



# STRUCTURAL ENGINEERING

QUARTERLY JOURNAL OF

INDIAN SOCIETY

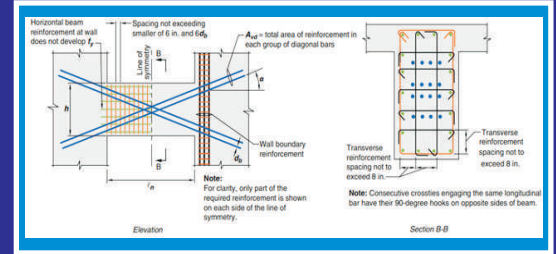
OF

STRUCTURAL ENGINEERS

# ISSE

VOLUME 25 - 2

APR - MAY - JUNE 2023



**GEM 36 PROF. A. R. SANTHAKUMAR - OUTSTANDING TEACHER,  
CONSULTANT AND RESEARCHER - see page 3**



**MITIGATING RISK DURING DEEP EXCAVATION – IN MONSOON  
- see page 22 & 23**



**NEWS AND EVENTS DURING APR TO JUNE 2023 see page - 24**

**LET US BUILD A STRONG STRUCTURE OF INDIAN SOCIETY**

## NEWS AND EVENTS DURING JAN TO MAR 2023



◀ 13 Jan 2023

ISSE Palghar Local Centre in association with ULTRATECH Technical Lecture was held on  
a) MEP FOR HIGH RISE STRUCTURE BY Er. Manish Parekh (MEP Consultant)  
b) CONCRETE FOR HIGH RISE STRUCTURE BY Er. Mahesh Tendulkar (Concrete Technologist) at Boisar.

31 Jan 2023 ▶

ISSE Student Chapter inaugurated at Aditya Engineering College, Surapalem, Andhra Pradesh. Er. Madhav Chikodi from ISSE Mumbai was invited as Chief Guest for the function.



◀ 17 Feb. 2023

ISSE in association with ULTRATECH CEMENT and IEI conducted a technical lecture on Methods of Demolition for Bridges and Buildings by Er. Ram Matte

17 Mar. 2023 ▶

ISSE Navi Mumbai chapter in association with ULTRATECH CEMENT and IEI Belapur Local Centre arranged lectures on how to make earthquake resistant buildings and learning from failures on the sidelines of the Turkey earthquake.





# STRUCTURAL ENGINEERS

## INDIAN SOCIETY OF STRUCTURAL ENGINEERS

# ISSE

**VOLUME 25 - 2, APR - MAY - JUNE 2023**

Correspondence Address : C/O, Maansi Nandgaonkar, 101, Sunflower, Sakharam Keer Road,  
Shivaji Park, Mahim, Mumbai - 400016

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Chameli Devi Group of Institutions, Indore

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Walchand College of Engg. Sangli.

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VJTI College, Mumbai

Aditya Engineering College, Surapalem

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**Editor : Hemant Vadalkar**

*Views expressed are authors' or reporters' personal and do not necessarily reflect views of ISSE. ISSE is not responsible for any consequent actions based on contents or information given in the journal.*

## AIMS & OBJECTIVE OF ISSE

1. To restore the desired status to the Structural Engineer in construction industry and to create awareness about the profession.
2. To define Boundaries of Responsibilities of Structural Engineer, commensurate with remuneration.
3. To get easy registration with Governments, Corporations and similar organizations all over India, for our members.
4. To reformulate Certification policies adopted by various authorities, to remove anomalies.
5. To convince all Govt. & Semi Govt. bodies for directly engaging Structural Engineer for his services.
6. To disseminate information in various fields of Structural Engineering, to all members.

## FIELD OF INTEREST

* Structural; Designing & Detailing	* Construction Technology & Management
* Computer Software	* Geo-Tech & Foundation Engineering
* Materials Technology, Ferrocement	* Environmental Engineering
* Teaching, Research % Development	* Non Destructive Testing
* Rehabilitation of Structures	* Bridge Engineering
	& Other related branches

## Fraternity News WELCOME TO NEW MEMBERS (APR - MAY - JUNE 2023)

2294	Riyasameer Razzaqueali Shah	2316	Kailas Babunppa Todkari
2295	Mohd. Sameer Mohd. Zahid	2317	Sanjay Vasantrao Denge
2296	Pallavi Jeevan Rupnvar	2318	Nivin Philip
2297	Rushabh Sanjay Kothari	2319	Simanta Jyoti Sonowal
2298	Rishi Rajkumar Agrawal	2320	Rama Rahul Kulkarni
2299	Shrikant Madhav Harle	2321	Abhishek Kumar Soni
2300	Ram Sagar Borra	2322	Tejas Ravindra Wankhade
2301	Nataru Anusha	2323	Kapil Prabhakar Nanote
2302	Maheswara Ran Bandi	2324	Vedang Dhairyashil Patil
2303	Murtaza Saifuddin Ali	2325	Rameshwar Gorakshnath Chitale
2304	Pratik Satish Deshmukh	2326	Mansingh Rathore
2305	Supriya Pal	2327	Jitendra Kumar
2306	Santosh Mohan Dhupkar	2328	Rajat Abhay Sirsakar
2307	Suhas Vilas Jadhav	2329	Vaibhav Arya
2308	Ganesh Madhukar Jadhav	2330	Milind Sanjay Kahale
2309	Shraddha Sachin Waman	2331	Anil Kumar Bansal
2310	Swapnil Arjun Pajgade	2332	Sulahman Khan
2311	Kishor Sopanrao Gavali	2333	Mayank Kumar Gupta
2312	Swanil Dattatray Rasane	2334	Sujit Vasant Matala
2313	Dipak Sadashiv Shinde		
2314	Pratik Dinesh Phulari	JM 73	Ganesh Kumar
2315	Chandrashekhar Dnyanu Pawar	IM 06	Maharaja Institue of Technology, Thandavpura

Patrons : 38

Members : 2334

Student Members : 444

Organisation Members : 36

Junior Members : 73

Sponsor : 8

IM : 06

**TOTAL STRENGTH : 2,939**

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# GEM 36 PROF. A. R. SANTHAKUMAR - OUTSTANDING TEACHER, CONSULTANT AND RESEARCHER

Dr. N. Subramanian, Ph.D., FNAE



Prof. A. R. Santhakumar (1943-)



Parents of ARS



Family of ARS

Prof. A.R. Santhakumar, B.E., M.Sc. (Engg.), Ph.D., is a former Dean and Chairman of Faculty of Civil Engineering, Anna University, and a former Emeritus Professor, Indian Institute of Technology Madras, Structural Engineering Laboratory. In a lifetime service to Anna University he has guided many research fellows. Prof. Santhakumar is also a pioneer in many structural developments in India. A good orator he has an excellent communication skill

which makes the listeners spell bound. Prof. Santhakumar has been actively involved with research in the area of diagonally reinforced coupling beams and transmission line towers for several decades. Prof. Santhakumar has published more than 200 journal papers, won several awards, and is a sought after professional consultant.

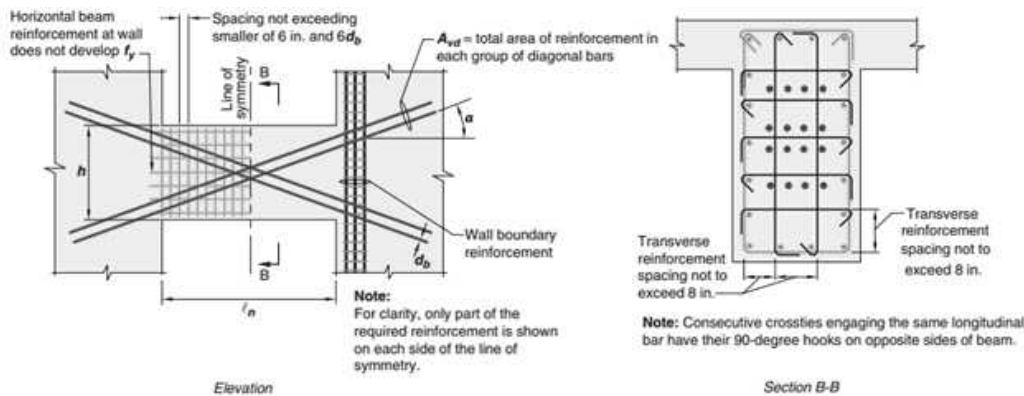
## EARLY LIFE AND EDUCATION

Santhakumar was born in the year 1943 in India to Mr. A.M. Ramalingam and Mrs. R. Pushpavathi. While his father was a Superintending Electrical Engineer in the Madras Electricity System (Now TNEB) his mother was an accomplished player of musical instruments such as Veena and fidel.

