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ANALYSIS AND DESIGN OF MULTI-STOREYED BUILDING IN STEEL USING IS 800 DRAFT CODE

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ABSTRACT Institute of steel development & Growth and Ministry of Steel, the bureau of Indian Standards, has jointly circulated a new draft IS: 800, based on Limit State Method. In Introduction to Limit State, the design philosophy is based in probabilistic approach. The design is based on characteristic values for material strengths and applied loads, which take into account the probability of variations in the material strengths and in the loads to be supported. In Limit State Method of design partial safety factors for both material and load variability is considered. In Limit State Method of IS: 800 – Draft, there are separate partial factors for material strengths and applied loads & load combinations. In India, most of multi-storey buildings are made in concrete. With recent development in steel, it can be possible to construct it in steel. An attempt is made to design 10 storey building in steel using IS: 800 – Draft having RC voided slab. RC voided slab is used to minimise the weight of the slab and to economize section of beam & column which ultimately reduces the total weight of the structure.

The shear connector is designed for full shear connection using eurocde 4 as a composite beam element. The flow chart of the design of flexural member including bearing stiffener is prepared and the built up I section is designed as a laterally restrained beam with all necessary checks such as check for section classification, check for section modulus, check for shear, check for bearing stiffener, check for outstand and check for buckling as per IS 800 Draft. It also provides the percentage strength of the Indian rolled steel I sections. The beam flange and web splices having bolted connection are designed with the use of HSFG bolts as per IS 800 Draft considering reduction in strength due to bolt holes.

The box column with perforated plates and 4-ISA at corners is designed as a beam-column for the governing load condition with all necessary checks i.e. check for section strength, check for slenderness ratio, check for overall member strength, check for shear and check for clear distance between perforations. Also design moment capacity about major axis is reduced due to lateral torsional buckling about minor axis as mentioned in the IS 800 Draft code. This phenomenon is similar to beam column designed by IS 800-1984 where permissible stress about major axis is reduced as compared to permissible stress about minor axis i.e. 0.66fy. Also as an economical section, the comparision of the designed column with the section 2ISHB with cover plates is provided.

The column splices (lap joints) are designed for minimum required strength 0.6 times $f_y A_f$ for each flange splice and 0.6 times $f_y A_w$ for each web splice with the partial penetration groove welds considering design strength of the joints of at least equal to 200% of the required strength as mentioned in IS 800 Draft code. The moment resisting column bases are designed with the welded stiffening plates which is provided at all four sides of column. Also HSFG bolts are provided to resist the tension in the base.

Keywords: Shear, Deflection, Moment

I. INTRODUCTION

Population of India is increasing at very fast rate and now it is more than 1300 million people. By the turn of the century, land will become scarce and there will be an urgent need to built high-rise structures in greater number in middle cities also. At present these cities are expanding horizontally or in a mixed manner but with the scarcity of land there is need for vertical expansion.

The advantages of multi-storey buildings are as follows:

- Easy availability of community facilities
- Closer network of services and transport
- Better planning of city
- Availability of more open space
- Fresh air at upper height of building

The construction of multi-storeyed buildings is dependent on available materials, the level of construction technology and the availability of services such as elevators necessary for the use in the building. In ancient Rome, people used to build multi-storeyed structures with wood. For those buildings built after the Great Fire of Rome, Nero used brick and a form of concrete material for construction. Wood lacked strength for buildings of more than five stories and was more susceptible to fire hazard and the buildings constructed with brick masonry occupied a large space for their walls. So due to these drawbacks, development of construction materials took place with the high strength and structurally more efficient materials like wrought iron and then subsequently steel. It permits the lightweight skeletal structures with greater height and larger interior open spaces.

1.1 DESIGN PHILOSOPHY OF IS – 800: DRAFT

Structural engineers design structures that are safe, serviceable & economical with the use of art, skill, science, experience, judgments and integrity. Structural design features are:

- Safety: It should not collapse or experience excessive damage duringits intended lifetime.
- Serviceability: It should perform satisfactorily during its intendedlifetime.
- Economy: It should be economical to build & maintain.

