Indian Association of Structural Engineers

Join The Panel Discussion On

Draft Code IS 1893 (Part 1) General Provisions

June 17, 2023 (Saturday) at 4:30-6:30 PM (IST)

Lead Speaker

C. V. R. Murty
IIT, Madras

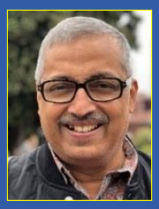
Panelists

Rupen Goswami
IIT Madras

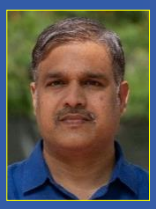
Alpa Sheth
VMS Consultants Pvt Ltd.

Praveen Khandelwal
NTPC

Moderators



Alok Bhowmick
Past President, IAStructE



R. Pradeep Kumar
President, IAStructE

S. T. G . Raghukanth
IIT Madras

I. D. Gupta
Former Director, CWPRS, Pune

D. Srinagesh
Prof of Practice, IIT Madras

About The Panel Discussion

With rapid strides in earthquake engineering in the last several decades, the seismic codes world over are becoming increasingly sophisticated. Indian seismic codes are no exception. The first Indian seismic code (IS 1893) was published in 1962 and it has since been revised in 1966, 1970, 1975, 1984, 2002 and 2016. The code is once again revised and the revised draft is currently in wide circulation for comments from wider community. The Part-1 of current code is split into two parts in revised version. Part-1 containing general provisions (applicable to all structures) and Part-2 specific provisions for buildings has been published.

This time, the revision of the seismic code is a quantum jump and brings in many significant changes, introducing many advances that have occurred in the knowledge related to earthquake-resistant design of structures over the last 20 years, since its publication in 2002. Some of these new developments have been incorporated in the 2016 version of the code, while many others have been left out so that the implementation of the code does not become too tedious for Indian professional engineers.

IAStructE is happy to organise a panel discussion on the Draft IS 1893, in two sessions, where the code makers and experts, who piloted this revision, will look at the process of development of the draft code IS 1893 (Part-1) and IS:1893 (Part-2). In the first panel discussion on 17th June 2023, the eminent panellists will discuss the main changes that are proposed in Part-1 of the revised code. This will be followed by an interactive session where participants can directly ask questions to the esteemed panellists and clear their doubts.

ABOUT IAStructE

Indian Association of Structural Engineers (IAStructE) is a national apex body of structural engineers established two decades ago with the objective to cater to the overall professional needs of structural engineers.

DRAFT CODE IS 1893 (PART 1) GENERAL PROVISIONS

With rapid strides in earthquake engineering in the last several decades, the seismic codes across the world are becoming increasingly sophisticated and the Indian seismic codes are no exceptions. The first Indian seismic code (IS 1893) was published in 1962 and it has since been revised in 1966, 1970, 1975, 1984, 2002 and 2016, and now the code is once again revised. This time, the revision of the seismic code is a quantum jump and brings in many significant changes, introducing many advances that have occurred in the knowledge related to the earthquake-resistant design of structures over the last 20 years. In order to discuss the developments, IAStructE has organized a panel discussion on IS 1893 (Part 1) on 17th June, 2023 where experts who contributed for the development of the code participated in the discussion.

Prof. R. Pradeep Kumar, President IAStructE and Mr. Alok Bhowmick, Past President IAStructE welcomed the esteemed speaker and eminent panelists to the deliberation on the proposed revision of IS 1893. Mr. Bhowmick highlighted that the proposed revision of the standard is a quantum jump and captures many significant changes. The intent of the workshop was to provide better insight into the proposed changes to the structural engineers and also invite their valued suggestions to make the standard more comprehensive

Mr. S. Arun Kumar, Head – Civil Engineering Department (CED), Bureau of Indian Standards (BIS) excellently set the stage for the session and spoke about the massive exercise that was taken up by the national standards' body for the revision of the standard. He mentioned that the promotion of safety is one of the key objectives of standardization and in line with the objective, standards are reviewed and updated to imbibe the practice and define clear provisions, thereby providing a framework for future technological development. IS 1893 has seen multiple revisions since its inception in 1962. In this revision, the standard is developed in 2 parts – the first part deals with the general provisions and the second part highlights the design requirement.

He added that in 2010, the Government of India published its first probabilistic seismic hazard map of the nation. Over the years, other countries have codified them in way of their national standards. Hence, the CED-39 committee, which is responsible for the development of earthquake-related standards in the country, decided to include the PSH map of India in the current revision of the standard. During the development of this standard, extensive research work was taken up at IIT Madras under the patronage of the National Disaster Management Authority (NDMA). The PSH map and the rationale have been very explicitly spelt out in the standard and pave the way for any future research work and development.

