STRUCTURAL ENGINEERING

QUARTERLY JOURNAL OF

INDIAN SOCIETY

OF

STRUCTURAL ENGINEERS

ISSE

VOLUME 21-1 JAN-FEB-MAR 2019

GEM 19 PROF. DAVID P. BILLINGTON WHO PIONEERED STRUCTURAL ART

CSMT Foot over bridge collapse and structural audit – Structural Engineers' View point

13 Feb 2019 : Meeting with Hon. Minister Shri Ranjeet Patil at Mantralaya

9 March 2019: ISSE Site visit to Sardar Sarovar Dam and Statue of Unity

26 Feb 2019 : Inauguration of ISSE Student chapter at Chameli Devi Group of Institutions, Indore

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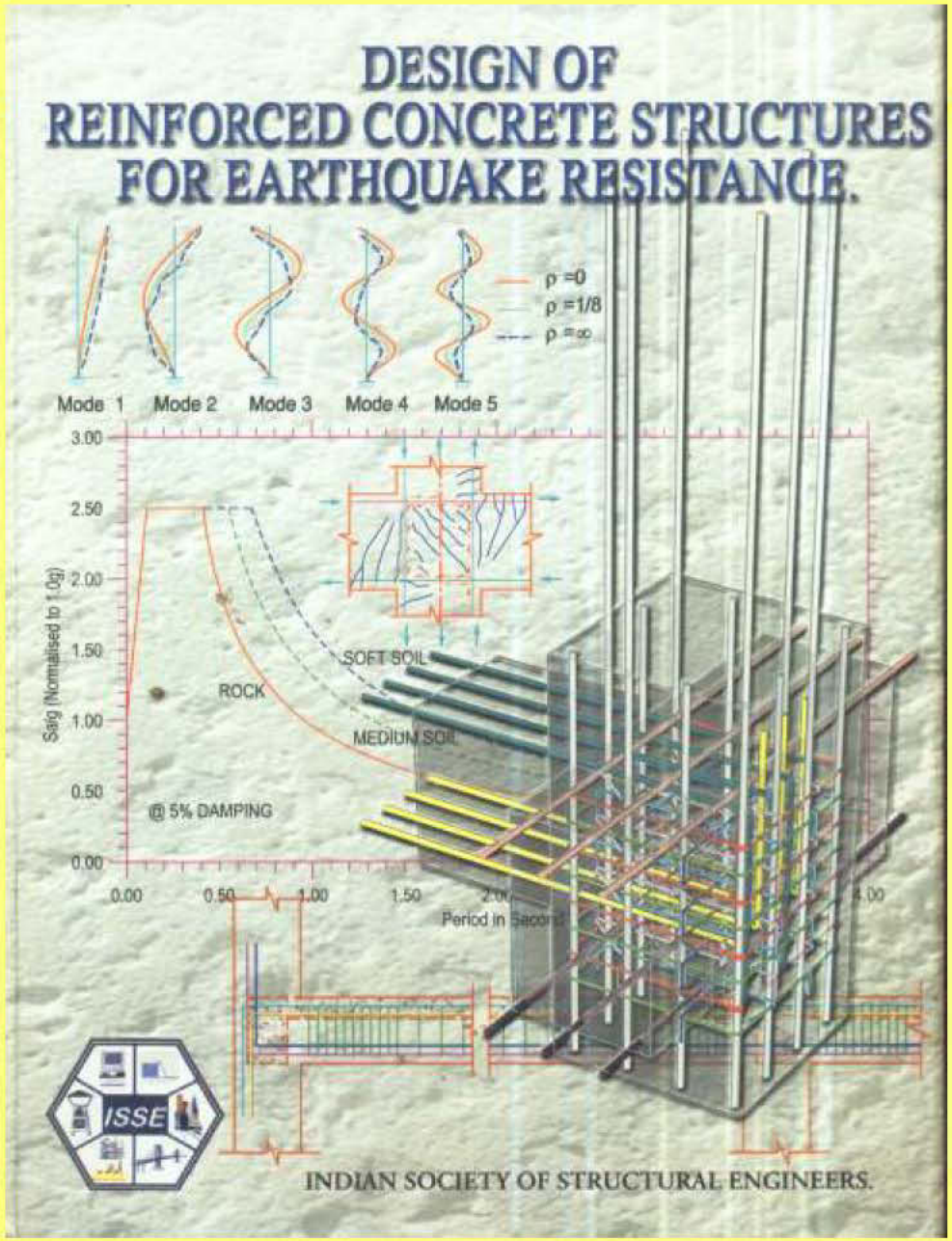

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TO

DESIGN OF REINFORCED CONCRETE STRUCTURES FOR EARTHQUAKE RESISTANCE
by Mr. D. S. JOSHI et al, MUMBAI

The book *Design of Reinforced Concrete Structures for Earthquake Resistance* is written by a team consisting of Mr. D. S. Joshi, Mr. R. L. Nene, Mr. M. D. Mutay, Mr. S. Salgaonkar and Mr. N. D. Joshi. It is published by Indian Society of Structural Engineers (ISSE), Mumbai, in the year 2001. All the authors are structural engineers and are members of ISSE committee for Standards and Codes. The team leaders, viz. Prof. D. S. Joshi and Mr. R. L. Nene are highly experienced and eminent structural consultants.

In the 12 sections that the book has, the subject has been dealt with very ably from the point of view of structural consultants and the book aims to provide in a consolidated form, information available in India and abroad. The book discusses mainly the IS codes by pointing to salient features concerning the seismic design with figures, pictures, details and references along with the filtered recommendations by the ISSE as a summary. Starting from a section on causes of earthquakes in the context of Hindu Mythology, the book covers in its various sections, the anatomical aspects of structural framing system, principles for determining design earthquake forces, the clauses in the relevant IS and other codes, important aspects of ductility, stiffness, strength and capacity design of buildings to resist earthquakes. There is one section called 'open forum' where various questions commonly asked by both public and technical persons on various aspects of earthquake design, have been dealt with explicit answers. There is a noteworthy section which includes a practical designing example of an eleven storey residential RC building, giving step-by-step procedure with explanations, covering all aspects, which would benefit particularly the young design engineers.

The purpose of this book has been to present a logical and practical basis for the design of RC buildings against earthquake forces. The book has more than 300 pages and is enriched with more than 250 coloured figures and photographs (with high quality production and printing) to make it interesting and easily understandable.

The Awards Committee and the Governing Council of ACCE confer the ACCE Nagadi Award 2004 for Best Publication in Civil Engineering to Design of Reinforced Concrete Structures for Earthquake Resistance by Prof. D. S. Joshi et al. on 17th June 2004.

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STRUCTURAL ENGINEERS

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Fraternity News

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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.

GEM 19 PROF. DAVID P. BILLINGTON WHO PIONEERED STRUCTURAL ART

By Dr. N. Subramanian and Er. Vivek G. Abhyankar

Prof. David P. Billington (1927-2018) (Photo: Brian Wilson)

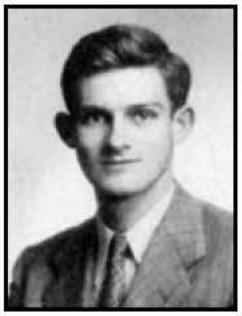
Prof. David P. Billington, the Gordon Y.S. Wu Professor of Engineering Emeritus at Princeton University, pioneered the discipline of structural art, evaluating artistic expression under the practical constraints of structural engineering. His work inspired a generation of scholars and redefined great engineering works such as bridges and buildings from the perspective of structural art.

"The disciplines of structural art are efficiency and economy, and its freedom lies in the potential it offers the individual designer for the expression of a personal style motivated by the conscious aesthetic search for engineering elegance," Billington wrote in his 1983 book The Tower and the Bridge.

In ten books and many journal articles, Billington explored the works of innovators who designed graceful structures,with a particular focus on bridges. Michael Littman, a professor of mechanical and aerospace engineering and a longtime colleague, said Billington had a historian's breadth of knowledge and an engineer's disciplined focus.

ENGINEERING EDUCATION AND RESEARCH

David Perkins Billington was born in Bryn Mawr, Pennsylvania, on June 1, 1927.He spent one year in the U.S. Navy.



