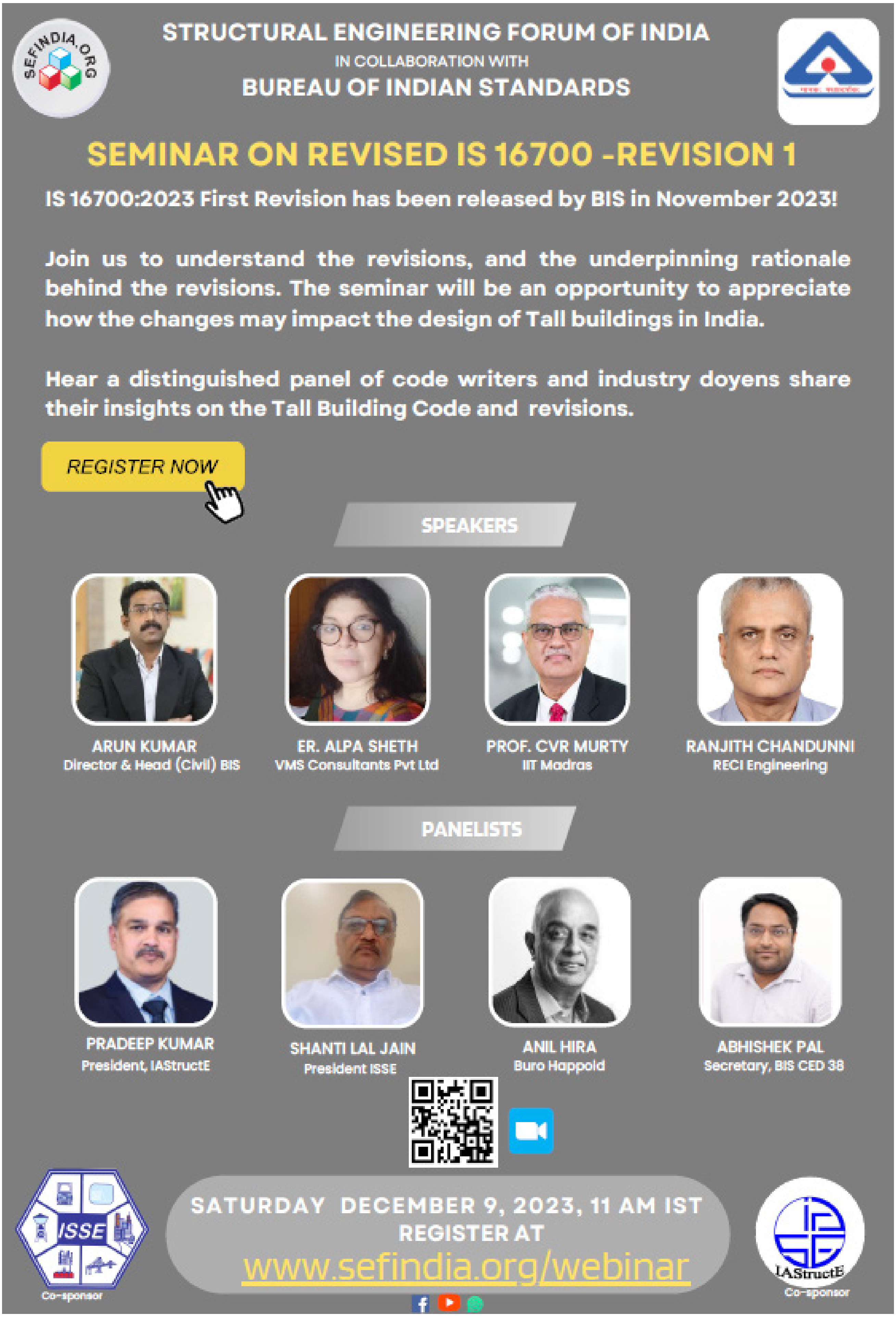


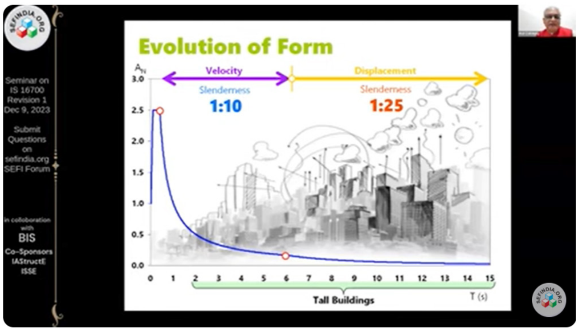
https://youtu.be/ENsMpyTg2X0?si=mKpBnoW7VS9oNede