At school he was judged as the Best Scholar (1959) of St. Pauls High School in Chennai. He obtained both his Bachelors (B.E.) and Masters Degree (M.Sc.(Engg.)) in Civil Engineering and Structural Engineering, respectively, from the College of Engineering, Guindy, University of Madras (Now, Anna University) during 1960-1968, under the Technical Teachers Training Programme. Later as a Commonwealth Scholar, he received his Ph.D. (1974) from the University of Canterbury, Christchurch, New Zealand, working with the famous professor Thomas Paulay (See GEM 9, in Vol. 18, No. 3, July-Sept. 2016, pp 3-8, for more details).



Paulary and Ars @ Univ. of Canterbury



Diagonally reinforced coupling beams, incorporated in many codes

## Teaching and Research

Dr Santhakumar has more than 45 years of teaching and research experience and has guided 26 Ph.D. students and 30 M.E. Students for their thesis work during his long teaching tenure at Anna University. His work on diagonally reinforced coupling beams has been incorporated in all international codes of practice including IS: 13920.

## BUILDING TECHNOLOGY CENTRE

Prof. Santhakumar was instrumental in establishing the Building Technology Centre in 1994 by HUDCO and it functions under the aegis of Anna University Chennai. The centre is involved in the production of cost effective building materials for building construction like Hollow concrete block, Ferro cement roofing channel, Prestressed precast roof planks, FAL –G bricks and blocks. The Centre is involved in Consultancy and construction activities. The G + 3 Bi-centenary Hollow concrete block composite structure without beams built at Anna University Guindy and Gym for Corporation of Chennai with space truss roof built near Anna Nagar Chennai are worth mentioning.

## HONORS AND AWARDS

He has received several awards during his illustrious professional career, including the Nagadi Award (1994) from the Association of Consulting Civil Engineers for his book Transmission Line Structures, Visveswaraya Gold Medal (1993) for research in Transmission line towers from The Institution of Engineers (India), Nagpur Chapter,

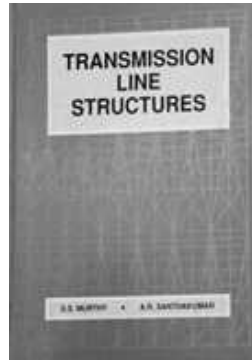
Best paper Award (1990) for his contribution on tower foundation from Central Board of irrigation and Power, Government of India, the prestigious ICI–L&T Lifetime Achievement Award, and the Lifetime Achievement Award at Construction Industry Awards 2013. Recently, the Indian Concrete Institute conferred Honorary Fellowship on him.



Honorary Fellowship of ICI being conferred on Prof. A.R. Santhakumar

## PUBLICATIONS

Prof. Santhakumar has contributed a number of research papers to refereed National and International Journals and conference proceedings. He has also contributed many articles in magazines and newspapers. His articles in the Tamil language on technical matters are noteworthy. Prof. ARS has also delivered several invited lectures in New Zealand, Australia, the USA, and Singapore. He also appeared in several Television shows, discussing about Civil/Structural Engineering. He also published several useful booklets under the Building Technology Centre of Anna University for the benefit of those working at site.



Prof. Santhakumar has written the well received book on Concrete Technology, Oxford University Press, New Delhi, Second edition, 2018, 712 pp.

Prof. Santhakumar coauthored with Prof. S.S. Murthy to write the book on Transmission Line Structures, McGraw Hill Book Company, Singapore, 1990, 342 pp., which is the only book available in the market which discusses about the analysis, design and foundation of these structures.

He is the coauthor (along with Prof. S. R. Satishkumar of IIT Madras) of NPTEL Course on Design of Steel Structures.

He has been the Honorary editor of the Tamil magazine “Kattumana Thizhil” for masons and artisans for the past 20 years. His book on “Kattumana Thozhil Kalanjiam” is the only book available in Tamil for educating masons and artisans.

### LEADING CONSULTANT

He is a leading consultant to several organizations and has designed a number of infrastructure

projects such as bridges, novel buildings, towers, dams, and plants for public sector corporations, Indian Railways, and the Government of Tamil Nadu.

He has developed full scale test facility at Anna University for testing and validation of designs for RCC and Steel structural elements. The tests include simulation of earthquake effects involving reversed cyclic loading.



Full Scale test of a node



Training at BTC



Kattumana Thozhil

The author of this article knew Prof. ARS for several years and has consulted him whenever there was a dispute or expert opinion needed on structural design of various structures and structural elements. On all these occasions, the author has found the advice of Prof. ARS to be very simple and practical. In addition, he found that Prof. ARS as a very kind and unassuming person.

## FAMILY

Prof. Santhakumar married to Vanaja during the year 1970. Vanaja did her B.Sc (Chemistry) at Sarada College, Salem and later completed MCA at IGNOU. They have two daughters - Viji and Durga. Viji is a Doctor, who completed her MBBS at the Kilpauk Medical College, and did her PG at the University of California, Irwin. Currently, she is a Professor of Neuro science at University of California, Riverside Campus. Durga completed her BSc at Ethiraj College Chennai and did her MS in Dallas at Southern Methodist University. She is now working for Amazon in Seattle. Both are now in USA. Prof ARS has four grand children- Indira, Calvin, Bharath and Katie.

## About The Author



### **Dr. N. Subramanian,**

Ph.D., FNAE is an award winning Author, Structural Engineering consultant and Mentor, currently based at Maryland, USA, with over 45 years of experience in Industry (including consultancy, research and teaching). He was awarded

with a 'Life Time Achievement Award' by the Indian Concrete Institute and many other awards for his contributions towards Structural Engineering. He is the author of 26 books, including the famous books on 'Design of Steel Structures', 'Design of RC Structures' and 'Principles of Space Structures' and the recent 'Building Materials, Testing and Sustainability'. (email - drnsmani@yahoo.com)

Publications For Sale		
Publications		
Sr. No.	Name	Rs.
1	Design of Reinforced Concrete Structures for Earthquake Resistance	950/-
2	Professional Services by Structural Design Consultant – Manual for Practice	250/-
Proceedings		
1	National Conference on Corrosion Controlled Structure in New Millennium	500/-
2	Workshop on ISO-9001 for Construction Industry	250/-
3	Workshop on- seismic Design of Building – 23 <sup>rd</sup> February, 2002	250/-
4	Workshop on Effective Use of Structural Software, 6th March, 2004	250/-
5	One Day Seminar on "Shear Walls In Highrise Building", 30th October, 2004	250/-
6	Seminar on "Innovative Repair Materials / Chemicals", 1st October, 2005	300/-
7	Seminar on "Foundations For Highrise Buildings", 23rd September, 2006	250/-
8	Seminar on structural Detailing in RCC Buildings- 26th May, 2007	300/-
9	One Day Work Shop on "Pile Foundations", 20th February, 2010	250/-
10	One Day One Day Seminar on "Pre - Engineered Structures", 29th January, 2011	250/-
11	One Day workshop on "Insight into Wind Loading using IS875, Part 3 : 2015", 27th April 2019	300/-
12	One day workshop on "Structural Health Evaluation Vis - A - Vis Prescriptive "Mandatory Format Of Structural Audit" On 18 <sup>th</sup> Jan ,2020	300/-
13	"Performance Based Seismic Design of Buildings" by Er. Vatsal Gokani released on 5th August, 2022	600/-
14	Any ISSE Journal Copy	100/-
Note : Additional courier charges for Mumbai Rs. 50 for outstation Rs. 100).		

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# HIGH RISE BUILDING COMMITTEE IN MUMBAI

By Ranjeet Sawant

**1.0 Introduction :** In the limits of Municipal Corporation of Greater Mumbai, for a building which is taller than 120m, a clearance from High Rise Building committee is necessary. A separate proposal is required to be submitted to this committee as per the check list provided. General requirements for obtaining approval from high rise building committee are outlined in this article for the information of civil engineers.

**2.0** For submission of the High Rise Building proposal, following documents are generally required

## **2.1 Geotechnical points of view:-**

- 1) Soil Report indicating soil strata, depth of the hard rock, etc.
- 2) Details of the rock anchors, if any provided for basement.
- 3) Details of the soil retaining methods.
- 4) Type of foundation i.e. piles foundation or raft foundation or open foundation.
- 5) Geotechnical (soil investigation) report -Input soil parameters from field/NABL accredited lab to be obtained for Physical & Engineering properties.
- 6) Foundation analysis by PLAXIS under lateral load.

## **2.2 Structural points of view:-**

- 1) Design Base Report (D.B.R.) for the proposal along with Etabs & SAFE Model calculations.
- 2) For building Height more than 150 Mtrs wind tunnel test is compulsory.
- 3) Gust factor & deflection.
- 4) Time factor and modes
- 5) For height of the building more than 250 Mtrs and form Code exceeding Building the review of the structural parameters from Expert Review Panel is compulsory.

