NATIONAL AWARD COMPETITION FOR STUDENTS 2015 - 2016

Civil / Structural Engineering Students For Best Innovative Structural Steel Design

Competition Theme :

Six Storeyed Shopping Complex

Institute for Steel Development & Growth

BRIEF OF NACS (C) 2015 - 2016

INTRODUCTION

The Indian retail market has gone through a remarkable change and has emerged into its current manifestation. The traditional and semi-established shopping formats are rapidly transitioning into established formats like hyper markets and multi-storied shopping malls offering a range of products and services, all under a single roof. The need for bigger shopping complexes is quite conspicuous today and the modern day malls are not only expanding horizontally but also vertically. However, the focus has over the years shifted to intricacies of mall design, which has an important role in making a mall successful. Mall developers have now realized that just creating a glitzy building with lots of stores and food courts etc does not guarantee the success of a shopping mall. Apart from adequate planning, large column free area, ambience and positioning are largely instrumental in determining the fate of a shopping complex.

APPOINTMENT AS CONSULTANT

One of the reputed promoters of North East India proposes to build one state of the art Shopping Complex in the region. The client intends to have unimpeded convenience in the shopping complex layout and wide circulation area with high ceilings. Considering that you have been appointed as a structural consultant for this project and have been asked to furnish structural solution for **"Six Storeyed Shopping Complex"**, the tasks are to convince the client that steel intensive construction would be the most appropriate choice for the purpose and to achieve the benefits of steel based construction by providing most economical, aesthetically pleasing scheme and all relevant design and detail drawings thereof.

The scope of work includes preparation of a report that should have the following:

1. Development of an Economical, Stable and Aesthetic / Innovative structural scheme within the specified requirement fulfilling all the structural aspects.
2. Structural design engineering and Detail drawings for the developed structural scheme.
3. Bill of materials.
4. Encompass the advantages of Steel farmed building over conventional RCC based building. No calculation is needed for comparison.

FACILITIES

Architect has specified the following requirements for the proposed project:

1.	Site Location	:	Guwahati, Assam
2.	Area per floor	:	576.0 Sq.m
3.	Plan Shape	:	Rectangular / Square
4.	Building width, minimum	:	16.0 m
5.	Floor to floor height	:	3.90 m (max)
6.	Minimum Clearance at floor level (top of floor to underside of beam)	:	3.0 m
7.	Column Spacing, c/c (minimum)	:	8.0 m
8.	Basement	:	No Basement, provision for car parking need not be considered.
9.	Wall Load	:	No internal walls, consider only external walls @ 10kN/m
10.	Stair & Lift Block	:	2 nos stair blocks and 1 no Lift block (1 no stair and 1 no lift block shall be together)
11.	Floor Slabs	:	RCC with 50 mm finish. Composite floors with Deck slabs are also acceptable.
12.	Bracings	:	Vertical bracings at outer walls may be used.
13.	Foundation	:	Raft

MATERIALS FOR CONSTRUCTION

1. Foundation system	:	R.C.C. of minimum grade M25 with Fe500 Rebar
2. Structural members like columns, beams, members and bracing systems	:	Structural steel of mild steel (grade E250BR) or high tensile steel (grade E350BR / E410BR)
3. Deck Sheet	:	Galvanised Steel Deck Sheets of any reputed manufacturer (if adopted).

STANDARD SHAPE OF THE STRUCTURE

While considering the shape and arrangement of the Structure, aesthetics, economy as well as structural integrity of the entire system has to be considered. Use of fabricated I sections as columns and beams is permitted.

DESIGN LOADS

1. Dead Load:

Dead load will be the weight of the structure itself along with all permanent weight carried by it.

2. Live Load:

Live load on Floors (typical)	- 4.0 kN / Sqm	- as per IS: 875 Part 2 -1987
Live load on Roof	- 2.25kN / Sqm	
Live load on Roof	- 3.0 kN / Sqm	Water Proofing Load

3. Wind Load:

Basic wind speed to be considered as 50 m /sec. as per IS: 875 Part 3 – 1987.

4. Seismic Load:

Seismic Zone to be considered as Zone – V as per IS: 1893 – 2002 (part 1)

5. Other Loads:

Temperature variation of 20°C may be considered if necessary. Please consult relevant specification for other specific loads and action points.

GUIDELINES

The following guidelines should be taken into consideration:

1. Items designed in accordance with design scope, should be checked for axial, bending, bearing and combined stresses etc. as applicable. Equivalent stresses and any other stresses necessitated by the relevant codes should also be calculated.
2. Deflection calculated should be within stipulations given in relevant IS code.
3. For designing of Base Plates and Foundation Bolts, grade of concrete to be considered as mentioned above.
4. While selecting the steel sections for use, please refer INSDAG website or any manufacturer's website for availability.

DESIGN SCOPE

For designing the building, the following scope of work needs to be undertaken:

1. Layout Plan, Elevation and Sectional views should show the arrangement facilities provided.
2. Beams & Columns: Sections, such as MB/MC [refer IS 808-1989(2004)], built-up sections or parallel flange sections [refer IS 12778-2004], Tubular Sections [refer IS 1161 - 1998 and IS 4923 - 1997] will be preferred.
3. Connections: All connections shall be either welded connection or bolted connection using mild steel or high tensile black bolts, turned bolts or HSFG bolts.
4. The design and detailing of the following items shall be done:
   a. Analysis of the structure in 2D or 3D as applicable. For seismic load only static analysis is required.
   b. All Columns / trestles and Girders / Beams
   c. All RCC floors and roof (including composite flooring system, if adopted).
   d. All Bracings, Struts and cables / steel ropes.
   e. Connection designs for Critical joints
   f. Any other members conceived in the scheme.
   g. Foundation System design is NOT REQUIRED.
5. Bill of Materials: A bill of materials (in A4 sheet) should be prepared for all items under design scope to determine the quantity of materials required.

