STRUCTURAL ENGINEERING

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REVISED STRENGTH AS ON 31-3-2007

Members : 834 Organisation Members : 14 Junior Members : 6

Patrons : 29 Sponsors : 8

TOTAL STRENGTH : 891

OUR INTENTIONS

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

FIELDS CONSIDERED AS ASPECTS OF STRUCTURAL ENGINEERING

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

& Other related branches

ISSE Publications

Title	Donation Rs.
Publications :	
• Design of Reinforced Concrete Structures for Earthquake Resistancea	700
• Professional Services by Structural Design Consultant - Manual for Practice	150
Proceedings :	
• National Conference on Corrosion Controlled Structure in New Millenium	400
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• Brain Storming Session on Use of Speciality Products in Structures	200
• Workshop on Software Tools for Structural Design of Buildings with CD	500
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• Seminar on Foundations for Highrise Buildings	150

(The above volumes are available at ISSE Head Office)

BE AN ISSE AUTHOR

Articles and technical papers are the heart of a technical journal. We invite you to write technical articles and papers for publication in the ISSE Journal. You may write about:

- An innovative concept or approach
- Proposed theoretical, computational or practical improvement on an existing concept
- An experimental study
- Guidelines and standards developed
- Compilation of rare/scattered information on the latest technological advances
- A case study: Challenges in design and construction
- Your viewpoint on current professional practices

While submitting your article for publication, please follow the guidelines given below:

- Page size: A4, Top, Bottom, Left and Right margins: 1", Font: Arial, 10 pt
- Max length of article: 5 pages including tables and figures
- The manuscript should contain the title of article and names, qualifications, designations, addresses and email addresses of the authors.
- The matter should be relevant to the subject and should be organized in a logical flow. It may be divided into sections and sub-sections, if necessary.
- While, sketches and drawings should preferably be in Corel-draw, other appropriate formats are also acceptable. Photographs should be sharp and clear.
- Figures, photographs and tables should be numbered and should have captions.
- Notations, if used, should be clearly defined.
- Article should be sent by email to isse@vsnl.net with a copy to mail@technoesis.co.in

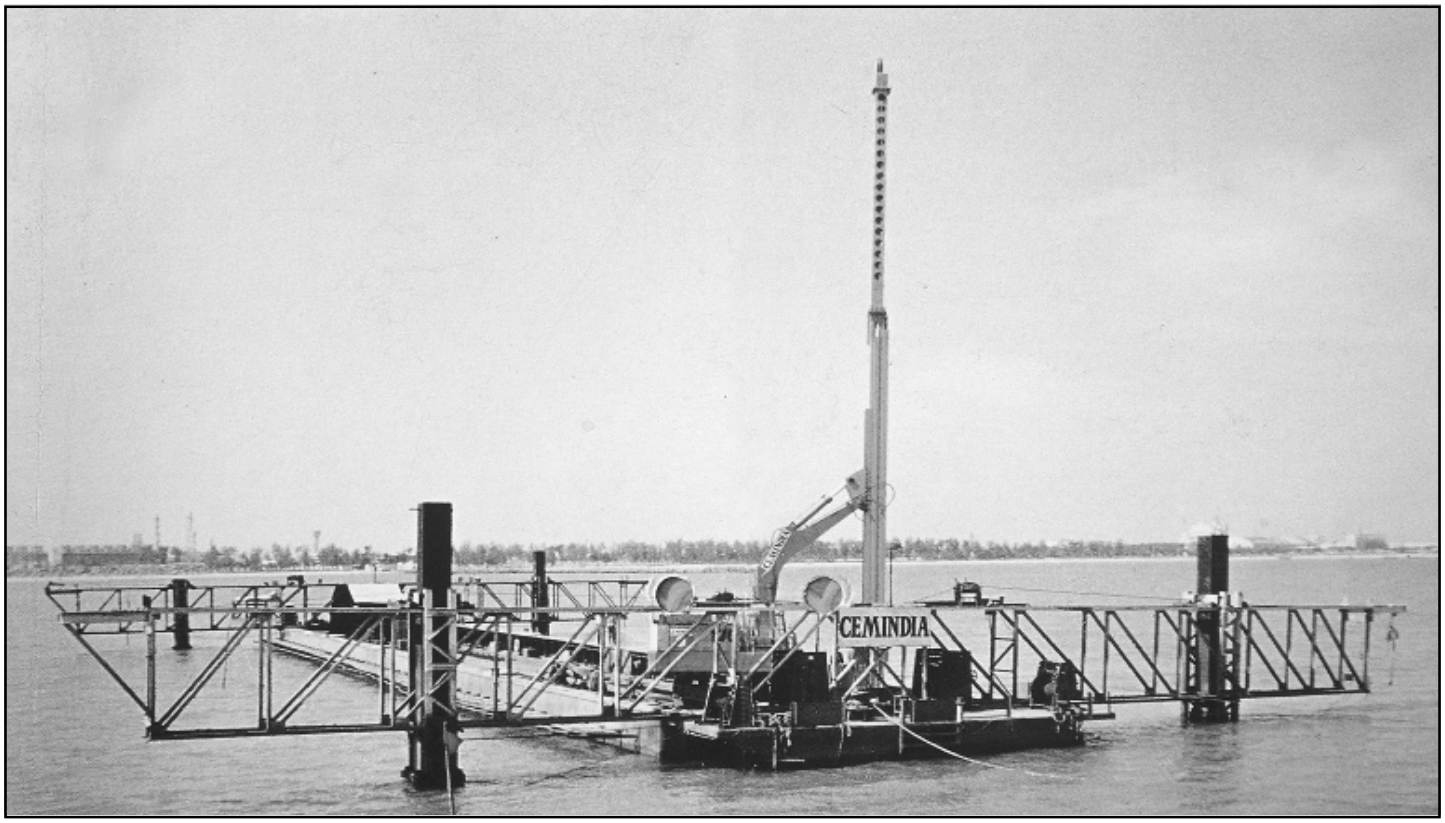
Articles may be reviewed and suitably edited before publication.