## **2.3 C.F.O. points of view:-**

1. CFO NOC for full height is compulsory.

## **2.4 Scrutiny Fees:-**

Demand Draft / Pay order / Cheque of Rs. 1, 81,500/- per wing in favour of 'Brihanmumbai Municipal Corporation'

**Note :** The Scrutiny fees will be increased by 10% every year on 1st of April.

## **3.0 General Procedure of the HRC :-**

1. Submission of the proposal in the Development Plan department HRC section along with requisite documents and Scrutiny fees, the project proponent will get the Number for the Proposal. Like HRB- 1234.
2. Site visit of the committee members
3. Present the proposal in the High Rise Committee meeting with following presentations
  - A. Architectural
  - B. MEP Presentation from CFO point of view
  - C. Geotechnical Presentation
  - D. Structural Presentation
4. After presentation if any additional comments are given by Committee members then compliances for the comments to be submitted to the committee and if those are satisfactory then proposal will be cleared in the next meeting.
5. Remarks from Building Proposal / SRA to be obtained for approvability of the proposal.
6. After submission of 3 plan sets, the signature of the Development Plan Staff and committee member along with Chairman is to be obtained and report is to be submitted to Hon. Municipal Commissioner for approval. After the approval HRC Clearance is to be issued by Dy. Chief Engineer (Development Plan)
7. Time required for obtaining HRC Clearance from the date of Submission is generally four Months.

## **4.0 Check list of documents to be submitted and parameters as per IS16700 is enclosed as Annexure 1 and Annexure 2**

## **About the author :**



**Er. Ranjeet Shatrughna Sawant**

B.E. Civil (Hons.), D.C.E.,

CHARTERED ENGINEER,

License Surveyor with MCGM

Email : sawant.ranjeet4@gmail.com

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## ANNEXURE 1 : CHECK LIST FOR HRC SUBMISSION

Documents necessary for Technical High Rise Committee scrutiny

**A) New proposal for buildings with height more than 120 mtrs or slenderness ratio more than 9 :-**

1. Forwarding letter addressed to Deputy Chief Engineer (DP) - Member Secretary on letter head of Architect clearly mentioning therein;
    - a) Configuration of proposed building,
    - b) List of technical consultants for project.
  2. Scrutiny fees: Demand Draft / Pay order / Cheque of Rs. 1,65,000/- per wing in favour of 'Brihanmumbai Municipal Corporation'
- Note:** The Scrutiny fees will be increased by 10% every year on 1st of April.
3. DP 2034 remarks / T.P. remarks, if applicable & certification from Architect / L.S. regarding minimum width of road to which plot is abutting.
  4. Appointment letter of architect.
  5. Site summary with signature and stamp of Architect and Developer.
  6. Present site photographs.
  7. Copies of approval of concessions approved by the competent authority for the proposed building. Approved concession report (with block plan and section plan only).
  8. NOC from CFO for proposed building for which NOC from HRC has been sought.
  9. Environment Clearance, Civil aviation NOC, Railway NOC, any other NOC if applicable to project.
  10. Geotechnical (soil investigation) report - Input soil parameters from field/NABL accredited lab to be obtained for Physical & engineering properties
  11. Foundation analysis by PLAXIS under lateral load.

12. Design Basis Report.

13. Expert Review panel requirement certificate from concerned Structural Engineer with proof calculation.

14. Wind Tunnel Certificate & optimised value of wind forces to be considered for design.

15. If opted for EODB policy circular no. CHE/29621/DPWS/HRB dated 24.09.2015, the copy of Undertaking cum Indemnity submitted to respective Building Proposal department shall be submitted alongwith proposal. (If plinth is partly constructed alongwith shoring etc)

**B) Revision of height in buildings of height more than 120 mtrs or slenderness ratio more than 9 :-**

1. Forwarding letter addressed to Deputy Chief Engineer (DP) - Member Secretary on letter head of Architect clearly mentioning therein;
    - a) Earlier High Rise Committee NOC/NOCs number, date and configuration.
    - b) Revised configuration of proposed building with reason / justification,
    - c) list of all technical consultants for project. Past as well as present alongwith work stage carried out under their supervision & certificate to that extent.
  2. Scrutiny fees: Demand Draft of Rs. 1,65,000/- per wing in favour of 'Brihanmumbai Municipal Corporation'
- Note:** The Scrutiny fees will be increased by 10% every year on 1st of April.'
3. DP 2034 remarks / T.P. remarks, if applicable & certification from Architect / L.S. regarding minimum width of road to which plot is abutting.
  4. Appointment letter of architect.
  5. Site summary with signature and stamp of Architect and Developer.

6. Present site photographs.
7. Copies of approval of concessions approved by the competent authority for the proposed building. Approved concession report (with block plan and section plan only).
8. NOC from CFO for proposed building for which NOC from HRC has been sought.
9. Environment Clearance, Civil aviation NOC, Railway NOC, any other NOC if applicable to project.
10. Geotechnical (soil investigation) report - Input soil parameters from field/NABL accredited lab to be obtained for Physical & engineering properties
11. Foundation analysis by PLAXIS under lateral load.
12. Design Basis Report.
13. Expert Review panel requirement certificate from concerned Structural Engineer with proof calculation.
14. Wind Tunnel Certificate & optimised value of wind forces to be considered for design.
15. Height revision checklist with signature and stamp of Architect and Developer.
16. If opted for EODB policy circular no. CHE/29621/DPWS/HRB dated 24.09.2015, the copy of Undertaking cum Indemnity submitted to respective Building Proposal department shall be submitted alongwith proposal.

**Notes:-**

- 1) Proposal will be accepted only on submission of above documents.
- 2) If there is revision in proposal, the earlier paid scrutiny fees will be forfeited.
- 3) The proposal submitted with all above documents will be taken on agenda for next immediate site visit.
- 4) If site visit is not necessary, the proposal will be taken on agenda for next immediate meeting/ presentation.

- 5) The number of proposals per site visit and meeting will be limited to five (5). The proposals will be taken on agenda as per serial number.
- 6) Proposals submitted 10 days prior to site visit or meeting will only be considered.

**Additional documents for meeting / presentation:-**

Scanned copies of following along with PPT for presentation shall be submitted 10 days prior to meeting date to office of Dy. Ch.E.(D.P.)-II:

**A) Architect:-**

- 1) Last approved plans by Planning Authority for proposed height.
- 2) Architectural presentation.
- 3) Any other relevant document as informed during site visit.

**B) CFO / MEP:-**

- 1) CFO NOC for proposed height.
- 2) CFO approved plans.
- 3) MEP presentation.
- 4) Any other relevant document as informed during site visit.

**C) Geotechnical:-**

- 1) Geotechnical report.
- 2) Geotechnical presentation.
- 3) Any other relevant document as informed during site visit.

**D) Structural:-**

- 1) Etabs / safe model and analysis.
- 2) Design Basis Report.
- 3) Structural drawing.
- 4) Structural presentation.
- 5) Any other relevant document as informed during site visit.

**E) Additional documents:-**

- 1) Height revision checklist, in case of height revision proposals.
- 2) Environment clearance.
- 3) Other NOCs.