Young Billington

Billington began his studies at Princeton University in 1946 where he enrolled in a program called Basic Engineering and earned his BSE degree in 1950. After graduation, he received a Fulbright scholarship that enabled him to spend two years in Belgium, where he studied civil engineering. In the second year of his Fulbright scholarship in Belgium, he had the opportunity to work with Professor Gustave Magnel, a major figure in the development of prestressed concrete. In those days, Prof. Magnel's Laboratory was known worldwide for its advanced research on prestressed concrete and many visitors travelled to Ghent to become acquainted with this new technique. Billington was involved in a research project on the dynamic testing of self-anchorage in a prestressed concrete beam, under the supervision of Prof. Magnel

PROFESSIONAL EXPERIENCE

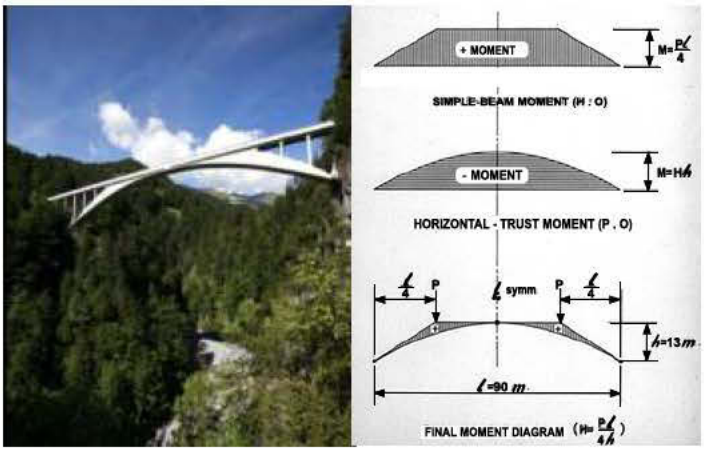
In 1952 Billington began to work for the Roberts and Schaefer Company, consulting engineers in New York City, where he spent eight years as a structural engineer designing bridges, aircraft hangars, piers, thin-shell tanks and rocket-launch facilities. In 1958, he was chosen to be a member of the six-man American delegation to Russia to observe concrete construction.

HIS WORK AT THE PRINCETON UNIVERSITY

Billington was a Visiting Lecturer for two years before joining the full-time faculty of Princeton University in 1960. In his early years at Princeton, Prof. Billington taught civil engineers and also a structural engineering class to students of architecture. In 1966, he was a Visiting Professor at the Technical University of Delft in the Netherlands. He was a Visitor to the School of Historical Studies at the Institute for Advanced Study in Princeton in 1974-1975 and in 1977-1978. In 1984-1985, he was a Phi Beta Kappa Visiting Scholar, the first engineer in the 30-year history of this program. In a 2003 article in the

Princeton Alumni Weekly, Billington recalled how his architecture students grew bored and asked "why structures could not be studied through examples of beautiful works". They showed him photos of bridges that swept like concrete ribbons across gorges in Switzerland.

Billington was fascinated and began his foundational study of the work of the Swiss engineer Robert Maillart. It was the beginning of his lifelong work to recognize engineering as an artistic as well as a technical discipline."Maillart was an artist," Billington wrote in the preface to his 1990 book Robert Maillart and the Art of Reinforced Concrete. He noted that "his major works are exemplars of a new art form prototypical of the 20th century."



Maillart's Salginatobel Bridge- A three-hinged reinforced concrete hollow box girder arch bridge (1930)

Professor Billington taught various courses on structural analysis and design at Princeton University. He also taught a course on structural engineering to graduate students in architecture, as well as two slide-lecture courses in engineering for liberal arts students as well as engineers. In 1974, Prof. Billington began teaching "Structures and the Urban Environment", a course that traces the development of outstanding structures that arose with the Industrial Revolution and its introduction of new materials starting with iron, structural steel, reinforced concrete and finally prestressed concrete. In this course, he emphasized the creativity of the engineer along with the technical content and showed how efficiency, economy, and elegance could be integrated in the best civil engineering structures. This integration became the central tenet of Structural Art. His other course on "Engineering in the Modern World" included other branches of engineering and began in 1985.

Prof. Billington with his bridge model

He found the idea of teaching through elegant examples (rather than abstract line drawings) very appealing. His two slide-lecture courses, which combined the study of engineering with an exploration of aesthetic and social values, were among the most popular on campus for decades. Prof. Billington also explored the humanistic side of civil engineering through conferences that brought together leading designers whose works exemplified the integration of elegance into engineering structures. Billington went on to apply the measure of art found within the strict boundaries of engineering to structures as varied as Othmar Ammann's George Washington Bridge in New York and Félix Candela's Chapel Lomas de Cuernavaca in Mexico City.

His research at Princeton focused on the engineering of large structures, including the design and rehabilitation of bridges, thin shell concrete structures, tall buildings, and concrete dams. He often emphasized the interaction of efficiency and beauty in structural design and the transformative influence engineers had on American society.

He served as the director of the Program on Architecture and Engineering from 1990 to 2008. Twice he was a visitor at the Institute for Advanced Study in Princeton and held summer visitor positions at the Swiss Federal Institute of Technology in Zurich. Billington was named the first Gordon Y.S. Wu Professor of Engineering in 1996, and moved to emeritus status in 2010.

"Billington was magisterial in the lecture hall," said John Ochsendorf, who earned his master's degree

at Princeton in 1998 and is now Class of 1942 Professor of Architecture and Professor of Civil and Environmental Engineering at the Massachusetts Institute of Technology. "We were all spellbound by the force of his arguments, the breadth of his cultural references, the beauty of his images, and of course, the wit of his jokes. To attend a Billington lecture was to be changed forever."

Billington's classes became enduringly popular. According to an estimate, roughly one in five Princeton students attended either "Engineering in the Modern World" or "Structures in the Urban Environment" during their time at the University. In his classes, the students were challenged to evaluate engineering structures in terms of their scientific, social, and symbolic contributions. They learned to apply Billington's standards of efficiency, economy and elegance."Efficiency means minimal materials, economy means minimal cost," Littman said, "elegance means maximum expression."

Eric Hines, a principal at the LeMessurier engineering firm in Boston and a Professor of Practice at Tufts University, earned his BSE at Princeton in 1995. He decided to pursue engineering after taking "Structures in the Urban Environment" at the end of his freshman year at Princeton. He said Billington showed students that engineering could be more than simply functional."This was in line with Billington's thesis of structural art – the design comes out of the engineering imagination; the aesthetics and the design concept are the same thing," he said. "You really had to understand structures at a fundamental level to understand that."

For Billington, the engineering principles behind a structure were the first step in understanding the importance of the work. He often taught designs through simple formulas. In "Engineering in the Modern World," for example, he used the formulas for the horizontal and vertical reaction forces to teach students about design choices in Thomas Telford's Menai Straits Bridge in the United Kingdom. Billington used a classic formula to show students that a suspension bridge, with high towers and deeper cable sag, would require lower strength cables to support the load. The cables would cost less, but the tall towers would cost more. A flatter, shallower bridge would require higher strength cables. In this case, the cables would cost more, but the shorter towers would cost less and give a more elegant profile. It was these types of calculations that governed Telford's design, which created the world's longest span in 1826. Telford's bridges are beautiful and light.

"He made design factors understandable through basic engineering formulas," Littman said. "I know of no scientist or engineer that looked at formulas in the way that David did."

EXHIBITION ON CANDELA'S WORK

In addition to several courses and books - designed for a general audience - Prof. Billington curated eight museum exhibitions, most of which traveled to various museums and abroad. Billington and his Princeton colleague in civil and environmental engineering, Professor Maria Garlock, developed a 2008 exhibition on Felix Candela's work in cooperation with the Princeton University Art Museum. Candela's work often involved constructing thin concrete shells over falsework. A saddle-shape form, called a hyperbolic paraboloid, minimized stresses and provided a stiff and strong structure.

David P. Billington. Photo courtesy Princeton University Office of Communication, Denise Applewhite.

Prof. Billington with models of Candela shells

The result was a supremely efficient structure with sweeping, graceful lines – a picture of efficiency, economy and elegance. Besides introducing Candela's work to a larger public, the exhibition served a teaching purpose. Students visited Candela's structures and evaluated them in papers that were featured in the exhibition.

Seminal Books and Museum Exhibitions

Books by Prof. Billington

Soon into his academic career, he wrote *Thin Shell Concrete Structures*, a seminal text published in 1965. The book is full of partial differential equations solving equilibrium for various thin shell forms - with and without bending stresses - that established him as an authority on thin-shell structures. His scholarship, later work as a consultant, and leadership as Chairman of the ACI-ASCE Joint Committee on Concrete Shell Design & Construction (1973-79) helped define standards and means for designing thin shell concrete structures around the world.

