AFFORDABLE HOUSING

WITH

STEEL CONCRETE COMPOSITE

CONSTRUCTION

by

Dr. V.V.V.S.Murty

DEFINITATION OF AFFORDABILITY

MINISTRY OF HOUSING AND URBAN POVERTY ALLEVIATION-TASK FORCE REPORT 2009

	EWS/LIG	MIG
Size	300-600 sq. ft. carpet area	Not exceeding 1200 sq. ft. carpet area
Cost	Not exceeding 4 times household gross income	Not exceeding 5 times household gross annual income
EMI/Rent	Not exceeding 30% of gross monthly income	Not exceeding 40% of gross monthly income

The Task Force visualizes the size of household as five members.

Technology for Cost Effectiveness

MINISTRY OF HOUSING AND URBAN POVERTY ALLEVIATION-TASK FORCE REPORT 2009

- A low-rise high-density built form is recommended as an
- appropriate measure for upgrading, redevelopment or
- construction of housing projects for the lower income groups.

PREVENTING LOSS OF HOUSING STOCK AND ACCESS TO HOUSING DUE TO NATURAL DISASTERS (HUDCO-11th PLAN CHAPTER)

About 59% of the land area of the country is vulnerable to disasters on account of earthquakes,

8.4% of area is vulnerable to cyclonic wind and storm surges and

4.9% of are is vulnerable to flood damage.

The country loses roughly 1% (12 lakh houses) of the national housing stock on account of these calamities

CREDAI

Confederation of Real Estate Developers' Association of India
(formed by 3500 member companies)

As of December end 2007, the PAN-INDIA average rate (per sq.ft) for a residential apartment is around Rs 2,700/- of Which Rs. 700/- per sq.ft (little over 25%) can be directly attributed to various Local, State and Central Duties and Levies and Direct & Indirect taxes. We may consider 30% escalation over the above figures for present scenario.

Special Residential Zone (SRZ)

"A Special Residential Zone (SRZ) is a notified geographical region that is free of domestic taxes, levies and duties (both for the creation of, operation and maintenance of the SRZ) with special development rules to promote large scale, green-field, affordable housing projects for the country's masses. The SRZ would have a prescribed minimum number of dwelling units with a maximum prescribed size, and each SRZ would require adequate social infrastructure including schools, medical facilities etc."

THE BENEFITS OF SRZ ADVOCATED BY CREDAI

(a) Decreased Housing Cost

(b) Uniform Infrastructure & Housing Plan

(c) Employment & Per Capita Income

(d) Economic Growth of the region

(e) Controlling Slum Population

(f) Planned Urban Development

(g) Lesser Time for Development

(h) Positive impact on rate of Interest on funds

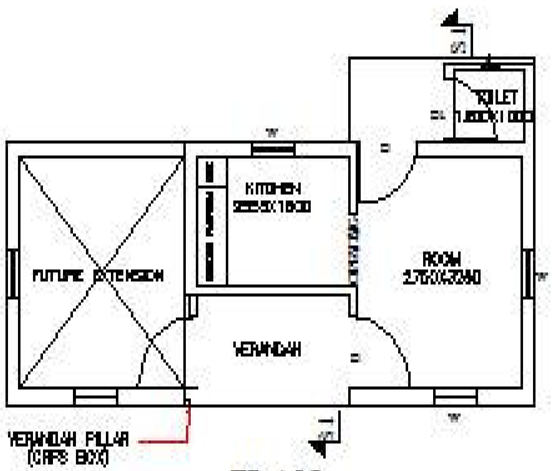
(i) Revenue for Government

Public-Private Partnership in Housing Sector

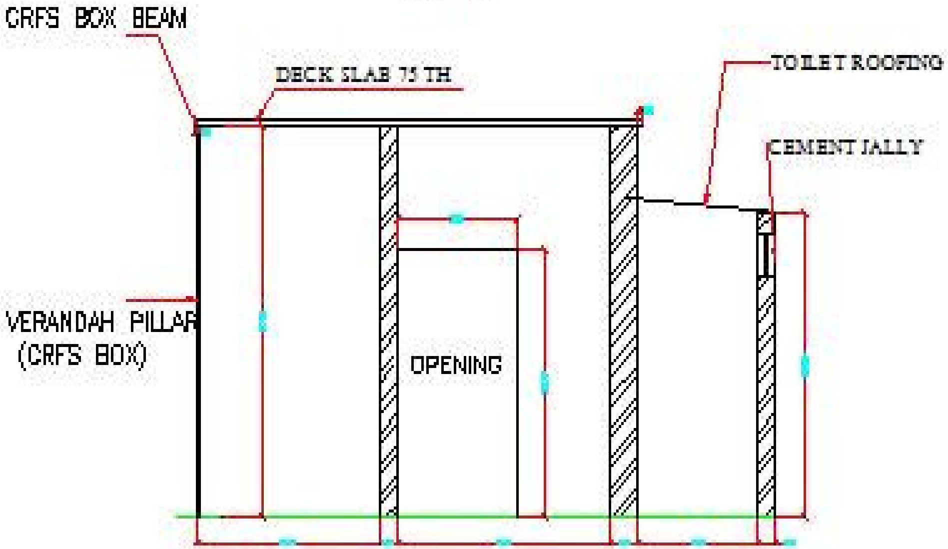
As Public Sector efforts are found to be insufficient in fulfilling the housing demand the National Urban Housing and Habitat Policy, 2007 focuses on multiple stake-holders namely, the Private Sector, the Cooperative Sector, the Industrial Sector for labour housing and the Services/Institutional Sector for employee housing for realizing the goal of Affordable Housing for All.

Ministry should ensure that at least 25% of houses are reserved for EWS and LIG segments by the private developers

EWS HOUSING PROJECT



PLAN



SECTION S1 - S1

SCHEDULE OF OPENINGS

DOORS:– D-1015 X 1879
D1-862 X 1879

WINDOWS:– W-690 X 842

VENTILATORS:– V – 762 X 305

OPENING:– 1015 X 1879

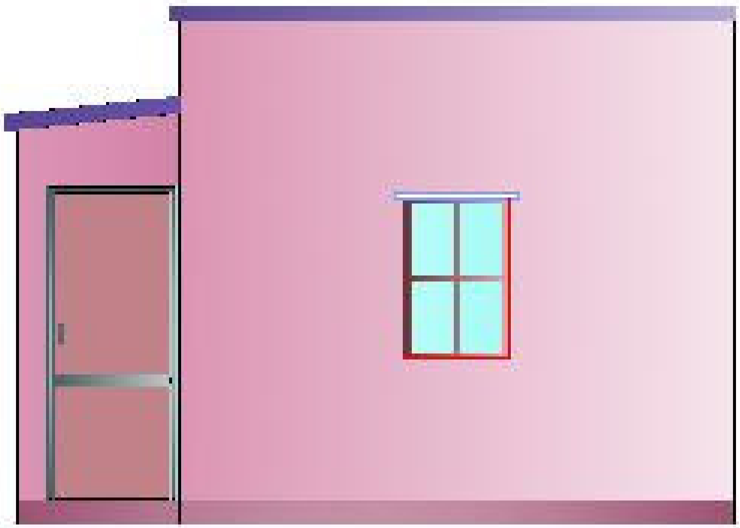
PLINTH AREA:

PRESENT SCOPE : 24 SqM (257 SQ.ft)

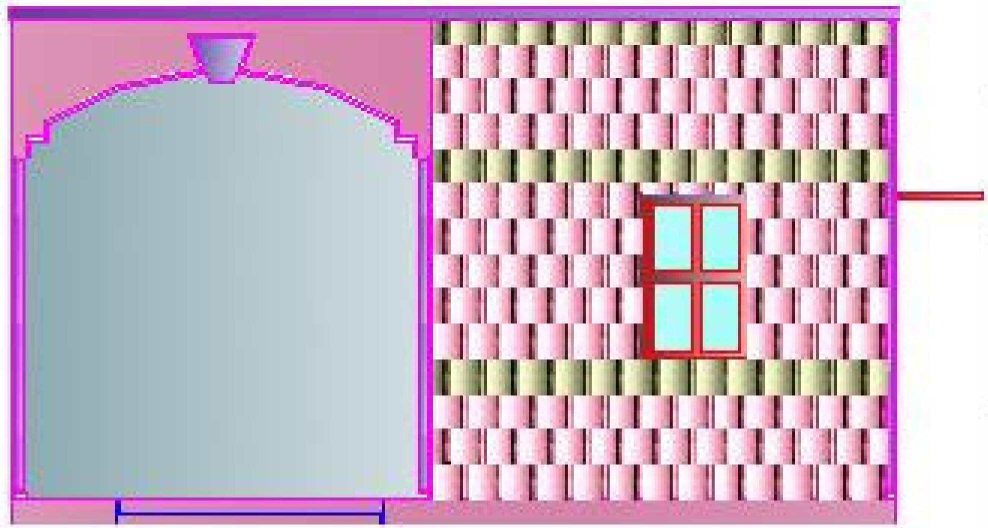
SCOPE INC. FUTURE: 32 SqM (345 Sq.ft)

NOTES:

1. ALL DIMENIONS ARE IN mm U.N.O
2. DONOT SCALE THE DRG., IF IN DOUBT PLASE ASK.
3. MATERAL FOR CRF STEEL SECTIONS CONFORMS TO IS : 10748 GRADE – II OR EQUIVALENT.



SIDE ELEVATION



FRONT ELEVATION

EWS CATEGORY BUILDINGS FOR GOVT. OF A.P.
(USING COMPSITE DECK ROOFING & COLD FORMED STEEL LINTELS, DOORS & WINDOW FRAMES)

TEMPARATURE & SHRINKAGE REINFORCEMENT
(WELDMESH TACK WELDED TO DECK SHEET)

INSITU CONCRETING OF ROOF

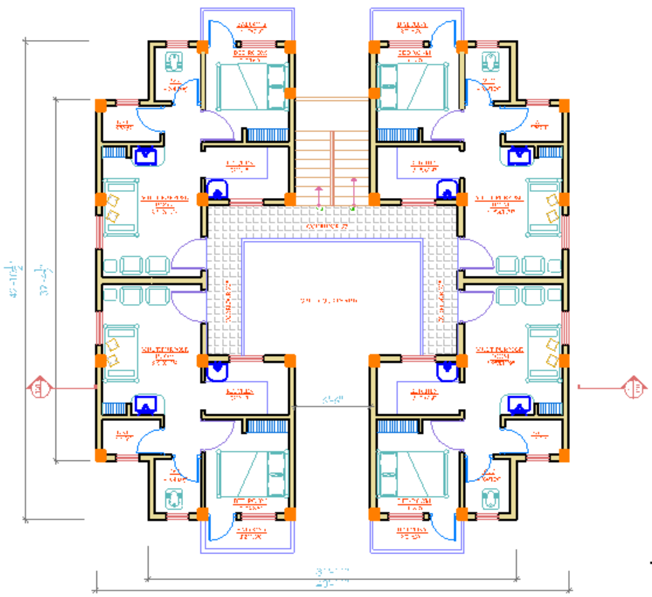
URBAN AFFORDABLE HOUSING

G+3 URBAN HOUSING

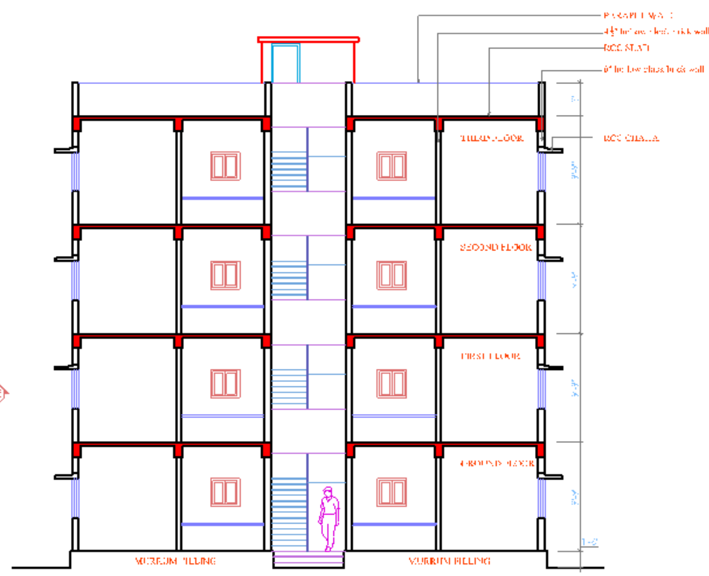
GREATER HYDERABAD MUNICIPAL CORPORATION

PROPOSED TYPE DESIGN FOR JNNURM HOUSING SCHEME

FRONT ELEVATION



TYPICAL FLOOR PLAN (G+3)



SECTION AT - 101

AREAS STATEMENT :

PLINTH AREA : 29.43 SqMts per UNIT
CARPET AREA : 25.04 SqMts per UNIT
COMMON AREA : 4.65 SqMts per UNIT
BUILT UP AREA : 136.28 SqMts per BLOCK

SHORT SPECIFICATIONS

SPECIFICATIONS

FOUNDATIONS	: RCC IN 1:1 ½:3
BASEMENT	: CRS MASONRY
SUPERSTRUCTURE	: HOLLOW BRICK MASONRY
BEAMS, SLAB,	: R.C.C. IN 1:1 ½:3
FLOORING	
GROUND FLOOR	: ROUGH SHABAD STONE
UPPER FLOORS	: C.C. FLOORING
PLASTERING	: IN CEMENT MORTAR (1:5)
ELECTRIFICATION	: AS Per STANDARDS
SANITARY	: AS Per STANDARDS
DOORS	
FRAMES	: RCC
SHUTTERS	: FLUSH SHUTTERS
WINDOWS	
FRAMES	: RCC
SHUTTERS	: FLUSH SHUTTERS

PROPOSED | EXISTING

SCALE : 0'-1" = 5'-0"

ENGINEER-IN-CHIEF
G.H.M.C.