## ANNEXURE 2 : IS16700 CHECKLIST

IS 16700 : 2017		IS 16700: 2017 CHECKLIST			
Table 12 Generic Format for Checklist for Code Exceedance of Buildings ( Clause A-1.3)					
[If any of the queries (I) to (xi i), returns 'Yes' as an answer, the building will need to go through review process. If any of the queries ( xiii) to ( xxvii ) , returns " No " as answer, the building will need to go through review process.)					
SI No	Ref: to Clause	Description	Code Compliance		
			Yes	No	NA
i)	1.1	Is building height Greater than 250 m tall ?			
ii)	1.2	Is the building located less than 10 km (Shortest distance) away from any seismogenic fault ?			
iii)	1.5	Does the building house more than 20 000 occupants ?			
iv)	3.15	Does the building have any transfer structure ?			
v)	5.1	Does the building's structural system exceed the height restrictions specified in Table 1 ?			
vi)	5.1	Does the building's slenderness ratio exceed the requirements specified in Table 2 ?			
vii)	5.2	Does the building exceed plan aspect ratio?			
viii)	5.3	Is the lateral translational stiffness of any storey less than 70 percent of the lateral translational stiffness of the storey above ?			
ix)	5.3	Is the lateral translational strenght of any storey more then that of the story above ?			
x)	5.4	Is the inter-storey elastic lateral drift ratio at any level in exceedance of the specified limits ?			
xi)	5.5.1	Is the first or second natural mode of vibration a torsional mode ?			
xii)	5.5.2	Is the fundamental translational lateral natural period in exceedance of specified limits?			
xiii)	5.6.1	For a precast floor sytem, is the screed thickness provided less than that specified requirements ?			
xiv)	5.6	Any floor openings, if any. in conformance to size and location requirements as per 5.6.2 ?			
xv)	5.7	Is minimum structural concrete greater or equal to grade M 30 ?			
xvi)	6.2	Are wind tunnel studies in conformance with "specified requirements?			
xvii)	6.3	In Seismic Zone IV and V, is the design based on deterministic site specified design spectra ?			
xviii)	7.2	Is the design based on cracked section properties, as noted in Table 6 ?			
xix)	7.3	Is the stability coefficient less than or equal to 0.20 ?			
xx)	8.1	For project with multiple towers connected with a singal podium, are the requirements specified in 8.1.3 satisfied ?			
xxi)	8.4	Where moment frame - Structural wall system is provided in Seismic Zone IV and V, are the special moment frames and shear walls continuous ?			
xxii)	8.5	Where structural wall system is provied :			
		a) Is the minimum wall thickness 160mm of h/20, whichever larger ? Are all openings per requirments of 8.5.2?			
		a) Are the nominal design shear stresses in structural walls with in the specified limits of 8.5.8 ?			
		a) Are the longitudinal reinforcement ratio in Coupling Beam less than the limits specified in Table 8 ?			
		a) For projects in Seismic Zones IV and V, are the requirements of 8.5.14 satisfied ?			
xxiii)	8.6	Where flat slab - structural wall system is provied, do the structural walls carry all lateral loads without any contribution form the column strips of flat slab system ?			
xxiv)	8.7	Where franed tube or tube -in-tube or multiple tube system is provied :			
		a) Is the plan shape of the system regular ?			
		b) Is length to width ratio less than or equal to 2 ?			
xxv)	9.3	Is the geotechnical investigation completed as per requirments of 9.3.1 ?			
xxvi)	9.4	Is the minimum depth of foundation provied as per the requirments of 9.4 ?			
xxvii)	9.8	Are the estimated design settelment values with in specified limits ?			

Member of Indian Society of Structural Engineers

To,  
Bureau of Indian Standard  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG, NEW DELHI 110002  
Email : ced39@bis.gov.in

Subject: ISSE comments on Draft IS1893 Part1 and Part 2

Ref: DOC. NO: CED 39(22343) WC

TITLE : CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES PART 1 GENERAL  
PROVISIONS [Seventh Revision of IS 1893 (Part 1)] (ICS 91.120.25)

Kind Attn: Chairman Sectional committee CED 39

Sir,

Indian Society of Structural Engineers (ISSE) is a premier association of Professional Structural Engineers with its Head Quarters at Mumbai looking after the development of the profession to the benefits of Indian society with the focus on construction industry in particular. We assist Government, Self Government, Municipal Corporations and other Corporate bodies in framing their policies for sound and stable structures in their built assets.

We publish a technical journal for free circulation amongst members and complementary to heads of industries. We have more than 2500+ structural engineers as our members.

We would like to express our views on behalf of our practicing structural engineer members. We are attaching our comments in the desired format.

Our general observations are as follows –

1. Need to educate Architects, planners and approving authorities: After going through the revised draft, it has been noticed that regular configuration with distribution mass, stiffness and symmetry both in plan and elevation are desirable for good structures. Placement of lateral force resisting members in a symmetrical pattern along the periphery, continuity of wall / column from ground to top etc for achieving good structural behaviour during seismic events are also emphasised.

We would like to inform you that we do not have any control over the building configuration. We have to work on the plan prepared by Architects based on the plot size, client's requirements and as per local municipal bye-laws. Authorities want only structural stability certificate from the structural designer stating that our design is complying with relevant IS codes. We therefore request you to kindly insist on plan approving authorities that they should not approve the plans which do not comply with four attributes mentioned in proposed code for earthquake resistant structures.

2. Ideal symmetrical building as described in the code is not the reality. Even if we wish to follow the code, it is not possible to comply many code clauses. We feel that the code should be as simple as possible and the practicing engineers should be able to implement it. Otherwise, the compliance rate will be very low. Code writers can suggest alternatives (like limiting deflections or increasing force by 2.5 times etc) if certain conditions are not complied with.

3. In case of IS16700, for code exceeding building, review by expert panel is recommended. In reality, there are very few expert panels, may be in one or two metro cities otherwise it is not existing. Even the expert panel may not be able to provide solutions to complex issues and still building are being constructed without expert panels. So let us think about the possible solutions and alternatives rather than referring to some panel.

4. We humbly request you come out with code commentary (which will be useful to understand the intent of code) and with illustrative examples of simple and complex actual building with step by step calculations as per code guideline. This will be very useful for practicing engineers who wish to implement the code.

5. We strongly feel that practicing structural engineers / associations should be taken into confidence before finalizing the draft considering practical difficulties faced in design and execution by the professionals. This will improve code compliance level in our country. We hope you will consider our suggestions.

Thanking you,

President  
Shantilal Jain

Yours faithfully,

ISSE Secretary  
Hemant S Vadalkar

Comments from Indian Society of Structural Engineers on Draft code IS1893 Part 1				
SI No. (1)	Clause / Subclause / Para No. (2)	Comments / Suggestion (3)	Modified Wordings of the Clause (4)	Reasons / justifications for the Proposed Change (4)
1	General	All changes should be justified and session should be carried out by code committee to educate the code intent and method to follow the analysis and design. A commentary and handbook is desirable.		
2	5.2	.....rocks or soil, which do not settle, liquefy.....	Remove line "which do not settle"	
3	5.9.b	Please include Temperature load if needs to be considered along with EQ		
4	Table 4 -ii , iv	Influence depth of 2B seems to be unreasonable format and large pile group		
5	6.2.4.b	he - defination is not mentioned		
6	7.1.2.2	Please clarify where it is applicable		
7	7.2.1.a.5	Clause not mentioned		
8	7.5.1	Combinations differs in 7.5.1.e & 7.5.3		
9	7.5.1 - e)	Did not find "Ω" in IS 1893 (part 2)		
10	5.2.2.1	Elastic maximum horizontal PSA depending on the natural period T of the building of horizontal translational mode [as per 6.2.4.4 or 6.3.1 of IS 1893 (Part 1)], corresponding to the return period TRP and the category of building specified in Table 1 of IS 1893 (Part 1) for strength design,"	"Horizontal" to be replaced with "Vertical"	Typing mistake to be corrected.
	6.2.4.2	Please check possible typing mistake	NV, 5 % ( TH) to be replaced by NH, 5 % ( TH).	
11	7.8.3 page 50	Please explain each term below each equation for clarity and ready reference. Similarly, explain x and y axis underneath each figure.		More commentary and references required for the expressions provided f
12	7.8.2.1b page 54	This clause is not explicit. 1. What is intended by field tests? 2. Is it Seismic profile? This will mean that other than residential buildings, all buildings (hotels, malls, schools, offices, hospitals, etc.) will require seismic profiling. If that is the requirement, then it is suggested to make it mandatory for zone 4 and zone 5.		Please indicate type of field tests required.
13	7.8.2 page 54	Please check the clause number for typing mistake. It should be 7.8.5 in serial order after 7.8.4		

Comments from Indian Society of Structural Engineers on Draft code IS1893 Part 2				
Sl No. (1)	Clause / Subclause / Para No. (2)	Comments / Suggestion (3)	Modified Wordings of the Clause (4)	Reasons / justifications for the Proposed Change (4)
1		Code commentary and Hand book will be useful.		
2	5.2.1.1	The drift limits in seismic codes around the world are a strength requirement and checked at MCE level. Hence, it should be a Strength Limit check similar to what is provided in separation of buildings check of clause no. 5.2.6.1	The lateral storey drifts in buildings, under the load combinations corresponding to the Limit State of Strength specified in 7.5.1 and 7.5.3 of IS 1893 (Part 1), shall not exceed the values given in Table 2.	
3	5.2.1 Table 5	Slab modifier is increased to 0.35 and should not be more than 0.25 for Strength Design. This is seen in all seismic codes around the world		There is significant cracking in slabs under seismic loads. The slabs will start participating and acting like frames, reduce drift and hence forces in members will reduce, if slabs modifiers are more than 0.25.
4	5.1.5.3 - a) pg 27	$\Delta_{ave} = (\Delta_{max} + \Delta_{min}) / 2$	$\Delta_{ave} = (\Delta_{max} + \Delta_{min}) / 2$	Typing mistage to be corrected.
5	Table 2- pg 30	Zone II is repeated twice. Zone III is not there	Kindly provide details for Zone III	Please check for typing mistake
6	5.2.2.1 a page 31	Description of A(v) T	in explanation ..... word "horizontal" to be replaced by "vertical"	Typing mistake to be corrected.
7	5.2.3	The minimum base shear for important buildings of Set 2 comes to 3.1% for Zone III, 5.6% for Zone IV. This is too highx especially for tall buildings as compared to any international code		
8	5.2.5.2 Torsional flexibility factor	Bit complicated calculations		More commentary and sample calculation will be helpful
9	5.1.5.2 Torsional flexibility	This existing wording can be simplified for better understanding - "Buildings with torsional flexibility shall not be permitted. The structural elements of the members shall be re-proportioned to make a lateral translational mode the fundamental torsional mode separate the two modes"	"Buildings with torsional flexibility shall not be permitted. The structural elements of the members shall be re-proportioned to make two lateral translational modes as first two modes of oscillation along each principal plan directions	Making the statement simple.
10	5.2.2 Strength requirements	Clause no 5.2.2 is repeated on page30 and page33		Clause number and sequence to be checked.
11	7.1.3 b Structural wall plan density	Table 10 provides Minimum Structural Plan Density of Structural Walls alone in RC Buildings based on plinth area.	Either structural wall density can be defined as a percentage of total built up area or based on average stress level in walls at plinth level which will be more rational than % of plinth area.	Plinth area for 5 storey building and 15 storey building may be same but it will need different wall density which is not reflected from the present provision which only considers plinth area. This needs to be looked into.

