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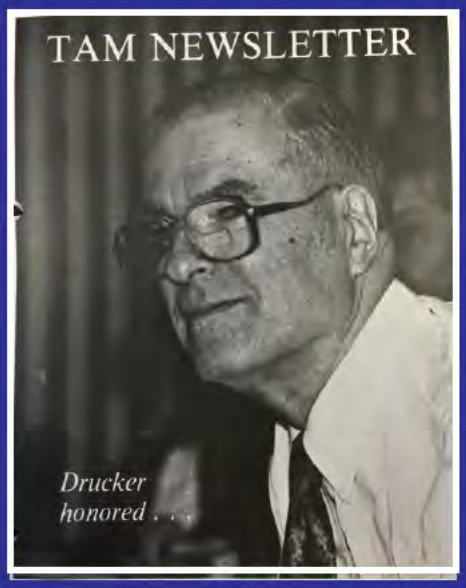
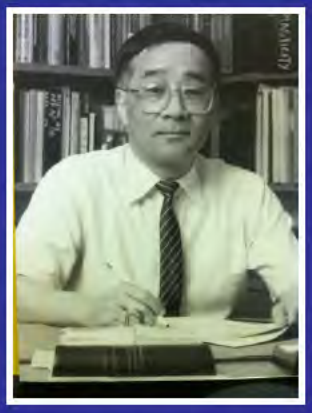


Prof. D. C. DRUCKER

Prof. L. S. BEEDLE



Prof. W. F. CHEN

GEM 21:PROF. D. C. DRUCKER AND PROF. L.S. BEEDLE

FACTORS INFLUENCING CHOICE OF ENABLING SYSTEM FOR DEEP EXCAVATIONS

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INDIAN SOCIETY OF STRUCTURAL ENGINEERS

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VOLUME 21-3, JUL-AUG-SEP 2019

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Editor : Hemant Vadalkar

Fraternity News

WELCOME TO NEW MEMBERS

(April to September 2019)

1	M-1711	Sangram Surendra Laigude	35	M-1745	Rohini Nandkumar Patil
2	M-1712	Parag Prakash Chopada	36	M-1746	Parthesh Nilesh Parekh
3	M-1713	George Thuruthiyil Deepu	37	M-1747	Niranjan Chandrakant Waichal
4	M-1714	Priyanka Rohit Navandar	38	M-1748	Sandip Balasaheb Bhalerao
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6	M-1716	Hashmi Sibgatullam Mujahid	40	M-1750	Yogesh Rajendra Chopda
7	M-1717	Mudaliar Srinivasan Kanna	41	M-1751	Chitra Prashant Usturikar
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9	M-1719	Harish Totala	43	M-1753	Vivek Laishram
10	M-1720	Anil G. Khandelwal	44	M-1754	Rupesh Narhari Kale
11	M-1721	Hemant Ijjatrai Mehta	45	M-1755	Zaki Ahmed Shaikh
12	M-1722	Sunil Jawaram Patil	46	M-1756	Aparna Devndra Dabak
13	M-1723	Ashish Kumar Jangalwa	47	M-1757	Agarwal Arpit
14	M-1724	Raana Pathak	48	M-1758	Indrajeet Krantikumar Patil
15	M-1725	Harshad Dilip Mahale	49	M-1759	Sangram Bhalchandra Patil
16	M-1726	Parth Atulbhai Shah	50	M-1760	Amit Raosaheb Shinde
17	M-1727	Ranjeet Shatrughna Sawant	51	M-1761	Zalani Abhinav
18	M-1728	Atulkumar Jagdishkumar Mehta	52	M-1762	C. Tamilvendan
19	M-1729	Suhas Vaman Kale	53	M-1763	V. Arun
20	M-1730	Umesh Sharad Joshi	54	M-1764	RohanTushar Karkare
21	M-1731	Bhavinkumar Arvindbhai Patel	55	M-1765	Rajesh Rastogi
22	M-1732	Narendra Mohanlal Ajugia	56	M-1766	Niyat Vatsal Patel
23	M-1733	Vijay Ramesh Salunkhe	57	M-1767	Abhijeet Adinath Galatage
24	M-1734	Saurabh Harishikesh Pandit	58	M-1768	Debjit Mitra Roy
25	M-1735	Sapna Alkesh Shah	59	M-1769	Ankit Kantilal Patel
26	M1736	Shilpa Bhaveshkumar Patel	60	M-1770	Rohan Shrikant Jirage
27	M-1737	Prachi Madhusudan Dixit	61	M-1771	Deepak Vasantrao Sanglikar
28	M-1738	Jitendra Subhash Hatkar	62	M-1772	Sandeep V. Shah
29	M-1739	Raju Kumaraswamy Vurugonda	63	M-1773	Partha Pratim Roy
30	M-1740	Ashok Kumar Abani Chattopadhyay	64	M-1774	G. Palanivelu
31	M-1741	Bhushan Sudhakar Kasar	65	M-1775	Abhijeet M. Kulkarni
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33	M-1743	Ajinkya Uday Pachhapurkar	57	M-1777	Deepak Krishna V. M.
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GEM 21:PROF. D. C. DRUCKER AND PROF. L.S. BEEDLE - HOW THE MATHEMATICAL THEORY OF PLASTICITY SHAPED THE MODERNSTRUCTURAL DESIGN

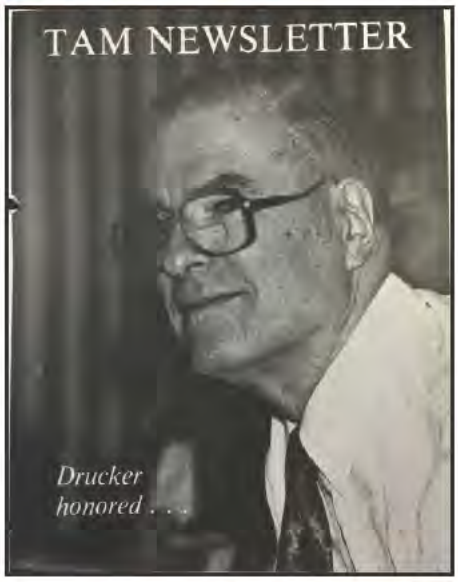
By Prof. Waifah Chen

Brown University

When the mathematical theory of plasticity was first introduced to civil engineers in the1950's under the leadership of William Prager of Brown University, the topic was taught in the applied mathematics department with tensor notations that is hardly readable and understandable for most civil engineers. The Brown group in solid mechanics was founded by William Prager who was a mathematician and the father of applied mechanics and also the father of plasticity in particular. And through his fine leadership the group became internationally known for its pioneering work in plasticity.

In this period, the classical incremental plasticity theory was in its golden time, but our computing capability in engineering practice was in its infancy, the slide rule computing.We had a rigorous theory but few practical solutions. For engineering practice, we must develop simple theory that is realistic and practical. There is nothing more practical than the simple limit analysis theorems and techniques developed by Drucker et al.of Brown University in the 1950's.