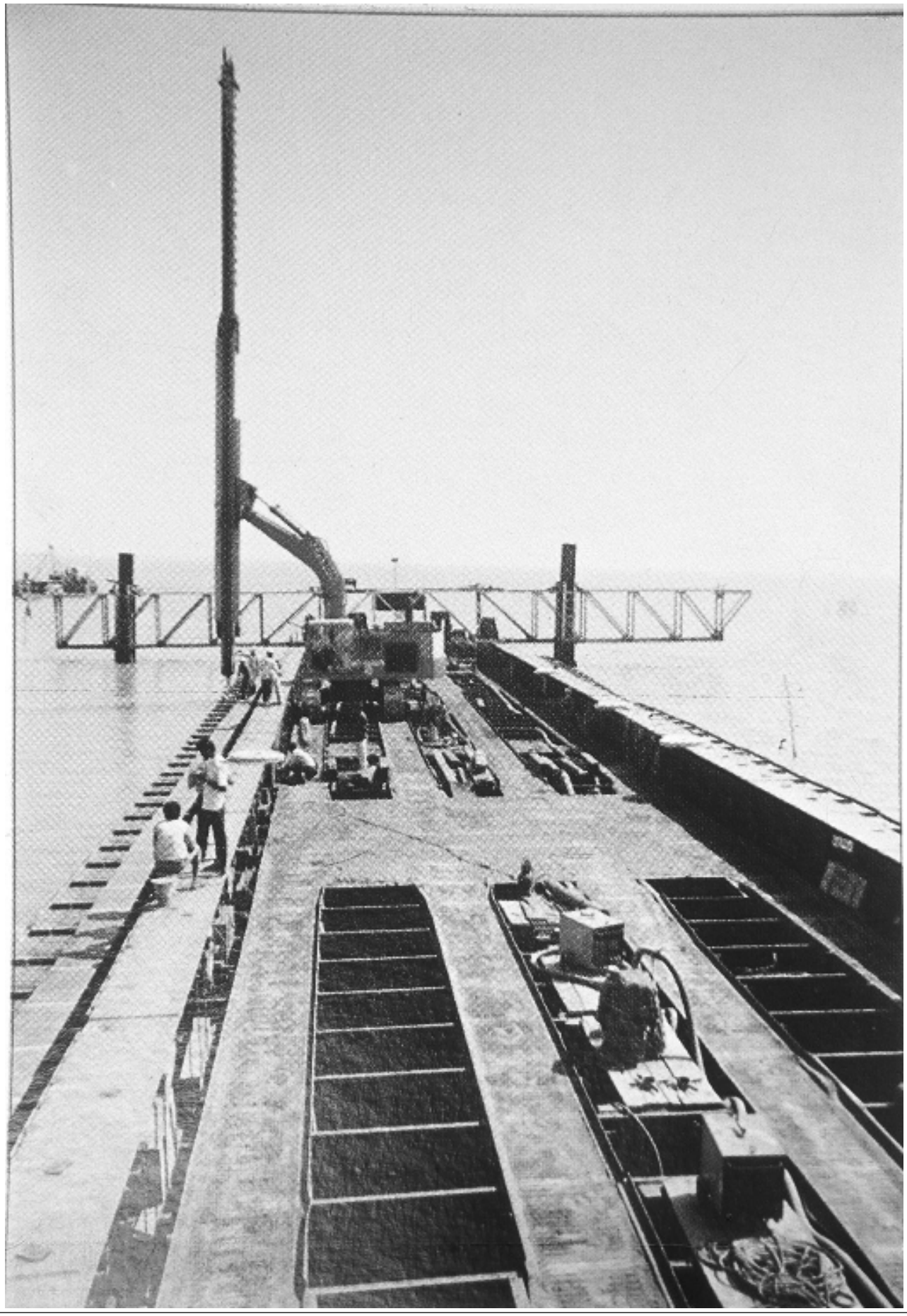
Editorial

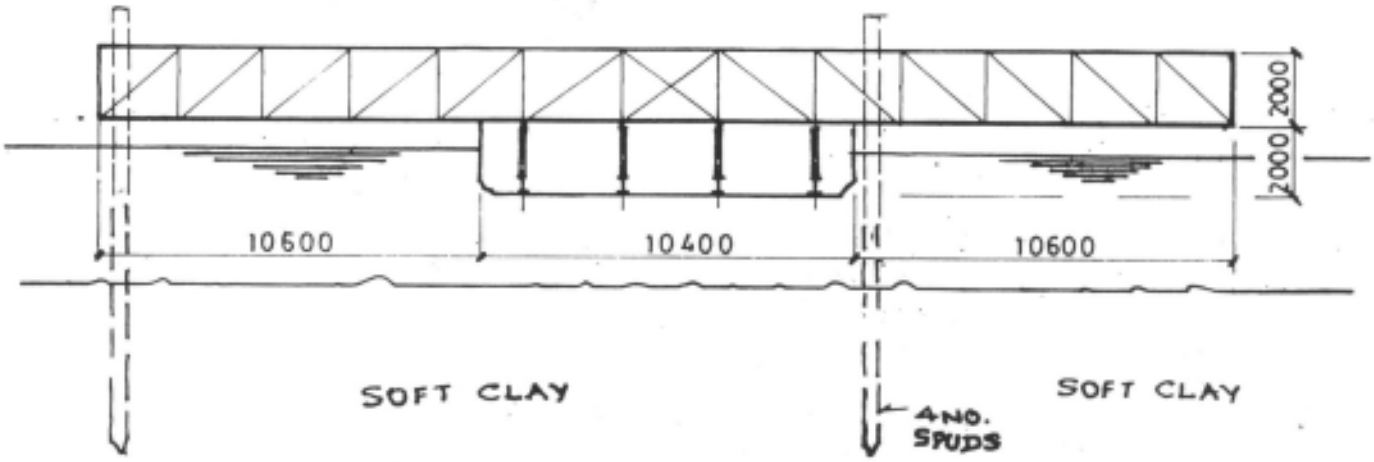
Consolidation Of Marine Clay In Sea Bed For Deep Water Port At Kakinada