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# SAMPLE DESIGN BASIS REPORT

by Hemant Vadalkar

R2					
R1					
R0					
REV NO.	DATE	DESCRIPTION	STATUS	PREPARED BY	REVIEWED BY

Job : +++

STRUCTURAL ENGINEERS

VADALKAR AND ASSOCIATES

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**R1 : Aug 2020**

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**1.0 Based on inputs from client, material of wall has been revised and load calculations updated**

3.0 List of Codes

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4.0 Design Parameters

+++++

5.0 Separation / Expansion Joints

+++++

6.0 Proposed Approach of Structural Analysis

+++++

7.0 Load Combinations

**R2: 14 Oct 2020**

8.0 Design of Structural Elements

**1. Based on series of meetings with Architectural department, certain changes in the framing plan were incorporated and column positions have been revised.**

9.0 Stability of Structures

**2.**

10.0 Geotechnical data, Soil parameters and Foundation system

**R3 : Nov 2020**

11.0 Other Data

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12.0 Value Engineering Exercises

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**1.0 Foreword** : The intent of this document is to identify and record all the pertinent input requirements, analysis & design criteria for structural design of the building. It is aimed at formulating the basis of the structural analysis, design & detailing work that the Structural Engineer is planning in delivering the structural scheme of the building. The scheme will be compatible with the architectural theme, satisfy the functional needs, at the same time conforming to the Indian Standards and other applicable building norms to achieve safe, stable, strong and yet optimally economical structures.

The parameters adopted in this report are going to be the basis of the structural design calculations. Hence it is expected that the planning and design team members - architects, services consultants and project management team - give their feedback and approval to the parameters, suggestions, recommendations mentioned in the report.

This report covers the minimum design requirement to establish the unified design basis that will form the overall design philosophy to be adopted in the structural design of the proposed building.

The design will aim to achieve

- Structural & functional integrity.
- Desirable Structural performance under characteristic service design loads.
- Resistance to loads due to natural phenomena i.e. wind and earthquakes.
- Structural durability & maintainability.

## 2.0 Project Description

Project : Proposed ++++++ Building for ++++++

Location : ++++++, MUMBAI-+++

## 2.1 Agencies involved

Owner : ++++++

Architects : ++++++

Structural Consultants: ++++++.

Geotechnical consultants : ++++++

Services Consultants : ++++++

Project management consultants : ++++++

## 2.2 The Project:

The proposed structure comprises of Ground Floor + 15 floors + terrace. The approximate plan dimensions of the building are 57m X 51m. The building will be used for hostel purpose. The maximum height of the building up to terrace is approximately 51 m above ground level. The columns are tied at every level. The column grid is planned at 6.58m X 7.3m.

Lift machine room and overhead tank are provided above terrace floor level. The building is essentially a R.C.C. framed structure. The columns and shear walls are connected to each other with a network of beams and slabs with the slabs acting as in-plane rigid diaphragms for each of the floors. In order to enhance the lateral stiffness at the stilt level, concrete walls have been provided in orthogonal direction.

Seismic design code IS1893 recommends regular / symmetric configurations for better seismic performance. However, the approved building plan is of C shape as planned by the Architects. We have tried to provide the design for the given geometry and configuration.

## PROVISION FOR FUTURE

### ADDITIONAL FLOORS:

As per the directive from the client, there is no provision for any additional floors above terrace floor. Hence, the foundations and columns/shear walls will not be designed and constructed for any additional floors.



Fig.1. Typical Architectural Plan

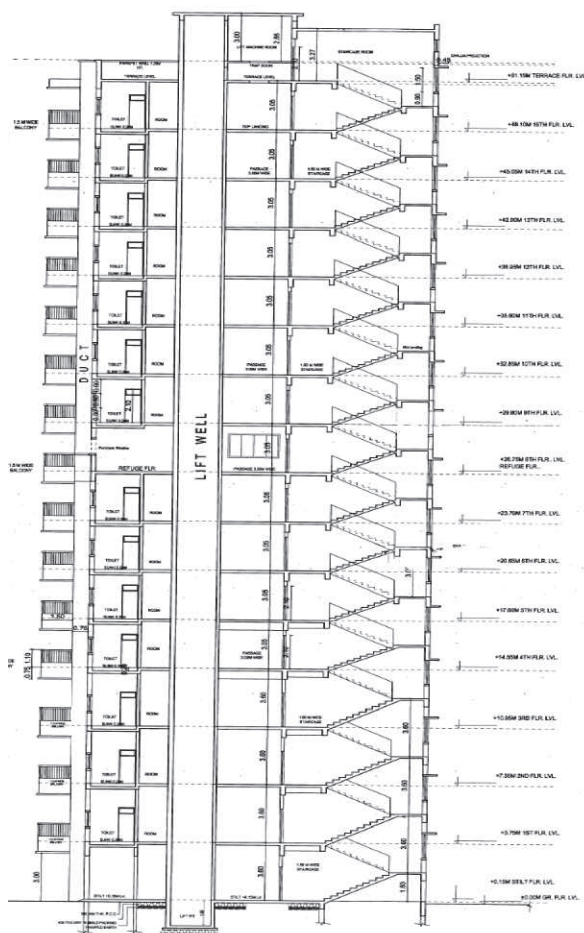


Fig. 2. Architectural Section of the building

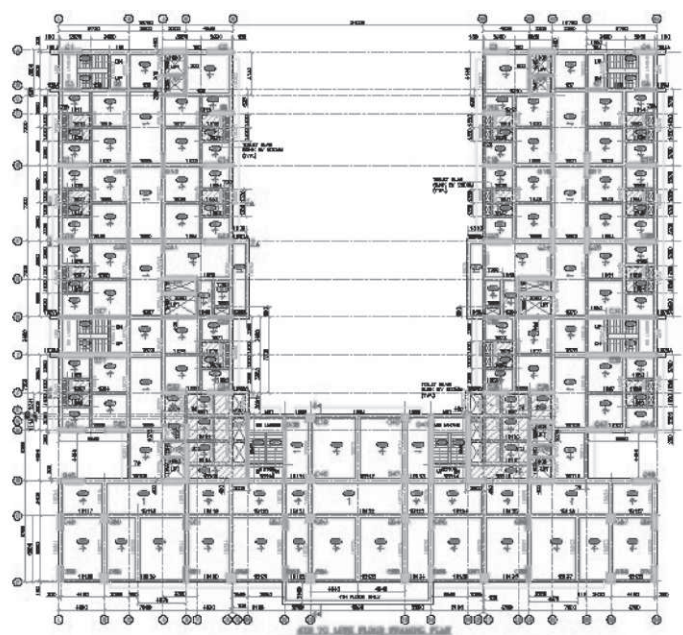


Fig. 3. Typical floor

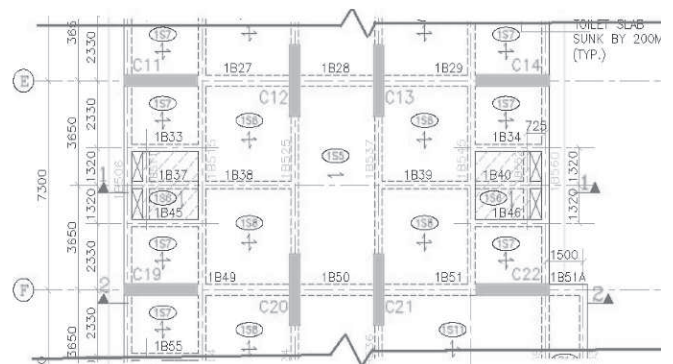


Fig. 4. Typical grid

### 2.3 Detail Description of Building:

**Ground Floor :** Ground floor is at +0.15m level.

The floor height is 3.6 m.

