefore considered desirable to request Shri Sanjay pant to give a brief review of the code and rst Article in this document is by Shri Sanjay Pant and Shri Arun Kumar. Another person who played very important role for NBC 2016 is Shri V.Suresh, Vice Chairman NBC Sectional Committee CED 46. So an article by him is also being published in this Journal.

Dr. K.M. Soni Addl. D.G., CPWD is an outstanding professional and his article on repair, rehabilitation and retro tting has also been included in this volume. Dr. Mahesh Kumar former E-in-C PWD Haryana has done extensive work on quality of water for construction. It is a well known fact that buildings can prematurely deteriorate if water is not proper. His study for safe water has been included. In fact his study can be incorporated in next revision of National Building Code.

For quality assurance, the rms have come to adopt norms provided in ISO documents. In fact IRC published a document for adoption of ISO in concrete work, SP-47 in 1998. It was adopted for some yover projects by PWD and detailed study has been brought out in article on Basic Concept of ISO by Shri K B Rajoria and Shri Deepak Narayan. We have to develop futuristic vision regarding applications of ISO.

Another important missing link for proper construction is non availability of trained and certi ed man power. Shri H.K. Srivastva has given an article on this subject. Dr. Vimal Kumar has thought beyond NBC-2016 and given perspective for bricks in futuristic way. Shri Rajeev Goel has brought out di culties in procurement of proper sand and aggregates and administrative initiatives are suggested.

To enhance general knowledge of engineers working in Government, a review of Haryana PWD Code 2009 has been brought out. It is a unique document and other State Governments can follow.



(K. B. Rajoria)
Editor-in-Chief

National Building Code of India 2016- The Building Code for the Nation

Sanjay Pant
Head (Civil Engg.), Bureau of Indian Standards

S. Arun Kumar
Scientist 'D' (Civil Engg.), Bureau of Indian Standards

Prologue

The National Building Code of India (NBC) is a national instrument of BIS providing guidelines for regulating the building activities across the country. It is widely referred to and used by state/ local bodies regulating urban development and building construction activities of Government departments, private construction agencies/builders/developers, building professionals and consultants, academic and research institutions, including building material and technology suppliers. NBC mainly contains administrative regulations, development control rules and general building requirements; fire safety requirements; stipulations regarding materials, structural design and construction (including safety); building and plumbing services; landscape development, signs and outdoor display structures; guidelines for sustainability, asset and facility management, etc. The NBC was first published in 1970 and was revised in 1983 and 2005.

Due to large scale changes in the building construction activities and complicated nature of building services, development of new/innovative construction materials and technologies and greater need for preservation of environment, there has been a paradigm shift in building construction scenario. As such a project at national level for comprehensive revision of the NBC was taken up under the aegis of the National Building Code Sectional Committee, CED 46 of BIS and its 22 expert Panels; involving around 1000 experts.

Shri Sanjay Pant as Head, Civil Engineering Department of BIS in association with Shri S. Arun Kumar were instrumental in spearheading of the latest version of National Building Code - 2016 in the present form.

A very informative Article- A must read.

-Editor-

Introduction

Construction programmes are interwoven in a large measure in all sectors of development, be it housing, transport, industry, irrigation, power, agriculture, education or health. Construction, both public and private, accounts for about fifty percent of the total outlay of the planned expenditure in the country. Half of the total money spent on construction activities is spent on buildings for residential, industrial, commercial, administrative, educational, medical, municipal and entertainment uses. It is estimated that about half of the total outlay on buildings is on housing. It is imperative that for such a large national investment, optimum returns are assured and wastage in construction is avoided.

Soon after the Third Plan, the Planning Commission decided that the whole gamut of operations involved in construction, such as administrative, organizational, financial and technical aspects, be studied in depth. For this study, a Panel of Experts was appointed in 1965 by the Planning Commission and its recommendations are found in the 'Report on Economies in Construction Costs' published in 1968.

These studies led to conclusion that one of the important steps towards achieving economy is through the formulation of a unified building code at the national level, which would rationalize and unify building codes and byelaws of various departments and local bodies, respectively and which would reflect the latest trends in building construction activity. For this, it was recommended that a National Building Code be prepared to unify the building regulations throughout the country for use by government departments, municipal bodies and other construction agencies. The then Indian Standards Institution (now Bureau of Indian Standards) was entrusted by the Planning Commission with the preparation of the National Building Code. For fulfilling this task a Guiding Committee for the preparation of the Code was set up by the Civil Engineering Division Council of the Indian Standards Institution in 1967. This Committee, in turn, set up 18 specialist panels to prepare the various parts of the Code. The Guiding Committee and its panels were constituted with architects; civil engineers; materials experts; structural, construction, electrical, illumination, air conditioning, acoustics and public health engineers; and town planners. These experts were drawn from the Central and State Governments, local bodies, professional institutions and private agencies. The first version of the Code was published in 1970. After the National Building Code of India was published in 1970, a vigorous implementation drive was launched by the Indian Standards Institution to propagate the contents and use of the Code among all concerned in the field of planning, designing and construction activities.

Since the publication of the 1970 version of the National Building Code of India, a large number of comments and useful suggestions for modifications and additions to different parts and sections of the Code were received as a result of use of the Code by all concerned, and revision work of building byelaws of some States. Based on the comments and suggestions received, the National Building Code of India 1970 was revised in 1983.

Some of the important changes in 1983 version included: addition of development control rules, requirements for greenbelts and landscaping including norms for plantation of shrubs and trees, special requirements for low income housing; fire safety regulations for high rise buildings; revision of structural design section based on new and revised codes, such as Concrete Codes, Earthquake Code, Masonry Code; addition of outside design conditions for important cities in the country, requirements relating to noise and vibration, air filter, automatic control, energy conservation for air conditioning; and guidance on the design of water supply system for multi-storeyed buildings. Thereafter three major amendments were issued to the Code, two in 1987 and the third in 1997.

Considering a series of further developments in the field of building construction, including the lessons learnt in the aftermath of number of natural calamities like devastating earthquakes and super cyclones witnessed by the country, the National Building Code of India was revised in 2005. Some of the important changes in 2005 version included: incorporation of a new Part 0 'Integrated approach – Prerequisite for applying provisions of the Code' emphasizing on multi-disciplinary team approach for successfully accomplishing building/development project; addition of new chapters on structural design using bamboo, mixed/composite construction and landscaping; incorporation/modification of number of provisions relating to reform in administrative aspects, also detailing therein provisions to ensure structural sufficiency of buildings; incorporation of planning norms and requirements for hilly areas and rural habitat planning, apart from detailed planning norms for large number of amenities; categorization of fire safety aspects distinctly into fire prevention, life safety and fire protection; assigning importance to the aspects like energy conservation and sustainable development in various parts and sections through appropriate design, usage and practices with regard to building materials, construction technologies and building and plumbing services giving due consideration to renewable resources like bamboo and practices like rain water harvesting; incorporation of the revised Earthquake Code for due implementation of the provisions thereof in applicable seismic zones of the country, by the Authorities.

Two amendments were thereafter issued to the Code in 2015, first to include a new chapter relating to sustainability namely, Part 11 'Approach to Sustainability', and the second to modify/include certain provisions in Part 4 'Fire and Life Safety'.

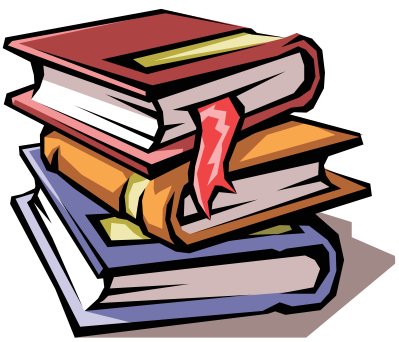
Need for Current Revision and Major Modifications Incorporated

Due to large scale changes in the building construction activities, such as change in nature of occupancies with prevalence of high rises and mixed occupancies, greater dependence and complicated nature of building services, development of new/ innovative construction materials and technologies, greater need for preservation of environment and recognition of need for planned management of existing buildings and built environment, there has been a paradigm shift in building construction scenario. Considering these, a Project for comprehensive revision of the Code was taken up under the aegis of the National Building Code Sectional Committee, CED 46 of BIS and its 22 expert Panels; involving around 1 000 experts. As a culmination of the Project, the revised Code has been brought out in 2016 as National Building Code of India 2016 reflecting the state-of-the-art and contemporary applicable international practices. The salient features of this latest revision of the Code are:

1) Detailed provision for streamlining the approval process in respect of different agencies in the form of an integrated approval process through single window approach thereby avoiding separate clearances from various authorities, with a view to ensuring ease of doing business in built environment sector.

   The objective is to ensure building approval within 30 days to facilitate early completion of the projects and final building occupancy permit.

2) Progressive computerization of approval process, for enabling online submission of plans, drawings and other details, and sanction thereof.



The objective is to dispense with the cumbersome process of submission, checking and approval of physical drawings and other details thereby increasing convenience and reducing overall time in obtaining building plan sanctions.

3) Updated mechanism of ensuring certification of structural safety of buildings by the competent professional and peer review of design of buildings.

This provides for assigning responsibilities to the competent structural engineer and the supervising engineers to certify regarding structural safety compliances during design as well as execution stage of the project.

4) Defining the roles and responsibilities of all professionals and contractors involved in a building construction project.

The Code now includes more professionals and entities such as geotechnical engineers and constructors who would be responsible for their part of the activities.

5) Comprehensive planning norms for minimum amenities to be provided in a city/town.

The Code gives minimum amenities such as education, healthcare facilities, distribution services (petrol, diesel, CNG, LPG, milk booths, and fruit and vegetable distribution booths)

6) Detailed provisions relating to requirements for accessibility in buildings and built environment for persons with disabilities and the elderly.

It now covers comprehensive treatment leading to universal accessibility, and for ensuring the same, deals with key accessibility issues, anthropometrics, site planning and development, accessible parking, accessible entrance to building, accessibility within building, level changes, operating control and devices, seating spaces, toilets, signages (see Fig. 1), assembly room, accessible housing, maneuverability spaces (see Fig. 2), etc.

7) Planning and development norms, such as, Transferable Development Rights (TDR) and Accommodation Reservation (AR).

These are tools for rejuvenation of dilapidated built environment for their safe and effective utilization for appropriate applications more useful to the society at large.

FIG. 36 DIRECTIONAL SIGNAGE LEADING TO DESIGNATED ACCESSIBLE PARKING SPACES

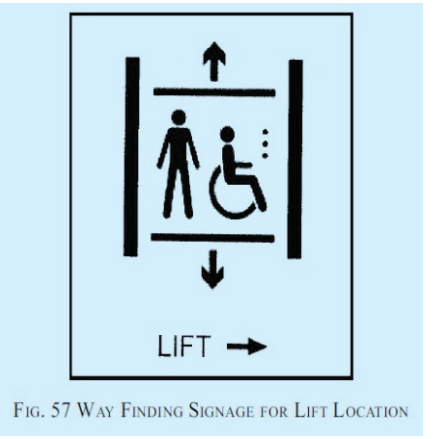
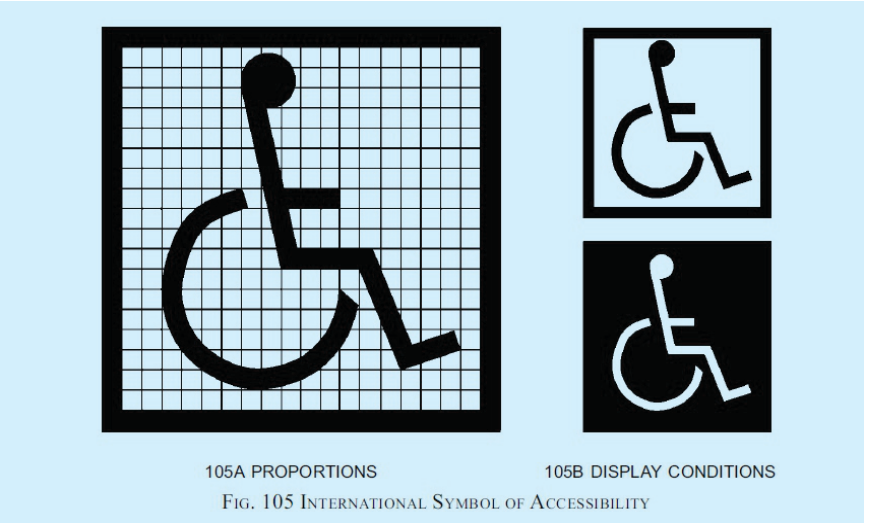


FIG. 57 WAY FINDING SIGNAGE FOR LIFT LOCATION



105A PROPORTIONS 105B DISPLAY CONDITIONS

FIG. 105 INTERNATIONAL SYMBOL OF ACCESSIBILITY

Fig. 1 Some Signages

8) Provisions for underground or multi-storeyed parking as also mechanized parking of vehicles.

This ensures safe and more effective space management to accommodate burgeoning vehicle population in urban areas.

9) Norms for solar energy utilization.

The Code provides that the solar power generated may be used for in-house utilization or for transfer to the grid. (See Fig. 3) The Authority

shall have required provisions in the building bye-laws and mechanism for required clearances and approvals.

10) Requirements for buildings on podium for ensuring fire and life safety in such buildings.

In consonance with the development of building systems on podium, the Code provides comprehensive illustrative guidance for such built

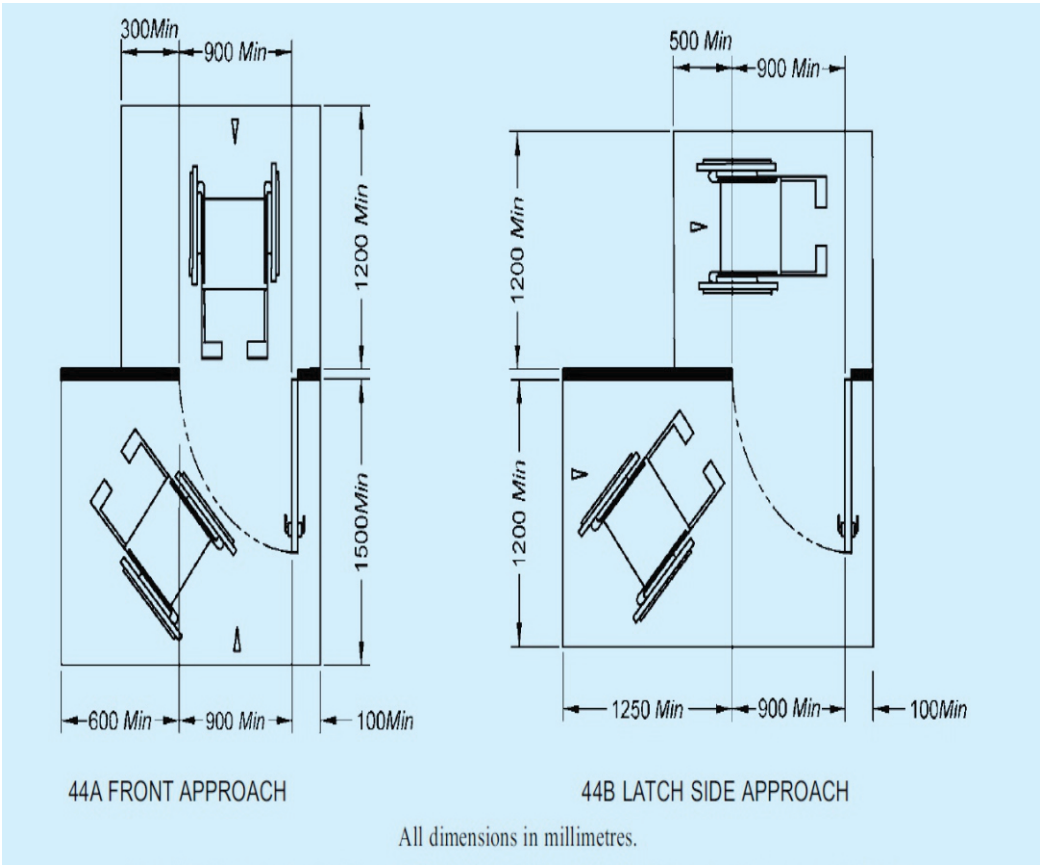


Fig. 2 Manoeuvring Space Needed by Wheelchair Users to Approach Doors

environment along with the mechanism for fighting fire externally. (See Fig. 4)

11) Fire and life safety in modern complex buildings including the high rises, glazed buildings, atria, commercial kitchen and car parking facilities.

The Code describes the various components of an exit (see Fig. 5) and covers elaborate provisions for life safety giving specific guidance in

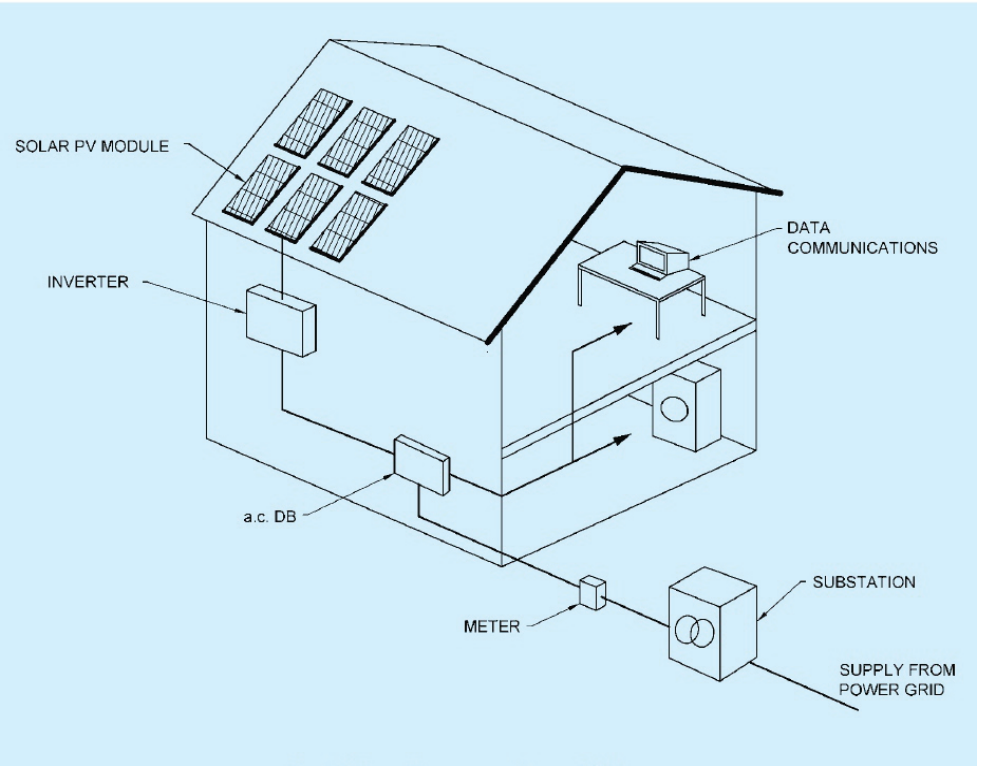


Fig. 3 Grid Connected Solar PV System

respect of each of these components. Also, concepts like fire fighting shaft (see Fig. 6), designed to provide fool proof mechanism for egress as well as for facilitating fire fighters to travel for assisting evacuation and fighting the fire, have been introduced.

12) Updated structural design provisions for wind and seismic loads, imposed load due to helipad, and blast loads, for safe design and construction of buildings with due focus on ductile detailing.

13) Latest research and development inputs and provisions on concrete, steel and masonry buildings with a view to ensuring disaster resilient buildings.

14) Assessment of liquefaction potential of a site and ground improvement techniques for maximum utilization of land resources including at seismically vulnerable sites.

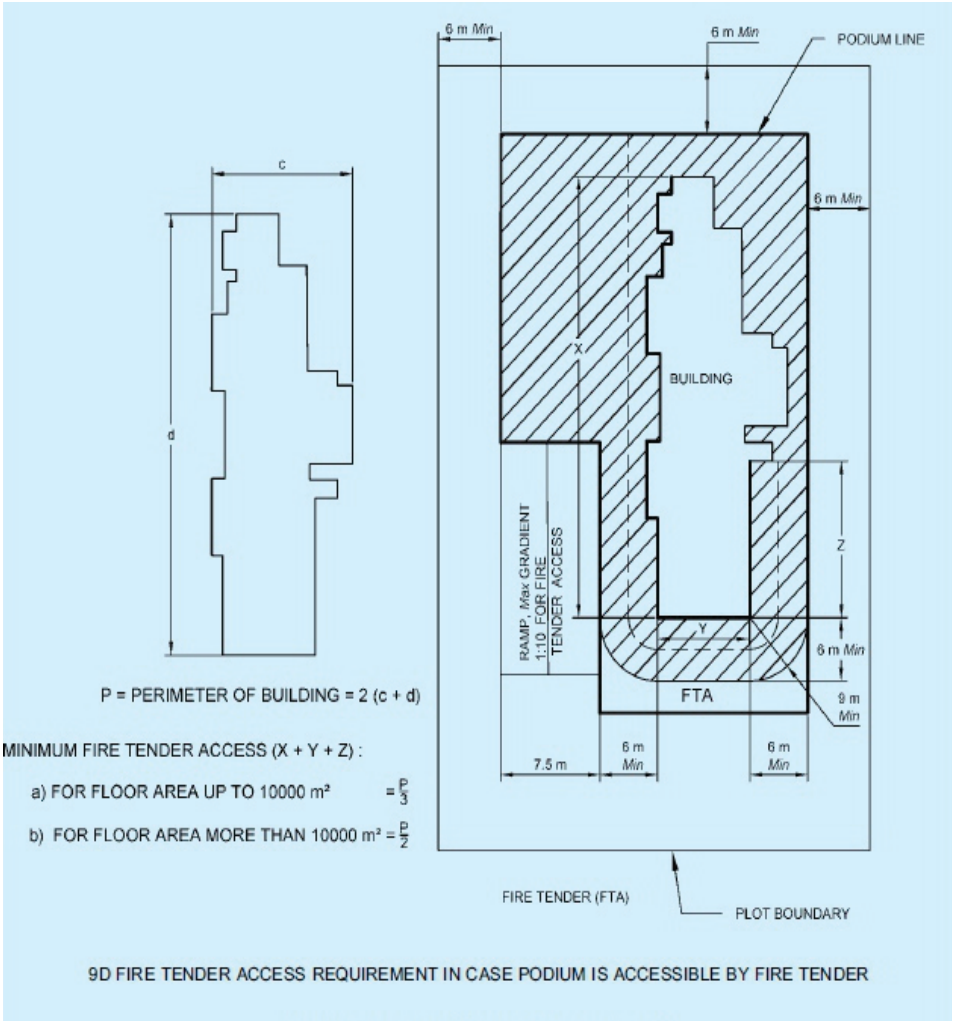


Fig. 4 Requirement for Fire Tender Access

15) Updated provisions on engineered use of bamboo in housing and other building construction.

Various possible structural elements using bamboo including in foundations (see Fig 7) have been illustrated.

16) Promotion of use of agricultural and industrial wastes including construction and demolition wastes in building construction without compromising the quality and safety.

17) Inclusion of provisions on self compacting concrete, high performance

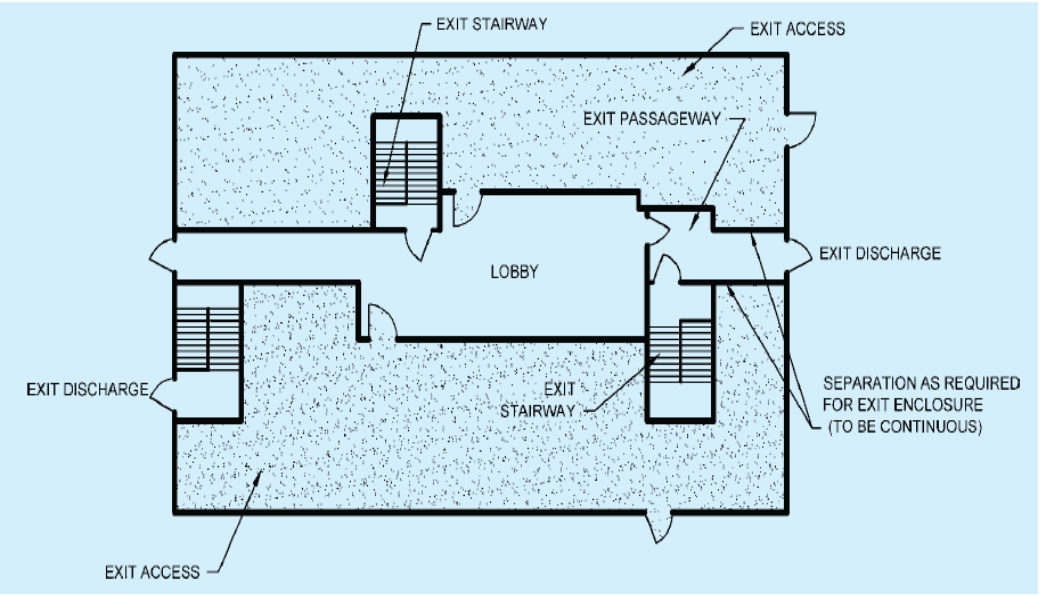
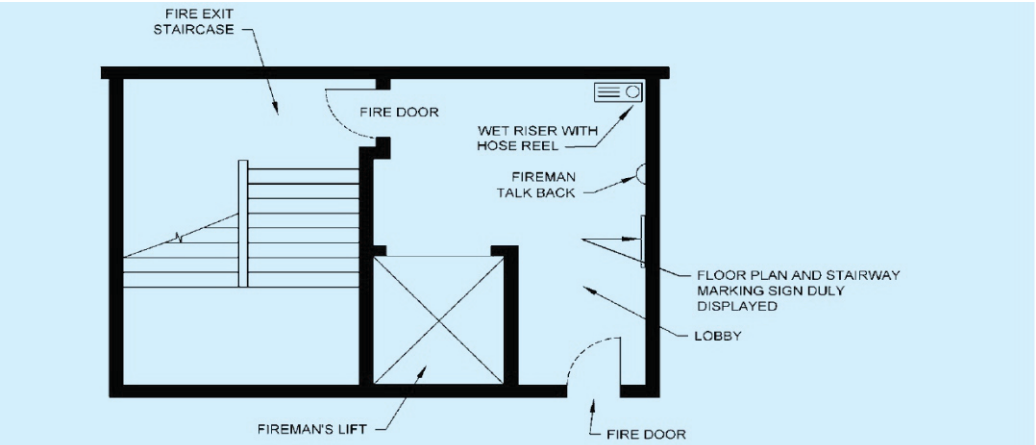


Fig. 5 Components of an Exit



(LAYOUT TO BE PLANNED AS PER PROJECT BASIS MEETING ALL THE REQUIRED DETAILS)

NOTES

1 Where such lobbies and staircase in the firefighting shaft are naturally ventilated/cross-ventilated, the shaft may not be enclosed and fire door need not be provided.