DANIEL C. DRUCKER



Education

Dan Drucker was born in New York City on June 3, 1918, and started his engineering career as a student at Columbia University. His ambition was to design bridges, but as an undergraduate he met a young instructor named Raymond D. Mindlin who told him that “he would pursue a Ph.D. degree and he would write a thesis on photoelasticity.” Dan complied and he obtained his B.S. in civil engineering in 1938 and his Ph.D. in mechanical engineering in 1940 under Professor Mindlin.

Careers

He taught at Cornell University from 1940 to 1943 before joining the Armour Research Foundation. After serving in the US Army Air Corps, he returned to the Illinois Institute of Technology for a short time before he went in 1947 to Brown University, where he did much of his pioneering work on plasticity. In 1968 he joined the University of Illinois as dean of engineering. During his more than 15 years there, the College of Engineering was consistently ranked among the best five in

the nation. The college was known for both its insistence on technical excellence. Dan left Illinois in 1984 to become a graduate research professor at the University of Florida, from which he retired in 1994.

Contributions

He was known throughout the world for contributions to the theory of plasticity and its application to analysis and design in metal structures. He introduced the concept of material stability, now known as Drucker's stability postulate, which provided a unified approach for the derivation of stress-strain relations for plastic behavior of metals. His theorems led directly to limit design, a technique to predict the load-carrying capacity of engineering structures. He also made lasting contributions to the field of photoelasticity.

Awards

ASME honored him with the Timoshenko Medal (1983), and ASCE presented him the Theodore von Kármán Medal (1966), the first William Prager Medal (1983) from the Society of Engineering Sciences, the John Fritz Medal (1985) from the American Association of Engineering Science, and the Modesto Panetti and Carlo Ferrari International Prize and Gold Medal (1999) from the Academy of Sciences of Turin.

Honors

In 1988 he received the National Medal of Science. He was elected to the National Academy of Engineering in 1967 and the American Academy of Arts and Sciences in 1955. He was a foreign member of the Polish Academy of Sciences.

Lehigh University

The plastic design method for steel structures were first developed, refined at Lehigh University and implemented into the AISC specifications in the 1960's, under the leadership of Lynn Beedle of Lehigh University in the U. S. among others.

Lynn S. Beedle

Education

Lynn S. Beedle was born in Orland, California In 1917. He received his B.S. in civil engineering from the University of California at Berkeley in 1941 and both his M.S. and Ph.D. degrees from Lehigh University in 1949 and 1952, respectively.

Careers

In 1947 he joined the Navy and later in the same year, he joined Lehigh University as an instructor. His groundbreaking studies on the properties of steel structures and his creation in 1969 of the Council on Tall Buildings helped the university become a center for civil and structural engineering research.

Honors

He was elected to the National Academy of Engineering in 1972, and was recognized by the Engineering News-Record named him as one of top 125 people who made invaluable contributions to the construction industry since the magazine's founding in 1874. He also received a lifetime achievement award from the American Institute of Steel Construction in 2000.

Awards

He received Franklin Institute's Frank P. Brown Medal in 1982, as well as the John Fritz Medal

and the Berkeley Engineering Alumni Society Distinguished Engineering Alumnus Award in 2000. He was named Distinguished Professor of Civil Engineering by Lehigh University in 2003.

Fritz Engineering Lab, Lehigh University

Lehigh's Fritz Lab had the world largest testing machine conducted many full scale tests on steel frames to verify the plastic theory before AISC code implementation which is now known as Plastic Design in Steels. The most famous full scale plastic design demonstration test of steel frame was done in 1963 at Fritz Lab with suspicious representatives from AISC specification committee as well as sponsors from American major steel industry companies watching Intensely. This included the two steel giants: US Steel and Bethlehem Steel at the time. At the time, American steel industry was dominating the world market and they sponsored major steel research work at Lehigh in particular. They wanted us to show right before their eyes that the plastic theory really worked with its prediction of the formation of a series of plastic hinges one by one till reaching the formation of a complete plastic collapse mechanism.

That was the year Dr. Beedle wrote his pioneering book on "Plastic Design of Steel Frames". That was also the year AISC added the plastic design method as part of its new building codes. That also was the year Bethlehem Steel Company built its state of art research facility on the top of the Hill where Lehigh campus was located. Dr. Beedle's contributions on the implementation of plastic design methods to steel frames were immense and his book on Plastic Design of Steel Frames is now a classical one, and we may call him the father of plastic design in steel frames in America in particular. He was also the first ever Lehigh faculty member ever be elected later to the National Academy of Engineering.

I recall we had a very hard time to convince the Specification Committee members and steel industry representatives to accept the statement that "with a proper load factor we could design the building to reach its collapse load". The word "collapse load" would scar many owners so the compromise term was to use "limit load" to avoid a possible rejection by architects who represented owners interest to avoid any potential implication of building collapse during the design process.

The first full size prestressed concrete girders in the U. S. were tested in Fritz Lab, and based on these tests, the state of Pennsylvania become the pioneering state in the United States for this successful form of bridge construction. The interstate highway system also benefited a great deal from these tests.

With this new testing facility, Lehigh's structural group in steel research expanded greatly. Graduate students around the world came to Lehigh as the Mecca to study this new concept of plastic design and they returned to their home countries to teach this new design concept to their postwar engineers. As the result, Lehigh became an extremely nfluential university whose graduates taught this new steel design method in almost every major universities in the United States.

My Life Journey with the two giants

When I was a graduate student at Lehigh in 1961, University of Illinois Civil Engineering School under the leadership of Newmark was alway considered to be the best civil engineering school in the nation with top testing facilities and super who's who giants on its CE faculty list, including for example, the soil mechanics giant R. Peck who coauthored the first ever Soil Mechanics textbook with the father of soil mechanics K.Terzaghi, and the structural guru Hardy Cross who invented the famous classical Moment Distribution Method for everyone of us to learn in structural engineering. N. Newmark on the other hand, who helped build the famous Alaska pipeline by overcoming the very difficult permafrost soil foundation problem in order to transport the very hot Alaska oil to mainland USA

without causing the supporting foundations sinking. Newmark is now widely considered as one of the founding fathers of Earthquake Engineering.

All engineering faculty at the time was hands-on real world engineers with deep physical insights. They used little mathematics like differential equations but with their deep physical insights and slide rules and simple calculators, they could estimate the right amount of forces in their structures or soil foundations with their ingenious simple methods just like today we used widely the popular limit analysis methods like the simple plastic design methods for steel frames or strut-tie model for RC design.