His second book "*Robert Maillart's Bridges : The Art of Engineering*", published in 1979, is an elegant study of the work and art of Robert Maillart (1872-1940), a creative Swiss engineer and designer of forty-seven bridges of extraordinary beauty that demonstrated the aesthetic and economic potential of a new material: reinforced concrete. Maillart's ingenious designs eliminated the heavy columns and solid arches that had dominated bridge building since Roman times, and through such innovations as the three-hinged arch and the deck-stiffened arch he was able to exploit the properties of reinforced concrete to make bridges simple, safe and inexpensive. For this book Billington received the 1979 Dexter Prize of the Society for the History of Technology. In 1990 he published *"Robert Maillart and the Art of Reinforced Concrete*" in which he further analyzed Maillart's work visually and technically. In 1997, he published the comprehensive biography, "*Robert Maillart. Builder, Designer and Artist*".

In his seminal book, *The Tower and the Bridge*, published in 1983, he introduced the concept of structural art starting with the striking examples of the Eiffel Tower and the Brooklyn Bridge. The book has been translated into Japanese, Spanish, and German languages and is a classic in the literature on the philosophy of structures. Prof. Billington also brought this approach to the wider profession as the founder and Chairman of the ASCE Committee on *Aesthetics in Design* (1978-85).

In much of his teaching and research, he explored the connections between engineering and the liberal arts and he developed curriculum materials aimed at teaching engineering to liberal arts students. This resulted in his book *The Innovators* (1996) in which he gave a chronological survey of the first one hundred years of advances in technology. His other books include *The Art of Structural Design: A Swiss Legacy*; *Power, Speed and Form: Engineers and the Making of the 20th Century,* with his son, David P. Billington Jr.; *Big Dams of the New Deal Era: A Confluence of Engineering and Politics*, with Donald C. Jackson; and *Félix Candela: Engineer, Builder, Structural Artist, w*ith Maria Garlock.

In addition to all the above activities, Prof. Billington continued to do research and consulting on a variety of technical problems in civil engineering, such as thin shells, bridges, and highways.

Awards and Honours

Prof. Billington earned numerous honors for his scholarship and teaching. In 1985, Prof. Billington was elected to the Executive Council of the Society for the History of Technology. In 1986, he was elected to the National Academy of Engineering and also received the History and Heritage Award from the American Society of Civil Engineers.

At Princeton, he was a multiple winner of the Engineering Council's Excellence in Teaching Award and an honorary member of the classes of 1979 and 1995. He received the Princeton President's Distinguished Teaching Award in 1996, and in 2003 he was awarded a National Science Foundation Director's Award for Distinguished Teaching Scholars.

Prof. Billington was appointed an Andrew D. White Professor-at-Large at Cornell University in 1987, a six-year appointment. In 1990, he received the Dana Award for Pioneering Achievements in Education. In 1998 he was electedas a Fellow of

the American Academy of Arts and Sciences, and in 1999 as an Honorary Member of the American Society of Civil Engineers. Also in 1999 he was named by the magazine *Engineering News Record* as one of the top five engineering educators over the previous 125 years.He received honorary doctorates in humane letters from Union College (1990), in science from Grinnell College (1991), in engineering from the University of Notre Dame (1997), and in science from Princeton University (2015).

FAMILY

The Fulbright grant also enabled Prof. Billington to meet and marry Ms. Phyllis Bergquist, a Fulbright scholar studying music, who became his principal support in life. He enjoyed concerts with his wife Phyllis, and both had many friends in the Princeton community. Mrs. Phyllis died in 2016.He is survived by his brother and sister-in-law, Librarian of Congress Emeritus James H. and Marjorie Billington; his sister-in-law Lynn Billington; six children (David Jr., Elizabeth, Jane, Philip, Stephen, and Sarah); and 11 grandchildren. Billington's principal summer activity for many years was to photograph bridges, often assisted by his children.

He passed away in Los Angeles on March 25, 2018, at the ripe age of 90.

You may hear his lectures at
http://videolectures.net/david_p_billington/

Read his interview at:
https://architectureboston.wordpress.com/2009/11/09/civil-service/

Through his books, papers, art exhibitions and lectures Prof. Billington inspired a remarkable range of people -engineers, students, and the general public - and contributed to create a better awareness of the importance of engineering. With his death the world lost one of its most inspiring, passionate, and innovative civil engineering professors.

Acknowledgements: We wish to thank Prof. Billington's son for going through the article and making modifications. We also thank Prof. Dr. Maria E. Moreyra Garlock, Professor, Dept. of Civil & Environmental Engineering and Head of Forbes College, Princeton University for coordinating with Prof. Billington's son.

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THE SPECIFICATION OF CONCRETE DURABILITY BASED ON ABSOLUTE PERFORMANCE

By Prof. Tom Harrison

1. Introduction

The durability of concrete is specified in the European concrete standard (EN206 [1]) today by limiting values, e.g. maximum w/b ratio. Complementary national provisions with the exception of Switzerland follow the same procedure [2]. For special structures these limiting values are often supplemented by performance requirements in accordance with some specified test method. It should be noted that standards are written for normal structures with an opening for 'Other technical requirements' to accommodate the needs of special structures.

The two European standard committees for the design of concrete structures (CEN/TC250/SC2) and the specification of concrete (CEN/TC104/SC1) jointly agreed in 2015 that in the future concrete durability will be specified by 'Exposure Resistance Classes' (ERC). There were two main reasons for this development. The first reason was that the present version of Eurocode 2 [3]) mainly covers durability by changes in the minimum cover and they wanted the flexibility to trade-off cover against concrete quality, i.e. to compensate for a reduction in the minimum cover, the concrete quality has to be increased to ensure the same design working life.

The second reason is that when the structural committee looked at the very wide range of national provisions [2] for the same notional exposure class and the wide range of binder types permitted at the same w/b ratio they were concerned that some of the limiting values in EN206 and the national provisions may not achieve the performance they intended.

Limiting value specification are based on 'experience' and when, for example, a new cement is to be included in the national provisions, they are tested using relevant test methods to determine if they perform as well as a selected reference concrete. The reference concrete is selected as being one that has been proven to perform adequately in the local environment. This procedure is called 'the equivalent durability procedure' [4] and it is a 'relative' test.

What Europe is attempting to develop is to define the concrete durability requirement in absolute terms from fundamental considerations and deterioration models. Once this work has been completed, it will be possible to check whether the national limiting value specifications achieve this intended performance. This is still 'work in progress', but a number of the building blocks have already been established. These are:

-design working lives of different types of structures;
-exposure classes related to the form of deterioration;
-concept of minimum cover and nominal cover.

Work is in progress on:

-what event defines the end of design working life;
-criteria for concrete;
-the reliability index for the system (beta value);
-modelling to assess the impacts of exposure variability and test precision;
-allowances for uncertainties.

As the specification of durability by performance cannot be achieved without standardized test methods of known and adequate precision, Europe is limiting the development of the concept to carbonation-induced corrosion, chloride-induced corrosion and freeze-thaw resistance. In the future other aspects of durability will be covered when suitable test methods are agreed and standardized.

Due to the practicality of using limiting values, Europe has accepted that conformity to the specified ERC will be based in the majority of cases (>90%) on conformity to proven limiting values.

The procedure for determining absolute performance requirements for resistance to corrosion of reinforcement applies equally to India as it appears that there are very different views on the durability of the new binders entering the Indian market. Checking that limiting value specifications used in India achieve what is intended from the concrete should be a priority.

2. Design working lives

Indicative design working lives for different types of structures are given in EN 1990 [5], Table 1. These are independent of the type of construction - concrete, steel, timber, composite. The terms

such as '50 years' is just conventional, and are the same used for the establishment of the intensity of actions for the design of structures. For durability purposes the design working lives should be better taken as meaning, for example, 'at least 50 years'.

Table 1: Indicative design working lives

Examples	Indicative design working lives
Agricultural and similar structures	15 to 30
Building structures and other common structures	50
Monumental building structures, bridges, and other civil engineering structures	100

3. Exposure classes

Eurocode 2 [3] and EN 206 [1] share the same set of exposure classes based on the type of deterioration mechanism, Table 2. At present there is no European classification for abrasion, but some CEN Member Countries have a national classification [2]. Each of these forms of deterioration are split into 3 or 4 sub-divisions with increasing levels of severity. For example the classes for corrosion due to carbonation are split into four, five if the X0 class is included, Table 3.