2 For all enclosed firefighting shaft, the shaft's lobby should have floor plan duly displayed for the information of fire fighters.

Fig. 6 Fire Fighting Shaft

concrete and steel fibre reinforced concrete.

18) Updated provisions on prefabricated construction technique for speedier

construction.

19) New chapter on structural use of glass in buildings.

It covers complete aspects for selection of glazing, structural design to withstand loads, fire safety, human impact safety, and typical illustrations for installation of glass (see Fig. 8).

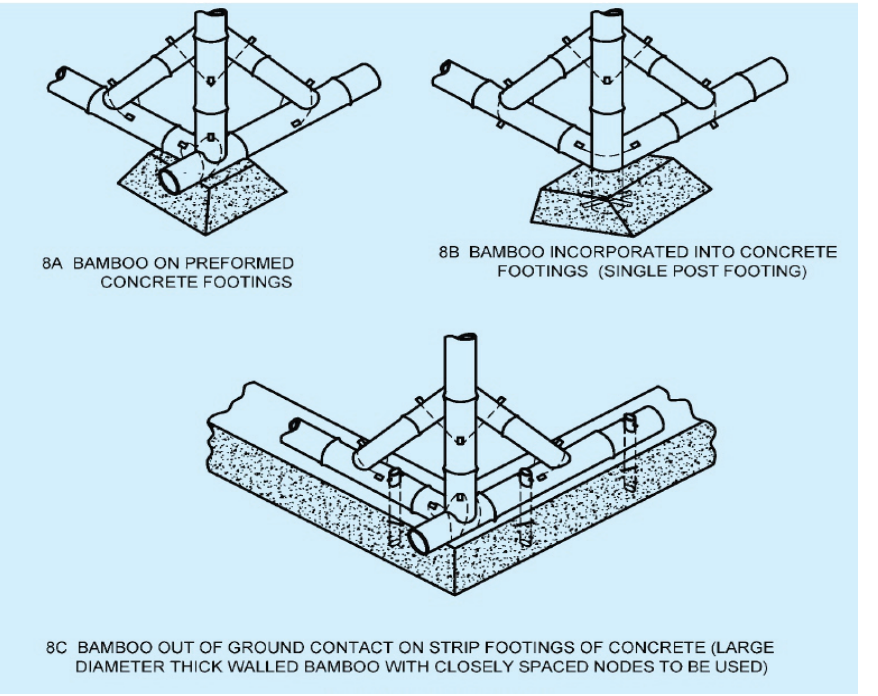


Fig. 7 Bamboo Foundations

20) New and alternative building materials, and technologies for building construction such as, reinforced masonry, confined masonry building construction and masonry wall construction using rat-trap bond.

21) Construction project management guidelines for timely completion of building projects within the budgeted cost with desired quality.

22) Habitat and other welfare requirements for workers at construction site.

23) Inclusion of modern lighting techniques such as LED and induction light and their energy consumption.

24) New provisions on compact substations and updated provisions on installation of energy meters.

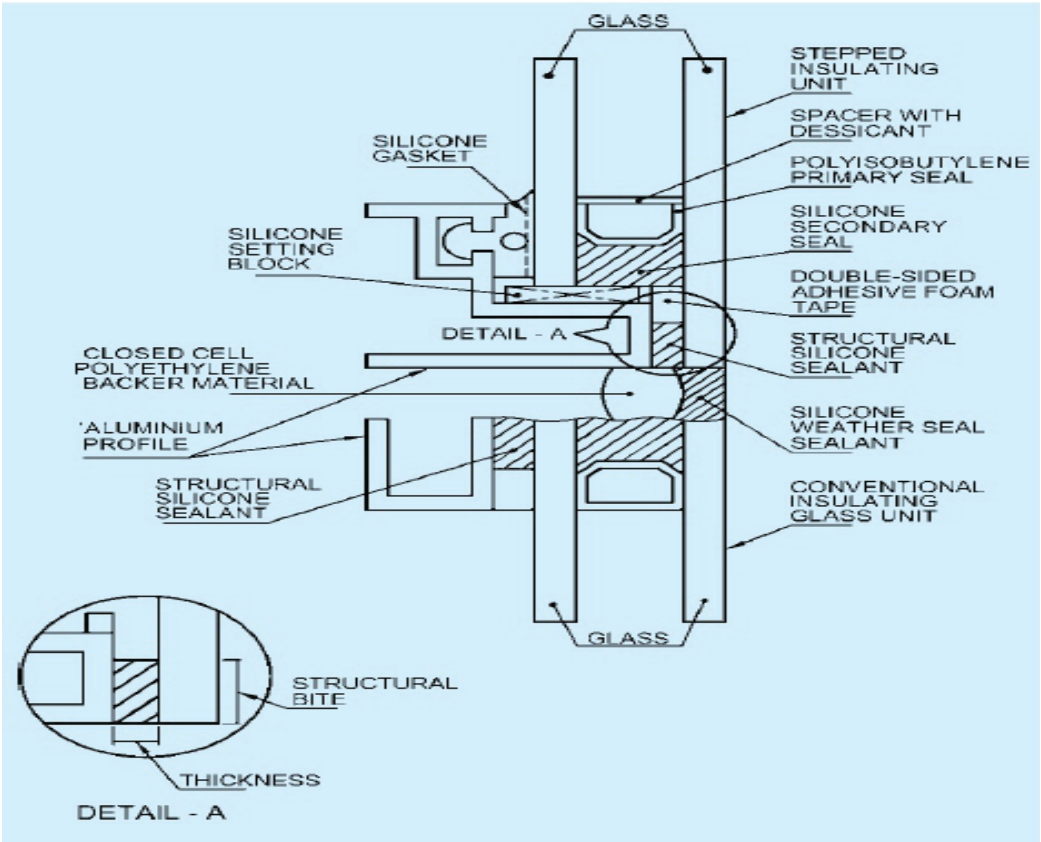


Fig. 8 Typical Structural Glazing Detail

25) Comprehensive provisions relating to lightning protection of buildings.

26) Provisions on aviation obstacle lights; electric vehicle charging and car park management.

27) Protection of human beings from electrical hazards and against fire in the building due to leakage current.

28) Use of refrigerants for air conditioning addressing zero ozone depletion potential (ODP) and ultra-low global warming potential (GWP).

29) Inclusion of new and energy efficient options of air conditioning, heating and mechanical ventilation, such as variable refrigerant flow system, inverter technology, district cooling system, hybrid central plant using chilled beams, radiant floor components, and geo-thermal cooling and heating.

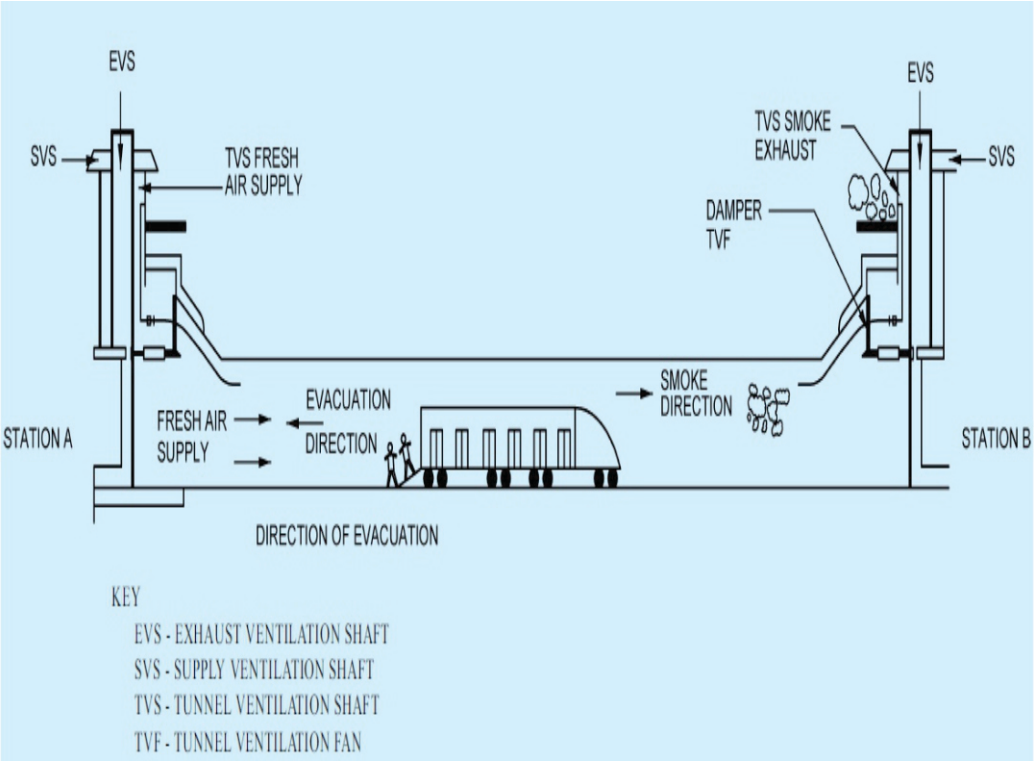


Fig. 9 Ventilation in Tunnel during Fire on a Train

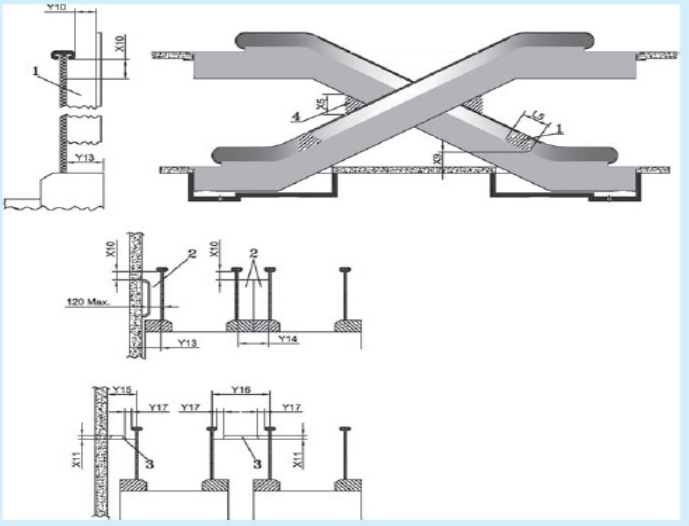
It also suggests the ventilation systems in tunnel (see Fig. 9).

30) Thrust on envelope optimization using energy modelling, day lighting simulation, solar shade analysis and wind modelling software to optimize the air conditioning load.

31) Air conditioning, heating, and ventilation (HVAC) provisions considering adaptive thermal comfort conditions for energy efficiency.

32) Provisions pertaining to metro trainways and metro stations with respect to fire and life safety; and air conditioning, heating and ventilation for metro stations.

33) HVAC requirements for data centres and healthcare facilities; refrigeration for cold stores; efficient strategies for winter heating using reverse cycle operation, solar heating systems, ground source heat pump and electric heat pump; and modern system of mechanical ventilation for industries, commercial kitchen and underground car parking.



Key
1 Anti-climbing device (*see* **6.3**)
2 Access restriction device (*see* **6.3**)
3 Anti-slide device (*see* **6.3**)
4 Vertical deflector (*see* **6.1.4**)

Principal Dimensions	*Ref to Clause*
Y13, Y14, Y15, Y16	**6.3**
Y17 ≥ 100 mm	**6.3**
X5 ≥ 0.30 m	**6.1.4**
X9 = (1 000 ± 50) mm	**6.3**
X10 = 25 mm to150 mm	**6.3**
X11 ≥ 20 mm	**6.3**
L5 ≥ 1 000 mm	**6.3**

Fig. 10 Anti-Misuse Devices

34) Updated provisions on building automation system to include the latest practices for web-based monitoring and control of performance parameters.

35) High speed lifts for tall buildings.

36) New chapter on escalators and moving walks for comfortable and safe movement of people.

Various safety features associated with the operation of escalators (see Fig. 10) and moving walks have also been included in the Code.

37) New chapter on information and communication enabled installations in buildings.

Requirements of telecommunication spaces and connecting hardware including suggestive configurations (see Fig. 11) have been covered.

38) Updated provisions on water supply, drainage and sanitation for modern

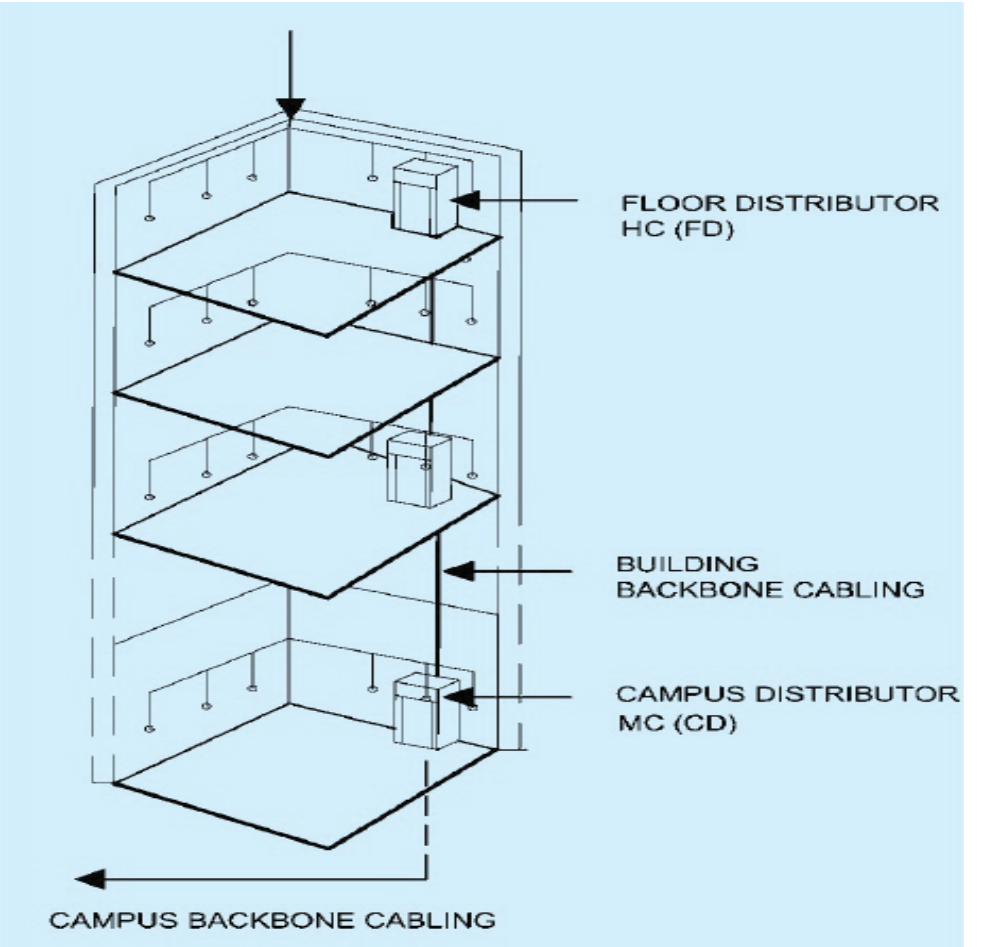


Fig. 11 Typical Cabling Star Configuration in a Building

high rise buildings and complexes.

39) Provisions relating to swimming pools covering hygiene and safety.

40) Updated provisions on rainwater harvesting.

It covers rain water harvesting guidelines for rural, semi-urban and urban areas using artificial ground water recharge (see Fig. 12) and roof top rainwater collection system, as applicable.

41) New chapter on solid waste management covering various solid waste management systems within the building and building complexes.

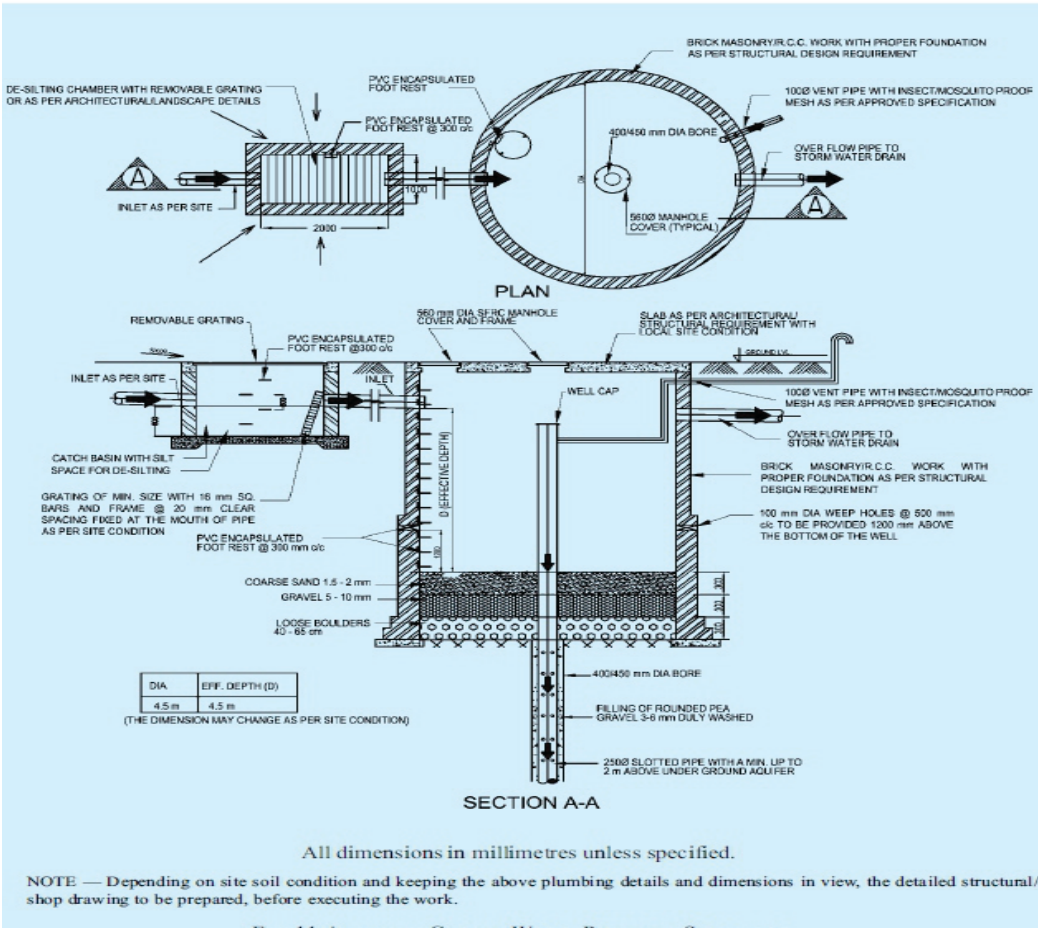


Fig. 12 Artificial Ground Water Recharge Structure

42) Updated provisions on piped gas supply in houses, and in hospitals for medical purposes.

43) Promoting quality of outdoor built environment through updated provisions on landscape planning, design and development.

44) Promoting sustainability in buildings and built environment in tandem with relevant sustainable development goals.

The chapter covers philosophy, and guidelines on achieving sustainable development through appropriate town planning and development, incorporating soft capes, walk ability, accessibility; selection of building materials which are energy efficient (see Fig. 13) and may be locally

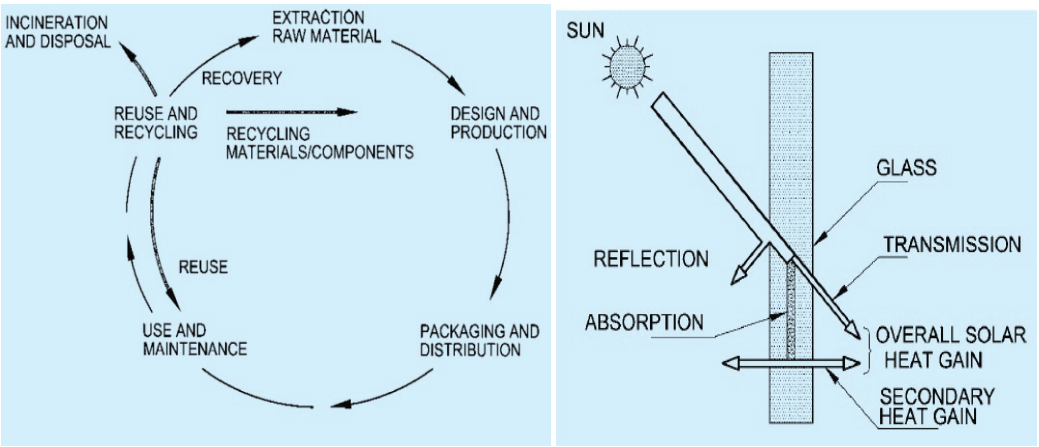


Fig. 13 Life Cycle of Building Materials

available, have better thermal properties, and may utilize industrial or agricultural wastes; envelope optimization covering effective harnessing of natural lighting and ventilation (see Fig. 14); efficient building services; integrated water and waste management; observance of sustainability issues during construction and use of buildings and built environment.

45) New chapter on asset and facility management to cover provisions relating to management of building assets and associated services, also covering responsibilities of occupants for maintenance of facilities, such as structures, equipment and exterior property.

This new Part 12 covers provisions relating to management of building assets and associated facilities and includes various aspects relating to maintenance (see Fig. 15 illustrating maintenance methods) of all types

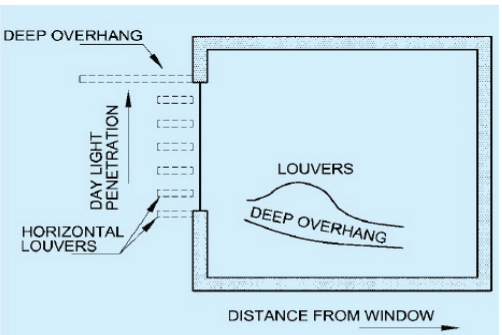


FIG. 13 COMPARISON OF DAYLIGHT PENETRATION WITH USE OF TWO SHADING DEVICES NAMELY DEEP OVERHANGS AND LOUVERS

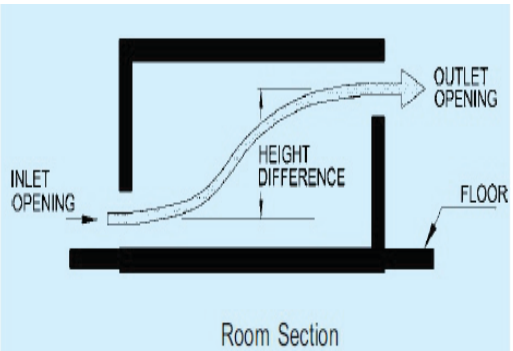


FIG. 14 ARRANGEMENT OF OPENINGS IN WALLS FOR ENHANCED VENTILATION

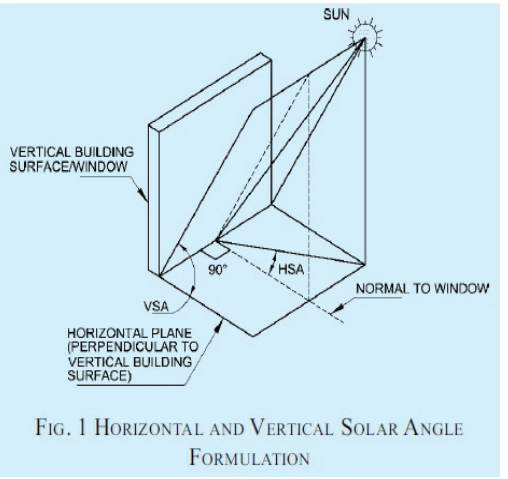


FIG. 1 HORIZONTAL AND VERTICAL SOLAR ANGLE FORMULATION

Fig. 14 Effective Harnessing of Natural Lighting and Ventilation

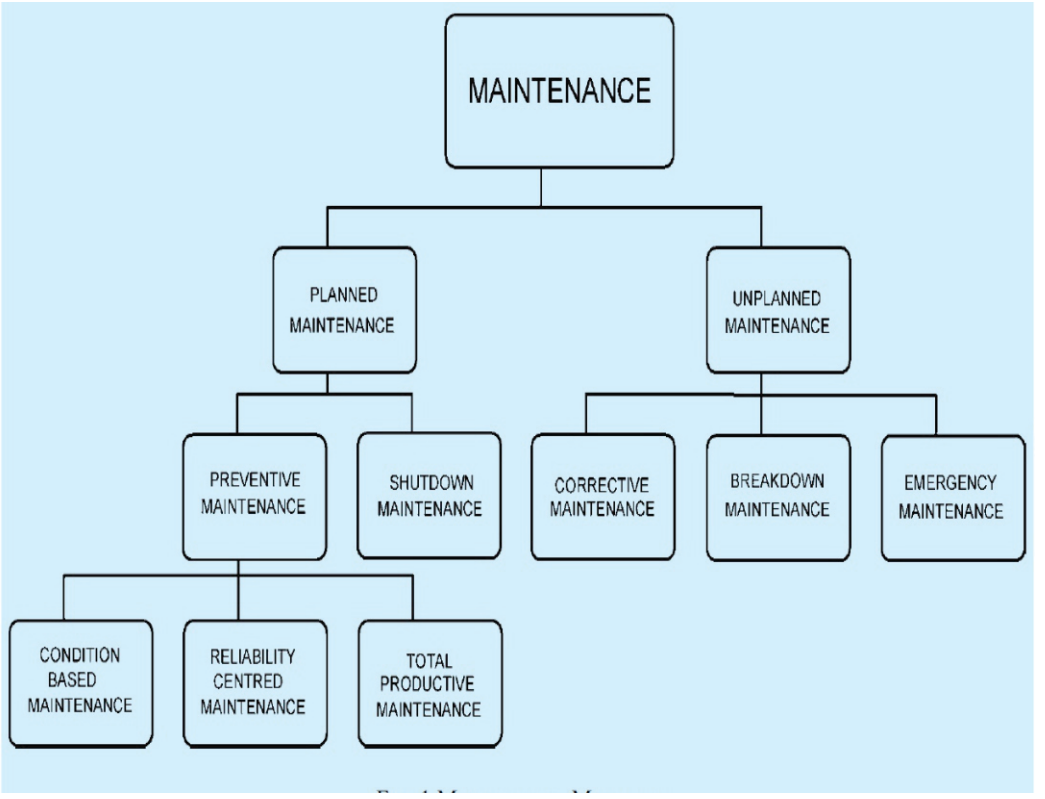


Fig. 15 Maintenance Methods

of facilities and fixed assets, such as, buildings and building services.

