Analysis and Design of (G+5) RC Multi Storied Building Using Staad Pro. Software

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Abstract: In this paper, multi storied (G+5) building has been molded and analyzed by using STAAD Pro. Software as per IS1893:2002 part-1.This paper consider the parameter such as seismic zone (IV), response reduction factor (R), importance factor (I) and other properties like type of soil, type of structure, damping ratio etc. STAAD Pro. gives the results after run analysis in the STAAD output viewer which shows joint displacements, support reactions, member forces, reactions, base shear and lateral load. This economical way of analysis and design of the structure discussed in this paper with the help of an example of a multistory building. The output file generated by Staad Pro. consist of detailed numerical results for analysis and design.

1. INTRODUCTION

STAAD Pro is leading and most popular design software in the market today. Many more companies use this software for design purpose and analysis. The full form of STAAD is Structural Aided Analysis And Design.

This software is easy to use interface, user friendly, accurate results, solve any type of problem and based on Indian Standard Codes. Staad Pro. is used to analyze and design steel, concrete, timber, aluminum and cold-formed steel design of low and high rise buildings, culverts, tunnels, bridges, piles and much more.

Designing is done to analyze the building and its structural components with different load and load combinations in the Staad Pro. To perform accurate analysis in the software a structural Engineer must about information such as structural load, support conditions, geometry, material property, soil condition, location of building unit. Software include design of each and every member like beam, column, slab, footings and results like stresses, reactions, displacement etc.

2. PROBLEM DEFINITION

For problem analysis assume (G+5) storey building situated in region of Zone III and the soil conditions is medium stiff soil. RCC building of span 20m in X and Z direction (symmetrical structure), Floor to floor height is 3.00m, number of storey are six, size of beam is 0.30X0.45m And size of column as 0.45X0.45m, material assume to be concrete. All the supports are assigning as fixed supports. Calculation of design seismic force and other parameters by Response spectrum analysis method by using STAAD-PRO software.

Table 1:-**Design data of model Structure**

Elements	**Dimensions**
Length x Width	20m*20m
No. of bays along X-direction	4 bays
No. of bays along Y-direction	4 bays
No. of story	6 Story
Height of each story	3 m
Beams sizes	300mmx450mm
Columns sizes	450mmx450mm
Slab Thickness	150 mm
Support Conditions	Fixed Supports
Wall Thickness	250 mm
Seismic Zone	Z=III (0.16)
Type of soil	Medium soil
Grade of Concrete	M 20
Grade of Steel	415 M Pa

3. METHODOLOGY

The model plan is drafted to prepare the model of (G+5) building in Staad Pro. which comprising the following steps:

Step - 1: Creation of nodal points.

Step - 2: Represent the beams and columns. Use command of add beam.

Step - 3*:* 3D view of structure. Use Transitional repeat command in Y direction to

get the 3D view of structure.

. **Step - 4:** Assign the Supports and property.

Step - 5*:* 3D rendering view.

The six storied symmetrical building consisting of four bays in each direction. The height of building is 18.00m from the ground level and the building considered as symmetrical in all the directions. The 3D rendering view is shown in below figure.

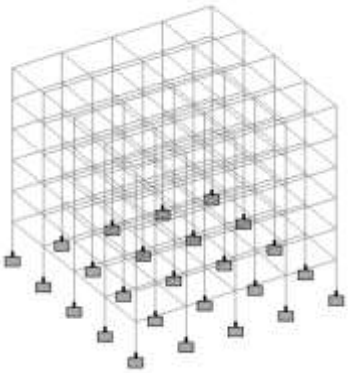

Fig.1 Structural model of building

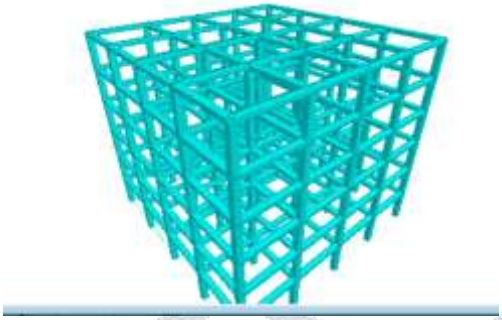

Fig.2 3-D Rendering view of building

Step - 6*:* Assigning the dead load as per IS 875 PART 1.