A. B. Karnik, Consulting Engineer

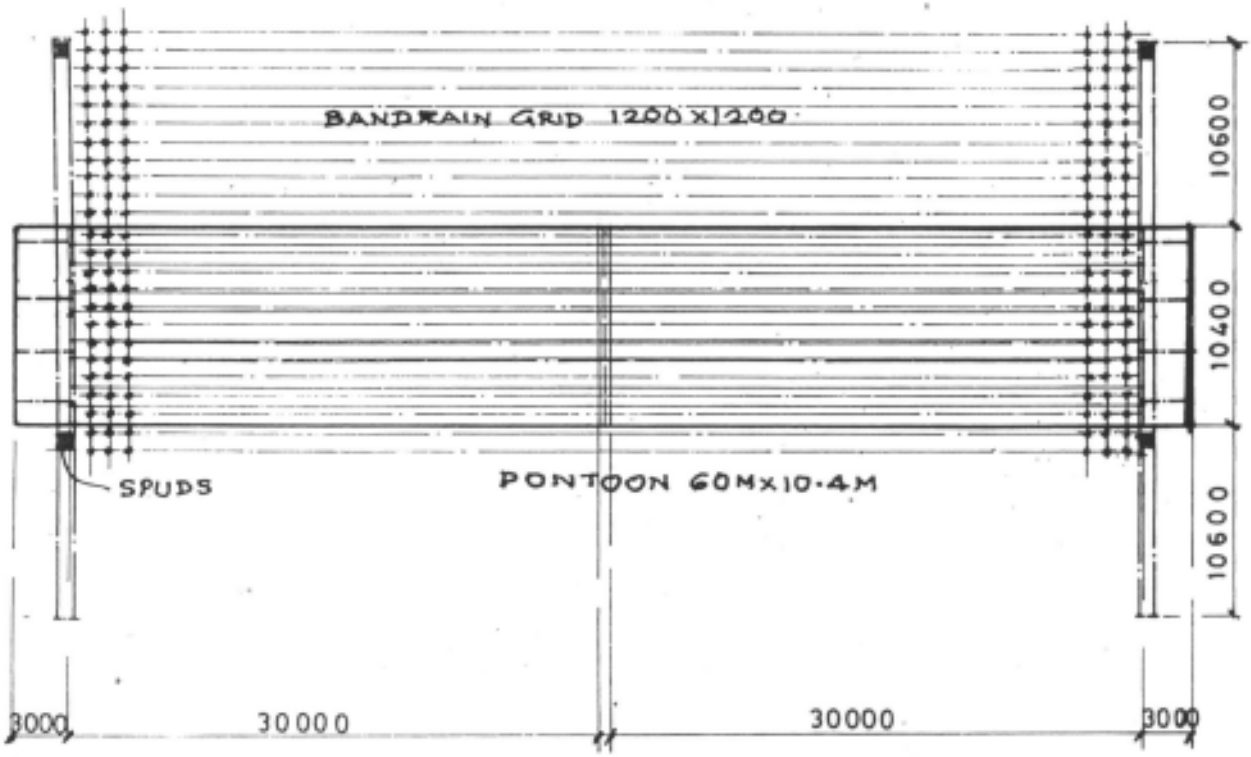
Existence of very soft marine clay layer of about 8 to 10 m at site for Break- Water Construction was a difficult problem. Soil consolidation was absolutely necessary. Project consultants had recommended provision of Band-drain Grid at 1200 mm c/c in two directions by lakhs in number under the break- water and some distance beyond. Band-drains are similar to sand-drains conventionally known. Marine Clay has characteristics of very poor shear and compressive strength. SPT value very close to ZERO and very high compressibility. For soil consolidation and improving compressive strength of clay, trapped pore water in clay is required to be removed as the pore water pressure increases with constructed structure load, in this case that of break-water. Installation of Band-drains on 1200 mm grid by lakhs in number as stated above in shortest time was Herculean task. Challenge was accepted and innovative ideas were evolved without any back references available for doing such work in India. Floating Pontoon 60 m in length, 10.4 m in width and 2 m in depth was designed for the purpose. Relevant sketches and photographs will clarify the provisions. Launching 60 m long pontoon at one go was difficult on the existing sea shore, hence, it was launched in two pieces and welded together in floating mode. Design was meticulously done for the entire super-imposed load in service with proper factor of safety for buoyuancy, meta-cetric height for worst loading condition and safe freeboard under floating condition. Guide Girders were welded at each end (short side) of the pontoon, cantilevering 10.6 m beyond edge of the pontoon plus inside width of 10.4 m. Two vertical spuds on each end of the pontoon and positioned in between double leaf guide girder were provided to steady the pontoon and position in floating condition. Guide frame along vertical movement of pontoon as per the tide variation. Bucket of L & T Poclain 170CK was replaced by mandrel for installation of Band-drains. This Poclain could finish two rows of band-drains on one side length of pontoon at 1200 mm c/c. giving yield of 192 numbers in one positioning of pontoon. Pontoon is then shifted by 2400 mm (guide girders between spuds maintain the necessary alignment) to complete another set of band-drains in next pontoon position. With such accuracy of alignment provided and fast movement of Poclain achieved on pontoon, the arrangements in entirety created (presumably) a world record of 2200 band-drains in a day. Innovations helped speedy completion of work in record time.







TYP. SECTION



KEY PLAN SHOWING CONCRETE TRACK

PRODUCT REVIEW

From the next issue (Jan-Feb-Mar 07), we will be introducing a new section, “Product Review” into the ISSE journal. This is where manufacturers and dealers can introduce their products such as construction materials, chemicals, equipment, software etc, through a technical review. A space of up to two pages of the journal may be allocated to this feature.

The main purpose of this feature is to introduce the newer products available in the market to our readers, and therefore, the review should be technically intensive. The manufacturers and dealers can highlight the advantages and uniqueness of the featured products in the review.

The review should cover one or two products only and may include their technical specifications, method of installation/ application, available product range, unique features, advantage, photographs etc. It should not be a direct commercial promotion of the products. However, the contributor may include his contact details at the end of the review. Matter received may be suitably edited and modified in consultation with the contributor.

For details please call the editor.

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UPDATE YOUR CONTACT DETAILS ON
www.isse.org.in

Our website www.isse.org.in contains the latest particulars of our members. The website also offers you a facility to update your own particulars in the database. However, we have observed that many of our members have still not updated their contact details such as postal and email addresses and telephone numbers. As a result, we can neither send them the Journal nor mail them information about our forthcoming events.