Table 2: Main classification of exposure classes in EN 206

Class designation	Description of the environment
X0	No risk of corrosion or attack
XC	Corrosion induced by carbonation
XD	Corrosion induced by chlorides other than from seawater
XS	Corrosion induced by chlorides from seawater
XF	Freeze-thaw attack with or without de-icing agents
XA	Chemical attack

Table 3: European sub-divisions of the XC class

Class designation	Description of the environment	Informative examples
XO	For concrete with reinforcement or embedded metal: Very dry	Concrete inside buildings with very low air humidity
XC1	Dry or permanently wet	Concrete inside buildings with low humidity. Concrete permanently submerged in non-aggressive water
XC2	Wet, rarely dry	Concrete subject to long term water contact. Many foundations.
XC3	Moderate humidity	Concrete inside buildings with moderate or high humidity. External concrete sheltered from rain.
XC4	Cyclic wet and dry	Concrete surfaces subject to water contact not within exposure class XC2.

The XC3 class will give the fastest rate of carbonation where corrosion is a significant risk and the XC4 class will give the fastest propagation rate, but a slower rate of carbonation than the XC3 class. Consequently in the UK, the XC3 and XC4 classes have been merged and the same limiting values and minimum cover apply.

4. Concept of minimum and nominal reinforcement cover

The concept of minimum and nominal cover are established in Eurocode 2 [3]. The minimum cover is that needed for bond or durability reasons and to this minimum cover is added an allowance for deviation, i.e. a fixing tolerance, so that there is a high probability that the minimum cover is achieved in the structure. The sum of the minimum cover and allowance for deviation is called 'nominal cover'. The nominal cover is shown on the construction drawings and it identifies the size of the spacers to be used on site.

This approach makes it clear what is the essential requirement for the structure, i.e. the minimum cover.

5. End of design working life for XC, XD and XS exposure classes

There has been long discussions on this issue and the compromise solution is that taking the initiation period, which is the time for carbonation to reach

the rebar or the chloride level at the rebar to reaches the critical level, only into account is a safe solution, but at the national level, part of the 'propagation period' may be taken into account.
In the opinion of the author, it is unlikely that any National Standards Body (NSB) will take any part of the propagation period into account for the XD and XS exposure classes, but there is a case for taking some of it into account for the XC exposure. Indoor concrete at a relative humidity of about 55% to 65% is likely to carbonate very rapidly, but from then the rate of corrosion will be so slow that the design working life will be achieved even if the concrete is carbonated to the rebar within a few years. Without taking part of the propagation period into account, this condition would be the worst case for carbonation-induced corrosion and experience has shown this not to be true.
No guidance has yet been provided on what portion of the propagation period may be taken into account, but it is unlikely to be more that first visible cracks due to corrosion or localised spalling.
The case against taking any of the propagation period into account is where there are bond stresses there will also be bursting stresses in the concrete cover and additional stresses due to corrosion might be unacceptable. These situations include:

-anchorage zones of normal reinforcement;
-lap zones of spliced reinforcement;
-zones with large bond stresses due to variations in shear (bending zones, typically over supports in continuous construction);
-reinforcement acting as dowels at shear cracks;
-reinforcement in curved sections;
-anchorage zones of prestressed reinforcement.

6. Criteria for concrete

As of today the structural committee has proposed that for carbonation-induced corrosion:
'The exposure resistance for concrete exposed to carbonation shall be referred to the carbonation depth (characteristic value 90 % fractile), in mm, expected to be obtained after 50 years under reference conditions (proposed 400 ppm CO_2 in a constant 65 % RH environment and at 20°C)'
and for chloride-induced corrosion:
'The exposure resistance for concrete exposed to chlorides ingress shall be referred to the depth of chlorides penetration in mm (characteristic value 90 % fractile), corresponding to a reference chloride concentration (2 kg/m³), expected to be obtained after 50 years on a concrete structure exposed to one-sided penetration of reference seawater (30 g/l NaCl) at 20°C.'
Expressing the necessary performance in these terms is based the reference conditions used by modellers, but there are problems with this approach.
The reference conditions for the carbonation-induced corrosion penalise slowly reacting cements and binders in conditions where the in-service relative humidity is above about 75%. While it might be possible to modify the curing procedure in the test to overcome this issue, such a procedure is not yet proven. An alternative approach would be to specify the performance requirements in terms e.g. of the BS EN 12390-10 [6] outside protected from direct rainfall test. In northern Europe these conditions reflect the worse realistic situation where corrosion due to carbonation is likely and such an approach avoids all the uncertainties due to modelling; however, the uncertainties due to differences between test specimens and the structure, and test precision need to be carefully taken into account. Under such conditions the maximum rate of carbonation can be calculated from:
γ_M(minimum cover – R)/$\sqrt{t_{ip}}$
where
γ_M partial factor for differences between test specimens and the structure;
R reproducibility of the test (2.0 mm);
t_{ip} initiation period (this equals the design working life if none of the propagation period is taken into account).
The partial materials factor is not yet defined and this will be the subject of further discussion. On proposal is to use the same factor as for compressive strength, namely 0.85. By taking these uncertainties into account for the maximum rate of carbonation, the measured value can be compared directly this maximum rate.

The reference conditions for the chloride-induced exposure require a consensus on the length of the ageing period, which is the period over which the concrete continues to increase its resistance to chloride ingress. At present there is no consensus, but a solution may be that different exposure

conditions have different ageing periods. Another issue is the level of chlorides needed to start corrosion and again this may be related to the exposure conditions such as the availability of oxygen.

7. Reliability of the system

As recommended in BS EN 1990 [5] for serviceability (irreversible), the target reliability index, the so-called beta value, for a 50 year period is being taken as 1.5. A modelling exercise is underway to determine the effects of variations in the exposure conditions and test precision, but this work is not yet completed.

8. Discussion

There is a lot of discussion in India as to whether the new cement and binder types will give at the same limiting values the expected design working life. As India is such a vast country with significant regional differences, the appropriate limiting values and associated binder types may be different in the various regions. A major exercise to check or develop appropriate limiting value specifications is strongly recommended using exposure sites both sheltered from direct rainfall and exposed to direct rainfall. The reason for recommending both exposure conditions is that in some places in India the relative humidity is so low for part of the year that the concrete may not have enough water to carbonate and consequently the exposed environment may be worse than the sheltered environment.

For normal structures conformity to a limiting value specification is today the most effective way of achieving a durable concrete, but these limiting values must be proven to provide what is intended by designers. This is the second step after defining absolute performance requirements. The third step is to provide the opportunity to check for a specific concrete whether the absolute performance requirements will be achieved. Such a procedure may be instigated by the specifier, but it will require them to provide sufficient time to prove the mix, or by the producer seeking to prove the performance to justify having less onerous limiting values.

9. Conclusions

Establishing absolute performance criteria for concrete using fundamental principles is the first step in checking limiting value specifications. The procedure outlined above is a way to determine such criteria.

10. References

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3. BS EN 1992-1-1: 2004, *Eurocode 2: design of concrete structures – Part 1-1: General rules and rules for buildings.*
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5. BS EN 1990: 2002 + A1: 2005, *Eurocode — Basis of structural design.*
6. BS EN 12390-10:2018, *Testing hardened concrete – Part 10: Determination of the carbonation resistance of concrete at atmospheric levels of carbon dioxide.*

Author

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CSMT FOOT OVER BRIDGE COLLAPSE AND STRUCTURAL AUDIT – STRUCTURAL ENGINEERS' VIEW POINT

Unfortunate incident happened on 14 March 2019 when part of the deck slab of Himalaya foot bridge outside CSMT collapsed killing 6 people and injuring more than 30 people.

In one day, Chief engineer Vigilance from Municipal Corporation of Greater Mumbai provided the preliminary report. Is CE (Vigilance) competent to prepare such report? Why this CE (Vigilance) did not make this report earlier? Why did he wait till 6 people died?

MCGM suspended some junior officers and started departmental enquiry against some of their officers. Show cause notice was issued to the Structural audit firm Prof. D D Desai's Associated Engineering Consultant and Analysts by MCGM. The question is who is to be blamed for the bridge collapse? It's a system failure. The Electronic media, print media along with MCGM put the blame on structural engineer Niraj Desai who audited the bridge and reported that bridge requires minor repairs. As usual, the structural engineer who had given the audit report had been made a scape goat. Police arrested him like a criminal and put him behind bars. FIR has been filed under stringent Section 304 (II), culpable homicide not amounting to murder which attracts up to 10 years in prison. **Any engineer has no intention to kill when he does his work.** The humiliation and arrest of a professional without any technical inquiry was not warranted.