YEAR – 2015-2016

COMPETITION TOPIC:

SIX STOREYED SHOPPING COMPLEX

DESIGN OPTION

BY

1ST Prize Winner – Team W-18

from
CEPT University, Ahmedabad

National Award for Competition for Students 2015-2016

Civil/Structural Engineering Students for Best Innovative Structural Steel Design

Competition Theme:

Six Storeyed Shopping Complex

Institute for Steel Development & Growth

Group No. W-18
Name(s): Mayank Singh
College: CEPT University Ahmedabad, Gujarat

Parameters given

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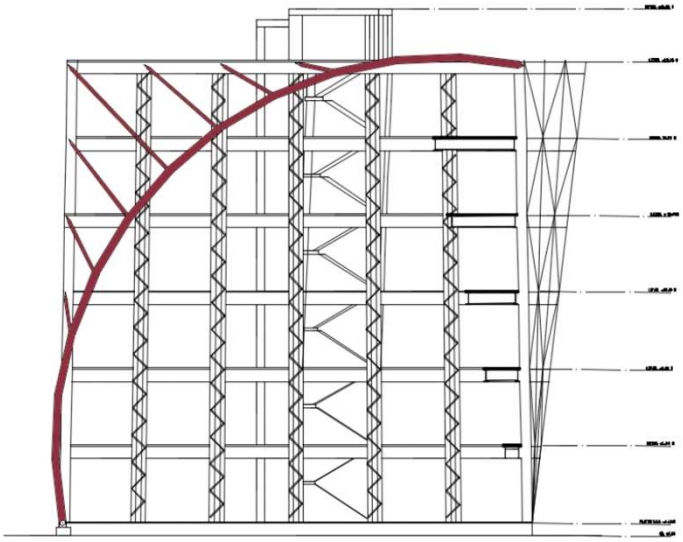
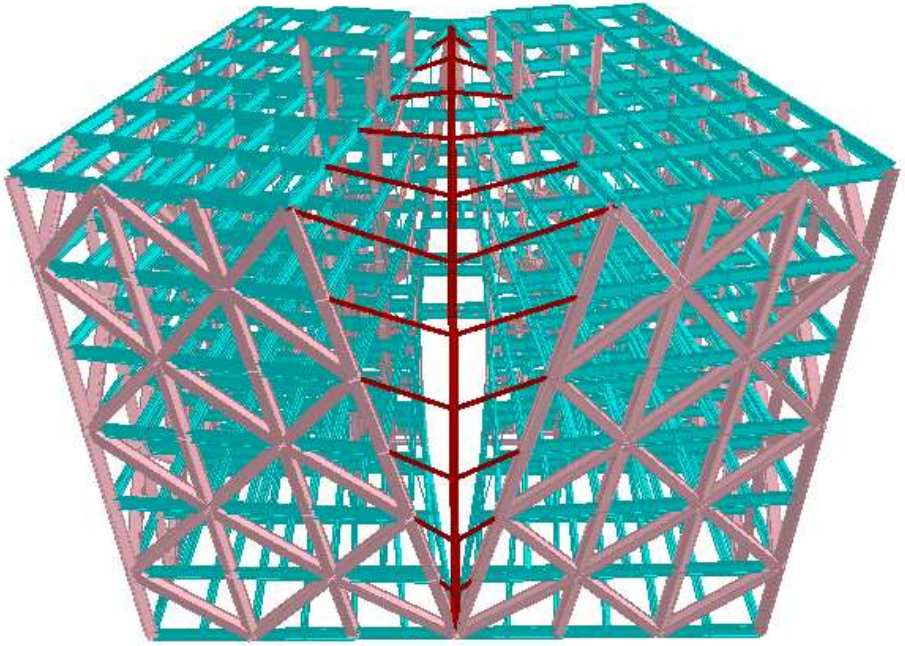
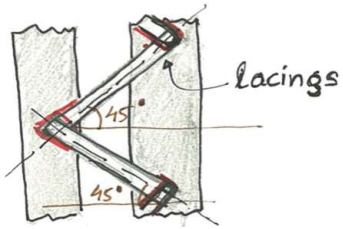
The Spine

- A curved spine made up of 12 welded pipe sections introduced centrally
- Smaller pipes emerging from it towards both the towers, these being
- Pinned on both ends.
- This spine acted as a central sink for energy dissipation from one tower to the tower during the transfer of lateral forces. Two models with and without
- Models with and without spines were analyzed and the deflections with spines were reduced drastically.