Step - 7*:* Assigning the live load as per IS 875 PART 2.

Dead loads consist of the permanent loads the roof, floor and walls.

Live load is the movable load on the building unit.

In Staad Pro. software assignment of dead load and live load is done automatically by giving the property of the member. Live load is assign in term of U.D.L. in Staad pro.

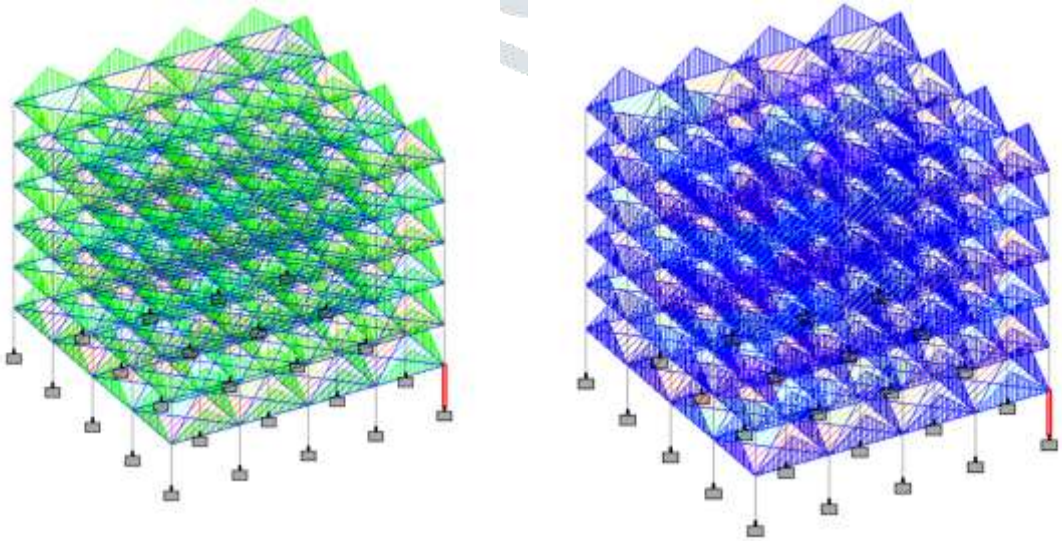

Fig.3 Diagram of Self Weight and Live load

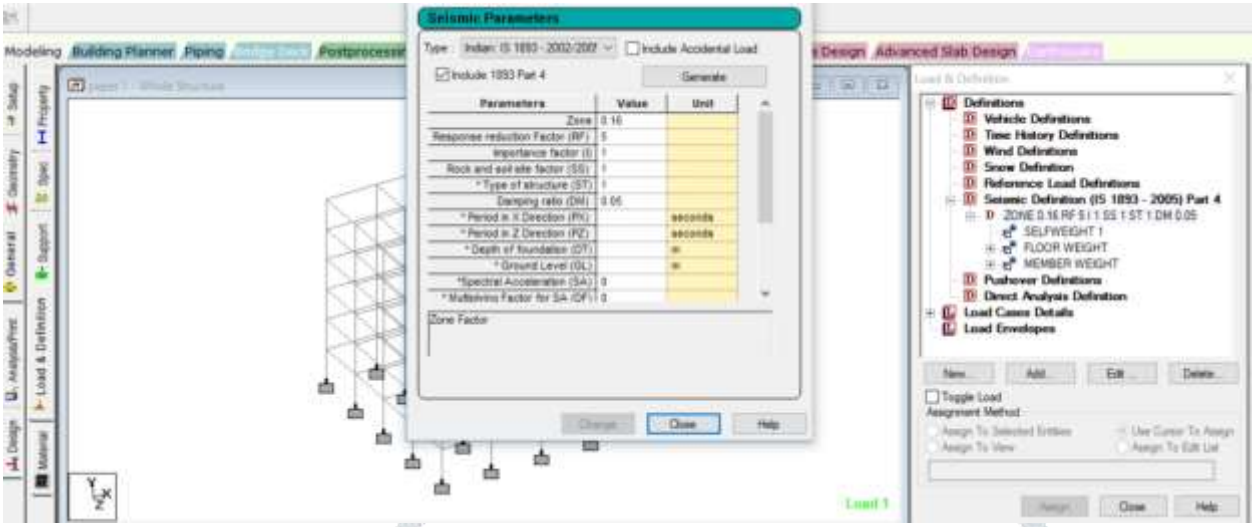

Fig. 4- fig shows the seismic load definition

In India, the earthquake resistant design IS 1893 (Part 1) 2002 code, the seismic zoning map of India divided four levels of seismicity for India in terms of zone factors i.e. seismic zones (Zone II, III, IV and V). Zone V has highest level of seismicity where as Zone II has lowest level of seismicity. Zone V covers the areas with the highest risks zone as compare to the Zone II.

Table 2:-Seismic zone Factor

Area	Value of Z (zone factor)	Seismic Intensity
II	0.10	Low
III	0.16	Moderate
IV	0.24	Severe
V	0.36	Very severe

Load Calculations

Dead Load code IS 875 (Part-I)

Live Load code IS 875 (Part-II)

Seismic Load code IS 1893-2005)

Following loading is adopted for analysis:

Dead Load:

Self Weight = 3.75 KN/m3

Live Load = 4 KN/m3

Roof Live Load= 2 KN/m3

Wall member Weight =15 KN/m3

Step - 8*:* Add load combinations as per IS 875 PART 5.

Different Load Combinations:

1.5(DL+-LL)

1.2(DL+LL+-EQ)