EXECUTIVE ENGINEER (H) JNNURM	S.E. (PROJECTS) G.H.M.C.
A.E. (H) JNNURM	Dy. Ex. ENGINEER (H) JNNURM

INSDAG AND SCI REPORT ON TIME SAVING WITH COMPOSITE CONSTRUCTION

	10 storey		7storey		3storey	
	structure	over all	structure	ove rall	structure	overall
Steel concrete composite construction	25 weeks	82 weeks	15 weeks	64 weeks	6 weeks	33 weeks
Rein forced concrete construction	48 weeks	116 weeks	31 weeks	85 weeks	15 weeks	44 weeks
Time saving in option-I over option-II	23 weeks	34 weeks	16 weeks	21 weeks	9 weeks	11 weeks

COMPARISION OF COSTS AND STEEL CONSUMPTION COMPOSITE Vs RCC CONSTRUCTION (CBRI & SAIL)

Building	Cost of Composite compared to RCC	Steel Consumption in Composite compared to RCC
Auditorium (large single-span)	Marginally Cheaper	27% Higher
Residential (4-storeyed)	Same	11.6% Higher
Commercial (7-Storeyed)	6% Cheaper	8.7% HIgher
Slim Floor (7-storeyed Building)	Marginally Cheaper	121.3% Higher

COST BREAK UP OF BUILDING COMPONENTS IN COMPOSITE CONSTRUCTION (ARUP ASSOCIATES UK)

Cost Component	*Cost of Construction (as % of total cost)*	*Annual Rental (as % of total cost)*
Frame (Steel or Concrete)	5-7	25-30
Concrete Works including foundations	5-6	
Building envelope (Cladding)	25-30	
Services	25-30	
Finishing	26-36	

METAL DECKING

Composite Floor Deck is a steel deck with a ribbed profile, which binds with concrete slab and together forms a part of the floor structure. This interlocking between the concrete and the floor deck is brought about through a system of embossment and ribs which are built into the deck, creating a reinforced concrete slab that serves the dual purpose of permanent form and positive reinforcement. Composite decking is one of the most effective method of constructing floors in steel building and very useful in high rise RCC / Steel Buildings.

TECHNICAL SPECIFICATIONS

PENNAR SUPER DECK SERIES is available in 44mm, 52mm and 75mm depth profiles with thickness range of 0.80mm to 2mm.

Length	:	upto 12000mm
Material	:	CR Steel as per IS:513 D-Quality / HR Steel as per IS:1079 / Galvanized Steel (as per IS:277)
Type	:	Bare, Primer coated, Galvanized, Pre-Painted

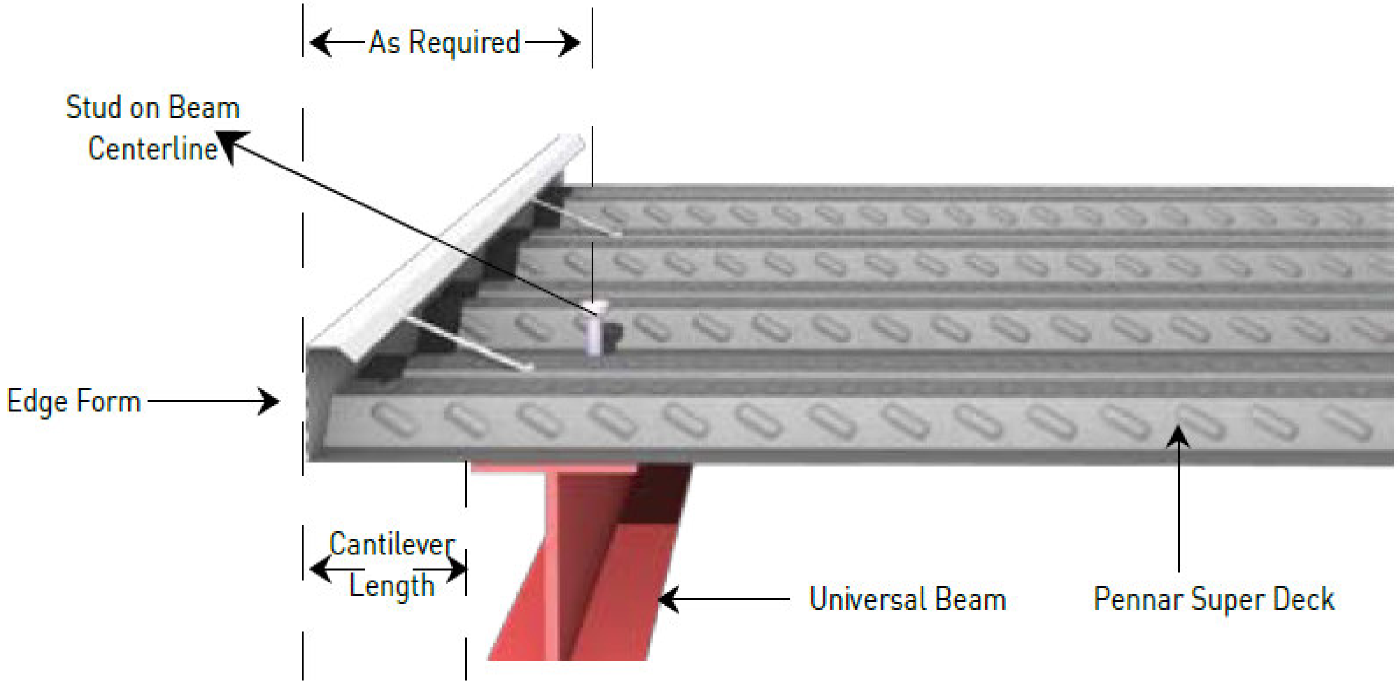
We supply suitable size of decking with optional feature of dimpling, shear connectors and ribs, as per customer's specifications / drawings, for easy erection and also to avoid any wastage / rework at site.

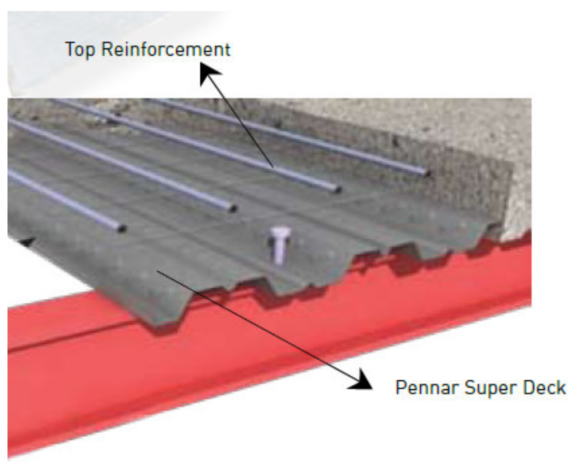
Benefits of Metal Deck sheets

- Versatility (Can also be used as roofing and cladding
- Reduces slab thickness (Concrete)
- High Strength to Weight Ratio
- Aesthetical
- All weather conditions
- Required Fire Resistance ratings
- Uniform Quality
- Durability
- Economy and value
- Acts as Composite member & Permanent shuttering
- No major reinforcement required
- Can be used as working platform during construction
- Speedy construction

METAL DECK SHEET FOR COMPOSITE SLAB

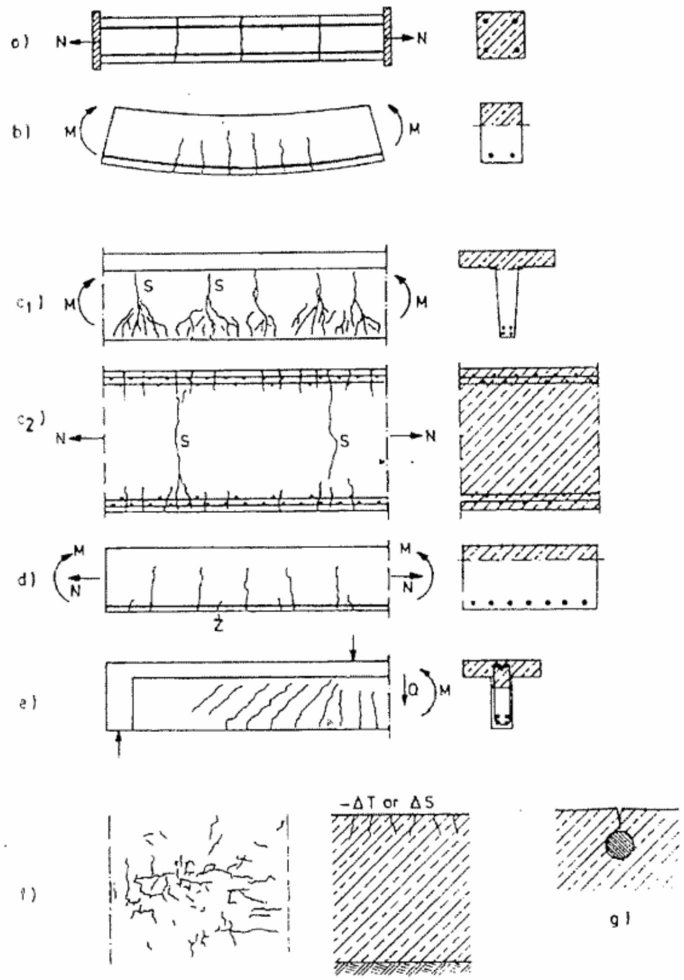
Fixing of Deck Sheet





METAL DECK ON RCC/STEEL BEAMS

Types of Cracks
for RC Beams without Steel Soffits



a. Separating cracks

b. Bending cracks

c. Forking cracks (S)

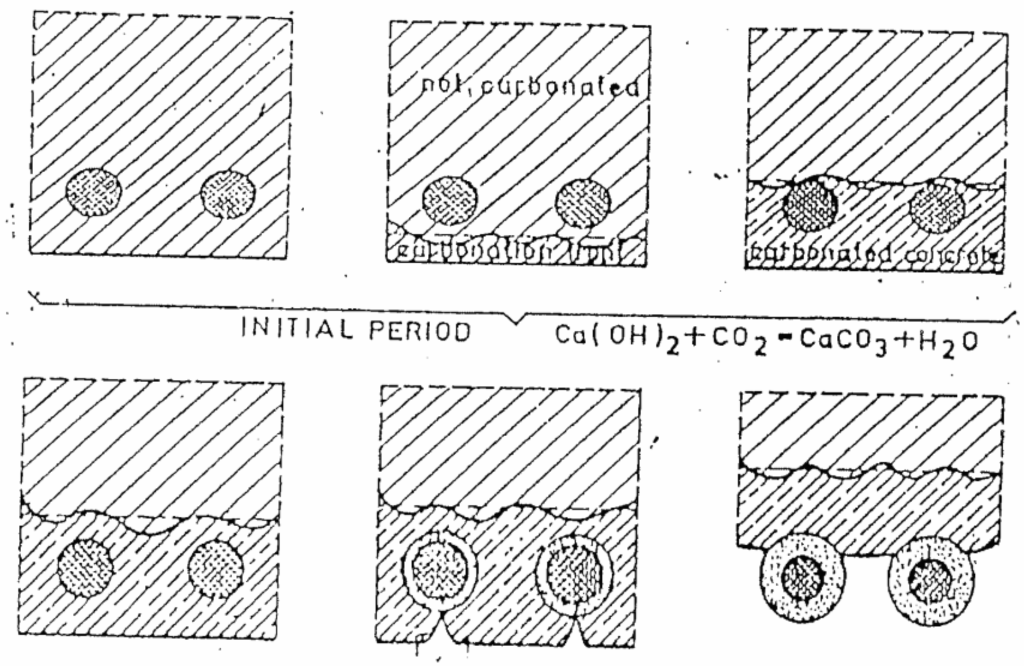
d. Secondary or bond cracks (Z)