It was at Brown University that I learned for the first time ever what was known at the time as the engineering science education as I was taught solely the highly mathematical theory of plasticity with tensor notations and treated every structure just as a continuous body known as continuum. Over the three years at Brown, we never sketched a single real structure like a beam or a plate or a shell, it was just to draw a continuum to represent any structure we were in mind.

During the period 1961-66, I attended Lehigh University in 1961 and received my M. S. in structural engineering in 1963. I then transferred to Brown University to continue my graduate study and wrote my doctoral thesis on soil plasticity and limit analysis under the supervision of Professor Daniel C. Drucker. I was second to the last Drucker's Ph.D. student at Brown in 1966. My advisor Drucker who was recruited by Prager to Brown and he made major contributions to the foundations of plasticity. Among them, the most important impact on me was their discovery and proof of the classical limit theorems on which the limit analysis techniques were developed in the 1950's.

In 1966 when I returned to Lehigh to teach, there is no chance to teach mathematical theory of plasticity for structural engineers at Lehigh so I had to figure out a way to cover the subject that was useful for civil engineers. So limit analysis became my obvious choice. In the teaching process, I developed the course contents tailored to civil engineers applications in soil mechanics in particular. In the process, I was able to reproduce almost all Terzaghi's work in his famous soil mechanics book with limit analysis methods. To my surprise, Terzaghi developed most of his solutions based empirically on the large amount of test data he collected during the construction of New York subway. Simply put, he had all the real world engineering answers to every geotech problem but did not have a rigorous mechanics based theory to guide him to reach the same conclusions.

In 1975, I wrote the book "Limit Analysis and Soil Plasticity" introducing this limit analysis techniques to geotechnical engineers in particular with most examples taken from Terzaghi's book as a validation for the techniques and its solution for practical applications. The book received an instant and wide acceptance in the geotech community and created such an excitement around the world. The merit of limit analysis lies in the fact that engineers can now make practical and safe decisions on the design of complex load-bearing components on the basis of relatively simple calculations.

Only in last decade, the lower bound limit analysis methods were successfully implemented in the design of reinforced concrete structures especially for deep beams, web opening and torsion and beam to column connections. This is now known as Strut-Tie Model in the terminology of reinforced concrete engineering field.

In the 1970's, our computing power changed drastically with mainframe computing. The Finite Element Methods were well developed and widely used in structural engineering. We were able to apply the theory of stability and the theory of plasticity to simulate the actual behaviors of structural members and frames with great confidence. It was the first time we were able to replace the costly full-scale tests with computer simulation. As a result, the limit state approach to design was advanced and new specifications were issued.

It was at Lehigh University that I worked closely with Beedle and made the major part of my contributions to the theory of plasticity and to its application to the design of biaxially loaded columns in engineering structures with the use of

newly developed plastic theory. As a result, in 1976-77, I published a two-volume work on "Theory of Beam- Columns" with my doctoral student, T. Atsuta, the first ever in this field to discuss systematically the complete theory of in-plane and space beam-columns. The landmark work shows how these inelastic theories are applied for the solution of practical design in steel frames beyond their elastic limits in contrast to the well-known elasticity-based books written by Stephen Timoshenko, the father of engineering mechanics in the 1950's.

My Memorial Tributes

With the wide use of computers and real world field electronic gages in real time monitoring in civil engineering in recent years, many universities in the U. S. nowadays started to hire new faculty members basically trained as a structural scientist rather than a structural engineering practitioner. These engineering scientists trusted more on their computer solutions since most of them are lack of physical insights because few have experienced with full scale tests that is required for any large scale innovative new civil engineering projects, that is truly a worrisome fact for us. Unlike the older generations of structural and geotechnical engineers with their strong gut feelings, these days structural and geotechnical scientists are mostly talking about applications of AI technology and use of accumulated large databases seeking for their solutions.

I, like my former mentors Beedle and Drucker, still believe that structural and geotechnical engineers must still learn some quick short methods to confirm on the back of an envelope calculations to check their sophisticated computer solutions in order to avoid any potential disasters like recent Boeing 737 Max that will sure happen one of these days as predicted by the Murphy Law, "Anything that can go wrong will go wrong". Right!

For almost half a century, the advances in the theory of plasticity and the work of Daniel C. Drucker and the implementation of the plastic theory to steel structures and the leadership of Lynn S. Beedle were intimately linked in the United States. It has been a wonderful experience and rewarding career for me to have the privilege to work under and along side them. As they both liked to emphasize, a true fulfillment of engineering research and education is "a place in practice". Their impacts on engineering practice and education have been tremendous. This article is my tribute to them. They remind role models for us all.

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Education
National Cheng Kung University (1955-1959)
MSCE, Lehigh University (1961-1963), Ph. D., Brown University (1963-1966)

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Purdue University, Professor (1976-1992), Distinguished Professor (1992-1999)
University of Hawaii, Dean, College of Engineering (1999-2006)

Specialties
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Awards and Honors
Member, U.S. National Academy of Engineering (1995)

Honorary Member of American Society of Civil Engineers (1997)
Academician, Academia Sinica, R.O.C. (1998)

FACTORS INFLUENCING CHOICE OF ENABLING SYSTEM FOR DEEP EXCAVATIONS

Gaurav S. Parab, Vijay V Dandage, Anirudha V Sharma

(Partners M/s. Global Geotechnics) http://www.ggeotech.com

ABSTRACT:

The various types of retaining elements commonly used to support deep excavations are discussed in the paper as also their applicability in different types of geologies. In an attempt to understand the overall mechanical behavior of the various retaining elements the other factors influencing their application is also discussed. A case study of one of the deep excavations in central Mumbai has been discussed at the end.

INTRODUCTION:

Limited space and high demand have made land in cities like Mumbai & Pune very expensive. In the past few years, the demand for housing and parking space has risen exponentially. Planners are increasingly turning to the option of tall buildings to optimize the ratio of floor to land area. This also enables the planners to provide car parking facilities in the form of multiple level basements, leading to deep excavations. Deep excavations are also required in the urban scenario due to construction of subways, guide walls on nallahs and retaining walls. For these deep excavations, temporary soil retaining structures such as diaphragm wall, circular touching piles, secant piles and meter panels may be used.

The type of enabling system for a particular project is selected as per depth of excavation, type of stratification, distance from and type of surrounding structures and economy.

In the following paragraphs, a few general stratifications are described followed by the various options for enabling systems. The suitability of a particular type of enabling system based on stratification is discussed.

STRATIFICATION

The different types and groups of stratification covered in the present discussion are as follows -

1. Sandy/silty soil from commencement to termination of excavation.
2. Soft clayey soil at commencement followed by igneous geology at greater depth.
3. Sandy / silty / clayey soil at commencement followed by igneous geology at shallower depth.
4. Filled up soil till greater depths.
5. Sites with no constraint on space availability.