1.1.1 RELIABILITY

- It is defined as a quantitative measure for accounting structural safety.
- Reliability = 1- P_f , where P_f = Probability of failure.
- It is to be calculated based on uncertainties in the structures. i. e. calculated from scientific method for handling varying quantities (from experiments & research).

1.1.2 UNCERTAINTIES

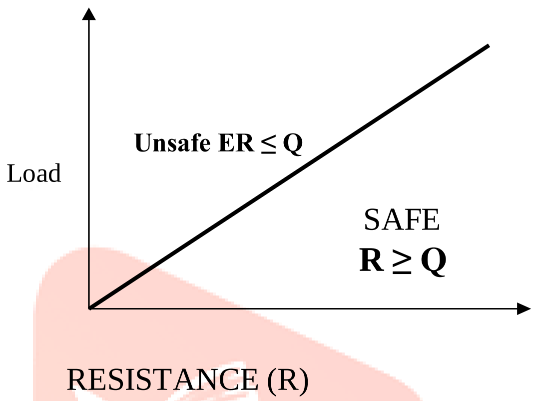
TABLE 1.2 UNCERTAINTIES IN LOADS & RESISTANCE

1)Dead Load :-	1)Geometry :-Dimensions & Sizes
Less uncertainties(Density) 2)Live Load :-	2)Material :-
High uncertainties(Magnitude & Position)	Variation in material properties Assumptions of isotropic, homogeneity
3)Environmental Loads :-	3)Analysis Method :- Approximations Linearity assumption
Very High uncertainties(Magnitude, Location, Duration, Repetition, Occurrence)	Simplifications

1.1.3 EVOLUTION OF DESIGN CODES

After considering all uncertainties in the structure, decide the safety factors fromprobability such that following criteria must be satisfied:

Design Loads ≤ Design Strength (Design Resistance)



1.2. OBJECTIVE OF WORK

The main objectives of the project are:

- To analysis and design ten storey building in steel using IS-800: Draft code (Limit state method of design) considering dead load, live load, wind load, earthquake load and its combinations.
- To analysis thirty storey building in steel using IS-800: Draft code (Limit state method of design) considering dead load, live load, wind load, earthquake load and its combinations.
- It is also planned to carry out parametric study of effect on drift due to change in orientation of column.

2. LITRATURE REVIEW

Ahmed Aboyhy [1], Ahmed Soliaman [2], Ahmed Atwa [3] 2021 : The General Concept Of Voided Biaxial Slabs Relies On Voids Created Within The Concrete At The Time Of Casting. This Creates An Internal Array Of Hollow Boxes In The Slab, Which Acts As Grid Of Horizontal Supports For The Flat Surface On Top. Another Advantage Is The Reduction In Weight, Achieved By Removing Mass Which Does Not Directly Transfer Weight To A Vertical Member. Typical Solid Slabs Have A Loading Capacity Of Around One-Third Of Their Own Weight, Which Can Create Problems For

Long Spans And High Loadings. by Reducing The Weight Of The Slab Without Compromising Its Structural Strength, It Is Possible To Create A Thicker Slab To Support More Weight Over A Longer Span.

D. A. Narkhede et al., 2017: They carried out research work on the comparison of seismic behaviour of shear wall and bracing system in RC frame structure. Shear wall and bracing systems are generally used in medium to high rise building according to their need. This system gives stiffness, strength and energy dissipation to resist lateral loads induced due to earthquake. In paper author consider G+10 building which is analyzed by using STAAD Pro V8i software. The comparison reaction of shear wall and bracing system by using the response spectrum method. The author concludes that shear wall and bracing are very effective to reduce lateral displacement and deflection of building. As compare to bracing system the shear wall gives more stiffness to the building. The concrete bracing is very useful to existing structures for retrofitting and strengthening of structure. by using X bracing very effectively reduces lateral displacement in building. The use of shear wall at the centre of is most suitable as compare to other location to reduce lateral displacement in building. Shear wall is most preferred to medium high rise building to further improve the quality of structure against seismic load. Also, X bracing is most suitable to reduce lateral displacement, story shear, defection.