e. Shear cracks

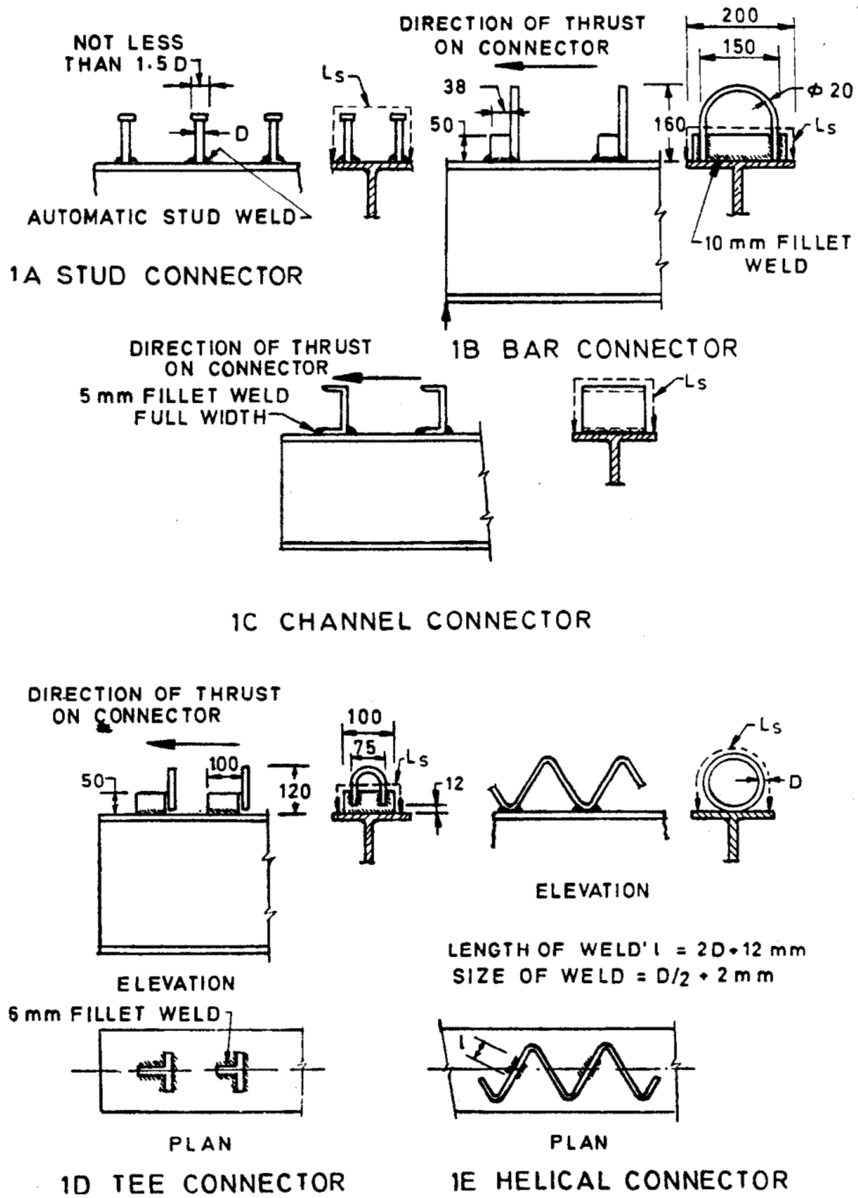
f. Surface cracks

g. Longitudinal cracks along reinforcing bars

Carbonation Induced Corrosion in R.C.C. Beams without Steel Soffits



Corrosion Progress & Deterioration of Re-bars

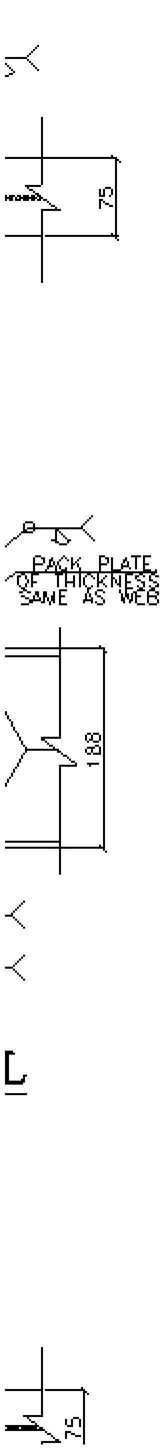


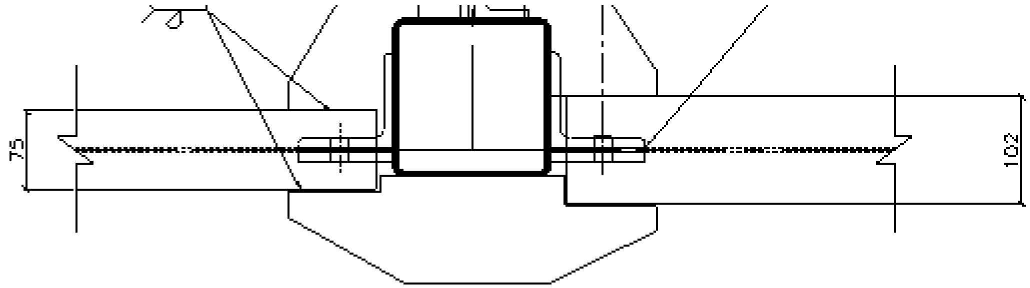
All dimensions in millimetres.