Prof. C.V.R. Murty, Chairman of the CED39 Committee, started his talk by mentioning that the focus of IS 1893 is earthquake hazard and hence the implications can also be traced to the upcoming revisions of IS 13920 and IS 13935. The mandate from BIS is to undertake comprehensive harmonization of all standards related to earthquake safety and hence all parts pertaining to the dominant set consisting of IS 1893, IS 13920 and IS 13935 will be sequentially taken up for publication.

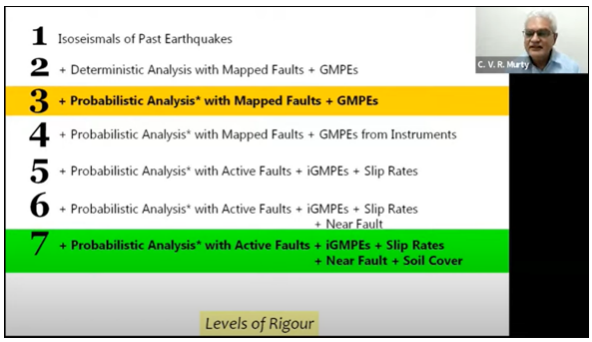
Prof. Rupen Goswami, IIT Madras reinforced the same message in his lecture. Prof. Murty mentioned that the motivation for this revision came from the past earthquakes and the loss of life which occurred due to them. As per statistical analysis, about 50,000 lives have been lost in India in the last 35 years due to earthquakes. Both Prof. Murty and Dr. D. Srinagesh, IIT Madras took reference of the 1967 Koyna earthquake, 1993 Killari earthquake and 1997 Jabalpur earthquake which have been shown to spring surprises and cause extensive damage.

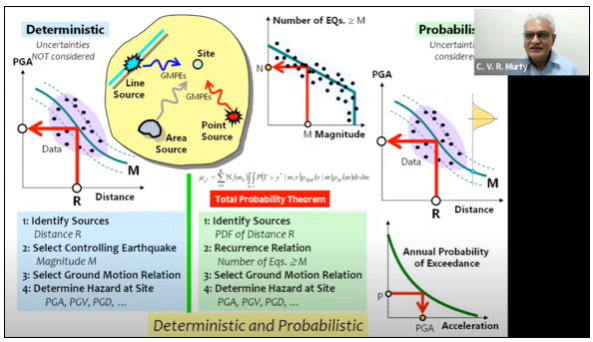
Prof. Murty added that the earthquake zoning of the country has undergone an evolution from 1962 when there were 7 zones, which then got modified to 5 in 1984 and further compressed to 4 in 2002. All the earlier versions were motivated by the MSK intensity that was experienced by different parts of the country and then isoseismal was used as the basis for zonation. He identified three gaps in the current framework –

1. Insufficient data on the past earthquakes
2. Underestimated earthquake hazard in the part
3. Insufficient instrument to record strong ground motion in future earthquakes

Dr. I.D. Gupta, former Director, CWPRS Pune, also mentioned that the zone boundaries in all previous maps were demarcated from a limited number of observations and zone factors were decided based on engineering judgement, rather than ground motion analysis. Such maps were qualitative and subjective in nature, without explicit use of the source.

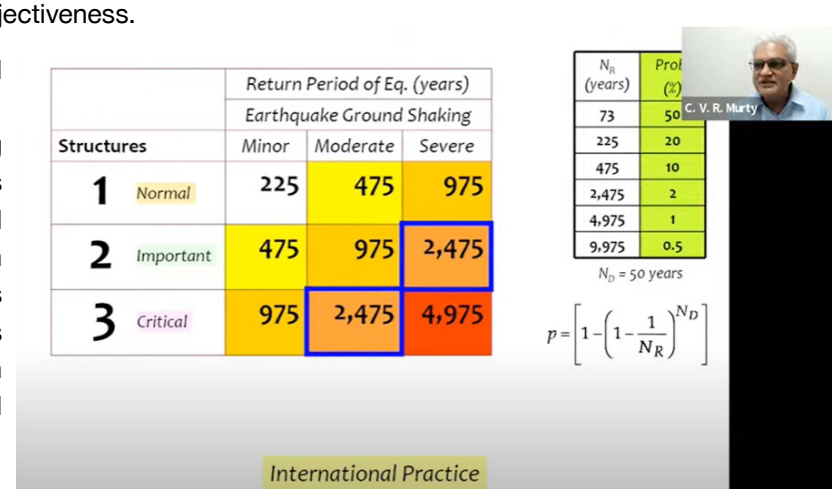
Looking at the earthquake hazard assessment levels, Prof. Murty mentioned that the current proposal is to include both probabilistic and deterministic assessment as the baseline. The way forward is to include the ground motion derived from instruments, capture active faults, and understand the slip rates and near-fault effects, which have become prominent in recent times