Structural audit process of all bridges in MCGM limit was initiated in Oct 2016.

There are many unanswered questions. This bridge was repaired during 2012-2014. How? Who repaired? Was any advise taken during repairs? Are MCGM engineers competent to repair? If they are, how they did not find, even when the audit was going on that it is on the verge of collapse? Why should a bridge collapse within 5 years after repairs? Will MCGM put the facts in public domain about, why they thought repairs were necessary? Did any one certified after repairs that Bridge was safe?

There was partial collapse of Gokhale Bridge pedestrian pathway portion at Andheri on 3 July

2018 due to over loading and corrosion. No one was arrested.

On 2 Jan 2004, under construction foot over bridge near Dombivli collapsed and two persons died. The design and supervision was done by Railway Department. It was later found out that there was a design fault. Only person arrested that time was contractor who was not responsible for design.

Probable cause of collapse ?

The bridge was standing for last 30 years with some repairs done five years back by MCGM. In the present case, prima facie it appears from study of the photographs and video clips that the collapse of secondary beams was due to shear failure of welded joints due to corrosion. Detail investigation by experts will throw more light on the exact cause of collapse.

It is surprising that MCGM had immediately dismantled the entire steel bridge there by destroying the evidence for any forensic investigations. Secondly, as per the press report around 10,000 people that were using this bridge daily would be affected. The beauty of steel structures is that it can be modified , strengthened very fast without adding much weight. With the help of expert advise, it would have been possible to re-erect the steel deck on the existing bridge skeleton (which was more or less intact) and open it for public in a weeks time. This opportunity has been lost.

Structural Audit

The word "structural audit" has a very broad meaning which includes the audit of the original design, calculations, structural drawings, quality of construction and workmanship, audit of any major repair, maintenance of the structure done by owner over the years, its present condition from stability point of view etc. Purpose of structural audit needs to be defined. But in present context, the word "structural audit" has been wrongly used by authorities like MCGM to represent only condition survey or inspection report by structural engineer based on the data provided and some tests carried out. Indian Society of Structural Engineers (ISSE) had insisted that it should be called "Condition survey / Inspection report" and not Structural audit.

Process of Structural Audit :

One has to clearly understand the meaning of the phrase "structural audit" as nomenclature by the authorities. The process of carrying out structural audit is a complex one and has many limitations. Most of the times, the person carrying out structural audit of any structure is not the original designer of the structure. Client / owner has to provide all the details like copies of original plans, construction history, test reports during construction, quality control reports, history of any subsequent changes made to the structure or repairs carried out, copies of earlier structural audit and other relevant documents related to the structure. Based on the data provided, structural engineer visits the site , inspects the structure, takes photographs of the important structural components. He may or may not carry out some non-destructive tests as may be felt essential by him. Studying the collected data and based on his experience and judgement, he provides an inspection report to the owner which is termed as "structural audit report".

Limitations of Structural Audit :

Most of the times, the data about the original structure is not available with the Client / Owner. In such situation, the structural engineer has no clue about the original design and he has to go by his own judgement.

Secondly, it is the responsibility of the owner to provide access to all structural elements for inspection. In case of buildings, many structural compoents like columns and beams are covered by non-removable false ceilings and other interior items and are not accessible. In case of bridges, all the joints, main girders, secondary girders, bearings etc may be or may not be accessible. In such situations, it is really a challenge to inspect the structural components. In steel bridges, it is very difficult to estimate the extent of corrosion in various parts of the bridge if it is not accessible.

MCGM is forcing structural engineers to carry out stipulated non-destructive tests enlisted by it (those are for concrete structures) which should be attached with the audit report. Without the said tests, the audit report is not accepted. Indian Society of Structural Engineers (ISSE) had suggested MCGM that let the structural engineer decide on whether to carry out any non-destructive tests or not and type of tests required for the given structure. But this was not accepted. It is like the medical practitioner recommending type of tests based on his diagnosis.

It is understood from the press reports that non-destructive tests which are meant for concrete were carried out for this steel bridge ? ? ? ?

Structural engineer providing the audit report is acting in a capacity of a consultant and there can be variation in the reports from person to person based on quality of data available and his expertise. A consultant can not be entirely blamed for any such accidents unless proven by a detailed technical inquiry. A time has come that we need to draft a code for audit coupled with responsibilities, exceptions, limitations, methods, specify (minimum) tests for different types of structure and certification formats.

Reasons for collapse in general :

There can be many reasons for the collapse of a structure in general .

1. Deficiency in the original design.
2. Deficiency in quality of Materials and or workmanship used during construction.
3. Changes made by occupants by damaging any critical component there by endangering stability of the whole structure.
4. Overloading of the structure.
5. Neglect of regular maintenance which results in gradual degradation of the strength and stability. When the damage like corrosion reaches to such a level that the capacity falls below the actual loads to be supported, collapse occurs.

It is really difficult to point finger at one person for collapse of the structure as there can be many complex parameters responsible on case to case basis.

Suggestions :

Following are some suggestions for improving the performance of our assets and minimizing the risk of collapse –

1. Clearly define role and responsibilities of external consultants. Follow transparent process of selection of competent external professional not only on lowest cost but on the experience, capability, infrastructure etc as followed for World bank aided projects.
2. Provide adequate time to the professionals to carryout their work and have balanced contract terms and conditions which are enforceable and realistic.
3. Preserve and provide the data of original structure including design basis report, structural drawings, construction history and material test reports, data on subsequent repairs and any addition alteration done. This data is very useful during the structural audit and further retrofitting.
4. Every bridge needs to be Inspected as mandated by Indian Road Congress guidelines (IRC). Such inspection should enable the bridge inspector to create a prognosis for the cause of distress. Such prognosis should be confirmed or rejected by proper testing. IRC has specified over 24 different tests to confirm the cause. Once the cause is confirmed then remedial action for that cause needs to be adopted. Progressive inspection records should be stored in a database like IBMS (which has point based marks) for further analysis and determination of probable balance service life, risk involved in prolonging repairs etc. This data base for all the assets will be helpful in taking correct decisions at the correct time.
5. MCGM has full fledged bridge department with experts and engineers who can manage the assets with proper planning and budgeting for repairs in consultation

with experts in the field. Training of engineers in design and inspection will help.

6. Structural audit formats and procedure can be prepared in consultation with experts in the field and referring to international standards. Rationalisation of certification formats is necessary.
7. Allocate sufficient budget for maintenance of all assets.
8. Government should put all the technical reports on collapse in public domain, so that, we learn from failures and similar mistakes can be avoided in future.
9. Do not waste energy in blame game trying to find the scapegoat. Believe in working together with consultant. Nobody is perfect and has all the knowledge in the world. So, work in a complementary manner with all the agencies involved like Consultants, Engineers from authorities, contractors and whoever is involved in the work to achieve safe structures during repairs or new construction.
10. Make the agreements with all agencies very crisp and clear pertaining to their responsibilities and fees. Pay the fees in time after completing the job.
11. Take up the repair work within time as mentioned in the report and keep the funds ready well in advance, so that, no time is wasted due to lack of funds and approval procedure.

We hope that the overall system will be improved in consultation with experts and professionals and we will be able to minimize the risk of collapse in future.

Technical Team
Indian Society of Structural Engineers
www.isse.org.in

INDIAN SOCIETY OF STRUCTURAL ENGINEERS

in association with The Civil Engineering Department of Mukesh Patel School of Technology Management and Engineering, NMIMS is arranging one day workshop ON

" Insight into Wind Loading Using IS 875 (Part 3): 2015"

By : Dr. Suresh Kumar RWDI (India)

Date & Time : Saturday, 27th April 2019, 09:30 AM TO 05:00 PM

Venue : Mukesh Patel School of Technology Management and Engineering Mumbai Campus, 6th floor, Seminar hall, behind Homeopathy college Bhakti Vedant Swami Marg JVPD Scheme Vile Parle (W) Mumbai - 400056

For more information visit www.isse.org.in

Participation fees : Delegate Rs.1500

ISSE member Rs 1300/-

Student member Rs.1000/

registration can be send on E-mail

Tel: 022 2431 4423 /2431 4445 E-Mail : issehq@hotmail.com

Convener :

Mr. Hemant Vadalkar (ISSE) , Dr. Tanuja Bandivadekar(MPSTME)

"STABILITY CERTIFICATE" : MOST SOUGHT-AFTER DOCUMENT

1.0 Introduction :

Stability certificate is a most sought-after document by many agencies. Structural Engineer has the authority to issue such certificate. This is provided for various type of structures like buildings, industrial plants etc.