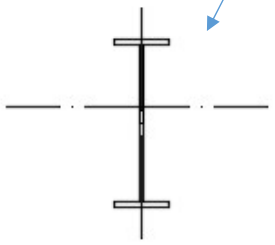




Sections

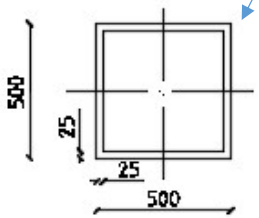


Primary Beams



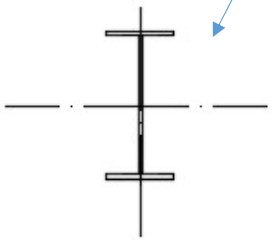
1. ISMB600

Columns

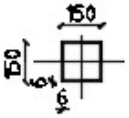


2. BU-B

Secondary Beams

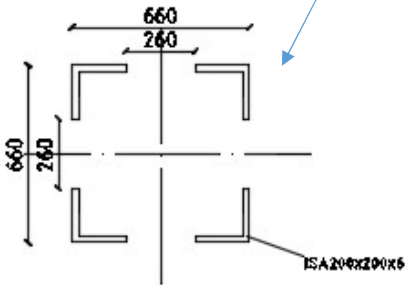


3. ISWB550

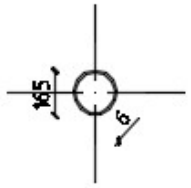


4. TUB1501506

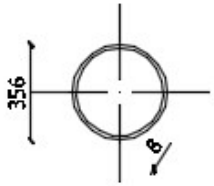
Interior columns – Laced Angles



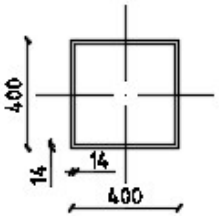
5. BU-A



6. PIP1651H

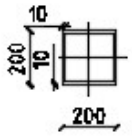


7. PIP3556H



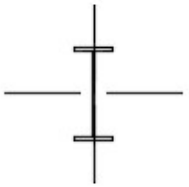
8. BU-C

Diagonals



9. TUBE (Staircase)

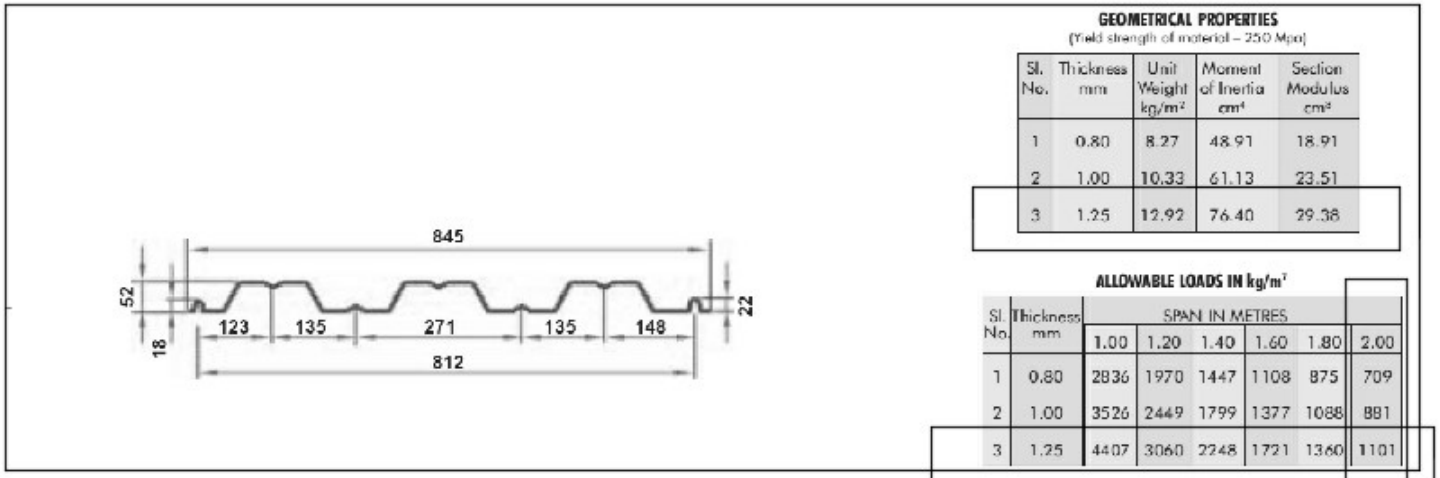
10. ISWB600H



11. ISMB350

SIX STOREYED SHOPPING COMPLEX	12.
National Award Competition	
INSTITUTE FOR STEEL DEVELOPMENT AND GROWTH	
TYPES AND LENGTH OF SECTIONS	
	MAYANK SINGH Group no. W-18

Deck Section



GEOMETRICAL PROPERTIES
(Yield strength of material – 250 Mpa)

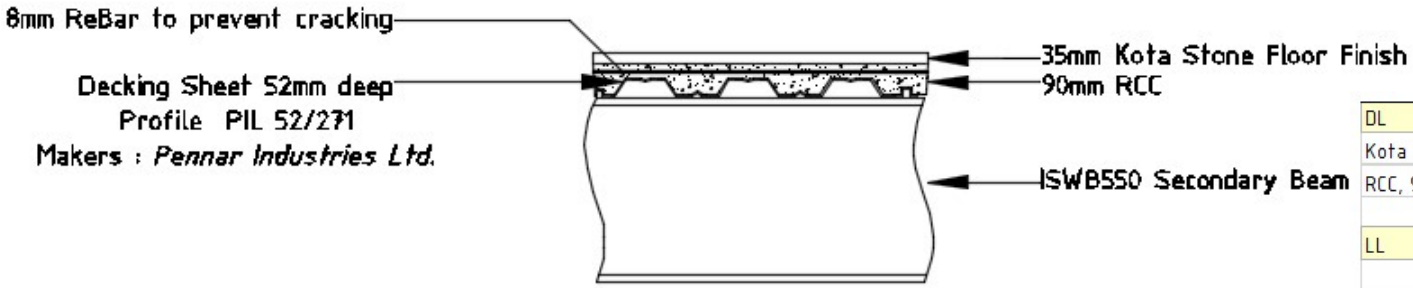
Sl. No.	Thickness mm	Unit Weight kg/m²	Moment of Inertia cm⁴	Section Modulus cm³
1	0.80	8.27	48.91	18.91
2	1.00	10.33	61.13	23.51
3	1.25	12.92	76.40	29.38