Dr. I.D. Gupta added that the need to refine the standard arose since the state-of-the-art methodology had been established as the PSH approach in the late 1990s in the United States. A probabilistic map of India was published in 1999 under GSHAP and the same is now being realized in practice. PSHA is a fully quantitative approach based on sound mathematical principles and models developed using available data, with minimal subjectiveness.

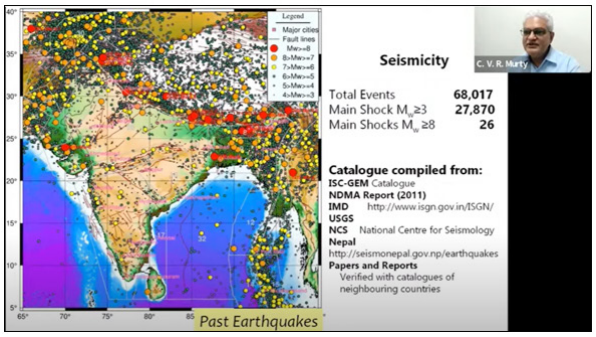
The PSHA estimates the ground motion at a place which has a 2% probability of exceedance during its design life (considered as 50 years). Looking at international practices, a significant decision was that severe earthquakes which are used as a basis for design have been taken corresponding to a return period of 2,475 years.

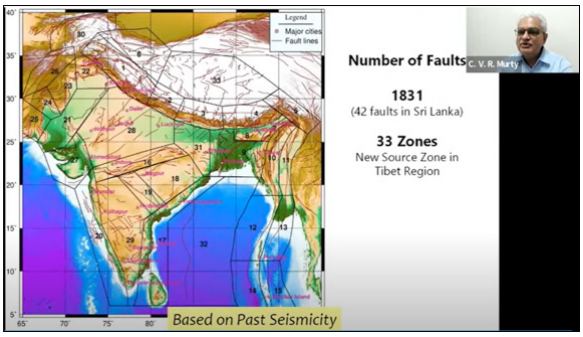


The PSHA method performs this by modelling possible seismic sources and defining an earthquake occurrence model for each source. Thus, the first step in carrying out the PSHA was to identify the seismic sources. Based on the past occurrence of earthquakes from different sources, a catalogue was prepared. Prof. Murty and Dr. I.D. Gupta touched base upon the observation that more than 27,000 earthquakes of magnitude 3 or more have hit the landmass of India with 26 events having a magnitude of more than 8. The Shillong earthquake, the Kangra earthquake, the earthquake at the Bihar-Nepal border and also the one in Arunachal Pradesh formed the basis for deciding the zones. The landmass has been divided into 3 regions – the Himalayan segment, the Indo-Gangetic segment, and the continental base for prediction of ground motion. India and its neighbouring landmass have been divided into 33 seismogenic source zones. For each of these sources, the relevant parameters have been extracted and used as a basis for quantitative assessment.

For probabilistic hazard assessment, peak ground acceleration, peak ground velocity, peak ground displacement and corresponding contours were considered.

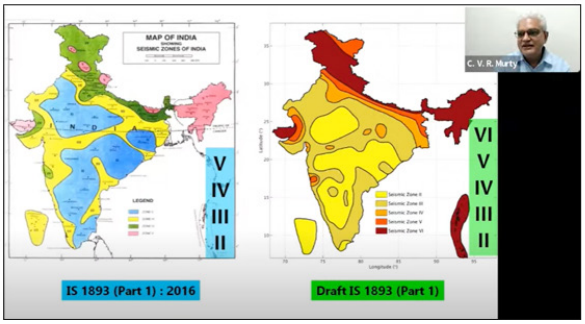
An earthquake recurrence model was developed for each zone and this resulted in improved hazard distribution as compared to previous practice.