SEMINAR ON REVISED IS 16700 -REVISION 1

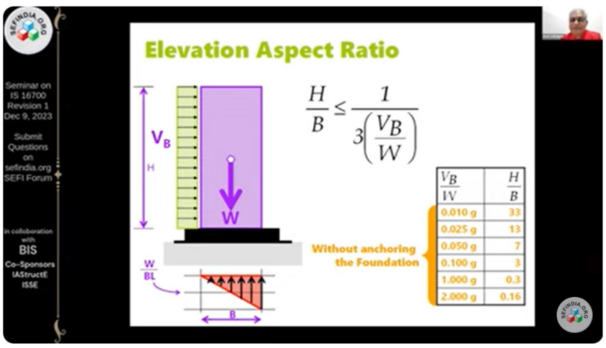
In light of the recent revision of Indian Standard IS 16700:2023 – "Criteria for Structural Safety of Tall Concrete Buildings', a detailed discussion in the form a webinar was organized by Structural Engineering Forum of India (SEFI) jointly with the Bureau of Indian Standards (BIS), in collaboration with Indian Association of Structural Engineers (IAStructE) and Indian Society of Structural Engineers (ISSE) on 9th December 2023. The session started with a warm welcome by Er. Alpa Sheth (VMS Consultants Pvt. Ltd.) to all the participants.

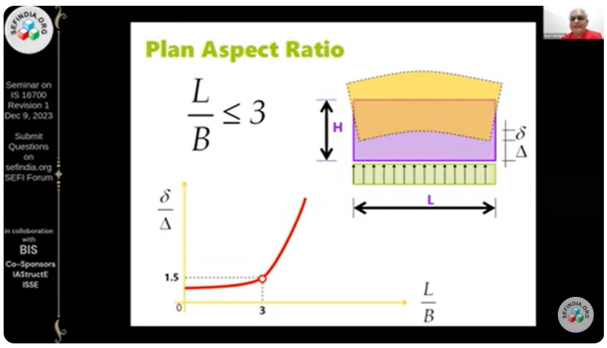
Mr. Arun Kumar (Director, and Head - Civil, BIS) started his opening remark on a very positive note highlighting the change in approach among the wider section of the construction professionals wherein they have started to appreciate the different standards and more importantly, different authorities have also started to indicate them in their relevant documents to ensure strict adherence. He mentioned that in India, about 65% of the total population is likely to shift to urban areas by the year 2050. Currently, the tall concrete structures are common in few cities, possibly due to their limited landscape. When it comes to high rise buildings, should essentially involve variety of building professionals including architects, structural designers, geotechnical specialist, MEP experts, accessibility, and sustainability experts and a strong project management team, from the concept stage of the project. At the same time, it is important to give adequate attention to address the livability aspect and maintain the quality of life of the inhabitants. He aptly mentioned that our race to going tall should also be addressing the betterment of the people.

Prof. CVR Murty (IIT Madras) started his deliberation with the fact that earlier tall buildings had their slenderness restricted to a ratio of 1:10 but over the period of time the engineering has taken new levels and the slenderness ratio of some of the high rise buildings have gone as high as 1:24. As the ratio goes higher, the relative displacement of the structure becomes somewhat more than comfortable. While there were few modifications with respect to the use of lightweight building materials or restricting the storey height, the issues of glass façade and leakage along the perimeter in adverse weather conditions, have always been matter of concern. And that is where the concept of minimum base shear comes into consideration.