ALLOWABLE LOADS IN kg/m²

Sl. No.	Thickness mm	SPAN IN METRES					
		1.00	1.20	1.40	1.60	1.80	2.00
1	0.80	2836	1970	1447	1108	875	709
2	1.00	3526	2449	1799	1377	1088	881
3	1.25	4407	3060	2248	1721	1360	1101

1. Preliminary Loads Calculated
2. Equivalent per unit Area Load determined
3. Load capacity matched from the options in the brochure

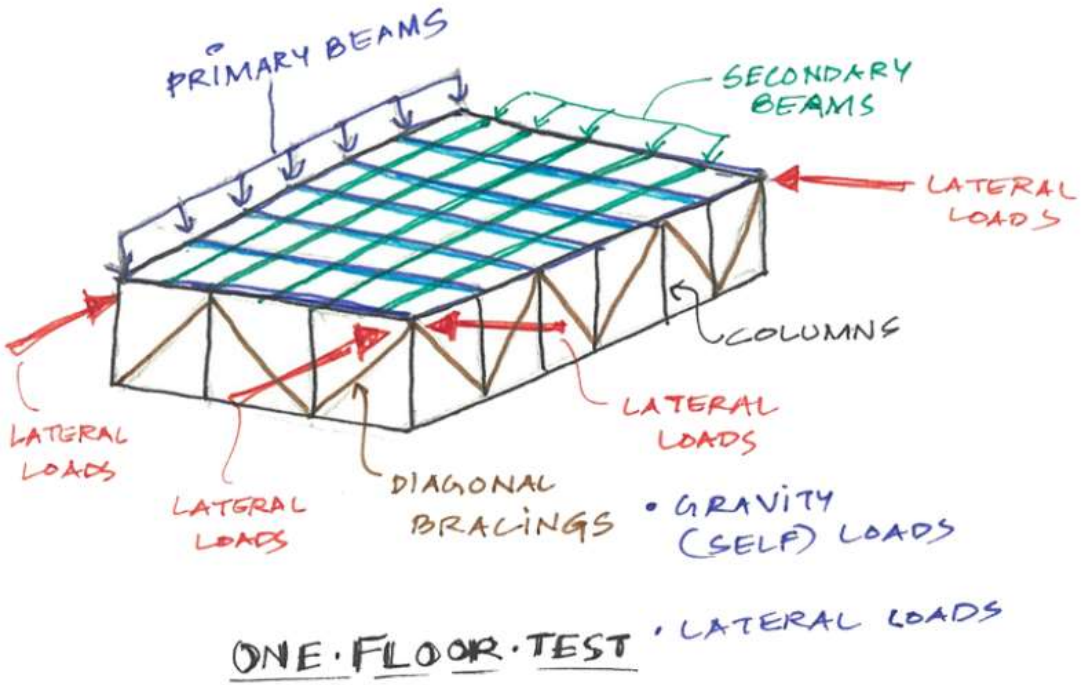
DECKING SHEET PROFILE
SELECTION from BROCHURE
Makers: *Pennar Industries Ltd.*