Rohith kumar B.R[1], Sachin P.Dyavappanavar[2], Sushmita N.J[3], Sunitha.V[4], Vinayak.Yadavad[5] 2017 : This project investigates that most buildings are of straight forward geometry with horizontal beams and vertical columns. Although any building configuration is possible with ETABS in most cases, a simple rigid system defined by horizontal floors and vertical columns lines can establish building geometry with minimum effort, most of the floors level in buildings are similar. This can reduce the modeling and design time. The main aim of this project is to complete a multi storey building and to ensure that the structure is safe against gravity loading conditions and to fulfill the function for which the structures have been built for the design of structure dead loads and live loads have been considered. The analysis and design of the structure is done by using Etabs Software and also with the confirmation of IS 456-2000.

Dr. Harshvadan S. Patel[1], Merool Devarsh Vakil[2] 2017 : The evaluation consists of code based studies on European, British and American standards for flexural capacity and limiting geometrical & material parameters. Subsequently, parametric analysis is performed to further investigate effect of material and geometric parameter variations such as - steel grade, concrete grade, profile sheet thickness and concrete depth on flexural capacity and neutral axes. The study proposes guidelines for flexural capacity of composite deck as per Indian scenario. It also suggests neutral axis factor, to ensure under reinforced section theoretically. The guidelines will be useful for users in India, in absence of Indian code of practice for a composite deck.

Harshitha M N[1] , Binod Kumar[2], Rajiv Kumar Chaudray[3], Saurabh Singh[4], Shivam Shivhar[5] 2017 : This paper investigates about the Analysis and Design of a Commercial Building by using ETABS software and also gain sufficient knowledge in complete Analysis and Design Procedure. In this research they checked on G+4 Commercial Building frame made up of Reinforced Concrete. Providing with all necessary specifications. This project mostly stressed on Indian Standard Code Books and National Building Code (NBC) because planning and design of any building will be recognized as per the standards by these design aids. This paper provides information about the design procedure Analysis Results i.e. Shear Force, Bending Moment, Deflections etc. and various IS Code books.

Mr Yadav Jaideep Purushottam [1], Prof Tambe Yogesh Hemantkumar[2] 2016 : Deformation is the change in the shape of a body caused by the application of a force and proportional to the stress applied within the elastic limits of the material. The finite element analysis of the slab panels has been carried out using ANSYS workbench 14.5 program to find the deformation of both the slab systems under the same loading conditions. The dead load intensity varies as the span of slab increases and superimposed dead load of 20 psf is considered for all slab panels. The live load intensity of 80 psf is constant for all bay sizes. The slab panel is supported at its corner on four columns on which uniformly distributed load is applied for finding the corresponding deformation of the slab panel.

3. METHODOLOGY

3.1 Modeling

The plan of the building is as shown in fig. 3.1, the layout has following details: Plan area: 43.6 m x 23 m [6 grids (1 to 6) in z–dir and 4 grids (A to D) in x–dir]Storey height: 5 m at ground floor and 3.5 m at typical floor

Building Type: Office building

S.B.C. - 250 kN/m^2

Concrete Grade – M_{20} for Slab & M_{30} for Footing

The structure is modeled as beam-column space frame structure with fixed support condition in the STAAD PRO as shown in fig.3.2, with steel beam as ISMB600 and ISMB 450 and the steel column as box section 300 x 400 x 12 mm of weight 131.9 kg/m. Here the rigid diaphragm property is provided ateach storey for the equal deflection of all nodes in a storey.

3.2 Loading

- Dead Load =
  RCC (Slab) = 25 KN/m^2
  Floor Finish = 1.0 KN/m^2
  Steel Density = 7850 Kg/m^3
  E = 2×10^5 N/mm^2

- Live Load
  As per IS: 875 (Part- 2) -1987, Live Load – 4.0 kN/m^2.

Reduction in LL is made for the design load calculation of column at different storey.