We earnestly request you to visit www.isse.org.in and update your particulars as soon as possible so that you do not miss the Journal or important announcements.

MISSING YOU

In the past few months, ISSE journals and other correspondence sent to some of our members have been coming back undelivered. It appears that they have moved to a new address. A list of such members is given below. We are very keen in having their latest contact details with us so that we can reach them in future.

If you know any of these members, please ask them to get in touch with us (Phones: 022-24365240, 24221015) or send an email to isse@vsnl.net or update their contact details through our website www.isse.org.in.

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Reconstructing Your Own Building

G. C. Oak

This is a success story of reconstruction of a 37-year-old cooperative housing society in Mulund (E), Mumbai. Originally the Society consisted of four buildings of G + 2 floors. The buildings were reconstructed as a G + 7 tower by the members themselves by directly appointing the necessary professionals. Thus the Society itself assumed the role of the developer. In this case the professionals appointed were also members of the Society. This unique and interesting case study is presented by the author who himself acted as the structural engineer and project management consultant for the reconstruction work.

Preamble:

Chintamani Co-operative Housing Society Ltd. ("Society") at Mulund (E) had 4 buildings of Ground + 2 floors constructed in 1965. Building No 1 had a triangular shape and housed 6 members. Building Nos 2, 3 and 4 housed 12 members each. Bldg No.1 was not liked by the occupants because of its shape. It had also deteriorated badly particularly its terrace leaked heavily. Moreover, the flats in building no. 1 were the smallest (about 525 sft carpet) whereas flats in other buildings were bigger. These buildings were standing on 4 individual plots of a layout, which were purchased by the Society. The plots were not amalgamated while constructing the original buildings. The original layout was of approx 42,000 sft.

Repair or Reconstruction?

In the year 2001 it was realized that the cost of repairs for corrosion damages and leakages would be about Rs 25 lacs. Some members felt that this would be very heavy and unbearable burden for them. Moreover recurrence of such repair cost in future could not be ruled out. Also many members felt the need of increasing their flat areas to meet the needs of growing families and therefore the possibility of horizontal expansion was studied. Though some small quantity of FSI was balance for some buildings, horizontal expansion was found to be unviable because of 1) building repair necessity, 2) restrictions on open spaces of individual plots and 3) non uniform requirements of flats.

Eventually it emerged that the ideal solution would be to construct a new G+7 Tower to house all members, in place of the old buildings. However this solution would have the following hurdles:

1) There was no balance FSI for constructing additional areas, after amalgamating all plots and leaving compulsory garden space for amalgamated plot. Therefore additional areas could be constructed only by purchasing TDR.

2) It was not possible for old members to bear full reconstruction costs.

3) For reconstruction by builders, all members would have to vacate, go out first and then come back after reconstruction. This would have potential risks and uncertainties. The members, who were mostly of age 55 and above would not take that risk.

A Win Win Solution:

After a lot of brainstorming meetings, a solution was evolved along the following steps:

1) Construct a T shaped Tower of G+7 floors with 50 flats all of 910 sft B.U. area and 32 commercial units by purchasing TDR of about 22,000 sft from market

2) Sell 8 surplus flats and all commercial units at market rates for creating finance of reconstruction

3) Collect Rs 2 lacs from each member and give him each a new flat of 700 sft carpet area (assuming average carpet area of old flat as 550 sft, he would get an additional carpet area of 150 sft).

4) Construct the full T shape of Tower in 3 phases … first the central arm, then the left arm and lastly the right arm. This phase wise plan would ensure that nobody had to go out of the plot

5) Construct the first phase in Society's open space – nobody goes out, but some flats bear the inconvenience of having new construction almost touching their windows!

6) When the first phase is complete, people from building no. 4 would occupy those flats and people from building no. 2 would shift to the vacated flats of building 4. Then start the second phase after demolishing vacated building no. 2. On completion of phase 2, temporary occupants of building no. 4 would move to those flats and people of building no. 3 would shift to vacated flats of building 4. Complete the third and final phase by demolishing building no. 3 and shift the remaining members into the tower. Thereafter, demolish building no. 4.

(During actual execution, however, this sequence was slightly changed, after satisfactory completion of first phase. When the members developed confidence in working of the scheme people of building 3 – of last phase – opted to go out earlier for enabling speedier construction).

Getting Started :

Architect Shri Abhay Gokhale, Consulting Engineer Shri G.C. Oak appointed by the Society were old members of the Society and were highly experienced in their fields. Shri Oak, who is also the author of this article, performed the roles of the structural engineer (for RCC) as well as that of project management consultant. After a long debate in the general body meeting, where the issue of appointing some builder for the scheme was discussed, the Consulting Engineer's

proposal of "Society itself to perform role of builder" was approved because of availability of "the in-house Team". The advantages of flexibility, sharing of profit, quality control etc were appreciated by members. It was also decided that no brokers would be allowed and all the bookings would be generated by members only. To avoid nuisance from unhealthy elements of bye-passers, the ideas of advertisements / site banners etc were ruled out.

Professional Inputs :

To clear apprehensions of members about finance aspects, the Consulting Engineer prepared feasibility reports and cash flow charts coupled with time schedule charts. This logical approach satisfied the members and the proposal was finally approved.

The Architect not only evolved a wonderful plan having all flats of equal areas spread out to suit working of phase wise program, but also took the pains of going through the process of getting the plans sanctioned for various phases. Similarly the Consulting Engineer provided all valuable inputs of project management besides structural consultancy. Members of managing committee of Society, worked with exceptional positive approach to all problems, which helped to evolve effective project management. And above all, cooperation of all members was of par excellence!!!

During execution of internal details, all members were given freedom of pre-planned variations from standard specifications / amenities and those variations were suitably accounted later. Result? They virtually got the pleasure of constructing their own home! Surely no outside builder would have allowed that! Throughout the project, the members were advised to eliminate grudges / unhappiness arising out of comparisons, by resorting to wisdom of "half glass full philosophy". That is to be content in viewing what you have received and not getting unhappy by brooding over what you have not received.

