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: Hemant Vadalkar

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Members : 946 Organisation Members : 16 Junior Members : 9

Patrons : 29 Sponsors : 8

TOTAL STRENGTH : 1008

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 Resistance	800
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• Workshop on ISO-9001 for Construction Industry	200
• Brain Storming Session on Use of Speciality Products in Structures	250
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• Workshop on Effective Use of Structural Software.	200
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• Seminar on Innovative Repair Materials / Chemicals	250
• Seminar on Foundations for Highrise Buildings	200
• Seminar on Structural Detailing in RCC Buildings	250

(The above volumes are available at ISSE Head Office)

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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.

FUNDAMENTALS OF STRUT AND TIE MODEL

Hemant S. Vadalkar & Prasad Samant

INTRODUCTION

In concrete structures, design engineers often encounter portions of structures subjected to significant shear stresses (corbels, deep beams, pile cap, dapped-end beams, or post-tensioned anchorage zones etc.). Traditional design assumptions, specifically those regarding plane sections remaining plane after deformation, do not apply to such locations. Difficulty in analyzing these types of elements often arises due to the inability to apply kinematic compatibility. These locations traditionally have been designed using empirical formulations or past experience. A strut-and-tie model or strut-and-tie modeling (STM) offers an alternative to such methods, Equilibrium of the nodes is considered during the analysis stage.

FUNDAMENTAL STRUT AND TIE MODEL

Each model has three basic elements Strut, Tie & Nodes

1.0 Struts

Struts are the elements within strut-and-tie models that carry compressive stresses. The geometry of a strut varies widely and depends upon the force path from which each individual strut arises.

1.1 Prismatic struts have a uniform cross section over their length (Fig. 1). Such a strut can occur in beam bending where the compressive stresses are confined by the neutral axis. The compressive stress block of a beam in a section of constant moment is an example of a prismatic strut.

1.2 Bottle-shaped strut can form when the flow of compressive stresses is not confined to a portion of a structural element, (Fig. 1). In this case, the force is applied to a small zone and stresses disperse as they flow through the member. As compression disperses, it changes direction forming an angle to the axis of the strut. To maintain equilibrium a tensile force is developed to counteract the lateral component of the angular compression forces. A bottle- shaped strut can be modeled by a collection of struts and ties to adequately account for the tensile force.

1.3 Fan-shaped strut is characterized by stresses that focus into a very small area. Stresses flow radically from a large area to a much smaller one. A compression fan can develop when large distributed loads flow into a support (Fig. 1). There are no tensile stresses developed within a compression fan because the forces are collinear without any tension components perpendicular to the radii of the fan.

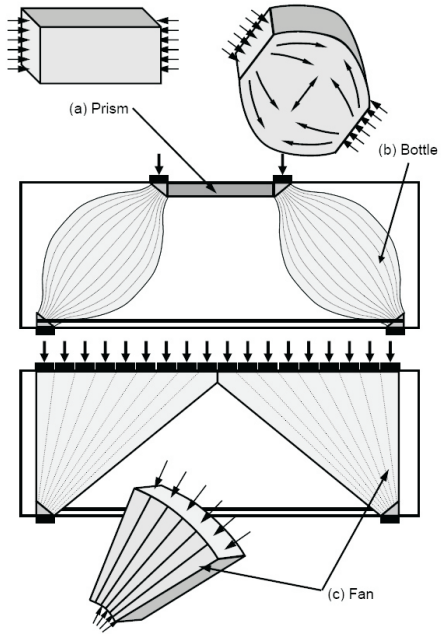


Figure1: Common type of struts

2. Ties

Ties are the elements within a strut-and-tie model that carry tension, and are generally confined to reinforcing or pre-stressing steel. The geometry of a tie is therefore much simpler. The tie is geometrically confined to elements that can carry high tensile forces, and the allowable force is generally given as a fraction of the yield force.

3. Nodes

Nodes form where struts and ties intersect (Fig. 2). Nodes are described by the types of element that intersect at the node. For example, a CCT node is one, which is bounded by two struts (C) and one tie (T). Using this nomenclature nodes are classified as CCC, CCT, CTT, or TTT. A CCC node is expected to have a higher strength than any other type due to the effect of confinement. Each other node type has some tensile stresses acting upon it due to presence of the tie(s). Tensile stresses can cause cracking within the nodal zone, and reduce strength.

The geometry of a node may be defined by the detail of the structure. Wherever concentrated loads are applied to the structure, there will be some finite bearing area. The dimensions of that bearing area will define the geometry of the adjacent node. Nodes that do not occur on the boundary or are not influenced by a bearing area of a structural member are much harder to define geometrically.

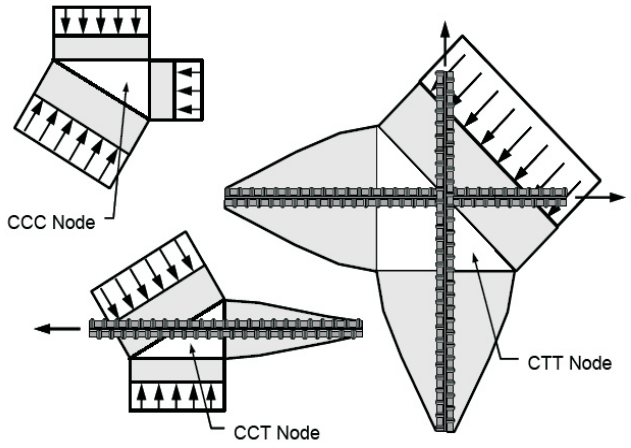


Figure 2: Schematic depictions of nodes

TYPICAL D-REGION MODEL

Disturbed regions or D-regions occur wherever there are a local disruptions of the stress flow within a member. Such disturbances can be classified into two groups: Static and Geometric. Static disturbances are due to the presence of concentrated loads. The loads can be the result of concentrated loads applied to a structure or to reactions. Geometrical disturbances arise from local changes in a structure's geometry such as a dapped end or a beam, joint, or opening. Examples of both types of discontinuity are depicted in Fig. (3) with geometric discontinuities on the left (a to c) and static discontinuities on the right (d to f). Typical D-regions are shown in Fig. 3 (a) notch in beam (b) opening in beam (c) beam-column junction (d) beam near support (e) beam acted upon by point load (f) deep beam (geometric discontinuities a to c and static discontinuities d to f). Sample strut and tie models are shown in Table 1.

CONCLUSION :

Analysis using Strut-and-tie model is very simple and efficient. The reinforced concrete structure is considered as a composite material, without separating contribution of concrete and steel. Strut-and-tie method provides a framework to understand and assess the flow of forces and the resisting mechanism. With clear understanding of the structural behaviour, it is a valuable tool for achieving proper ductile detailing of concrete members.

REFERENCES :

1. ACI 318-2005, Building Code Requirements for Structural Concrete and Commentary, Appendix A, Strut-and-Tie Models. American Concrete Institute.
2. Jorg Schlaich and Kurt Schafer,1993 "The Design of Structural Concrete" IABSE Workshop New Delhi 1993

AUTHOR :

Hemant Vadalkar is a consulting structural engineer praciting at Mumbai. Mr. Prasad Samant is working with him as a senior design engineer They can be reached at vadalkar@gmail.com

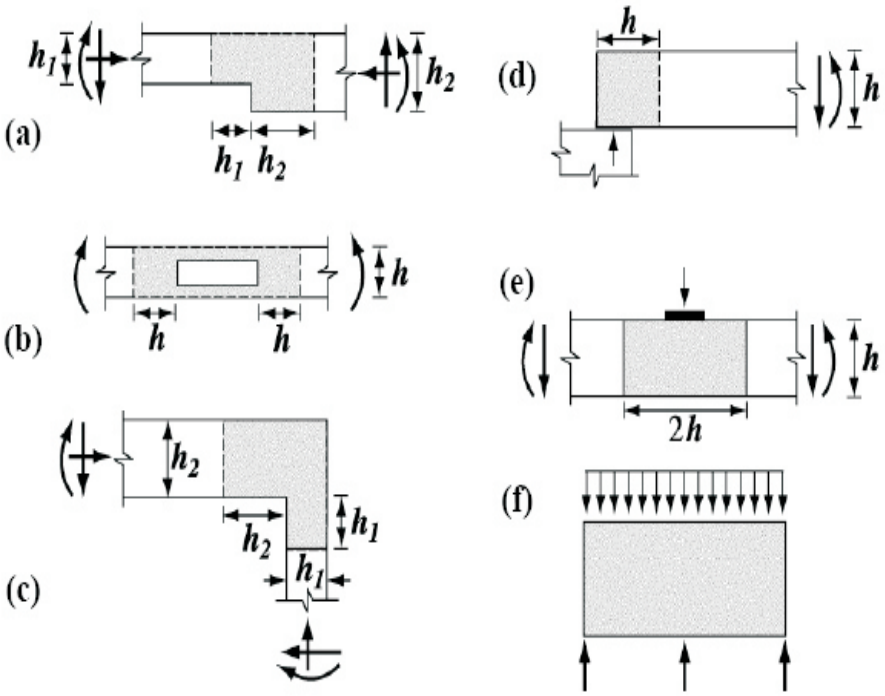
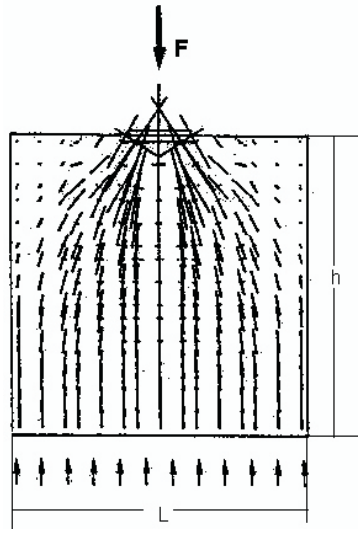
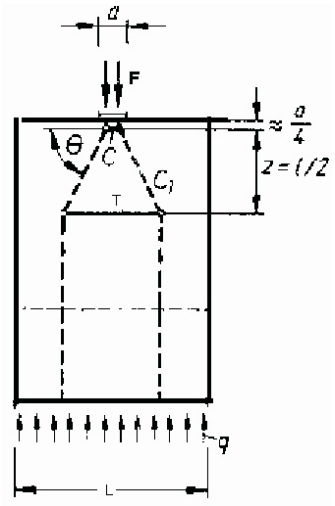
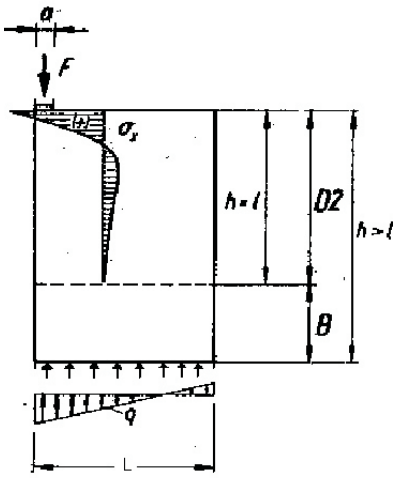
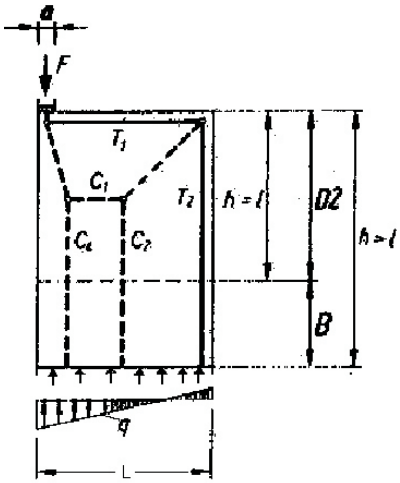
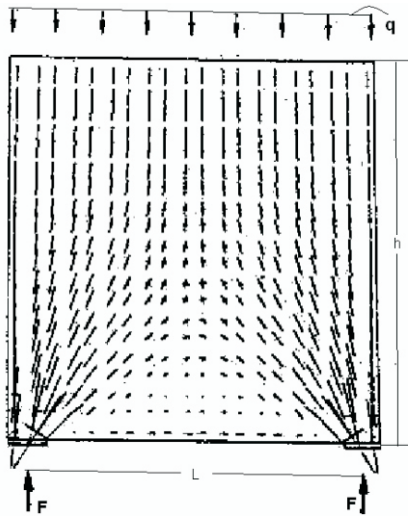
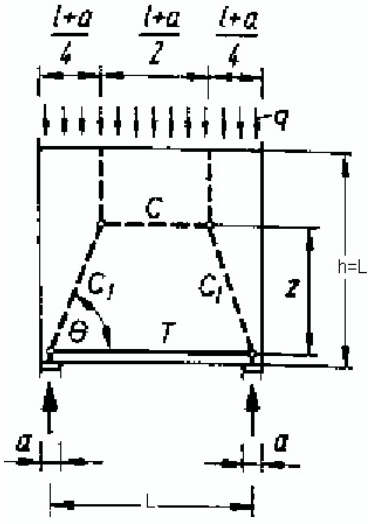