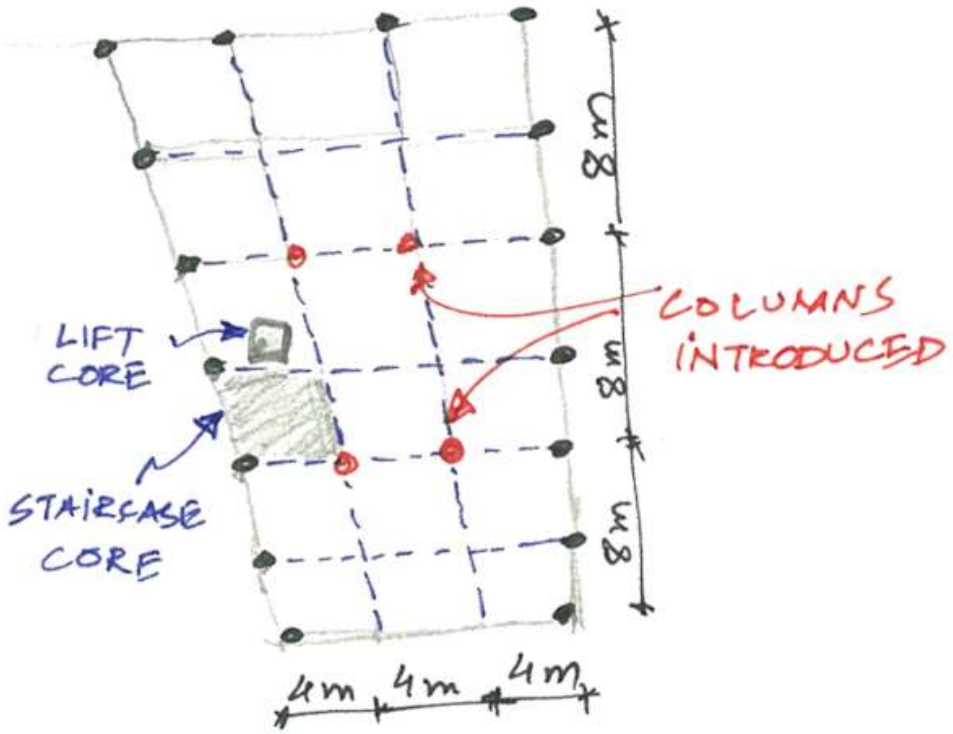


Load on Decking Sheet

DL							
Kota Stone, 35mm thick			24*0.035	=	0.84	KN/m²
RCC, 90mm thick, 45mm efffective depth			25*0.045	=	1.125	KN/m²
				=		
LL				=	4	KN/m²
			TOTAL	=	5.965	KN/m²
		(1.7*)	Factored	=	10.1405	KN/m²
				=	1014.05	Kg/m²

Analysis - Part to Whole





Load Combinations

- DL+LL

- $1.7(DL \pm EQ_x \pm 0.3EQ_z)$
- $1.7(DL \pm EQ_z \pm 0.3EQ_x)$
- $1.3(DL+LL \pm EQ_x \pm 0.3EQ_z)$
- $1.3(DL \pm LL \pm EQ_z \pm 0.3EQ_x)$

- 1.7DL
- 1.7(DL+LL)

- $DL+LL+WL_x$
- $DL+LL+WL_z$

- $1.2DL+0.5LL \pm 2.5EQ_x$
- $1.2DL+0.5LL \pm 2.5EQ_z$

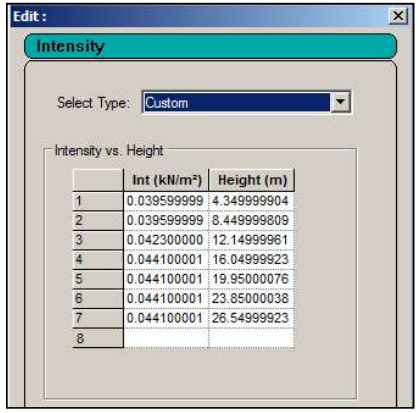
- $0.9DL \pm 2.5EQ_x$
- $0.9DL \pm 2.5EQ_z$

Earthquake Analysis - *Static Analysis, as per IS 1893:2002*

- Provide **pinned supports** at all joints at all levels in the STAAD Model
- Run STAAD Analysis for a Load Combination of **DL+0.5LL** *(since Imposed Load > 4 sq.m given, Table 8, IS 1893, Part 1)*
- Sum Reactions to final **Seismic Weight** (W_i) for every storey
- Calculate Design **Horizontal Acceleration Spectrum** coefficient (A_h) and **Design Seismic Base Shear** (V_B)
- Calculate **Storey Shear** $Q_i = V_B \times \frac{W_i \times h_i^2}{\sum(W_i \times h_i^2)}$

- Find Lateral Loads at each Node using Storey Shear and Ratio of Nodal Reactions to the respective total Seismic Floor Loads
- Copy the Lateral Loads in FX and FZ Direction into the Editor File of the STAAD Model

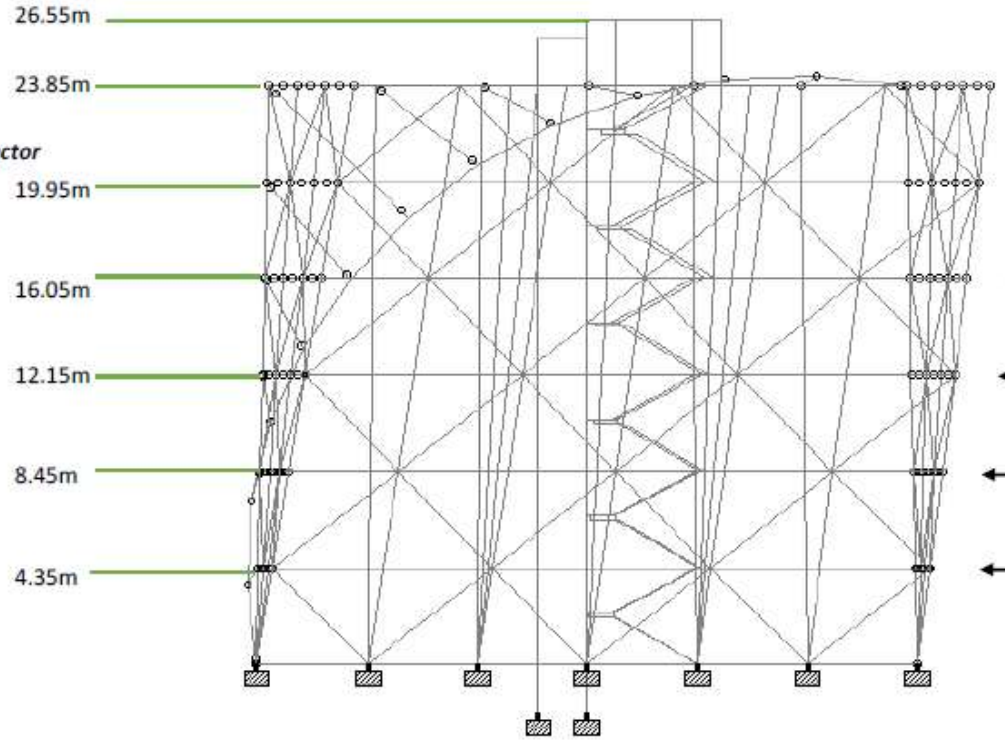
Wind Analysis – *as per IS 875-Part III*