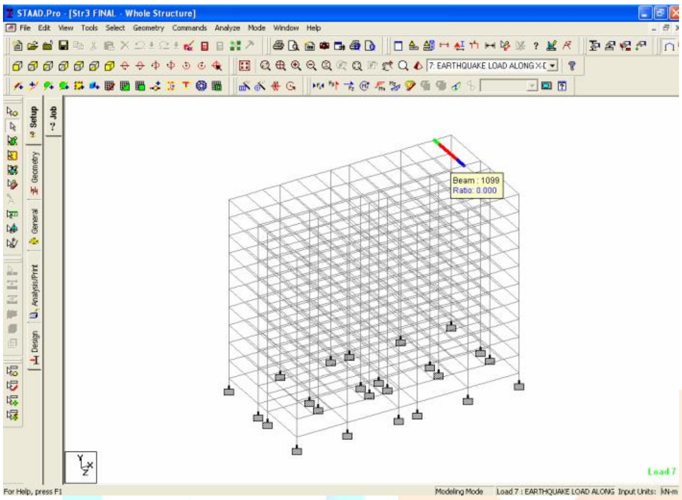


FIGURE 3.1 STRUCTURES MODELED IN STAAD PRO

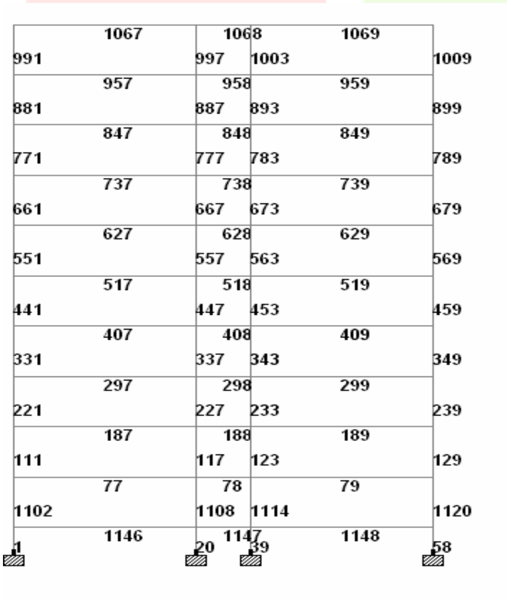


FIGURE 3.3 BEAM AND COLUMN NUMBERS OF FRAME-1 IN Z DIRECTION

- **WIND LOAD**

As per IS: 875 (Part 3) -1987

Basic wind speed, V_b = 39 m/sec Risk Coefficient, K_1 = 1.0

Terrain Height and Structure Factor K_2 = 0.88 for Height upto 10 m.

K_2 = 0.94 for Height upto 10 - 15 m.

K_2 = 0.98 for Height upto 15 - 20 m.

K_2 = 1.03 for Height upto 20 - 30 m.

K_2 = 1.09 for Height upto 30 - 50 m.

Topography Factor K_3 = 1.0

Design Wind Speed Vz = Vb × k_1 × k_2 × k_3

- **EARTHQUAKE LOAD**

As per IS: 1893 (Part 1) – 2002,

Zone – IV

Soil Condition – Medium

Importance Factor – 1.0

Response Reduction Factor R – 5.0

Time Period - $T = 0.085h^{0.75}$

3.3 LOAD COMBINATION

3.3.1 LOAD COMBINATION FOR ULTIMATE LOAD

1 1.5*DL+1.5*LL

Wind load combination

2 1.2*(DL + LL ± WL_X)

3 1.2*(DL + LL ± WL_Z)

4 1.2*(DL + LL) ± 0.6*WL_X

5 1.2*(DL + LL) ± 0.6*WL_Z

6 1.5*(DL ± WLX)

7 1.5*(DL ± WLZ)

8 0.9*DL ± 1.5*WLX

9 0.9*DL ± 1.5*WLZ

Seismic load combination

10 1.2*(DL + LL ± EQ_X)

11 1.2*(DL + LL ± EQ_Z)

12 1.2*(DL + LL) ± 0.6*EQ_X

13 1.2*(DL + LL) ± 0.6*EQ_Z

14 1.5*(DL ± EQ_X)