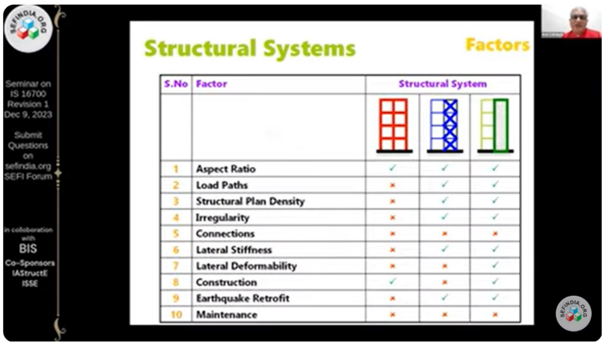


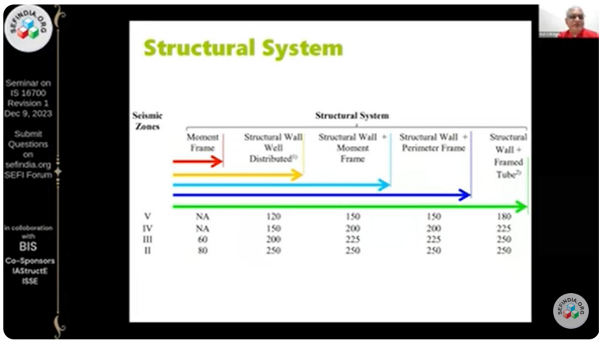
Adding on to this, Prof. Murty mentioned that if the tall buildings are not properly anchored, then one would be restricted to small size of the structure or in other words a limited value of the acceleration. Similarly, if the plan size if too large e.g., beyond a L/B ratio of 3, the criticality will be little more than comfortable. In tall buildings, this is being addressed wherein the plan length is increasing in some of the buildings. In the new standard, the allowable slenderness ratio has been restricted to 9 for zones IV and V while for zones II and III, the permissible value is 10. For structures in high seismic regions, they need to suitably anchored at the foundation level.





Prof. Murty also touch based upon the commonly designed structureal systems i.e. the frame system, the truss system and the wall-frame system, and concluded that the wall-frame system would always outperform the other two systems in terms of almost all the parametric and design requirements. The wall-frame system can also be a combination of wall & perimeter frame, wall & tube or simply tubes and the performance of the individual structures would also vary, leading to improved understanding of the behaviour. Corresponding to every type of structural system, there is a restriction of building height for a given seismic zone, beyond which a superior structural system has to be adopted.





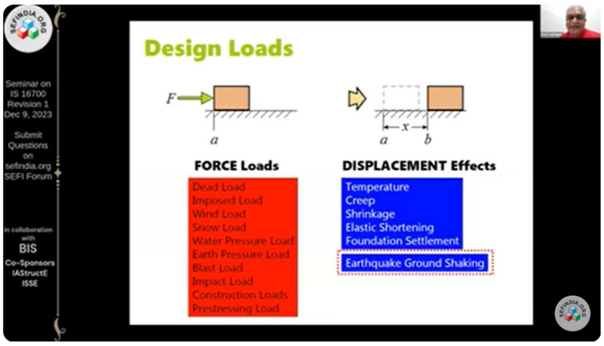
Structural plan density (SPD) in the range of 1-4% are being commonly required for normal multi storied buildings, however the same is not applicable for tall building. As a practice, it is recommended to adhere to the guidelines given in the standard for the minimum structural wall area, without creating any exception.

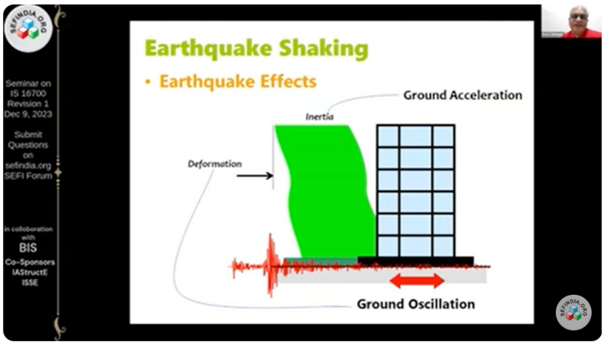
He added that in order to accommodate for livable spaces at intermediate heights of a tall structure, there would be vertical irregularities in terms of stiffness and strength, that would occur and those need to carefully addressed while designing phase of the structure itself. Another issue which has to be taken into consideration is the plan irregularity of the structure.

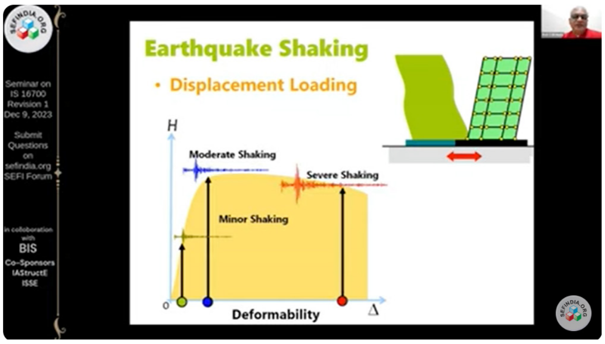
Preferably the geometry of the structure should be regular. Having said that, there ought to be certain departures from the ideal situation since member stiffness across the building would also not be uniform. He encouraged to undertake some manual exercises to make primary evaluation. Where it in not possible to completely remove the plan irregularity, it is to be ensured that the mass per unit area and the stiffness per unit area of the building across the entire plan is same.