Actual Coverage

The National Building Code of India lays down a set of minimum provisions designed to achieve orderly, safe and sustainable building construction and development; and inter alia covers the following important aspects:

a) Integrated approach through multi-disciplinary team work to obtain maximum benefits in terms of quality, timely completion and cost effectiveness by utilizing appropriate knowledge and experience of qualified professionals right from the conceptualization through construction and completion stages of a building project and indeed during the entire life cycle.

b) Administrative provisions which pertain to the efficiency and effective application of the Code defining powers, duties and responsibilities of those concerned.

c) Development control rules and general building requirements including such aspects as subdivision and layout rules, land use classifications, open spaces in and around buildings, area and height limitations, means of access, parking spaces, requirements of various parts of buildings, etc.

d) Fire and life safety requirements, related to the occupancy and use of buildings.

e) Stipulations with regard to use of accepted and new building materials from consideration of safety, performance, compatibility, durability and economy.

f) Design and construction practices for structures as a whole using various materials like reinforced and prestressed concrete, structural steel, timber, bamboo, masonry, glass, etc, and guidelines for design of prefabricated structures and mixed/composite constructions, duly taking into account the various loads, forces and effects including due to natural calamities like earthquake.

g) Guidelines for construction project management and measures to ensure safety of workers and public during construction including habitat and other welfare requirements for workers at construction site.

h) Provisions for safe and efficient design of various building services, such as lighting, ventilation, electrical and allied installations, air conditioning, heating, lift, escalator and moving walk installations,

acoustics systems, and information and communication enabled installations.

j) Provisions with regard to the requirements of water supply, drainage and sanitation including solid waste management and the design of water supply and drainage system in buildings, and safety requirements for the installation of gas supply.

k) Requirements regarding landscape planning, design and development, signs and outdoor display structures with a view to promoting safety and quality of outdoor built environment.

m) Guidelines relating to sustainable planning, design, construction, operation and maintenance of buildings and built environment.

n) Provisions for asset and facility management in buildings.

This information is brought out in 13 Parts, details of which are given below:

PART 0 INTEGRATED APPROACH – PREREQUISITE FOR APPLYING PROVISIONS OF THE CODE
PART 1 DEFINITIONS
PART 2 ADMINISTRATION
PART 3 DEVELOPMENT CONTROL RULES AND GENERAL BUILDING REQUIREMENTS

PART 4 FIRE AND LIFE SAFETY
PART 5 BUILDING MATERIALS
PART 6 STRUCTURAL DESIGN
- Section 1 Loads, Forces and Effects
- Section 2 Soils and Foundations
- Section 3 Timber and Bamboo
  - 3A Timber
  - 3B Bamboo
- Section 4 Masonry
- Section 5 Concrete
  - 5A Plain and Reinforced Concrete
  - 5B Pre-stressed Concrete
- Section 6 Steel
- Section 7 Prefabrication, Systems Building and Mixed/ CompositeConstruction
  - 7A Prefabricated Concrete
  - 7B Systems Building and Mixed/Composite Construction

Section 8 Glass and Glazing

PART 7 CONSTRUCTION MANAGEMENT, PRACTICES AND SAFETY

PART 8 BUILDING SERVICES

Section 1 Lighting and Natural Ventilation

Section 2 Electrical and Allied Installations

Section 3 Air conditioning, Heating and Mechanical Ventilation

Section 4 Acoustics, Sound Insulation and Noise Control

Section 5 Installation of Lifts, Escalators and Moving Walks

5A Lifts

5B Escalators and Moving Walks

Section 6 Information and Communication Enabled Installations

PART 9 PLUMBING SERVICES (INCLUDING SOLID WASTE MANAGEMENT)

Section 1 Water Supply

Section 2 Drainage and Sanitation

Section 3 Solid Waste Management

Section 4 Gas Supply

PART 10 LANDSCAPE DEVELOPMENT, SIGNS AND OUTDOOR DISPLAY STRUCTURES

Section 1 Landscape Planning, Design and Development

Section 2 Signs and Outdoor Display Structures

PART 11 APPROACH TO SUSTAINABILITY

PART 12 ASSET AND FACILITY MANAGEMENT

Theme and Philosophy of the Code

The National Building Code of India is a single document in which, like a network, the information contained in various Indian Standards and other information is woven into a pattern of continuity and cogency with the interdependent requirements of Parts/ Sections of the Code carefully analyzed and fitted in to make the whole document a cogent continuous volume. Thus the Code gives all the information required by the architect, engineer, structural engineer, construction engineer, services engineers and other professionals from the early stages of planning to translating the building on to terra firma.

The provisions of the whole Code have been drafted with performance orientation, with a view to giving full freedom to the ingenuity of the architects and engineers. However, in certain cases, these performance oriented clauses have been translated into empirical rules for easy implementation of such provisions.

The whole Code has been built around the four pillars of safety, namely, (i) structural safety, (ii) health safety, (iii) fire safety, and (iv) public safety (encompassing

safety during construction and during use of building services), and sustainability. The various provisions of this Code have been specified after checking them against these safety requirements and requirements for sustainable development.

This Code strongly emphasizes the importance of preplanning in the construction activity and lays down areas where preplanning would have to be done in a more coordinated manner. A continuous thread of preplanning is woven which, in itself, contributes considerably to the economics in building construction particularly in building and plumbing services. The need for spaces and areas required for such services is brought out so that the same can be assessed at the planning stage and provided for.

The need for proper planning and coordination among professionals right from conceptualization to completion and subsequently in operation and maintenance, has been conspicuously brought out in Part 0 of this Code.

As this Code is intended to help regulate the building construction activity for the whole country, this would be applicable to municipal corporations, municipalities and other local bodies, public works departments and other construction departments and agencies dealing with construction. Therefore, the administrative byelaws and technical provisions, which are required in these regulatory media, are both included in the Code.

The Code as now published represents the present state of knowledge on various aspects of building construction. The process of preparation of the Code has thrown a number of important issues which have been duly dealt with. However, a continuous programme is envisaged by which additional knowledge that is gained through technological evolution, users' views over a period of time pinpointing areas of clarification and coverage and results of research in various connected fields, would be incorporated in the Code from time-to-time to make it a living document.

Implementation

The National Building Code of India is intended to serve as a model for adoption by PWDs and other construction departments, local bodies and other construction agencies. Existing PWD codes, municipal byelaws and other regulatory media could either be replaced by the National Building Code of India or suitably modified to cater to local conditions.

In the case of municipal corporations, municipalities and other local bodies which are the main agencies to regulate the building activity within the jurisdiction of the cities and towns, it is the administrative requirements and byelaws provisions for the health safety aspects which should mainly constitute the coverage of their byelaws. Guidelines on all these aspects are included in the National Building Code of India. The information cited above is mainly covered in Part 2 and Part 3 of the Code. The other parts of the Code are equally valid and should be referred to in the byelaws.

In the case of Public Works Departments of the States and Centre, MES, Railways

and other government construction agencies who would regulate the construction within their jurisdiction with the help of their handbooks, codes and specifications of works, it is the information contained in Part 0, 4, 5, 6, 7, 8, 9, 10 and 11 of the Code which should mainly be used/adopted to modernize their regulatory media. The PWD specifications and handbooks dealing with the materials specifications and the construction procedures for various items of work, should utilize the provisions given in Parts 5, 7 and 11 of the Code to update these documents. The structural design requirements and procedure for the design and installation of various services, etc, are not covered in detail in the above codes and detailed information on the same is given in Parts 6, 8, 9 and 11 of the Code. Even though the essential contents of the departmental code should be aimed only for the design and construction of the buildings, there are certain planning requirements which should also be included in these codes, which are covered in Parts 3 and 4; depending upon the setup in each department, information from the above parts should be included in their regulations.

In the case of other construction agencies like public sector projects, the whole Code would be applicable to them and implementation of the complete Code would result in substantial economies along with safety. Similarly the private construction agencies should make full use of the provisions of the Code.

The Publication

The Code has been published in two volumes containing all the Parts and Sections. Besides, five separate groups to cater largely to the interests/agency dealing with different aspects of building activity have also been published as follows:

Complete Code in Volume 1 and 2 (Parts 0 to 12 – all sections included)
Group 1 (Parts 0, 1, 2, 3, 4, 5, Part 10 Sections 1 & 2 and Part 11) – For Planning Building/Development work
Group 2 (Part 0, Part 6 Sections 1 to 8 and Part 11) – For Structural Design
Group 3 (Part 0, 7, 11 and Part 12) – For Aspects relating to Construction and Asset and Facility Management
Group 4 (Part 0, Part 8 Sections 1 to 6 and Part 11) – For Building Services
Group 5 (Part 0, Part 9 Sections 1 to 4 and Part 11) – For Plumbing Services

However, while using a particular group, it may be borne in mind that there are other areas of information available in other groups which would require the attention of the same agency even if not directly connected with that phase of work. For example, while Group 1 would mainly help in planning the building schemes, Group 4 and Group 5 also draw the attention from the point of view of preplanning in respect of building and plumbing services.

The Way Forward

The NBC 2016 which has been brought out as a result of research and development relating to buildings and built environment, also incorporates contemporary applicable international practices and latest technological advances in all the subject areas. It incorporates all the practices adopted by the modern cities of the country which proved to be beneficial and can now be extended to other parts as well.

- Adoption and enforcement of the Code will help in disaster mitigation by enhancing our response to meet the challenges posed by natural calamities like earthquakes, cyclones and landslides.
- Provides guidelines on streamlining approval procedure for real estate projects (SAPREP) through single window system, thus ensuring Ease of Doing Business.
- Important instrument to help in creation of accessible buildings and built environment by adopting principles of universal design, thereby giving equal access to persons with disabilities and the elderly. This addresses the objectives of Accessible India Campaign.
- Provides mechanism of ensuring certification of structural safety of buildings by competent building professionals.
- Facilitates robust fire and life safety mechanism in buildings, especially high-rises and modern complex buildings.
- Covers modern planning and development norms for urban areas, such as, transferrable development rights, accommodation reservation, etc. Also covers norms for low income housing, rural area habitat planning, hill area development, thus covering wide ground and applicability country-wide for all strata of society.
- Tool for strengthening core and critical facilities so that these can withstand disasters and continue to provide essential services.
- Potential for redefining the modern urban landscape by utilizing modern building technologies and materials, including prefab components, glass, etc.
- Incorporates integrated approach for planning and providing modern, sustainable and efficient building services in a building, namely, lighting, ventilation, electrical services, aviation lighting, air conditioning, heating,

sound insulation and noise control, vertical and horizontal transport systems, ICT installations, so as to provide desired quality of life to the occupants.

- Guides in improving durability and resilience of existing buildings in the country through its provisions on retrofitting of existing buildings.
- The state-of-the-art document comes as a powerful tool for implementation of various goals set under Pradhan Mantri Awas Yojana-Housing for all (Urban) Mission and the Technology Sub-mission created under the Mission, through its various chapters. Some are listed below:
  - ★ Assists in creation of earthquake and disaster resistant buildings.
  - ★ Assists in creation of sustainable habitat.
  - ★ Assists in integrated development of rural and urban areas.
  - ★ Facilitates preparation and adoption of building designs including its services suitable for various geo-climatic zones.
  - ★ Facilitates adoption of modern, innovative, environment friendly and energy efficient technologies and new/ alternate building materials for faster and quality construction of houses.
  - ★ Facilitates creation of urban infrastructure services, such as, efficient water supply, drainage, sewerage and sanitation systems including storm water drains for avoiding flooding.
  - ★ Facilitates enhancement of amenity value of cities by creating and upgrading green spaces, parks and recreation centers.
  - ★ Promotes switching on to public transport by creating facilities for non-motorized transport, for example, walkways, cycle tracks, etc, thereby helping in reduction of pollution.
  - ★ Promotes utilization of renewable energy in building for various applications.
- Promotes utilization of waste materials, such as construction and demolition (C&D) waste, industrial wastes like flyash, slag, etc in building construction work after due evaluation and without compromising on the safety and quality of the constructed assets; includes guidelines on safe sanitation and solid waste management and also minimum responsibility of owners/occupants for keeping their buildings and surroundings clean, thereby helping in achievement of objectives of Swachh Bharat Abhiyan.
- Facilitates creation of digital built environment so that the digitized services under the Digital India Mission can be efficiently and effectively utilized.

Conclusion

Considering the national need for housing and infrastructure development, a large number of Indian Standards have been brought out in the important fields of planning, designing and construction of buildings, as also on the methodologies for enabling speedier construction and requirements for low income housing. Also, numbers of Indian Standards have been developed for ensuring sound practices and safety during construction and the durability and safety of structures. The focus has been, of late, on the earthquake resistant design and construction of buildings, for which series of Standards had been already available for design and construction engineers, including for strengthening and retrofitting of buildings.

Notwithstanding the above, the repeated onslaught of natural calamities such as earthquakes, cyclones, landslides, etc faced by the country, has brought home the ever increasing need for the common guiding document to enable monitoring and implementation of sound technical provisions and practices through techno-administrative mechanism and comprehensive features built-in, in such a document. The NBC fulfills this need apart from bringing at one place comprehensive provisions relating to fire safety, selection of building materials, various building and plumbing services, management of assets and facilities, etc, all ensured following an approach to sustainability.

The unprecedented exercise of revision of the Code through the 22 expert panels and other groups involving 1000 experts who in around 50 meetings spread over two years, worked consistently lead to a landmark third revision of NBC, reflective of the state-of-the-art, applicable international practices and aspirations of the citizens of the country. The revised Code has the necessary ingredients for ensuring safe and orderly development of our villages, towns and cities. In a disaster-prone country like ours, NBC 2016 would serve as an effective tool for design and construction engineers, architects, other professionals, government construction departments and other construction agencies, builders and developers and for administrators/local bodies to ensure safe, healthy and sustainable habitat for citizens of our country.

National Building Code of India 2016- Comprehensive Guiding Framework for Safe and Sustainable Built Environment

V. Suresh
Vice Chairman, NBC, Sectional Committee CED 46 &
Past President, Indian Buildings Congress

Prologue

India is affected by many natural calamities be it earthquakes, landslides, floods, cyclone, tsunami etc. Safety of citizens and property should be the basic consideration. In addition, it is absolutely essential to take care of the safety concerns and considerations for structural safety, health safety, fire safety, public safety, life safety, construction safety, environment safety, electrical safety etc for natural and manmade vulnerabilities and disaster situations. Equally important are considerations of quality of construction and materials and components used and the construction process and quality control and quality assurance processes. The speed of construction and nature of technologies used play a large role. The fast paced introduction of diverse options for new building materials and technologies and for services installations needs an enabling environment.

Way back in 1966, the then Planning Commission entrusted this task of formulating the National Building Code to the then Indian Standards Institution [ISI] to serve as a model and guiding document for all stakeholders. Five solid years of work resulted in the formulation of National Building Code of India 1970 which was subsequently revised in 1983, 2005 and presently in 2016. Shri V. Suresh as Vice Chairman of National Building Code Sectional Committee, CED 46 was instrumental in bringing out

NBC -2016 in a very short time. A very interesting Article which needs to be given serious thought.

-Editor- I

Introduction

India's demographic growth is scaling new heights. From 100 crores plus in 2001, India's population has grown to 121 crores by 2011. Adding 20 crores in 10 years at the rate of 2 crore per year. At this rate India will cross over 140 crores in 2021. The increase in population is also characterised by urbanisation shift. With 17% urbanisation levels in 1947 out of total population of 32 crores then, India was rightly called as "country living in villages", as Gandhiji had said. There is a major shift towards urbanisation as more than 50% of the new population is taking place in urban areas. India's urban population will double from 28 crores in 2001 to 56 crores by 2024. Expected to be 60 crores by 2030. Urban areas are growth engines and contribute 70 % of GDP.

All these demographic explosion in both urban and rural areas , powers in major construction boom in all sectors. Building construction activity contribute to more than a third and balance for other construction for Infrastructure for all facilities and amenities , transportation modes , multipurpose dams for irrigation and power sectors . Building construction itself has contribution of nearly Rs 6 lakhs crores of investments annually , of which Housing (Residental) construction itself would account for around Rs 3 lakh crores. This would be the contribution from central, state and local government sectors as well as corporate, co-operative, private sector and individual sectors. This will cover all building construction needs for residences, offices, hospitals, hotels, schools , colleges and campuses , assembly and recreational facilities , retail and commercial , storage and logistics and industrial and administrative , regulatory and governance related buildings. In short, it will cover all uses of buildings in urban and rural areas, coastal areas, plains , hilly regions for all geo- climatological zones.

With such large investments in the building construction sector needed to cater to the growing population, it is imperative that optimum use of all the limited resources, be it land, building materials, natural resources of minerals and forestry, energy, water, finances and manpower are utilised effectively, efficiently and economically.

India is affected by many natural calamities be it earthquakes, landslides, floods, cyclone, tsunami etc. Safety of citizens and property should be the basic con-

sideration. In addition, it is absolutely essential to take care of the safety concerns and considerations for structural safety, health safety , fire safety , public safety, life safety, construction safety, environment safety , electrical safety etc for natural and manmade vulnerabilities and disaster situations.

Equally important are considerations of quality of construction and materials and components used and the construction process and quality control and quality assurance processes.

The speed of construction and nature of technologies used play a large role. The fast paced introduction of diverse options for new building materials and technologies and for services installations needs an enabling environment by welcoming and providing space for application and growth of all innovative options.

Buildings are not four walls and roofs. The live ability will depend on all the facilities and amenities and services needed, be it lighting and ventilation, water supply and sanitary facilities and disposal needs, electrical installations, lift installations, air conditioning , gas installations and acoustic and thermal comfort needs.

If safety and strength were the top most criteria till recently, durability has become a by word now. The performance of the buildings over its differential life cycle, for structural, non structural, finishes and services has assumed importance to measure life cycle costs combining CAPEx and OPEx.

With the universal global adoption of Sustainable Development Goals to the year 2030, by 193 countries in September 2015, the sustainable habitat development needs will embrace 11 out of the 17 SDG ‘s.

Energy, Environment and Ecological considerations and advent into green building movement has become a basic necessity.

Lastly and more importantly, is the right recognition needed for all professional inputs and the space to be provided for the right interventions by each of them, be it a physical or spatial planner, architects, urban designers, engineers, structural engineers, MEPF Engineers, vertical transportation consultants, landscape architects, green building consultants, accessibility specialists, construction and project manage-

ment teams , interior designers and building delivery groups for construction and installation of services and lastly the association of Assets and Facility management teams to ensure the performance of buildings in the right way during the occupancy stages for long duration.

If that is the internal operative environment needs so do we have multiplicity of agencies and regulatory framework at the city level through municipal corporations, municipalities, development authorities, water and sewerage development agencies, electricity department, lift inspectorate, fire brigade officials, EIA clearance agencies and central and state pollution control agencies at state and central level and other parastatal agencies with whom the building development team has to interface. The Central government agencies for civil aviation clearance, forest clearance, defense clearance, archeological and heritage clearance, high way clearance, coastal zone regulatory clearance etc put a plethora of agencies to move from “pillar post” . Therefore speedier approvals of 29 to 31 days like in Singapore, Taiwan, Hong Kong and Chicago does it through multi disciplinary interface mechanism of single window clearance has to be brought in among the agencies. Till recently, India was 182 out of 187 countries for “Ease of doing business” and approval process.

The National Building Code of India

It is in this context that the work of National Building Code has to be viewed. Way back in 1966, the then Planning Commission entrusted this task of formulating the National Building Code to the then Indian Standards Institution [ISI] to serve as a model and guiding document for all stakeholders, be it construction departments at the centre and states or the large number of urban local bodies and building regulatory bodies, builders, professionals to deal with the built environment sector .

Five solid years of work resulted in the formulation of National Building Code of India 1970 with the participative involvement of all stake holder interests.

It had served well for the development needs of the country during the seventies. With advent of new materials and products and new urban development challenges the first revision was brought out in 1983.

The nineties saw series of natural calamities through earthquakes in Latur, Khillari, Jabalpur, Uttarkashi and Rudraprayag, the massive cyclonic damages in Odisha and Andhra Pradesh, the Gujarat Earthquake, tsunami damages in coastal India in southern states, the landslide and flood damages in Alaknanda etc. The series of structural collapse of buildings and fire induced damages in schools, hospitals, offices, factories, hotels, government buildings also provided cause for concern.

That was the trigger for taking up a major revision to NBC at the request of Central Government. The National Building Code of India 2005, the second revision

came 22 years after the 1983 version. It truly was a new millennium document and provided a techno legal regime to take care of pre disaster mitigational efforts depending upon the multi disaster vulnerabilities in different parts of the country. It also covered the needs of the housing needs of the poor and marginalised as well.

Over the forty years since NBC 1970 and new versions coming up, different construction departments at centre and states and urban local bodies at state and city levels have made efforts to revamp and modify their building regulatory documents and improvise process for speedier approvals. But that was mere tokenism rather than total coverage or total transformation.

The past decade also saw the phenomenal urbanisation impact. Cities with developmental needs for higher density and taller buildings beyond 30 storeys and stepping into the 40, 50 and 60 storeyed era.

Mixed use occupancy developments, larger parking needs, increased technological needs for tall buildings from structural design, services design for fire safety, water supply, lift installation, air-conditioning and accessibility concerns for all groups had raised challenges to builders ,developers and regulating agencies. The SDG goals and global call to take building development in a sustainable manner with water conservancy and savings, energy efficiency and savings, efficient and healthy waste management treatment [liquids, solids] options gave new challenges. Urban sector got a major fillip through the launch of 100 Smart Cities, 500 AMRUT ciites, SBM, Housing for All by 2022 and gave new development needs for all cities and building development groups.

The Bureau of Indian Standards had responded to these challenges in a befitting manner, The National Building Code of India 2016 was an excellent effort to grasp all the current development concerns and provide the guiding development framework.

This has been done through 22 expert Panels with over 1000 expert members and 50 rounds of deliberative meetings to formulate the NBC 2016 in two years time. The NBC 2016 was gazetted in the National Gazette in March 2017.

The NBC 2016 has received wider acceptance from all stakeholders. Over 20 state /city level implementation conferences and seminars have been organised already and many are on the anvil for creating wider dissemination and propagation.

Creating Awareness, Appreciation and Application are the three thrust areas for making NBC 2016 an increasingly user friendly regulatory and guiding document.

Major Facets

There are 13 parts including Part 0.In the balance 12 Parts there are 33 sectional

documents on various facets of Parts. The salient features are highlighted below:

1. Part 0 is a fine piece of guidance for the much needed inter disciplinary co-ordination required between each of the professionals from the concept level to design level leading to project approval from all agencies. The second stage is during implementation or construction phases and the last stage is during the operation for performance parameters during the life cycle.

2. Part 1 is on Terminology for uniform transparent understanding of all definitions in various parts and sections and where they appear, some in many parts or sections. It also helps in locating areas where coverage is given through the terms arranged alphabetically; a good search engine as well.

3. Part 2 on Administration covers all facets of processes between builder or Owner and various professionals entrusted with design of project from all points of view. There is clarity in notations and colour scheme for drawings, plans and elevations and sections for furnishing details of project. Electronic filing of all details make paper work reduced. On line processing of applications for building or land development permit is provided for. Over 1400 cities have already adopted this in the last two years, The association of right professionals with educational background and experience for the right job and competence levels have been identified. The interdisciplinary needs for associating with various facets and fixing responsibility for contributions for accountability has been delineated. The speedy processing for approval through single point posting with related clearances from other agencies brought in .It is encouraging to note that the ease of doing business ranking has improved from 182 to 55 recently. The multi stage clearance also is an innovation. The administrative responsibilities during supervision and implementation for work quality and safety issues are covered in details. The Completion stages and Certificates from service agencies for getting Occupancy certificate for buildings elaborated. The need for periodic renewal certificates to ensure that the statutory provisions are maintained and in working condition is innovative, linked with new Part 12 on Assets and Facility Management.

4. Part 3 on Development Control Rules and General Building Requirements gives the complete guiding framework for planning of land and facilities and different parts of buildings. The development control rules give all development planning needs upto the building plot including land subdivision, layout needs and facilities for circulation, open spaces , hierarchical needs for community facilities and functional needs. The General Building requirements cover the needs of building design and all the needs of open spaces and height restrictions and new flexible provisions for podium access, circulation, basement uses and parking needs linked with size of urban spaces for small and medium towns to cities, metro cities and mega cities . Access requirements for differently abled has been covered elaborately linked with new statutory regulations for the same. The requirements for all parts of buildings for various uses as well as special needs of weaker sections, low income housing has been rationalized. The needs of rural areas, coastal areas and hilly areas have been spelt out.

The building regulations of most municipal corporations and municipalities are based on contents for Part 2 and Part 3.

5. Part 4 on Fire and Life Safety has assumed substantial importance, due to the large amount of damages to property and lives . The estimated loss to property due to fire loss is around Rs 10,000 crores annually. The Design interventions to minimise the losses though passive planning for safer exits for speedy evacuation and refuge areas, and active design through fire resistant construction and containment through compartmentation and smoke control are issues where the architects, engineers and Fire professionals have to work together. Table 7 gives a comprehensive road map for all detection , alarm and fire fighting facilities depending on the use occupancy, scale and heights of buildings. The local fire fighting capabilities of local Fire Brigade is important to provide for back up support or insist on in house fire extinguishing capabilities. The special fire fighting requirements for all building uses like residences, hospitals, hotels, schools, offices mercantile and retail, storage and hazardous uses and industrial uses have been covered. Special requirements of tall and super tall buildings have been covered including the need for progressive evacuation with horizontal and vertical nearby protected spaces. The need for conducting periodic fire drills will also familiarise the Resident welfare associations and users about the fire protection facilities and how to respond and act like a group will help occupants of tall buildings . Fire zoning and provision of service floors will also contribute to added protection. The joint work areas between Fire engineers and structural engineers come in to provide fire resistance ratings of differing fire resistance levels in terms of hours or minutes of fire resistance to columns, beams, slabs and other members and what can contribute to the same.

6. Part 5 Building Materials gives a complete list of all building materials, components, fixtures for all building construction elements including Building and Plumbing Services. Performance based approach to use of new and innovative or alternate building materials through proper performance evaluation has been provided to encourage new materials and technologies and products.

7. Part 6 Structural Design and its 8 sections give comprehensive requirements for making buildings and structures structurally safe. Section 1 on Loads forces and effects cover all possible load combinations and how to introduce the same in locations with differing vulnerabilities based on maps for seismic zone, wind loads, flood, landslides, snow loads, etc. Seismic resistant design and wind resistant design and landslide and flood protected buildings also is important. Section 2 on Foundations provides for different soil foundation characteristics. The role of geo technical engineers has been brought in for the first time. Section 3 to 7 covers all structural design safe provisions for buildings using bamboo, timber , masonry of all masonry units including brickwork [including Rat trap bond], reinforced concrete, pre-stressed concrete, steel, prefabricated and precast construction. The latest state of the art provisions for structural design using various materials and technologies have been carved out. The latest section 8 is on Glass and Glazing to provide structural and other re -

quirements being used for Fire safety, thermal performance, manadaory10 percent openings and right U and R values helps designers to use glass for structural glazing and yet provide green options and safety.