15 1.5*(DL ± EQ_Z)

16 0.9*DL ± 1.5*EQ_X

17 0.9*DL ± 1.5*EQ_Z

3.3.2 LOAD COMBINATION FOR SERVICEABILITY CONDITIONS

18 1.0*DL+1.0*LL

Wind load combination

19 1.0*DL + 0.8*LL ± 0.8*WL_X

20 1.0*DL + 0.8*LL ± 0.8*WL_Z

21 1.0*DL ± 1.0*WL_X

22 1.0*DL ± 1.0*WL_Z

Seismic load combination

23 $1.0*DL + 0.8*LL \pm 0.8*EQ_X$

24 $1.0*DL + 0.8*LL \pm 0.8*EQ_Z$

25 $1.0*DL \pm 1.0*EQ_X$

26 $1.0*DL \pm 1.0*EQ_Z$

3.1 DESIGN

3.1.1 RC VOIDED (RIBBED) SLAB -WITHOUT HOLLOW BLOCK

- The principal advantage of these types of slab is the reductions in weight as much as 15% to 30% achieved by introduction of voids in the slab. They also reduce loads on the foundations allowing more storeys to be built on the same foundations
- For slabs without hollow blocks the minimum thickness of topping is generally recommended by BS 8110 to be 50 mm or one tenth distance between ribs, whichever is greater

Size & Position of ribs: (As per IS- 456:2000/Cl:30.5)

1) $b_w > 65$ mm 2) $b < 1.5$ m

3) $d_w < 4 * b_w$

Let the sectional properties of slab are as follows:

1)	b_w = 100 mm	Check O.K.
2)	**b = 600 mm**	**Check O.K.**
3)	d_w = 150 mm	Check O.K.
4)	**d_f =**	**60 mm**

Load Calculation:

Design rib as T- beam

Effective flange width = c/c distance of ribs Density of Concrete = 25 kN/m^3

		DL (kN/m^2)		LL (kN/m^2)
1.Load on topping:				
a) Self Weight	=	1.5	+	0
b) Floor Finish	=	1	+	0
c) Live Load	=	0	+	4
\ Total Load	=	2.5	+	4.00 kN/m^2

		DL (kN/m)		LL (kN/m)	
2. Load on rib:					
a) topping load (b* total load)	=	1.5	+	2.4	
b) Self Weight (bw*dw*25)	=	0.38	+	0	
\ Total Load	=	1.88	+	2.4	kN/m
\ Factored Load Wu = (1.5*T.L.)	=	2.81	+	3.6	kN/m

Taking continuity advantage for rib:(From IS-456:2000/Table 36)

Shear Force Coefficient:

End Support	Next to End Support		Inter. Sup.	Load	S.F.
AB	BA	BC	CB		
0.4	0.6	0.55	0.5	DL	S.F.C.
0.45	0.6	0.6	0.6	LL	*Wu*l

Bending Moment Coefficient:

Span Moments		Support Moment		Load	B.M.
Mid End Span(+ve)	Mid Interior Span(+ve)	Next to End Support(-ve)	InteriorSupport(-ve)		
0.083	0.063	0.1	0.083	DL	B.M.C.
0.1	0.083	0.111	0.111	LL	*Wu*l^2

4.1 RESULT ANALYSIS FOR 10 STOREY BUILDING

In preliminary analysis, the structure is checked for permissible deflection and inter-storey drift for the governing serviceability load combination i.e. $1.0*DL + 1.0*EQ_Z$ and the column section is revised as shown in table 4.1. So the revised box column section is 400 x 500 x 12 mm.

Permissible Deflection = H/650 = 56 mm

Permissible inter-storey drift = 0.004*h = 14 mm (for 3.5 m ht.) and 20 mm (for 5 m ht.)