TYPES OF PRIMARY ENABLING SYSTEMS

Various primary enabling scheme commonly adopted are as follows -

1. Touching Piles
   - i) Micro piles
     - a) Cantilever Piles
     - b) Piles with one or multiple level anchors
   - ii) Big diameter piles
     - a) Cantilever Piles
     - b) Piles with one or multiple level anchors

2. Secant piles
3. Diaphragm wall
   i) Cantilever
   ii) one or multiple level anchors
4. Sheet piles
   i) Cantilever Piles
   ii) Piles with one or multiple level anchors
5. Meter Panel
   i) Cantilever Piles
   ii) Panels with one or multiple level anchors

TYPES OF AUXILARY ENABLING SYSTEMS

1. Prestressed anchors
2. Passive anchors (soil nails)
3. Cancellation struts
4. Shotcreting (guniting)

The above mentioned stratifications and enabling schemes are presented in a rather simplified way. Often on sites, the selection of a shoring scheme is also dependent on following factors.

a) Location and accessibility of site
b) Availability of drilling rigs at site location
c) Distance and type of adjoining structures.
d) Ground water table
e) Season of excavation

The type of enabling structure has to be adopted based on all the above parameters. An over sight in even a single parameter may cause disaster. Nevertheless, the following table gives a guideline of how the stratification influences the choice of enabling system assuming that points a through e as mentioned above are more or less favourable

Type of geology	Preferred primary retention scheme	Preferred secondary retention scheme
Sandy/silty soil from commencement to termination of excavation	a. Large diameter touching piles b. Diaphragm walls if water table is high c. Secant piles if water table is high and sand is dominant.	a. Prestressed anchors b. Internal struts c. Soil nails (least preferred but can be used if designed adequately)
Soft clayey soil at commencement followed by igneous geology at greater depth.	a. Secant piles with anchors are preferred. b. Diaphragm walls can also be considered. c. Large diameter touching piles can be adopted if the igneous geology is favourable for drilling. This option may require the use of plates to control the flow of clay through gaps between piles. d. Pneumatically drilled micro piles are the least preferred option, but can be provided if other alternatives are infeasible.	a. Prestressed anchors b. Cancellation struts
Sandy / silty / clayey soil at commencement followed by igneous geology at shallower depth.	a. Large diameter piles are the best option provided drilling can be done in rock. b. Pneumatically drilled micro piles with anchors can be provided if the rock is hard and large diameter drilling is not possible.	a. Prestressed anchors b. Cancellation struts c. Soil nails (least preferred but can be used if designed adquately)
Filled up soil till greater depths.	a. Pneumatically drilled micro piles with permanent anchors are the most feasible option as presence of boulders in the filled up layer may hamper the drilling of large diameter piles.	a. Prestressed anchors b. Cancellation struts
Sites with no space constraints	The ideal scheme at such sites is to carry out the excavation with stable slope angles	Secondary retention in the form of shotcreting (guniting) may be applied to prevent erosion with the implicit assumption that the slope is stable.

Case Study

The case study of a deep excavation near Mumbai Central railway station and Girgaon area, is discussed. The primary enabling system was chosen as secant piles wall due to high water table and presence of soft soil. Cancellation struts were provided in order to avoid anchors fouling with the neighbouring properties. Few photographs and stratification are given below. The design is done by software and hence for brevity's sake it is not being shared here.

Quality check and Monitoring of enabling system

Quality check during execution of work is very important to ensure that the theoretical design matches the site performance.

Variation in stratification is very common phenomenon which has to be monitored by regular pile penetration records and verification of recovered samples.

The methodology of piling, dimension of tools adopted for design, types of rigs used for execution also has to be monitored. The design may have to be reviewed based on tools used for drilling.

The deflections/strains/inclination have to be monitored using suitable instruments having adequate least count. This shall help to improvise the scheme during execution of work.

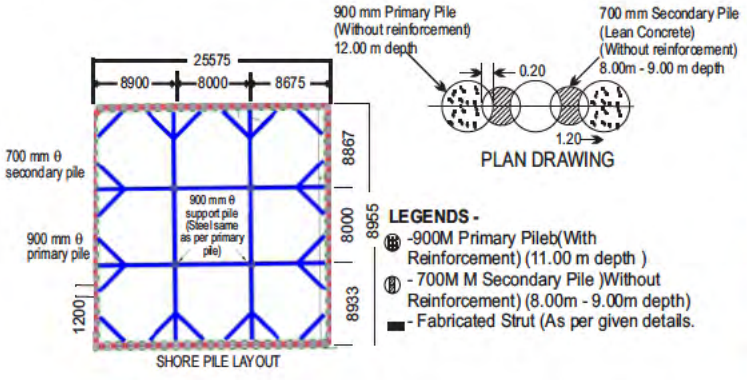

Fig.1. Plan and cross section of Shoring scheme with Secant piles and support struts

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POINT OF VIEW

Views expressed by eminent Structural engineer Shirish Patel on Structural inspection report and Stability certificate are produced here for the information of readers

Question : MCGM is asking for stability certificate from a person doing structural audit which is not correct. Most of the times, owner does not have any structural drawings or any data related to the structure. Structural inspection will provide basic idea about the condition of the structure. ISSE stand is that only Structural inspection certificate can be provided after condition survey. Later, engineer who is providing repair consultancy or supervising the repair can provide fitness certificate / fit for habitation indicating validity period like driving license renewal. What are your comments on this ?

Shirish Patel : First, you have to insist that all you can provide is a Condition Survey, not a Stability Certificate certifying that the structure is safe.

I would say that it is only if the Condition Survey shows a building to be in doubtful condition that a Stability Certificate should be insisted upon. Perhaps ISSE can persuade MCGM to demand Condition Surveys for all buildings, but Stability Certificates only to those that require it.

If the owner / MCGM insists on a Stability Certificate (better to call it Fitness Certificate) that can only be provided with a far more elaborate investigation, for which the client must be prepared to pay. It involves the following series of actions:

(a) Preparation of a full set of drawings for the structure, dimensioned, dated with the date of construction and the date of preparation of the drawings. If structural members are covered up and not available for sizing, the covering needs to be removed to allow inspection. It should be made clear to the client that without this full set of measured structural drawings no Stability Certificate is possible.

(b) Estimates of reinforcement in the structure, based on whatever investigations can reveal, together with estimates of extent of corrosion.

(c) Estimates of strength of concrete at various locations based on whatever tests are appropriate, including cores if necessary to confirm estimates based on NDT values.

(d) Structural analysis, followed by determination of load carrying capacity. This should be in accordance with prevailing Codes of Practice. We are not concerned with whether the original designer did his job correctly or not. We are interested only in where the structure is non-compliant. This should be explicitly set out.

(e) List of repairs to be carried out, including steps to make the structure fully compliant.

(f) Appointment of a repairs Contractor, to work under the supervision of the consultant providing the Stability Certificate.

(g) Satisfactory completion of repairs.