	Int (kN/m²)	Height (m)
1	0.039599999	4.349999904
2	0.039599999	8.449999809
3	0.042300000	12.14999961
4	0.044100001	16.04999923
5	0.044100001	19.95000076
6	0.044100001	23.85000038
7	0.044100001	26.54999923
8		

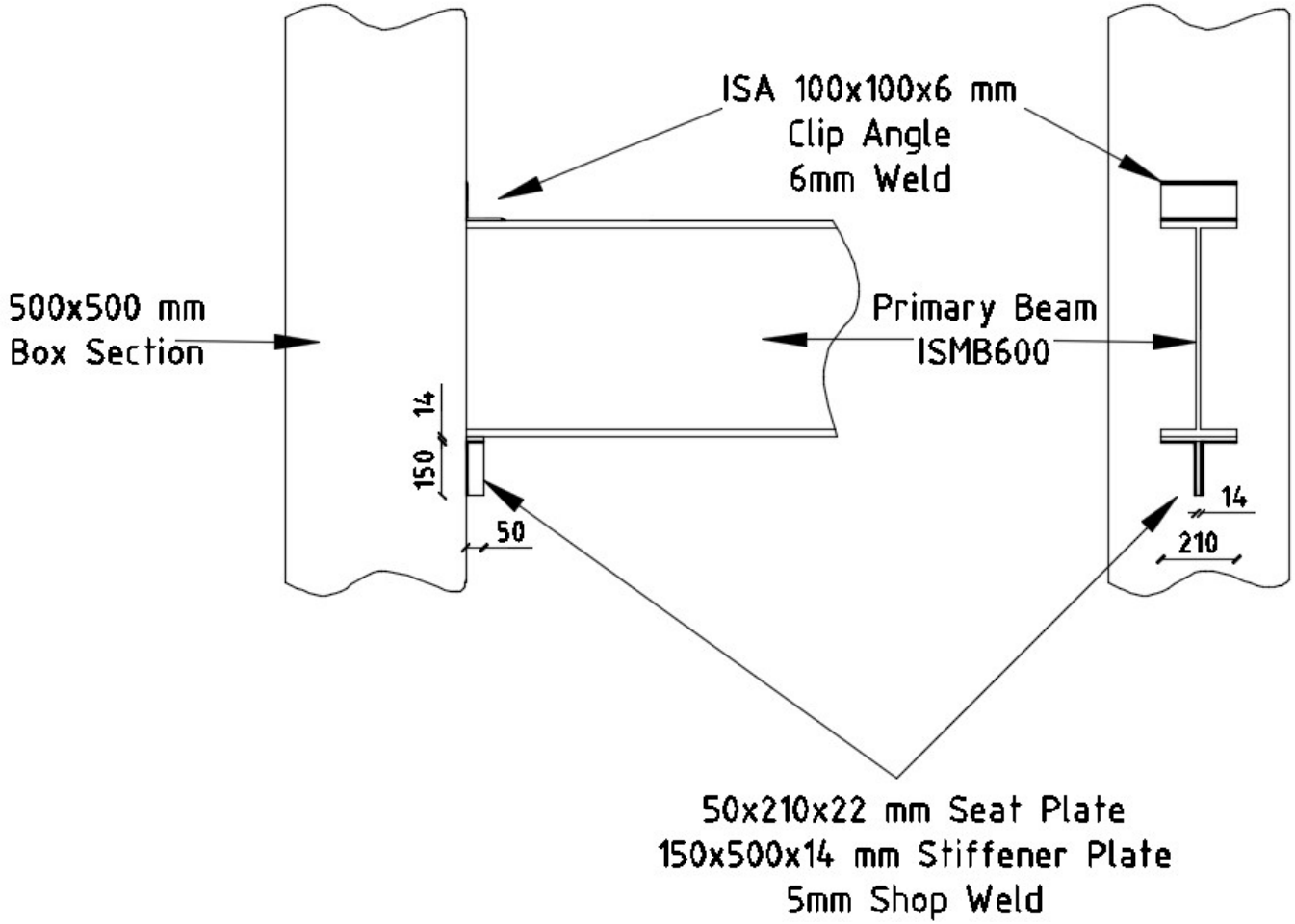
V_z	=	50	m/sec	*Given Basic Wind Speed*
k1	=	0.9		*Probability Factor*
k2	=	as shown		*Terrain, height, structure size factor*
k3	=	1		*Topography Factor*