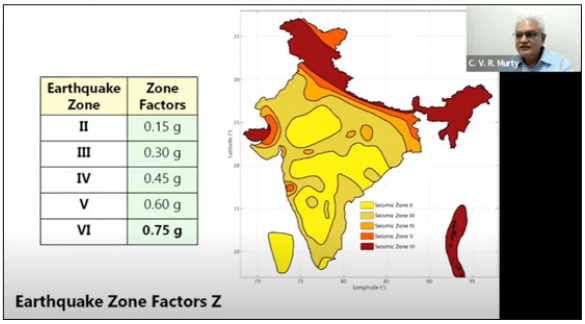




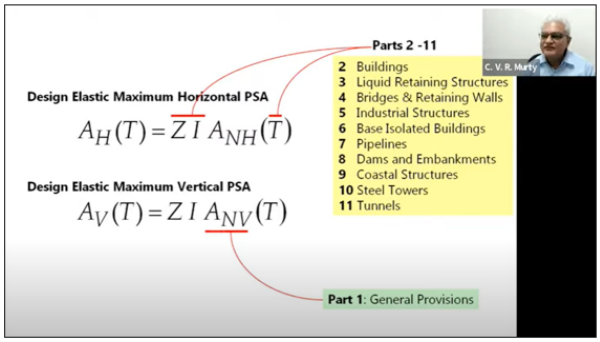
Prof. Murty added that considering earthquake as a natural phenomenon and uncertainty of its place of occurrence, the approach of taking median value as the base has been adopted and a return period of 2,475 years forms the reference. Background seismicity has been considered for all 33 regions and results were validated basis input received on different ground motion prediction equations (GMPE).

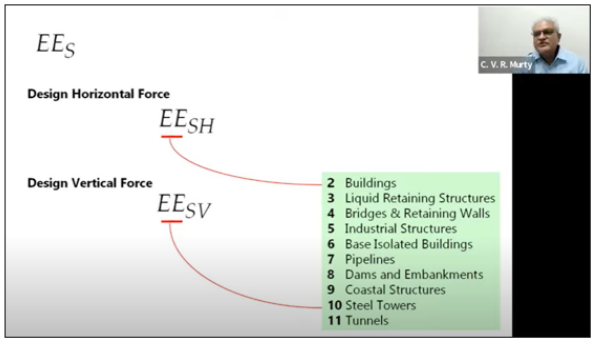
The seismic zone map of India that was derived was superimposed on the seismicity of the country and found to be fairly consistent with earlier events and also with the fault lines. As per the new standard, there are 5 seismic zones – Zone II to Zone VI with the PGA values ranging from 0.15g to 0.75g at increments of 0.15g.





The design elastic maximum pseudo spectral acceleration (PSA) is a function of the zone factor, importance factor of the structure and the normalized spectral shape. The design force is calculated by dividing the PSA by the response reduction factor.

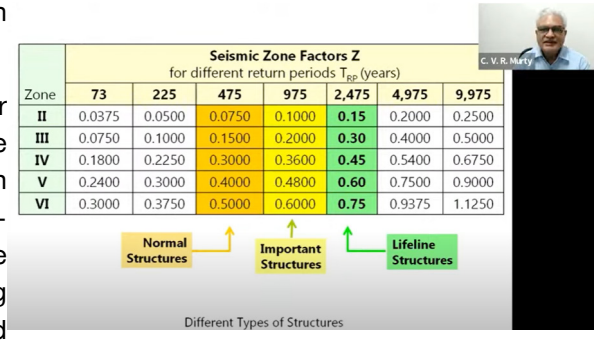




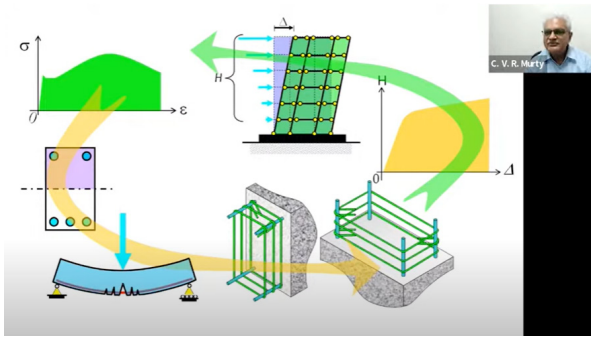
Prof. Murty added that certain modifications have been made in the load combinations to be considered for both strength and serviceability criteria. Another welcome addition is the inclusion of safety factor for soil design under earthquake shaking for different types of structures. Another significant addition is the soil structure interaction in the design provision.