Once the above have been carried out, I think it is reasonable for the client to expect the consultant to issue a Fitness Certificate for 5 years, after which a fresh inspection is called for.

If the original designer in involved, steps (a) to (c) can be bypassed, other than estimating the extent of corrosion of reinforcement and any degradation in concrete. Clients incurring unnecessary expense because they don't have the original drawings will rapidly learn the value of keeping records.

Author

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CONSTRUCTION TECHNOLOGY IN HOUSING INDUSTRY

Arun Kashikar

Indian real estate Industry and affordable housing:

Indian real estate Industry is going through peculiar time. On one hand there is oversupply of units in premium and luxury housing segments resulting in average 3 to 4 years of inventory overhang across the cities, while on the other hand there is huge demand-supply gap in affordable housing segment. Majority of projects are also getting delayed and the average delay is about one year across sectors.

It is well a known fact that current shortage of affordable homes in India exceeds 24 million units. It is also known that labours are in short supply and labour shortage is going to increase with time. Productivity of Indian labour also is much lower compared to other parts of the world including China. With current labour dependent construction practices and increasing shortage of labours, it is impossible to meet the current housing demand, especially in affordable housing sector.

Current technology used for Housing construction in India:

Conventional construction technology – beam column frame with red brick infill wall

More than 90% projects in India are being constructed using Beam-column RCC framed construction with brick infill masonry walls. This technology has many limitations viz.

1. Only RCC beam column frame, which consumes hardly 10% volume of the entire structure, is load bearing part of the structure, while majority part of the structure like masonry walls are loads acting on these frames. This makes structural system highly inefficient.

2. All Masonry walls are made up of red clay brick. Clay brick is highly climatically unsustainable material, as it uses top fertile soil for it's manufacturing and brick manufacturing kilns employ child labourer at most of the locations

3. This type of construction requires masonry walls to be plastered. Plastering is most laborious part of the building construction

4. The entire structure is cast at site using wet concrete and masonry blocks, again labour intensive and therefore highly vulnerable form safety and quality perspective

Considering the above, it is essential to give way to newer technologies which will make the structural system more effective, which are climate friendly and which reduces manual labour in the construction. Safety and quality also need huge improvement, which can happen only if construction is moved to off-site form in-situ. Tata housing has therefore moved away from conventional Beam-column framed construction and employed industrialised construction which

is much better in safety and quality, less labour intensive and faster.

Following some of the alternatives to conventional technology, already implemented by Tata housing, have potential of becoming common in Indian construction industry in near future.

Monolithic construction:

This is lightweight aluminium formwork system, where in all elements of one floor including walls, slabs, staircase etc. are cast in one go, resulting in saving of construction time. The formwork can be used for more than 100 repetitions, thus achieving economy.

This technology overcomes major limitations of conventional technology as below:

1. Structural system is shear wall–slab system, hence major portion of structure is load bearing element instead of load, making structural system very efficient.

2. Plaster is eliminated, making it less labour intensive

3. Since entire floor is cast in one go, typical slab cycle achieved is 7 days making it much faster compared to conventional, wherein typical slab cycle is 15 days.

Reinforced concrete block shear wall-slab system:

RCB – under construction, New Haven, Ahmedabad – Tata Housing

This is improvement over conventional load bearing wall construction, which was prevalent but now largely replaced by RCC framed construction. Conventional load bearing construction went out of vogue because of two issues – a) Strength of brick used was limited by the quality of local clay available, which made wall thickness higher as height of building increases and b) Structures constructed using this technology were poor in earthquake resistance. Recent advancement has made it possible to manufacture high strength concrete blocks, which can replace conventional clay bricks. This enabled us in keeping the wall thickness to 200mm even for seven storey building. Introduction of reinforcement and ductile detailing of the structure made it one of the best systems for earthquake resistant structures. In fact, RCB is used as earthquake resistant seismic rehabilitation structures in almost all earthquake hit areas in India.
This technology has many advantages viz.

i. Customer acceptability is not an issue, as look and feel is same as conventional technology

ii. There is a significant cost and time saving compared to the conventional construction

iii. Specialised labour is not required as this is adaptation of conventional load bearing structure used in India for many years.

There are some limitations also, which makes its use limited to value homes like:

i. As most of the walls are load bearing walls, modification of the walls post construction is not possible

ii. Wall thickness less than 200mm is not possible which increasing the architectural loading

iii. This technology cannot be used easily for the structures mare than 10 storey high.

Precast technology:

Precast construction at Peenya, Bangalore – Tata housing under erection

Only complete solution to reduce the labour dependency is to change the place of construction from sites to factory. This can be done by employing precast concrete construction. Since, in this case, lots of cranes and equipment are required and structure have to be designed for 'handling stresses' in addition to usual loads, the cost of structure becomes slightly higher compared to conventional construction. Therefore, cost effectiveness in precast construction can be achieved only by employing volumes and due to significant time saving.

There are various types of equipment / combination of equipment used for precast construction. Two major types of precast plants used are:

1. Battery moulds and tilting table combinations with or without hollow core slab unit: In this case battery moulds are used to cast typical walls and tilting table is used to cast 'non-typical walls' and other elements. Slab can be cast either using hollow core machine orusing separate slab moulds.

2. Carousel plant:

Carousel plant at New Haven Peenya-Bangalore, Tata housing

The carousel plant is very similar to car factory, wherein all elements of buildings including walls and slabs are cast on workstation known as pallets. Pallets move on pedestals form one workstation to another after time required to complete particular activity is over. The plant can be fully automated with minimal manual intervention. The elements cast in this factory are

then moved to site, erected and joined to complete the building.

Precast construction has many advantages, some of which are:

1. The entire construction is done off-site in controlled factory environment, making it one of the safest way of housing constructions

2. Quality of elements are much superior as the work is done in the controlled factory environment.

3. Labour requirement at site is reduced to 40% compared to cast-in-situ construction

4. Construction time is reduced to 50%

5. Since the technology is much less dependent on manual labour, on-time completion of projects can be ensured.

3D Precast

This is advancement over plain precast, wherein three dimensional modulesare cast in the moulds, off-site. Series of moulds are then transported and erected at the construction site to make the complete building. Advantage in this case over plain precast is reduction in number of joints, making it less vulnerable to leakages through joints.

GRRG panels shear wall slab system:

In this technology panels made up of 'glass fibre reinforced gypsum' is fabricated in the factory. These panels are then transported and erected at site like precast concrete construction. This is most climatically sustainable technology of all described above as the panels are made up of gypsum and glass fibre, both being recycled products.

Conclusion:

Though Indian real estate industry has remained largely conventional till today, it has started moving towards industrialised construction due to labour shortage and low labour productivity leading to projects delay. Introduction of RERA, will still enhance use of industrialised construction, as project completion on time becomes legally binding. Sustainability also will be very important aspect which will govern any new technology becoming popular. Other advancement in the construction world like 3D Printing may also become popular in future once it becomes cost effective and practical.