TABLE 4.1 CHECK FOR DEFLECTION FOR DIFFERENT COLUMN SECTION

No.	Checked Column Section	Area (cm^2)	Weight (kg/m)	X-Trans (mm)	Z-Trans (mm)
1	Box Section 300 x 400 x 12 mm	168	131.88	66.31	61.5

2	Box Section 400 x 400 x 12 mm	192	150.72	48.65	56.9
3	Box Section 400 x 500 x 12 mm	216	169.56	45.52	48.69
4	Box Section 400 x 550 x 12 mm	228	178.98	44.29	46.08

The permissible deflection and inter-storey drift of chosen box column section 400*500*12 mm is as shown in table 4.2. The deflected shape of the structure in x and z direction is as shown in fig.4.4 (a) and (b) respectively. It shows that it is more flexible than rigid frame having maximum inclination at top and minimum at bottom.

TABLE 4.2 DEFLECTIONS FOR BOX COLUMN SECTION 400 X 500 X 12 mm

Storey	Height (m)	X-Trans (mm)	Z-Trans (mm)	Inter-storey Drift (mm)	
				X – dir	Z - dir
Base	0	0	0	0	0
1	5	5.43	5.17	5.43	5.17
2	8.5	11	11.07	5.57	5.9
3	12	16.65	17.2	5.65	6.13
4	15.5	22.21	23.25	5.56	6.06
5	19	27.55	29.08	5.34	5.82
6	22.5	32.54	34.51	4.99	5.43
7	26	37.02	39.38	4.48	4.87
8	29.5	40.81	43.49	3.78	4.11
9	33	43.69	46.64	2.89	3.15
10	36.5	45.52	48.69	1.82	2.05

4.2 ANALYSIS OF RESULT

4.2.1 SHEAR DISTRIBUTION

The shear distribution for the earthquake wind load is as shown in table 4.3 which is equal in all the frames. Also the base shear distribution due to earthquake is shown in fig.4.3.

TABLE 4.3 SHEAR DISTRIBUTION IN Z-DIRECTION (kN)

Column	A1	B1	A2	B2	A3	B3	Storey	Base
Storey	Frame-1 Shear		Frame-2 Shear		Frame-3 Shear		Shear	Shear
1	38.1	76.9	38	77	38	77	1380	8.2
2	44.5	69.8	45	70	45	70	1372	21.8
3	43.4	69.1	43	69	43	69	1350	41.3
4	42.6	66.5	43	67	43	67	1309	65.5
5	40.9	62.7	41	63	41	63	1243	93.3
6	38.3	57.6	38	58	38	58	1150	130.8
7	34.4	50.5	34	51	34	51	1019	174.7
8	29.1	41.2	29	41	29	41	844.2	224.9
9	22.1	29.5	22	30	22	30	619.3	281.4
10	13.7	14.5	14	15	14	15	337.9	337.9

4.2.2 BEAM FORCES AND COLUMN FORCES COMPARISION

TABLE 4.4(a) DESIGN END SHEARS AND END MOMENTS OF BEAMS IN Z-DIR

Storey	Exterior Frame	Shear kN	Moment kNm	Interior Frame	Shear kN	Moment kNm
1		108	324.1		174.5	435
2		107	331.2		169.7	435.6
3		101	316.3		161	412.9
4		96.2	304.3		152.7	393.2
5	Beam	91.5	294.4	Beam	144.7	375
6	AB	89.2	278.2	AB	142.4	363.1
7		85.7	255		141.8	345.8
8		80.9	223.5		142	320.5
9		75.8	195.5		142.9	297.2
10		73.8	146		139.7	237.8
1		124	184.2		129.9	193.3
2		121	180		126.6	188.8
3		107	159.4		113.1	168.2
4		94	139.5		99.9	148.2
5	Beam	85.4	126.4	Beam	91.3	135.1
6	BC	74.8	110.3	BC	80.7	119
7		61.3	90.1		67.2	98.7
8		44.6	65.1		50.5	73.9
9		24.3	33.3		30.6	40.9
10		16.5	29.1		24.4	47.9