Another important aspect which has been addressed in the modification of the standard is the closed loop design process which highlights the likely behaviour of a structure and the estimation of damage location.

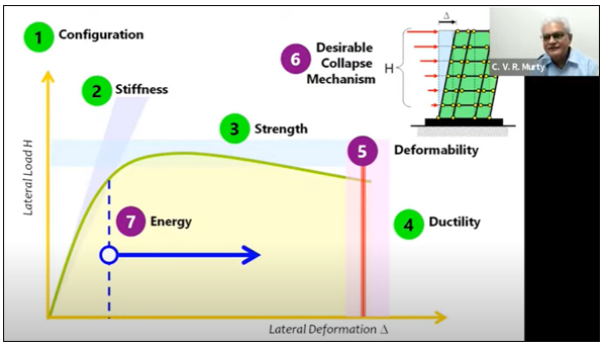
This will form the basis of earthquake retrofit which will be addressed in the revision of IS 13935.

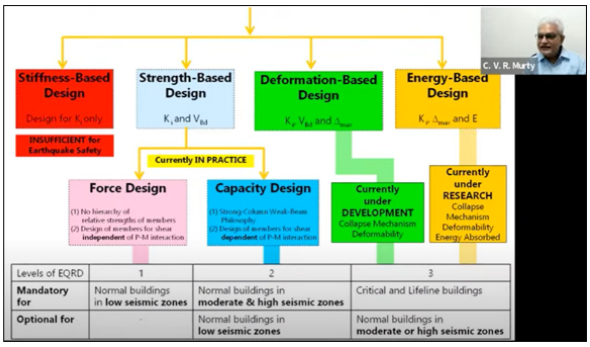


Earthquake-resistant design has progressed over the years and from strength-based design, we transitioned to capacity design in the last revision of the standard. In the current draft, a deformation-based design has been introduced for the purpose of retrofitting. There is a graded use of it, depending on the normal buildings, important buildings, and critical buildings. Earlier the design philosophy was based on 4 virtues – configuration, stiffness, strength, and ductility. Ductility was never quantified but assumed to be achieved if the prescribed detailing was followed. In the current standard, the aim is to estimate the deformation and establish that the demand is less than the capacity, implying the structure will not collapse (at least for critical structures). Revised clauses, addressing the requirement of liquefaction of soil have also been presented.



The last important addition is the concept to protect the architectural elements and utilities in the building to protect life and assets.





Prof. Raghukanth, IIT Madras mentioned that lot of advancement has happened in the subject of seismology and hazard analysis. Some of the earthquakes recorded ground motion as high as 1.0g in the epicentral region and very close to the faults. The recent Turkey earthquake also demonstrated the same. With extensive research going into the subject, much clarity has been built around the topic and all this information has been pulled up to refine the standard with a more consistent approach.