Watch Points :

1. The techniques used in Management of this project formed important lessons of "Human Engineering".
2. At the beginning of construction of first phase as well as of subsequent phases, all members joined in a prayer which included prayer of almighty God as well as assertion of our good intentions. Because of faith, that prayer coupled with our best possible efforts gave us success.
3. The most important guideline always remembered was that there should be approval of all the members to any decision and as far as possible no decision should be taken on ground of "majority". For this utmost efforts were made to remove even slightest opposition! It is easy to gather support for criticism, but it is difficult to gather support for any creative action! Therefore, the cautioning principle remembered was that the opposition if allowed to crystallize, it increases fast and can topple any scheme. The members took elaborate and thoughtful steps to achieve it. God really helped our sincere intent efforts. We looked into to the back of mind of even a slightest opposition and analytically removed that.
4. Initially one member objected to the scheme on the ground that how could we undertake a big project like this (Rs 5 crores) and how bad it would be if we are stuck halfway in between. To remove this objection, the Consulting Engineer clarified that he himself being a member of the Society, he was equally cautious. He promised not to start the work of total project unless the booking of shops / offices of first phase was achieved after casting 2 slabs of that portion. The investment for this small portion was small and was created by raising loans from members. For quick sale of units of this portion, the rates were kept at reasonable level to attract bookings. This strategy (of realizing bookings at the earliest) worked and our path of progress was cleared.
5. Two members were feeling upset by the proposal because they had recently incurred substantial expenses in renovation of their flats. Their reluctance was overcome by some advantages / compensation they would get in the scheme.
6. Allotment of flats in the new building was the mos sensitive issue. It was overcome by evolving a logical formula which eliminated the confusion generally caused by clashing choices of various members and also avoided any partiality / special favours to anybody.
7. Based on the feasibility report and cash flow charts, the Consulting Engineer worked out the quantum of finance needed at various stages of project. He explained that if attractive higher rates of interests are offered (and also provided for in project costing) attracting loans / deposits would not be difficult. When the bank's F.D. rate was not more than 12 %, we offered 18 % interest! Initially this assumption was challenged by a member on ground that nobody would give such "unsecured" loan. But later it was found that members thought of this as an opportunity and diverted their savings for the project. Hs the problem of raising finances was solved. In later stages we even had to refuse offers for new deposits. Even the member who had first raised doubt about getting such deposits, later became one of the highest depositors!!
8. After completion of the trial portion, it was felt that if we made some changes in the initial allotment, it would increase the saleable commercial area (at the cost of reducing "saleable residential area"). Three members were coaxed to accept the changes by explaining them some specific advantages they would get in doing so.The Consulting Engineer played an important role in this exercise.
9. Transparency in all matters, serious efforts for maintaining equality and fairness to all, and effective communication with all members, helped in developing mutual faith and confidence in the working.

10. Hierarchy of management consisted of "Architect + Consulting Engineer" > "Construction Group of Architect + Consulting Engineer + 2 members" > " Project Execution Team consisting of 16 members" > "General Body". Construction Group met once a week, Project Execution Team on the next day and General Body every month for the management of he project. All the meetings were like open house participations, which ensured real democratic working of project execution. Anybody was welcome to offer any suggestions any time and also to seek clarifications in any of these meetings.

11. All cash transactions were witnessed by two / three members.

12. Marketing Committee of "Consulting Engineer + 2 members" monitored sale details, and also strategies which were required to be altered to suit subsequent parameters of cost / time.

13. The necessity of installing Transformer for M.S.E.B. and increase in prices of all construction materials caused substantial increase in cost of the project.

14. Every month the feasibility report was updated based on changes in costs as well as booking rates. Cash flow charts also were updated to enable arrangement of finance. Considering rise in cost of materials etc., occasionally the booking rates were suitably raised.

15. Sometimes progress was hampered due to problems such as shortage of sand / cement, transport strike, introduction of VAT, rationalization of plot area etc. To minimize the damage due to these delays, the members of the last building opted to temporarily go to rented premises out of plot. Their rents were borne by the Society.

Time Schedule :

1.	Finalization of Reconstruction Scheme b General Body	----	Dec 01
2.	Award of contract of construction	----	April 02
3.	Commencement of Phase 1	----	May 02
4.	Completion of shops & offices of Phase 1	----	March 03
5.	Completion of flats of Phase 1	----	May 04
6.	Commencement of Phase 2	----	Aug 04
7.	Completion of shops & offices of Phase 2	----	April 05
8.	Completion of flats of Phase 2	----	Oct 05
9.	Commencement of Phase 3	----	Sept 05
10.	Completion of Phase 3	----	Jan 07
11.	Project Completion	----	March 07

Author: Mr. G.C. Oak is a Mumbai based senior Consulting Engineer and Vice President of Indian Society of Structural Engineers. He can be reached at gcoak@vsnl.net

Readers' Response

Mr. D.S. Joshi writes

The authors of the article "Understanding Quenched & Tempered Rebars" deserve a pat for giving information about steel rebars. I want to draw their attention to the fact that IS 1786 is under revision and the mechanical properties recommended even in the proposed IS 1786 draft code are quite inferior as compared with those required for good ductile steel to be used in earthquake resistant RCC structures. I on behalf of ISSE, M.R. Patil on behalf of Practising Engineers Architects and Town Planners' Association and Mr. S.H. Jain on behalf of Institution of Engineers had suggested corrections to BIS in 2005 as under:

- Upper limit on variation in yield stress should be max 20 percent (498 MPa for Fe 415 & 600 MPa for Fe 500).
- Ratio of Ultimate to Yield Stress should be at least 1.25.
- Total Percentage Elongation should be minimum 18 percent and Uniform Percentage Elongation should be minimum 10 percent.
- Fe 550 and Fe 600 grade steel need not be used.

As reported in the discussion forum of Dec 2006 issue of Indian Concrete Journal, these suggestions are accepted by IIT-Kanpur & they have proposed changes in IS 13920 accordingly.