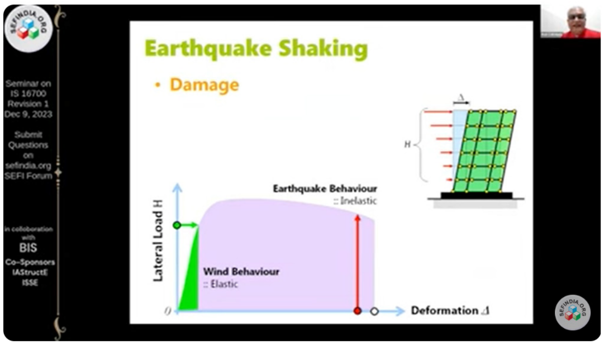
Currently the structures are being designed against earthquake considering configuration, stiffness and strength, but it is time to also plug in the concepts of ductility and deformability in the design workflow, which will be important to ensure no collapse of the structure. The future is defining the collapse mechanism and understanding energy dissipation of the structure.

Of the major loads acting on a structure, some are force loads while others are displacement effects. Adequate attention shall be given to the latter, especially for tall buildings. Earthquake shaking will be a point of concern for tall buildings because the level of shaking will indicate the deformation demand imposed on the structure. This is quite differerent from how the wind loads are to be accounted for. There is a common practice to design for one zone higher in case of earthquake, however, this may not always be a safe design to perform because the deformability of the structure is the key and if this is not satisfied, the design may be futile in the eventuality.

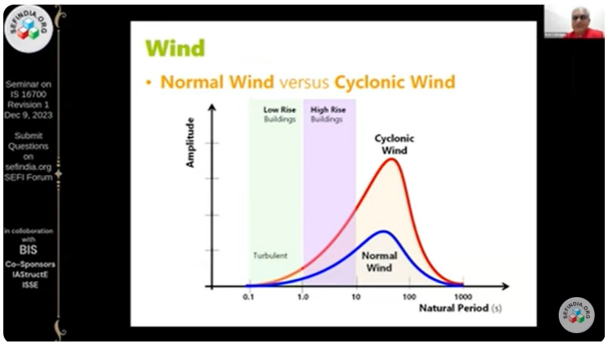


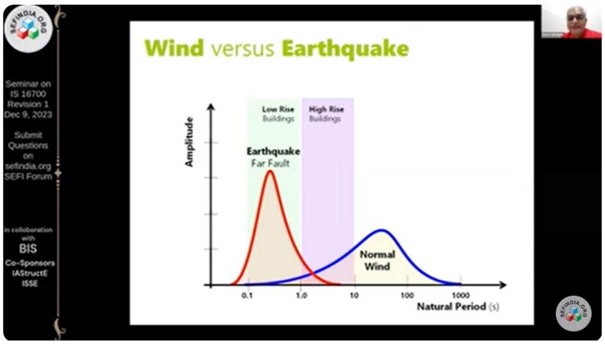


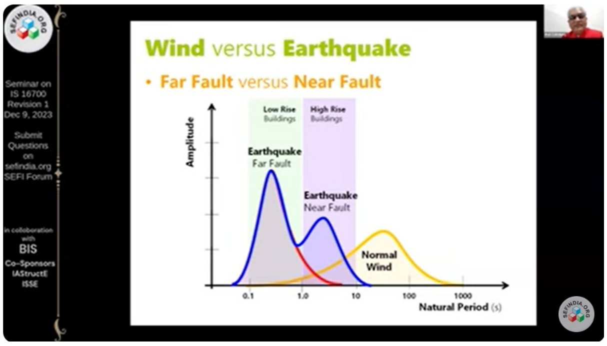




When it comes to analysis under wind load, during cyclones the frequency and the amplitude will change as compared to normal wind. However, when it comes to comparison with earthquake, the amplifications are much different for far fault earthquakes in case of low building heights. As we make the buildings taller, the effect of wind becomes more pronounced. However, in the near fault region, this logic does not hold good and earthquakes play a significant role in the design process.