There are many agencies asking for stability certificate from the structural engineers. Most of the times, our structural engineer friends provide all sorts of certificates demanded by architects, clients, authorities as per wordings demanded. Structural engineers must understand that the content of the certificate is very important and must be carefully worded. **Engineers must provide a certificate only related to their scope of work**.

2.0 Major areas where stability certificate is demanded:

1. Design of new building or industrial plant : Approving authorities like local municipal authorities generally demand stability certificate from the structural engineer in the format specified by them. This format may contain reference to design codes, words like supervision at site and quality of materials which is not in the scope of structural engineer.

2. Industrial Development Corporations: Industrial owner demands stability certificate as per "DISH" authority (Director of Industrial Safety & Health) with the prescribed format, Form No. 1A (Rule 3A). As per requirement, the structure is required to be certified for various loads including that of machinery. The certificate further requires foundation checking and their condition.

3. Financial Institutions: Companies providing loans to buy residential or commercial premises insist to inspect a particular premise and provide stability certificate stating that the structure is good will be stable. The building will have a life till the end of loan period as they have to complete the loan processing document.

4. Educational Institutions: Based on the requirements of AICTE or Education department, a certificate is asked from structural engineer stating that the building is safe for the students. Sometimes a mention about fire safety, FSI regulations, approved plans is imposed in the certificate which engineers are signing blindly which is really not in the scope of a structural engineer. A sample certificate is enclosed for reference. Engineers must refrain from giving such certificates.

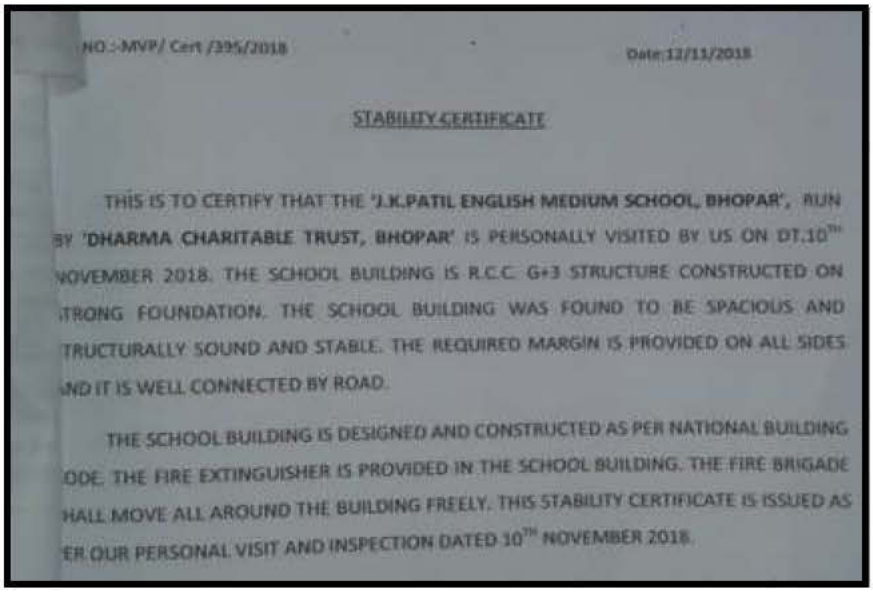
5. Public Works Department: PWD demands Stability certificate for lift shaft and lift machine room slab along with two hours fire resistance.

6. Structural audit and Stability certificate: For buildings more than 15 years old, it is mandatory to conduct structural audit. This is related to age of building and for the purpose of any repair that is required to be undertaken. This is demanded by local municipal bodies from the registered structural engineers. This structural audit is generally related to condition survey, testing and providing report on overall condition of building and suggestions for repairs as required. This must be correctly termed as condition survey or inspection report indicating the condition of structure on the date of inspection and suggestions for any repairs and upkeep of the structure. There is no question of providing stability certificate. But local authorities are demanding it and engineers are providing it under pressure which is wrong.

3.0 Who can issue a stability certificate?

Only a qualified and experienced structural engineer registered with the local authority can issue a stability certificate for a structure designed by him. This means stability certificate can be issued only by the original designer only once.

Now, the latest National Building Code 2016 provides certification formats for structural engineers, supervising agencies which must be followed by all departments. NBC2016 Part II, Section 3 under Annex A provides Guide for qualification and competence of building professionals like Architect, Engineer, Structural



NO:-MVP/ Cert /395/2018 Date:12/11/2018

STABILITY CERTIFICATE

THIS IS TO CERTIFY THAT THE 'J.K.PATIL ENGLISH MEDIUM SCHOOL, BHOPAR', RUN BY 'DHARMA CHARITABLE TRUST, BHOPAR' IS PERSONALLY VISITED BY US ON DT.10TH NOVEMBER 2018. THE SCHOOL BUILDING IS R.C.C. G+3 STRUCTURE CONSTRUCTED ON STRONG FOUNDATION. THE SCHOOL BUILDING WAS FOUND TO BE SPACIOUS AND STRUCTURALLY SOUND AND STABLE. THE REQUIRED MARGIN IS PROVIDED ON ALL SIDES AND IT IS WELL CONNECTED BY ROAD.

THE SCHOOL BUILDING IS DESIGNED AND CONSTRUCTED AS PER NATIONAL BUILDING CODE. THE FIRE EXTINGUISHER IS PROVIDED IN THE SCHOOL BUILDING. THE FIRE BRIGADE SHALL MOVE ALL AROUND THE BUILDING FREELY. THIS STABILITY CERTIFICATE IS ISSUED AS PER OUR PERSONAL VISIT AND INSPECTION DATED 10TH NOVEMBER 2018.

Sample of Wrong Stability Certificate

Engineer, Geotechnical Engineer, Services Engineer etc. along with certification formats. Annex C provides form for certificate for Structural Design Sufficiency and Annex E provides Form of Supervision. There is no mention of "Stability certificate" any more. All the formats must be followed from the national standard.

4.0 What should be the content of so called Stability certificate?

Format provided in NBC2016 must be followed with the following information

Description of the structure and building permission letter number

Reference to design codes

Name of Arch

Name of supervisor and his certificate reference

Disclaimer like

This certificate is issued on the clear understanding that my/ our overall responsibility for the structural stability of the building and its proper structural performance will cease the moment any additions or alterations to the structure by accident or due to tampering by the users/ occupants for any reasons whatsoever. My/ our responsibility will also cease in the event of overloading or lack of proper maintenance of structure or any such act, which is detrimental to the structure.

ISSE Pune team has worked out the formats and suggested it for Unified DCR2017 to be made applicable to entire Maharashtra.

5.0 What should be the content of structural audit report which is related to condition survey?

Many municipal corporations demand the structural audit in their prescribed format. MCGM had published a circular CHE/Gen-341/DP/Gen dated 9-6-2009 (available on ISSE website) which states that private buildings more than 30 years old must conduct structural audit. Repairs should start in six months after the report is given. MCGM can initiate the action against the owners if the due process of audit and repair is not followed.

Engineers must provide distress marking plans, photographs, observation on the existing building, previous repair data, their own observations and suggestions in the report. One must clearly mention the limitations of the audit and exclusions like data that is not available architectural / structural drawings, past history of repairs / addition alteration, certain area could not be inspected as access was not provided or structural members were covered under false ceiling or interior work, foundations could not be inspected etc. it can be mentioned that the report is valid for six months.

It must be clearly mentioned in the report that this report should not be treated as a stability

certificate and it is the responsibility of the owner to carry out necessary repairs under the guidance of structural engineer. Engineer who supervises the repair can provide satisfactory repair completion certificate and building fit for habitation.

6.0 Market condition

We have come across numerous complaints that many engineers are providing structural audit and or stability certificate without even inspecting the structure for a meagre fee. Similarly, many NDT (Non-destructive Testing) agencies have opened their shops to provide NDT report as demanded by MCGM (along with structural audit) with as low fees as Rs.5000/-. This is ridiculous and dangerous. The intent of structural audit is not mearly to produce a report for submitting against the notice issued by the local authority. It is for the safety of the occupants and to initiate necessary repair process.

Owners must be careful in selecting the competent person for structural audit and testing agency and not only on lowest quotation.