Mr. D.S. Joshi, Consulting Structural Engineer, joshiconsultants@rediffmail.com

The authors reply

We thank Mr. D.S. Joshi for his words of appreciation and comments on our article. As regards his comments on our article, we would like to point out that the article was based on the currently available technical literature including IS 1786:1985, which is currently in circulation. We fully agree with Mr. Joshi's observations and hope that the next revision of IS 1786 incorporates such points and is made available to practicing professionals without further delay.

Mr. Umesh Dhargalkar, umesh@technoesis.co.in

Congratulations to **Dr. Manjrekar**

Dr. S.K. Manjrekar, a well-known scientist in India has been recently given ìBoard Committee appointmentî on International Committee of ACI for a 3-year term. The Committee is authorized to approve the formation of international chapters and the establishment of their boundaries, to provide a forum for International Partners and to provide inputs on international issues and relations to the Board of Direction as appropriate.

He is a one of the three Indians to be a ìFellowî of the American Concrete institute USA since 1999 in recognition of his outstanding contributions to the ACI and to the Concrete Technology. He has already been bestowed upon with International Chapter Activities Award at the ACI spring Convention at Vancouver, Canada in 2003.

Dr. Manjrekar, Ph.D. from Mumbai University, is actively involved in Research and Development in Material Science, Polymer and Concrete Chemistry. He is a member of ACI committee 364 and on certification viz. ëIC-Certí. The mission of ACI committee 364 is to develop and report information and maintain standards for rehabilitation, renovation and preservation of concrete and masonry structures.

He is the current President of India Chapter, ACI and the Chairman and Managing Director of M/s Sunanda Speciality Coatings Pvt. Ltd, Mumbai, which is a Patron of ISSE.

We heartily congratulate Dr. Manjrekar on his latest achievement.

INNOVATIONS IN OFF-SHORE PILING FOR JETTY CONSTRUCTION

(A. B. Karnik, Consulting Engineer)

This case history is for Marine Work for Jetty at a place called Dahej in State of Gujarat. This place is

known for large variation of tide (10 m), high urrents (3 to 4 m/ sec) and conditions are furious in monsoon.

The Approach Jetty was 1152 m long and Jetty Head was 208 m long. It was decided to start construction of jetty from land. This method is called end-on method by using Piling Gantry (ref.dwgs A, B and photographs P1 to P5). Although approach arm had two permanent piles per bent, it was necessary to construct temporary bridge for the movement of men & material during construction of a jetty about one km. long and this temporary bridge required additional third pile in a bent.

In view of the tight time schedules, it was necessary to complete maximum number of piles at one setting of Piling Gantry. Pile spacing in long and cross directions was 12 m and 8 m respectively. It was decided to provide additional temporary pile in cross direction as stated above.

Expeditious construction of piles of 1 / 1.2 / 1.4 m dia. (increased progressively with increased depth of water) with max. 55 m length of in-situ concrete pile was Herculean task. **Water current of 3 to 4 m per second, required guide frames and bracings for pile liners in greater depth of water, to avoid swinging of pile liners till they touched the bed.**

Taking on the challenge, the Gantry design catered for construction of six piles in one go from 24 m cantilever. Main Gantry length thus worked out to 52 m to ensure stability and safe working conditions. Break-up of length was, 24 m cantilever + 24 m supported span + 4 m rear projection.

Main width of the Gantry worked out (on the basis of 2 x 8 m c/c of piles + 2m additional width on either side) to 20 m. Front Tee Head was provided to cut the Gantry along Tee to do similar work for Jetty Head pile construction.

Main girders transferring whole gantry load of 600 T on stationery wheels (on piles) had to have strong bottom chord to take care of point load from wheels transferred in between node points of the lattice girder of 7.80 m depth while rolling to next location. Heavy plate girders of 2 m depth were provided for the purpose (ref. dwg. A shown hatched). This was a rare combination for lattice girder with bottom chord as a plate girder.

Further innovative idea was in provision of 15 T capacity Under Slung Crane cantilevering 30 m from Gantry rear end for material Handling from the rearmost end to the Gantry tail.

This facility was available for any kind of erection activity. Gantry was always supported on Four Wheel Assemblies, whether during piling or while shifting to the next location. Wheel Assemblies were designed for maximum load of 300 T (during pile construction from front cantilever). Maximum load on the Gantry, all inclusive, worked out to 600 T. All the activities were fully mechanized electrically, which could complete one cycle of six piles construction in FIVE days.

One more built-in arrangement was provision of 36 m length of Rolling Bracings which were used to clamp and brace freshly concreted piles (sacrificial mild steel liners are provided for containing concrete for under water construction).

As far as piling was concerned, soil / rock boring could start simultaneously. Right combination of pile construction sequence was strictly adhered to as specified.

Concreting was done with transit mixers and pumps.

Above design received ACCE Simplex Award 97 for Innovative Design of Structures from Association of Consulting Civil Engineers (India)

Structural Design Using Quenched & Tempered Rebars

Umesh Dhargalkar and Rupali Joshi

Introduction :

Quenched and tempered (QT) rebars are manufactured by heating rolled bars and then rapidly quenching them to get a hardened surface and a soft core. Their manufacturing process, chemical composition and mechanical properties have been documented in our article "Understanding Quenched & Tempered Rebars" published in the last issue (Vol 8-4) of the ISSE Journal. QT rebars are qualitatively superior to the conventional CTD bars. But if we want to design RCC structures using QT bars as reinforcement, we also need to know their stress-strain relationships and the yield stresses of grades available in Indian market. In this article let us discuss the structural design aspects of QT bars and see how they compare with the conventional CTD bars.

QT Bars in Indian Market :

There are mainly three rapid water-quenching processes available, viz Thermex, Tempcore or Torsid, using which QT bars are manufactured. Tata Steel (TISCON) and SAIL (SAIL -TMT) are the major manufacturers of QT bars in India. Their product range is as follows:

- Grades: TMT 415, TMT 500 and TMT 550 corresponding to yield stresses of 415, 500 and 550 N/mm2 respectively. Yield stress specified for structural design refers to the guaranteed minimum yield stress, and the actual yield stress is usually somewhat higher than the specified value.
- Diameters: 8, 10,12, 16, 20, 22, 25, 28, 32, 36 & 40

Structural Design :

QT rebars were first introduced in India in 1985. IS 13920 explicitly allows their usage. Today, not only are they easily available, but the difference between the cost of QT bars and that of CTD bars is so marginal that many people use QT bars just for the advantages they offer over CTD bars in terms of better corrosion resistance, ductility etc. But, if the superior engineering properties of QT bars are also exploited properly in structural design, it can reduce the quantity of reinforcement in RCC. However, currently there is no design stress-strain curve specified for QT bars in IS codes. Similarly there are no design aids or software available which use QT rebars. Therefore, even when structural designers know that QT bars would be used for a project, most of them still design structures using the stress strain curve and design aids corresponding to CTD bars. The latest revision of IS 1786 is awaited and let us hope it puts QT bars in a clearer perspective for structural design.