8. Part 7 Construction Practices and Safety is one of the finest parts for project execution with least amount of time and cost overruns. The right construction scheduling and use of project management tools for mobilization of all the right resources at the right time and ensuring quality linked construction execution will ensure least amount of rework and save on materials and products. The safety aspects in construction is a challenge in line with OHSAS 18001 with least accidents and loss of lives of workmen , right working hours and at the same time provide PPE to all workman working at different heights and critical locations.

9. Part 8 Building services with earlier 5 sections is a boon to all MEPF team and architects and engineering team to deal with lighting and ventilation, electrical installations, air-conditioning and heating, acoustics and sound insulation, installation of lifts , escalators and travelators, moving walks. Excellent coordination will be needed. Enormous energy saving options and use of renewable energy options provide a potential opportunity for energy saving and efficiencies. The Electrical inspectorate and lift inspectorate use these provisions as part of rules for compliance and approval and annual renewal. The new Section6 on Information and Communication Technology provide a strong back bone for ICT applications as part of layout and within buildings. This will be truly in line with the smart city and digital city applications framework. The ICT professionals are brought into the fray right from initial stages to provide the infrastructure badly needed in all modern buildings.

10. The Part 9 Plumbing service with initial 3 sections covers all needs of water supply, sanitation plumbing and gas supply. The performance of any building will largely depend on the sensitive plumbing needs and the effective working systems for water supply and distribution and sewage and sullage disposal including treatment options. The water saving potential with low flow fixtures, rainwater harvesting, acquifer recharging and waste water recycling and reuse for various purposes as well provide innovations in plumbing systems. The public health engineers and plumbing engineers have to be kept in close touch during design and implementation stages to bring in efficiencies and water resistant and non damp wet core areas. The safe and efficient gas supply in buildings bring in many safety features, The new Section that is added is on the much needed solid waste management inputs in buildings. All these features contribute to sustainable development and segregation, collection, transportation and treatment for various applications for converting waste to wealth with circular economy principles.

11. Part 10 on Signs and outdoor display structures and Landscaping play an important role for structural, electric safety and visual pollution issues for hoardings. The signage control is an effective means well implemented in old and new cities. Landscaping is an important element for improving microclimate and reduction of heat island effect. The design and selection of right trees, plants and foliage play an important role especially for drought resistant plantation and landscaping using native species.

12. Consequent on SDG to the year 2030, National Building Code of India 2016 is the first building code in the world to have incorporated approach to sustainability through effective and efficient use of all natural resources with stress on land, water management, energy management, and greening and waste management. This has also led to green regulations being added in many local building regulations and also provided impetus to Green Building movement.

13. Part 12 is the new part added in any building code in the world to deal with Assets and Facility Management and covers the operation and maintenance of all structural ,non structural, finishing and services system for keeping track of the performance yard stick with proper checks and balances and periodic monitoring of all building performance parameters and features . All fire fighting, building and plumbing services come under ambit with right processes and SOP's including BMS. At the end of the day what gets measured gets managed.

NBC Impact and Way Forward

After the gazeting of the NBC 2016 many states and local bodies have come forward in adopting or adapting the code for their regulatory frame work. NBC is a guiding recommendatory document and does not, as such, have the mandatory status and force of law. The regulatory environment through State Town Planning Act, Municipal Corporation or Municipalities Act or Fire Prevention Act or Electrical installation or Lift Installation Act could revamp their existing operating regulations and bring it in line with NBC 2016 or make reference in the body of the respective rules to follow NBC provisions by reference. Parts 4,5,6,7,8,9 and 10 are universal practices and hence are referred in these documents and recommendatory provisions of NBC becomes increasingly mandatory.

Smaller towns and cities with smaller populations can utilize those portions relevant for them and larger cities will adopt the whole components. The administrative procedures in Part 2 and DCR and GBR in Part 3 can be adopted or adapted and utilized with such local variations as needed clearly justifying the changes and that the provisions keep the spirit behind each of the codal provisions of NBC. Construction Departments can fully adopt the code for their practices, specification of works and related SOR.

Consultants and design offices can fully utilize the NBC for their design and consultancy needs. Builders and developers, by and large use the positive NBC provisions for the projects increasingly, National Building Code of India is not a static document and is kept under constant review by the Standing Panels dealing with various Parts and Sections based on constant user feedback and technological changes to make it a vibrant and dynamic document .

It has indeed been an honour to be closely associated with the NBC work for over five decades for the NBC versions of 1970, 1983, 2005 and the latest 2016 versions.

Repair, Rehabilitation and Retrofitting

Dr. K.M. Soni
Additional Director General, CPWD

Prologue

In India, economic life of a normal RCC structure is considered to be 75 years (CPWD Works Manual 2014). In case, the structures are not repaired, rehabilitated and retrofitted for structural deficiencies, they are to be reconstructed resulting into wastage of financial and natural resources. At many places and particularly in coastal areas, structures are showing distress even in 15-20 years due to many factors including type of reinforcement being used. Hence, there is a need to incorporate type of reinforcing steel suitable for corrosion prone areas and the measures required to protect it from the corrosion in National Building Code (NBC) for the durability.

Structures in which corrosion has started are to be structurally rehabilitated as delay in rehabilitation accelerates the rate of corrosion particularly under adverse conditions. Rehabilitation of different components of buildings like slab, beam and columns is made without any design considerations using different materials due to non-availability of standard guidelines. There is a need to incorporate the materials, design methodology and precautions to be taken for rehabilitation of such structures in NBC.

Seismic retrofitting is another important consideration in old buildings in which such provisions do not exist and thus need to be incorporated during repair and rehabilitation. In RCC structures, jacketing is carried out in columns. In load bearing structures, horizontal and vertical seismic belts at various locations are provided. In case, jacketing and belts are not adequately anchored to the structures, seismic retrofitting may not serve the desired purpose. Thus, specifications, design and procedure of anchoring also needs to be incorporated in NBC.

A very interesting and comprehensive paper from one who has been at the helm of it.

-Editor-

Introduction

Deterioration in a structure leads to loss of its durability as durability in simple terms means the ability of concrete to last for a long time without significant deterioration. Thus, certain degree of deterioration is built in during the design but the materials, process, placement and maintenance have to correspond to the design requirements. To include durability in the design, codes specify the provisions for carbonation, chloride ingress, leaching, sulphate attack, alkali silica reaction and freezing thawing conditions affecting the durability. In case, durability gets reduced, it may be due to the followings (Soni, 2015);

- Engineers or designers not possessing required knowledge of design, specifications and construction techniques.
- Not following specified design criterion during structural design.
- Not following specified criterion of the design during its execution i.e. selection of materials, their mixing, placement, compaction and curing.
- Not following the specified criterion of maintenance required to maintain conditions of the construction.
- Change of specified conditions and assumptions of the design criterion either during its construction or maintenance period.

In a well designed, well executed and well maintained work, concrete would be substantially water tight and durable during the prescribed life of the structure. But if the structure is showing distress before completion of its useful life like cracking or spalling of concrete, it indicates corrosion of the reinforcement, normally due to penetration of water and aggressive chemicals in the concrete. Technical reasons of such deterioration of concrete may be carbonation, leaching, sulphate attack, alkali silica reaction and freezing-thawing or damage due to fire or natural disasters.

Theoretically, deterioration process is described by various models. In two stage model, deterioration is described from environmental effects. During first stage of loading and weathering, the voids and micro cracks in the interfacial zone between the cement paste and coarse aggregate or reinforcing steel becomes interlinked. When interlinked network of micro cracks gets connected to any crack present in the concrete, it provides the passage for fluid to the interior of concrete. In the second stage, water, oxygen, carbon dioxide and acidic ions penetrate easily into the concrete due to availability of passage into the concrete leading to cracking, spalling and loss of mass, resulting into loss of durability of concrete. From another model, loss of durability is from three stages. During first stage, protective barrier breaks down such as depassivation of the reinforcement steel, or chloride penetration. In second stage, damage is initiated and during third stage, damage gets propagated. From yet another model, deterioration of concrete is described through water cement (w/c) ratio. Therefore, three principal elements included in the concept are; interconnected porosity of cement paste, exposure to aggressive chemicals

and intermittent presence of water. All three elements are essential for the damage of RCC. But primarily, porosity or permeability of concrete is key success or failure of the durability of concrete where quality construction and maintenance play important role and also rehabilitation in case distress has already occurred. Low permeability is required for the success while high permeability is the cause of failure, caused due to deficient compaction resulting into air voids in the concrete, high w/c ratio, insufficient and inconsistent curing, over loadings, weathering and poor maintenance, micro cracks due to loading and cyclic exposure to thermal variations etc. In addition to this, improper proportion of aggregates may also be the cause.

Concrete is resistant to most of the conditions of natural environment and even many chemicals but if exposed to aggressive chemicals like sulphates and chlorides present in the atmosphere or soil in the contact surface of the concrete, deterioration of concrete starts once aggressive chemicals are able to penetrate into the concrete and migrate to the reinforcement steel. Here reinforcement needs to be such that it resists to corrosion but in case it favours the process, it is highly detrimental to the structure hence either reinforcement has to be selected properly or protective measures like coatings are to be applied over its surface. Cold twisted reinforcement bars were found to be highly susceptible to corrosion and as such structures with such bars showed distress and even failed under little adverse conditions. As the cover is provided in RCC to protect reinforcement, penetration starts from the cover. When concrete cover is not able to prevent penetration of aggressive chemicals, they reach inside and if interconnected porosity is present, attack to the cement and other constituents of RCC including reinforcement starts. Hence NBC and codes specify cover for the durability under different conditions. Also when the aggregates in concrete contain reactive forms of silica, the phenomenon of whose chemical reaction called as alkali silica reaction (ASR) leads to expansion, cracking, loss of strength, elasticity and loss of durability. Therefore, selection of proper aggregate, admixtures, reinforcement and water becomes essential for the durability. It is also known that a RCC structure is more vulnerable in the coastal areas and thus, special care is required in selection of mix design and materials used, not only in concreting but also for finishing items acting as protective layers. Repetitive wetting and drying process further affects the durability. Cracking and spalling are easy symptoms of durability distress in a RCC structure which may occur due to one or more of the followings;

- Poor quality of concrete leading to porosity and ingress of water/moisture leading to corrosion in RCC.
- Insufficient cover to the reinforcement.
- Excessive w/c ratio used in concrete mix producing porous concrete.
- Plaster/cladding works started when concrete is green preventing liberation of heat from the concrete due to insufficient curing leading to cracks.
- In cold climates, non provision of air entrained materials in concrete subject to freezing and thawing.
- Providing corroded steel in RCC.

- Alternate wetting and drying of concrete surface continuously widening micro cracks.
- Poor maintenance of RCC structures like cracks in plaster leading to exposure of RCC surface.
- Poor compaction of concrete leading to porosity.
- Damaging RCC members or protection layer for installation of coolers, false ceiling, service installations like electrical, telephone, dish TV antenna etc.
- Leakages due to dismantling of RCC members or poor installation of service pipes, sewer lines etc.
- Leakages and seepages

Though concrete has become a useful material in building construction as it has the resistance to deformation, any potential expansion or shrinkage may lead to complications. Cracks may be produced in relatively low tensile strength of the concrete. Cracks not only weaken the ability of a structure to carry its design loads but also affect its durability. In addition, shrinkage and creep may increase deflections in particular member adversely affecting the stability of the structure.

Concrete is in a plastic state before it begins to set. After the placement, there is a period of settlement when the particles come closer. During setting, there is volume change but not of great significance because the concrete is in a plastic or semi plastic state and no appreciable stresses result from these changes. During settlement, water often appears at the surface known as bleeding. Though accumulation of water at the top of a mass of concrete is often undesirable as the upper part can gain progressively more water as the concreting progresses leading to relatively poor quality at the top but it is also required to prevent plastic shrinkage in a limited quantity. But excess surface water may lead to weak susceptible layer on the surface of the concrete. When the evaporation rate exceeds the rate of bleeding, application of water sprays or application of a curing compound is required to minimise evaporation. Finishing should be started only after the bleeding period is over.

Since, concrete is not a solid inert mass and large number of small pores or capillaries exists in it, during curing process, the pores and capillaries are usually full of water and stresses do not develop but as drying takes place, stresses are said to develop in the concrete hence curing is very important. Also, in case of any unhydrated cement, stresses can develop. Therefore, poor quality of cement has the effect on volume expansion. Some of the mini cement plants controlling ingredients manually may not produce consistently good quality of cement.

Water content is probably the largest single factor influencing the shrinkage of paste and concrete. In general, higher water content ratio increases the shrinkage of con-

crete. For given materials and uniform water content, the shrinkage of concrete varies little for a wide range of cement contents and its grades under different conditions.

The size and grading of aggregate do not, by themselves, influence the magnitude of shrinkage, but aggregates of larger sizes permit the use of a mix with less cement and hence have lower shrinkage. Some aggregates of sandstones, slate, basalt, trap rock etc. may contain clay and have large shrinkage and thus the shrinkage of aggregates may be of considerable importance in the shrinkage of concrete. Various harmful effects of abnormal shrinkage of concretes, caused by the aggregate have excessive cracking, large deflection of reinforced beams and slabs and spalling. Particularly in fine grained aggregates (sand), clay content is observed which has the deleterious effect on durability of concrete. In case, fine or coarse aggregates or water contain deleterious materials or salts in original construction, it is very difficult to take corrective measures during rehabilitation.

Admixtures that increase the water requirement of concrete increase shrinkage and those that decrease the water requirement decrease it. Some admixtures, if used in somewhat larger than normal doses, do increase shrinkage greatly and care must be exercised in their proportioning.

The size of RCC member and conditions of exposure are important in the shrinkage problems. Temperature and relative humidity of the atmosphere have significant effect particularly in thin concrete members exposed to atmospheric conditions of particular temperature and humidity. Adequate precautions need to be taken for curing and providing cover especially thin members during such conditions.

In case, structure has shown the distress, it has to be rehabilitated which means corrosion and conditions favourable to corrosion are to be removed which pose very difficult problems on the site due to intricacies involved in removal of corrosion.

Rehabilitation

Once the structure has shown the distress, it has to be rehabilitated. A judicious decision is first taken based on structural evaluation and financial implications to go for rehabilitation or replacement/new construction. NBC has laid down the condition of 50% cost in repair, rehabilitation and seismic strengthening of reconstruction cost of the structure. Nevertheless, before carrying out the work, structural evaluation is carried out through condition survey and non destructive testing. Condition survey is carried out at four stages through preliminary inspection, planning, detailed visual inspection, and field and laboratory testing. Non destructive testing includes tests for in situ compressive strength like rebound hammer test, ultrasonic pulse velocity test, Windsor probe test, pull out test, core tests and load tests. Tests for chemical attack include carbonation tests, chloride test and sulphate test. Corrosion potential assessment can be made from cover meter/Profo meter, half cell method, and resistivity meter. Normally a series of tests or a combination of tests or all tests are carried out based on condition assessment and importance of the

structure. Though interpretation of tests is important and is to be carried out by the expert, testing procedure is equally or more important as incorrect testing procedure will lead to incorrect results only. Problem sometimes is that field testing is not normally carried out by the experts themselves but their juniors or non-technical staff. Sometimes results are so erratic that one may require retesting which may be due to non-calibrated equipments also. There are numeral factors on which correctness of indirect tests depends and thus one has to be very cautious while carrying out tests and interpreting test results. From the tests, one can reach to the conclusion whether the structure is safe and can be rehabilitated with reasonable cost. If one is unable to reach to the conclusion based on indirect tests, rehabilitation is recommended on the basis of load tests.

It should be understood that repair, rehabilitation and seismic retrofitting when taken together in an integrated manner is economic and convenient. Considering the importance and cost involved in rehabilitation, an exclusive chapter is required to be included in NBC.

Materials for Repair and Rehabilitation

Selection of materials for repair and rehabilitation depends upon factors like technical requirements, budget availability, expert's advice, importance and balance life of the structure, toxicity characteristics of the materials, aesthetic requirements and finally decision of the engineer/owner. Technical requirements of materials used for repair may include their shrinkage properties, compatibility to base materials, setting and hardening properties, workability, bond strength, thermal expansion properties, mechanical strength, curing requirements, permeability, and durability. Mostly materials used for repair and rehabilitation include cements, admixtures, polymer modified mortars/concrete, aggregates, polymers, epoxies, resins, grouts, plasticizers, steel in the form of reinforcement, sections, nuts/bolts, wire mesh, metallic sheets, glass fibre sheets, carbon fibre sheets, geo-synthetics in the same form or in modified form. During repair and rehabilitation materials not having shrinkage characteristics are preferred.

Sequence of Rehabilitation and Retrofitting

Repair and rehabilitation processes are to be followed in the required sequence as also given in NBC. Structural repairs are to be carried out first and thereafter retrofitting works for seismic requirements and then repair of non structural members. In case non structural members are repaired first, they superficially block the visibility of the repair required in the structural members. For example, one would not be able to see the distress in slab in case false ceiling is repaired first. In the last, repair and rehabilitation of architectural components should be taken up.

During the process, weak protective surfaces and materials like concrete, plaster, water proofing materials, corrosion and corroded steel are to be removed first. Though easy to say but it is very difficult process to remove corrosion of the reinforcement in an existing structure, more so in multi-storeyed structures hence specialised dedicated con-

tractors are required for the purpose. It is due to this reason that reinforcement in original construction prone to less corrosion should be used and included in NBC depending upon various conditions else corrosion protective coatings should be specified. Repair is carried out after removal of corrosion ensuring design requirements, compatibility of materials and other factors mentioned earlier. For example, if a lintel is to be repaired, it should be compatible to lintel belt being provided for seismic retrofitting, if planned. Still for repair of distressed structures, no standard method or materials can be listed as rehabilitation varies upon distressed structure to structure. Main activities during rehabilitation include removal of rust normally to be carried out through sand blasting, providing anti rusting coat in existing reinforcement, providing bonding coat, adding reinforcement through binding, welding or anchoring, providing wire fabric, fibre sheets of glass or carbon, shotcreting, micro-concreting, plate bonding, jacketing or fibre sheet wrapping, concreting, and underpinning.

One should take decision judiciously on the method of rehabilitation or replacement of structural members. For example, a slab will always cost more in rehabilitation compared to replacement. Slab may require sand blasting to remove rust of the reinforcement, anti rusting coat, additional reinforcement, binding coat, welding, anchoring or shear key and shotcreting. Shotcreting itself may be costlier than new slab, hence rehabilitation becomes costly but the feasibility of replacement is to be found out. In case of roof, cost of other installations like water supply system, water proofing etc are also to be considered including inconveniences to other users due to disruption of such services. Once it is decided to carry out rehabilitation, suitable method is to be devised. Many times, heavy "I" beams are provided to support distressed slab and wire mesh is inserted above the "I" beams (Fig.1). Such system provides a feeling of unsafe structure and is un-aesthetic. Also, there becomes a large distance between I beams, and wire mesh itself may sag after few years. Hence, other methods like angle sections may be provided at the ends, T sections in between in shorter direction (Fig.2) and wire mesh on top supported on the sections with proper anchoring or welding. Thereafter shotcreting can be done as per the site conditions or micro concrete applied. Such detailing including installation procedure needs to be included in the NBC.

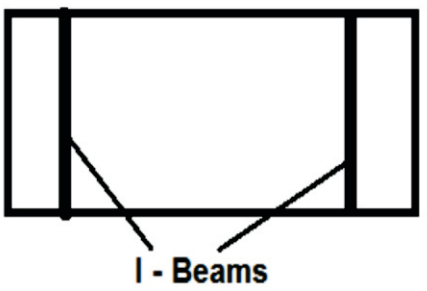


Fig. 1 "I" Beams Provided in Distresses Slab

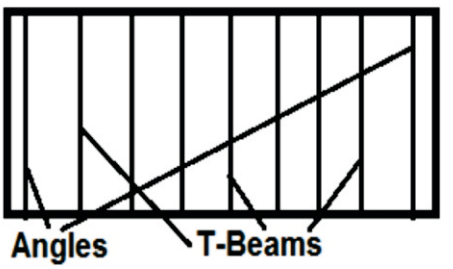


Fig. 2 Angles and Small T Sections

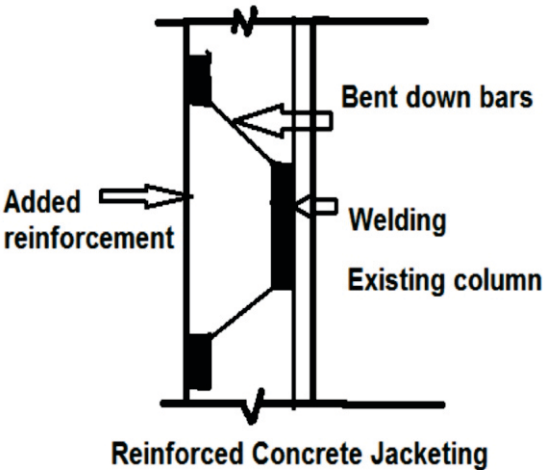


Fig. 3 Rehabilitation through Jacketing in a Column

Beams cannot be replaced easily hence are to be rehabilitated. Interconnectivity of additional reinforcement has to be ensured to make it integral part either through welding or anchoring. Welding though costly ensures integral action of additional reinforcement with existing one. In case of jacketing of columns, two precautions are to be ensured as enlarging the foundation as per the requirements of new loading and monolithic action of existing reinforcement with additional reinforcement through welding, shear keys or anchoring (Fig. 3) (Rai, 2005). In case of non monolithic action, cracks will appear between existing section and additionally jacketed section after some time.

Seismic Retrofitting

Seismic retrofitting means action taken to upgrade the seismic resistance of an existing building to achieve intended performance level as per the codes. In large number of old buildings seismic provisions have not been made in India. Seismic retrofitting in RCC members can be done by adding reinforcement or plate bonding, or fibre wrap techniques. When reinforcement is added from outside and concreting done, it is called jacketing. In fibre wrapping techniques, materials used may vary according to the requirements such as glass or carbon fibre which are installed through adhesives though mostly carbon fibres are preferred. Fibre sheets are wrapped to provide confining effect around the structural members after repair and rehabilitation of distressed members. Retrofitting in load bearing structures can also be done through fibre wrapping techniques or wire fabric covered with micro concrete. RCC structures are retrofitted after carrying out analysis but load bearing structures are retrofitted without analysis hence design methodology needs to be incorporated in NBC. Lintel band, roof band, plinth band, corner reinforcement and reinforcement around openings cannot be provided easily in existing load bearing buildings and as such horizontal and vertical belts are provided. Few buildings were seismically retrofitted following the provisions made in earlier draft code IS: 13935. As per the guidelines given in the

code, the following measures are required to be provided during retrofitting;

- Seismic belt around door/window openings.
- Horizontal seismic belts at plinth, lintel, and roof level.
- Vertical seismic belts at external corners.
- Vertical reinforcement at interior corners.
- Inter connections of segmental arches.
- Strengthening of foundation.

GI wire mesh reinforcement was provided for covering the jamb area on both sides of the openings (Fig.4). Specifications of mesh reinforcement for gauge, number of wires and spacing were adopted from the draft code based on seismic zone, category of buildings and openings though no basis or design is available in the guidelines. Horizontal seismic belts were provided on all walls on both the faces just above lintels of door and window openings and below roof. As the roof was jack arch roof and adequate space was not available between the ventilator and the roof level, belt of MS flat was provided. On the internal cross walls since stiffening is available, it is to be examined whether horizontal seismic belt can be restricted just to have anchoring effect on cross wall for a small length or deleted altogether.

Vertical seismic belt provided at the external corners of the building and junctions of walls. It is suggested that the width of the mesh should be kept a minimum of 250 mm on each face of the walls so that it covers minimum a brick width (230 mm) to avoid curtailment of wire mesh at the joints or before. The mesh is to be started 300 mm below the plinth level as per draft IS: 13935 and continued into the roof/eave level, horizontal belt however, it is recommended to start 300 mm below ground level in place of plinth level for anchorage to foundation otherwise also at some places plinth may be more than 300 mm. The vertical reinforcement was provided on the inside corners starting from 750 mm below the ground floor going up to the roof slab. This was anchored to the wall without damaging it though anchoring is not mentioned in the guidelines. Anchoring is better approach than dowel bars mentioned in the code/guidelines. Plaster/micro-concrete is applied over the mesh/reinforcement. External corner seismic belt is shown in Figure 5 and inside corner reinforcement is shown in Figure 6. As the roof consisted of steel joists or segmental/jack arches, it was connected with horizontal ties holding the joists horizontally in each arch span so as to prevent the spreading of joists during earthquakes through welding.

Strengthening of foundation may be required in some cases which can be done by introducing new load bearing members though in the present case it was not required but drainage of the area was improved by providing drain around the building and plinth protection.

When GI wire mesh is cut according to the requirements, there is no galvanisation at the cut points hence before use of GI wire fabric, anti corrosive paint should be applied

Fig. 4 Seismic Belt around Window Openings

Fig.5 Seismic Belt at External Corner

Fig. 6 Vertical Reinforcement at Interior Corner

Fig. 7 Anchoring

on cut points. Such provisions are also required to be incorporated in the NBC. There is a need to include design of wire fabric and carbon/glass fibres in the code/NBC.

Anchoring

Anchoring of welded steel wire fabric/reinforcement is essential to make it a monolithic part of the structure. There are two types of anchors as mechanical and chemical anchors. In old brick work, chemical anchors are better to be provided as it does not damage the brickwork and chemical gets filled up in micro cracks developed if any, during drilling operation. In the present case also, chemical anchors were used. Stainless steel anchors of size 8 mm diameter having resistance against direct pull of 110 KN were provided at a spacing of 600 mm in a staggered way in mesh reinforcement and at 750 mm for M.S. flats though specifications and spacing are not mentioned in the code/guidelines. Chemical used was HY 50/310 in a ratio of 2:1 having resin and hardener about which nothing is included in the guidelines/NBC. In anchoring process, a hole was drilled using drilling machine and thereafter the hole cleaned by the cleaner and by blowing air from the pump. The chemical was then inserted in the hole through a foil pack. For this, a foil pack was inserted into holder and screwed on mixer. The cartridge was then put into the dispenser containing resin and the hardener, which comes out in a fix proportion. First two-trigger pull

mix was thrown out for proper mixing and then chemical grout was injected into the hole and stainless steel anchor inserted into the hole. After self-curing time the anchor attains the strength. A view of the anchors is shown in Figure 7. In the inside corner reinforcement, a prefabricated MS piece was used having two holes, one used for inserting into the bar which can be adjusted at any position and other end used for inserting anchor. MS washers (Fig. 8) were of size 50x50x5 mm and painted with anticorrosive paint. Specifications of MS washer also need to be included in NBC as the same are not given in the code/NBC. Anchoring on wire mesh should be in staggered (zigzag) manner. NBC does not include anchoring design, method of installation and specifications to be used during seismic retrofitting and thus details are needed to be included in the code/NBC. A building repaired, rehabilitated and seismically retrofitted is shown in Fig. 9.