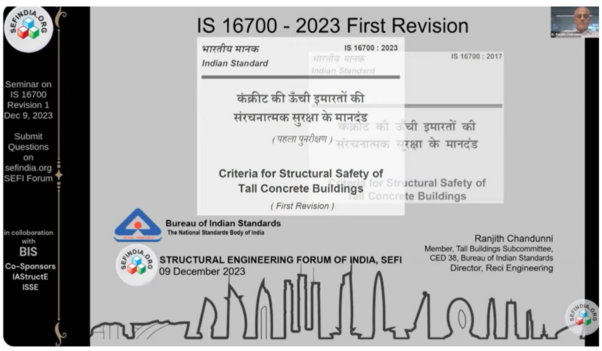




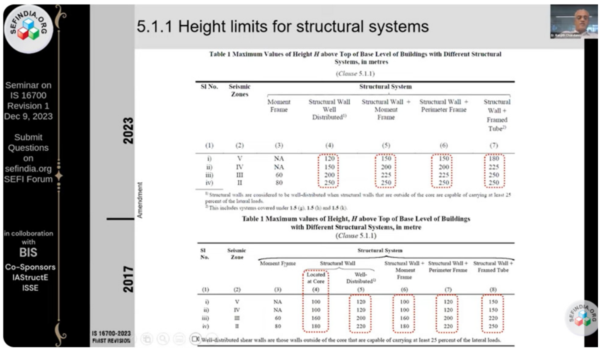


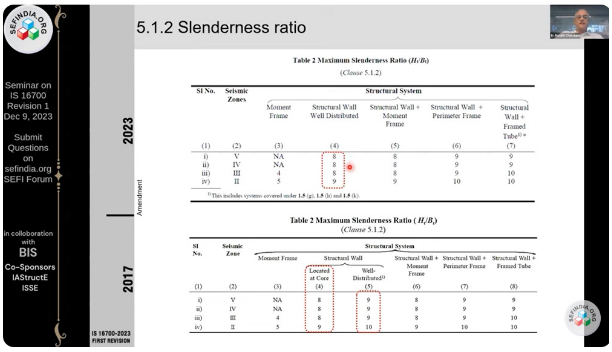
In conclusion, Prof. Murty encouraged the use of adequate size of structural members, specially building columns since large size of the columns will take us to the possibility of less or no damage under earthquake shaking.

Mr. Ranjith Chandunni (Director, RECI Engineering) in his deliberation focused on the major changes that have been made during revision of IS 16700. He mentioned that the intent of the code has remained the same – setting prescriptive parameters for satisfactory design of tall buildings with certain exceptions for the designers, provided there are checks and balances in place. Major changes which have been considered in the revision of this standard is with respect to the modification to the structural systems, wind load return period for serviceability, some changes to the vertical and lateral floor acceleration, there is a new expression for the estimation of time period, P-Delta load combinations have been specified, modification to the expression for interstorey drift stability coefficient, some changes with respect to the thickness and reinforcement for structural walls in high seismic zones and minor changes to the approval process.



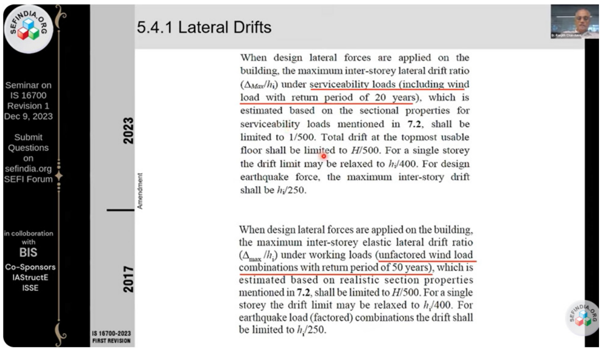
Regarding the structural systems, the earlier standard had structural walls with well distributed systems and walls located in the core area only. In the revised standard, the latter system has been dropped due to the fact that the redundancy offered by the core only system is less than the well distributed system and in case something goes wrong with the core only system, there is no alternative system to address the shortcoming. There is also a revision to height restriction of the buildings for all seismic zones. Except for moment resisting frames, the allowable building heights have been increased to 250 meter in Zone II and as the zones go higher, the building height reduces. Changes have also been made in the slenderness limits.

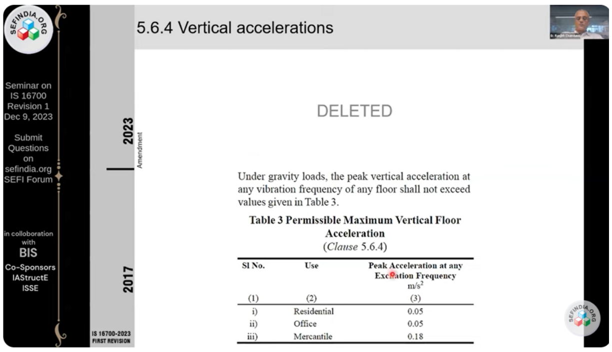




With regard to the lateral displacement due to wind, the return period has been modified to 20 years against the earlier value of 50 years. This lower level is followed for serviceability requirement, whereas for strength requirement, the earlier recommendation holds good.