Figure 3 From Appendix A of ACI 318-05

Table 1 : Samples of Strut & Tie models for various loading.

LOADING DIAGRAM	STM MODELS	DESCRIPTION
		**Case 1** Load F applied centrically to a strip of unit width. The distribution of load practically takes place within the limits of a D-region. Depth of D1 region is approximately equal to its width. The deviation of the compressive stress trajectories generates transverse tensile stresses, often termed splitting tensile stress.
		**Case 2** Load F migrates from centre towards the corner of the strip, the transverse tensile forces T beneath the load decrease in magnitude. At the same time tensile forces T1,T2 originates in the loaded edge
		**Case 3** Uniformly distributed load q applied. This is the most common pattern of D region. Where prismatic strut can be observed at top & tie at bottom. Diagonal member C1 is bottle strut.

ISSE CENTRE AT SOLAPUR

K.L. Savla

ISSE members in and around Solapur were feeling a long term need of having a platform to discuss and deliberate on issues of Structural Engineering and related problems of the region. The need has been fulfilled now with opening of a centre at Solapur having met the required norms. Er.H N Somani of Solapur led a membership drive to bring formation of the centre to a reality.

On 30th Aug 2009, an Inaugural function of the centre was organized at Nagesh Orchid College of Engineering, Hipparaga, Solapur. President, ISSE, Er. S G Dharmadhikari presided over the function. Welcome address was made by Er. Pramod Joshi. Director of the College. Dr. (Er) Nitin Sonaje, Registrar, Solapur University was the Chief Guest who made an eloquent speech, declared the centre open and distributed certificates to 27 new members. The following Office bearers were installed.

Parent Advisors	… …	Er. N G Mhetras Er. H N Somani
Chairman	… …	Er. P V Joshi
Vice Chairman	… …	Er. S U Furde
Secretary	… …	Er. G N Chitari
Treasurer	… …	Er. O G Darak

Chairman, P.V. Joshi, highlighted the technical problems faced by engineers at Solapur which were mostly related to structural audit, design of machine foundations, stability certification of existing buildings and resolution of anomalies in IS codes.

President, ISSE, Er. Dharmadhikari elaborated the aims and objectives of ISSE and the present activities to which ISSE is engaged to. He mentioned about the services rendered by ISSE after Gujarat earthquake and requested Er, Somani to prepare a hand book on brick masonry construction and make documentation of seminars organized by Solapur centre. Solapur centre should coordinate with Solapur municipality as regards eligibility of engineers and contractors for certification.

Advisory Trustee, Er. S H Jain spoke about the strength of ISSE and its professional relevance. He informed the engineers assembled that action is in hand to nominate four ISSE members in BIS committees. He requested all to take more interest in IS codes and their implementation.

Secretary, ISSE, Er. K L Savla made a power point presentation on ISSE to inform the gathering about functioning of the Society. He gave some reminiscence of Parent advisor, late Er. R L Nene, the founder figure of ISSE and of his vision about ISSE. He also referred to the contributions of late Er. G C Oak to improve the ISSE journal.

After lunch break, a presentation on bridge construction was made by Er. S A Reddy. Ex-Dy.MD, Gammons India, out of his 40 years experience. Er. Reddy gave an account of masonry, RCC, pre-stressed as well as cable stayed bridge constructions and informed that bridges made of nominal mix design 72 years back still do not need maintenance. In his opinion, besides intricacies of design, a practical approach to constructability, at times, results more economical design. He also presented some case studies of bridge failures.

At the end, Dr C V Kand shared a detailed account of his experience in bridge construction and mentioned about the importance of site visit before finalizing a bridge design. He explained how Vastu shastra was implemented in Temple structures and Sompuras inherited knowledge of architecture, structure and craftsmanship from their fore fathers through generations.

The function ended with a vote of thanks given by Er S U Furde.

Congratulations

Er. S. H. jain

Er. S. H. jain, Chairman, IEI, MSC & Advisory Trustee, ISSE has been appointed on the MCGM Technical Committee on High Rise Buildings

LIMESTONE STOCK PILE SHED FOR A CLINKER PLANT AT JAFARABAD

A.B.Karnik

INTRODUCTION :

Limestone used to be kept in the open as a raw material for a cement plant. The location of the limestone stacking is critical for the plant operation. It was felt necessary to cover the raw materials to protect these from rain. Therefore, a large shed was required to be erected of dimensions 200m long x 53m wide and 21.12 high at ridge level. The challenge was to construct the shed without shifting the lime stock in place or hampering the stacking operation which was requirement of the running plant.

SCHEME PLANNED :

After studying site conditions of an existing working plant and Limestone stock pile which was required to be covered, the final dimensions of the shed were decided. The overall dimensions of 53m width X 200m X 21.12m height to ridge level were fixed. These dimensions were evolved to allow clear movement of and working of a reclaimer of the Plant. Shed of above dimensions was difficult to be erected in required position as plant working was not to be disturbed. Therefore it became necessary to fabricate and erect the shed away from the plant and move by rolling on wheels to the required location. The design of structure was done such as to erect ten equal units of 20 m length one after another 30 m away from erection site for rolling them to respective positions. One unit consisted of two portals 10 m apart and triangular purlins and similar cladding frames across, with 5 m cantilever on either side making one unit of 20 m length. Simple track was made on a rubble masonry plinth wall capped with R.C.C., coping capped with an inverted channel MC100 (web horizontal and cement mortar infill) to act as a rail for rolling of portal assembly. First unit rolled out to the farthest end traveling 230 m of length. Subsequent units rolled to shorter lengths in sequence. Units reaching their respective positions started receiving roof sheeting without waiting for balance units to be in position.

ENGINEERING DETAILS

It is necessary to describe in detail, design aspects for a sound and most economical structure which required 500 T of structural steel which comes out to be just **47 kg per sq. m.** for such a huge structure.

1) **Structural Arrangement :** The structure is to be designed for Dead loads and Wind loads. With a substantial height of 21.12 m, high wind pressure and very less self weight, excessive bending moments at foundation level will occur for a fixed portal design. In such situations, it will be difficult to design the foundations with very a less vertical load and huge bending moments. Hence, the choice of hinged portal was adopted. Thus, the basic engineering concept was a two pinned portal for a span of 53m.

2) **Built-up section for portal :** Since, the ends are pinned, the bending moment in the portal will be maximum at the eaves level. To resist the large bending moments, reasonable lever arm is necessary. Two extreme faces (flanges) of Portal were decided 2500 mm apart for reasonable level of stresses. Compared to bending moments at different locations, shear values were low. Plate girder design with 2500 X 10 mm web plate would have been very heavy and uneconomical. Hence, choice was for latticing to make up built-up cross section. Flange and diagonal members could be varied just as per requirements of force at any section throughout the portal profile. Each side flange member was also made up of two channels 400 mm apart for better Ryy for reducing slenderness value. Thus, flange members were each 2 Nos.MC 250 reduced to 2 Nos. MC 200 as per requirements lacing with angle 50X50X6.

3. **Roofing and cladding :** Roof and side sheeting required purlins/runners at 1400 c/c. Purlins and side claddings were chosen to be triangular in cross-section of side 1400 mm. with angle 50X50X6 at their apex. This choice was to give better RIGIDITY to pair of portals rolling to their destination. They gave Virendeel formation for the desired rigidity forming simultaneously bracing system as well. Further vertical depth of purlins and side cladding worked out to 1212 mm. Hence, vertical depth of portals was chosen as 2500, almost double of purlins and side cladding. Attached drawing clearly shows aesthetic value added to the structure by these proportions.

4. **Erection sequence :** Attached photographs show erection sequence for Portals. Vertical legs along with part of inclined rafter on either side in cross section were erected on trolleys to start with. Temporary columns with temporary foundations accurately located, were provided for supporting part of inclined rafters. Central rafters were then erected to form total portal. Erection of triangular purlins and side cladding of 10 m span and side cantilevers of 5 m then followed. Four trolleys, two on each side in tandem between portal legs got ready for rolling. Base plates of portal legs were placed accurately and in correct level in advance on foundations. After reaching destination, connecting channels 2 Nos. MC 250, a link between portals and base plate got welded. Thus, accurate shed erection were completed.

5. **Provision of hinge at base :** Important, provision of 2 Nos. MC 100 box at centre of base plate for resisting maximum shear of 20 T due to hinge behaviour was the best substitute for four No. 25 mm dia. bolts spaced some distance apart which could not provide hinge action.

6. **Resisting horizontal force at foundation :** Lastly, maximum horizontal force on foundation at hinge level was to be transmitted to soil. This was achieved by backfilling excavation around pedestal by plum concrete 1:4:8, butting

the excavated vertical faces. Thus, the horizontal force was dissipated in soil by passive resistance of surrounding soil.