FIG. 1 TYPICAL SHEAR CONNECTORS

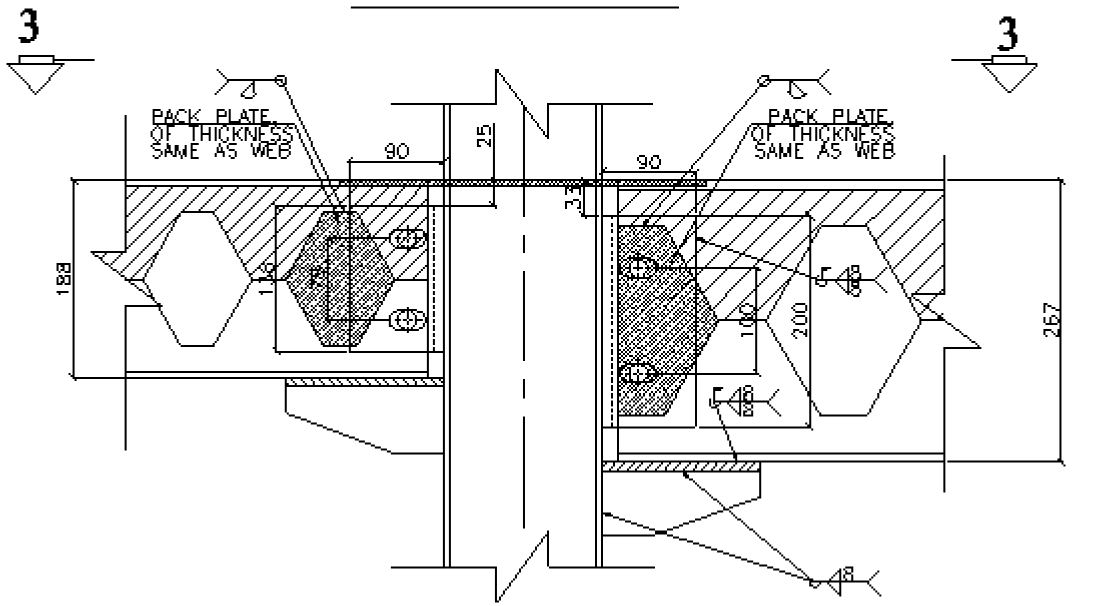
CONCRETE FILLED STEEL TUBES FOR COLUMNS

4-STOREYED BUILDING IN INDORE

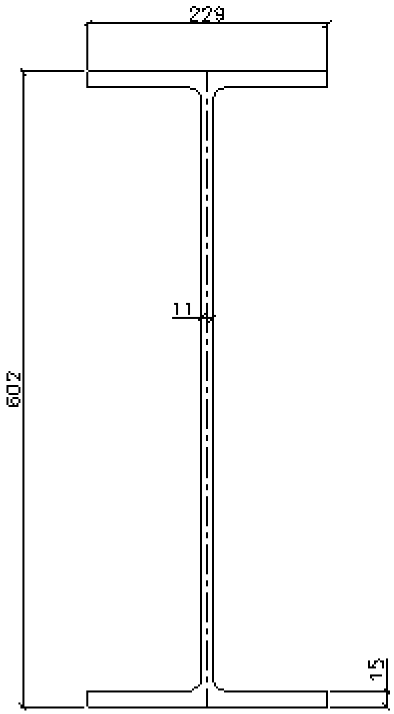




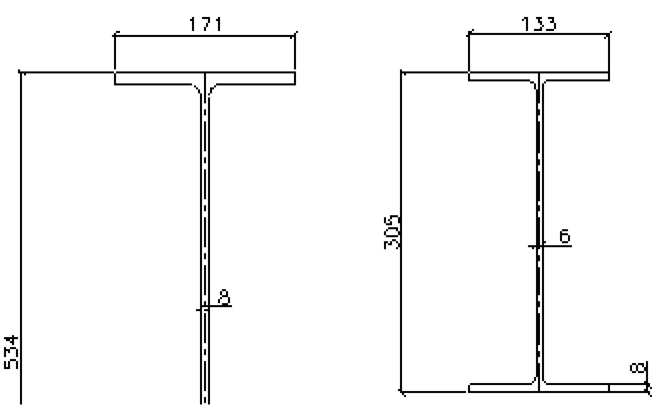
PLAN VIEW 3-3

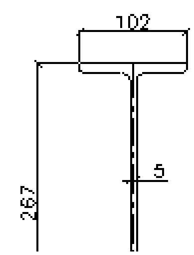


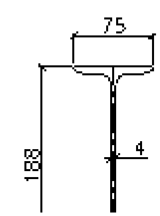
TYPICAL BEAM-COLUMN CONNECTION DETAIL

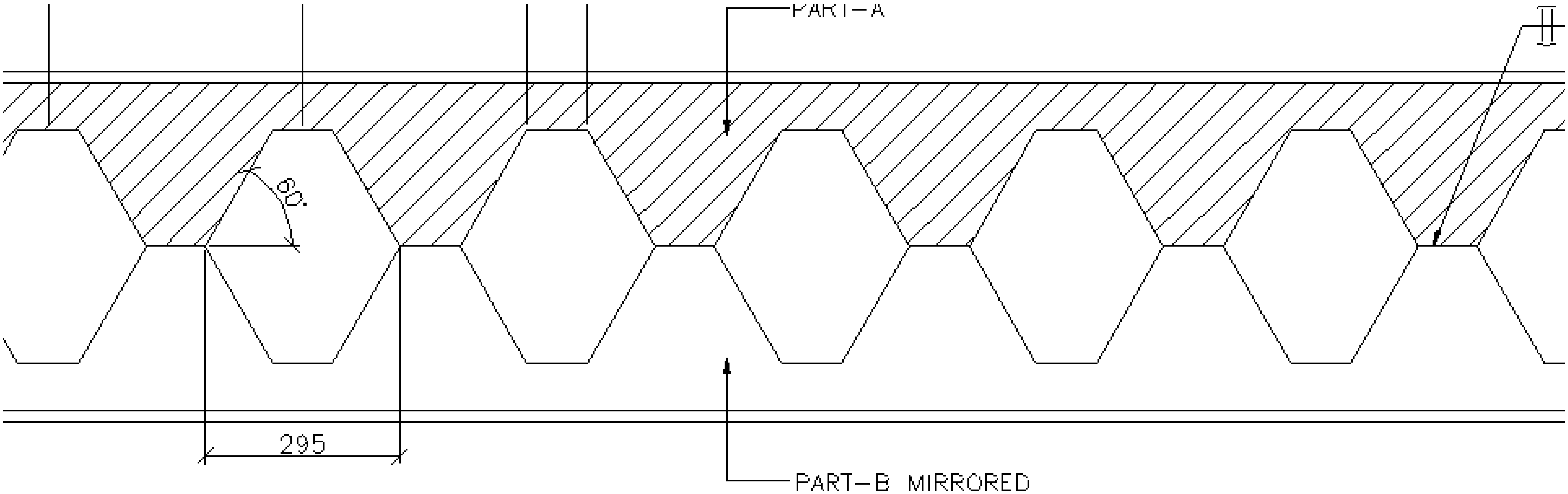


UB 602x229

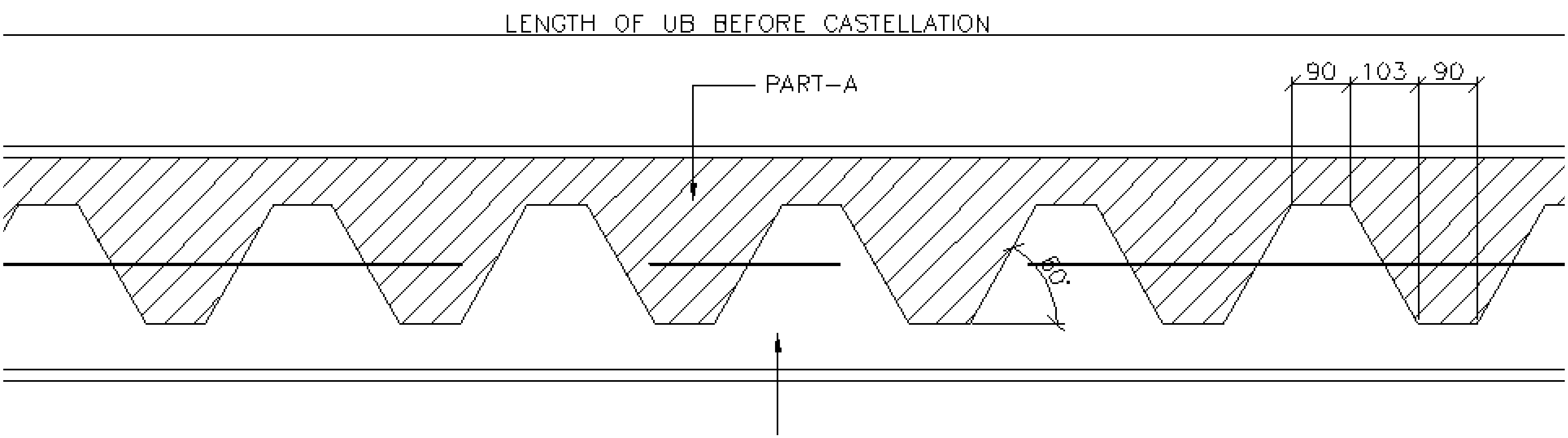


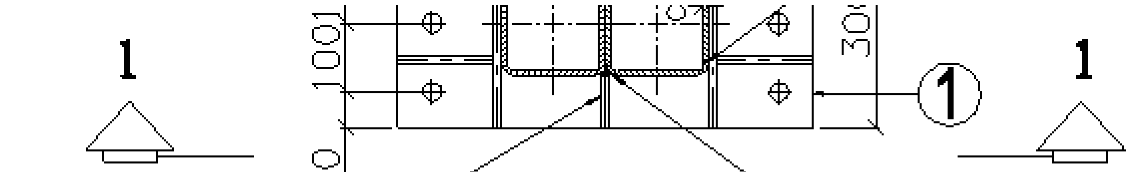




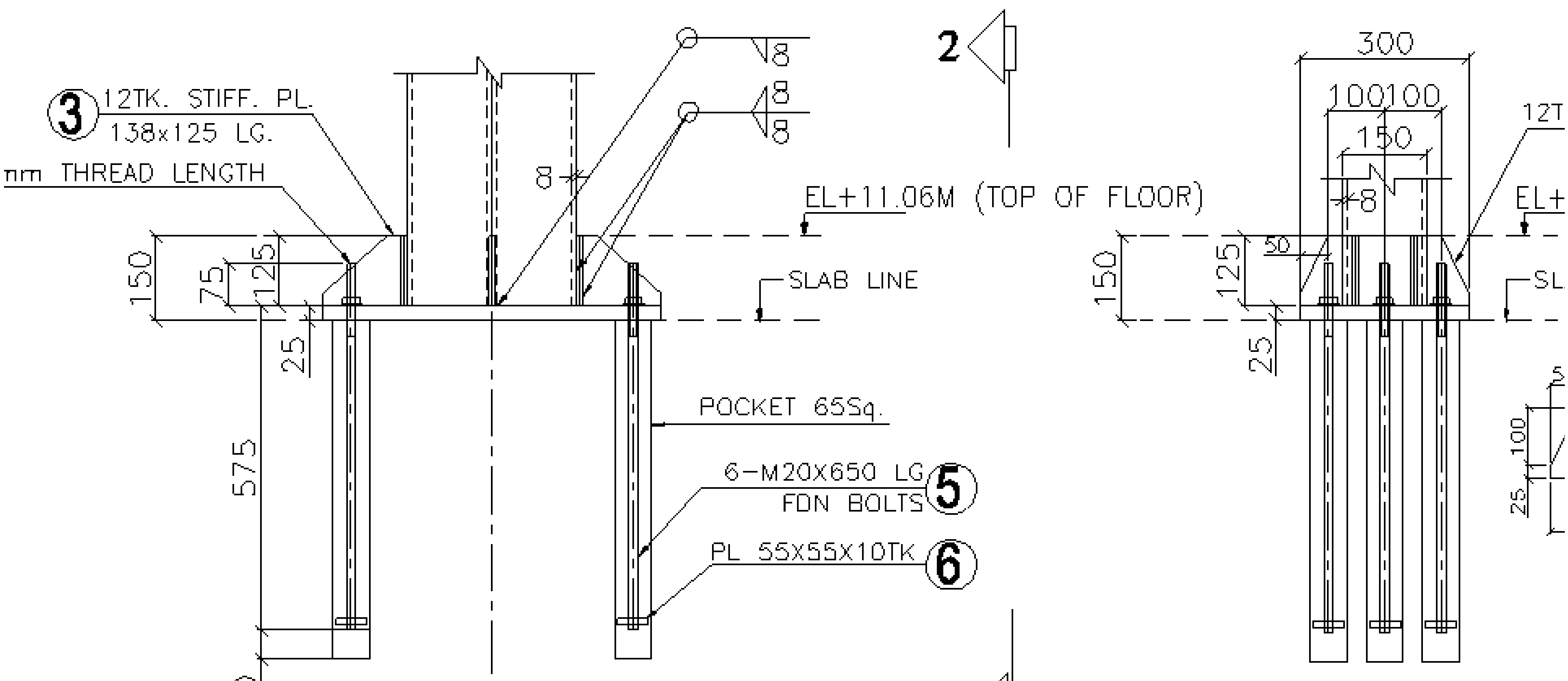


TYP. DET. OF CASTELLATION FOR UBC 356x534x171x57KG/M
TYPE-1

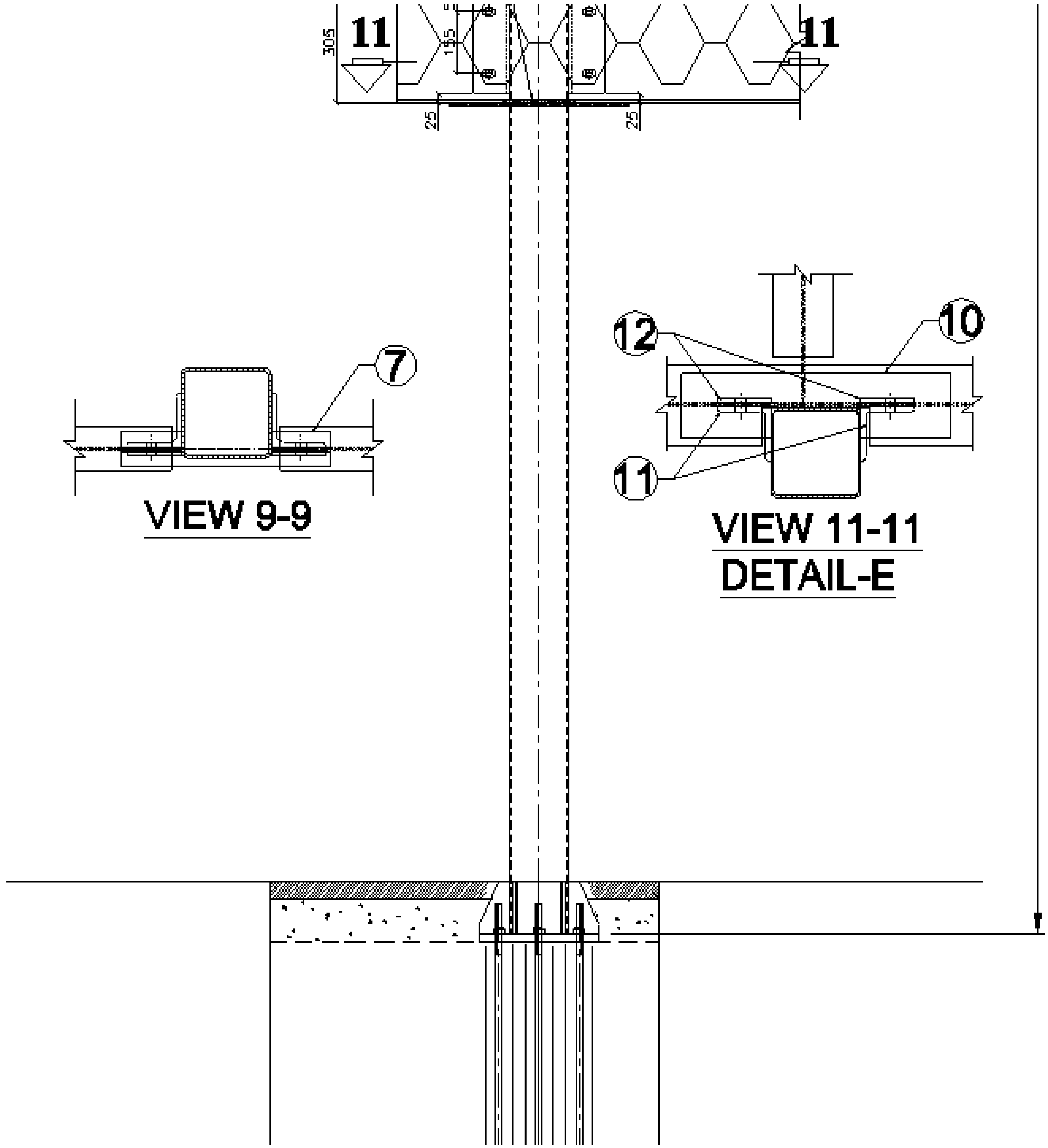




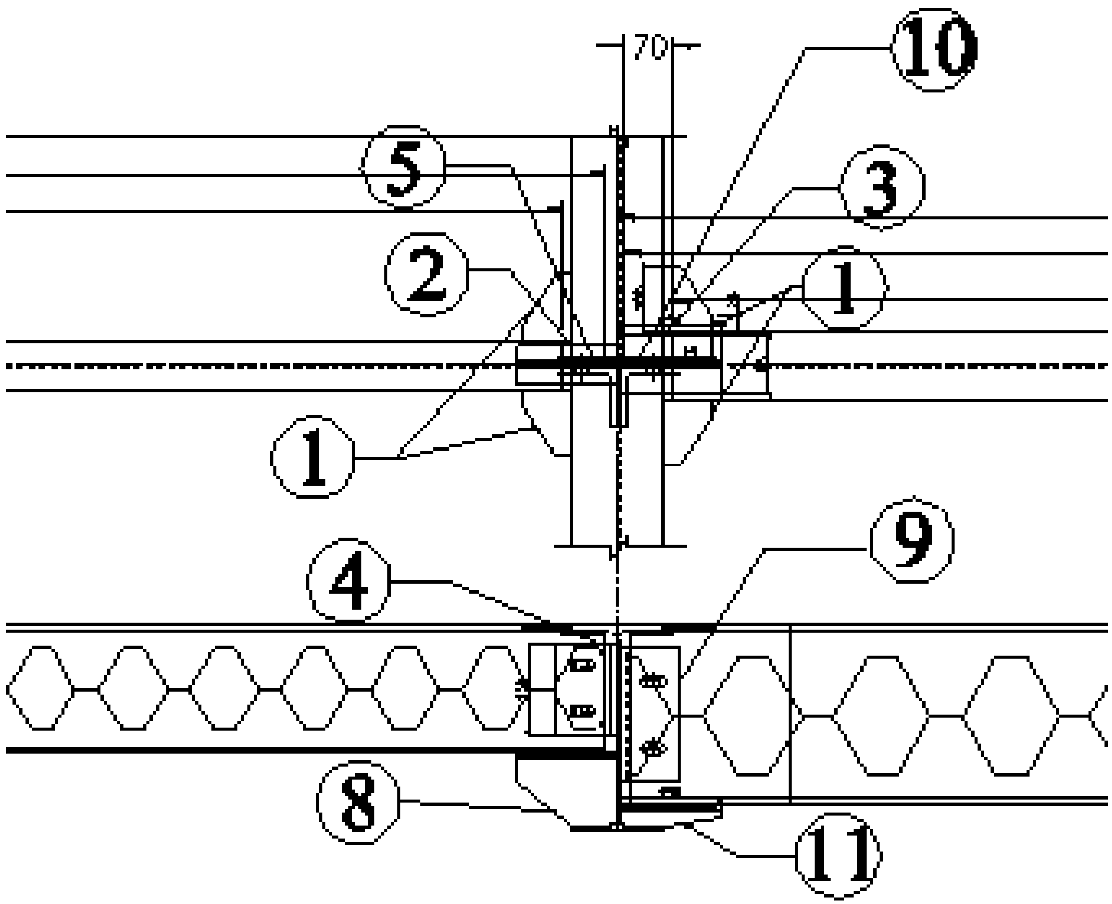
PLAN
TYPE-1



VIEW 2-2



305
11
155
11
25
25
7
VIEW 9-9
12
10
11
VIEW 11-11
DETAIL-E


70
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3
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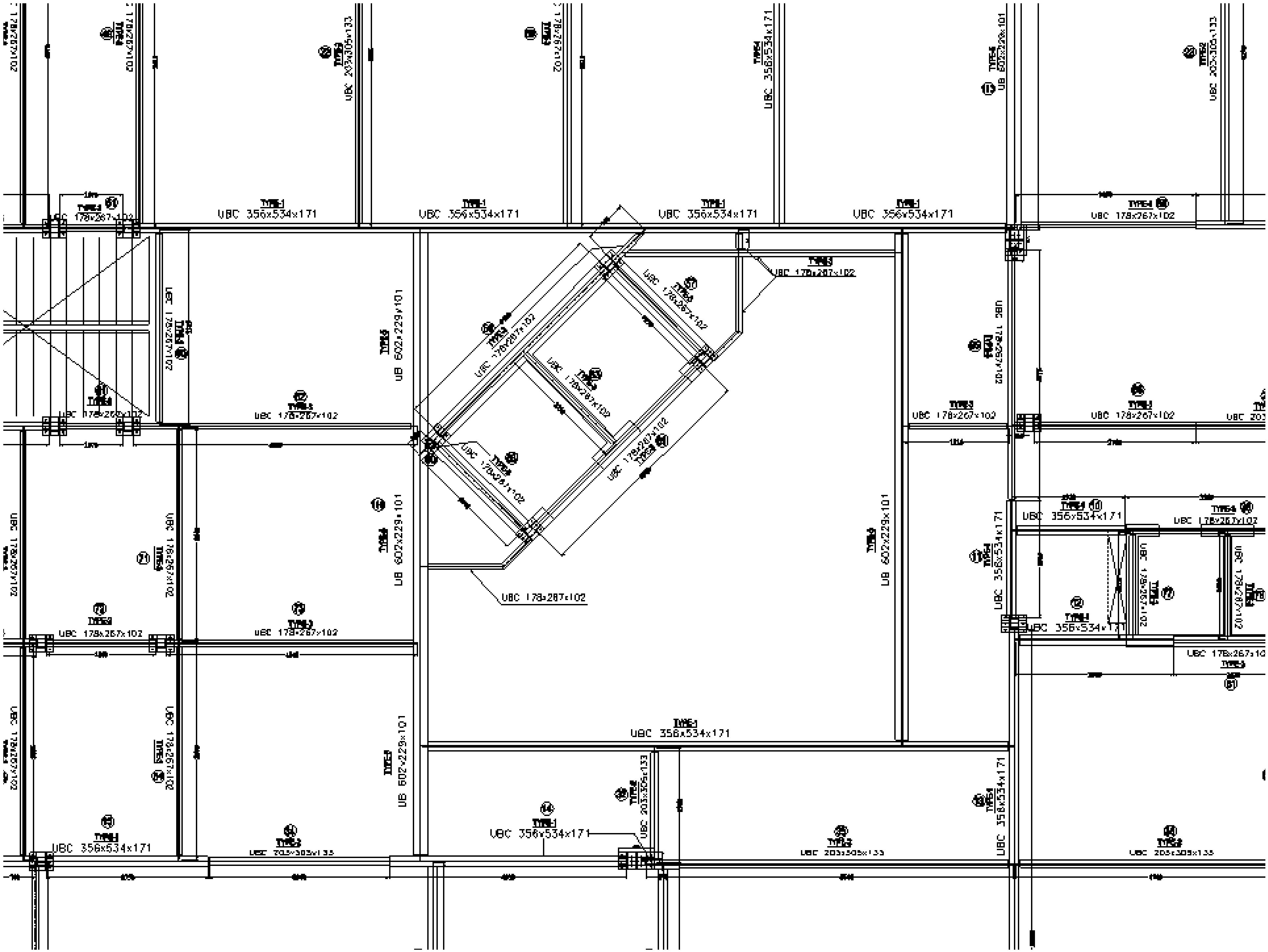