0.9DL+-1.5EQ

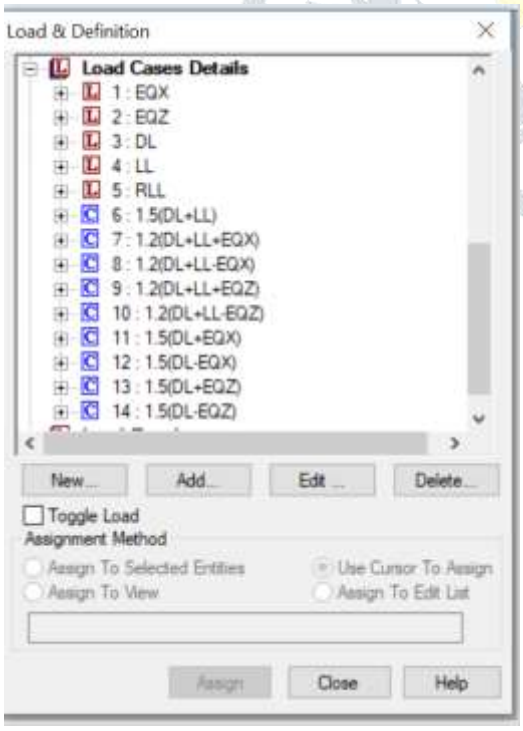

Fig. 5 fig shows the seismic load combinations

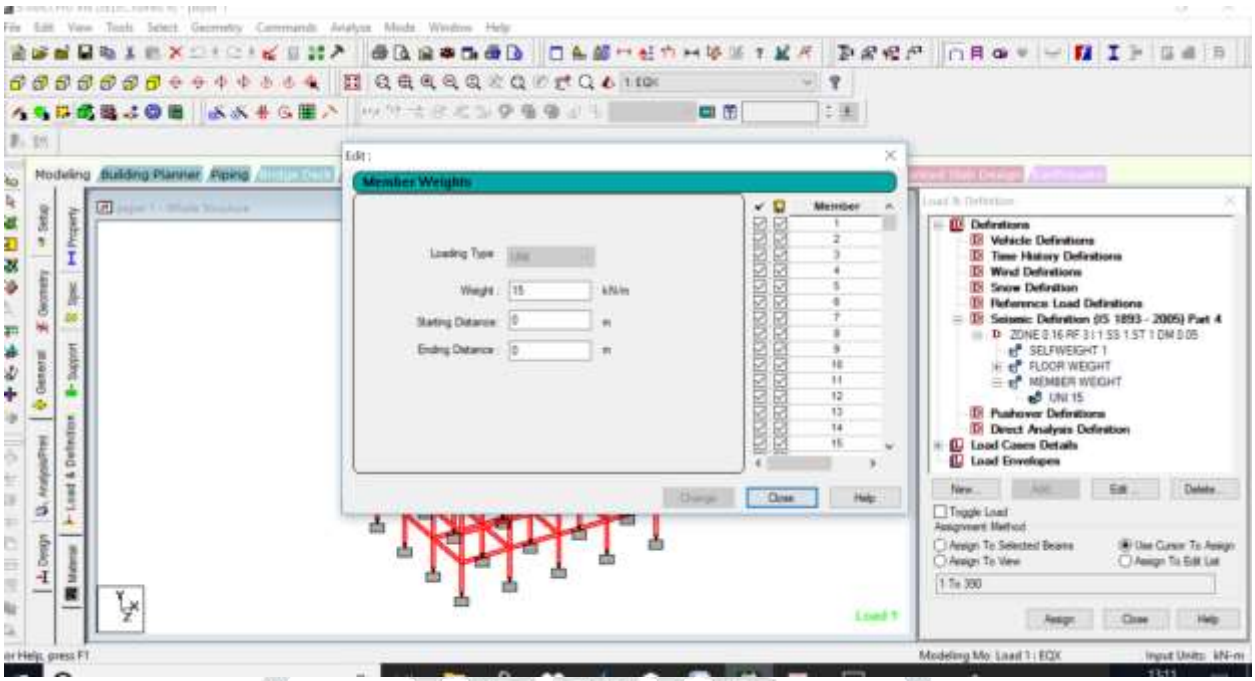

Fig. 6 fig shows Member weight .

Step - 9: Perform the analysis and check for error.

Step - 10*:* Concrete design is performed as per IS 456: 2000 by using design commands. After assigning of commands again perform analysis for any error.

Design Parameters:

Fc: Compressive Strength of Concrete

Fy main: Yield strength of main reinforcement Steel

Fy Sec: Yield strength of Secondary reinforcement Steel