TABLE 4.4(b) DESIGN END SHEARS AND END MOMENTS FOR BEAMS IN X-DIR

Storey	Exterior Frame	Shear kN	Moment kNm	Interior Frame	Shear kN	Moment kNm
1		230	512.6		304	624.8
2		213	478.9		281.8	580.8
3		200	463.3		264.3	553.6
4		192	452.5		252.8	540.3
5	Beams	184	437.5	Beams	241.5	522.6
6	12 & 23	185	431.2	12 & 23	243.4	517.6
7		187	420.4		245.1	508.2
8		187	418		245.8	507.8
9		190	417.3		249.6	505
10		179	352.5		235.8	451.9
1		135	280		142.8	305.1
2		131	272.1		139.2	290.6
3		121	255.2		128.9	274.1
4		110	236.6		117.9	255.7
5	Beam	97.7	216.1	Beam	105.9	235.4
6	34	83.8	191.9	34	92	211.4
7		66.7	161.9		75	185.4
8		45.6	129.6		53.8	156.5
9		19.5	94.4		31.5	126.3
10		27.1	152.9		37.5	200

The design column forces are shown in table 4.5 (A), (B) and (C) for the frame- 1, frame-2 and frame-3 respectively. The comparison of design column forces in frame A & B are shown in fig 4.3(A) & 4.3(B) respectively.

TABLE 4.5 (A) DESIGN COLUMN FORCES FOR FRAME -1

Column	ID No.	AXIAL FORCE(kN)	SHEAR-Y kN	SHEAR-Z Kn	MOMENT-Y KNm	MOMENT-Z kNm
	1	2942	109.9	110.85	206.3	265.2
	111	2480	89.39	141.48	255.7	164.9
	221	2179	89.81	133.01	233.4	157.9
	331	1889	88.66	131.71	231.1	158
	441	1611	86.68	127.33	224.2	156.8
A1	551	1344	83.17	124.52	222.5	153.3
	661	1075	77.58	122.35	219.5	146.4
	771	805	70.52	119.53	217.5	138
	881	534	57.25	106.84	194.4	114.7
	991	259	66.15	160.64	324.5	146.2
	20	3643	166.6	131.12	241.7	335.6
	117	3059	121.9	169.58	306.4	221
	227	2681	121.6	158.89	278.7	214.6
	337	2320	116.9	157.24	275.5	206
	447	1975	110.8	151.91	266.8	197.6
B1	557	1647	102.7	148.93	265.5	185.8
	667	1317	91.79	147.19	263.1	169.3
	777	986	77.95	147.01	262.5	148.4
	887	654	58.46	136.39	248.2	115.3
	997	320	45.25	205.05	414.3	99.14

TABLE 4.5 (B) DESIGN COLUMN FORCES FOR FRAME - 2

Column	ID No.	AXIAL FORCE(kN)	SHEAR-Y kN	SHEAR-Z kN	MOMENT-Y kNm	MOMENT-Z kNm
	2	5562	157.6	90.86	177.7	323.2
	112	4635	122.1	95.3	168.9	222.7
	222	4040	118.3	96.36	169.1	207.9
	332	3479	115.7	95.68	169	203.9
	442	2952	111.2	92.84	165.1	197.6
A2	552	2459	107.5	87.68	157.2	194.8
	662	1967	103.8	79.71	144.7	190.1
	772	1477	99.4	68.48	126.6	186.6
	882	988	84.43	53.84	102.8	155.5
	992	502	117.6	37.79	76.7	243.9
	21	6936	213.4	92.48	177.4	376.6
	118	5755	138.1	95.35	168.9	251.1
	228	5004	136.2	96.62	169.7	240.5
	338	4300	130.7	96.09	169.8	230.2
	448	3643	124.3	93.37	166	221.1
B2	558	3032	115.9	88.33	158.4	208.8
	668	2424	104.6	80.45	146.1	191.7
	778	1821	90.85	69.24	127.9	171.1
	888	1219	69.83	54.82	104.6	133.9
	998	624	104.4	41.8	73.96	192.9