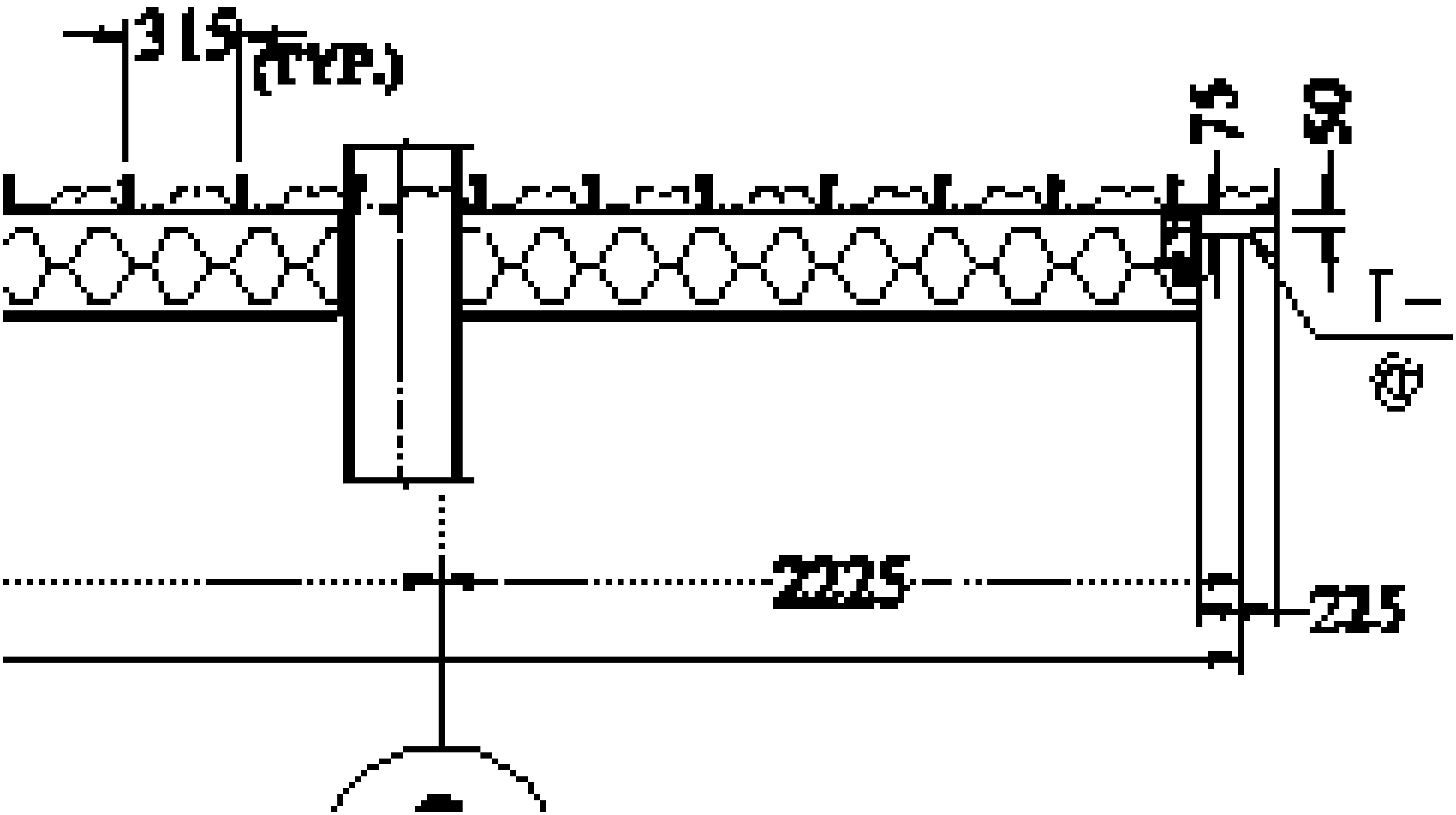
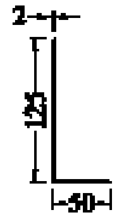
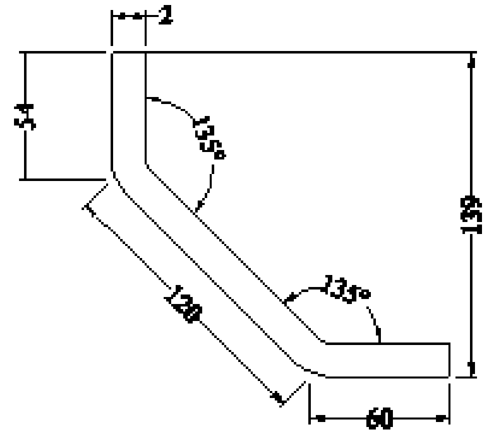

UBC 356x534x171
UBC 178x267x102
UB 602x229x101
UBC 203x305x133
UBC 356x534x171
UBC 178x267x102
UB 602x229x101
UBC 356x534x171
UB 602x229x101
UBC 178x267x102
UBC 178x267x102
UBC 356x534x171



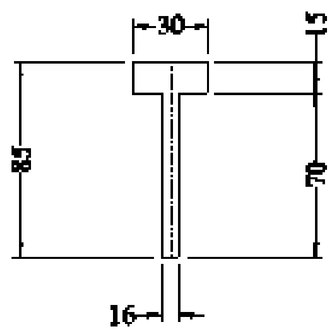
315
(TYP.)
75
95
2225
225



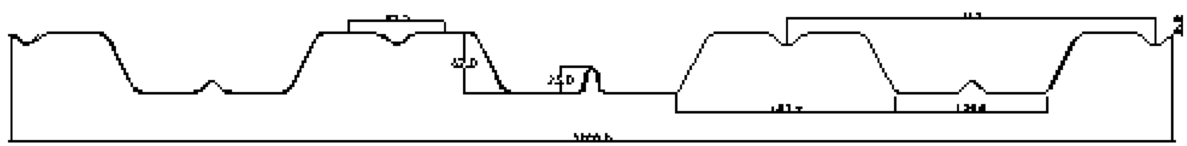
ET (EDGE TRIM)



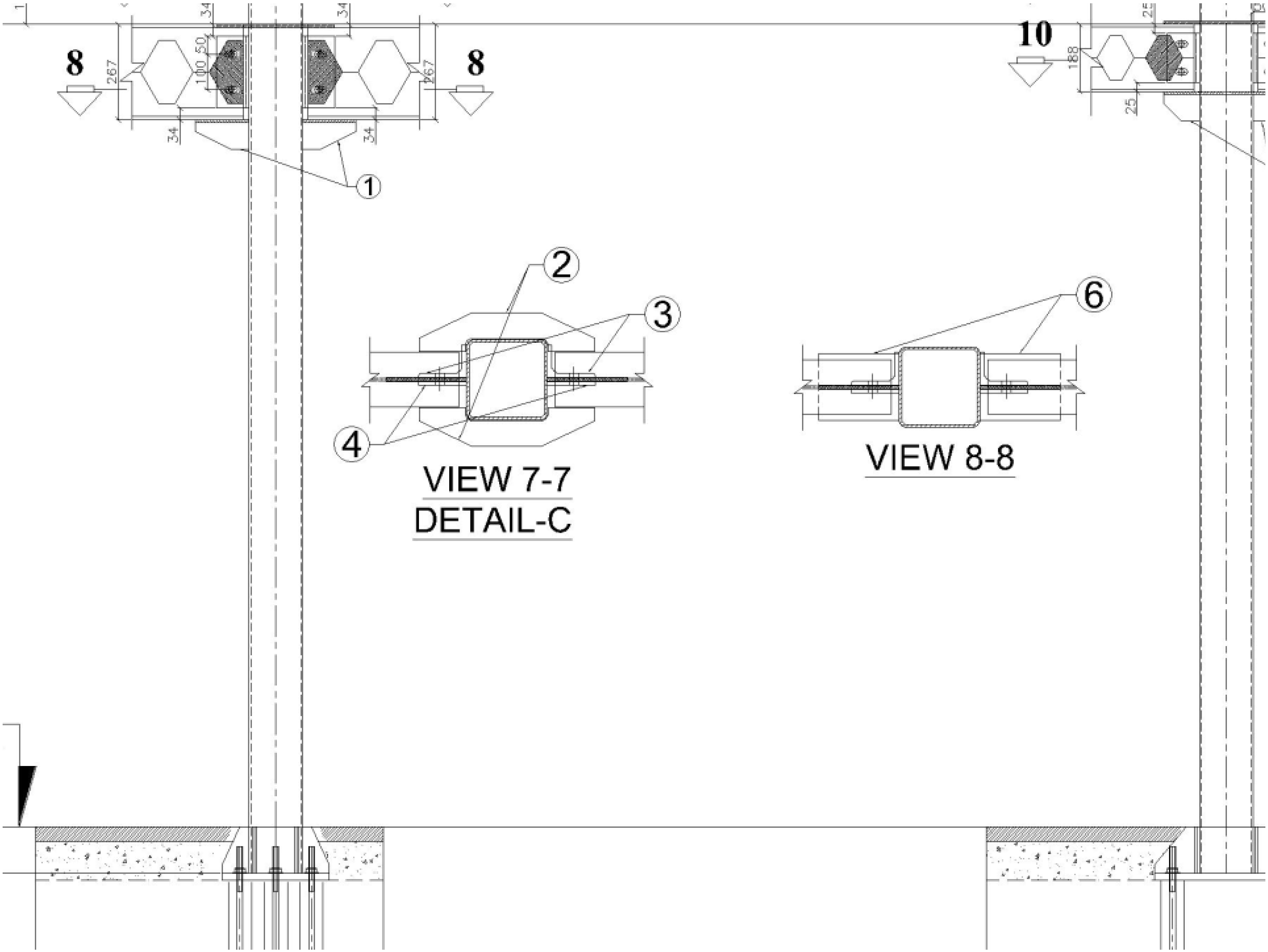
HS (HOLDING STRAP)



STUD SHEAR CONNECTOR



TYP. METAL DECK SHEET PROFILE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188
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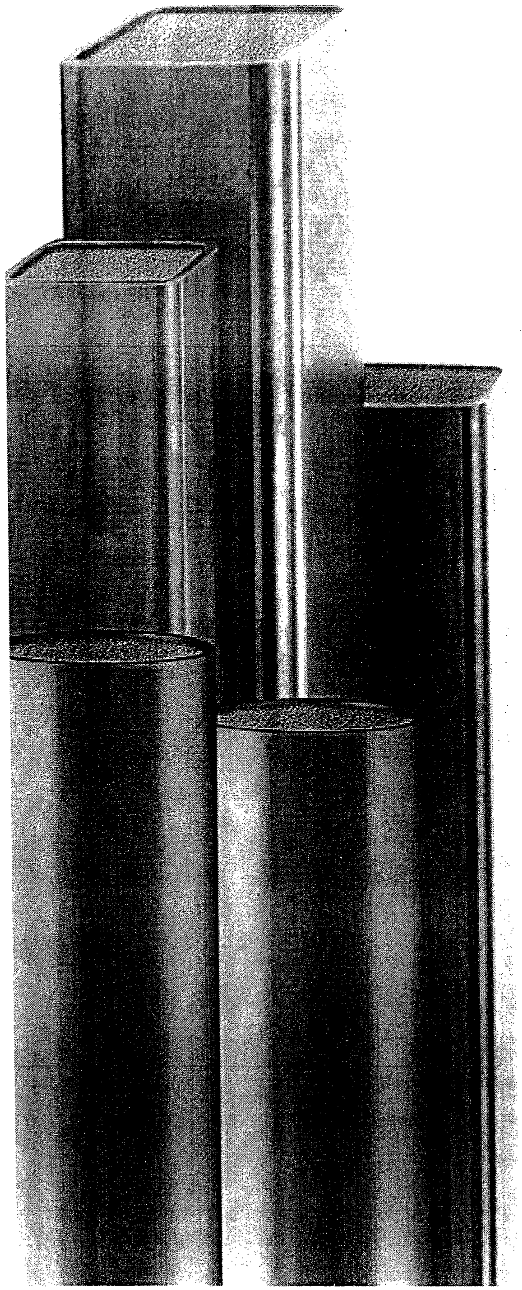
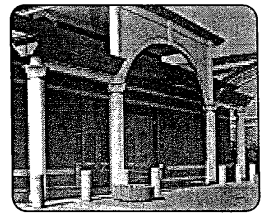
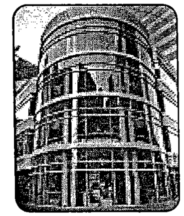
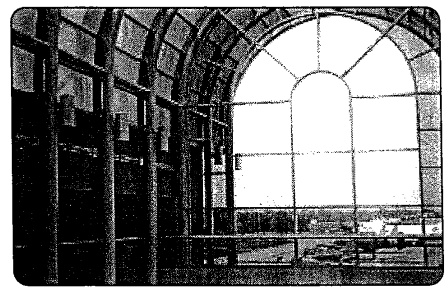
VIEW 7-7
DETAIL-C
VIEW 8-8