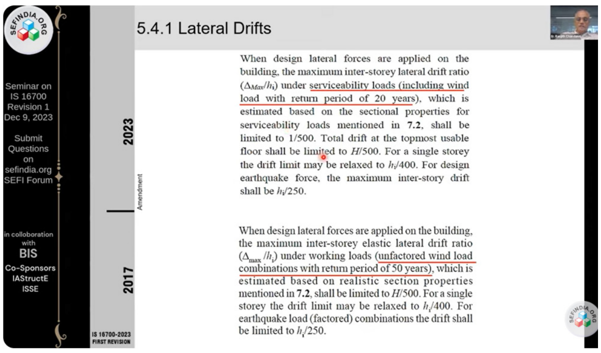
With regard to the floor acceleration, there was a requirement for peak floor accelerations, setting the limit for various types of usage. In the new standard, this requirement has been taken out completely. The requirement for floor frequency is still there as 3 Hertz.

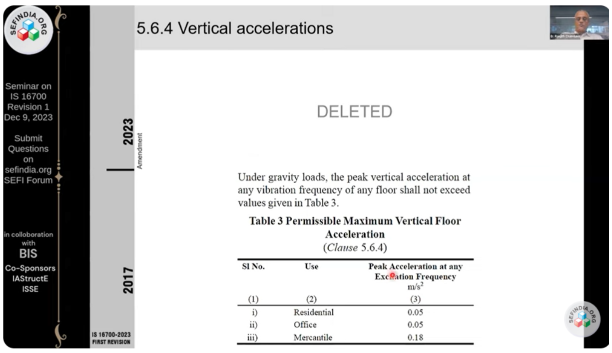




With regard to reinforcement, there was a requirement of the ratio of actual strength to design strength. This requirement has entirely been shifted to IS 13920. Also, earlier, the diameter of bar for use of couplers have been increased to 20 mm from 16 mm as in the earlier version.

Similar to vertical acceleration, there was a requirement of horizontal acceleration for any floor under wind load. The permissible value of allowable horizontal acceleration has been revised to 0.18 m/s2 for residential against the earlier value of 0.15 m/s^2. For commercial buildings, the limit has been set as 0.25 m/s^2.



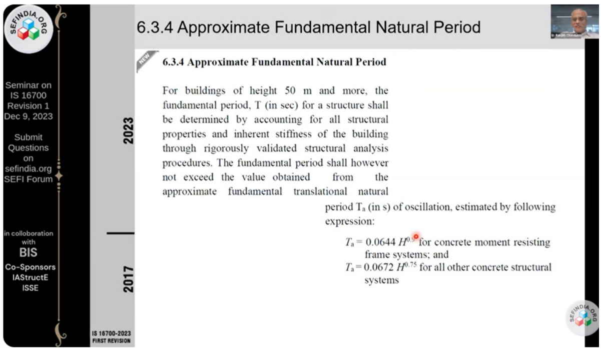


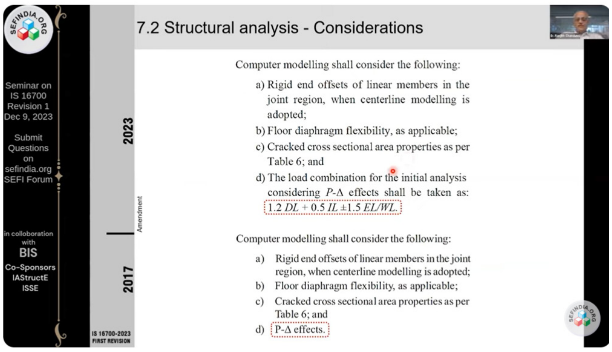
For buildings in sesmic zone V, the deterministic site specific design spectra has been made optional while the same has been withdrawn for zone IV.

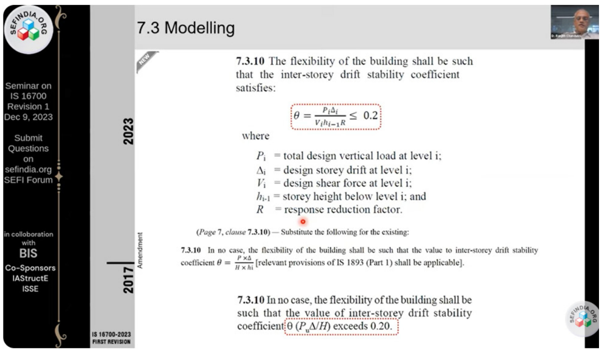
A new addition to the standard is the fundamental natural period for moment resisting frames and other systems. For structural analysis, the P-Δ effects had been made mandatory for analysis and design of tall structures in the earlier version of the standard. In the revision, the initial load combination has been specified.