TABLE 4.5 (C) DESIGN COLUMN FORCES FOR FRAME - 3

Column	ID No.	AXIAL FORCE(kN)	SHEAR-Y kN	SHEAR-Z Kn	MOMENT-YkNm	MOMENT- ZkNm
	3	3869	135.6	149.49	256.1	299.3
A3	113	3251	124.7	160.09	286.6	229.4
	223	2851	118.2	151.77	266.5	207.5
	333	2467	115.5	148.02	259.6	203.2
	443	2101	110.4	142.39	250.9	195.9
	553	1753	106.3	134.75	238.8	192.7
	663	1403	102.3	124.16	221.6	187.5
	773	1052	97.78	112.53	201.8	183.7
	883	700	82.75	95.82	171.7	152.6
	993	345	114.6	103.6	199.6	238
B3	22	4818	189.5	166.59	274.5	361.6
	119	4032	142.3	179.59	321.5	259.5
	229	3527	138.2	169.81	298.4	243.7
	339	3047	133.4	163.92	287.6	234.9
	449	2591	127.2	155.58	272.3	226.2
	559	2160	118.9	147.97	261.7	214.2
	669	1728	107.9	140.28	249	197.4
	779	1296	94.25	129.7	231.9	177.1
	889	863	73.08	112.49	200.4	139.5
	999	429	76.26	130.72	251.8	163

5. CONCLUSION

This Project work of Analysis and Design of multi storeyed building using IS Code has been an eye-opening as well as an enriching experience for me. We can gain an in-depth and thorough knowledge on the Structural Engineering Practices exercised by Engineers in India. It is important that a prospective engineer such as me develop a strong understanding in the basics of structural element design and I felt that this objective was reached throughout the project work period.

In this project, finally It is concluded that :-

- RC voided slab reduces the dead weight of structure by 15%. So gives economical beam & column section.
- Due to composite action between slab & beam by shear connector, the design negative moment at support reduces and leads to the economical section.
- Box Section with perforated plates and 4 ISA as a column having high radius of gyration @ minor axis, gives economical design section.
- Change in orientation of box column in shorter direction increases the drift of the structure by 10 % which is very less.
- The tube in tube structures shows the shear lag effect and the shape of the building (i.e. without end column) enhances the lateral load behavior of the building by reducing the axial stresses as shown in fig 5.5.
- The design of 10 storeyed steel building with various elements like RC voided slab, shear connector, flexural member (laterally restrained beam) with bearing stiffener , beam flange & web splices, beam-column, beam column welded connection, column splices(lap joint) and column bases have been discussed.
- In the analysis of 30 storey steel building, different analysis results like the design column axial force, the behavior of building as vertical cantilever and shear lag effect of the used tube in tube structural building is shown.
- Axial forces are lower in Steel structures due to the lower Weight of Steel structure compared to RCC structure.
- Steel provide light weight structure in comparison to concrete .
- Steel is dimensionally accurate material produced with modern computerised technology.
- Steel structure result less health hazards, less waste, less Energy usage, less emissions and better Environmental work.

5.1 *FUTURE SCOPE OF WORK*

Specialized steel structures are testimonials to the achievements of the structural engineering industry. These space structures are not only true three-dimensional representations of the equilibrium equations but also an affirmation of design standards & construction practices.

Last 20 years, steel structures has seen a significant rise in use for single story & multi story applications. Being totally re-usable, steel is the ultimate environment friendly product. Today's steel structure will almost certainly be re-used in the buildings of tomorrow. The demand of specialized steel structures has rapidly grown due to some demanding and outstanding features.

Specialized steel structures are widely used in various multi storey buildings due to their positive characteristics. The steel structures are pre-engineered and made from structural steel that is designed especially to carry a huge amount of weight. Steel building manufacturers follow structural fabrication process to make these pre-engineered steel structures. Currently, they are highly in demand in industries like petrochemical industry, airport terminal buildings, ports, metro and rail, power plants, oil and gas, stadiums, residential and commercial buildings etc

As everyone knows, steel is durable, flexible and also recyclable, so **it's outlook in a futuristic world looks bright for years to come**. Steel has a place as a sustainable material, and is always reinventing itself, so it can be expected to remain the backbone for many structures for years to come.

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