"Designs for the 21st Century"







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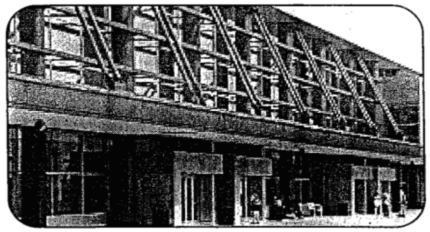
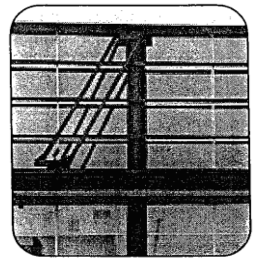
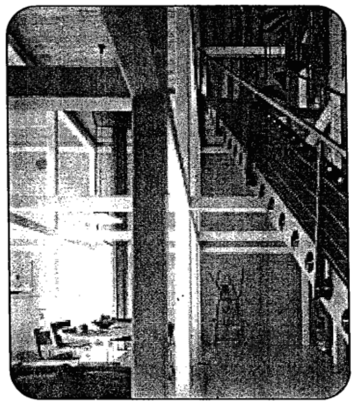
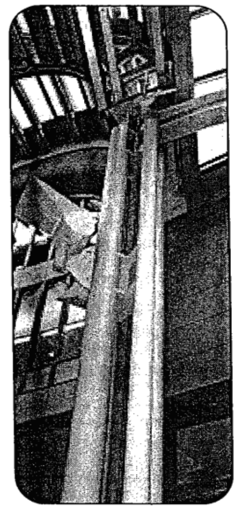
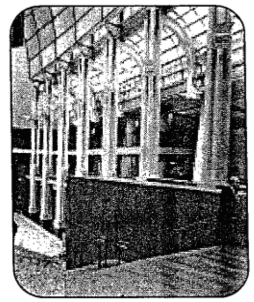
HSS APPLICATIONS





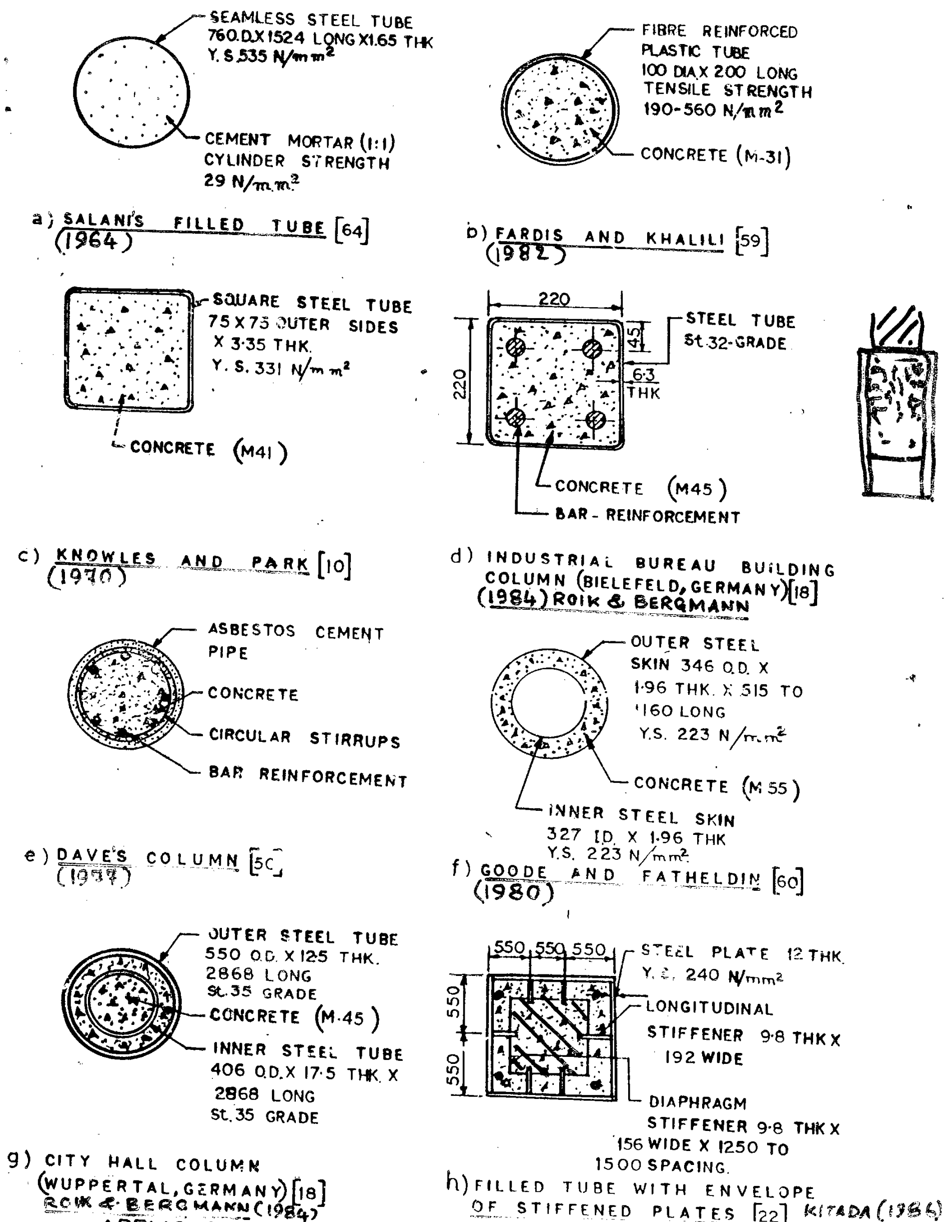






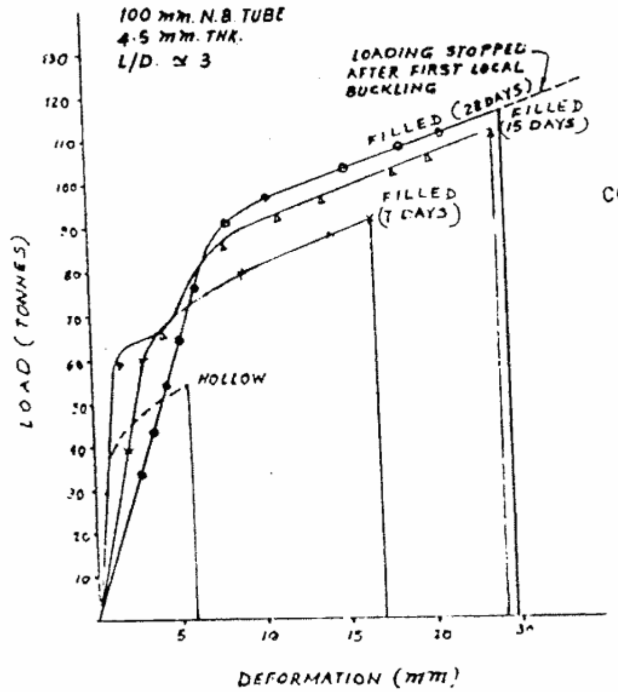
Steel Tube Institute
OF NORTH AMERICA
2516 Waukegan Road, Suite 172, Glenview, IL 60025 • Tel 847 461 1701 • Fax: 847 660.7981
E-mail: STINA@steeltubeinstitute.org • Website http://www.steeltubeinstitute.org

American Iron and Steel Institute



APPLICATIONS OF PERMANENT FORMWORK IN CONCRETE FILLED STEEL TUBULAR COLUMNS

Compressive Load - Deformation Behavior



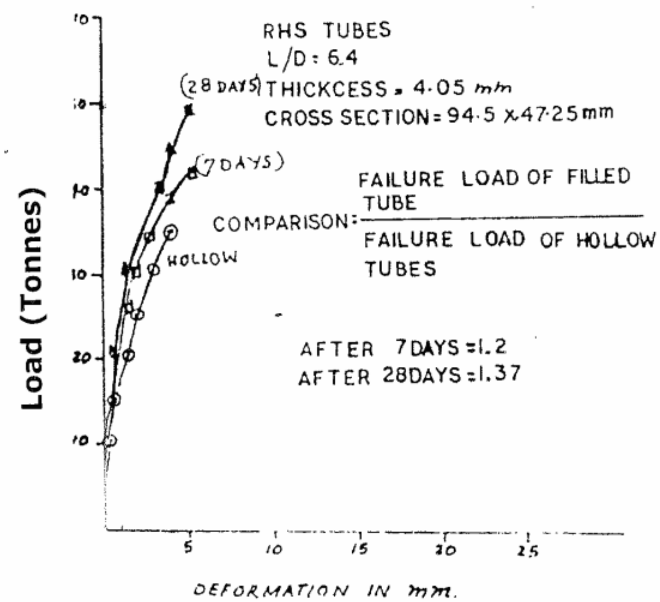
COMPARISON: $\frac{\text{FAILURE LOAD OF FILLED TUBE}}{\text{FAILURE LOAD OF HOLLOW TUBE}}$

AFTER 7DAYS : 1.69

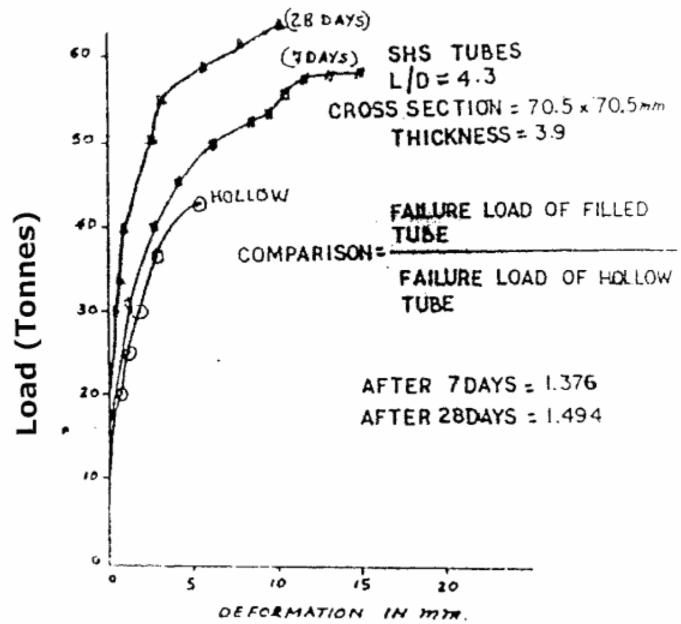
AFTER 15DAYS: 2.06

AFTER 28DAYS: 2.15

Circular Tubes

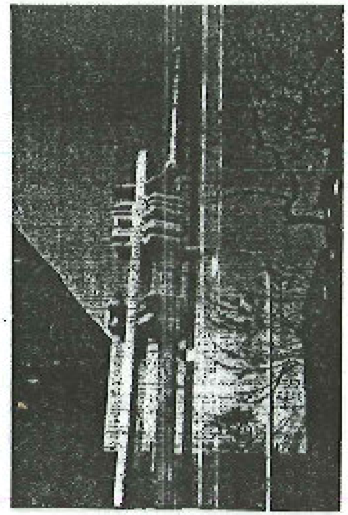


Rectangular Tubes

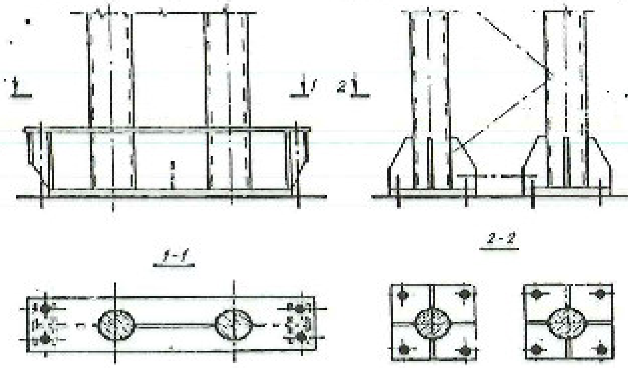


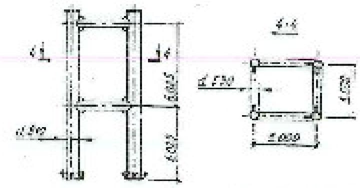
Square Tubes

APPLICATIONS

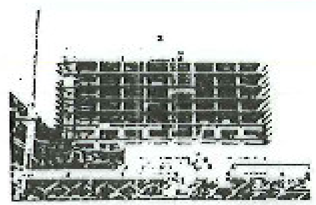


TV TOWER (PRAGUE)





CONVEYOR GALLERY TRESTLES (UKRAINE)



12 - STOREYED HOTEL BUILDING (JAPAN)

CONCRETE - FILLED STEEL TUBULAR COLUMNS

construction is applied in the past, but reinforced concrete(R.C.) is used in order to save steel afterwards. Howe r t e structures and constructi ns of the R.C. are very complex because of the big amounts of buring details. so, outer cover steel members are created, and this makes the save of steel and fast of construction.