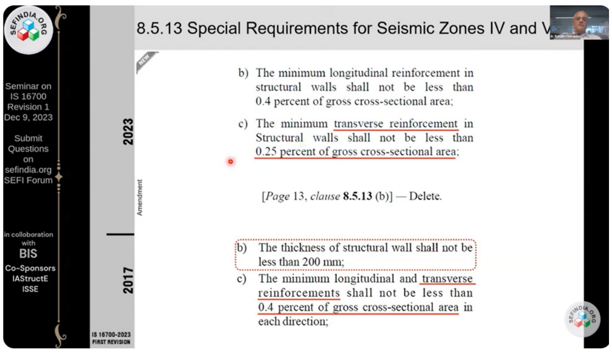
There is limit to the flexibility of the building in the form of inter storey drift stability coefficient, which has been elaborated with respect to the earlier version. With reference to the seismic detailing in high seismic zones, the earlier version had the requirement of minimum wall thickness of 200 mm and both longitudinal and transverse reinforcements as 0.4 percent of gross corss cross-sectional area. In the revision, the requirement of minimum thickness has been removed and the transverse reinforcement requirement has been relaxed to be 0.25 percent, the longitudinal reinforcement requirement remaining unchanged.

The requirement of flat slab structural wall systems have appropriately referred to the provisions of IS 1893 while for all issues related to geotechnical aspect, reference has been made to IS 1892.









Additional clauses have been provided in the annexure to address the approval process for tall buildings not meeting the requirements of the standard.

Er. Alpa Sheth started her deliberation with a very important perspective that only a handful of countries across the globe have dedicated standards for tall building design while for other countries, these are generally integrated into other standards. She highlighted that the standard is targeted more towards the practicing engineers who can appreciate and implement the standard more effectively than fresh graduate engineers.

She added that any provision of this standard which is deviated from IS 1893 or IS 13920 shall be appreciated and adherence shall be made to IS 16700 for tall buildings.

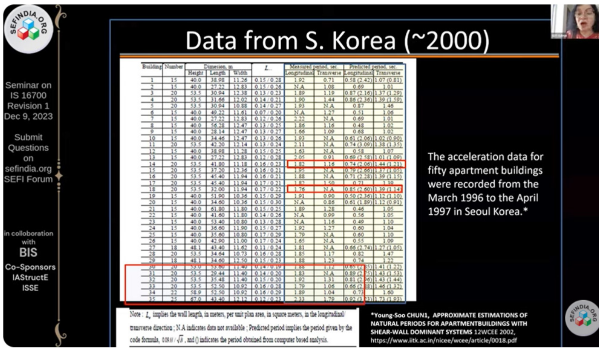
As per Er. Sheth, more than half of the tall buildings in India do not follow all the prescriptive requirements of the standard and there is no system for approval of these buildings. This is because the approval system requires to onboard building authorities having jurisdiction and presently, there is no such framework in place.

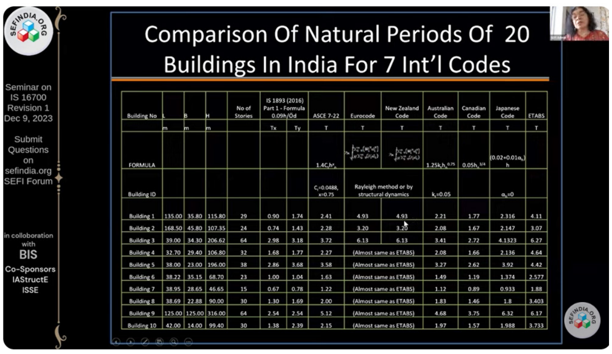
While she touch-based upon the major changes in this revision of IS 16700, the focus for the session was mainly on the genesis of the empirical equation for natural period. In the 1990s, the high rise building would be 8 to 10 storeys with thick internal partition walls of brick or concrete block masonry with conventional formwork systems, concrete walls were mostly restricted to elevators. As we transitioned into the 2000s, not just high end residentials but also the regular residential structures have gone up to as high as 20+ storeys. There has been changes in the materials used as well in the construction methodology which has witnessed a change to modular construction to address the speed, labour shortage and ensure consistency in the quality of work. Due care must be exercised to ensure that the partition walls are so designed that they do not participate in the load transfer mechanism.