Design Commands:

Design Beam: Design Beam for flexure (bending), Shear and Torsion

Design Column: Design columns for Axial load and biaxial bending

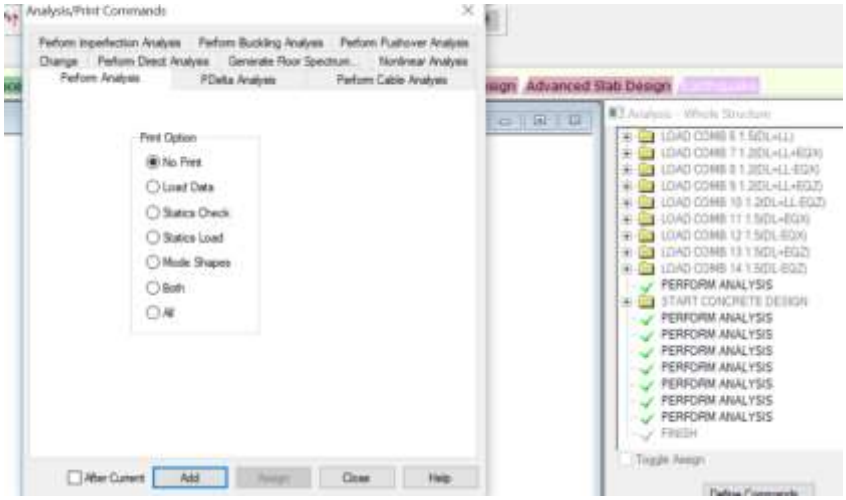

Fig. 7- fig shows the analysis of model.

Fig. 8- fig shows Output file

4. RESULTS AND DISCUSSION

In this chapter, the results of various parameters such as Axial Force, Bending Moment, Displacement, member forces, Percentage of steel, Quantity of concrete etc. of framed structure were obtained by post processing unit and output file of Staad.