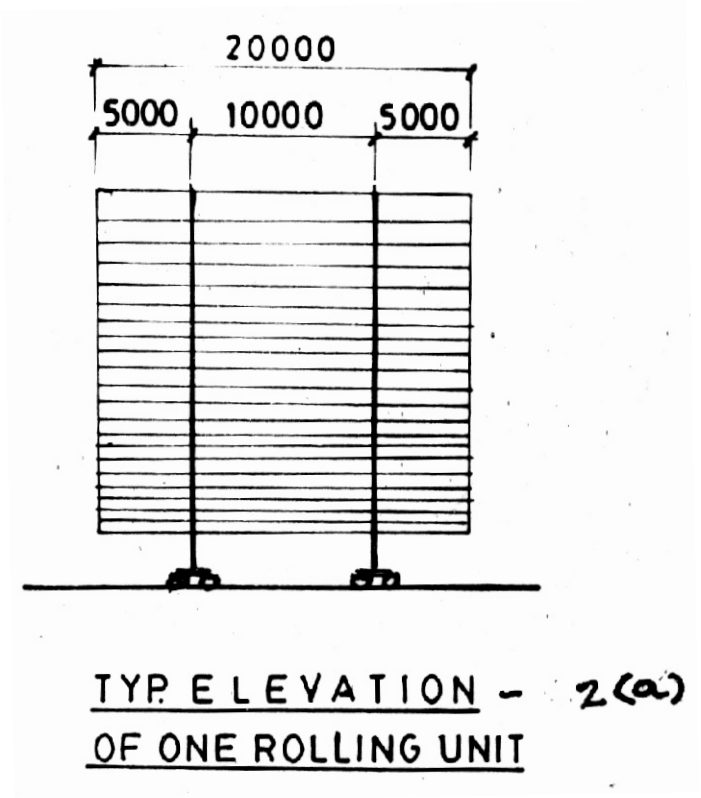
7. **Efficient Structural arrangement :** It will be seen that best effort was made to get maximum benefit for economy and soundness of structural arrangements.

8. **Drawing :** Author of this article has designed above innovative and economical structure in May 1994 and drawn himself general arrangement drawing on tracing paper accompanying this article. Development of such a drawing by designer himself brings out better ideas, without missing basics of design and economy. Mere instructions to draftsman may leave some error.

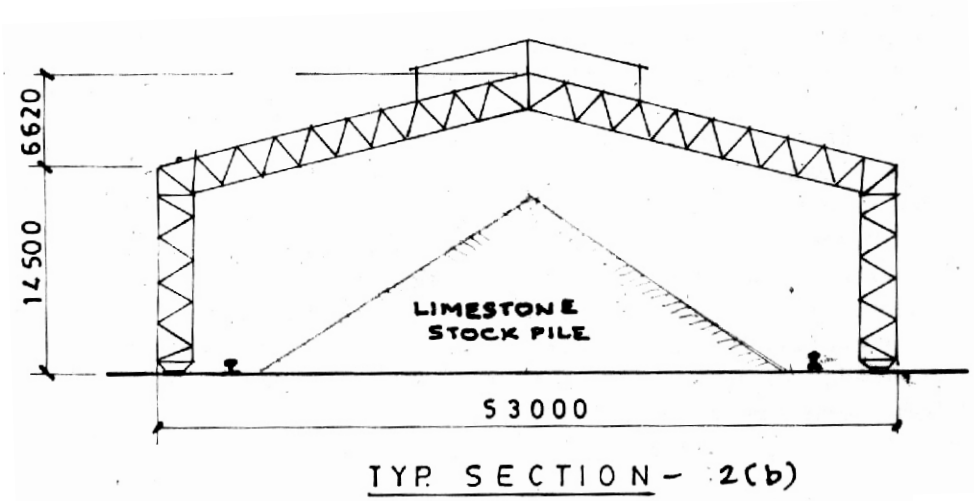
9. **Award :** The author of this article compiled in 1997 was awarded S.B.Joshi Smriti Paritoshik by the Institution of Engineers (India), Maharashtra State Centre, Mumbai.

AUTHOR

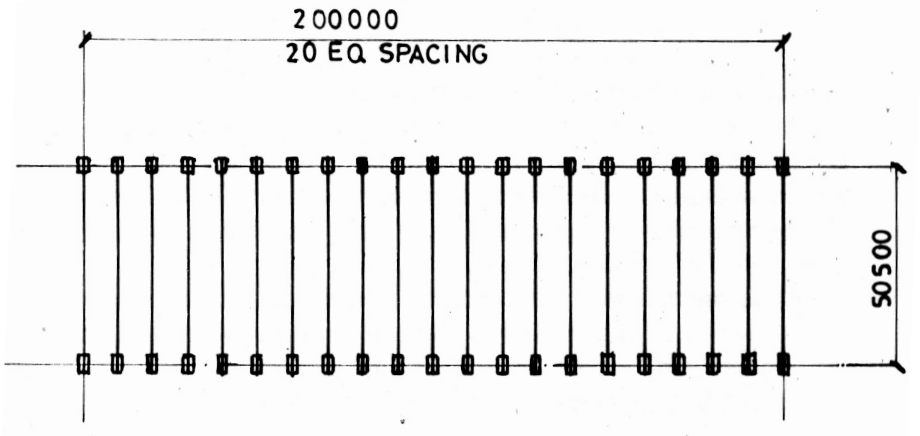
Mr. A. B. Karnik, (arunodaya22@gmail.com) is a senior Consulting Structural Engineer practicing in Mumbai with more than 50 years of experiences.



TYP ELEVATION - 2(a)
OF ONE ROLLING UNIT



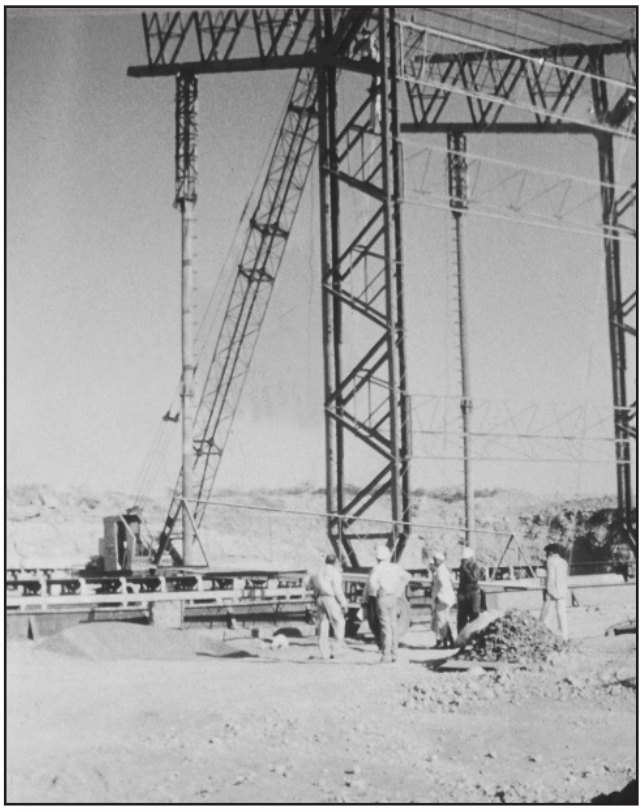
TYP SECTION - 2(b)



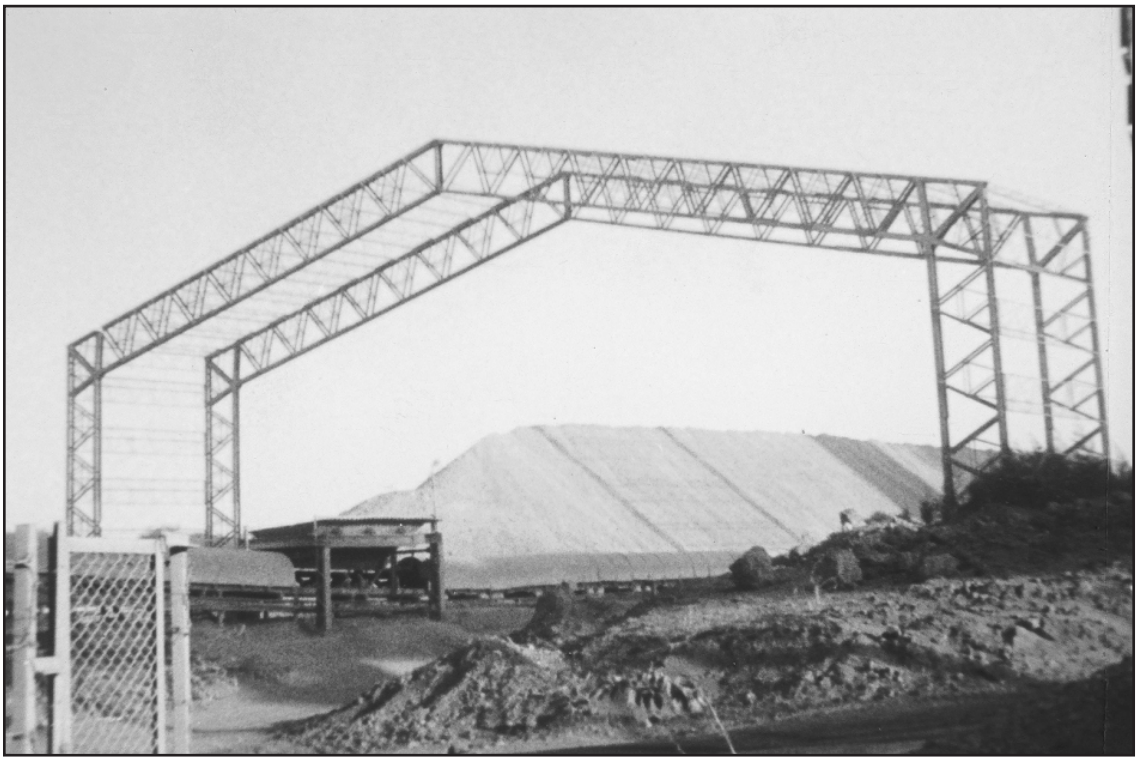
KEY PLAN - 2(c)