This floor will be used as stilt.

**1st Floor :** 1st floor is at +3.75m level.

The floor height is 3.6 m.

**2nd Floor :** 2nd floor is at +7.35m level.

The floor height is 3.6m.

**3rd Floor :** 3rd floor is at +10.95m level.

The floor height is 3.60m.

**4th Floor :** 4th floor is at +14.55m level.

The floor height is 3.05m.

**5th Floor :** 5th floor is at +17.60m level.

The floor height is 3.05m.

**6th Floor :** 6th floor is at +20.65m level.

The floor height is 3.05m.

7th Floor	: 7th floor is at +23.70m level. The floor height is 3.05m.
8th Floor	: 8th floor is at +26.75m level. The floor height is 3.05m.
9th Floor	: 9th floor is at +29.80m level. The floor height is 3.05m.
10th Floor	: 10th floor is at +32.85m level. The floor height is 3.05m.
11th Floor	: 11th floor is at +35.90m level. The floor height is 3.05m.
12th Floor	: 12th floor is at +38.95m level. The floor height is 3.05m.
13th Floor	: 13th floor is at +42.00m level. The floor height is 3.05m.
14th Floor	: 14th floor is at +45.05m level. The floor height is 3.05m.
15th Floor	: 15th floor is at +48.10m level. The floor height is 3.05m.
Terrace floor	: Terrace floor is at +51.15m level. The floor height of staircase cabin is 3.27m. This floor will be used for lift room and water tank.

### 3.0 List of Codes

In the analysis, design and detailing of the building, the latest editions of following Indian Standards will be referred.

IS Code	Description
IS 875(Part 1): 1987	Dead Loads - Unit Weight of Building Material and Stored Material
IS 875(Part 2): 1987	Imposed Loads
IS 875(Part 3): 2015	Wind Loads

### 3.1 DESIGN LOADS (OTHER THAN EARTHQUAKE LOADS)

IS Code	Description
IS 1893 Part 1 :2016	Criteria for earthquake resistance design of structures.
IS 4326: 1993	Earthquake Resistant Design and Construction of Buildings – Code of Practice
IS 13920: 2016	Ductile Detailing of Reinforced Concrete Structures subjected to Seismic Forces - Code of Practice.

### 3.3 DESIGN OF PLAIN AND RCC CONCRETE ELEMENTS

IS Code	Description
IS 456: 2000	Plain and Reinforced Concrete - Code of practice
SP 16	Structural use of concrete. Design charts for singly reinforced beams, doubly reinforced beams and columns.
SP 34	Handbook on Concrete Reinforcement & Detailing
IS 1904	Indian Standard Code of practice for design & construction foundations in Soil: General Requirements
IS 2950	Indian Standard Code of Practice for Design and Construction of Raft Foundation (Part – 1)
IS 2974	Code of practice for design & construction of machine foundation

### 3.4 DESIGN OF STEEL STRUCTURAL ELEMENTS

IS Code	Description
IS 800: 2007	Code of Practice for General Construction in Steel

### 4.0 Design Parameters

#### 4.1 Materials of Construction

The building is RCC frame structure with columns; floor slabs being used as diaphragms in redistribution of lateral forces.

#### Concrete

The Grade of Concrete in all RCC structural members shall be M40 and M35.

The Grade of Concrete in RCC column shall be M40 and M35.

Concrete of Grade M20 shall be used in filling, plum concrete, levelling courses and other non-structural items.

Density of reinforced concrete is assumed as 25 KN/cu.m.

Minimum cement content, water cement ratio etc. shall conform to IS 456:2000 provisions for durability and strength criteria.

## Cement:

Portland Pozzolana Cement conforming to IS 1489 Part I is suggested for concrete grades ranging from M20 to M40.

## Aggregates:

The sizes of coarse aggregates conform to IS 383. Nominal maximum size of coarse aggregate shall be 20 mm, suitably graded as per the requirement of mix design.

The fine aggregates conform to the specifications of IS 515.

## Water:

Mixing Water shall conform to IS 456: 2000.

## Reinforcement

High yield strength deformed bars conforming to IS 1786 with Fe-500D,  $f_y = 500$  N/ sq.mm. shall be used.

## 4.2 Loading Parameters

### 4.2.1 Self Weights

Self-weight of the structural members will be considered on the basis of the following properties.

Density of reinforced concrete	25 KN/cu.m
Density of plain concrete	24 KN/cu.m
Density of steel	78.5 KN/cu.m
Density of flr finishes / plasters	20 KN/cu.m
Density of soil	18 KN/cu.m

#### Density of brick masonry

wall with plaster 20 KN/cu.m

Density of AAC blocks

without plaster 8 KN/cu.m

### 4.2.2 Imposed Gravity Loads on floors

The following are the imposed gravity loads adopted in addition to the self-weight.

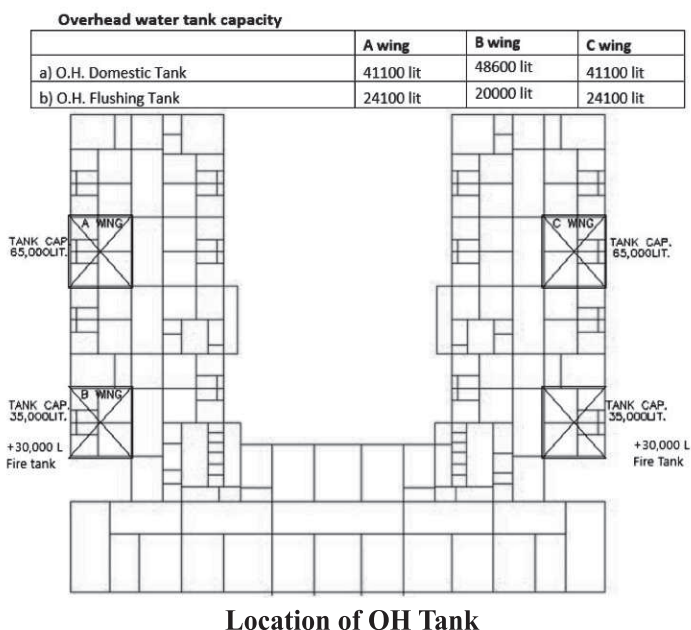
(Self-weight of slab / beam / columns will be as per the dimensions adopted in the respective drawings. Floor finishes of 75 mm thickness have been considered on all floors.)

## (i) Terraces:

Load Component	Thickness (mm)	UDL (kN/m <sup>2</sup> )
Water-Proofing	150	3.0
Screed	50	1.0
Live Load		2.0

## Overhead water tank capacity

	A wing	B wing	C wing
a) O.H. Domestic Tank	41100 lit	48600 lit	41100 lit
b) O.H. Flushing Tank	24100 lit	20000 lit	24100 lit



**Toilets: Sunk in toilet slab of 200mm has been considered based on client input.**

Load Component	Thickness (mm)	UDL (kN/m <sup>2</sup> )
Finishes	75	1.50
Services		Nil
Sunk Filling	200	4.0
Live Load		2.00

## Corridors, Passages, Floor area, Lobbies and Balconies: (In typical room)

Load Component	Thickness (mm)	UDL (kN/m <sup>2</sup> )
Finishes	75	1.50
Services		Nil
Live Load		2.00

## Staircases:

Load Component	Thickness (mm)	UDL (kN/m <sup>2</sup> )
Steps	150 (Riser) / 300 (Tread)	1.875
Finishes	75	1.50
Live Load		3.00

## A.H.U., Lift Machine Rooms, Battery area Elec. Rooms:

Load Component	Thickness (mm)	UDL (kN/m <sup>2</sup> )
Finishes	75	1.50
Services		0.75
Live Load		10.00

Specific loads given by vendors will be adopted wherever applicable.

## (ii) Self - Weight of Different Walls:

Wall Type ( Wing A and C)	Thickness (mm)	UDL (kN/m <sup>2</sup> ) of wall surface
<b>External Wall</b>		
Burnt clay Brickwork 230mm	230mm + plaster(35mm)	5.3
Parapet wall 230mm	230mm + plaster(35mm)	5.3
<b>Other Internal Walls</b>		
Burnt clay Brickwork 150mm	150mm + plaster(35mm)	3.7
<b>Wall type for Wing B AAC Block wall</b>		
External walls 200mm thk	0.2 * 8 Kn/cu.m + 0.035* 20 Kn/cu.m	2.3
Internal walls 150mm thk	0.15* 8 Kn/cu.m + 0.035 *20 kn/cu.m	1.9

Equipment loads have not been considered.