Category 3
Class B

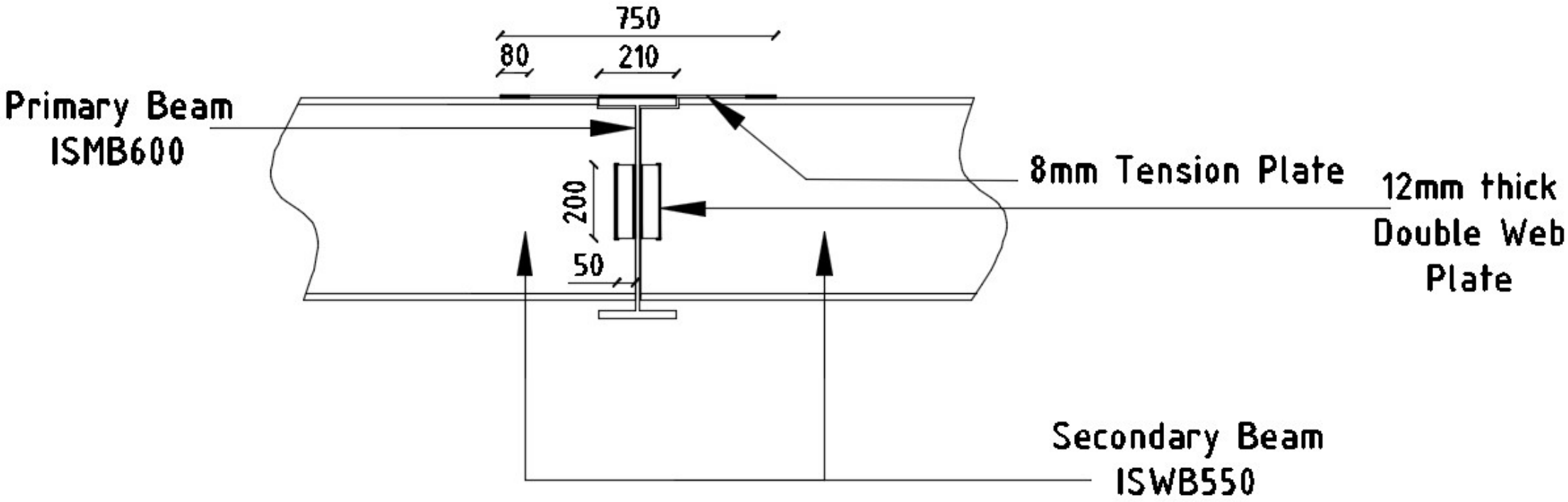


k_2	P_z
0.98	44.1
0.98	44.1
0.98	44.1
0.98	44.1
0.94	42.3
0.88	39.6
0.88	39.6

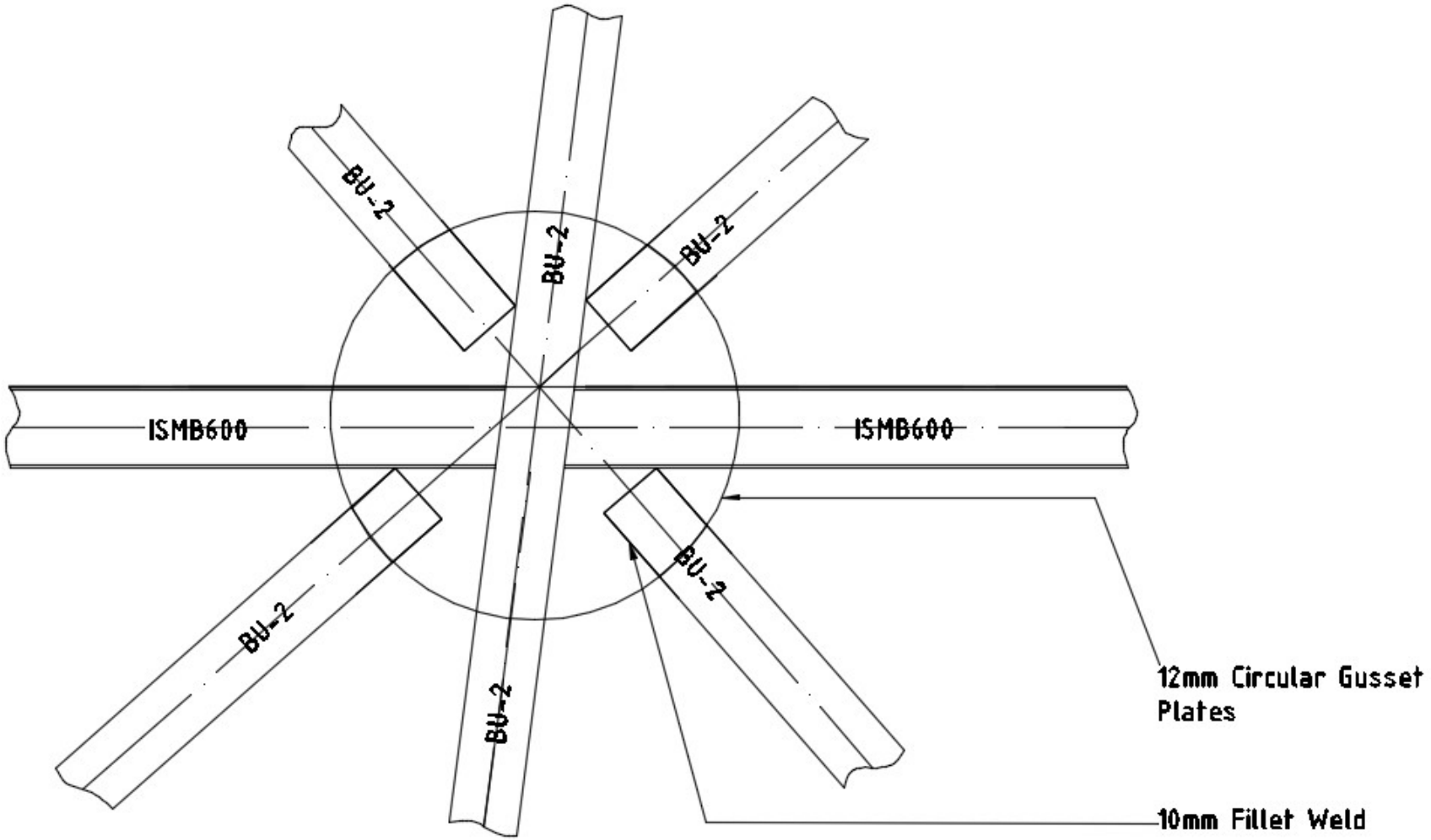
Connections – *Moment – Beam to Column*



Connections – *Shear – Beam to Beam*



Connections – *Circular Gusset – Columns + Diagonals*



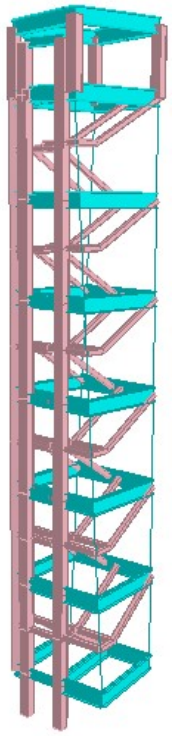
BOQ

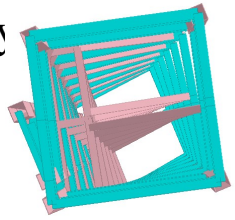
Length of Different Members						

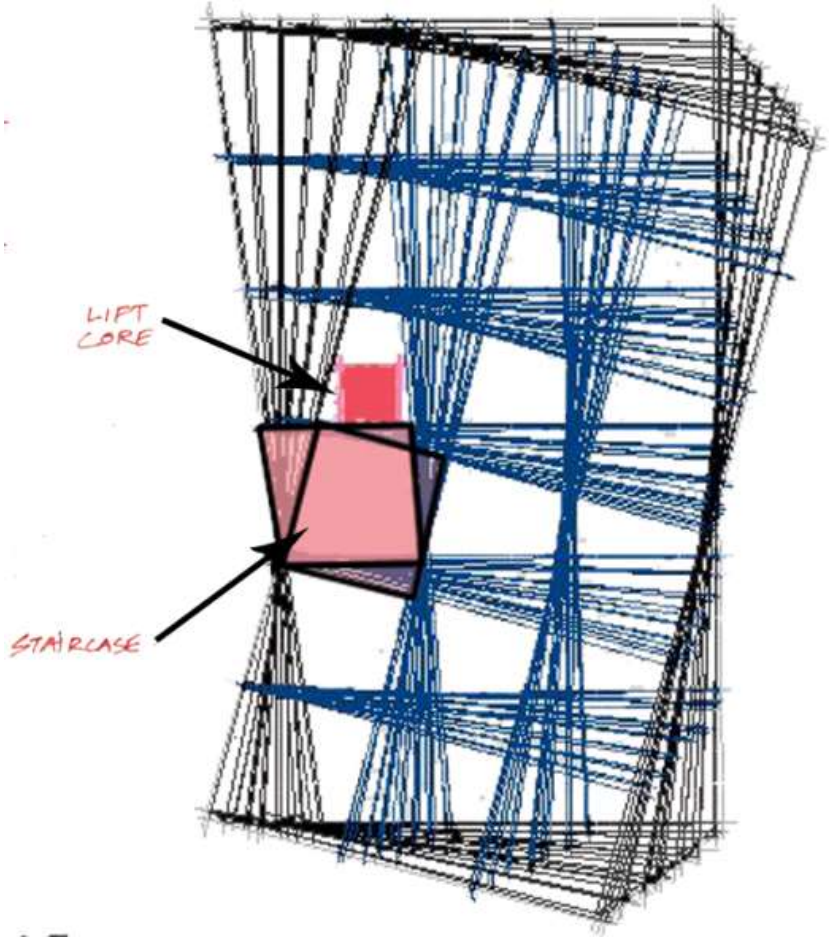
	STAAD NAME	DRAWING NAME	REMARKS		LENGTH(METER)	WEIGHT(KN)
1	ISMB600		Primary Beam		1968	2328.146
2	TUBE	BU-B	External Columns/Bracings		1436.7	5242.47
3	ISWB550		Secondary Beams		1632.55	1793.391
4	TUB1501506		Secondary Beams (Bridge)		3.8	0.98
5	20020025	BU-A	Internal Columns		423.56	1220.823
6	PIP1651H		*Spine Wings*		98.28	20.461
7	PIP3556H		*Central Spine*		39.28	26.372
8	TUBE	BU-C	Lift Columns		178.11	295.761
9	TUBE		Staircase		308.94	180.368
10	ISWB600H		Primary Beam (Bridge)		5.06	7.185
11	ISMB350		Lift Tie Beams		53.88	27.609
				Total	**6148.16**	**11143.566**

Special Mention – *Vertical Transport*

- The given requirement was to accommodate 2 staircases with one staircase adjoining an elevator.
- The assumed riser was 156mm with 25 steps and a 280mm long tread.
- The width of the stairway was kept 1.8 metres.
- Similarly, an elevator shaft was separately modelled for sizing and loads and then later introduced in the main model. This shaft was placed, modelled orthogonally vertical, for obvious reasons, adjacent to one of the staircases.
- OTIS Standards were referred for a car capacity of 8 persons.







Thank You