ISSE in co-ordination with various concerned authorities can prepare certification formats to suit the requirement. We expect support from our members.

7.0 Conclusion :

In medical field, the doctor takes an undertaking from the patient before operation. Lawyer fights the case with an undertaking from his client. Whereas, we structural engineers, take the responsibility of all wrong doings of others for meagre amount of fees. This is really strange! We We should not accept the tender conditions which are not feasible or one sided.

In our present system, even for collapse of old structure, engineers connected with the project are called for questioning or arrested without any technical investigation which is shameful. Structural Engineers can not take perpetual responsibility of the structure. Engineers that are acting as consultants can provide the expert advise based on the scope of services. We need to define our role, responsibility and liability very clearly in the technical offer and must provide certificate only related to our exact scope of work.

Technical Committee
Indian Society of Structural Engineers (ISSE)

'Amendment To: Comparative Study of Gust factor values as per IS 875 (part 3): 2015, IS 875 (part 3) draft code: 2007 and Australian Code AS 1170-2: 2002' ISSE JOURNAL VOL 20-4

by Satish Marathe and Avinash Jadhav.

Amendments:-

This amendment presents revised results for various parameters used for calculation of dynamic wind and corrections to typing errors over the ones that were presented in **ISSE journal Volume 20-4** in the paper titled '**Comparative Study of Gust factor values as per IS 875 (part 3): 2015, IS 875 (part 3) draft code: 2007 and Australian Code AS 1170-2: 2002'.**

a. Sr no. 13) The formula for G/C_{dyn} needs to be amended as given below.
b. Previously results for dynamic wind using IS 875 (part 3): 2015, IS 875 (part 3) draft code: 2007 and Australian Code AS 1170-2: 2002 were calculated assuming Hourly mean wind speeds but the results for Australian code and IS draft code needs to be calculated using Peak wind speeds. The amended results are presented in tabular form below for the same example.
c. Damping in AS code is taken as 0.015 as per comments received.

Sr. No	IS 875: 2015	IS DRAFT CODE	AUSTRALIAN CODE
13)	**Gust Factor (C_{dyn} or G)**		
	$1+2I_{hi}\left[g_v^2 B_s(1+\emptyset)^2+\frac{H_s g_R^2 SE}{\beta}\right]^{0.5}$	$\frac{1+2I_{hi}\left[g_v^2 B_s+\frac{H_s g_R^2 SE}{\beta}\right]^{0.5}}{1+2g_v I_h}$	$\frac{1+2I_h\left[g_v^2 B_s+\frac{H_s g_R^2 SE_t}{\zeta}\right]^{0.5}}{1+2g_v I_h}$
14)	**F_z(N or KN)**		
	$C_{fz}A_z P_d G$	$C_f A_e P_z C_{dyn}$	$(0.5\rho_{air})A_{ref}\left[V_{des,\theta}\right]^2 C_{fig} C_{dyn}$
	***Use Hourly Mean wind speeds for calculating P_d (k_{2i} factor)**	***Use peak wind speeds for calculating P_z (k_2 factor)**	***Use peak wind speeds for calculating $V_{des,o}$ (k_2 factor)**

Results:-

The amended results for values of various terms/equations used in gust factor method are presented in the table below.

Sr. No	IS 875: 2015	IS DRAFT CODE	AUSTRALIAN CODE
1)	**I_h- Turbulence Intensity @ ht.=h**		
	0.177	0.183	0.183
2)	**g_v- Peak factor for upwind velocity**		
	3- for category I and II 4- for category III and IV	3.5	3.7
3)	**B_s- Background factor**		
	0.8086	0.4580	0.8086

4)	**s- Level at which effects are to be determined**		
	0	0	0
5)	**b_{sh-}**		
	Average breadth of structure between s and h= 8m	Average breadth of structure between s and h= 8m	Average breadth of structure between s and h= 8m
6)	**L_h- Effective turbulence at ht.= h**		
	133.64	157.22	133.64
7)	**H_s- Height factor for resonant response**		
	1	1	1
8)	**G_{R-} Peak factor for resonant response**		
	3.88	3.88	3.387
9)	**S- Size reduction factor**		
10)	0.148	0.127	0.137
	E- Spectrum of turbulence		
	0.054	0.047	0.052
11)	**β -Ratio of structural damping to critical damping**		
	0.02	0.02	0.015
12)	**N- Effective reduced frequency**		
	2.15	2.66	2.31
13)	**Gust factor- G or C_{dyn}**		
	2.885	**0.949**	**0.979**
14)	**F_z(KN)**		
	54.52	**43.90**	**48.84**

Conclusion:-

1. No direct comparison can be made on the values of G or C_{dyn} since IS 875 (part III) 2015 uses hourly mean wind speeds while the IS draft and AS code uses Peak wind speeds
2. The final values for F_z show an increase in the values over the ones obtained from draft and Australian code in the problem considered.

The Authors would like to thank Dr. K. Suresh Kumar of RWDI Consulting Engineers (India) Pvt. Ltd. and Mr. Hemant Vadalkar for their valuable comments and extended help with the revision of the results.

NEWS AND EVENTS DURING JAN – MAR 2019

5 Jan 2019 : Seminar on Concrete by EFC

Epicon friends of concrete arranged a seminar on Concrete daily use and advancements. Dr. N V Nayak provided simple tips for improving quality of concrete. This includes innovations for providing top cover to transit mixer to avoid rain water entry, extending delivery hopper at batching plant to avoid spillage of concrete while filling the transit mixer, 24/7 water curing of vertical RCC face by using perforated pipes around the surface wrapped up with cloth, wrapping of transit mixer drum with wet hessian cloth to keep it cool, keeping admixture drums with lid and using stirrer before using it at batching plant, opening of cement bags by removing thread to minimize wastage, importance of correctly filling and casting of test cubes at site. Mr. Manish Mokal talked about heat of hydration during mass concrete and precautions to be taken. To avoid thermal cracking in mass concrete maximum temperature should be restricted to 70 degree and differential temperature should not be more than 20 -25 degree. Placing temperature of concrete can be reduced by cooling the aggregates or use of chilled water. To reduce the heat of hydration cement can be reduced by use of fly ash or GGBS. Mass concrete (like Raft) surface should be insulated by covering it with plastic or insulating material to reduce the differential temperature. Water curing on outer surface during initial 3 to 5 days should not be permitted when the core temperature reaches 70degree to avoid thermal cracking. Other experts in the field talked on advancement in admixture, quality improvement at site for better concrete.

17 Jan 2019 : Visit to Cluster Development project at Bhendi Bazar SBUT project

ISSE members along with Mumbai Vikas Parishad members visited cluster development project executed by Saiffe Burhani Upliftment Trust at Bhendi Bazar, Mumbai. The tower has 2 basement+ commercial floors from ground to third level. Podium parking is from third to seventh level. Transfer girders are provided and the residential block starts from 9th to 41st floor. It has total 613 flats, 8.2L sq. ft built up area and estimated project cost is Rs. 255 Cr.

29 Jan 2019 : Inauguration of ISSE Navi Mumbai Centre

ISSE Navi Mumbai centre was inaugurated at IEI Belapur centre premises by Shri K K Varkhedkar, Chief Engineer CIDCO. Hemant Vadalkar informed about the aims and objectives of ISSE and handed over a set of ISSE publications to the new centre. Dr. Mohan B. Dagaokar introduced the new committee members of Navi Mumbai centre. Tata Tiscon representative provided information on Ready Build Steel Solutions and services provided like cutting and bending of rebars at factory without any wastage to client's account. V. C. Kamble proposed vote of thanks. Around 60 engineers attended the function. Indu Corporation and SKM Constra sponsored the event.

30 Jan 2019: ISSE Student chapter (Saboo Siddiq) site visit

Mr. K L Savla along with Prof. Ashutosh Dubli from M H Saboo Siddiq college of Engineering arranged a site visit for students to to cut and bend steel factory at Taloja. More than 40 students participated in the visit. Process of cutting and bending of reinforcement steel used in RCC structure was demonstrated.

1 Feb 2019 : Lecture on Use of Ferro Cement

Indian Society of Structural Engineers, Pune arranged a technical lecture on "Use of Ferro Cement **in Design and Construction of Building"** at Institution of Engineers hall, Pune on 1st February 2019. Eminent Engineer Dr. Arun Purandare was invited to deliver the lecture.