Erection Sequence

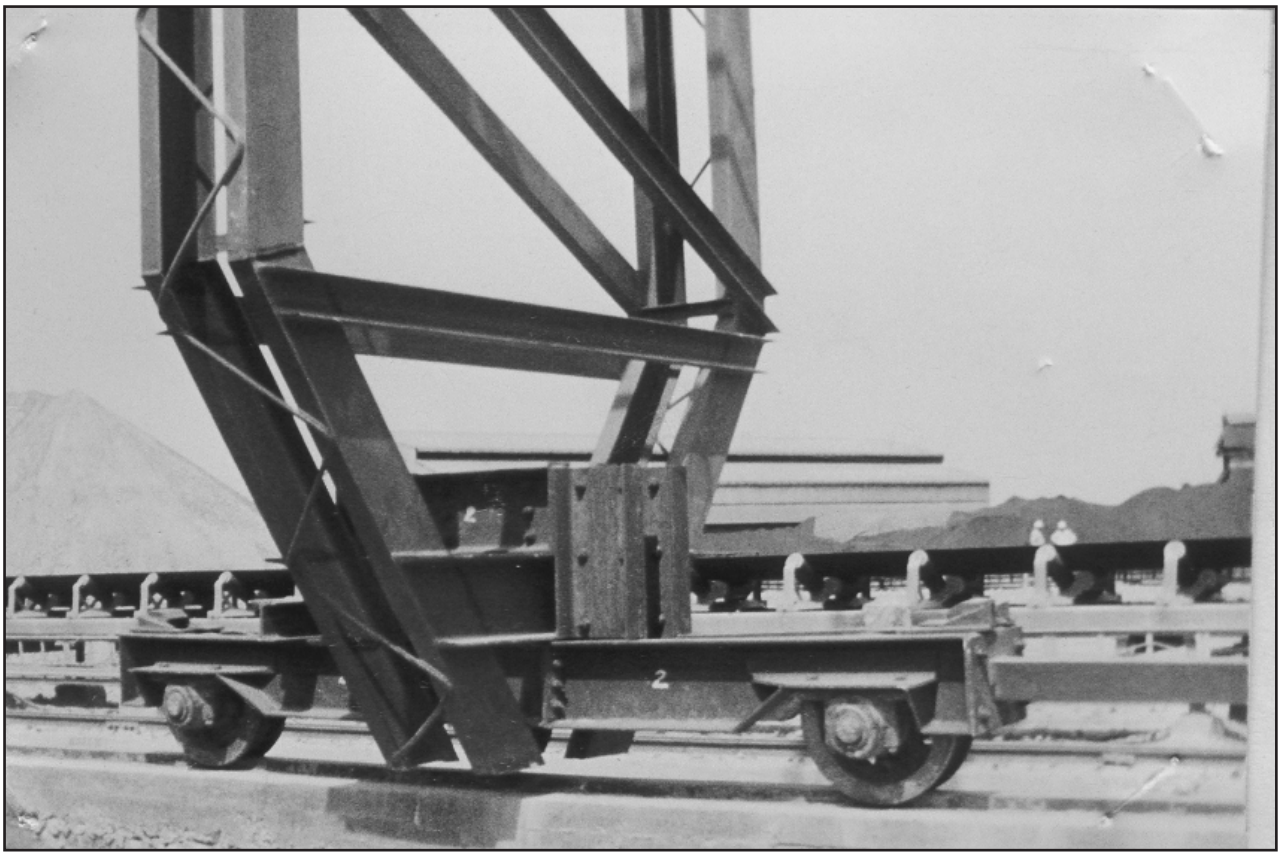
1 - Erection of frame with temporary support left side



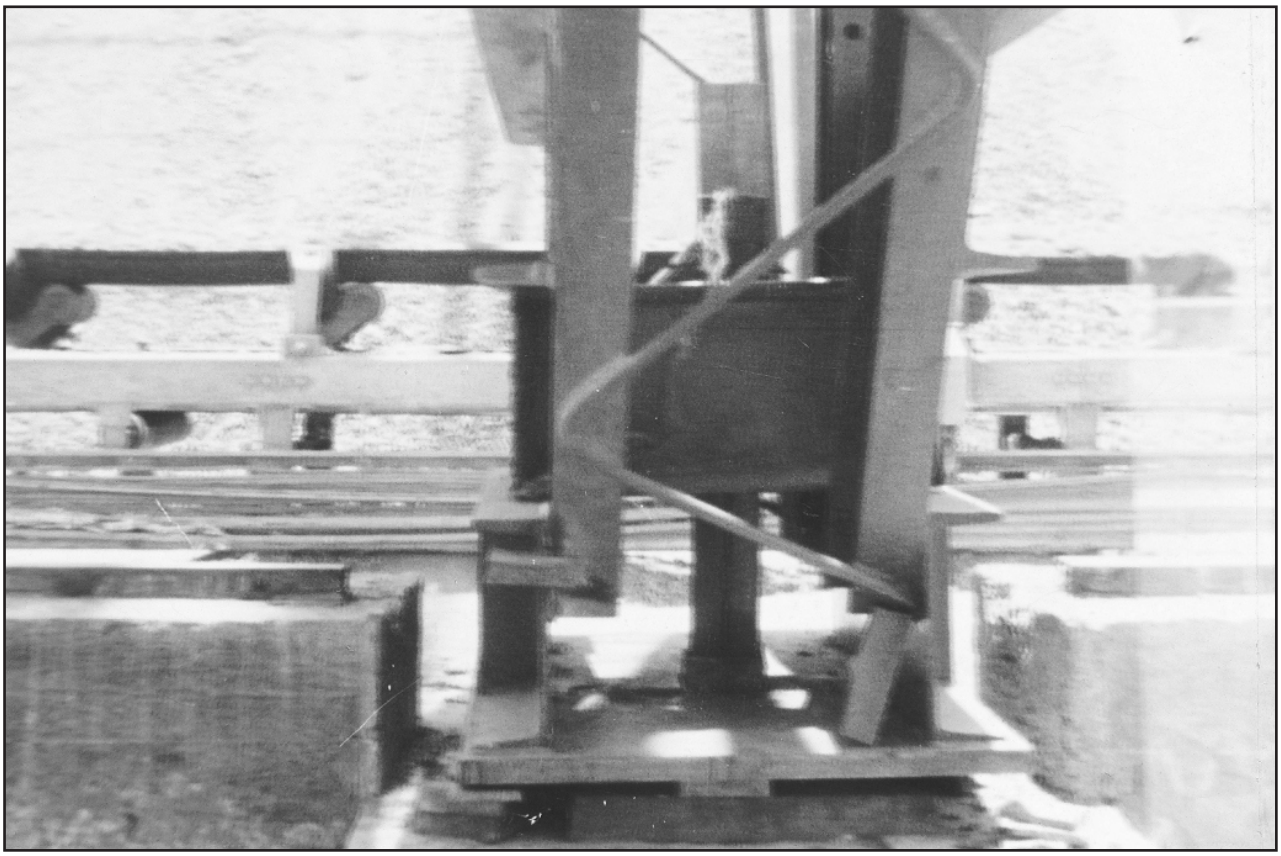
2 - Erection of frame with temporary support right side