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BOOK REVIEWS

By Hemant Vadalkar

Some new books have been published recently related to Civil Engineering. A review has been provided for the information of our members.

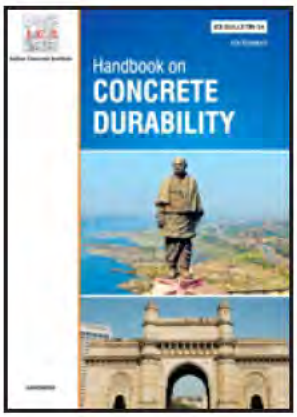
A) Handbook on Concrete Durability

The Indian Concrete Institute (ICI) has recently published 'Handbook on Concrete Durability'. The Handbook contains state-of-the-art information on the topic of durability of concrete, including the foremost national and international trends.

The Durability Committee of ICI, which prepared the Handbook with painstakingly efforts, was drawn from a diverse background, representing around two dozen practicing senior professionals from cement and concrete industries, consulting engineers, government officials, contractors, academics, researchers, etc.

The contents of the handbook are organized in 11 chapters that are divided in three major sections, namely, (i) Background and Fundamentals, (ii) Durability Assessment and Design and (iii) Practical Aspects and the Way Forward.

The 100-page handbook underwent many revisions and re-revisions. The contents of the Handbook have been reviewed by three renowned experts from abroad and many of their suggestions have been incorporated in the document.



The Handbook is intended to assist the specifiers, clients, consultants and engineers in making informed decisions about the control of durability in their concrete construction. It contains a variety of recommendations, chief amongst which include: realignment of the existing definitions of exposure classes in the Indian Standards in line with the anticipated severity of exposure during the service life of structures, specifying appropriate test methods for assessing durability,control on cover to the reinforcement, adoption of service life design, adoption of performance-based specifications for critical civil engineering structures such as bridges, metro-rails, viaducts, tunnels, ports, airports, industrial structures, commercial complexes, etc.

The Handbook fulfils the long-felt need of a user-friendly and educative document on the topic of concrete durability.

The cost of the Handbook is Rs. 750 (US$ 20.00) and is available at a discount of 20% to the members of the ICI and 10% to other professional bodies. For more details, please write to ICI Headquarters at ici4@airtelmail.in or indconhq@gmail.com.

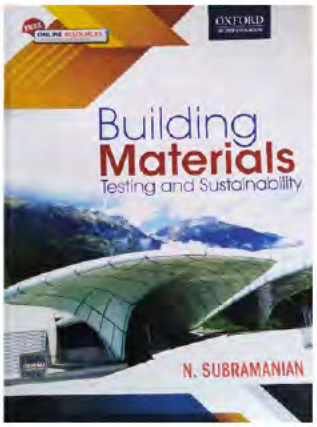
B) Building materials testing and sustainability by Dr. N. Subramanian, Oxford University Press 2019.

(drnsmani@gmail.com)

Dr. N Subramanian the author of popular RCC design and Steel design books and Consulting engineer has written a new book on building materials. Various building materials used in the building construction and their testing procedures along with the BIS code reference have been explained in the book.

The book has been organized in 25 chapters with good pictures, diagrams, tables, references from BIS. Properties of different building materials were discussed including sustainable materials to be used for Green buildings. In various chapters Building stones, brick and brick substitutes, building lime, Cement and cementitious materials, aggregates, mortars and

plasters have been discussed. Special chapter on Concrete and reinforced concrete and special structural concrete has been added. Other materials like Gypsum, ferrous metals other than steel, steel, non-ferrous metals and alloys, glass, clay and ceramic products, plastic and rubber, paint and varnishes, asphalt , bitumen and tar, thermal insulating materials, sound insulating materials, waterproofing materials, miscellaneous materials have been discussed. Special chapter on Testing and evaluation of building materials and deformation and fracture of materials including creep, fatigue, fracture toughness has been discussed.



This 788 page book will be very useful to Engineering students, Professionals, Clients, Architects, Contractors, Government organisations for having diverse information on materials at one location.

C) Handbook on Quality and Productivity improvement of Concrete by Dr. N V Nayak and Manish P. Mokal (manish.mokal@afcons.com)

With vast field experience with AFCOS and Gammon India both authors have provided practical guidelines for improving concrete quality and productivity. This 236 page book has been published by Narosa Publishing House in 2019 and is very useful for all civil engineering working with concrete. The book has been praised by Dr. P C Basu(Ex-Director (SSED)-AERB) and Dr. Ravindra Gettu (IITM). Book provides valuable guidelines on different aspects of concrete technology in its 12 chapters. Solution to many problems faced by concrete technologist are addressed in innovative but simple approaches. Book puts more emphasise on curing which is important for durability but which is often forgotten by construction engineers. Another important aspect of sustainable concrete by use of blended cement and increasing durability has been brought out.

Various aspects of concrete starting with the concrete ingredient like cement, water, air content, supplementary cementitious materials, aggregates, chemical admixtures has been discussed in different chapters. Factors affecting concrete quality and productivity like concrete temperature, batching plant issues, transportation , placing, compacting and curing of concrete has been discussed in length. We hope that this book will be useful for all concrete professionals, teachers, students.

D) Lessons not learnt from Failures – A collection from various sources since 1993 to 2017 by Jayakumar J. Shah

(jayakumarjshah@gmail.com)

Mr. J J Shah a senior civil engineer with vast construction and repair experience of more than five decades had presented his thoughts through various articles and compilation of press reports , technical articles and other sources. In various chapters ,he talks about failure due

to fire, failure due to building collapses, why buildings
collapse inIndia ?, Can structural
audit alone stop collapse of buildings, how to choose repair consultant? failure due to slab collapses, failure due to various reasons and elaborates on the importance of durable constructions.

A cartoon from renowned Structural Engineer N. Prabhakar raises a question how a building stood for so long in-spite of the fact that it was under designed, poorly detailed, badly constructed with less cement, silty sand, corroded steel, hardly any curing combined with overloading and poor maintenance ? This should be really a topic of research- how buildings are standing with all these deficiencies ?

He also questions In some more chapters he discussed on Failure due to land slide, failure due to wall collapse, failure due to accidents, failure due to caving, failure due to leakage in locations other than buildings, failure of bridges, anticipated failure at Heritage Structures. He had attached the book reviews on some available literature and articles. The book has good colour photographs showing various types of deterioration in the structures and failure patterns. The author has given suggestions for new construction and repair work and how to make the structure long lasting and durable. With a vast experience in construction and repair the collection of thoughts on Failure of structure by Mr. J J Shah will be a useful reference for all civil engineers. For more information the author can be contacted by email.