ISSE Pune center Joint Secretary Er. Anshuman Bhide welcomed the delegates, followed by brief about ISSE and program details by ISSE Pune Chairman Er. Dhairyashil Khairepatil. Er. Mrs. Deshmukh Madam Secretary of Institution of Engineers India, Pune felicitated Dr. Arun Purandare. About 40 to 45 structural engineers attended the lecture.

13 Feb 2019 : Meeting with Hon. Minister Shri Ranjeet Patil at Mantralaya

Indian Society of Structural Engineers Pune center had a meeting with Hon. State UD Minister Shri Ranjeet Patil for issues related to the site accidents on the construction site and instructions required to be given to Police and UD department in such cases.

The meeting was requested by Hon. MLA Sou. MedhaTai Kulkarni, Kothrud VidhanSabha Constituency Pune. On behalf of Pune Municipal Corporation, City Engineer Shri Prashant Waghmare sir, Er. Litke, Er. Gavhane attended the meeting. On behalf of ISSE Pune, Chairman Er. Dhairyashil Khairepatil, secretary Er. Kishor Jain, Treasurer Er. Parag Deshpande, Committee members, Er. G. A. Bhilare and Er. Umesh Joshi along with ISSE Mumbai Chairman Er. Shantilal attended the meeting.

CE PMC Er. Prashant Waghmare sir explained the suggestions proposed in DCPR 2017 by Pune Municipal Corporation to the UD department regarding the roles and responsibilities of all the consultants and others involved in the building construction. The UD representative Under Secretary Mr. R.M. Pawar reviewed the suggestions proposed by PMC, he informed that it will get incorporated in the Uni DCPR Maharashtra to be published by Govt. of Maharashtra by February 2019. The Hon. State Minister welcomed the suggestion and requested Mr.R.M. Pawar to do it on priority. The Under Secretary Home Department Mr. Ajayvet in the meeting raised the issue about how to decide the responsibilities in case of any site accident. ISSE Pune chapter Chairman Er. Dhairyashil Khairepatil proposed to form a committee of 5 members similar to the medical field. The committee will review the case and based on the responsibilities of each mentioned in the proposed Unified DCR for Maharashtra, will submit their initial report before taking any action. The committee will comprising of

a) City Engineer of that City/ MC
b) Executive Engineer PWD
c) Professor of applied Mechanics Dept. of near by Govt. Engineering Collage
d) Structural engineer representing, Indian Society of structural Engineer Association
e) Safety Engineer.

The suggestion was well appreciated by all and Hon. State Minister instructed UD and Home department representative to take further actions and its approval from both UD and Home department of priority basis.

The proposal of One licence of Structural Engineer for rest of Maharashtra except Mumbai was proposed on behalf of ISSE Members to save the valuable time of structural consultants in terms of its coordination and yearly renewal process.

15 Feb 2019 : Inauguration of ISSE Student chapter at MIT WPU Pune

Indian Society of Structural Engineers, Pune center has started 1st"ISSE Student Chapter" in Pune on 15th February 2019 at MIT WPU, Kothrud Pune. The Eminent Professor and Director IIT Jodhpur Prof. C.V.R. Murty was

invited as a chief guest for this program.
Prof. L.K. Kshirsagar felicitated Chief Guest Dr. C.V.R. Murty, ISSE Mumbai office bearers Prof. C.B. Chaudhari, Mr. Madhav Chikodi, Mr. Ashutosh Danki and K.L.Savla. Prof. Dr. Mrudula Kulkarni, Head of school- Civil Engineering, MIT WPU felicitated ISSE Pune office bearers Er. Dhairyashil Khairepatil and Er. Kishor Jain.
Prof. C.V.R. Murty talked to students about how integrated structural engineering is connected with life and nature. He emphasized that structural engineering is an art. We must pay attention to safety, functionality, durability, aesthetics and economy during our designs.

26 Feb 2019 : Inauguration of ISSE Student chapter at Chameli Devi Group of Institutions, Indore

With the vision to improve Industry-Academia tie-up, Chameli Devi Group of Institutions has become the first institution in central India to set up student chapter of ISSE (Indian Society of Structural Engineers) in Civil Engineering Department . From ISSE Mr. Hemant Vadalkar (Secretary ISSE), K. L. Savla (Sr. Member), Prof. G. B. Choudhari (Past President), Mr. Madhav Chikodi (Sr. Member) graced the occasion. Hemant Vadlkar made a presentation on "Application of Software in Civil Engineering" and shown real life projects designed by him. Prof. G B Chaudary talked on Ground improvement using wedge shear elements and shown some live examples of how it can be used in the field.

The inaugural ceremony was attended by Director of Institution Dr. Joy P. Banerjee, head of departments from CDGI, eminent structural engineers like Mr. Harish Totla, Mr. Pankaj Sethia, Mr Anil Khandelwal, and architects from Indore and nearby cities. The technical presentation has provided exposure on real-life practical problems faced in general civil engineering field. This will provide a platform for students to interact with professionals.

9 March 2019: ISSE Site visit to Sardar Sarovar Dam and Statue of Unity

ISSE under the leadership of Mr. K L Savla arranged site visit to Sardar Sarovar dam and Statue of Unity near Vadodara. Total 48 members attended this technical visit including students from M H Saboo Siddiq college of engineering. Narmada dam site area was visited in the morning. Beautiful garden with amazing flowers has been created near the dam site. Canal connecting five lakes in the down stream site were seen along the route. Tent accommodation has been created for tourist. Air conditioned bases are available to ferry passengers from point to point. Helicopter ride for 15 minutes is also available to see the entire area. Guide provided from Narmada Nigam provided all the information.
After the dam site, Statue of Unity the tallest statue in the world was visited. Engineer from Larsen and Toubro who was involved in the construction provided technical information and challenges faced during construction. Bronze plate 8mm thick have been used as cladding on the steel frame work for the statue. Two central RCC cores have been provided with lift and stair case. Viewing gallery is provided at the chest level.

16 Mar 2019 : ISSE Student chapter at Chembur.

ISSE Student Chapter at Vivekanand Polytechnic, Chembur, Mumbai was inaugurated on 16 March 2019. Trustee Shri Lala, Principal Shri Vikrant Joshi and HOD Mrs. Vidya Lunge welcomed ISSE sectary Hemant Vadalkar, Past President Prof. G B Chaudhary, Madhav Chikodi and Paresh Unnarkar. This is a student chapter for diploma students. Madhav Chikodi explained about activities of ISSE. Hemant Vadalkar spoke about the avenues for civil engineers. Prof. G B Chaudhary made presentation on shore piles and challenges in deep excavations. Mr. K L Savla and Mrs. Vidya Lunge were instrumental in forming a student chapter at Vivekanand Polytechnic. ISSE assured help and guidance.

29 and 30 March 2019 : Workshop on Advanced analysis by EFC

EFC arranged a workshop on "High end analysis of buildings" in Mumbai. During the inauguration function, Dr. V N Gupchup eminent structural engineer was felicitated by senior structural engineer Satish Dhupelia. Dr. Yogendra Singh from IIT Roorkee talked on Push-over analysis and P- delta analysis and theory behind the analysis procedures. Prof. M G Gadgil, Prof. K K Sangle shown examples of the push-over analysis and P-Delta analysis. Anil Hira talked about the digital engineering and how the tools can be used to analyse complex structures through some international examples. Ranjith Chandunni elaborated on Column shortening analysis in tall buildings. Kiran Acharya discussed on progressive collapse analysis with case studies. More than 100 engineers attended the workshop.

Edited and published by Hemant Vadalkar for ISSE, C/o S G Dharmadhikari, 24, Pandit Niwas, 3rd floor S K Bole Marg, Dadar (W), Mumbai 400 028. Tel 022-2431 4423. e-mail issehq@hotmail.com Web : www.isse.org.in for private circulation and printed by S. L. Bengali, 15, Pandit Niwas, S K Bole Road, Dadar, Mumbai 400 028.

17 Jan 2019 : Visit to Cluster Development project at Bhendi Bazar SBUT project

29 Jan 2019 : Inauguration of ISSE Navi Mumbai Centre

30 Jan 2019: ISSE Student chapter (Saboo Siddiq) site visit

15 Feb 2019 : Inauguration of ISSE Student chapter at MIT WPU Pune

26 Feb 2019 : Inauguration of ISSE Student chapter at Chameli Devi Group of Institutions, Indore

9 March 2019: ISSE Site visit to Sardar Sarovar Dam and Statue of Unity

16 Mar 2019 : ISSE Student chapter at Chembur.