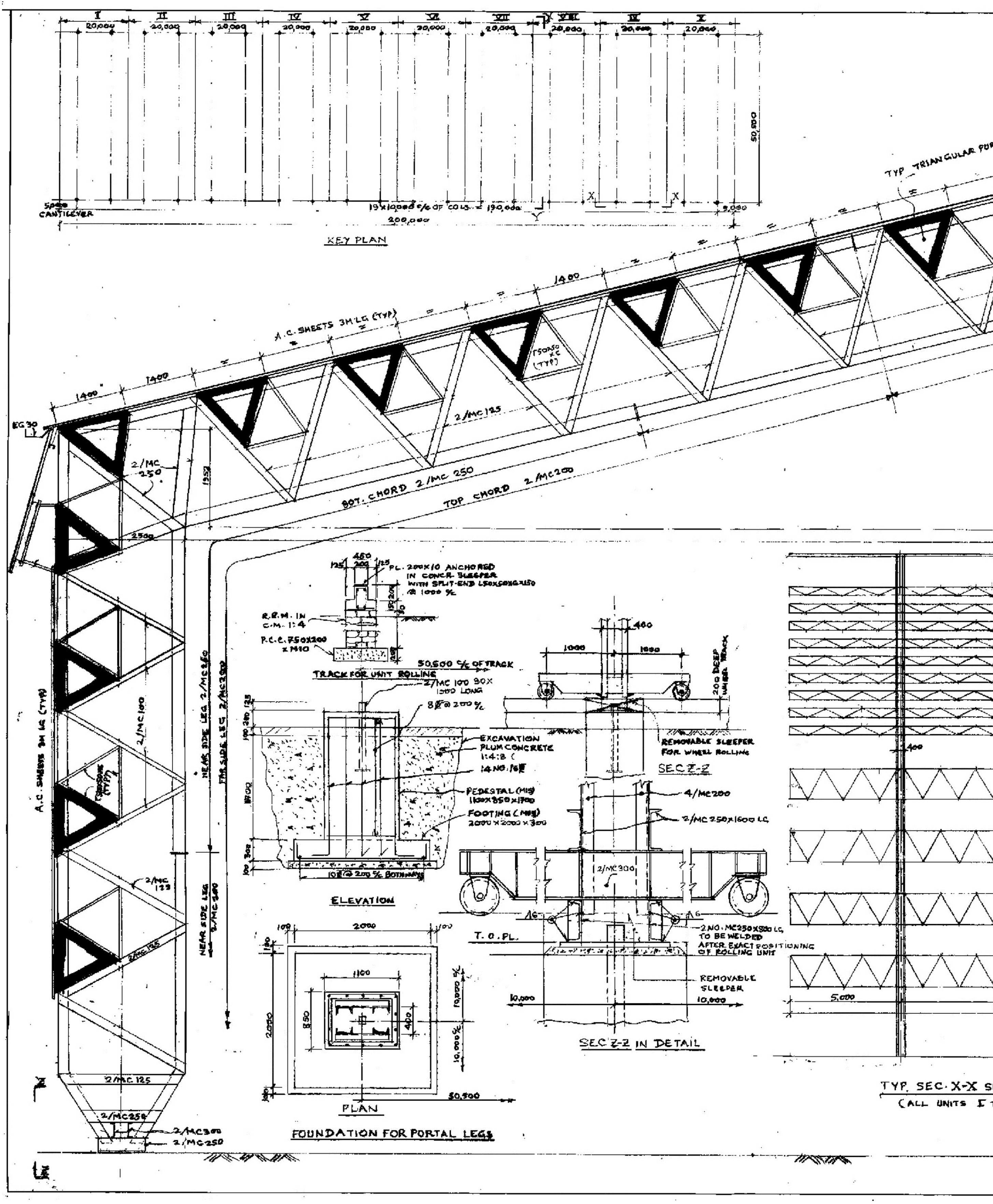
3 - Erection of portals in pair

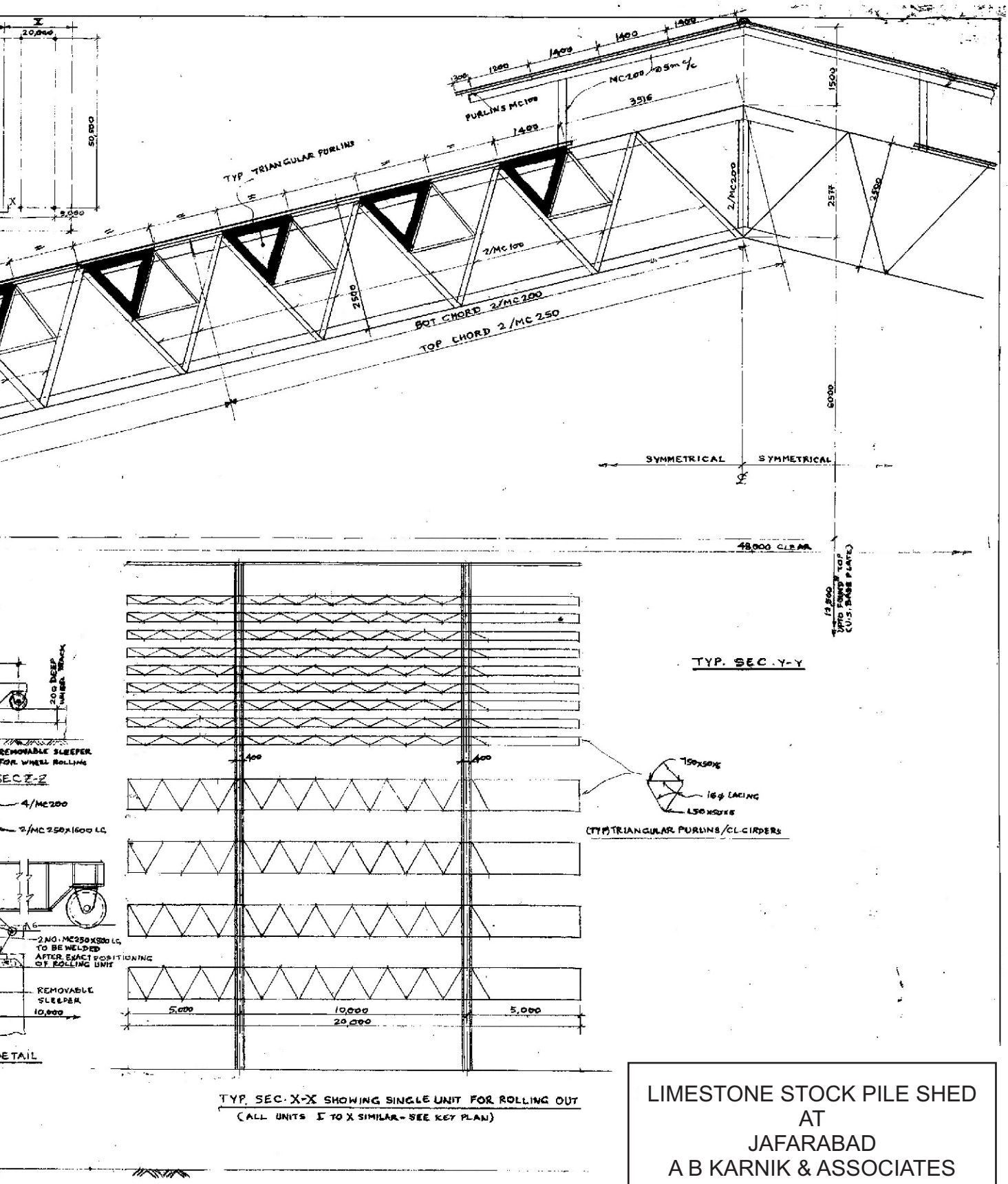


4 - Rolling the portals on wheels to required location



5 - Welding with base plate at final location


KEY PLAN
CANTILEVER
19 x 10,000 c/c OF COLS. = 190,000
200,000
50,500
TYP. TRIANGULAR PURLIN
A.C. SHEETS 3M LG (TYP)
2/MC 125
BOT. CHORD 2/MC 250
TOP CHORD 2/MC 200
NEAR SIDE LEG 2/MC 250
FAR SIDE LEG 2/MC 200
A.C. SHEETS 3M LG (TYP)
2/MC 100
2/MC 125
2/MC 250
2/MC 300
2/MC 250
TRACK FOR UNIT ROLLING
50,500 c/c OF TRACK
R.R.M. IN C.M. 1:4
P.C.C. 750X200 x M10
EXCAVATION PLUM CONCRETE 1:4:8
PEDESTAL (M15) 1100X850X1700
FOOTING (M15) 2000 X 2000 X 300
ELEVATION
PLAN
FOUNDATION FOR PORTAL LEGS
SEC Z-Z
REMOVABLE SLEEPER FOR WHEEL ROLLING
4/MC 200
2/MC 300
T.O.PL.
2 NO. MC250X500 LG TO BE WELDED AFTER EXACT POSITIONING OF ROLLING UNIT
REMOVABLE SLEEPER
SEC Z-Z IN DETAIL
TYP. SEC. X-X



LIMESTONE STOCK PILE SHED
AT
JAFARABAD
A B KARNIK & ASSOCIATES

QUALITY SCHEME FOR RMC

Vijay R. Kulkarni

Commercially-available ready-mixed concrete arrived in India in the mid nineties. Taking advantage of the boom in infrastructure and housing sectors, ready-mixed concrete industry spread its wings in major cities in India in the past decade. Last year, the industry produced around 25 million m^3 of structural-grade concrete. However, in absence of any norms on quality of concrete, the Ready Mixed Concrete Manufacturers' Association (RMCMA), India, took the lead in developing a self-regulatory framework of quality. The paper describes the salient features of the quality scheme evolved by the Quality Team of the RMCMA. The framework the scheme rests on two strong pillars — best practices from advanced countries that are suitable for Indian conditions and strict observance of provisions in the relevant Indian codes. The quality scheme, which is divided in two parts, is described in details in RMCMA's Quality Manuals Part I and II. While the QC Manual Part I includes a comprehensive Check List essential for certification of ready-mixed concrete facilities, the QC Manual Part II provides guidelines for quality control and quality assurance of RMC. With a view to enhance credibility and customer confidence, RMC facilities are being subjected to annual audits by external auditor. The credibility is further enhanced as the quality framework allows the customer to visit the RMC facility and cross check compliance with the Check List. With the quality framework in place, the RMCMA commenced the program of external audits and till date nearly 100 RMC facilities of member companies spread in different locations in India have been audited and certified. Before undertaking audits, strict observance with statutory norms, which includes permission from local authorities, permission from state pollution control board and factory inspector is carefully verified by auditors. The latter provides assurance about compliance with statutory norms relating to health, safety and environment.

INTRODUCTION

Concrete construction scenario in India has witnessed significant changes in the past decade. Traditionally, construction involving concrete has been a labour-intensive activity, and even today, an overwhelming majority of concrete produced in the country is site-mixed, and most of it is volume-batched. However, thanks to the liberalization of the Indian economy and emphasis on the development of physical infrastructure, the construction scenario in India — especially in urban India — has witnessed considerable growth in the recent years.

The demand for higher speed of construction, especially for residential and commercial housing, flyovers, roads, etc. in metropolitan and other big cities of India, necessitated adoption of mechanized and semi-mechanized techniques of construction. The need for large volumes of concrete as well as faster speed of concrete construction was felt. This was conducive for the development of ready-mixed concrete (RMC).

The first commercial RMC facility in India was set up in Pune in 1992 and was quickly followed by establishment of similar facilities in Mumbai, Bangalore and other places. Today, RMC is available as a commercial commodity in every metropolitan and many other large and medium-sized cities of the country.

INTERNATIONAL SCENARIO

Ready mixed concrete is not a new technology. It was first patented in Germany, way back in 1903. The first commercial delivery of RMC was made in Baltimore, USA, in 1913 and the first revolving-type transit mixer, of a much smaller capacity than those available today, was born in 1926. By late 1930s, RMC was introduced in some of the European countries. The industry in Europe and USA witnessed remarkable growth in the latter half of the 20th century. It spread its wings in smaller countries of Europe and even in some developing countries like Singapore, Thailand, Indonesia, South Africa, etc.

Currently, RMC is a matured industry, both in Europe and USA. The data from National Ready-Mixed Concrete Association (NRMCA), USA, indicate that RMC is $ 30 billion industry in the USA with an annual output of 351 million m^3 (March 2007). Some 6,000-odd plants owning around 70,000 trucks constitute the US industry[1]. In that country, nearly 75% consumption of cement is through the RMC route!

According to the statistics of the European Ready Mixed Concrete Organization (ERMCO), its 21-nation members produce 439 million m^3 of concrete per annum from some 14,

586 plants[2]. An average of around 47% of cement used in these countries is consumed through the RMC route.

In all these countries RMC is a well-established product. Time-tested quality standards backed by up-to-date national codes are in vogue in these countries. Countries like U.S.A., U. K., and Canada have well established quality certification schemes. In addition, there are stringent norms for health, safety and environment. Responsibility of RMC player is well defined and proper systems are in place.

CURRENT STATUS IN INDIA

The concept of RMC is not new to India. Captive RMC plants arrived in the country in 1950s; but remained confined for application in mega projects such as hydro-electric projects, construction of long-span bridges, industrial conglomerates, etc. Cement was a controlled commodity till early 1980s. With the full decontrol of the industry, the availability cement improved. Simultaneously, with the government's efforts to boost housing and infrastructure growth, speed of construction assumed importance. This was conducive for the introduction of ready-mixed concrete. Early 1990s witnessed the beginning of RMC industry in India. After overcoming the initial teething troubles, the industry started looking up. Yet, it is a fact that after independence, India missed 'commercial' RMC technology for nearly five decades!

Growth of the RMC industry is a recent phenomenon. It can mainly be attributed to the growth in commercial and residential housing, and emphasis given to development of physical infrastructure. During the recent past, the construction industry has grown with more than 10% growth rate, and this growth trend naturally gets reflected in the concrete industry.

The growth of RMC started with metropolitan cities, then spread to other major cities, and is now trickling down to medium and even small cities, vindicating the fact that RMC is the right solution for different markets. Major national players are striving hard to expand operations whereas a number of regional/local RMC players have simultaneously entered into markets.

No accurate data on the current status of the RMC industry in India is available. However, as far as our knowledge goes, there are around 450-500 plants producing about 20-25 million m^3 of concrete per annum. In terms of the percentage of cement consumed through RMC route, it is less than 5% of the total cement produced in India. Thus, there is a vast scope for growth. This is both a challenge and opportunity to the RMC industry. We have yet to go a long way.

WHAT IS RMCMA?

Once the RMC industry was on the growth track, the need for an industry association was felt to give leadership to the industry and provide direction on issues related to promotion and regulation. The Ready-Mixed Concrete Manufacturers' Association (RMCMA) was established in March 2002. It is a non-profit industry organization of leading ready-mixed concrete producers from India. The vision and mission of RMCMA are highlighted in Table 1. These would give an idea about the tasks before the organization.

Table1: Vision and mission of RMCMA

Vision	Making ready-mixed concrete the preferred building material of choice across the whole of India
Mission	1. Provide leadership to the concrete industry in India 2. Provide exceptional value to the Members without sacrificing the interests of end users, specifiers, designers and owners. 3. Develop, maintain and improve self-regulatory framework of Quality. 4. Encourage sustainable development with the use of Ready Mix Concrete. 5. Establish and promote within Members the highest business, operational and quality standards. 6. Share latest developments and knowledge in concrete technology within Member companies and with customers.

One of the important thrust areas of activities of the association is to evolve a self-regulatory framework by setting up the quality standards which are at par with the international standards.

Quality Scheme

RMC is both a service and product. It is essential that the customer is assured of quality from RMC producer. Unfortunately, there exists no regulatory framework in India through which the customer could have certain level of quality assurance about the product being delivered to him. Therefore, the RMCMA undertook the responsibility of

developing such regulatory framework.

India, being a late starter in RMC business, had the advantage of having the latest generation technology of batching and mixing plants, the use of which augurs well for producing quality concrete. With the state-of-the-art plant and equipment, a considerable level of sophistication has been brought into the production of concrete. For example, the erstwhile electrical and mechanical weighing system has been replaced with the load-cell based electronic system, the efficiency of the mixer has been vastly improved with the introduction of power mixers and the production process has been fully automated with computer-controls. All this has led to improvements in both the quality and uniformity of the product.