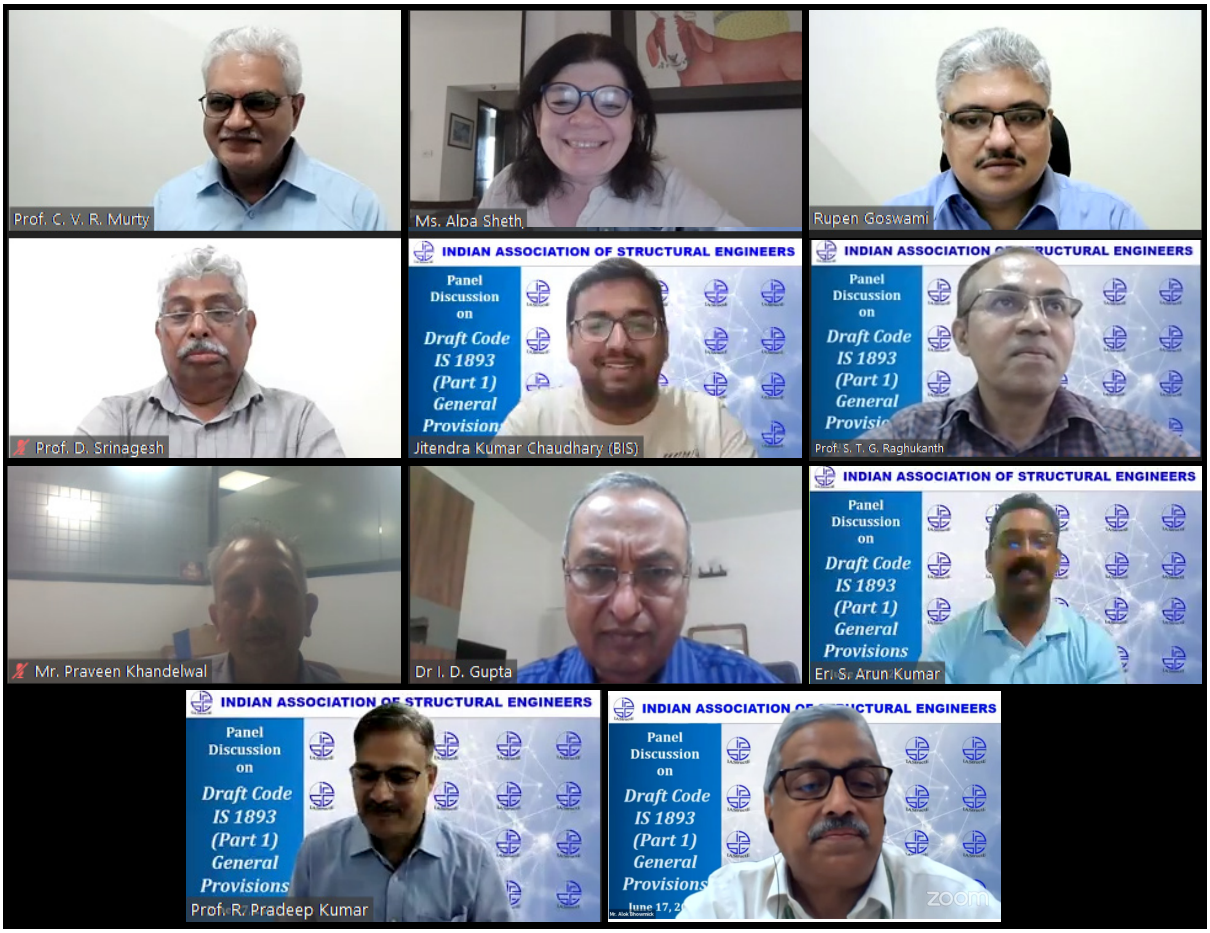
Prof. Rupen Goswami added that it is not recommended to compare zone factors with previous editions of the standard, since they are not based on the same philosophy. Also, it is evident that there will be an increase in the design forces in certain cases, but this should be a reason to panic. He encouraged that with the proposed design standard, there is much more rationale being built into the approach and is optimistic that engineers will come out more confident with their designs.

Mr. Praveen Khandelwal, NTPC appreciated the great initiative to put all information related to earthquake engineering in one place and this will help the stakeholders by and large. The code is a visionary approach towards defining the limit state and is very structured. He highlighted that where the zone factor is not changing, the increase in seismic force is not extensive. Even though the zone factor is increased, the factored load will increment will compensate for the same, owing to the revised load combination. In industrial structures, where the civil cost is comparatively less, the cost implication for a change of code is minimal and does not alter the economics drastically. For buildings where the civil

cost is on the higher side, a change of seismic zone for a specific area may lead to an increase in the project cost.

Ms. Alpa Sheth, VMS Consultants Pvt. Ltd. appreciated the concern of practising engineers about the design process and the cost implication the revised standard would have. She encouraged the adoption of the new standard with thorough understanding. She added that the past is not necessarily an indication of the future and if we have not seen earthquakes in the past, it is all the more concerning, since there is more stress concentration built at the fault.

The discussion was followed by a panel discussion where panelists addressed the questions raised by the participants. Mr. Jitendra Chaudhary, Member Secretary – CED 39, BIS gave closing remarks. Finally, Prof. Pradeep proposed a vote of thanks and requested all the participants to register for the second-panel discussion which is scheduled on 1st July, 2023 focusing on IS 1893 (Part 2): Buildings.



4,700 EARTHQUAKES OVER 72 HOURS!

Spreads Concern of Impending Volcanic Eruption in Iceland

The area surrounding Reykjavik – capital city of Iceland has experienced an extraordinary number of earthquakes in the past 72 hours, raising concerns of an imminent volcanic eruption, as per the Icelandic Meteorological Office (IMO).

As per a report by news agency AFP, approximately 4,700 earthquakes have been recorded beneath Mount Fagradalsfjall located on the Reykjanes Peninsula. And the largest earthquakes have been felt in the Southwest part of Iceland. This region has witnessed two eruptions in the past two years.

Iceland is Europe's largest and most active volcanic region. It is situated on the Mid-Atlantic Ridge, a geological feature separating the Eurasian and North American tectonic plates.