NEWS AND EVENTS DURING JULY - SEPT 2019

By Hemant Vadalkar

19 July 2019 : MCGM Municipal Architect Dept published advertisement asking expression of Interest from " Architects and Project Management Consultants under categories A B C and D based on the plot size from 2500sqm to 7500 sq.m., experience, cost of work, turnover for empanelment. ISSE had written a letter to MCGM requesting them to allow civil / structural engineering firms to apply for empanelment of Project Management Consultants.

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25 July 2019: ISSE has submitted comments on Subsurface investigation codes edited by Prof. Chaudhary to BIS.

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31 July 2019: ISSE had written a letters to MAHA RERA and Housing federation of Mumbai and Thane. In MahaRERA letter, it was emphasized that building should be maintained by the occupants without any damage to the structural frame. Timely repair and maintenance is the key to the long life for the structure. Dos and Don'ts were provided by ISSE. For housing federation, it was suggested to amend the CHS bye laws by adding clause that CHS should appoint a structural consultant to scrutinize the proposals submitted by the members for any addition and alteration in their flats. Secondly, repair of the main structural building frame like Foundations, columns , beams and slabs should be done by the society by a single qualified agency and not be left to the individual member (Bye law 159).

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3 Aug 2019: Epicons Friends of Concrete conducted workshop 78 on Inspection , Testing and maintenance of bridges at IEI Belapur centre.Shri C P Joshi, Secretary Roads Maharashtra Govt, gave the overview of condition of bridges in Maharashtra and informed that PWD is working on a manual of inspection of bridges. Sachin Joshi provided information on working of IBMS (Indian Bridge Management System) a national level platform for last five years which has more than 1,72,000 bridge inventory. Much more work is yet to be done. Atul Bhobe shared his experience and difficulty in bridge data collection during condition survey.He mentioned limitations of data collection such as inspection of foundations and structures below the water level could not be done. Costly Mobile Bridge inspection unit is required to carry out inspection of bridges. He suggested that Structural Health Monitoring system can be installed in all new bridges. Chetan Raikar shared his experience in the bridge inspection in the Mumbai region. He elaborated on factors responsible for deterioration of bridges and challenges in accessing all parts of the structure for inspection. Vikas Ramgude, SE PWD, shared his experience on the bridge inspection in Raigad area. Lowest bidder and lowest structural cost is selected in the present system which is just satisfying the code provisions is also one of the reasons for early deterioration of bridges. Sand mining near the bridge foundation poses stability problems in many cases. Water way calculation is very important during the design of bridge which ultimately affects the performance of the structure. Wearing course is added without removing the earlier coat which increased substantial load on the structure. He said bad quality and workmanship is responsible for leakages and early deterioration in our structures. Mr. V L Deshpande explained various types of distress and their probable causes in prestress concrete bridges. Some of the reasons attributed are incorrect assessment of loss of prestress, increase in loading, sharp cable profile, tension zone created near bearing if the PT cable is at much higher level, sharp curve and reduced cover near blister, incorrect assessment of long term deflections, improper grouting of cable ducts, honeycombing near anchor zones, damage to shear key in the match cast system etc. Mr. Sunil Jadhav presented case studies on restoration of bridges by external

prestressing.Vikram Potdar from Pune illustrated the use of drones with digital and thermal camera in survey and mapping of the existing structure even in inaccessible area and how 3D as built drawing can be generated. Prof. Abhay Bambole of VJTI explained the method of load testing of bridges and discussed sample studies done by his team. Chandrashekhar Khandekar, retired executive engineer from MCGM presented statistics of bridges under MCGM, Mumbai. He emphasised that owner of the bridge must maintain all the data of an asset which is unfortunately is not available most of the times. There is not sufficient allocation of funds for maintaining these important assets. There has to be sufficient budget provision for repair and maintenance of built structure if we expect better service life. More than 170 engineers attended the function.

9 Aug 2019: ISSE HQ arranged R L Nene memorial lecture at VJTI. The subject was " Role and Responsibilities of Structural Auditor". President Shantilal Jain in his welcome address talked about work done by ISSE founder Late R L Nene and importance of the subject. Chief Guest Mohan Dagaonkar expressed the view that all civil engineers are doing their work as per their ability. There are good and bad engineers. We need to create proper frame work defining roles and responsibilities of all professionals involved in civil projects. Chandrashekhar Kandekar made the complex subject interesting comparing cricket match analogy with structural audit and provided suggested work order format from client. AS per MCGM guidelines for their internal projects, structural engineer involved in carrying out structural inspection should decide on number of tests and type of tests to be carried out. Hemant Vadalkar spoke about ISSE format provided to MCGM. Main points to be implemented as per ISSE guideline are - the word" Structural Audit" should be replaced by " Structural inspection report", Structural engineer to decide on the type of Non Destructive Tests to be carried out and MCGM should not insist on "Stability certificate" by a person who is just inspecting a structure. Like birth certificate, Stability certificate can be issued only once by the original structural designer. Validity of report for six months should be mentioned. Areas not inspected or not accessible are to be mentioned in the report. Certificate should be issued based on the honest assessment of actual condition of structure supported by photographs and deterioration marking plans. Fitness certificate can be provided after satisfactory repairs were carried out by the owner under the guidance of structural engineer.

Supervision certificate should be provided by the person supervising the construction process. As per NBC2016 format, Structural Design sufficiency certificate is only to be issued by the structural engineer stating that the design is conforms to latest codes. He also emphasised that disclaimers should be provided like in case of overloading or damage to any structural member or if the structure is not maintained properly by the owner the certificate will not be valid.

Mr. Manu from TATA Structura made the presentation on new products and tubes developed by TATA Steel which are being used for all the new airport terminals and other infrastructure projects. The program was sponsored by TATA Structura. There was overwhelming response and more than 160 engineers attended the function.

23 Aug 2019 : Indian Concrete Institute along with Department of Civil Engineering IIT Bombay organized a seminar on Concrete Durability at IITB. Handbook on concrete durability was published by Indian Concrete Institute. Additional Municipal Commissioner Er. Pravin Darade released the handbook. Mr. Darade expressed that due to so many failures of bridges, buildings in recent years, he is reluctant to introduce himself as a civil engineer. We need to change the image of civil engineers, contractors, builders in our society by our hard and honest work. Mr. V R Kulkarni gave brief overview of international and national scenario on concrete durability. Prof. Manu Santhanam IITM talked on Prescriptive Vs performance based approaches for durability design. Prof. Prakash Nanthagopalan presented paper on Ingradients for durable concrete on behalf of Prof. P. Dinakar IIT Bhubaneshwar. Prof. B S Dhanya of RIT Kottayam described major deterioration phenomena in concrete structures. Prof. Radhakrishna Pillai, IIT Madras elaborated on critical evaluation of test methods on durability. Vijay Kulkarni discussed on examples of structures adopting durability based specifications and Prof. Manu presented recommendations of Durability Committee. Ultratech Cements sponsored the event. More than 250 concrete lovers attended the seminar.