However, the crucial question is: will the mere use of state-of-the-art plant and equipment result in ensuring quality concrete? The answer is certainly 'no'. Thus, what is needed is a framework of quality, providing assurance that the modern tools and equipment being used are capable of producing quality concrete on the one hand and the producer is capable of implementing a Quality Plan to provide assurance about the quality of his products, on the other hand.

Experience from other counties

For developing an indigenous framework of quality for RMC, the RMCMA undertook an in-depth study of quality schemes from some advanced countries — the USA, UK, Canada (Ontario State), and some countries of Europe — where RMC has been used for long years. The study revealed that these countries have well-established quality framework of their own, developed mainly by the RMC associations or other organizations in their country and backed by their national codes. For example, the National Ready Mixed Concrete Association (NRMCA), USA, developed the Plant Certification System way back in 1965[3]. This system based on ASTM C 94[4], was revised 10 times since inception, the latest revisions being done in December 2007. Most of the contracts executed in the USA and by US agencies abroad specify adherence to the NRMCA's system. The American Concrete Institute has published a Guide for Concrete Plant Inspection and Testing of RMC (ACI 311.5-04)[5]. This document provides sufficient guidance with regards to the minimum qualifications of inspector, his minimum duties and the type of reports to be made, etc. Further, based on AASHTO guidelines, NRMCA developed guidelines for quality control and quality assurance of concrete for the benefit of RMC producers[6]. In Canada, the Ready Mixed Concrete Association of Ontario (RMCAO) has evolved and is implementing Quality Scheme for RMC. The scheme involves audit of each production facility, which is inspected to ensure that by virtue of equipment, facilities, materials, statistical control and procedures, proper “capability” of producing quality concrete exists[7]. In the U.K., an independent organization, namely Quality Scheme for Ready-Mixed Concrete (QSRMC) provides product quality certification for design, production and supply of RMC[8]. The scheme is based on ISO 9001: 2000, BS EN 206-1:2000 and BS EN 8500-Part I and Part II [9, 10, 11]. It contains robust regulations and rigorous assessment procedures; however, it is quite complex and onerous.

The in-depth study of the international practice revealed that most of the developed countries have evolved their own quality systems and are implementing the same. It would certainly be not appropriate to adopt any system from a particular country; yet we can choose the best international practices, and adapt them to suit our conditions, giving due considerations to the existing provisions in the codes of practices of the Bureau of Indian Standards. Thus, the basis of developing Indian Quality Scheme was laid.

Indigenous quality scheme

The RMCMA took the decision of developing an indigenous quality scheme for ready-mixed concrete in India. It also decided that the quality scheme shall rest on two strong pillars, namely, best international practices that are suitable for Indian conditions and strict observance of the codes of the Bureau of Indian Standards.

For evolving the quality scheme, RMCMA constituted the “Quality Team” consisting of senior representatives from Member companies and imminent experts from the construction industry. The Quality Team met on several occasions and after thorough discussions, decided to divide the quality scheme in the following two parts:

- Audit-based certification of RMC production

facilities

- Guidelines for quality control and quality assurance.

Two separate documents were prepared covering the above-mentioned two parts. The initial drafts of the documents were discussed in detail in the meetings of the Quality Team and the drafts underwent several revisions.

The activities in a typical production facility can be grouped in six main areas, namely, material and storage handling system, batching equipment, central mixer, ticketing system, delivery fleet and testing laboratory. These activities can further be sub-divided into a number of areas as shown in Table 2. The QC Manual Part I developed by the RMCMA contains an exhaustive "Check List" covering all the areas covered in Table 2. It contains some 125 items. Out of these, conformance with some 110 items is considered to be strictly essential for achieving good quality concrete, and hence for getting the certification by the RMCMA.

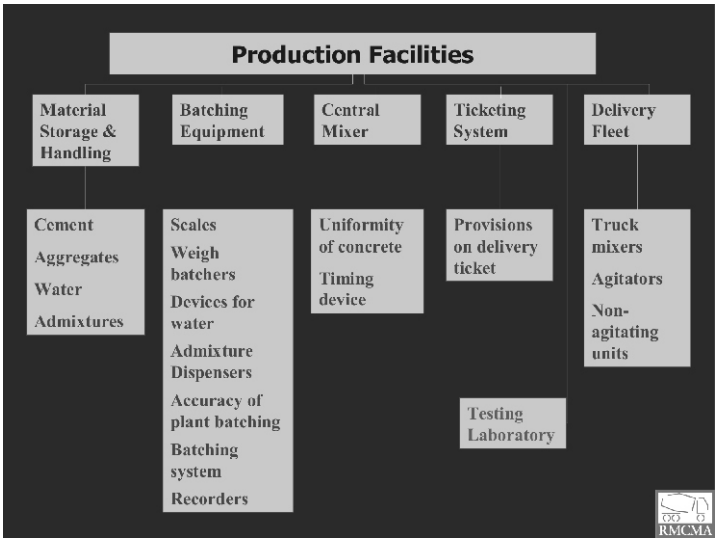


Table 2: Main areas of typical RMC production facility

While developing the Check List, it was ensured that the provisions in the same meet most of the stipulations in the Indian Standard on Ready Mixed Concrete, IS 4926: 2003 (second revision) and the other relevant codes on concrete such as IS 456, IS 383, IS 9103, etc. In fact, in certain cases, the RMCMA requirements are more stringent than those of IS 4926:2003.

Audit procedures

With a view to bring in transparency, enhance credibility and win over the confidence of customers, it was considered essential by the Quality Team of RMCMA to introduce a yearly audit of the RMC production facility by an external auditor. For this purpose a detailed audit procedure was drawn and the selection criteria for auditors were also finalized. These are included in the Quality Manual Part I.

Any RMCMA member or a producer intending to be a member of RMCMA can approach RMCMA for certification for his particular facility. Once the RMC producer deposits requisite audit fees with the RMCMA, it selects auditor from its own accredited pool and directs him/her to undertake the audit. Before undertaking audit, the auditor producers an undertaking that he has no business relationship with the Company whose plant he would be auditing. The audit carried out on the stipulated date and shortcomings, if any, are conveyed to RMCMA in writing. The RMCMA requests the producer to rectify the shortcoming within a period of two month. The auditor revisits facility and satisfies himself about the rectifications made by producer. Once the auditor gives his okay, RMCMA seeks an undertaking from CEO/Director of producer Company, stating that the "Company would abide by the provisions in the Check List during certification period" On receipt of audit report and the undertaking, certification is granted to producer's facility. It may be noted that the RMCMA and not the producer compensates auditors for the services rendered. Further, it is noteworthy that under the RMCMA scheme, the customers have the right to visit RMC facility any time during the certification period and cross check compliance in accordance with the Check List.

The RMCMA auditors are experienced professionals, who are carefully chosen based on the selection criteria laid down in the Quality Manual Part I. The auditors undergo orientation-cum-training program, including field work involving mock audit of RMC facility. Only after due accreditation, the auditors are permitted to undertake audits.

Adherence to statutory requirements

One more crucial feature of the RMCMA quality scheme is its adherence to the prevailing statutory norms in India. Before undertaking any audit, the auditor seeks and verifies certificates of compliance on the following three aspects from the RMC producer:

- Permission and consent to operate RMC facility from state Pollution Control Board

- Permission from factory inspector confirming adherence to health and safety norms
- Permission/license to operate plant from local body/municipal authority.

This feature of the quality scheme ensures that the certified RMC facility conforms to the requirements of health, safety and environment.

Guidelines for QA and QC

The RMCMA certification through external audit would provide guarantee to the user that the plant and equipment used in the production process of the certified plant conform to the requirements of the relevant IS codes as well as with the statutory norms. However, it needs to be pointed out that availability of proper plant and equipment is only one of the factors — although a very vital one — that controls quality of concrete. No claim is made by the RMCMA that certification of RMCMA will necessarily assure delivery of high quality concrete. The RMCMA certificate should therefore be accepted precisely for what it is — evidence that a certified production facility do possess certain capabilities to produce quality concrete. The existence of these capabilities will reduce the likelihood of deficiencies in quality of certified facilities.

Realizing that mere certification based on the Check List may not be sufficient to instill assurance on quality amongst customers, RMCMA's Quality Team prepared detailed Guidelines for QA and QC of concrete (Quality Manual Part II). The guidelines recommends establishment of a QC Plan by RMC producer, which would incorporate the following information:

- Source and properties of all ingredients of concrete
- Process control including mix design
- Data base on fresh and hardened properties of concrete
- Statistical analysis of the properties of concrete.

The Quality Team once again ensured that the minimum benchmarks suggested in the guideline document are based on the relevant provisions in BIS codes such as IS 456, IS 4926, IS 383, IS 9103, IS 3812, etc. In fact, certain benchmarks in the guidelines far exceed the provisions in different codes.

Different member companies of RMCMA follow different QA & QC practices. Further, these companies compete with each other in the market place, and on many occasions, the competition is based on quality of their products. Therefore, it was not found prudent to bind them under certain fixed norms, which would destroy the spirit of innovation, competition and variety. Therefore, it was decided by the Quality Team of RMCMA that the each RMC producer need to comply with the minimum benchmarks suggested in the guideline document; however, he is free to excel over the minimum benchmarks. Thus, if different RMC producers start competing with each other based on the excellence in the quality of their products, customers would benefit immensely.

Based on the Guidelines contained in the Quality Manual Part II, each RMC plant is expected to develop its own QA-QC Plan and documentation and make the same available to its customers on demand. Further, RMC producers can develop their own quality norms over and above the benchmark provisions in the guidelines. There would always be a room for continual improvement in quality and one should welcome it. Such documentation on quality will go along way in ensuring a higher confidence level amongst customers.

Current status of audited plants

With the finalization of the quality scheme including the two quality documents, and after selection and orientation of nearly two dozen auditors from different parts of the country, RMCMA has satisfactorily completed the audits more than 100 RMC plants till July 2009. These plants are spread in different locations in the country, Fig 1. The audits of more number of plants are in progress.

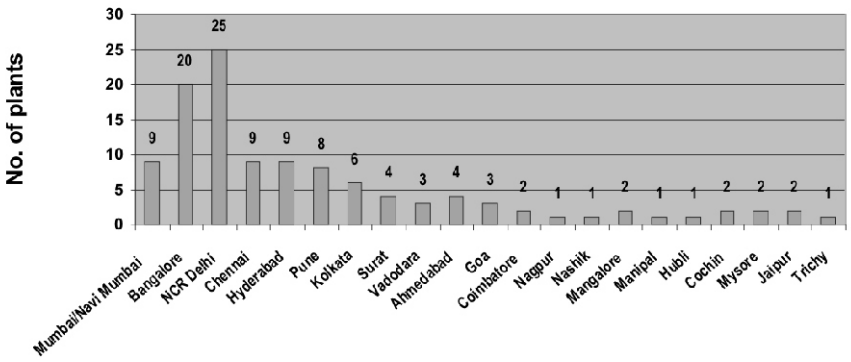


Fig 1 City-wise status (July 2009) of RMC production facilities

Future improvements

The Quality Team of RMCMA, which spearheaded the quality scheme will be a permanent committee and has been entrusted with the work of effecting continual improvements in the scheme. The committee will meet often to review the progress of the quality scheme and would certainly give due consideration to any constructive suggestions from RMC users.