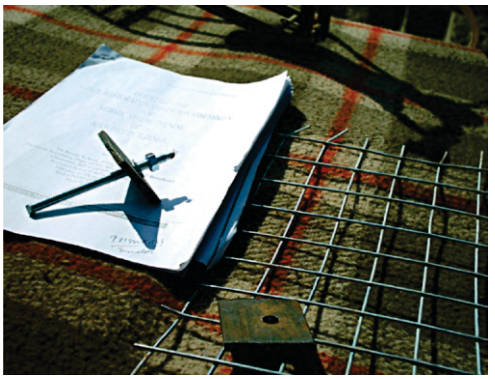


Fig. 8: An Anchor, GI Wire Mesh and MS Washer

Fig. 9: A Retrofitted Building

Safe Water – A Crisis for Construction Industry in National Capital Region (NCR)

Dr. Mahesh Kumar
President, ITC Pvt.Ltd. &
Past President, Indian Buildings Congress

Prologue

Civil Engineering structures depending upon the kind are designed for a life span varying from 60 to 100 years. The characteristic of ground water in several parts of North India is changing fast which on use result in a reduced life of Reinforced Concrete structures which may vary from 15 to 30 years depending upon severity of character of ground water. Appropriate care in use of water during construction and subsequently protecting the structure from the aggressive environment help in giving a designed life to such like structures. It is a high time when appropriate investigations in respect of aggressive environment which may be in form of harmful salts or water are conducted before taking the construction work in hand based on these investigations, an appropriate modality need to be defined regarding execution of work.

Damage to existing buildings before the design life of a structure have prompted to investigate the reasons concerning nature of water so used during the time of construction. The main working area at present has been confined to Rohtak and Sonepat districts in the National Capital Region adjoining to Delhi. Dr. Mahesh Kumar who had a long and rich experience during his stint as Engineer-in-Chief in Haryana PWD has suggested very valuable precautions which should be followed while using water during construction of projects.

-Editor -

Introduction

Reinforced cement concrete structures in buildings and other allied structures are designed for a life span varying from 60 – 100 years. A damage to existing buildings before the design life of a structure have prompted to investigate the reasons concerning nature of water so used during the time of construction. The main working area at present has been confined to Rohtak and Sonepat districts in the National Capital Region adjoining to Delhi. The remedial measures in use of water or precautions during the time of construction have been suggested.

Geological Characteristics

The geological survey reports on the soils in India reveal that the soils on the drier parts of Punjab, Haryana, North Bihar, Uttar Pradesh, and Rajasthan tend to be saline and alkaline efflorescence's. Those soil contain many undecomposed rocks and mineral fragments which with weathering liberates sodium, magnesium and calcium salts. Such soils are notably impervious and therefore have impeded drainage. Large areas, once fertile, have become impregnated with these salts (reh, kalar) destroying the agriculture value of the ground. The salts are normally confined to the top layers of the soil, being transferred from below by capillary action. Irrigation by canal water has resulted soils in the canal irrigated areas of Punjab, Haryana and elsewhere in the country to change during the past three or four decades. The alkali content in those soils is high and there is a large excess of free salts, combined with poverty in nitrogen and organic plant food material. Such lands pose problems not only for cultivation but also for construction of civil structures which are likely to withstand the attack of salts in soils and ground waters.

Salinity problems:

Effect of pH, Chlorides, Sulphates and Magnesium Ions on Durability

Portland cement on hydration gives rise mainly to calcium silicate to hydrates and some amount of calcium hydroxide. The calcium silicate hydrates are responsible for the strength of concrete and the calcium hydroxide is uniformly distributed in the calcium silicate hydrate matrix. Acidic water with pH below 6 dissolve the calcium hydroxide and also effect the stability of the calcium silicate hydrate matrix both leading to deterioration of concrete. On the other hand alkaline waters with pH in the range 7.5 to 10 are harmless to concrete.

The sulphates react with the calcium hydroxide giving rise to gypsum with a molar volume nearly 2.20 times that of calcium hydroxide. Also the sulphates react with the tricalcium aluminate in Portland cement giving rise to a calcium sulphoalumi - nate solid solution with a molar volume 2.5 times the original volume. Thus both these reactions lead to severe cracking of concrete structures exposed to sulphatic environ - ments. The cracking also create conditions for the reinforcement corrosion which in turn may lead to spalling of concrete.

Chlorides such as $MgCl_2$ and $AlCl_3$ reacting with lime and forming thereby unstable and water soluble compounds are detrimental to concrete. The chlorides of alkali metals (NaCl, KCl) which do not react with lime or with other components of the hardened concrete are harmless but in concentrated solutions they tend to leach lime from concrete. On the other hand the soluble chlorides may induce corrosion of the steel reinforcement and as such reinforced concretes exposed to chloride environ - ments need to be protected against attack and deterioration.

Magnesium ions are introduced into ground water mainly in the form of $MgSo_4$, $MgCl_2$ and $MgHCO_3$. The majority of magnesium ions originate from dolomitic rocks. Surface waters rarely contain more than 25 mg/litre of Mg++ions whereas the ground water may contain as much as 300 mg/litre. As such in water the magnesium ion con- tents is usually 1.3 g/litre.

All salts of magnesium with the exception of hydrocarbonate are destructive to concrete and are even more aggressive than $CaSO_4$ and Na_2SO_4 because in this type of attack the entire calcium content of the binding agent of the concrete may be replaced gradually by magnesium which may lead to the deterioration of concrete.

Water for Construction Vis-à-Vis Drinking for human beings consumption

Looking at the complexities so involved IS456 & Haryana PWD (B&R) as well have laid guidelines for use of water for construction purposes.

Contents relating to IS-456: 2000 are reproduced as under:

5.4 Water

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that

may be deleterious to concrete or steel.

Potable water is generally considered satisfactory for mixing concrete. As a guide the following concentrations represent the maximum permissible values:

a) To neutralize 100 ml sample of water, using phenolphthalein as an indicator, it should not require more than 5 ml of 0.02 normal NaOH. The details of test are given in 8.1 of IS 3025 (Part 22).

b) To neutralize 100 ml sample of water, using mixed indicator, it should not require more than 25 ml of 0.02 normal H_2SO_4. The details of 'test shall be as given in 8 of IS 3025 (Part 23).

c) Permissible limits for solids shall be as given in Table 1.

5.4.1 In case of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by the compressive strength and initial setting time tests specified in 5.4.1.2 and 5.4.1.3.

5.4.1.1 The sample of water taken for testing shall represent the water proposed to be used for concreting, due account being paid to seasonal variation. The sample shall not receive any treatment before testing other than that envisaged in the regular supply of water proposed for use in concrete. The sample shall be stored in a clean container previously rinsed out with similar water.

5.4.1.2 Average 28 days compressive strength of at least three 150 mm concrete cubes prepared with water proposed to be used shall not be less than 90 percent of the average of strength of three similar concrete cubes prepared with distilled water. The cubes shall be prepared, cured and tested in accordance with the requirements of IS 516.

5.4.1.3 The initial setting time of test block made with the appropriate cement and the water proposed to be used shall not be less than 30 min and shall not differ by +30min from the initial setting time of control test block prepared with the same cement and distilled water. The test blocks shall be prepared and tested in accordance with the requirements of IS4031 (Part 5).

Sl. No.		Tested as per	Permissible Limits (Max.)
i)	Organic	IS 3025 (Part 18)	200 mg/l
ii)	Inorganic	IS 3025 (Part 18)	3000 mg/l
iii)	Sulphates (as SO3)	IS 3025 (Part 24)	400 mg/l
iv)	Chlorides (as Cl)	IS 3025 (Part 32)	2000 mg/l For concrete not containing embedded steel and 500 mg/l for reinforced concrete work
v)	Suspended matter	IS 3025 (Part 17)	2000 mg/l

5.4.2 The pH value of water shall be not less than 6.

Haryana PWD Specification No. 3.1 (Extracts)

1. Water used in masonry work, making concrete, mortar, bricks or for other plain or reinfor ced general construction shall be reasonably clean and free from objectionable quantities of suspended material, vegetable or organic impurities, alkali, salts and other deleterious substances likely to cause efflorescence or which are likely to interfere with setting of mortar or other wise prove harmful to the work. As a rule water that is clear and potable will be considered quite satisfactory for all these purposes. As a guide, the following concentrations may be taken to represent the maximum permissible limits of deleterious materials in water.

a) **Limits of acidity** : - To neutralize 200 ml. sample of water, it should not require more than 2ml of 0.1 N caustic soda solution. The detail of test shall be as given in I.S. 3025.

b) **Limits of Alkalinity** : - To neutralize 200 ml. sample of water it should not require more than 0.1 ml of 0.1 N hydrochloric acid. The details of test shall be as given in I.S. 3025.

c) Percentage of solids should not exceed the following limits when tested in accordance with I.S. 3025.

Organic	200 ppm (0.02%)
Inorganic	3000 ppm (0.30%)
Sulphates	500 ppm (0.05%)
Alkali chlorides	1000 ppm (0.1%)

2. The water used for curing concrete and brickwork as well as for soaking bricks shall also be free from above impurities as turbid or unclean water is likely to impart its own colour to concrete, bricks or masonry. “The water used for curing should conform to clause 4.3.4 of I.S. 456”.

3. In case of large important concrete structures such as dams, water shall be subjected to chemical analysis with respect to its acceptability for use in mixing and curing concrete and its corrosive action on concrete. Once the source or sources of water have been established, regular testing and inspection is not necessary unless there is some cause warranting such action. Under such a condition the water shall be rendered satisfactory by removal of the contamination or by changing the source of supply.

(Haryana PWD Specification No. 3.1 Extracts ends)

The situation is getting alarming even in respect of drinking water at present. Shocking as it sounds, pollution has trickled through the troubled waters of the Yamuna and percolated the rapidly depleting ground water reserves of Delhi City. The study reveals that the concentration of arsenic, mercury, nitrates, sulphates and dissolved solids in the Capital’s ground water exceeds permissible limit.

“Keeping in mind the tremendous pressure exerted by developmental activities on the Yamuna, a detailed impact analysis of these activities to ascertain the changes in the chemical composition of ground water, which is crucial for a sustainable supply of portable water” was carried out.

For the record, the study entailed 50 samples of groundwater being lifted from random spots along a 22 km stretch between Palla and Okhla in Delhi. These samples were subjected to a detailed study for the presences of chemicals, heavy metals and bacteria. The quantum of pollutants detected, in turn makes for an unhealthy situation. While the excessive presence of dissolved salts in water affects the kidney and nitrates can trigger off the blue baby syndrome in infants. Besides, an overdose of sulphates can cause gastric problems and fluorides can lead to flourosis and dental disorders.

Pollutant	**Results**	**MPL***
Nitrate	174 mg/L	100 mg/L
Sulphate	680 mg/L	400 mg/L
Flouride	3.10 mg/L	1.5 mg/L
Mercury	4.60 mg/L	1 mg/L
Arsenic	69.5 mg/L	50 mg/L

*Maximum permissible limit.

While lab tests did not reveal the presence of any pathogenic organisms in the water so tested but “mercury and arsenic”, if present beyond the permissible limit is a matter of grave concern.

So what makes the India’s capital’s groundwater as polluted as it is? “The alarming presence of harmful substances in ground water can be traced to the continuous discharge of sewage and industrial effluents into the Yamuna and subsequently, into the groundwater aquifer which, being sandy in nature, allows pollution to spread at a rapid rate.

Table 2: District Wise Historical Fluctuation June, 1974 to June, 2013

Sr. No.	District	Depth of Water Table (m)			Fluctuation (m)	
		June 1974	June 1999	June 2013	June 1974 to June 2013	June 1999 to June 2013
1.	Ambala	5.79	5.45	10.70	-4.91	-5.25
2.	Bhiwani	21.24	16.19	20.76	0.48	-4.57
3.	Faridabad	6.42	8.71	16.25	-9.83	-7.54
4.	Fatehabad	10.48	6.42	23.05	-12.57	-16.63
5.	Gurgaon	6.64	15.22	26.03	-19.39	-10.81
6.	Hisar	15.47	5.87	7.35	8.12	-1.48
7.	Jind	11.97	5.92	12.92	-0.95	-7.00
8.	Jhajjar	6.32	4.49	4.57	1.75	-0.08
9.	Kurukshetra	10.21	16.72	33.24	-23.03	-16.52
10.	Kaithal	6.28	7.78	23.07	-16.79	-15.29
11.	Karnal	5.72	7.59	17.62	-11.90	-10.03
12.	Mahendergarh	16.11	25.01	45.68	-29.57	-20.67
13.	Mewat	5.50	7.14	11.21	-5.71	-4.07
14.	Palwal	5.37	5.72	9.38	-4.01	-3.66
15.	Panipat	4.56	8.53	16.97	-12.41	-8.44
16.	Panchkula	7.58	11.17	16.42	-8.84	-5.25
17.	Rohtak	6.64	3.80	3.71	3.92	0.09
18.	Rewari	11.75	13.07	22.96	-11.21	-9.89
19.	Sonepat	4.68	5.33	8.52	-3.84	-3.19
20.	Sirsa	17.88	9.45	17.34	0.54	-7.89
21.	Yamunanagar	6.26	7.13	12.69	-.93	-5.56
	State Average	9.19	9.36	17.16	-7.97	-7.80

*(+) indicates rise in water table and (-) indicates decline in water table

Another problem involves the strength of Delhi’s fresh-water flow. If pumping activities continue with the current frequency, the city’s supply of fresh water will mingle with saline water and Delhi’s groundwater reserves could turn completely saline.

It is clear from the above situation that the groundwater level is being over exploited. If this over exploitation will continue, the future of Construction Industry in Hary-

ana also would be dark.

Haryana is a water deficit state with respect to surface and ground water resources. The ground water level in the State particularly in the fresh water zone is depleting fast due to heavy exploitation of ground water and is posing a serious problem. Increasing demand and scarcity of Ground Water Resource underlines the importance of artificial recharge and water conservation. The State Average decline in water table from June 1974 to June 2013 is -7.97 m and June, 1999 to June, 2013 is -7.80 m. Based on average decline in water table of Dynamic Ground Water Resource estimation as on 31.3.2011, the blocks have been categorized as Over Exploited, Critical, Semi Critical and Safe. A block is over exploited where depletion of ground water has taken place more than 100 percent, Critical where it is 90-100 percent, Semi Critical where it is 70-90 percent and Safe where it is less than 70 percent. Presently, the number of Over Exploited, Critical, Semi Critical and Safe blocks in the State is 68, 21, 9 and 18, respectively. One is quite concerned about the fast depleting water table as ground water is a precious resource and sincere efforts are needed for the conservation of this natural resource.

The above details make it clear that guidelines for use of water for construction purposes and for drinking for human purposes as laid down separately needs to be monitored.

Case Studies

A severe damage to an indoor ward of old Medical College (now University of Health Sciences) Rohtak, University Teaching Department building of Maharishi Dayanand University, Rohtak, buildings of Govt. Polytechnic Jhajjar and to various buildings of Motilal Nehru Sports School, Rai (Sonepat) made us to think and comment the various aspects of water and eligibility of water for construction purposes. Case studies are being presented for the same.

Rohtak & Jhajjar Districts

The ground water table level varied widely and is in the range of 1.2 to 4.7 meters deep.

The pH of the soil samples of all depths is ranging from 7.6 to 9.6 and this is slightly in the alkaline range.

The chloride content in the samples varied from traces to as high as 1.296 percent. Also, the variation of chloride content either with depth at a particular location or with the location of the bore hole did not show any regular pattern. 43 samples out of the 60 soil samples tested from the 22 bore holes and from different depths contained chlorides in the range upto 0.1 percent, the remaining 17 samples were in the range 0.1 to 0.5 percent.

The sulphate content in the soil samples range from traces to as high as 0.556 percent. Quite similar to the chlorides, no clear pattern of the variation of the sulphate content either with depth at a particular location, or with the location of the bore hole was observed. Out of the 60 soil samples tested from the 22 bore holes and at different depths, 42 samples contained sulphates from traces to 0.1 percent, 12 samples contained in the range from 0.1 to 0.2 percent and 6 samples contained more than 0.2 percent.

The sub soil water samples collected at the water table level from 21 bore holes was found to be neutral to slightly alkaline with pH ranging from 6.65 to 8.35. The water samples also contained high concentrations of chlorides and sulphates in general. It was seen that the water samples collected from 10 bore holes contained chlorides from traces to 0.1 percent, 7 samples in the range 0.1 to 0.5 percent, and 4 samples contained more than 0.5 percent. The sulphate content in 3 water samples was from traces to 0.015 percent, in 5 samples in the range 0.015 to 0.10 percent, in 4 samples in the range 0.0 to 0.20 percent and in 9 samples above 0.20 percent.

Results to further analysis of selected sub soil water samples revealed that the sub soil water contains considerable amounts of alkalis particularly as sodium salts. They also contain small amount of calcium and magnesium salts. These results coupled with the chloride and sulphate results indicate that the water contained salts such as chlorides and sulphates of sodium, calcium and magnesium. The quantity of magnesium ions, though much higher than in normal waters, still seem to be in the safe range for concretes.

The following conclusions can be drawn from the chemical analysis results on the soil and ground water samples:

- The soil in the ground water is slightly alkaline with pH ranging from 7.6 to 9.6.
- Considerable amount of chlorides and sulphats are present in the soil samples. The chloride content ranged from traces to as high as 0.5 percent and the sulphate content ranged from traces to as high as 0.556 percent.
- The sub soil water is neutral to slightly alkaline in nature with pH ranging from 6.65 to 8.35. It also contained considerable amount of chlorides and sulphates in some samples. The chloride content in the sub soil water samples ranged from traces to as high as 1.296 percent. The sulphate content ranged from traces to as high as 0.49 percent.
- The sub soil samples also contained small amounts of sodium, calcium and magnesium salts.

The chloride and sulphate contents found to be present at different locations in the site do not indicate any regular pattern of occurrence inter alia site conditions except

that the later may be considered as mild to severe for concrete foundations thereby ruling out the approach of any rearrangement of the locations proposed for the different structures on considerations of their susceptibility to chemical attack.

Sonepat Distt

Four ground water samples were also studied in respect of Sonepat District and results showed that vol. of 0.2 N H2SO4 required to neutralize 100 ml. of H2O sample using mixed indicator required 22.1 to 33.57 ml. against I.S. limit of 25 max. which is incorporated in I.S. 456.

These results indicate that the ground water of Sonepat distt. is alkaline in nature and is not meeting the requirements of either Haryana PWD specifications or IS-456. This situation is more prevalent with an increase in distance from Yamuna River. But with minor addition of acids of required normality, the water can be brought to meet with the requirements of above specifications of IS:456. 155ml. of HCl of normality N-12 – can be added in 1000 litre of water to bring the water as per specification. Same can vary from area to area.

Table -3: Calculation for Teasting Water

HCl Acid of Specific gravity N

$N_1 V_1 = N_2 V_2$

Water **Acid**

$\mathbf{N_1 \times 100}$ $\mathbf{\frac{N \times 34}{50}}$ **(0.02N=N/50)**

N_1 (Normality of water) $= \frac{N \times 34}{50 \times 100}$

Equivalent Weight $= \frac{\text{Mol. Wt.}}{\text{Valency}} = \frac{100}{2} = 50$

Strength of Alkalinity in term of $CaCO_3$

Equivalent Alkalinity $= \frac{34 \times 50}{50 \times 100}$ gm/Lit. (Eq. Wt. Of $CaCO_3$} = 340 mg/ltr.

Normality $= \frac{\text{Strength (Alkalinity)}}{\text{Equivalent}}$

340 mg/Lt. – 250 = 90 mg/Lt.

580 mg. of Alkalinity is neutralized with HCl = 1 ml,

90 mg of Alkalinity is neutralized with HCl $= \frac{1 \times 90}{580}$

For 90 mg of Alkalinity, the requirement of HCl is 0.155 ml.

1 litre of water needs 0.155 ml. to neutralize the Alkalinity
1000 litres of water need 0.155 ml. to neutralize the Alkalinity 0.155 × 1000 = 155 ml
So 155 ml of HCl of Normality N-12 is required to be added to 1000 Litres of water so as to make it safe for use.

Recommendations

The following measures are recommended for adoption: -

Cement:

Ordinary Portland cement conforming to IS: 269 may be used with further stipulation that it should have a tricalcium aluminate (C_3A) content not more than 5 percent and tetracalcium aluminoferrite plus twice the tricalcium aluminate or solid solution ($4CaO.Al_2O_3 Fe_2O_3 + 2CaO. Fe2 O_3$) be not more than 20 percent. All foundations with cement concrete or cement mortar coming in contact with the soil of Rohtak or Jhajjar should be made with cement of the above specifications. In case of use for all other cements including ordinary Portland cement as per IS: 269, suitable precautions and protections will also have to be adopted.

Concrete:

a) The concrete should be made with sand, aggregate conforming to the requirement of IS:383.
b) The water used for mixing and curing of concrete or brickwork should at least be that conforming to IS:456.
c) The maximum water cement ratio for structural concrete should be restricted to 0.45 by weight.
d) The minimum cement content in reinforced concrete should be 370 kg. /m3 if sulphate resisting cement is issued, and 400 kg/m3 if any other cement is used
e) The clear cover to he reinforcement should be increased by 25 mm over and above what would be in normal situation as per IS:456.

Reverse Osmosis:

Wherever we do not have appropriate ground water or if there are no canals or water courses then, we have no alternative but to use principle of Reverse Osmosis to purify water for construction.

Reverse Osmosis (RO) is an advanced water purification technology initially used by industries located on sea coasts and the armed forces to purify sea water and make it drinkable. It has now been adopted for use in homes and offices to purify the increasingly polluted water in our cities. The Reverse Osmosis technology is used in

areas like Healthcare and Scientific research where purity is not just important but critical. It has now been adopted for use in homes and offices to provide the same level of purity at minimal cost.

It uses a special, semi-permeable membrane which removes impurities as small as 0.0001 micron (i.e. 0.00000004 inches) in size, cleansing water of all biological impurities, suspended particles, Total Dissolved Solids (TDS), salts, metals and chemicals. Most non-RO systems can filter particles only up to 0.5-10 microns in size, leaving out almost all dissolved impurities (like bad-tasting salts) and some finer physical impurities.

Bricks:

First class brick as per PWD specifications with additional stipulation that its water absorption be less than 10 percent should be used. However in the absence of the above type of bricks, first class bricks with suitable protective measures as described above should be adopted.

Protective Treatments:

In addition to the above steps, reinforced concrete or brick work in the foundation of the structures may require additional protection with coatings or membranes. Different types of protective treatments involve an increase in cost. A suitable choice of the protective measures may be based on technical and economic considerations in each case from among the various alternatives given.

Quality Control:

A proper quality control plan for ensuring the quality of materials, construction jobs and workmanship etc. be formulated in advance of the commencement of the construction programme.

In case of areas adjoining to Sonepat District, acid of appropriate normality is to be added in ground water so as to bring the same with in ambit of IS code: 456-2000. An example of calculations to bring the water of Sonepat within the requirement of IS Code: 456 is presented in Table 3.

Last but not the least, efforts should be made to use canal water as far as possible and that too should not be polluted by any effluent which may change its basic characteristics.

Conclusion

- The results of the investigation show that the soil in and near Rohtak & Jhajjar contains pH, sulphates and chlorides beyond permissible limits.

Unpolluted canal water & ground water treated with reverse osmosis should be used.

- The water in Sonepat district is alkaline and is beyond permissible limit need to be treated with acid of defined normality.
- Suitable protective measures are required to protect foundations from surrounding aggressive environment so that structures may give the normal expected life.

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Basic Concepts of ISO and Quality Management System: Quality Assurance for Concrete Structures

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Prologue

ISO:9000 is a family of QMS designed to help organizations to ensure that they meet the needs of the customer and other stakeholders while meeting the statutory requirements of products and services. Quality Management deals with various management functions that determine Quality Policy, requirements of Quality System, Quality Assurance Manual and implementation of Quality Assurance Plan.

The author Shri K.B. Rajoria who superan - nuated from the post of Engineer-in-Chief PWD, is a well known expert in the field of ISO application to quality management and implementation of projects pertaining to concrete structures. During his tenure as Engineer-in-Chief, PWD Delhi in 1999, ISO standard were applied for concrete structure, flyovers and bridges extensive-ly. Shri K.B. Rajoria also served as Pres-ident IBC and President IRC during his illustrious carrier.

This paper has been prepared to give an insight into application of principles of ISO quality management and an insight into quality assurance of concrete structures with special reference to flyovers and bridges.

-Editor-

Introduction

ISO 9000 is a family of Quality Management Systems designed to help organizations to ensure that they meet the needs of the customer and other stakeholders while meeting the statutory requirements of products and services. Quality management as per ISO – 8402 is a set of all activities of overall function that determines Quality Policy and implement the same through systems of Quality Planning, Quality Control and Quality Audit. Total Quality Management is the management approach of an organization based on participation of all concerned ensuring proper customer satisfaction, and benefits all members of the organization and society.

The aspects which need consideration for proper quality management through quality systems approach of ISO 9000 are (a) Fulfilling organizational and management responsibilities of various participants (b) Planned resources for needs of quality performance, activities of relevant programme schedule (c) Process for implementation, inspection, testing, performance evaluation, review and audits. The total systems of policy, management responsibilities, internal and external control, testing, quality control, acceptance criteria, corrective action and documentation are covered in the quality system. These also include project preparation of design and drawing, construction and supervision, and contract management.

The ISO 9000 standards broadly are ISO 9000: Quality Management, ISO (9001: Quality Management Systems Requirements, ISO 9004: Managing the sustained success of an Organization- a Quality Management Approach, and ISO19011: Guidelines on internal and External Audits of Quality Management System.

The paper deals with various aspects as above including guidelines to Quality Systems, Quality Assurance Requirements and typical Quality Assurance Plan with special reference to concrete structures.

Basic Concepts of ISO

ISO refers to International Standards Organization. ISO is a voluntary organization, whose members are recognized Standards Organization, each one representing one country. The bulk of the work of ISO is done by the various technical committees, sub- committees and working groups. Each committee is headed by a secretariat from one of the member organizations. Each member body who has an interest in the work of a committee is entitled to

be member of that committee. Standards are finalised by consensus with each member organization representing the interest of the vendors, manufacturers, consumers, professionals and Government of the country.

Each standard goes through a six stage process before being published as an ISO standard. These are, (i) First stage- Proposal stage in which need for a standard is determined and members are identified who are willing to work on it. (ii) Second Stage- Preparatory stage where -in a working draft is developed. (iii) Committee Stage- Draft is sent out for comments until consensus is reached. The output of this stage is a draft international standards (DIS). (iv) Enquiry Stage- It is circulated among all member bodies and then voted upon. If a DIS does not receive 75% of the votes, it returns to lower stage and work on it continues (v) Approval Stage- If it passes enquiry stage it becomes a final draft international standard and moves to the approval stage. It is again circulated through all member bodies for a final vote and again it must pass this stage with 75% of the votes. (vi) Publication Stage- After approval stage it enters publication stage and is sent to the ISO Central Secretariat for publication.