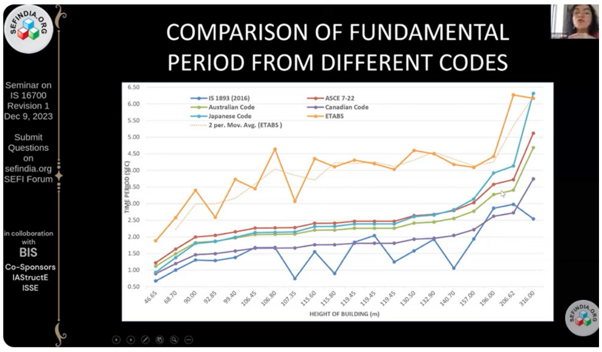
Er. Alpa Sheth mentioned that the current equation for deriving the fundamental period of a structure as per IS 1893 has been inspired by global standards and is essentially applicable to buildings up to 50 meters. She took reference of how the global standards have also evolved for tall buildings and here she highlighted the work carried out in Kores back in 2000 wherein the acceleration data for 50 apartment buildings were recorded. It was observed that there was a striking difference between the predicted natural period and the actual value. Similar activity was also taken up in Hong Kong few years later.

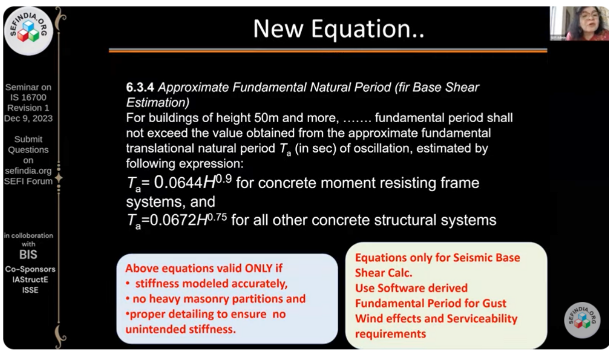
Er. Sheth shared the outcomes of her exercise wherein she had undertaken to prepare a comparative of the time period corresponding to different international standards for 20 buildings of different heights. It was observed that the ASCE gives a marginally higher fundamental period than the other standards which has also somewhat inspired the revision of IS 16700. It was also observed that there is a clear mismatch with what is actually modelled. While we calculate the time period with the empirical, it should be noted that the same is valid if the stiffness is accurately modelled, there is no heavy masonry partitions and there is no unintended stiffness.

Alternatively, it can be said that the structure should be designed at least for the value of the base shear as per the formula which will possibly give a lower time period than what the software analysis would provide.









Mr. Anil Hira (Buro Happold) added that the IS 16700 is not a prescriptive document which gives direction as to how to design, rather it is a document which forms the basis for being on the right track for compliance. With further inputs and experience, it can be further expanded and also modified as the need be. He encouraged that the first step is to get the concepts clarified, instead of focusing too much on the analytical model. Our effort should also be consistent to minimize the carbon footprint on the environment and build efficient buildings.

Dr. R Pradeep Kumar (President IAStructE) in his deliberation mentioned that the standard is very streamlined in terms of its recommendation for building height and slenderness ratio based on seismic zone and also the type of building structural system to be adopted. However, it is still little conservative in terms of the recommendation for natural period. And this would lead to more robust structures and as a result leading to higher carbon footprint. His recommendation was to test the buildings which are being constructed in India, gather the data and come up with more accurate natural period. This is no longer a challenge since we are well equipped, and the technology knowhow is available. He added that the clause on code exceeding building within the code could be misleading in few cases and requires adequate explanation. Also, more clarity would be required for the expert review panel and the criteria thereof.

Mr. Shanti Lal Jain (President ISSE) added that standards are getting developed but the implementation on ground is still a challenge. His recommendation was to BIS to create awareness among the practicing engineers. Another perspective was to also introduce a guideline for architects and approval bodies, so that the correct knowhow is available with the right stakeholders.

This was followed by a very detailed panel discussion and the questions were duly addressed by the esteemed speakers and panelists.

STRENGTHENING URBAN RESILIENCE: INSIGHTS FROM NIDM AND DDMA'S TRAINING PROGRAM

In a concerted effort to fortify urban areas against the growing threat of disasters, the National Institute of Disaster Management (NIDM), in collaboration with the Delhi Disaster Management Authority (DDMA), organized a three-day training program on "Developing Disaster Risk Resilience in Cities for Urban Local Bodies." This comprehensive initiative, held from December 27 to 29, 2022, aimed to equip senior officials from diverse government departments with the knowledge and strategies essential for enhancing disaster resilience in urban landscapes.

The three-day training program by NIDM and DDMA proved to be a pivotal step towards creating disaster-resilient urban areas. The collaborative efforts of senior officials from various government departments, coupled with expert presentations, exemplify a commitment to building safer and more resilient cities in the face of evolving environmental challenges. The insights gained from this program will undoubtedly contribute to a more prepared and resilient urban landscape.