Stress strain Curve :

Stress-strain relationship of QT bars is similar to that of mild steel except that there is no distinct yield plateau. In absence of a standard stress strain curve in IS codes, a few manufacturers recommend curves for their products based on their test data. Stress-strain curves for TMT 415 & TMT 500 as recommended by SAIL for their bars are shown in Figure 1 & Figure 2. Please note that after an initial slope, the design curve becomes flat at a stress of 0.87 x fy. A comparison with the curve for CTD bars of the same fy would show that the real difference is at the junction where the sloping shape changes to flat shape. In case of CTD bars the slope and plateau are joined by a transition curve whereas in case of QT bars there is a sharp kink at the junction.

Savings due to QT Bars :

Let us see how much reduction QT bars can offer over CTD bars of the same yield stress. With reference to the stress strain curve of CTD bars, in the range of strains corresponding to the transition curve between the slope and flat plateau, QT bars offer higher stress as compared with CTD bars. The following numerical example for fy = 500 N/mm2 will clarify this.

Case 1:

CTD bars in the curved part where 0.0017<= å<= 0.0042
For 0.0017 <= å<= 0.0023
ó = -64984576 (å) ^{2} + 343612.719 (å) - 53.195
For 0.0023 <= å<= 0.0042
ó = -14105880 (å) ^{2} + 113633.031 (å) + 206.69

Case 2 :

QT bars in the same part where 0.0017<= å <= 0.0042
For 0.0017 <= å<= 0.002175
ó = (å) * Es
For 0.002175 <= å<= 0.0042
ó = fy / 1.15 = 435

e.g. for strain = 0.0022 (at the location of kink), Stress (CTD) = 388 N/mm2 whereas Stress (QT) = 435 N/mm2

Thus it can be easily seen that saving in reinforcement using

QT bars is possible only when the strain is in the range corresponding to the transition curve of CTD bars. There is no advantage offered by QT bars while designing for tension reinforcement in under reinforced sections, which are designed at a stress of 0.87 fy. But in the following cases reduction is possible:

1. Compression reinforcement in doubly reinforced beams
2. Columns in direct compression and bending

Design Examples :

An exercise was undertaken to find out the probable range of reduction in reinforcement that may result by using QT bars in place of the CTD bars. For this purpose, the stress-strain curve as shown in the figures 1 & 2 were adopted for QT bars. The findings are listed in Table 1 below:

Design Parameters	CTD fy 415	QT fy 415
Under-reinforced Beam Size: 300 x 600 mm Mu: 200 KN-m	Pt = 0.69 %	Pt = 0.69 %
Doubly-reinforced Beam Size: 300 x 600 mm Mu: 400 KN-m	Pt = 1.49 % Pc = 0.31 %	Pt = 1.49 % Pc = 0.30 %
Column with compression & uniaxial bending Size: 450 x 450 mm Pu: 2500 KN Mu: 200 KN-m Lu: 3.0 M Rebars: Distributed on 4 sides	Pt = 2.50 %	Pt = 2.45 %

Note: Concrete grade assumed to be M25.

The authors have developed design charts and tables for QT rebars for various grades, which can be used in a design office. The same have been used in the above examples.

Conclusions:

In addition to other advantages, QT bars offer a possibility of cost savings by reduction in the quantities of reinforcement as compared with CTD bars of the same yield stress. However the reduction is limited to compression reinforcement in doubly reinforced beams and columns in direct compression and bending. Such reduction is due to higher stress offered by QT bars in the range of strains corresponding to the transition curve of CTD bars between the slope and flat plateau. No reduction is possible for under reinforced tension reinforcement.