In India, ISO is represented by Bureau of Indian Standards (BIS). ISO Standards in India are common for different industries. However the construction industry is presently lagging behind. It means a lot to have a quality system certification in accordance with ISO 9000. These standards define the requirements for quality management/ quality assurance system that is used by a company/organization for the purpose of manufacturing a product or providing a service to its customer.

At the present time, the entire certification process is voluntary, because customer contracts are not essentially requiring evidence of quality system certification. However it would be a sound business practice to develop a quality assurance system using the structure of ISO 9000, to take advantage of the benefits available, and to be prepared for the customers requirements of ISO 9000 Quality System Certification.

Quality Management Principles

As per ISO-2015, there are seven management principles upon which the family of standards is based. These principles are fundamental beliefs, rules

and values that are accepted as true and can be used as basis for Quality Management. These are follows:

- Customer Focus - The Organization must work to meet customer's requirements (needs) and strive to exceed his expectation. Sustained success can be achieved when organization attracts and retains the confidence of customers and the inter-related parties.

- Leadership - Leadership establishes unity of purpose and creates conditions in which people are engaged in achieving organization's quality objectives, unity of purpose and engaging people to enable organization to align its strategic policies, processes and resources to achieve its objectives.

- Engagement of People - To be able to create and deliver value, an organization requires an empowered, engaged and competent work force at all levels of an organization. Involving all people at different levels and to respect them at individual levels is the key to organization's effectiveness. Recognition, empowerment and enhancement of competence facilitates the engagement of people in achieving organization's objectives.

- Process Approach - Consistent and predictable results are achieved more efficiently when activities are understood and managed as inter-related processes that function as a coherent system. Quality management system consists of inter-related processes. Understanding how the results are produced by Quality Management System enables the organization to optimize its system and performance.

- Improvement - The underlying principle is that organizations must constantly strive for improvement if they want to be successful. The competitive industrial environment improvement is essential for an organization to maintain the current level of performance and to react to change in its internal and external conditions and to create new opportunities.

- Evidence Based Decision Making - Decision based on the analysis and evaluation of data and information are more likely to produce desired result. Decision making is a complex process and always involves some uncertainty. It often involves multiple types and sources of inputs as well as their interpretation. It is essential to understand the causes and effect of un-intended consequences. Facts, evidence and data analysis lead to greater objectively and confidence in decision making.

- Relationship Management - For sustained success, an organization needs to properly manage its relationship with interested parties such as suppliers. Quality and timely delivery of goods and services by suppliers more often than not influence the performance of an organization. To optimize their impact, organization must manage its relationship appropriately.

Guidelines on Quality System

Quality System

Practical approach for evolving TQM in construction according to Quality Management System as per ISO, which needs be worked out. The approach to TQM as per ISO requirements will be helpful in understanding practical approach in the context of a developing country like India. It will also be helpful to work out guidelines according to ISO standards.

To build safe, serviceable, durable and economic construction, structural members should meet certain requirements. Characteristics to fulfil these requirements have to be satisfied. The codes of practice and contract document define design criteria, practical rules, specifications, testing and acceptance criteria and workmanship. Human skill in construction work determines the quality. It is necessary to have strategy for management of human skills by Quality Systems. It is also necessary to define Quality. These guidelines facilitate preparation of appropriate Quality Systems. All these involved will be able to provide the quality product, as expected. In these guidelines attempt has been

made to achieve compliance with ISO 9000 series on Quality Systems.

These guidelines include project preparation, design and drawing, construction and supervision, contract management, quality of materials, equipment and workmanship. They also cover organization requirements to be adopted by suppliers, purchasers, owners, approving authorized personal and consultants. Thus these guidelines will enable (i) compliance with codal requirements of quality control, (ii) setting up of internal quality system of each of the organization dealing with various aspects and setting up of an external quality system by supplier, to ensure conformity to specified requirements at final inspection stage during production and installation or during intermediate stages.

General Approach

The term “quality” has been defined as the totality of feature and characteristics of a product or service that bear on its ability to safely satisfy stated/implied needs. In contractual environment, needs and requirements are specified. These are (i) acceptable materials of construction outlining tests of acceptance (ii) design criteria and sound engineering practices to guide designs and (iii) workmanship and other aspects of construction. The contract document and technical specifications define the inter relation of various parties and quality. The quality system covers policy, management responsibility, internal and external controls, testing and quality control, acceptance criteria, corrective action and documentation , It encompasses overall organization and structure, responsibilities, procedures and processes for implementing quality management. The overall management function is to determine quality policy and implementation by quality control and quality assurance within the quality system. It is referred to as “Quality Management”. Terms used in Quality Management, have acquired specific meaning and applications, different form the generic definitions. These are given in brief, in section 2.3 below.

ISO Terminology

(i) Quality – The totality of feature and characteristic of a product

or services that bear on its ability to satisfy stated or implied needs. (ii) Grade - Category or rank given to entities having some function and use, but about different requirments of quality. (iii) Requirements of Quality – Expression of the needs or their translation into a set or quantitatively/ qualitatively stated characteristics of an entity. (iv) Dependability – Term used to describe the availability, performance and its influencing factor. (v) Conformity/Non Conformity – Fulfillment/Non fulfillment of specified requirement. (vi) Defect – Non fulfillment of intended uses (vii) Product/ Service Liability – The onus on a producer to make good for loss related to different factors. (viii) Qualification Process – Demonstrating whether an entity is capable of fulfilling specified requirement.(ix) Qualified – Status of an entity when capability of fulfilling specified requirements is demonstrated.(x) Inspection/Self Inspection – Activities of a product or service and comparing with specified requirements to determine conformity. (xi) Verification – Confirmation by examination and provision of objective evidences. (xii) Quality Policy - The overall intention and direction of organization, expressed by top management. (xiii) Quality Management – That aspect of overall management function that determines and implements quality policy. (xiv) Quality Planning - Activities that establish the objectives and requirements for quality and for application of quality policy.(xv) Quality Control – The operational techniques and activities that are used to fulfill requirements of quality. (xvi) Quality Assurance – All planned and systematic action necessary to provide adequate confidence that product or service will satisfy given requirements of quality . (xvii) Quality System – The organization structure, responsibilities, procedures, processes and resources for implementing quality management. (xviii) Total Quality Management - Management approach of an organization centered on quality, based on the participation of all members and aiming at long-terms success through customer satisfaction and benefits to all members of the organization and to society. (xix) Management Review – A formal evaluation by top management of the status and adequacy of the quality system in relation to quality policy and new objectives. (xx) Design Review – A formal, documented, comprehensive and systematic examination of a design to evaluative the design requirements and capability of design to meet requirements. (xxi) Quality Assurance

Manual – Document stating the quality policy describing the quality system of an organization. (xxii) Quality Plan – Document setting out the specific quality practices, resources of activities which are product specific. (xxiii) Specification – The document that states the requirement for which product/services has to confirm. (xxiv) Traceability – Ability to draw the history, application or location of an item or activity, by means of recorded information. (xxv) Quality loop, Quality spiral – Conceptual modes of the interaction activities that influence the quality of product/services in various stages needed to assessments. (xxvi) Quality Surveillance – Continues methods, and verification of status of products and services, and analysis of records in relation to stated references. (xxvii) Quality Audit – Systematic and independent examination to determine whether quality activities comply with planned arrangements and whether these arrangements are effectively implemented to achieve objections. (xxviii) Production Permit: Deviation Permit – Written authorization for deviation, prior to production. (xxix) Concession: Waiver – Written authorization to use or release a quality of material, component or stores already produced but not conforming to requirements.

Principal Components of Quality System

(i) Supplier's Quality Policy (ii) Purchaser's Quality policy (iii) Internal Quality System and (iv) Inspection and Audit

Requirements of Quality System

Requirements as given below are aimed at achieving owner satisfaction by preventing non conformity, (i) Management Responsibility (ii) Quality System (iii) Quality Review (iv) Design control (v) Document and Data Control (vi) Purchasing (vii) Control of customer supplied product(VII) Product identification and traceability (x) Process Control (xi) Inspection and testing equipment (xii) Inspection and test status (xiii) Control of non conforming products (xv) Corrective and preventive action (xvi) Handling, storage, packaging, presentation and delivery (xvii) Internal quality audits (xviii) Servicing (xx) Statistical Techniques.

Quality Assurance and Quality Assurance Manual

Quality Assurance (QA) is defined as the planned and systematic activities implemented within the Quality System to provide adequate confidence A Quality Assurance Manual is base document outlining policy, procedures, responsibilities, compliance, acceptance criteria and documentation. It should be prepared and accepted by all parties. It should cover, (a) Identification of parties involved (b) Internal QA system of all parties (c) Levels of cross checking /verification/ controls (d) organization of personnel responsible for QA (e) criteria for acceptance (f) Inspection at the end of defect liability period (g) Items to be covered in Maintenance Manual (h) Documentation formats.

The ultimate responsibility of compliances rest with the concerned parties.

Quality Assurance Manual for Concrete Work

Several parties are involved in QA system. These include, owner, consultant, approving authority, main contractor, material suppliers, manufacturers of items incorporated, specialist/nominated sub contractors and equipment manufacturer. Depending on requirements the specified responsibility to different units/individuals are given, at four levels of organization, as detailed below.

Level One – Management level to decide TQM policy and over all responsibility.

Level Two – Implementation of quality policy and review.

Level Three – Quality Audit, Proof Consultant and Project In-charge.

Level Four – Engineers and Managers for different functions, as required, like Quality System Engineer, Resource Manager, Technical Engineer, Planning/ Monitoring Engineer etc.

The Organization Structure

Quality has to be according to requirements of individual specific tasks, Various activities for a concrete structure job are classified under three major groups. These are (i) design (ii) construction (ii) manufacturing (a) factory manufacturing (b) special items such as bearing manufactured by specialty suppliers for bridges.

For Activities Affecting Quality

For Activities Affecting Quality, such as accuracy of data, solutions as per Codes after accounting local data, documentation, internal reports, reviews, quality policy, workmanship, cash flaw etc., different relevant activities are:

(i) Project Preparation (Data collection, selection of suitable options).

(ii) Design and drawing

(iii) Preparation of contract document

(iv) Organization and Management of suppliers/contractor

(v) Material procurement

(vi) Production of sub-items like concrete prestressing cables etc in bridge work.

(vii) Management and organization of owner

Quality Assurance Requirements

These have been described here under subheads, viz (i) Project Report Preparation (ii) Design and drawings (iii) Contract aspects, (iv) Construction organization (v) Materials and workmanship. (vi) Project – Specific QA Plan – It is required to be prepared and documented in form of QA Manual. If prepared by contractor, it is to be approved by owner or his Consultants. It should form part of Contract Agreement. External control by owner or third party inspection agency has to be exercised.

The implementation of QA Plan is to be carried out by (i) Internal control by construction agency (ii) External control by owner or third party inspection agency.

Project Report Preparation

- Adequacy of data – Data collection from primary local sources, cross checked by in house or specialist agency or by other method. Supplementary check by other expert agency. Verification and certification by senior level professional in organization
- QA system and documentation - Project prepared by following QA principles and in the house/independent checking by external agency.

Design and Drawings

- Organization – Owner's/consultants/contractors design office with established internal QA procedure. Independent checking either internal or external
- (a) Drawings – Project specific drawings made at pre-execution stage indicating limits of details given in drawings. Drawings with full details issued after internal checking,
- (b) Bar bending/cable layout /stressing schedules – To be given by designer and verified by contractor.
- Design Review and proof checking – Checking of Design by in house/external agency.
- Design modifications due to site variations or substitution of materials – Changes to be incorporated in revised drawings and drawings to be re-issued
- As built drawings and design – Necessary after incorporating changes.
- Maintenance of as built drawing and designs- to be maintained by owner. Preferably to be put in digital state.

- Model tests/proto type tests – (a) River hydraulics if required, to be carried out before finalization of design (b) Structural model test – If required to be carried out before finalization of design (c) Non destructive testing to be encouraged through specified agencies.

Contractor

- Prequalification (main contractor) – It is essential (b) Suppliers/ sub contractors – Prequalification prior to engagement and (c) Nominated sub contractor/agency - As required, to be specified in the tender.

- (a) Specifications and contract document – To be available at site by adding specifications for non standard items. Pre bid meeting is essential before inviting tenders.

- QA Manual – With three levels of control in each unit (contractor, owner, others as required) for general as also specialized/innovative items.

- Defect liability period – Responsibility of owner and contractor to be defined in tender document. It has to be one year in general and extra as appropriate for special works.For manufactured items also defect liability period is to be specified.

Construction Organization

- Contractor – Staff responsible for the quality with external agency for quality surveillance and audit.

- Project Management Consultant – Either owner's staff or separate agency with additional quality surveillance and audit.

- Planning of construction activities – Broad planning to be made by contractor and approved by owner. Skilled labour to be deployed, execution to commence after intimation to supervisor of owner. Comprehensive planning of supervisors, labour, materials. Methods of quality control to be specified. Involvement of consultant for

planning work. Use of Bar Chart/Pert-CPM with monitoring and re planning by special cell of owner.

- Supervisor – Full time supervisor supplemented by full time supervisor by owner/consultant employed through specialist agency. Extra supervisor for innovative work. May be engaged as required.

Materials

- General (a) Material from natural resources – Sources to be mutually agreed by deciding to have bulk purchase from source. Independent testing/acceptance by contractor's and owner's Q.A. units. Testing at start of project and at specified frequency. Additional testing/acceptance by independent agency say PMC (b) Factory manufacture's test certificate accepted by sample check by independent agency. To set up two levels of mutually agreed QA methods. Third level of checking by specialist agency. ISO – 9000 certified agency to be given preference.

  Testing facilities – Testing at project site under control of QA personal of contractor and owner.

- Coarse Aggregates - Tests as required, at the beginning of mix design and for change of source. Frequency to be increased for higher quality. Tests to be included are grading, physical tests, deleterious content and reactivity.

  Fine Aggregates – (i) Grading at beginning of mix design, change of source and frequent tests at site laboratory.(ii) Other physical tests – For selection, at the beginning of mix design and two tier check at site (iii) Deleterious test – For selection of sources, (iv) Control of chlorides – frequent chemical tests at site and at external laboratory.

- Water – (i) Suitability – At the beginning (ii) Chemical test – Mandatory at beginning of projects for chlorides and sulphates and at frequency as required.

- Cement (i) Manufactures certificates and tests for each consignment at site laboratory and external lab, (ii) form of purchase, transportation and uses within acceptable limit – purchase, information, storage and transportation in dry and covered condition, supply from factory and transportation to site store – to be supervised and documented.

- Admixture - (a) Approval – acceptance test to be carried out independently for each source, chlorides test, manufactures certificates (b) Production controls at site to be finalized after field trial mixes, special mechanical device to be used for dispensing, frequent checks, for specific gravity and continuous monitoring of concrete work. Visual inspection of concrete for local defects including delayed setting.

- Reinforcement Steel – (i) Normal physical test – At the beginning and at change of source for each consignment and visit by experts at close intervals (ii) Chemical composition – At the beginning (iii) Welding – Not generally permitted, if requested to be done by qualified welders with specified electrodes. To be periodically tested by experts at site.

- Pre stressing steel/Anchorage system and cable Anchorage HT wires/Strands/ Anchorage system/ Cable Anchorage Assembly/ Sheathing/ – These are special items. Therefore specification, tests and frequency to be decided under guidance of expert.

Workmanship

- General Control (direct and indirect) by supervisor or skilled workmen with special training. Full time supervision by contractor and owner and checking by designer, giving certification of compliance. Supervision by outside experts and for new technology site visit by concerned designers to provide in contract document and to be implemented under expert supervisor.

- Concrete Mix Design – To be done at beginning of project and at change of source.

- Fabrication and fixing of reinforcement – To be done by skilled workers with qualified supervisors, bar bending schedules are to be checked, correct placement of reinforcement to be checked by Q.A team and bar bending schedule to be made by design team.

- Fabrication and fixing of pre stressing cables- To take precautions as specified and checks to be made.

- Formwork – (a) Materials – Any suitable material as per codal requirement. To have limited re-use. To be capable to absorb air released by concrete and good insulation to thermal variation. In steel shuttering to provide liner after de-shuttering.

  (b) Design Check – Design made and checked independently.

  (c) Experienced Carpenters/Fitters – Skilled carpenters and fitters are required.

  (d) Tolerance, geometry and leak tightness checks – Checks by supervisory staff. To be documented.

  (e) De-shuttering – Gradual and uniform de- shuttering

  (f) Form Work for special structures – As per design requirement under control of qualified staff with additional supervision by owner's supervisors or QA team by independent agency.

- Mixing/ Conveyance/Placing/Curing of concrete – Batching plant is mandatory, and specialized equipment is required for transportation. Adverse effect like segregation to be monitored controlled and documented. Special concreting gangs with two level control. Regular control are required by qualified staff and to use pour card to control. Regular quality control by qualified staff and occasional check by experts are necessary. Surveillances by QA team is also required. Proper curing under frequent checks by independent supervisor is to be done. All activities to be documented.

- Stressing of cable – Specialized job under control of specialist agency.

- Grouting and Grouts – Under the control of specialist agencies.

Typical Quality Assurance Plan for Construction and Design

General

It is possible to evolve method and appropriate documentation for QA plan in construction surveillance and project implementation to be well organized into QA plan.Step by step procedure would help in achieving consistent and comprehensive method of checking and approval of works at every stage, need to be established and documented. These procedures can be reviewed, amended and revised as necessary.

All parties to have Quality Assurance Manual (QAM) by evolving QA plan and defining internal QA system. QAMs to be made for different purposes like design by design organization, construction by contractor, manufactured product by manufacturers. The owner should also have its QA plan. An integrated plan to be approved by the owner. These plans are to be agreed and accepted by concerned parties. QA plan for construction project, documented in QA Manual, should comprise of following aspects. (i) Organization (ii) Control of data and documents, both product related and quality related. (iii) QA procedure for setting out works including temporary works. (iv) Methodology of working (V) Control of materials (vi) Control of work confirming procedures and (ix) Quality Audit.

Organization

The project specific organization is headed by Project Engineer, to be assisted by (a) Planning Engineers (b) Material Engineers (c) Construction Engineers (d) Plant Equipment and Instrumentation Engineers (e) Other staff for – Safety, HRD etc. (f) Quality Assurances Engineer (g) Quality Audit – Independent team. Duties of these Engineers and their assistants to be clearly defined.

Control of Data and Documentation

(i) Structural Drawings and Designs, specifications and work instructions to be maintained. Only latest documents to be used. These are required both for permanent and temporary works. Precautions to be taken are, (a) Issuing Authority to maintain Register of drawings with all relevant information (b) Receiving Authority to also maintain

the same (c) Maintenance and accessibility of site instruction (d) Maintenance of correspondence files (e) Daily diary of works (f) List of Registers at site.

(ii) Quality Related Records and Documents- Record for each/activity to be maintained as detailed. (a) Method Statement – Proposal given by construction agency, written in steps and supplemented by sketches if required. No change in procedure, given in Method Statement is allowed, without approval by Engineer. (b) Inspection Performa used for seeking approval from Engineer before starting work. Each and every operation like pour card, supplemented by standard check list to be verified by Engineer (c) Test Results to be recorded in set performas (d) Daily Diary of Work and Quality Records (e) Non confirming products and (f) Quality Audit.

QA Procedure for Setting Out Works and Temporary Works

Professional qualified surveyors to be employed for setting out works (both temporary and permanent). Establish and maintain Control Stations by following appropriate work method. Record for survey control stations, setting out points, schedule of stations and points, control and checking of stations and approval of stations and setting out. Temporary works are responsibility and liability of contractor and to be done with approval of Engineer. Design of temporary works to be got approved by contractor. The procedure for maintaining record of temporary work shall include (i) Design Drawing, method statement etc. (ii) Checking and approval of proposal (iii) Erection procedure (iv) Checking and approval of erection produce (v) Certification by competent authority (vi) Monitoring during loading and (vii) Dismantling. These are to be checked by approving authority, the Engineer.

Methodology of Working

Method Statement for execution of permanent works to be submitted by contractor to owner for approval. The procedure shall be (i) Submission (ii) Checking (iii) Trial of method if required and

assessment (iv) Sample of permanent work and its assessment (v) Execution of permanent work and (vi) Ongoing review of the method.

Control of Materials

The QA plan for materials to include (i) Testing and source approval (ii) Inspection and certification after receipt (iii) Testing of material (iv) Test records (v) Assessment and Analysis (vi) Test frequency and calibration schedules (Storage of issue of materials and (vii) Inventory.

Control of Workmanship

It is necessary to carry out inspection at different stage in regular and systematic manner. Contractor to devise an appropriate system for inspection and approval from Engineer. Points to be considered are (i) Method Statement including tolerances (ii) Request Forms for inspection (iii) Inspection proformas (iv) Authority level for inspection (v) Inspection procedure - primary, periodical and completion check (vi) Check lists and (vii) Record inspection. These points are to be considered separately for various activities of construction.

Protection during Construction Stage

To achieve final quality it is necessary to lay down procedure for preventing damage/deterioration of materials/part works/completed work, till completion of entire job. These procedures are to be laid down for, (a) Storage (b) Protection of partly completed work, (c) Prevention of accidents and (d) Servicing of components such as bearings.

Non Conformity Products

Non-conformity work is to be rejected. Separate detailed procedure to be laid down for dealing with non conformity products. For concrete work, the non conformity is known only after 28 days and as further work proceeds. So, at times non conformity approval becomes necessary.

Quality Audit

The QA Manuals of contractor and owner shall establish document and programme for independent quality audit. The audit has to include process and product quality as well as adequacy of system as laid down in QA Manual. The audit programme shall assign qualified personnel to perform such audit and define procedure as also frequency, method of reporting the findings, recommendations, action for corrective action and their re audit.

Design Aspects

Design, if given by contractor, the QAM should include the agreed procedure for (a) Organization and Functional responsibilities (including personnel qualification) (b) Design and basic report for development of design to include (i) Requirements of project/ client (ii) Preliminary data and drawings source, responsibility and methods of verification (iii) Design approach, applicable codes, special design specification (iv) Method of analysis, calculation, checking and internal approvals (v) Detailed calculations (vi) final drawings and (vii) Checking and approval by external agency (c) Audit and corrective action and (d) Design documentation and records.

Proformas for Quality Records

Detailed and exhaustive proformas will have to be evolved to suit requirements forming part of QA manual.

Conclusion

ISO 9000 is a set of international standards on quality management and quality assurance developed to help organizations effectively document the quality system elements to be implemented at site. An ISO 9001 (or other ISO standard quality system) provides the structured way of delivering a better product and service and is supported by documents information such as procedures, work instructions, responsibilities and actions to achieve the stated quality goals.

Quality consciousness amongst the parties involved in construction i.e. contractor, engineer and architect is required to ensure requirements quality of work. The standards of quality that the engineers team tries to achieve should be consistent with the requirements given in the quality control documents. The quality of materials and standards of workshop have to be controlled by the contractor through implementation of quality plan. The quality plan ensures the resources required and the control of activities of specific processes, monitoring and tests. The required workmanship can be achieved through proper training of workman, site supervision, monitoring and feedback systems. This can achieve the god of continuous improvement and customers satisfaction which is of utmost importance to all concerned parties involved in various activities for implementation of the construction project.

The working of the organization needs to be understood and analysed in respect of hierarchies' linkage, decision making process and its flow throughout the organization. Organization's implementation mechanism covering translation of decision taken into actions, system of review, analysis and creative action in respect of each of the process goes into delivery of goods and services. Quality management thus in the final analyses becomes managing the quality and functioning of organization.

Training and Certification of Workmen
Need for Standardisation

H K Srivastava
Former Addl DG, CPWD

Prologue

Construction sector is highly process oriented. For adhering to the specified processes, trained and skilled manpower is essential at all operative levels so as to deliver the infrastructure projects on time and with quality. In developed countries, only trained and certified workmen, operators and supervisors are employed for construction activities. Studies indicate that only about 10% of Indian labour force – 8% informally and 2% formally acquire vocational skills. Thus, there is a huge scarcity of skilled workers and practice of certification as an empowerment criterion is practically missing. Standard contract formats across the country do provide for deployment of skilled workers but it is not defined therein, how a worker will be judged for his skills. Book of Specifications, which form part of the Contract, do not spell out the category of workmen either by trade or by requirement of a particular skill for the specific item. The Standard Data Book also does not help as it mainly categorises workers by skilled, semi-skilled or skilled and follows broadly the categories as in the circulars prescribing the minimum wages. Thus, we have a situation where the contract provision does not or cannot specifically provide for a specifically suitable person with a specific trade understood to mean the same for all the players ie, worker, trainer, contractor and the employer for a specific item of work.

Shri H.K. Srivastava who had rich experience while working for Delhi Metro Rail Corporation suggests that the appropriate standard setting body, i.e., BIS, takes a lead in standardising the same to ensure that national standards and quality for skilling are globally aligned and Indian youth can aspire to secure local, national and international job opportunities.

-Editor-

Introduction

Civil construction work is common for built environment and infrastructure sectors. For civil constructions, manufactured goods and natural mineral products are brought to the project site. Thereafter, workmen of different trades and machine operators with different tools / plants work at the project site to develop/ produce the finished goods according to drawings and designs. Workmen, Machine Operators and Supervisors of different trades work to implement the project. Construction sector is highly process oriented. It is well known that unless each and every step of the process is carried out as specified, the end results are bound to be flawed. For adhering to the specified processes, trained and skilled manpower is essential not only at managerial and supervisory level but also at the cutting-edge level of workmen and technicians. At times, the project is designed by the best consultants and even assigned to the best construction agency at the best rates, but the outcome may not be the best, if the competent and skilled work force is not deployed at the construction site. Construction industry, being the third largest employer, employs more than 5.6 crore workers who fall largely into unorganized sector. It is a fact that the performance of even those in the organized sector remains largely dependent on such workers. The key focus therefore needs to be on building capabilities of the construction industry to deliver the desired results and to cope with the envisaged work plans and deliver the infrastructure projects on time and with quality. Lack of this potential would mean additional cost, lack of durability and substantial reduction in our competitive position with respect to international players.

In developed countries, only trained and certified workmen, operators and supervisors are employed for construction activities.Studies indicate that only about 10% of Indian labour force – 8% informally and 2% formally acquire vocational skills.There is a huge scarcity of skilled workers and practice of certification as an empowerment criterion is practically missing. Even for operating a number of heavy equipment, no driving license is required - not even for a Road Roller.

Existing Scenario: Categorisation by Trade and Category

Efforts at Contractor level: Realising the usefulness of deployment of trained workmen on their projects, a few construction houses have initiated their own training programmes for a few categories of workers employed by them. Training to workers in a few trades is provided at National Academy of Construction (NAC), Construction Skills Training Institutes (CSTIs), Central PWD Training Institute, and various skill develop-

ment and training programmes of the Central Government.