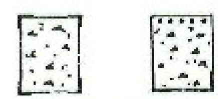
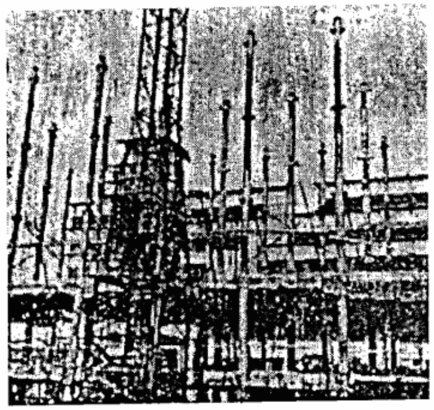


Fig.3 outer cover steel members

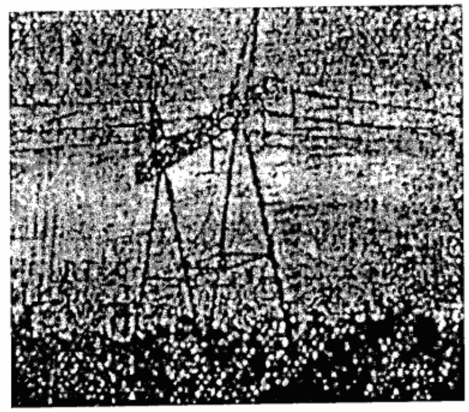
Outer cover steel members had been adopted in several electric power plants in China, and good economic effects had been gained.

BEAMS WITH LIGHT - GAUGE STEEL ENVELOPE (CHINA)

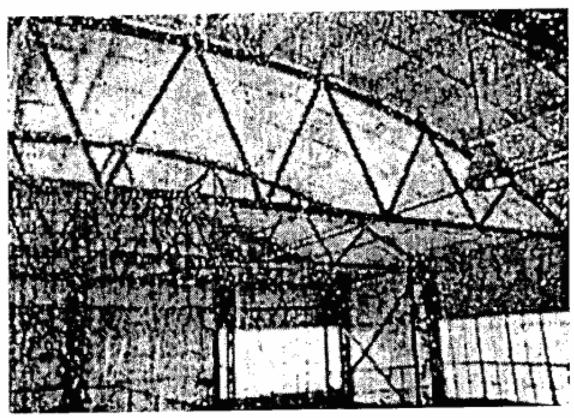
Concrete - Filled Steel Tube Applications



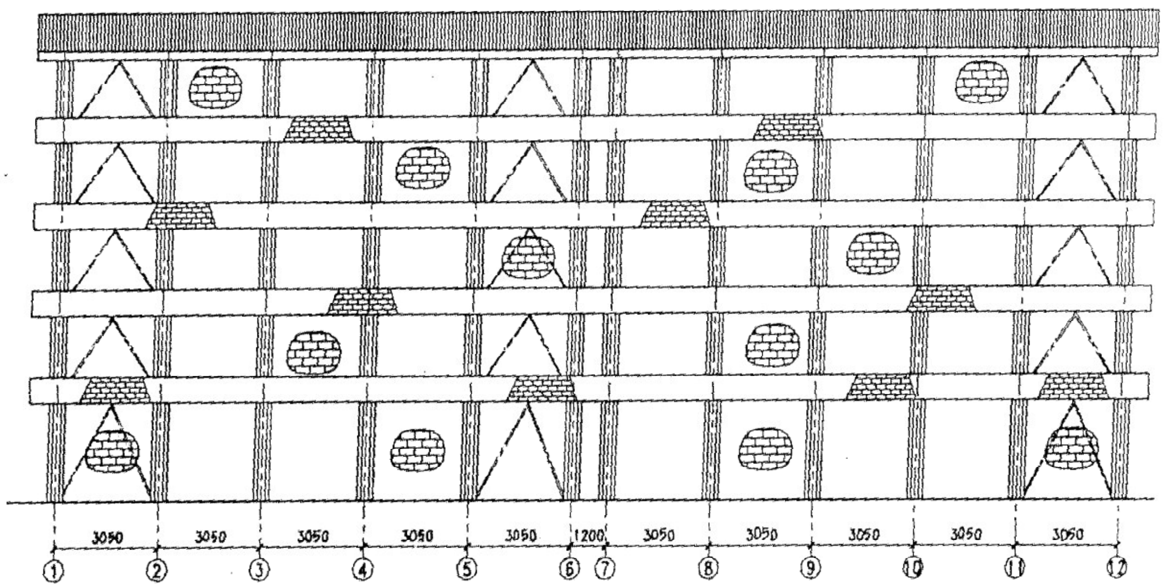
Scientific Research Building Shanghai, China (7-Storeys)



220KV TLT for Jilin Province, China.



Filled Tube Truss Chords and Compression lacings for Jilin Paper Mill Building, China.



LONGITUDINAL ELEVATION

Economics of Concrete - Filled Steel Tube for Different Applications

Sl. No.	Application	Project Description	Saving in steel	Saving in concrete	Saving in cost
1.	Transmission line Towers (TLT)	220KV TLT for Jilin province of China built in 1980	50%	—	30%
2.	Multi storied building columns	Scientific research building of special foundation institute, Shanghai, China, 7 Storied building 14Mx40Mx27M Tall.	-15%	57%	12%
3.	Columns of trussed industrial buildings.	Diesel engine assembly workshop building of Eastern Shanghai Dockyard China, with 125/20T EOT Crane.	50%	—	30%
4.	Compression Members of Truss.	Jilin paper mill building truss built in 1981, spanning 24M, China.	15%	—	13%

Indian Standard

CODE OF PRACTICE FOR COMPOSITE CONSTRUCTION IN STRUCTURAL STEEL AND CONCRETE

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 September 1985, after the draft finalized by the Prefabricated and Composite Construction Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Composite construction consists in the use of prefabricated structural units like steel beams, precast reinforced or prestressed concrete beams in combination with *in-situ* concrete. The construction should ensure monolithic action between the prefabricated and *in-situ* components so that they act as a single structural unit. This code deals only with steel-to-concrete composite construction, that is, one in which the prefabricated components is a steel beam, either rolled or built up. It is intended to issue a separate code dealing with concrete-to-concrete composite construction. Again because of the special nature of bridge structures where dynamic loadings are expected, this code is restricted to buildings. This code will replace the existing IS : 3935-1966*. The code incorporates important changes including the introduction of limit state design concept to bring it in line with other major structural codes issued by the Indian Standards Institution.

0.3 Whilst the common methods of design and construction of steel-concrete composite structures have been covered in this code, special systems of design and construction not covered by this code may be permitted on production of satisfactory evidence regarding their adequacy and safety by analysis or test or both.

0.4 In this code it has been assumed that design of composite construction is entrusted to a qualified engineer and the execution of the work is carried out under the direction of an experienced supervisor.

0.5 All requirements of IS : 456-1978† and IS : 800-1984‡ in so far as they apply, shall be deemed to form part of this code except where otherwise laid down in this code.

*Code of practice for composite construction.

†Code of practice for plain and reinforced concrete (*third revision*).

‡Code of practice for general construction in steel (*second revision*).

BRITISH STANDARD

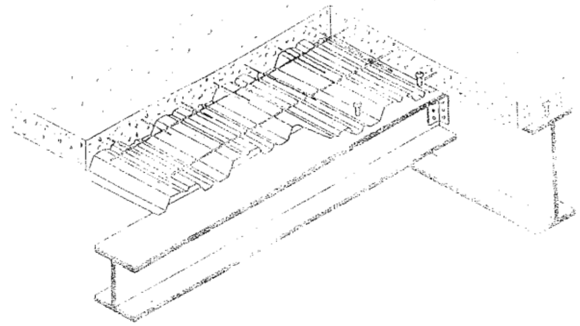
BS 5400-5:
1979

Reprinted, incorporating Amendment No. 1

Steel, concrete and composite bridges —

Part 5: Code of practice for design of composite bridges

UDC 624.21 01:624.016



Commentary on BS 5950: Part 3: Section 3.1 'Composite Beams'

Institute for Steel Development & Growth

The Steel Construction Institute

I.L.O Headquarters - Geneva, Switzerland

Rectangular hollow sections filled with concrete are used in the prestigious 14 storey headquarters building of the International Labour Organisation in Geneva (Figure 2.2). The building has a distinctive concave sided plan form 190m long and 30m wide. The lower three storeys are in reinforced concrete construction but the other eleven storeys are constructed with in situ reinforced concrete floors, 300mm x 300mm and 400mm x 400mm internal RHS concrete filled columns and 120mm x 120mm RHS concrete filled load bearing mullions at the perimeter (Figure 2.3). The columns are placed at 5m centres and the mullions at 1.67m centres; all SHS are in steel to BS 4360 Grade 50C (DIN 17100 St 52.3) The minimum specified 28 day cube strength of the concrete was $40N/mm^2$.

The columns and mullions were erected in storey height lengths and filled with concrete at the same time as the associated floor above was cast. Column lengths were joined by butt welding.

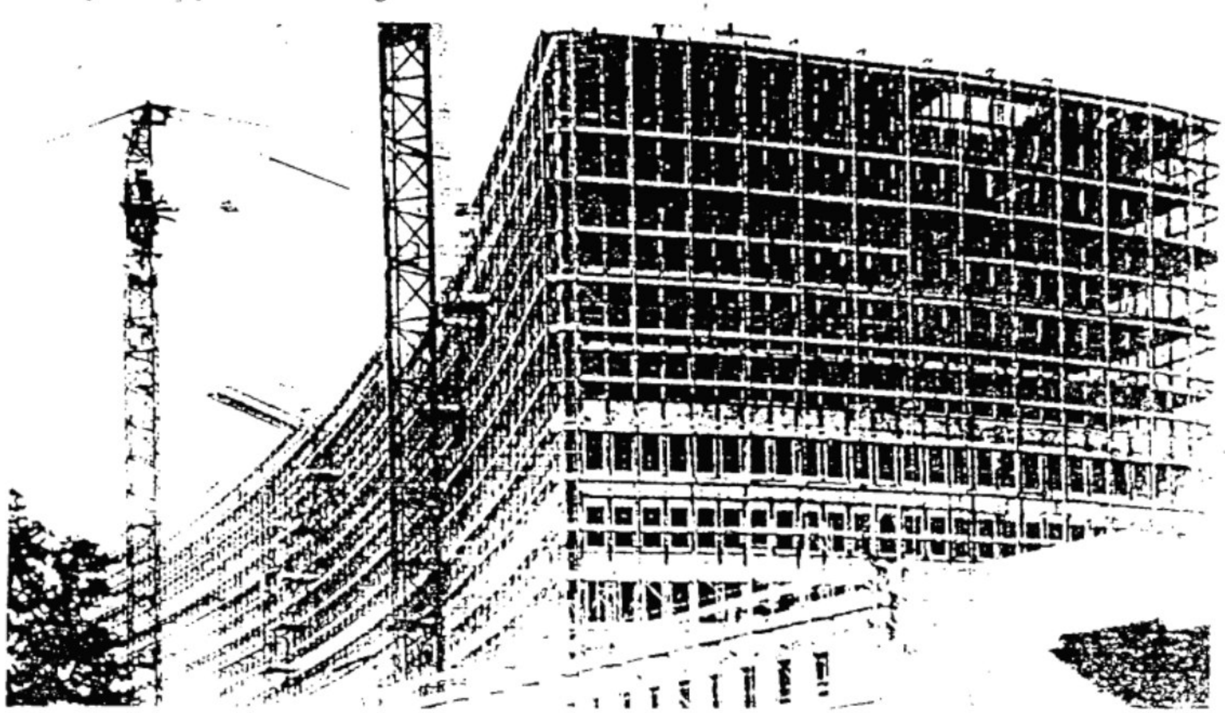


FIG 2.2

Darlington Memorial Hospital

RHS filled with concrete was adopted for the internal columns of the 8 and 9 storey development for the Darlington Memorial Hospital (Figure 2.4) so as to give the most compact columns to suit the module of the "Tartan" grid arrangement