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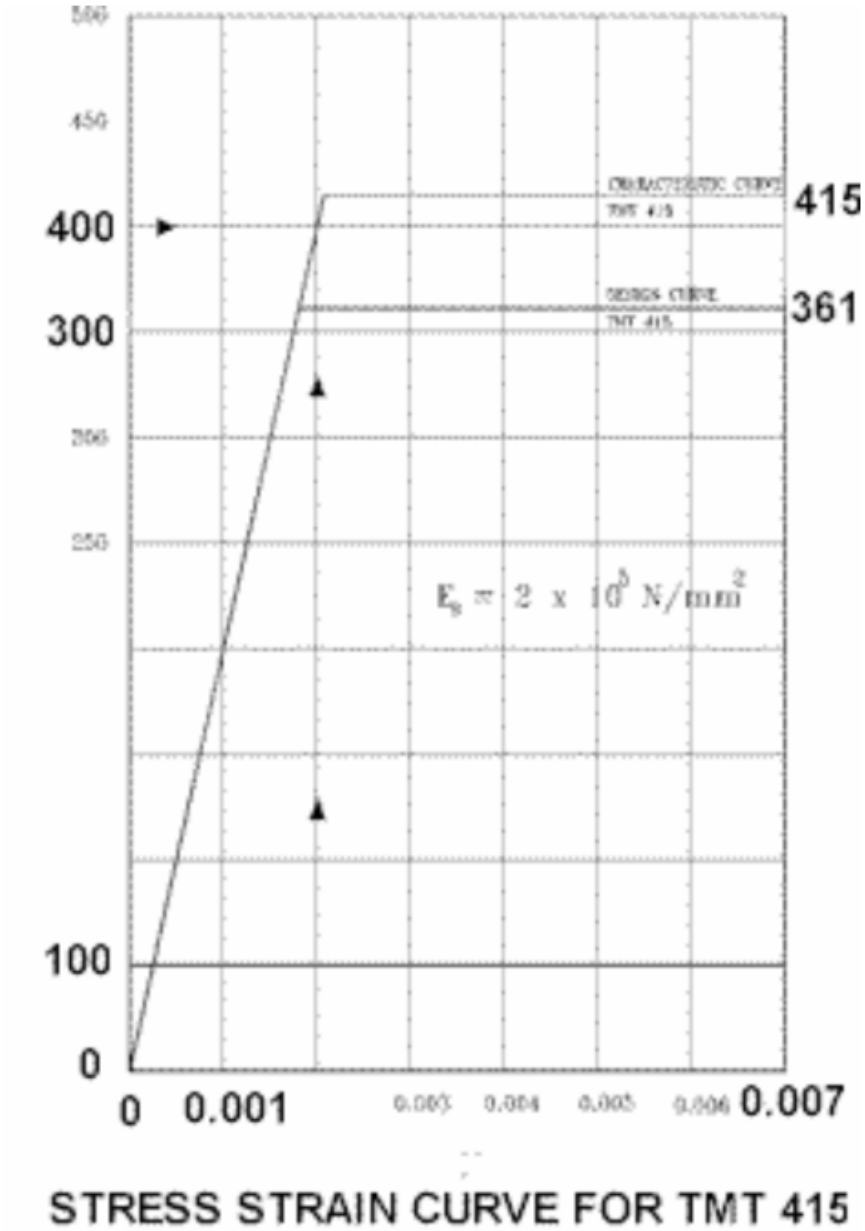
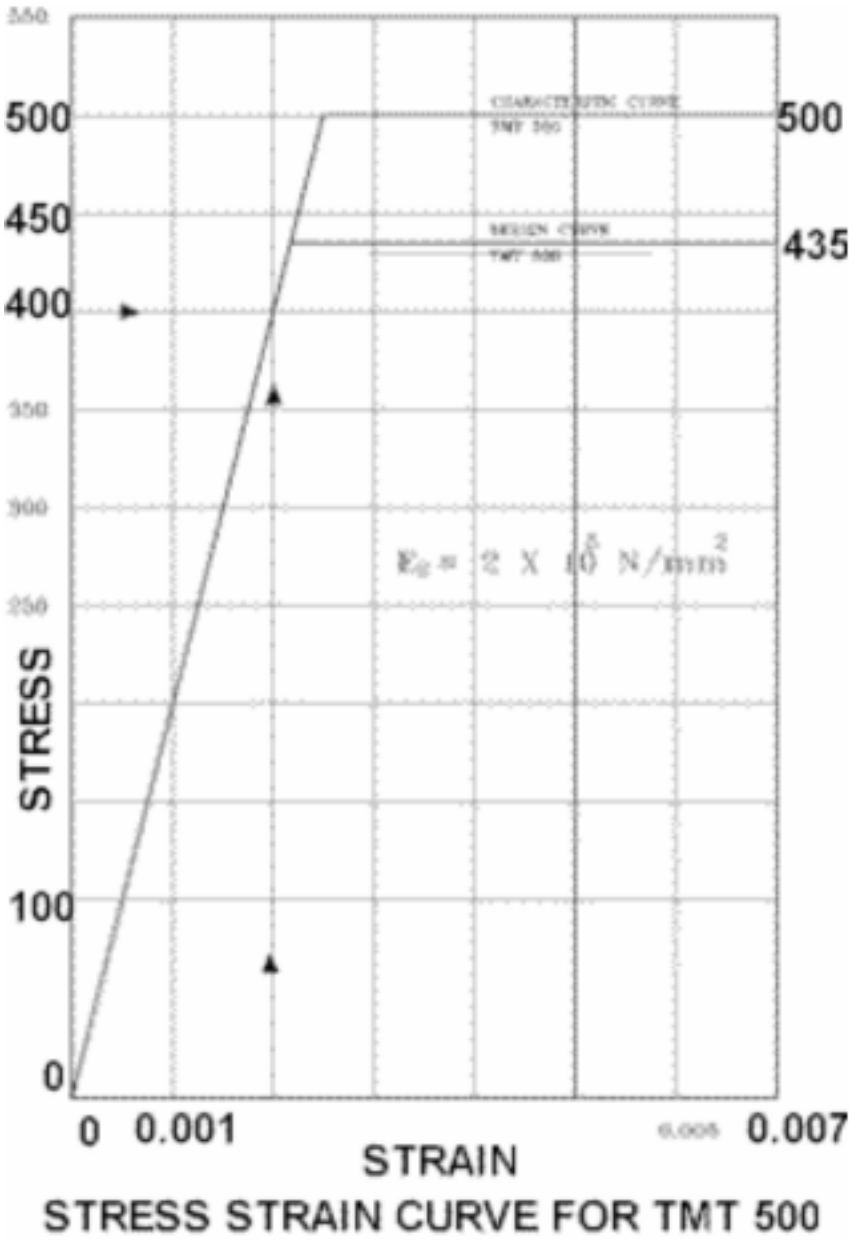


STRESS STRAIN CURVE FOR TMT 415

Figure 1



STRESS STRAIN CURVE FOR TMT 500

Figure 2

Be An ISSE Member

ISSE offers membership under three categories: Member, Junior Member & Organization Member

Eligibility

a) Member :

A degree in Structural/ Civil/ Construction engineering with minimum three years experience OR a diploma or equivalent qualification with minimum five years experience. This is life membership.

b) Junior Member :

Fresh engineer having a degree/ diploma in Civil/ Construction engineering or equivalent qualification. Junior membership is valid for three years for degree engineers and five years for diploma engineers from the date of obtaining qualifications, after which it will lapse unless it is transferred to the 'Member' category by paying difference in membership fees.

c) Organization Member :

Organization, which is engaged in any of the designated aspects of Structural Engineering and at least one top level employee (director/ chief engineer/ sr. manager etc) of which satisfies the criteria for 'Member' category. This is a life membership.

Membership Fees {Rs.}

Category	Entrance Fee	Membership Fee	Total Fees
Member	1,500	2,500	4,000
Junior Member	500	1,500	2,000
Upgradation of Junior Member	1,000	1,000	2,000
Organization Member	2,500	12,500	15,000