27th August 2019: ISSE Pune organized seminar on"DESIGN CONSIDERATIONS OF HIGH RISE BUILDING STRUCTURES' (CASE STUDY). Er. Nikhil Joshi &Er. RuchaWatve made the presentation on the subject. Presentationon 'GStarCAD SOFTWARE' was done by Mr. Taiyeb Rangwala.

30 Aug 2019 : Practising Engineering Architects and Town Planners Association (PEATA) arranged a seminar on Green Futures and Transitional Policy (2034) in Mumbai. Hon. Municipal Commissioner Shri Praveen Pardeshi was the chief guest. Joint commissioner Shri Ashutosh Salil, Director (E.S.&P) Shri Vinod P. Chithore and Chief Engineer DP Shri Rajendra B. Zope were the Guests of Honour. Presentations on various environmental issues were made by experts in the field. Forests the Miyawaki Way was presented by Shubhendu Sharma from Bangalore. Mala Singh MD-PEC Greening India talked on Green buildings. Shri Nirav Saraiya elaborated on Rain water Harvesting systems and how it can be implemented on various projects. Various type of Sewage Treatment Plants and its necessity for treating the sewage and getting the water for secondary use was emphasised by Ugendran K. Chettiar. Information on clean and cost effective solar energy for housing projects was given by representative of Adani Electricity Mumbai.

In the second part of seminar, Transitional policy related to DCPR2034 for Mumbai was discussed by various PEATA committee members and MCGM officers. Program was attended by around 300 people.

Sept 2019 : Review of Indian Seismic design codes and commentary

World bank sponsored and initiated a project on Improving Seismic Resilience of Built Environment in India. Under this project, team of experts across the country has been formed for proposing modifications and commentary for the Code on Criteria for Earthquake Resistant Design of Structures IS 1893 : 2016 (Part 1 General Provisions and Buildings) & Ductile Design and Detailing of Reinforced - Concrete Structures Subjected to Seismic Forces Code of Practice (IS 13920 : 2016).

Our member **Er. Narayan Kochak** from Pune is one of the team members. Congratulations Narayan.

The round table workshop was held at IIT Gandhinagar on 08-04-2019 to review and discuss seismic design codes. A seminar - cum - workshop was organized at IIT Gandhinagar on 17-05-2019, where in more than 189 academicians, practising engineers and students participated from across the country to publicly discuss the proposed modifications in seismic codes, in addition to discussing the codal compliance in seismic design of a few real - life buildings.

At the moment, review of proposed modifications in seismic design codes is in progress and recommendations will be submitted to BIS by the team members.

14 Sept 2019 : On the occasion of Engineer's Day, ISSE in association with Ultratech Cement arranged a lecture on "Concrete – Past, present and future" at Virar . ISSE wanted to conduct various technical activities in different areas of the Mumbai Metropolitan Region. This time Vasai – Virar region was chosen for the technical activity for the benefit of civil engineers in that area.

Shantilal Jain, President ISSE welcomed all the civil engineers on the occasion of Engineer's Day. Hemant Vadalkar informed about activities of ISSE and appealed to all civil engineers to become members of ISSE and help in strengthening the organisation. Ranganath Satam introduced the speaker.

Technical lecture on Concrete was delivered by Er. Mahesh Tendulkar. He shared his experience during various site visits, inspection of bridges and discussed various issues related to concrete. He provided tips to improve the quality of concrete right from selection of right materials, correct size of aggregates, proper mix design, maintaining correct water cement ratio, use of admixture, importance of curing which is neglected at site. He also shared his experience and correct test procedures on concrete slump test and cube test, setting of good laboratory at site and its advantages. He emphasised that durability is the main parameter for the future concrete.

Mr. Arvind Mahajan from Ultratech Cements gave corporate overview. He discussed different products like light weight concrete that can be used as bedding mortar or filling in sunken areas, providing slope at terrace level. Other building materials offered by Ultratech were also displayed.

Paresh Unnarkar proposed the vote of thanks. There was overwhelming response and it was a first technical program in the region. The function was attended by more than 125 engineers.

26th September 2019: ISSE Pune arranged technical lecture on "Advance methods of non destructive testing of concrete". CASE STUDY was presented by Dr. Charbel Aoun, Global Head(Consulting) ACTS, Beirut. Another lecture by Er. UjwalKunte (Managing DirectorDurocrete, Pune was on "Methods of sampling, analysis and interpretation of results of NDT"

27 Sept 2019 : Steel Day 2019 was celebrated by MX Business Media in Mumbai. Industrialist, professionals, representatives from large contracting firms participated in the event. Steel is a sustainable construction material and its innovative use was presented for construction of buildings , infrastructure and bridges. Some of our ISSE members attended the function. Hemant Vadalkar, Shekhar Ghate, Girish Dravid, Anil Hira made presentations during the event. Around 45 speakers and 300 delegates attended the function.

ISSE team congratulates ISSE family members for their accomplishment !

Dr. Prakash W. Kubde - PhD degree awarded by University Of Mumbai , Institute: Veermata Jeejabai Technological Institute, Matunga (VJTI) , December 2018 , TOPIC :Extension of direct strength method for load carrying capacity of cold formed steel perforated columns (non-prequalified sections) with and without stiffeners and two dimensional frames using finite element method

Sakshi Omprakash Darak graduated as Bachelor of Planning at College of Engineering Pune with Gold Medal 23 July 2019.

Aug 2019 : Inauguration of underground bunker at Rajbhavan by Hon. President of India. The restoration work was done under the guidance of Er. Chetan Raikar. Congratulations Chetan.

HAPPY DIWALI & PROSPEROUS NEW YEAR

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Seismic Analysis and Design

Seismic Analysis as per IS 1893 : 2016.
Reinforced concrete design as per IS 456 : 2000 & IS 1893 : 2016

Drawings

AutoCAD readable site drawings

The site drawings are auto generated in .dxf format which can be read in various CAD softwares such as AutoCAD.

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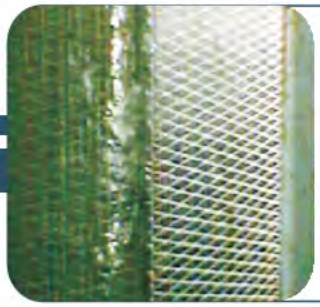

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- Near surface reinforcement & micro jacketing

SHIELD™

Engineering Solutions For Corrosion Damages
- Bipolar penetrating type corrosion inhibition system
- Cathodic protection system
- Execution of corrosion damaged repairs

DATA STRONG

Strengthening Data Centre & Ware Houses
- Post-tension carbon laminates
- Near surface reinforcement
- Steel fabrication
- Span shortening

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