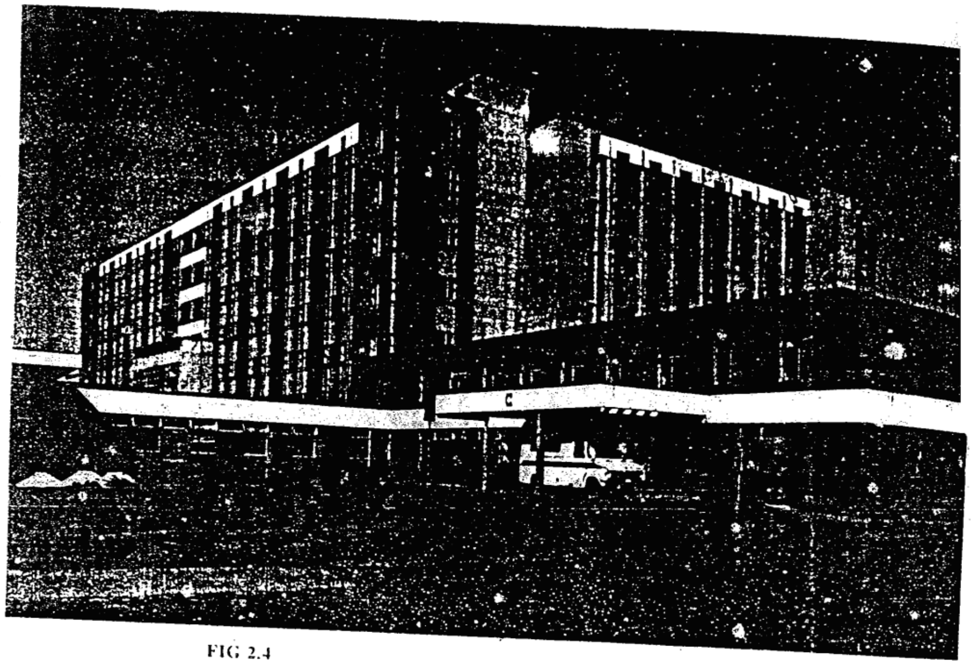
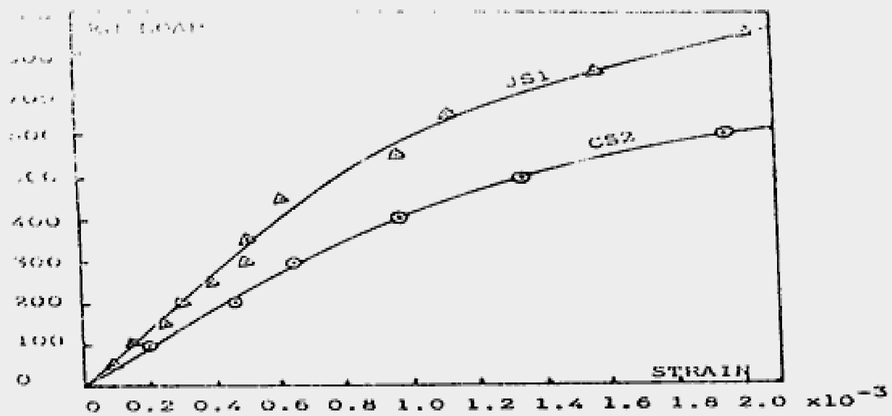


FIG 2.4

The building has a plan of 94m x 48m and a maximum height of 33m. The lower three floors have twin columns of 150mm x 150mm RHS filled with concrete with a 28 day cube strength of 60 N/mm^2. Higher levels have single columns of 203.2mm x 152.4 RHS filled with 30 N/mm^2 concrete. All the RHS sections are to BS 4360 grade 50C.

The columns were erected in three storey lengths and were filled with concrete after construction of the concrete floor slab at the top of each column length (Figure 2.5). Column Connections were made with bolted flanges at floor level (Figure 2.6).

Fire resistance required was 1 hour apart from the basement [illegible] where 1.5 hours was required. Fire resistance was provided by encasement with 38mm of vermiculite plaster after construction. No account was taken of the beneficial effects of concrete filling in determining fire prevention thickness requirements.



COLUMN CURVE FOR COMPRESSIVE LOAD-STRAIN BEHAVIOUR

(a)

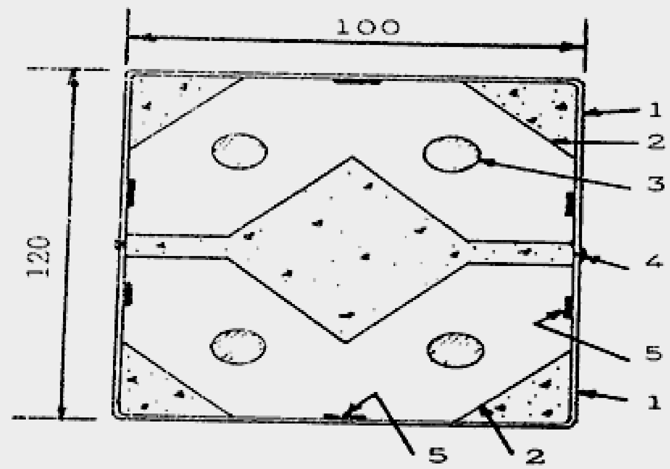
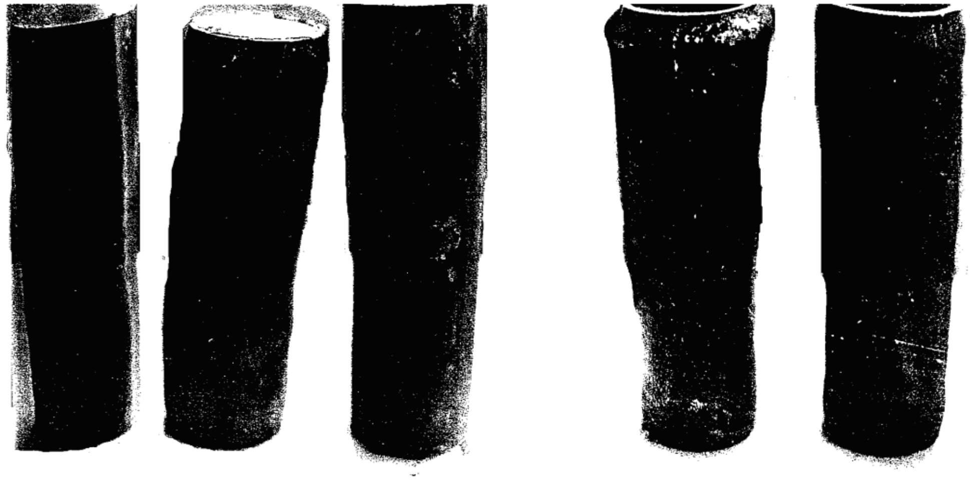


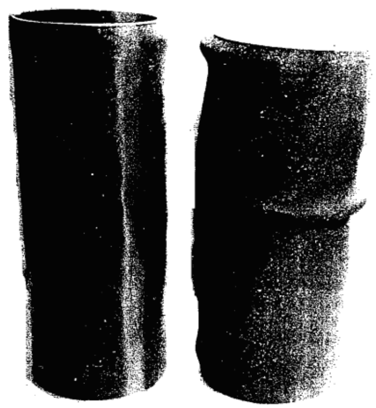
FIG. 1 CROSS SECTION: 1. Cold formed light-gauge steel channels 100 x60x2.5 thk. 2. Diaphragm plates 4 mm. thk @ varying spacing (100-200 mm) in different specimens. 3. 12 mm dia. holes for 10 mm dia HYSD Fe415 bars. 4. Tack weld 10 mm. long 5. Fillet weld 10 mm long and 4 mm. size.

(b)

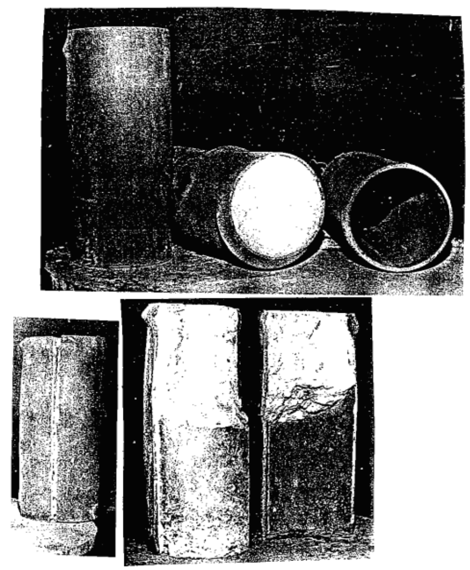
FIG. 54. SECTIONAL DETAIL & P BEHAVIOUR OF COLUMNS WITH BAR REINFORCEMENT



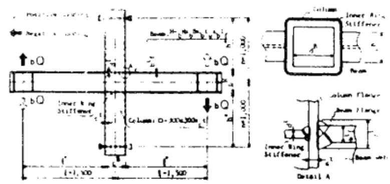
(d3) Failure modes of specimens with varying thickness



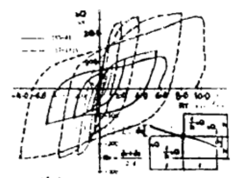
(d4) Multiple buckling failure of circular specimens



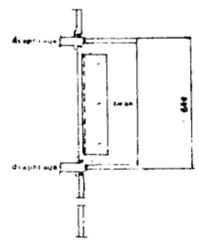
(d5) Saw cut specimen showing perfect bond between concrete and steel



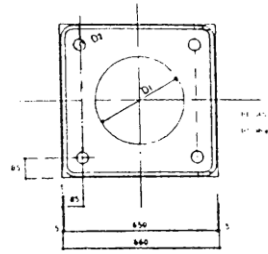
(a) Configuration of Specimens



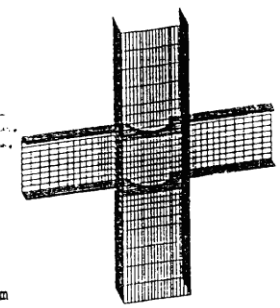
(b) Hysteretic Curves of Representative Specimens ($_bQ$-R_T Curves)



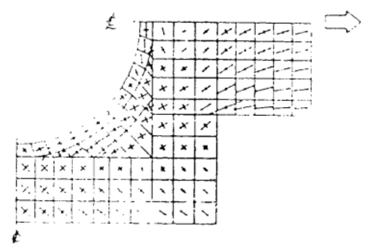
(c) Detail of Beam-to-column connection



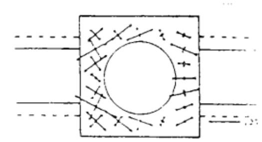
Detail of diaphagm



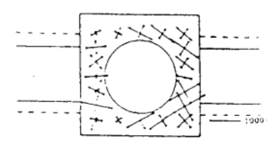
(d) Analytical model by FEM



Stress flow in diaphagm (by FEM)



Upper diaphragm



Lower diaphragm

Measured strain in diaphragm (SC-1, R=1/100)

(e) Stress and strain intensities

FIG. A-35 EFFECT OF DIAPHRAGMS AT JOINTS

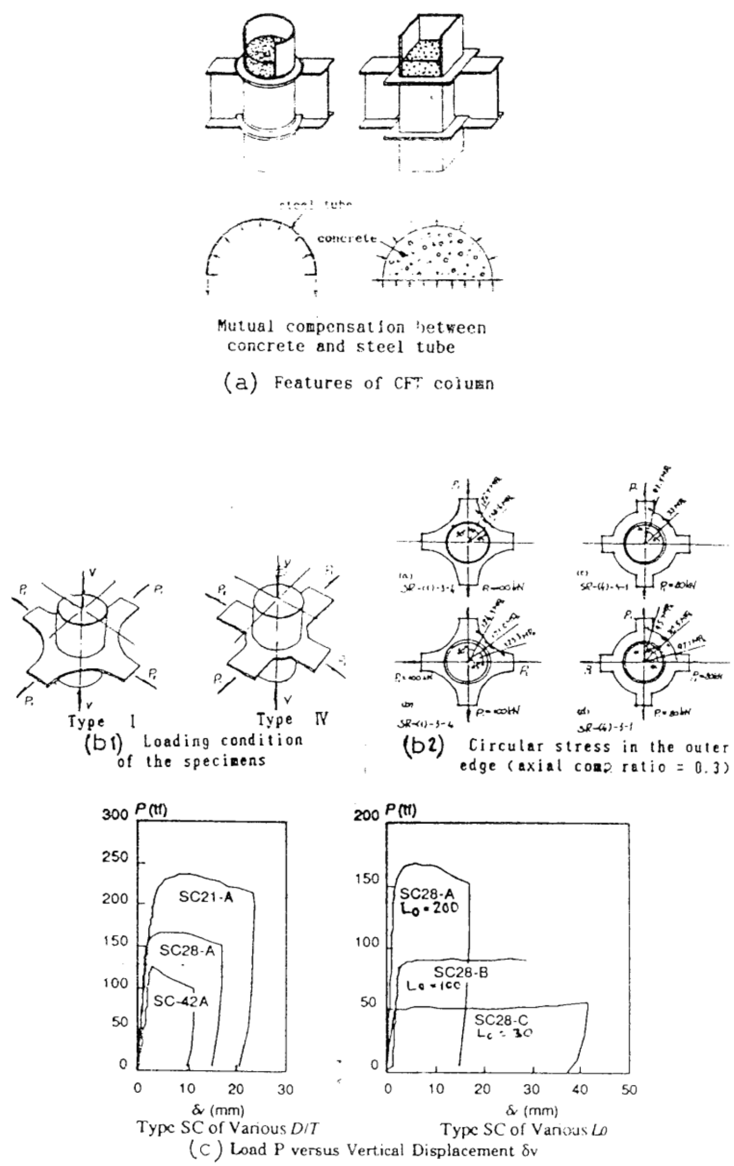


FIG. A36 EFFECT OF EXTERNAL RING STIFFENERS AND BEARING FORCES ON JOINT BEHAVIOUR

Thank You