CONCLUSION

Recent years witnessed urban-centric growth of the RMC industry in India. Considering the fact that less than 5 % of the total cement produced in the country is presently consumed through the RMC route, there is vast scope for the further growth of the industry. The RMC industry in India faces many challenges, chief amongst which was the development of a regulatory framework for ensuring quality of concrete. The Ready Mixed Concrete Manufacturers' Association (RMCMA) took up the challenge and with the help of eminent experts from the construction industry, developed a self-regulatory framework for quality. The quality scheme of RMCMA is contained in two meticulously prepared manuals, namely, Quality Manual Part I and II. The scheme rests on two strong pillars — best practices from advanced countries like the USA, UK, Canada, etc. that are suitable for Indian conditions and strict observance of provisions in the Indian codes like IS 4926:2003, IS 456:2000, IS 383, IS 9103:1999, etc. While the QC Manual Part I includes a comprehensive Check List essential for certification of ready-mixed concrete facilities, the QC Manual Part II provides guidelines for quality control and quality assurance of RMC. With a view to enhance credibility and customer confidence, it was unanimously decided to subject the RMC facilities to annual audits by external auditor. The Quality Team of RMCMA finalized the detailed procedure of audit and also the selection criteria of auditors. With the Quality Framework in place, the RMCMA commenced the program of external audits and till July 2009, more than 100 RMC facilities spread in different locations in the country have been audited and certified. The RMCMA would like to appeal to engineers, architect, consultants, government and semi-authorities to make use of the framework of quality developed by the RMCMA Quality Team including eminent experts from the construction industry and specify compliance with scheme in their contracts, involving the use of RMC.

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READERS' RESPONSE

Effect of Positioning of Reinforced Shear walls on Seismic Performance of Buildings having Soft Bottom Storey
by Dr. Mrs S. K. Hirde & Mrs S. T. Charjan
published in ISSE Journal, Volume 11-1, Jan-Feb-Mar - 2009

It is true, as the authors have pointed out; that many buildings with open ground floor used for Parking have collapsed during past earthquakes.

It is also true that no guidelines or codes of practice are available to practicing professionals for designing such type of buildings. Therefore the authors deserve Congratulations for writing this paper.

However, the type of layout of columns given in the paper may not be feasible to adapt in actual design practice, particularly with beam spans as low as 3.5 Meter. It can also be seen that size of column 450 x 450 mm; and beam size of 300 x 450 and 300 x 500 mm, for spans as low as 3.5 meter appear to be on higher side.

Coming to the question of shear walls they may not be needed for a building with only six or seven floors. That apart the shear walls shown in Figures 3,4,5,6 will obstruct parking.

The multistorey building illustrated in the paper will require, staircase, lifts, service core for water mains, electric conduits, garbage disposal ducts etc. A RCC enclosure around these facilities will furnish sufficient stiffness to the building frame, but without sacrificing movement of vehicles in the parking area. This is shown in plan X.

I may add that storey drift for such medium height building, even without shear walls, will not be significant, nor will be alarming.

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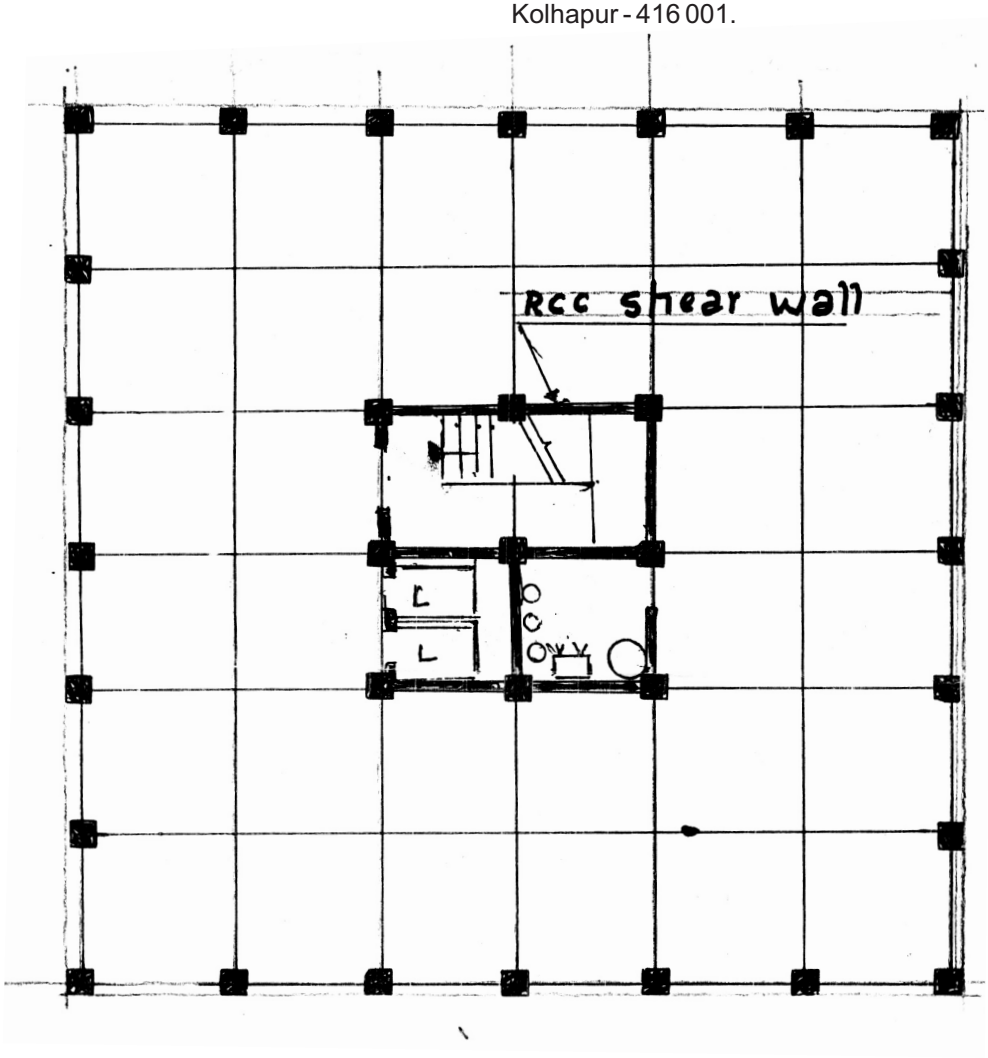

PLAN X
showing staircase, lift & services room

MUNICIPAL CORPORATION OF GREATER MUMBAI

No : CHE / GBN 341 / DP dt. 09-06-09

CIRCULAR

Subject :Structural audit of private buildings, as per the new section 353B incorporated in the MMC Act 1888

The Government of Maharashtra vide their notification dt. 7.2.2009 has communicated that Govt. has modified the M.M,C. Act, 1888, thereby incorporating a new Section 353B for making structural audit compulsory in respect of the existing building, which have completed 30 years. The Govt. has further directed that the amendment to the Act will come in force with immediate effect.

The salient features for the Section 353B of Amended M.M.C. Act, 1888 are given below. It may be seen that the Govt. has accepted our suggestions in respect of making the Structural Audit of privately owned properties compulsory with some minor changes. The salient features are as under

1) For the buildings which have completed a period of 30 years after issuing of Occupation Certificate or such buildings where more than 50% built up area is occupied physically for a period of 30 years or more, with or without obtaining Occupation Certificate, it is necessary to submit a Certificate certifying that the building is fit for human habitation from a registered Licensed Structural Engineer within one year and thereafter on completion of every 10 years.('इमारत सुस्थिती प्रमाणपत्र')
2) The Commissioner is empowered to give notice to owner or occupant of the building in writing at any time to get the structural audit of the building done from a registered Licensed Structural Engineer within 30 days from issue of such notice and to submit the certificate that the building is structurally sound for inhabitation.
3) Any remedial measures suggested by the Structural Engineer shall be carried out by the owner / occupants to the satisfaction of Structural Engineer. The Commissioner has power to issue notice to the owners / occupants, if necessary.
4) The owner / occupants who fail to start the remedial measures suggested by the Structural Engineers within 6 months from the submission of Structural Audit Report, shall be liable for the penalty as per amended Section 471 0f M.M.C. Act, 1888.
5) The Commissioner has authority to prescribe a suitable time period to the owner / occupants after giving the notice in writing to take steps for carrying out remedial measures and if the owner / occupants fails to do so, the Commissioner will carry out such remedial measures and can demand the expenditure incurred therein from the owner / occupants. If the owner / occupants fail to pay the same within 30 days, the same can be recovered in the form of pending Assessment Bill from the owner / occupants.
6) If a dispute regarding the amount of expenditure arises, the owner / occupants can appeal in the Small Causes Court within 21 days from receipt of such notice along with the receipt of requisite amount deposited with MCGM. Failing which, his appeal will not be considered.
7) If the decision is given in favour of the Appellant, the additional amount deposited, if any, will be refunded to the Appellant with the interest of 6.25% p.a. from the date of deposit of the amount.
8) The Sub Clause 85 (a) is added in Clause 471 for penalizing the defaulters, wherein the defaulters are required to pay Rs. 25,000/- or amount equal to one year's assessment tax, whichever is more as penalty.

(I) The Implementation Machinery.

a) For performing the statutory function, on behalf of Municipal Commissioner, the Executive Engineer (Ward), will be the authority, who will use the service of A.E. (B&F) of the ward or form a special Cell for this purpose, as may be decided by City Engineer. He will report to the Dy. C. E. (Zonal), yet to be appointed, and till such time that the appointments are made, to the respective Dy. CH. E. (BP)

b) Structural Auditors :-

Licenses to the Structural Engineers for preparations of structural design of proposed buildings in Municipal limit are issued by Dy. Ch. Eng. (BP) City. The License is issued in accordance to the field of experience and the maximum height of the building which the licensee can design, is stipulated. There appears to be no need to have a separate registration of the Structural Engineers for structural audit purpose. The licensed Structural Engineers will be considered competent for carrying out structural audit as per the restriction of maximum height mentioned in their license.

A large number of qualified engineers presently working as restoration consultants may not have registered themselves with MCGM, so far. In order to pool their talent and experiences in the field of restoration, a fresh advertisement will be published in local news paper in English & Marathi appealing such Structural Engineers who are engaged in restoration jobs, but registered with MCGM, to get themselves registered.

c) Panel of Structural Engineers to work under EE (Ward)

On failure of the owners to act in accordance with the statutory provisions, it will be necessary to appoint a structural auditor by MCGM. For the purpose, a panel of such willing registered structural engineers will have to be formed by inviting EOI, and this will be done by CE. The remuneration for the four stages of work, viz., (1) inspection, auditing and submission of report, (2) preparation of Estimates of Repairs,(3) Supervision on work of the contractors appointed by MCGM for repairs. And lastly, (4) Issuing Structural Stability Certificate after completion; will be fixed by C.E. based on the past experience of that Department. C.E. will also take appropriate steps to prepare schedule of rates for special items (if necessary).

d) C.E. will also take steps to appoint an agency for each Ward, who can be entrusted with the job of structural repairs as suggested by Structural Engineers; to be supervised by Structural Consultants appointed by

E.E. (Special) of the Wards. The detailed guidelines will be prepared by C.E.