Initiative at Government Level: India has made skill development a national priority with the institution of its National Skill Development Mission in 2015, a programme that has an annual budget of about Rs 17,000 crore. A number of incentives by way of subsidies, tax exemptions etc are also available.

Initiative by Ministry of Labour and Employment: At National level, Directorate General, Employment & Training (DGE&T) under the Ministry of Labour and Employment (MoLE) was the nodal body for formulating polices, laying down norms, standards, conducting trade tests and certification. The Skill Development initiative scheme was developed by this Ministry. The DGE&T has provided a list of Modular Employable Skills (MES) courses. The revised list issued in September 2012, covers 72 sectors. Sector No. 25 is 'Construction' and covers 42 courses. The special feature of this listing is that each MES course has a code number and are graded. For example, under 'Sector 25 Construction', first- grade course code starts with 1, the second-grade course code starts with 2 and third- grade course code starts with 3. For example, CON 101 is for Assistant Shuttering Carpenter & Scaffolder and minimum educational qualification is 5th Class, duration of training is 300 hours. Other second grade courses are CON 202 for System Shuttering Carpenter and minimum educational qualification for this MES courses is 5th Class plus CON 101, CON 203 is for conventional Shuttering carpenter, CON 204 is Scaffolder and CON 205 is for Building Carpenter.

Initiative by Ministry of Skill Development: Both Workmen Training and Apprenticeship training were shifted from Ministry of Labour and Employment to Ministry of Skill Development in April 2015. The Skill Mission was launched by the Prime Minister on 15 July 2015. The objective of the National Policy on Skill Development and Entrepreneurship, 2015 is to meet the challenge of skilling at scale with speed and standard. To manage the task of skill development across the country and meet the current and future skill needs of the construction industry Construction Skill Development Council of India(CSDCI) has been formed. It has developed 101 Qualification Packs under 17 Occupations along with Curriculum & Assessment strategy for Construction & Infrastructure Sector. It has assigned seven different job roles under Shuttering Carpentry and six job roles for workmen under Scaffolding. The list includes Helper Shuttering Carpenter, Assistant Shuttering Carpenter, Shuttering Carpenter System, Shuttering Carpenter Conventional, Charge hand - Shuttering Carpenter – System, Chargehand- Shuttering Carpenter

-Conventional and, Foreman Formwork. Needless to mention that none of these matches with any of the categories in any Standard Data Book or The Book of Specifications.

CSDCI is participating in all Government & Industry Programs, through its Training Providers & Assessment Agencies under various ministries including Ministry of Road Transport & Highways, Ministry of Urban Affairs, Ministry of Rural Development.

Skill Development in Infrastructure Equipment Sector: The Infrastructure Equipment Skill Council (IESC) is another organisation promoted by the Indian Construction Equipment Manufacturers Association (ICEMA) and supported by the Confederation of Indian Industry (CII) and funded by the National Skill Development Corporation (NSDC) to spearhead the skilling of workforce in the Infrastructure Equipment Sector with primary focus on training and certification of operators and mechanics and has listed 33 training packs.

Concern & Issues

Provision in Contract Documents: There exists a provision for deploying only skilled workers in standard contract formats across the country but it is not defined therein, how a worker will be judged for his skills. In the absence of certification, only choice left to a worker is defining himself of his skills and there is no option for the Contractor or Engineer, but to rely on him. A few Central government organisations like CPWD, MES have been using contract clauses to induct certain percentage of trained workmen on their works, at least for a few categories. Presently the situation is that when the contractor wants to deploy capable workers, facilities are not available to designate their capabilities and quantify their skills. Question also arises as to how to bind the contractor to send the deployed workmen for the training since it amounts to paying the worker not for the job at site but paying for his training, though in the long run it will be beneficial to the contractor by way of better workmanship and increased output.

Provision in Specifications & Standard Data Book (SDBs) or Analysis of Rates: Book of Specifications, which form part of the Contract documents, do not spell out the category of workmen either by trade or by requirement of a particular skill for the specific item. The Standard Data Book also does not help as it mainly categorises workers by skilled, semi-skilled or skilled and follows broadly the categories as in the circulars prescribing the minimum wages. The category of workmen listed by the CSDCI as Qual-

ification Packs (QP) is entirely with different nomenclature as could be seen from the category of carpenter mentioned in CSDCI QPs above.The CPWD Specifications does not give out any category. In the CPWD Analysis of rates, carpenters are categorised as carpenter 1st class and carpenter 2nd class as the purpose here primarily is to work out the cost of item based on two level of skills i.e.1st Class and 2nd Class without specify - ing experience/training to reach a particular level. In absence of which, it is difficult to en- force particular level of skill in Contracts. Beldar is considered as helper to the carpenter. If we consider the item of “Centring and shuttering including strutting, propping etc and removal of form work for columns, pillars etc (DAR item number 4.3.3) labour compo - nent is Fitter grade -1 and Beldar. In case of items requiring scaffolding only, like item of concrete work in super structure above plinth level, or rate for execution of suspended /hanging GI or SCI pipe (DAR item 17.35.1.2), the cost for scaffolding is on Lump Sum basis with code 9999 which is for sundries. Thus, the categorisation by CSDCI for laying down the qualification and training standards and the categories adopted in the SDBs do not match.

Conclusion

Deployment of trained workmen is essential to deliver the infrastructure projects on time with quality. The government, as a part of skill development initiative, is provid- ing a number of incentives, subsidies and tax exemptions to facilitate skilling of work- men. However, categorisation of workers is not on a uniform basis in different contexts. Thus, we have a situation where the contract provision does not or cannot specifically provide for a specifically suitable person with a specific trade understood to mean the same for all the players ie, worker, trainer, certifying agency, contractor and the employ- er for a specific item of work.

As such, it is very necessary that the appropriate standard setting body, i.e., open ended so that as and when required, new categories can be added. Number of sub-heads for training under the road sector will also have to be developed. These may include Fabricator, welder, fitters, pneumatic well sinker, trades of bearing, expansion joint fitter/filler and the like. Certain categories like security, accounting, storekeeping etc which provide support to the construction agencies for smooth implementation need to be included. Categorisation and Training in these fields, though may not be in the main list, would enhance efficiency where deployment of such categories is made mandatory under the agreement.

Acknowledgement

The author is grateful to Shri K.B. Rajoria, former E-in C, Delhi PWD, for con - ceptualising the issue and providing guidance and encouragement in writing this paper.

Bricks Perspective: Beyond National Building Code-2016

Dr. Vimal Kumar

Secretary General, C-FARM

Prologue

NBC-2016 is culmination of sincere efforts and contribution of many experts. Significant advancements have taken place. BIS has endeavored to keep pace with the building construction materials and technologies by updating the relevant standards and bring out the National Building Code during 1970, 1983, 2005 and 2016 that guide all agencies involved in building construction works such as: Public Works Department, other Government construction departments, local bodies and private construction agencies. In addition to other objectives, it aims for adaptation of new and innovative building construction materials and technologies. A brief review of Bricks under NBC-2016 is presented in the paper to enhance its effectiveness.

The author who has wide experience in the field of Innovative Construction Materials especially fly ash has suggested incorporation of a mechanism for quick assessment and evaluation of new and innovative materials under Part 5: Building Materials of NBC-2016 which would facilitate to achieve the desired impact.

- Editor

Introduction

Clay Brick is an age old building construction material since time immemorial. References are there from the time of great river valley civilization of Harappa and Mo -

henjo daro. The scientific and engineering developments over the centuries coupled with evolution of varying needs of different end applications have resulted in a range of brick variety. Developments in building materials and technologies have brought in a sea change in the industry.

Significant advancements have taken place. BIS has endeavored to keep pace with the building construction materials and technologies by updating the relevant standards and bring out the National Building Code during 1970, 1983, 2005 and 2016 that guide all agencies involved in building construction works such as: Public Works Department, other Government construction departments, local bodies and private construction agencies.

NBC-2016 has many salient progressive features including (i) promotion of use of industrial wastes including Construction and Demonstration waste, (ii) Pre-fabricated/ Pre-casted and in-situ cast technologies for speedier and quality construction, (iii) New and alternate building materials, (iv) Energy and resource efficient materials and technologies and (v) Use of innovative construction materials and technologies.

Bricks as of NBC-2016

The building bricks fall under “Part 5: Building Materials” of NBC-2016. Its prime use is as a walling material meeting different requirements ranging from a hutment in an interior village to a load bearing multi-storey structure of affluent society as well as high quality non-load bearing filler wall in frame structure of high rise dwelling towers.

This part of “Building Materials” of NBC-2016 states under its scope “This covers the requirements of building materials and components and criteria for accepting new or alternative building materials and components”

Further, under “sustainable materials” and for usage of “new or alternate materials” it provides very relevant and detailed criteria:

- Conservation of natural resources
- Environmental impact of production and use of material
- Recyclable
- Structural stability including strength properties

- Durability
- Biological effect
- Ease of handling…..etc.

However, under the same “Part 5: Building Materials” it states that “every material used in fulfillment of the requirements of this part, unless otherwise specified in the code or approved, shall conform to the relevant Indian standards”. It is a dilemma. New or alternate material can not get an entry without having a code or approved relevant Indian Standard that takes a considerable time.

The bricks, blocks and other masonry building items listed under this part of NBC-2016 include all types of bricks, blocks, etc. with the same weightage even if some of them (or majority of them) have less relevance with respect to the objectives and focus of NBC-2016.

New Construction technologies that provide options of pre-fabricated walling panels, pre-cast wall panels or in-situ casting of walls, etc. are dealt with in NBC-2016 but in a stand alone manner without having reference or co-relation to bricks part.

Bricks: Beyond NBC-2016

With an objective to take forward the spirit of BIS to guide and facilitate the Building Construction Industry to adapt new and innovative technologies/ materials with ease and clarity, the following may be considered:

(i) A mechanism may be suggested for a quick assessment and evaluation of new building construction materials in this case the brick or in a broader term “a walling material” and paving materials with applicable criteria that could enable the building construction industry to adapt and use the new and innovative building construction materials.

One of the system in vogue that can be acknowledged and adapted by NBC is the Performance Appraisal Certification (PAC) Scheme of Building Materials and Technology Promotion Council (BMTPC), Ministry of Housing and Urban Affairs, Government of India.

(ii) On implementation of (i) above, the new materials accorded by PAC be included in the relevant code or appropriate provision for use in building construction.

(iii) With (i) & (ii) above, the mandatory requirement that every material used should conform to code or Indian Standard be modified accordingly.

(iv) Though bricks are used for varied applications such as paving, soling, construction of drainage, etc. in addition to building construction. However, use of brick as a walling material is the largest use and in building construction industry, brick generally means a walling material.

Therefore, it may be appropriate to include in the brick section the references to new construction technologies and pre-fabricated panels etc. that provide efficient and sustainable options for walling.

(v) The bricks, blocks and other masonry building units for which BIS Standards are listed under Part 5 of NBC-2016 include all items from low end use onwards (See Annexure-I). Appreciating that in our diverse socio-economic culture none of these items has become redundant. It may be appropriate to group these items based on their respective use and application so that high end applications and latest developments come to the fore. This would be in line with the objectives of NBC to promote and facilitate new and innovative building construction materials and simultaneously not to loose the sight of conventional materials that are still useful and required.

Conclusion

Incorporation of a mechanism for quick assessment and evaluation of new and innovative materials under Part 5: Building Materials of NBC-2016 would further facilitate to achieve the desired impact. Reference to new construction technologies including pre-fabricated panels etc. may be included in this part of NBC-2016 as viable walling options. Grouping of bricks in different categories from the basic/ elementary category to new/ innovative may help to make the desired visibility and impact.

Note: The views expressed are that of the author and not necessarily of the organizations of his current/ past affiliation.

Annexure-I

List of Bricks, Blocks and Other Masonry Building Units

Sr. No.	IS No.	Title
1	1077: 1992	Common Burnt Clay Building Bricks
2	1725:2013	Stabilized Soil Blocks Used In General Building Construction
3	2180:1988	Heavy-duty burnt clay building bricks
4	2185	Concrete masonry units
5	(Part 1):2005	Hollow and solid concrete blocks
6	(Part 2):1983	Hollow and solid lightweight concrete blocks
7	(Part 3):1984	Autoclaved cellular (aerated) concrete blocks
8	(Part 4):2008	Cellular concrete blocks using preformed foam
9	2222:1991	Burnt clay perforated building bricks
10	2691:1988	Burnt clay facing bricks
11	2849:1983	Non-load bearing gypsum partition blocks (solid and hollow types)
12	3115:1992	Lime based blocks
13	3583:1988	Burnt clay paving bricks
14	3620:1979	Laterite stone block for masonry
15	3952:2013	Burnt clay hollow bricks and blocks for walls and partitions
16	4139:1989	Calcium silicate bricks
17	5751:1984	Precast Concrete Coping Blocks
18	5779:1986	Burnt clay soling bricks
19	10360:1982	Lime pozzolana concrete blocks for paving
20	10772:1983	Quick setting lime pozzolana mixture
21	12440:1988	Precast concrete stone masonry blocks
22	12894:2002	Pulverized fuel ash lime bricks
23	13757:1993	Burnt clay fly ash building bricks
24	15648:2006	Pulverized fuel ash for lime pozzolana mixture applications
25	15658:2006	Precast concrete blocks for paving

Beyond NBC 2016:

Material Component Sand and Aggregates

Rajiv Goel

Earthcon Systems India Pvt. Ltd.

Prologue

Aggregate and sand are the main constituents of both concrete and asphalt. It is the primary constituent for building roads, parking lots, runways, homes, buildings and landscapes. According to the estimates, for each metric tonne of cement used, the construction industry needs about six to seven times more of sand and gravel. The construction industry has been facing a shortage of stones and sand for more than a year now. Since many stone quarries were closed because blasting of stone hills was prohibited. Developing countries like India and China have had to import significantly larger quantities to meet the demand created by recent construction booms.

Due to increased use of concrete in almost all types of construction work, the demand of natural or river sand has increased. To meet this demand of construction industry, excessive quarrying of sand from river bed is taking place causing the depletion of resources of sand which also impacts environment in many ways. Digging of the sand from the river bed reduces the water head so less percolation of rain water in ground results in lowering of ground water level. There is erosion of near by land due to excess sand lifting.

A very comprehensive paper which would be of considerable interest not only to civil engineers but also to the policy makers at the apex level.

- Editor-

Non Availability of Sand and Aggregates

Introduction

Aggregates and Sand are most important constituents of buildings and detailed Indian Standards are available for the same. But aggregate and sandas available in country and as made available at building project sites, are not according to Indian Standards.

In the current scenario, the availability of these materials is facilitated through the lease of mines under the Mines and Minerals (Regulation & Development) Act, 1957 (Amended in 2015 and 2016). As per the above Act, Minerals are classified into two groups, namely:

- Major minerals and
- Minor minerals (for construction purposes)

Major minerals include coal, manganese ore, iron ore, bauxite, limestone, kyanite, sillimanite, barites, chromite, silica sand, fluorite, quartz, sand etc. Grant of mineral concession for major minerals are governed by the Rules and Regulations formulated by Central Government and are therefore same throughout the country.

Minor minerals include building stones, gravel, ordinary clay, ordinary sand, limestone used for lime burning, boulders, kankar, murum, brick earth, bentonite, road metal, slate, marble, stone etc. Rules for grant of concessions of minor minerals are framed by the State Government as per powers delegated under section 15 of Mines and Minerals (Regulation and Development) Act, 1957. As can be seen that the rules are different for different states and is a major cause of confusion.

Grant of mineral concessions for minor minerals is through:

- Mining lease or quarry lease
- Quarrying permit
- Grant of mineral concession by way of auction

The role of governments is only to auction/ allot the mines and rest is left to the industry to mine and utilize the same for construction purposes. In the process only the locally available materials are used because the economy supersedes the quality aspect. Unfortunately Civil Engineers and contractors, a docile community of society, accept materials as available. They have never raised a voice as to why these materials are not made available according to requirements of Indian Standards. The fact is that agencies and different wings of Central and State Governments including ministries are not fulfilling

their obligations, to ensure that proper sand and aggregate are made available. Newspaper reports are confined to highlight mafias and corrupt government machinery only.

Illegal Mining

Illegal sand mining in India is something of an open secret but it has been brought under the scanner in recent days after a civil servant named Durga Shakti Nagpal was suspended. Ms. Nagpal had gained attention from the Indian media for her efforts to clamp down on the Illegal sand mining practice in the northern state of Uttar Pradesh.

Sand is difficult and heavy to transport, so construction companies prefer to source it from nearby areas, even from zones where it isn't allowed. The sand-hungry construction industry uses the material to mix with concrete and for making bricks. Almost all these mining are happening without licenses because the demand is unbridled and the regulatory consequences are minimal. The environmental consequences of such mining, though, can be serious. Even when miners get permission to extract a certain amount of sand, they often take around 100 times more than they are permitted.

The problem with trying to halt illegal sand-mining is that there aren't many substitutes for sand in construction. One possibility is to use crushed construction debris, but that is not yet commonplace because separating out what's usable from and what's not, is a complex process.The trick is to find an environment-friendly substitute for sand, until then, expect illegal sand mining in India to continue.

Manufactured (M) Sand

M sand is now being used in a big way but the limited availability is a problem. In southern India many contractors have also resorted to importing sand from Malaysia, Vietnam and Cambodia. Already Karnataka government has called for tender for supply of imported sand.

Experts vouch that manufactured sand is not only a viable alternative to natural sand, but is superior in many ways. River sand is not graded properly and has excessive silt and organic impurities like coal, bones, shells, mica and silt and these can be detrimental to durability of steel and concrete, whereas manufactured sand has no silt or organic impurities.

Manufacturing of sand involves three stages, crushing of stones into aggregates

by VSI, which is fed into a rotopactor to crush aggregate into sand in required grain sizes. Screening is done to eliminate dust particles and washing of sand eliminates very fine particles present within. The end product will satisfy all the requirements of IS:383 Zone II and can be used in concrete and construction.

Pune-Mumbai expressway was completely built using manufactured sand. Runway of Thiruvananthapuram International Airport, new flyover at Thakaraparambu and Palayam underpass at Thiruvananthapuram were constructed using M-sand.

Conclusion

The Impact of all the above on construction is:

- Uncertainty in availability
- Affects speed of construction
- Affects cost of construction
- Loss of revenue to Govt.
- Law and order issues
- Corruption

What can be done to improve the situation?

- Availability has to improve
- Uncertainly in pricing to reduce
- Govt. must manage resources either directly or through private sector
- This is necessary to deliver the construction projects of national impor tance in time and without cost overrun and simultaneously for environment protection

Haryana PWD Code 2009 - A Review

(Review prepared by Shri K.N. Agrawal, Former DG (W) CPWD)

Introduction

The "Haryana PWD Code" was made effective from 01.11.2009 by Government of Haryana through its Memo No.9/16/05-3B & R (W) dated 19.10.2009. This Code will thus soon enter in the tenth year of its use and a review of the same may be helpful in identifying the areas and aspects that may require a relook and reconsideration.

The idea of Haryana PWD Code was conceived and implemented for the stated need for updating rules, regulations and control systems and codifying the same into a Document as underscored by modern day requirements and to keep pace with changing times, including e-monitoring as well as transparency, encompassing the three PWDs and the Department of Architecture.The three PWDs are, Public Works (Irrigation) or 'Irrigation' in short, Public Works (Buildings &Roads) or B & R in short and Public Health Engineering or PHE in short.

The applicability of this Code to other public works undertaken by other departments, state undertakings, societies, agencies or bodies of State of Haryana would be subject to specific decision by these organisations in this regard. A few of the major departments engaged in creation and maintenance of public works are Haryana Urban Development Authority (HUDA); Haryana State Roads & Bridges Development Corporation; Haryana Rural Roads & Infrastructure Development Agency; Haryana State Agricultural Marketing Board; Haryana Housing Board; Haryana Police Housing Corporation; Haryana Tourism Corporation; Panchayati Raj Department; and Command Area Development Authority.

Haryana got separated from Punjab to become a full-fledged State in 1966. The state had been following the Punjab PWD Code, written in the early 1900s.This Code of 2009 now covers Public-Private Participation, safety mechanism, quality assurance, e-governance and other modern systems as deemed essential for the present day environment. Besides the Code has also included several new topics in adequate details, namely, 'Consultancy Services', 'Emergency/Disaster Management', 'Quality-Control,

Assurance and Audit', 'Inspection' and 'Asset Management and Maintenance'. The importance attached to this Code can be gauged by the fact that its 'Foreword' has been written by the Chief Minister of the State.

A Code is a set of rules to be followed by the personnel of the department concerned. In the context of Public Works Departments, a Code is required to compile mandatory orders and instructions to be followed for its various activities in time and space, by different levels of its functionaries, while also prescribing their respective roles, responsibilities and corresponding authority. The provisions of a Code are like Commandments which are non-negotiable and not to be compromised unless so specifically stated in the Code along with spelling out the authority to make any such compromise.

The Haryana PWD Code is however not limited to codifying the procedures, control systems and organisational structure for the functioning of PWDs butgoes beyond the concept of a Code by including general guidelines without any specific mandate.It also includes directions for upgrading/modernising the functioning of PWDs and also gives futuristic plans for further developing the PWDs through man power reviews at periodic intervals. It also covers in general, a number of institutes created for Research, Training and Management.This has made the Code rather bulky and one may debate the use of the terminology of it being called a 'Code'. It also specifically provides that each PWD can issue guidelines, instructions/orders on a specific issues of its concern.

The Code is divided into Chapters with its Introductory Chapter 1. The 28 chapters, in 262 pages of mostly text, are generally arranged in a well thought out logical sequence, although a relook at the sequencing of chapters may be helpful. A Chapter on Definitions of terminology used would also be desirable. In addition a Chapter on 'Documentation and Archives' may be considered. Besides one might wish to combine some of the chapters. For example the chapters 9 and 10 in respect of 'Approval of Estimates' and 'Estimates and Projects' respectively could be merged together in one chapter. Similar is the case with chapters 15 and 16, titled 'Commencement of Works' and 'Execution of Works' respectively. Yet another case is of chapters 18 and 19 on 'Measurements, Progress Reports and Records' and 'Completion of Works' respectively. One important aspect which may be desirable to be specifically covered is concerning "Planning a Project", which should cover the various considerations to be kept in mind by a Planner to ensure meeting the objectives efficiently with safety.

Yet another thing needed is providing monitoring mechanisms for compliance of various instructions, directions and periodic activities given in this Code.

II. CHAPTER WISE COMMENTS

Chapter 1: Introduction

The Code, while laying out its Scope has clarified in the beginning itself that

rules in the Code shall not be deemed to override any special rules laid down by the Government of the State for application to a special classes of works. It also makes it clear that unless specifically overridden by express provisions in the Code, the Rules/ Regulations outlined in Treasury Rules, Financial Rules, Account Code, Budget Manual, Civil Services Rules, etc. relating to classes of transactions which occurred in the Public Works Department, as well as in other departments of Government, are binding on PWD.

It has also mandated that for detailed working, including delineation of duties of various categories of officials, each PWD shall have its separate Manual of Orders, with a rider that such Manuals will not take away the essence of the duties provided in the Code and that the Administrative Secretary of each PWD should endeavour to get these reviewed periodically, at least once in five years.

The Code has thoughtfully covered the processes to be followed for further revisions of the Code, as also the authority level at which any instruction/circular can be issued under the provisions of the Code. It has also duly provided an Interpretation Clause for any provisions of this Code, as per which the view as given by the State Government in the B & R Department, which is the administrative department for the Code, will be considered as final.

Chapter 2: Organisation

This Chapter primarily deals with the organisational setup of Headquarters Office of each PWD under an Engineer in Chief and that of the various field units. Conspicuously, there is no mention of the Department of Architecture.

The organisational structure of the Engineer in Chief of the PWD has been detailed qualitatively without laying down a specific structure. Such a flexibility in approach may be welcome but it would need clarity on the decision-making process and the authority in this regard. The terms ‘branches’ and ‘sections’ needed to be more specifically defined with some basic details of duties to be assigned for each such section.

As regards the field units, in addition to the provision of usual Circles, Divisions, Sub-Divisions and Sections, there is a provision of a concept of Project Units for concentrated and repetitive works, stating that the hierarchical pyramid may not be followed for the project units. While it is a welcome provision, it also needs clarity on the decision-making process including the parameters on which such a decision is to be taken.It may have been desirable if the Code included model structures of various units of PWD along with work load norms.

The Code provides that every PWD shall carry out man power review once in five years, through the institution of a Standing Committee for the creation of field units. In today’s dynamic environment five years is perhaps too long a period and a flexible approach would have been more desirable than prescribing a mandatory five years period.

The code also lists out the five institutions as specific to the requirements and functioning of the PWDs. These are Haryana State Buildings and Roads Academy of Research and Training under the control of B & R Department; Haryana Irrigation Research and Management Institute (HIRMI) set up by the Irrigation Department; Haryana State Roads & Bridges Development Corporation Ltd (HSR DC); Haryana Rural Roads and Infrastructure Development Agency (HaRRIDA); and Command Area Development Authority (CADA) to promote optimal utilisation of irrigation potential on selected projects. However, the Code only gives the functions of these institutes without any indication of their organisational structure and control mechanism.

Finally the Chapter ends with a narrative of 'Other Implementation Models/Tie-Ups', which is more in the nature of guidelines and futuristic thoughts/plans.

Chapter 3: Establishment

The Code refers to various Rules as applicable to service matters for employees under the control of the Government of Haryana and not specific to PWDs alone. At places it sounds more like Conduct Rules, which are common to all services in a Government. It however mandates the examination of the Service Rules by the HODs, at least once in five years, to determine if any amendments are warranted and to take steps accordingly.

Some of the provisions under this chapter are somewhat tentative and indefinite. For example the Clause 3.2.2 provides that "The Administrative Secretary and the Engineer in Chief concerned shall try to ensure that the recruitment to engineering and other services is made regularly, The use of words like 'try' and 'regularly' do not appear to be appropriate for usage in a Code.

The clauses 3.4.5 and onwards are generally specific to PWDs functioning and are generally well enunciated. There is a welcome provision regarding Outsourcing of certain types of services/activities specific to PWDs, like horticulture work, maintenance of buildings, operation and maintenance of water works, storm water network and sewerage network. However, such outsourcing requires more detailed provisions/guidelines for the sake of uniformity of approach by various PWDs.

Chapter 4: Interface with General Administration

This Chapter lays down guidelines for the PWD's personnel/functionaries for their interface with General Administration of Haryana State. The same are expected to be serving a useful purpose for the functionaries of PWDs in respect of their roles in respect of VIP Visits and Functions, Inspections of certain buildings on being called upon by the district administration, No Objection Certificates (NOCs) regarding Cinemas, Petrol Pumps and some other Structures/Buildings as called upon by the district administration, Miscellaneous Works as do not fall within the normal sphere of duties of PWDs, compliance of Court Orders, Co-Operation by District Administration and Main-

tenance of Houses in the District.