## (ii) Elevation treatment load : Chajja projection considered

### 4.2.3 Wind loads

Wind loads will be calculated in accordance with IS 875: Part 3. Design wind speed

Design wind speed	$V_z = V_b \times k_1 \times k_2 \times k_3$	
$V_b$ → Basic wind velocity for Mumbai	=	44 m/s
$k_1$ → Risk coefficient for all general buildings (For a design life of 50 years)	=	1.0
$k_2$ → Terrain category 3 class C, for 50 m height	=	1.02
$k_3$ → Topography factor	=	1.0
Based on the above,		
Design wind speed ( $V_z$ )	=	44.88 m/s
Design wind pressure	$P_z = 0.6 \times V_z^2$	
	=	1208 N/m <sup>2</sup>

Further to Design Wind Pressure (P Z ) appropriate pressure coefficient will be used as applicable.

Wind load is not the governing the load compared to seismic load, hence not considered in the analysis.

### 4.2.4 Seismic Loads

The seismic load calculations will be carried out in accordance with IS 1893: 2002.

As per this code, Mumbai lies in Zone III with zone factor  $Z = 0.16$

The Design Base Shear is given by

$$V_b = Z/2 \times I/R \times S_a/g \times W$$

As the proposed building is a Residential building, the Importance factor  $I$  will be taken as 1.2

The Response reduction factor  $R$  will be taken as 5 and ductile detailing will be followed.

$S_a / g$  is the normalized Response Spectrum value for the structure which is the function of the fundamental time period of vibration of the structure and the type of the founding soil.

The soil strata is hard considering pile foundations and time period is calculated based on empirical formula given in IS1893-2016 for other structure with infill panels.

$$T = 0.09 \times H / (\text{SQRT}(D))$$

$W$  is the Seismic Weight of the building, which will be calculated in accordance with the relevant clause in the IS1893: 2016 considering Dead Load +50% Live load

Since the structure is a R.C.C. structure a damping value of 5% will be considered

Space frame analysis of the structure will be carried out using seismic coefficient method and response spectrum method.

## 5.0 Separation / Expansion Joints

Expansion joints are not provided in this building as it was not planned in the approved Architectural drawings.

## 6.0 Proposed Approach of Structural Analysis

The building is a R.C.C shear wall/columns, beam slab frame structure.

After preliminary sizing of various structural members, a computer model of the structural frame of the building has been generated for carrying out computer analysis for the effects of vertical and lateral load that are likely to be imposed on the structure.

The building structure has been analyzed using the STAAD.PRO / ETAB software.

This software has been thoroughly tested, validated and recognized internationally by several organizations and is well suited for the analysis of building systems.

Geometrical dimensions, member properties and member-node connectivity, including eccentricities have been modeled in the analysis problem. Variation in material grades, if present, has also been considered.

Wind load derivations have been carried out using coefficients / factors in accordance with the relevant codes.

The seismic load has been derived from the results of equivalent static / dynamic analysis of the structure in accordance with the relevant code of practice.

The permissible values of the load factors and stresses have been utilized within the purview of the Indian Standards.

The computer analysis has been carried out to evaluate individual internal member forces, reactions at foundation level and deflection pattern of the entire structure and in the individual members. This data has been used to verify adequacy of the member sizes adopted and after further iterations arrive at the most appropriate design of the structural members. Some re-runs of the analysis program has been done for arriving at the optimum structural space frame characteristics that satisfy the strength and stability criteria in all respects and satisfying architectural planning requirements. Space frame analysis has been carried out for gravity loads, wind loads and seismic loads

## 7.0 Load Combinations

The results obtained from the computer analysis in the form of member forces and reactions have been used for design the structural members. Following load combinations are considered for arriving at the design forces

Load Combination	LOAD FACTORS				
	D.L.	L.L.	Wind	Earthquake	Thermal
DL + LL	1.5	1.5	-	-	-
DL + LL + EQ(X+)	1.2	1.2	-	1.2 (x)	-
DL + LL + EQ(X-)	1.2	1.2	-	-1.2 (x)	-
DL + LL + EQ(Z+)	1.2	1.2	-	1.2 (z)	-
DL + LL + EQ(Z-)	1.2	1.2	-	-1.2 (z)	-
DL + EQ(X+)	1.5	-		1.5 (x)	
DL + EQ(X-)	1.5	-		-1.5 (x)	
DL + EQ(Z+)	1.5	-		1.5 (z)	
DL + EQ(Z-)	1.5	-		-1.5 (z)	
DL + EQ(X+)	0.9			1.5 (x)	
DL + EQ(X-)	0.9			-1.5 (x)	
DL + EQ(Z+)	0.9			1.5 (z)	
DL + EQ(Z-)	0.9			-1.5 (z)	

Suffixes x and z in the above table indicate the direction in which the force is applied.

All members are designed for the largest value of the design forces obtained due to positive as well as negative values of reversible forces (Wind and Earthquake).

## 8.0 Design of Structural Elements

For the design of R.C.C. elements, the Limit State Method is used as per IS 456-2000.

Materials of construction are predominantly concrete with consideration for strength and durability. The uniform grade of concrete adopted is M40 and can be reduced to M35 above certain height.

High Yield Strength Deformed bars conforming to IS: 1786 with  $F_y = 500\text{MPa}$  (Fe500D) is considered for calculation of main reinforcement and  $F_y = 415\text{MPa}$  considered for design of secondary reinforcement.

Ductile detailing norms are adopted to make the building earthquake resistant in accordance with IS: 13920:2016 and keeping in mind constructability. Axial stress ratio was limited to  $0.4f_{ck}$  for columns / walls and minimum width of column or wall shall be 300mm.

Covers to reinforcement shall be in accordance with IS: 456:2000 corresponding to moderate exposure conditions for the super-structure or severe exposure conditions for the sub-structure and to satisfy a fire rating of 2 hrs.

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## 9.0 Stability of Structures

9.1 For the purpose of stability of the structure as a whole against overturning, the restoring moment is not less than 1.2 times the maximum overturning moments due to dead load plus 1.4 times the maximum overturning moments due to imposed loads. In case where dead load provides the restoring moments only 0.9 times in dead load is to be considered. The restoring moments due to imposed loads is ignored.

9.2 The factor of safety against sliding is not be less than 1.40.

9.3 Factor of safety against buoyancy is not less than 1.20 ignoring the superimposed loading.

## 10.0 Geotechnical data, Soil parameters and Foundation system

Suitable foundation system will be chosen based on the recommendations of geotechnical report. Based on Soil investigation report, pile foundation with pile caps has been considered for the design. It is proposed to use 750mm ,900mm and 1000mm diameter piles. During the execution of work, actual founding strata should be checked and certified by the geotechnical consultant.

## 11.0 Other Data

Specific requirements of floor and wall cutouts for services, sinking of floors in services, kitchen and toilet areas, external architectural features, and entrance canopies will be provided as required by Architects and Service Consultants. The relevant information will be obtained from them in the form of drawings.

Lift loads and lift machine room equipment and cutout layouts will be obtained from the lift manufacturers. An impact factor of 100% will be considered in the lift supporting structures.

## 12.0 Value Engineering Exercises

In order to optimize the material consumption, sample analysis and design exercises have been undertaken with different combinations of member sizes and the required reinforcement and formwork has been estimated. Results of these exercises have been considered in arriving at the structural scheme of the building.

1. Various alternatives of structural arrangements were tried. Finally, column and beams with 6.58m x7.3m grid has been adopted in A & C wing. Larger spans up to 9m were considered in B wing for larger column free area up to 3rd floor.

2. Various requirement form client / architects were considered like requirements of having a sunk slab in the toilet area has been provided. In order to avoid sleeves or damage to the outer beams for taking out the plumbing pipes, beams have been dropped to the sunk slab level.

3. All masonry walls are placed on beam to avoid local load on slab.

4. Lift cores distributed in the building have been considered as shear walls in lateral load resisting system. This has relieved considerable lateral load on columns.

## 13.0 Design Development

1. A layout of columns and floor beams has already been developed. The column size is generally kept as 400mmX2500mm in A and C wings. For B wings 800mmx800mm square columns and 500mmx1600mm columns have been planned as per architectural requirements..

2. The main frame beams is generally taken as 400mmX750mm avoiding lintel. Percentage of steel is restricted to 2% in columns to get the economical design. As per IS13920 column area is considered to limit stress at 0.4fck

3. We have submitted the structural General Arrangement plans for perusal of the design team members, who will be expected to note the salient features of the structural system and examine the compatibility with various requirements of architecture and other engineering disciplines. The co-ordination among various design team members will be part of the design development process and we - as structural engineers - will be a part of the process.

4. We have tried our best to comply with seismic code requirements as far as possible for shape, framing , column shape and size and detailing requirements.