(II) Compilation of Data :-

a) The list of buildings which have completed 30 years after obtaining O.C. is not readily available. Hence, the Assessment Department of respective Ward will prepare year-wise lists of such buildings accordingly to their first date of assessment, which will be presumed as date of occupation. The aforesaid lists shall be collected by respective Executive Engineer (Ward) for compilation.

b) A similar ward wise list of buildings will be prepared by H.E.'s Department, depending on the date of first water connection given to the buildings either by way of regular connection or connection on humanitarian grounds.

c) The Building Proposal Department will also prepare a ward wise list of buildings as per the date of occupation granted.

d) The Executive Engineer (Ward) of respective Ward will collect the data from above departments and prepare a consolidated list of such buildings from the data available, and thereafter maintain the same up to date iin consultation with Building Proposal Department.

(III) Notices to be issued :-

a) Format of notice to be issued to the owner / occupants at various stages are as under :-
   a. Notice asking owner / occupants to get their structures audited.
   b. Notice to be given by the owners / occupants to MCGM informing their intention to carry out structural repairs.
   c. Notice informing owners / occopants Commissioner's intention to appoint Structural Auditor at their risk and cost.
   d. Form of notice for submitting Stability Certificate after expiry of period stated by the owners / occupants in their notice.
   e. Notice stipulating a period for allowing the owner to initiate action on the report submitted by Structural Engineer.
   f. on failure in complying above, a notice informing owners / occupants about MCGM's intention to carry out work on their behalf.
   g. Form of Supervision Memo / Consent Letter issued by the Structural Engineer in the name of MCGM for the particular property.

(IV) <u>Methodology to be adopted :-</u>

a) A request letter / notice for carrying out the structural audit the building will be served to the owners / occupants of such buildings which have completed 30 years of existence as mentioned above.

b) The owner / occupier will respond to the notice, by appointing a structural engineer and by submitting the Audit Report.

c) Owner / Occupier will inform the MCGM by issuing a notice to the EE (Wd), indicating his intention to carry out the work alongwith a consent form signed by the Structural Engineer.

d) The structural Engineer will submit his Certificate, certifying that the building is fit for human habitation.

e) If the parties fail to act as enumerated at (a) to (d) above, the E.E. (Ward) will give notice to the party informing his intention to take up the work of structural audit at their risk and cost, through a registered Structural Engineer appointed by MCGM.

f) The EE (Wd) will appoint one of the empanelled structural engineers, for undertaking this specific job.

g) The owner / occupier will be informed about the measures suggested by the Structural Engineer, with directions to get these works executed themselves. The Structural Engineer's fee will also be intimated to them for remittance to MCGM.

h) If no action is taken by the owner / occupier, the Executive Engineer (Ward) will work out the repair cost and the same will be intimated to the defaulter owner / occupant by issue of a notice, informing him that the work is now being executed through Municipal Agency.

I) The EE (Wd) will assign the work to the agency selected by CE, and get the work executed. The bill payment will be made by him on receipt of Bill Certificate by the Structural Engineer.

j) Asst. Assessor & Collector of the Ward will be the authority for recovery of the actual expenditure incurred inclusive of Consultant's fees from the property owner after receipt of intimation to do so from E.E. (Ward).

k) City Engineer will make appropriate Budget provision for this purpose and till such time, the Ward wise provision for 'Demolition' or any appropriate available head shall be used by the concerned E.E. (Ward) by obtaining sanction for individual proposals.

l) If temporary shifting of occupants become necessary, Asstt. Comm. of concerned Ward / Zonal D.M.C. will be apprised of the same and Asstt. Comm. of the Ward / Asstt. Comm. (Estate) will make available some tenements for temporary rehabilitation.

m) The action in respect of non tallying or unauthorized extension to existing building and structural audit of unauthorized buildings shall not be under the purview of Executive Engineer (Ward). Asstt. Comm. of the Ward will deal with such cases as per the prevailing practice.

n) A committee under the Chairmanship of Zonal Dy. City Engineers yet to be appointed and till such time that the appointments are made, under the Chairmanship of Dy. Ch. Eng. (BP) comprising of Executive Engineer (Ward) and his staff of the respective Ward, A.E. (BP) of the Ward, and Assessor & Collector of the Ward will be formed to discuss and sort out procedural problems. The committee will suggest improvements, in the formats, procedures. C.E. will resolve the issue and issue directives for changes.

o) The Zonal D.M.C. / A.M.Cs. will take periodical review to ensure that the statutory obligations Municipal Corporation are being fulfilled.

p) In case of any difficulties / clarification, etc. the matter shall be referred to City Engineer.

q) There is discrepancy in the Marathi & English version of notification published by Govt. with reference to word 'Structural Stability Certificate' and ('बांधकाम सुस्थिती प्रमाणपत्र')the matter is being referred to Govt. in this regard. Till the clarification form Govt. is received, the Marathi version shall be referred as the original bills in Marathi.

LETTER FROM ISSE TO MCGM ON BUILDING SAFETY

(Members are requested to send their views and supporting letters on this subject to ISSE. This will strengthen our case for follow up with the authorities for implementing good practices.)

To,
Shri Shinde
Jt. Municipal Commissioner
Disaster Management Cell,
Municipal Corporation of Greater Mumbai.
Head office, Mumbai -01

Subject : **Views on making the buildings safer in the city of Mumbai.**

Sir,

As discussed in our meetings of Disaster Management Cell, we are enclosing the collective views of Indian Society of Structural Engineers on the above mentioned subject.

1. **Open space around the building -** For fire engine movement around the building and for any emergency rescue operation, the requirement of 6m open space around the building can not be compromised under any circumstances. For SRA buildings, this condition is not followed reducing the open space to 1.5m in many cases which will be disastrous. The seriousness of the issue of open spaces around the buildings was voiced by Chairman High Rise Committee Prof. Taraun Kant of IIT Mumbai during a lecture at Institution of Engineers Mumbai on 30 Oct 2009. No compromise in open spaces at the cost of safety. If buildings are closely spaced, collapse of one building will damage adjacent buildings too. This is not desirable for safet.

2. **Allowing column in the cantilever projections and simplifying FSI calculations -** For better structural framing arrangement, columns can be allowed at the end of thebalcony or projections provided it does not affect the openspace around the building. This will improve the lateral load resistance of the building by proper framing.
   In the present situation, columns are not allowed in the balcony projections there by making the RCC frame work weaker to resist the horizontal forces. If necessary, the bye-laws can be suitably modified to for this very important structural requirement. Cantilever projections under any name to be limited to 1.0 Mt)

3. **Stop misuse of Free FSI :** FSI can be made 1.5 instead of 1.0 to account for the additional free areas like balconies, flower beds, elevations features, lift, lobby etc. Building FSI should be simply calculated based on constructed area using outermost boundary of building. This will stop misuse of free of FSI area.

4. **Loose mass for elevation treatment :** For elevation treatment, lot of loose mass in the form of boxing, double walls in half brick are provided along the building outer face. There is no control over these elevation features like long projections, loose thin brick walls on the outer face of the buildings. In the event of seismic shaking, this loose mass will create havoc. The falling debris will be very dangerous and will result in more casualties.
   Suggestion: Elevation features should be properly tied with the main RCC frame. These features can be allowed in RCC facia and not in the form of lose brick work.

5. **Glass clad buildings and dry stone cladding -** In our hot and humid environment, building with full glass cladding (copied from Western countries) is not desirable. if the building is having full glass cladding, it will add more load on air-conditioning system. In the event of fire, it becomes a glass walled gas chamber leading to more deaths due to suffocation. In the event of seismic shaking, the dry stone cladding or glass cladding may fall down resulting in more injuries. Safety aspects to be considered for allowing these types of claddings. In commercial buildings cladding should not be a replacement of masonry wall and masonry wall should be compulsory before the cladding work.

6. **Increased FSI and Tolerating irregularities by charging premium -** In the present system of Municipal approvals, lot of concessions are given for utilising full FSI on the plot. With limited land available in Mumbai and political pressure, FSI keeps on increasing over the years. Additional FSI is purchased from the market in the form of TDR (Transfer of development rights). Premium is paid to obtain extra area (not counted in FSI) like passages, stairs, lifts, lobby, flower beds, balcony etc. Concessions are requested from Municipal commissioner for inadequate open space, height beyond permissible limit, deficiency in parking spaces, inadequate light and ventilation, concessions for additions and alterations in plans, regularising the lofts and additional constructed area etc. Most of the irregularities can be regularised by paying premium to the MCGM.
   If this continues unchecked, we will be heading towards more unsafe buildings which will pose severe threat to our citizens. Irregularities can not be tolerated by charging premium to the developer at the cost of safety.

7. **Fire safety requirements –** Fire safety standards like adequate open space around building for rescue operation and fire engine movement should not be compromised. Refuge floors to be kept open and accessible all the time. These spaces can not be sold by builders and can not be covered for any purpose. Distance between two buildings should be sufficient so that the adjacent building is not affected by the fire in the next building. Two independent stair cases spaced apart should be provided in the high rise buildings as per fire safety norms which is bypassed. Refuge Area should be planned in such a manner that it can be used in case of fire.

8. **Inspection and Certification by a Structural Engineer -** Structural engineer can not be made scapegoat for the building failure during construction or repair. Original structural designer of the building can be responsible only for the correctness of his designs. In the present scenario, he expected to certify the quality of construction and structural stability as a whole which is beyond his control. Correct responsibilities should be fixed for all the agencies involved in the development.

   Services of Structural engineers can be sought for rapid assessment of the old buildings and identifying the weak buildings. Any registered structural engineer can study the details, visit the site and provide an inspection report for the building. Most of the times, the structural and architectural details are not available. He can suggest the measures for repairs if necessary. One should not expect stability certificate for the old buildings. These shortcomings should be corrected in the newly drafted "Structural Audit" policy by the MCGM. Third party quality and safety audit will improve construction quality of our buildings. Services of the site supervisors empanelled on the list of MCGM can be availed for this work and his appointment should not be just name sake as is the practice today.

9. **Other considerations for which method of Implementation can be thought off.**
   a. Design compliance with the latest Concrete and Seismic codes of practice.
   b. Implementation of quality checks for structural designs and most importantly strict quality checks at site by third party.
   c. Monitoring the health of the building.
   d. Avoiding overloading, abuse and misuse by the occupants. Timely repairs and strengthening will enhance the life of the structure.
   e. Special and complex structures to be reviewed by expert panel.
   f. Avoiding floating columns in normal circumstances.

We have put forth our observations and suggestions for your considerations. We hope, by implementing the suggested measures, we can expect better and safe buildings. ISSE is willing to provide help to MCGM whenever asked for.

With warm regards.

Yours truly,

ISSE Advisory Trustees