Sometimes works are executed by a PWD for a client department. Therefore, a Para on 'Interface with Client Department' with suitable guidelines may be helpful.

It is however observed that the Clause 4.7 titled 'Co-Operation by District Ad - ministration' along with its two subclauses, namely, 4.7.1 and 4.7.2 are actually guide- lines for the District Administration and not for the PWDs. Same is also the case with subclause 4.1.5. Therefore, the same to be effective would also require to be incor- porated in the concerned orders/manuals pertaining to the functioning of the District Administration.

Further, the guidelines with regard to issue of NOCs are somewhat tentative and would require more specific provisions.

Chapter 5: Office Procedure & Miscellaneous

Most of the provisions in this Chapter are of a general nature as would be ap - plicable for any of the offices/authorities of Haryana State and not peculiar to any office under the PWDs. Only Clause 5.4 on 'Maintaining Headquarters' and Clause 5.14 on 'Use of Information Technology' refer to PWDs in particular.

The Clause 5.14 requires each PWD to develop and maintain its website and host all information as desired by the State Government or the RTI Act 2005. It would be worth considering whether each PWD should maintain its separate website or it should be a part of the website of the State Government. It would also be desirable if the authority to maintain such a website (or the relevant pages of the website pertaining to PWDs) is identified/named along with an indication of the periodicity of updation of the information on such website.

In today's work environment, Information Technology plays a crucial role and therefore a separate detailed chapter on the elements of the website(s)/webpages for PWDs and its maintenance/updation would be desirable.

Chapter 6: Duties and Responsibilities of Officers

This Chapter details out duties and responsibilities of officers at different level in PWDs, starting from Engineer in Chief's level and down to Sub Divisional Engineer/ Assistant Engineer level, covering Civil, Electrical, Mechanical and even Horticulture.

It also includes Director (Personnel & Administration), Director Training, Director (Finance and Accounts), Chief Information Technology Officer (CITO), Principal Informa - tion cum Public Relations Officer, Law Officer and Deputy Collector, Irrigation.

In addition, it covers duties of Special Officers to be prescribed by HODs con-

cerned and duties of Engineer in Charge.

In respect of 'Other Staff', it provides that the same shall be laid down by each PWD and wherever such duties are not well defined, these shall be analogous to the duties of the employees working in other departments.

The Department of Architecture is however conspicuous by its absence in the assignment of duties.

Some of the provisions included in the duties of officers need a special mention -

For the Chief Engineer level, it is provided that the Chief Engineer shall spend at least five days in a month on inspection of works or offices. Such a provision seems unnecessary/unwarranted. An officer who rises to the level of Chief Engineer is expected to be responsible enough to schedule its activities according to the requirements. Similar provisions also exist for the levels of Superintending Engineer and Executive Engineer/Divisional Officer, without however mention of any mechanism to monitor the inspections made by the officers.

Another provision is that the Divisional Officer (Executive Engineer level) will be the ex officio professional advisor to all departments of the Administration within the limits of its charge. This provision may perhaps need modification to raise the level to Superintending Engineer and Chief Engineer depending upon the importance and magnitude of the issue concerned.

It is also observed that mandatory provisions as well as directory provisions are both in running text, which makes it hard to locate the mandatory ones.

Chapter 7: Training and Examination

The Training has been classified in three types, namely, (i) at entry level-Induction or Orientation training; (ii) around the time of promotion and (iii) in-service training in India or abroad.

It appears that the Training at entry level is meant only for the engineering personnel and the training requirements for such new entrants to Engineering Services have been well stated, except that there is no specific mention of Accounting Procedures, which too is an important aspect of learning for the engineers in PWD. It is also noteworthy that there is a provision of Evaluation after Training.

The training requirements for Officers due for promotion as well as for the In-Service training have been left to be identified by the departments concerned. There is also a mention of amendment of Service Rules to make it mandatory to pass an examination before a promotion.

It provides that the engineering officers should undergo at least one short-term (up to 15 days duration) training programme every five years, one medium term (15-89 days duration) training in ten years and two long-term (90 days of above duration) train - ing is in the entire service carrier, of which one preferably be in a foreign country. It also provides for finalising a calendar of training needs for the whole department every year as essential for the efficient management of training.

The chapter gives detailed guidelines for the conduct of mandatory Departmen - tal Examination to be passed by engineering personnel. It also provides for outsourcing of conducting examinations to agencies like IITs, Construction Industry Development Council, Institute of Engineers, Haryana Institute of Public Administration, Haryana State Buildings and Road Academy of Research and Training and Haryana Irrigation Research and Management Institute.

Training and Examination is an important requirement for the efficiency and competency of the departments' personnel and a further elaboration in this regard along with a system of monitoring may bring better results.

Chapter 8: Classification of Works

As evident by the title of the Chapter, it deals with Classification of Works on the basis of several parameters. Although the Chapter covers the topic adequately, a few additions as described below may be considered.

Another parameter of classification may perhaps be needed to be included, namely, 'Type of Work' so as to classify the works as being of Buildings-Residential, Office and Institutional, Roads & Bridges.

Also, in the classification category 'Source of Funds' in para 8.1.1 (b) one of the classification of 'Deposit Works' may also need to be included.

In para 8.4 about deposit Works, the scale of Departmental Charges (Agency Charges) and guidelines for its applicability may also need to be included.

Chapter 9: Approval of Estimates

The Chapter covers the process of initiating estimates and granting required approvals. The chapter is more in the nature of general guidelines in this regard.

It may be considered to include a matrix of time periods for different stages of estimates along with the authority concerned, with due reference to the nature, type and value of Works involved.

Chapter 10: Estimates and Projects

This Chapter too is mostly in the nature of general guidelines for preparation of Estimates at different stages of a Work/Project.

The Clause 10.3 on Schedule of Rates provides for having a Haryana Schedule of Rates (HSR) as well as for its periodic revision, without however indicating the authority concerned, who shall control the exercise and take decisions.

The Clauses 10.4 and 10.5 on Preliminaries of Building Projects and Pre-Planning of Building Projects should include provisions for Field Surveys (topographic survey) and Sub- Soil Investigations. Likewise the Clause 10.10 on Estimate of Roads and Bridges should include specific directions for Site Investigations, Hydraulic Data Collection & Analysis for Bridges Works, indicating the authority/authorities concerned responsible for the same.

The Clauses on Estimates for Water Supply, Sewerage, Environment Clearance and Environmental Impact Assessment and Management also required to indicate the authorities concerned responsible for collection/analysis of data and decision making.

The Chapter ends with Clause on Expediting Checks and Approvals, stating "Taking into account the guidelines contained in the Paras above, the Engineer in Chief shall chalk out detailed proformas and methodology whereby the estimates for different projects can be prepared expeditiously and in a professional manner." It would be desirable that the Code includes the required proformas rather than leaving it open.

Chapter 11: Consultancy Services

The Consultants have come to play important roles in complementing and supplementing the capabilities of PWDs in general and this chapter deals well with the subject. It lays out the variety of jobs and services as illustration, for which consultancy services could be taken. It also broadly lays out the types of consultancy services contracts and different methods of selection. On the whole a very well written chapter, which is crucial in the present day environment of working.

In addition, it would be desirable to have more specific provisions about the responsibilities and authority at different levels in the matter of appointments of consultants as well as evaluation and monitoring of consultancy work.

There are alsomentions of 'competent authority', without however designating one. There is also mention of 'blacklisting' of consultants. It is however unclear if the PWDs maintain any such 'blacklists' which also need to be defined. Such loose terminology is certainly avoidable in a Code.

Chapter 12: Acquisition of Land

The Land as may be needed for the PWD construction works may not always be available and therefore would require to be acquired. The Chapter nicely covers the Types of Land to be acquired along with the role to be played by the PWD Officers in the process of Land Acquisition.

The Chapter duly covers various other aspects like Possession of Land, taking over of land by consent/negotiations, acquisition under Externally Aided Projects, rehabilitation of Project Affected Persons, payment of annuity, Court Cases and finally monitoring the process of Land Acquisition at senior level.

The Chapter is expected to serve very well as a general guideline for the Officers of PWD in related matters.

Chapter 13: Contracts and Work Orders

The various provisions given in this Chapter are for general guidelines and observance, as is declared in its ultimate para-13.25, with a further provision that if in a particular Contract, provisions are different, the latter shall prevail. However, the chapter does include at places mandatory directions to be followed by the Officers concerned.

The Chapter begins with defining a Contract followed by describing the types of Contracts, like Lump-Sum Contract, Item Rate Contract, Percentage Rate Contract, Turnkey Contract, Labour Rate Contract and Long-Term Maintenance Contract along with the PPP modes of Contracts like BOT, BOT-annuity, BOOT and OMT. The PPP modes of Contract have also been separately described under Chapter 21.

The chapter also covers other modes of execution of works like Day Work, Piece Work and Departmental Execution of Work. It also describes contracting systems like Composite Contracts covering various components and services and Individual Contracts covering only specific component(s).

The chapter duly gives the procedure for preparation of tender documents, inviting tenders and eventual award. It gives in details the various principles to be observed while preparing the Tender Documents as well as the procedure for processing of the tenders.

In its paragraph 13.17, titled “Submission, Receipt and Processing of Tenders” states that detailed procedure for submission, receipt, opening, clarification, determination of responsiveness, evaluation and comparison etc. of tenders shall be given in the Instructions to Bidders (ITB), adding further that the procedure be widely circulated as part of departmental instructions and be made part of the Manual of Works/Orders.In para 13.23 titled “Approval of Tender Documents” it further provides that the Engineer

in Chief shall cause to prepare Standard Bidding Document and get the same approved from the State Government. It further states that Forms for 'Letter of Acceptance', 'Bid Security', 'Performance Bank Guarantee', 'Mobilisation Advance' & 'Machinery Advance', 'Indenture for Secured Advance' 'Agreement' etc. shall also be standardised. These are very important aspects and need to be clearly brought out.

Finally and perhaps most importantly in para 13.24 "E-Tendering" has been recommended to be extensively used, which is the current norm of the day.

The Chapter is non-speaking with regards the specific provisions about dispute redressal system in the contract documents.

Chapter 14: Contractors-Enlistment and Qualification

Contractors play a crucial role in the execution of Works & Services under the charge of PWDs and the quality & the speed of execution depends significantly on the technical and managerial capabilities of contractors.

The Code provides that each PWD shall have rules for enlistment of contractors for various categories of Works and gives broad guidelines for the same.

It also provides for action against enlisted contractors by way of demotion to a Lower Class, Removal from the Register, Blacklisting and Suspension for a specified period. While the chapter provides the grounds under which a contractor can be Blacklisted, its implications are unclear and the same are required to be stated explicitly.

The Code also lays out the guidelines for Pre-Qualification and Post-Qualification depending on the value of Works, along with the matter of determining Bid-Capacity and the circumstances when such Pre-/Post-Qualified Contractor may be disqualified.

The Code provides for Performance Appraisal of Contractors for all Works costing more than Rs. 50 lakh to be prepared by the Engineer-in-Charge. There is however, no clarity about the periodicity of such performance appraisal or about the stage of work when such appraisal is to be prepared.

The Code also provides that the Divisional Officer should meet the registered

contractors periodically, at least once a year, to resolve their problems and to obtain their suggestions on the improvements in working of the department. This appears to be somewhat impractical and such meetings with the Contractors should better be organised at the level of Chief Engineer, when The Divisional Officers as well as Superintending Engineers are present.

Chapter 15: Commencement of Works

This Chapter properly lays down the prerequisites for commencing any work and committing any financial liability for the same. It also lays down the considerations when advance action of call of tenders can be taken where the planning activities are complete but sanction is awaited.

Chapter 16: Execution of Works

The Chapter covers not only the various aspects of execution of works but also of Contract Management.

It provides for a mandatory Work Programme to be submitted by Contractor in respect of Works costing above Rs. 2.0 crore and it directs that suitable provisions be made in the Contract for the same.

In respect of Works costing above Rs. 5.0 crore it makes it mandatory that Method Statements be submitted by Contractor, which appears unnecessary for usual works as because the applicable specifications duly cover this aspect and therefore should be sought only for special types of Works/activities.

The Chapter duly covers various other aspects of execution, n otable among them being ‘Compliance with Laws’, ‘Labour Welfare and Safety Measures’, ‘Inspection and Approval’, ‘Environment Protection Measures’, ‘Delays and Extension of Time (EOT)’, ‘Liquidated Damages (LD)/Compensation’, ‘Variations’, ‘Urgent Remedial Work’, ‘General Guidelines during Execution’, ‘Coordination and Review Meetings’, ‘As-Built Drawings and Manuals’, ‘Time Over-Runs’, ‘Cost over-Runs’ and ‘Citizen Information’.

Certain directions contained in respect of Delays, LD/Compensation may not precisely be in line with the correct legal position as established by various case laws on these aspects. It would be desirable to have a relook on these provisions in the Code.

There is also an error in paragraph 16.11.4 about the quantum of Labour Cess, which had been fixed by the government of India as 1% by Government Order dated 26th September 1996

Chapter 17: Emergency/Disaster Management

Disaster Management is a very important subject and is crucial for the Governments to be prepared in advance so as to minimise the impact of natural and other disasters.

The Chapter starts with describing the emergency situations and differentiating between localised situations involving a PWD alone and those having wider implications involving the Civil Administration.

Since it is a PWD Code, it would be desirable to distinctly highlight the role and responsibilities of PWD Officers at different levels, which are though stated in between Paras of the Chapter but not readily meeting the eyes of a reader.

Communications, especially of the wireless kind, play a crucial role in management of emergency situations and therefore some specific provisions/directions in this regard, in relation to the PWD officers would be helpful.

The considerations stated under the para on “Preventive Measures” are highly welcome. However, some of them are related to the initial planning of Projects and therefore should also find a mention under a relevant chapter on Planning.

The paragraph on “Preparedness” for emergency situations may require to be a bit more explicit and should bring out the role and responsibilities more specifically at different levels.

The paragraph on “Execution of Emergency Works” states about a Negotiating Committee to be set up for allotting works by direct negotiations. It would be desirable that such a Standing Committee of Ex Officio Positions is identified and stated in the Code to save precious time in constituting such a committee when disaster strikes.

Chapter 18: Measurements, Progress Reports and Records

The Measurements of Works for the purpose of payment against works done, Progress Reports and Records are heterogeneous topics which are included in this Chapter.

As regards Measurements of works including taking down the Levels for the purposes of measurements of quantities of Earth Work etc, the Code describes the age-old practices with the addition of electronic modes of keeping the records of measurements.

Taking down such measurements has always been a cumbersome exercise, which needs a relook. In most advanced countries the measurements of quantities of various items are tabulated in various Construction Drawings and one has to only pick up those quantities for payment in the Abstract of a particular bill, once the work has been carried out corresponding to that drawing. Such a practice greatly reduces the burden of accuracy as well as labour in recording measurements and should be considered for adoption. It will also obviate the necessity of Test Checks on measurements required to be carried out by different levels of Officers.

In paragraph 18.2.4 it is a stated that “Attempt shall be made to take measurements in the presence of contractor/supplier or his authorised representative.” In fact it should be obligatory that the Contractor is duly notified of the time/date/place of measurements so that such record is not questioned later on the ground of measurements having been done in his absence.

As regards the Progress Reports to be generated by field level officers for higher authorities as also for Clients, there is a need to adopt the web based system of Project Monitoring which will make the reporting of progress and monitoring by different authorities in real-time far more easy and effective besides saving lots of paperwork and consequently saving the environment.

Chapter 19: Completion of Works

The Chapter defines the term Completion and gives guidelines about timely communications between PWD and the user department for which the works are being done. Italso lays down guidelines for preparation of a Completion Report and its communication to the authorities concerned.

It may be worthwhile to consider introducing a paragraph on 'Documentation' with respect to all important works, which should include the Project Report, the Con - tract document, the Completion Drawings along with salient details and photos of any- event like Foundation Laying Ceremony and Inaugural Ceremony etc. Such a practice of documentation and maintaining an archive of such documents would be of help in retrieving information at later dates, which is otherwise very hard to find.

Chapter 20: Quality-Control, Assurance and Audit

The Chapter begins with defining the terms 'Quality' and 'Quality Assurance' along with giving general directions for preparation of a 'Quality Assurance Manual' by each of the PWD.

The paragraph on Quality Management Plan (QMP) lays down the broad re- quirements of a QMP to be submitted by a Contractor executing a work of more than the prescribed estimated cost (stated earlier as Rs. 5.0 crore and above or such other limit as may be fixed). It is considered necessary that the authority which can prescribe the limit should be stated.

It is good that there is a specific paragraph 20.3.5 emphasising the importance of quality of water used for construction with general directions for proper tests and con- trols to be exercised in this regard.

The Chapter provides that the Employer shall devise an appropriate system covering a) Request for Inspection; b) Inspection Proformas; c) Authority levels for in- spection; d) Inspection procedures (preliminary, periodic and on completion); e) Check- lists to systematise the Inspections; and f) Records of inspection for various items of work/ activities involved.

It further provides that procedures shall be laid for preventing any damage or deterioration of the materials brought to site till their consumption in the work and in- dicating the various aspects to be taken care of in this regard. It however leaves the question open as to which authority would lay down such procedures.

The chapter gives general directions and guidelines with regards the various elements of Quality Assurance, Quality-Control, dealing with sub- standard work as well as Quality Audit through external agencies. It mandates the establishment of site labo -

ratory to conduct day-to-day tests on materials to be used in any major construction with due reference to the contract specifications. It also mandates training of staff engaged in laboratory.

At the end of the chapter there is a direction that for works costing about Rs. 5.0 crore (or such other limit as the government may fix) it should be obligatory for the contractor to employ a certain minimum percentage of skilled labour who have qualified in the particular trade from certified training institutes. The question is however left open depending upon availability of skilled work force and training institutes.

Chapter 21: Public-Private Participation

This Chapter serves as a good guideline about taking up Projects in Public-Private Participation (PPP) mode. It describes the various modes of PPP, like BOT, BOT-Annuity, BOO, BOOT, BLT & OMT.

It duly lays down the Procurement Process, including selection of a Project, preparation of Pre-Bid/Bid-Document, selection of Project Proponent/ Concessionaire, Financial Close, the role of Independent Engineer, Monitoring of Construction as well asconstitution of Steering Committee, Operation & Maintenance, Project Handover/Defect Liability Period and Termination.

It also briefly lays down provision of Dispute Resolution to be made in the PPP contracts.

Chapter 22: Safety Management

Construction activities by their very nature are highly prone to accidents and therefore the safety issues cannot be over emphasised. This Chapter duly brings out the issues of safety in all its aspects quite well. It would be desirable to include in this chapter the linkages with various other government departments concerned with safety, like Fire Department, National/State departments dealing with disasters etc.

Chapter 23: Inspection

The Chapter provides that the detailed instructions regarding inspections to be done by various officers will be issued by the Engineer in Chief/State Government, for

which an indicative list of objectives of such inspections is also provided.

A broad checklist is also included in the chapter for inspections of different types of works, like Buildings, Bridges, Roads, Electrical works, Irrigation Works, Water Supply works and Sewerage/Storm Water Drainage System.

The chapter generally covers well the various aspects of Inspections. However, some basics of inspections need to be highlighted. First is to inculcate a habit of looking at any project as a whole. Even while inspecting the work against a particular Contract, it is necessary to ensure that the various other components/contracts for the Project are being taken care of for its completion as a whole. Further, the progress as observed during an inspection must be relatable to an overall programme for the completion of the Project.

The Inspection Notes must include the decisions taken on the spot as also any action points for the field staff as well as other functionaries involved. The inspection note must take note of any situation which may have a safety concern along with suitable directions to mitigate the same.

Chapter 24: Disputes-Avoidance, Management, Resolution

This Chapter contains guidelines for the officers of the PWD concerning the disputes and their management as they arise out of a Contract and is essentially an extension of Chapter 13 on 'Contracts..'.

The para 24.4.2 needs to be properly re-worded to make it clear that the limit of Rs. 2.0 crore applies to the contract value. The provision of a three-member arbitral tribunal in para 24.4.4 (as also para 24.5.3) needs to bring out the appointment procedure for the three members, unless the same is already available in the standard bidding documents, which however is not clear either in Chapter 13 or this chapter. Similarly, the provision in para 24.4.5 about the Engineer in Charge taking a deposit of 2% of the claim amount, to be adjusted towards the award of costs in the final arbitral award will require to be backed up by a clear provision in the standard bidding documents.

Chapter 25: Stores and Procurement of Materials

The Chapter defines the types of the stores as relevant to PWDs and the man-

ner of purchasing the same. It also directs the PWDs to computerise the management of the stores, covering receipts, issues and balances.

It lays down that an annual review be carried out by the PWDs about the need of various locations of stores/stocks so that dysfunctional and unnecessary storage-sare closed down.

The Chapter provides the necessary guidelines for the various activities of procuring and managing stores by giving a reference to various relevant instructions/ orders, namely, instructions and purchase policy issued by the Directorate of Supplies and Disposals, Government of Haryana; the powers to purchase as per provisions of DFR/PFR and the procedure prescribed by the Stores Department, Government of Haryana. It also provides for the proper ABC analysis to minimise the inventory, especially of high value items and includes guidelines for disposal of Surplus Stores, Unserviceable Stores, Surplus/Obsolete Machinery/Old Machinery. The guidelines also cover fixing of Store Issue Rates, annual Stock Taking and dealing with Losses on Stores.

Chapter 26: Public Buildings

The term 'Public Building' has been used in this chapter to mean any Government Building, including residential buildings for the State Government's functionaries. With the increasing aspirations of the people and ever expanding functions of Government the stock of Public Buildings has been growing. The code provides for maintaining a record of all public buildings properly in a format, as stated to have been prescribed by the B & R Department. It further directs for having GIS coordinates for each of the Government Building.

This chapter includes various guidelines and directions concerning the topics of 'Provisions at Planning and Construction Stage','Maintenance/Renovation/Furnishing of Residences of High Dignitaries', 'Government Residences', 'Renovation and Demo - lition of Buildings', 'Purchase and Sale of Public Buildings', 'Hiring Private Buildings for Office Purpose', 'Taxes and Water/Electricity Charges', 'Rent Rules for Residences', 'Buildings of Historical Interest'and 'Losses and Accidents'.

It is seen that this chapter has certain commonality with the next chapter titled 'Asset Management and Maintenance' and it may be considered if these two chapters could be combined together into one chapter.

Chapter 27: Asset Management and Maintenance

This is a very important Chapter, starting with defining Assetto mean all the permanent assets under the administrative control and charge of PWDs, namely, Land, Roads including all road structures, Canals, Distributaries and allied Structures, Water Supply Systems, Storm Water Drains, Buildings, Sewage System and all other structures related to any of the services.

It mandates maintaining of Inventories of all assets and notifying one officer in each District to be the custodian of all such records inprescribed formatsas also their periodic reviewas prescribed.However, no prescription is apparent in the code and needs to be stated.

It also mandates that the land shall be demarcated and secured by a wall/fence or boundary pillars as considered necessary, without however stating the authority to take such a decision.

The Chapter contains general guidelines as well as directions for the management of various types of assets and allowing access to the roadside utilities like Bus-Stands, Petrol Pumps, the drains, cables etc.It requires the Engineer in Chief, PWD to issue detailed instructions for granting permission in this regard. It also specifically refers to Punjab Scheduled Roads and Controlled Areas Restriction of Unregulated Development Act 1963, as modified by Haryana Government from time to time to ensure safety and convenience of traffic, checking ribbon development and to meet future needs of upgradation of roads.

It lays down carrying out of half-yearly census of traffic including axle load surveys to build a reliable database for pavement design and investment decisions.

It also describes the systems of maintenance for Roads, namely Input-based Maintenance, Performance-Based Maintenance and Toll-Based Maintenance, leaving it to the PWDs to choose an appropriate method. Likewise it provides guidelines for Maintenance of Buildings as well. It also directs introduction of online registration of complaints.

It requires the Engineer in Chief to issue detailed instructions for preparation of annual Work Programmes with regards the Maintenance of Roads as well as Buildings.

It also appropriately refers to IRC publication 'IRC: SP 35: Guidelines for Inspection and Maintenance of Bridges'.

It gives general guidelines and directions regarding maintenance of Canals, Drains, Dams and Allied Structures, Maintenance of River Terrain, Maintenance of Drinking Water Supply Schemes and Maintenance of Sewerage and Storm Water Drainage.

It also mandates the PWDs concerned with public utilities to reduce the asset data to a computerised GIS database and its updation annually.

Finally it ends with a General Policy to exercise prescribed checks and controls, carry out the stipulated operation and maintenance procedures routinely and periodically and keep a strict surveillance against encroachments, cuts and breaches, unplanned/ illegal usage of the facilities with a direction that Special Repair measures as required should be initiated and completed well before major damage takes place.

Chapter 28: Miscellaneous

This Chapter briefly deals with a number of topics, namely, Maintenance of Accounts, Letter of Credit (LOC), Loss of Cash, Works funded by other agencies, Purchases against Contingencies, Annual Inspections of Offices, Laboratories, Construction of Works of public utility on Government Land, naming of Works, Private Works, Transparency of Procedures and Transactions; and Independent Evaluation Studies.

It is already stated in the Introductory Chapter 1 that the Rules/Regulations outlined in Treasury Rules, Financial Rules, Account Code, Budget Manual, Civil Services Rules, etc. relating to classes of transactions which occur in the Public Works Department, as well as in other departments of Government, are binding on Public Works Departments except insofar as they have been specifically overridden by express provisions in this Code. Therefore, such a brief coverage of certain accounting aspects in this chapter appears to be out of context.

The very starting line of this chapter under the title "Maintenance of Accounts" gives a shocking read, as it labels the PWD accounting system being archaic. The PWD Accounting system has robustly stood the test of times as it did not permit any Scam to have taken place in the PWDs. The accounting system of PWD, even though very old, works on very logical basis and therefore is easily amenable to computerisation.

However, the brief guidelines in respect of Annual Inspections of Offices, Laboratories, Naming of Works and Independent Evaluation Studies are considered to be a welcome provision.

EPILOGUE

Writing a Departmental Code is a stupendous task which on the whole has been done commendably in the case of Haryana PWD Code 2009, attempting very well to cover the gamut of various functions and activities of PWDs. It is far more difficult to write one than to put up a critique's version. Still however,improvements can always be made and should be made periodically.

Having taken upon the task of reviewing the Code, it has been my endeavour to be objective as much as I could bebased on my experience of about 36 years in CPWD/ PWD Delhi.If it serves to provoke a positive and constructive thought process among the concerned authorities to initiate further improvement, the purpose of this critique would have been served.