## About The Author



**Hemant Vadalkar** is a consulting structural engineering from Mumbai having three decades of experience in the design of concrete and steel structures. He is Hon. Secretary of ISSE. He can be reached at vadalkar@gmail.com

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# MITIGATING RISK DURING DEEP EXCAVATION – IN MONSOON

By Vivek Sanganal

In urban areas like Mumbai & many metro cities, due to scarcity of land, it has become quite common to go in for multiple basements to accomodate multi-level car parking and other Services.

The above requires deep excavation and this poses great challenge to geotechnical and structural engineers particularly in complex ground condition as well as close proximity to existing buildings. The execution of deep excavation becomes more critical during monsoons where the properties of soil changes due to variations in the ground water table level. It is very much essential that Geo-tech engineers in coordination with structural Engineers monitor the the process at every stage right from the initial planning.

Before carrying out such deep excavations if proper planning is done the risk of any untoward incidents happening can be minimised. Certain basic informations as given below will help us in achieving a proper solution

## 1. Type of soil likely to be encountered :-

- a). Stable rock
- b) granular soil, loose back filled soil, submerged soil, or soil from which water seeps freely, soil which swells in contact with water.
- c) soil which has been previously been disturbed subjected to vibration from heavy traffic, pile driving or similar effects.
- d) Cohesive soil with very high strength.

## 2. Subsurface investigation for following soil parameters

- a) Shear strength parameterrs
- b) stiffness of soil
- c) permeability of soil
- d) Ground water table level

## 3. Type of physical entities near by :-

- a) Details regarding near by structures , buildings, drains, sewer lines, railway tracks, roads, existing embankments etc.

- b) Near by water bodies like river , ponds lakes etc.
- c) foundation depth of ajacent strucures.

Having arrived at on a reasonably good solution, it is to be seen that the same is executed with utmost care. In Mumbai where Shore piling is mostly adopted as a means to retain the earth. During excavating operation, special attention should be given to avoid the following which are some of the major causes of failures.

- a) Excess excavation than that was planned for.
- b) Insufficient socketing of Shore piles.
- c) Poor piling work (improper concreting along its length or missing of piles due to negligence )
- d) Adding more surcharge than considered in design by dumping excavated soil or by movement of heavy machinery.
- e) Water pressure building up on earth retention side not considered in design



Also past experience have shown that the buildings tilt or are thrust upwards due to increase in water table level above than expected. Precaution should be taken by providing anchors to prevent such failures. In case of multiple basements there is ever chance that the basement may be pushed upwards at an intermedate stage when the complete construction is yet to take place and the desired balancing load to maintain the basement in its place against the upward thrust is not avialable. So care should be taken to avoid dewatering of basement during monsoon.



Even with proper planning , specially during Monsoons it is likely that we may have to encounter some unexpected situations while excavating. Arrangements must be made to safeguard and take some immediate actions

- a) Pumps and excavators if there is sudden collapse of sides or ingress of water flooding the excavated pit
- b) materials falling on people working in the excavation
- c) undermining of nearby structures causing their collapse into excavation
- d) Damage to underground services causing flooding, gas escape, electrocution etc
- e) Barricades to prevent vehicles & people falling into the excavation.

#### About the author :



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## NEWS AND EVENTS DURING APR 2023 TO JUNE 2023

by Hemant Vadalkar

**29 Apr 2023 :** Epicons friends of concrete arranged a webinar by Dr. Yogendra Singh ( IIT Roorkee) on the topic of Seismic analysis of tall buildings using Response spectrum and Time History method. Dr. Singh explained basis of response spectrum as given in IS1893 and theory behind the response spectrum curve given in the code. He also explained principals of time history method and the complexities involved in carrying out analysis. For Linear time history three Spectrum compatible Ground motions are required. For non-linear time history analysis eleven sets of recorded accelerograms are to be used. Scaling of ground motion is necessary for getting target response spectra. Matching of response spectra in the given frequency domain can be done from the available data bases and using appropriate software.

He also discussed some modelling issues faced by designers like modelling of basement / podium along with tower structure where 90% mass participation is difficult to achieve. In such case, two stage analysis can be performed. Tower can be analysed separately assuming it to be fixed at basement level. Reactions from this analysis can be applied to basement model as equivalent static method. Modelling of non-planer shear walls. Equivalent frame model is simplest way to model C shape walls in to three parts at the centre of each wall and connected by rigid beams. Other option is FEM model. But from FEM results, we need to integrate the axial force, shear force and bending moment across the section and then use it for design. He explained that capacity design of shear wall is not clearly given in our code. Design of boundary element in shear walls and provision of confining reinforcement in that zone is very important. He also explained importance of slenderness of shear wall to avoid buckling failure. Shear wall is to be designed for axial force and bi-axial moments. He also discussed issues of coupling beams, its design and detailing. Steel coupling beams can be used as fuse to absorb energy during earthquake which can be replaced using bolted connections. Column and shear walls can be distinguished using the bending moment diagram under lateral loads. If the behaviour is like a cantilever , it will act as a wall and then hinge will form at base. Ductile detailing at base is critical. If the BMD is reversing the sign at every floor, it acts as a column. Short span beams like in corridors attract more shear and moment and are very difficult to design. So the depth of these beams can be reduced with wider

widths to have less shear and moment. The webinar was attended by more than 200 participants.

**11 and 12 May 2023 :** Steel Day celebration organized by MX media at Hotel Lalit , Mumbai. The Theme of the event was Technology transforming usage of steel in construction. Steel as a green building construction material with various advantages was discussed. Steel manufacturers, Architects, Consultants, Academicians, Contractors, PEB vendors and civil engineers attended the event in large numbers. Amit Shah, DCS Consultants, Girish Dravid, MD Sterling Engineering Consultants P Ltd, Siddharth Mishra from TATA Steel , Abhijit Shah MD Walter P Moore, Francis Archer from ARUP and Avneet Singh from SSMB Magazine conducted inaugural session. Presentations on steel structures by various speakers were arranged on two tracks. One was on Building & Infrastructure and other on Warehouse, Industrial and special structures. Architect Hafeez Contractor and Dr. C. N. Srinivasan were honoured with Life Time Achievement Award. Jindal Steel and Power, JSW Steel, Tata Structura, Kirby, Everest Steel Buildings, Tata BlueScope, Zamil Steel, JSL supported the event attended by around 500 delegates. Variety of steel structures like Bridges, Building, airports, railway stations, commercial buildings, industrial structures, Auditorium, Convention centre were presented by various organizations. It was a great event for steel designers and constructors.



**11 & 12 May 2023 :** Indian Concrete Institute ( ICI) arranged International conference on Precast concrete construction at Mumbai.

**20 May 2023 :** Indian Society of Structural Engineers HQ(ISSE) arranged a small meeting of consulting engineers to discuss the draft code of IS 1893 Par 1 and Part 2 at Institution of Engineers hall, Mahalaxmi, Mumbai. Various clauses were discussed. ISSE appealed to all consultants to send their clause wise response , so that, ISSE can send it to BIS before the deadline.

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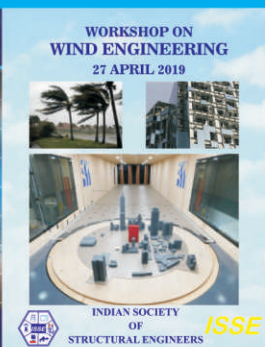
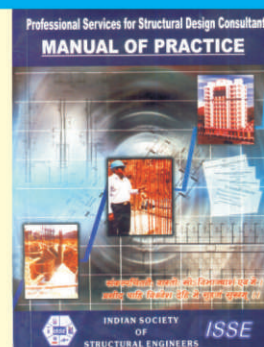
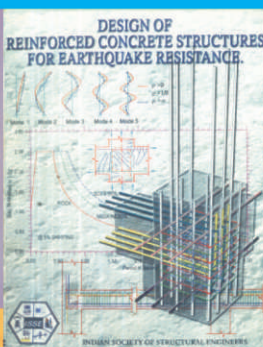
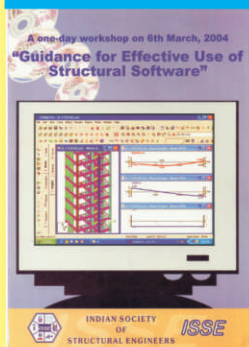


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Hemant Vadalkar felicitating Dr. K Suresh Kumar



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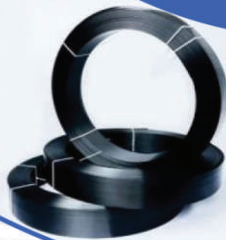
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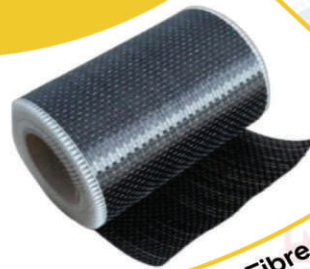
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