Beam Design:

BEAM NO. 217 DESIGN RESULTS				
M30	Fe415 (Main)	Fe415 (Sec.)		
LENGTH: 5000.0 mm	SIZE: 450.0 mm X 300.0 mm	COVER: 25.0 mm		
SUMMARY OF REINF. AREA (Sq.mm)				
SECTION	0.0 mm	1250.0 mm	2500.0 mm	3750.0 mm	5000.0 mm
TOP REINF.	515.68 (Sq. mm)	246.09 (Sq. mm)	246.09 (Sq. mm)	403.12 (Sq. mm)	1157.86 (Sq. mm)
BOTTOM REINF.	1175.09 (Sq. mm)	436.63 (Sq. mm)	260.05 (Sq. mm)	246.09 (Sq. mm)	310.56 (Sq. mm)
SUMMARY OF PROVIDED REINF. AREA				
SECTION	0.0 mm	1250.0 mm	2500.0 mm	3750.0 mm	5000.0 mm
TOP REINF.	3-16í 1 layer(s)	3-16í 1 layer(s)	3-16í 1 layer(s)	3-16í 1 layer(s)	6-16í 1 layer(s)
BOTTOM REINF.	6-16í 1 layer(s)	3-16í 1 layer(s)	3-16í 1 layer(s)	3-16í 1 layer(s)	3-16í 1 layer(s)
SHEAR REINF.	2 legged 8í @ 165 mm c/c	2 legged 8í @ 165 mm c/c	2 legged 8í @ 165 mm c/c	2 legged 8í @ 165 mm c/c	2 legged 8í @ 165 mm c/c

Column Design:

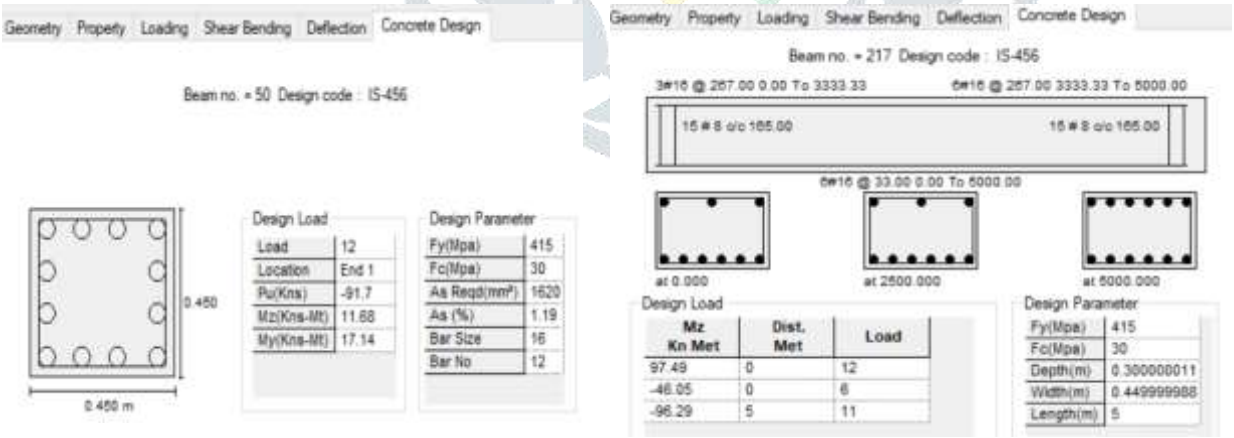

Fig. 9- Reinforcement results of Column and Beam obtain from STAAD

ELEMENT	STAAD RESULT
	Beam
Main Reinforcement	515.68 mm^2
Shear Reinforcement	2 legged 8mm dia. @165mm c/c
	Column
Main Reinforcement	1620 mm^2
Tie Reinforcement	8mm dia. @ 255mm c/c
Percentage of steel	1.19 %

Table 3: Design result of a column and beams

			Horizontal	Vertical	Horizontal	Resultant	Rotationa	
	Node	L/C	X mm	Y mm	Z mm	mm	rX rad	rY rad
Max X	101	11 1.5(DL+E	**52.622**	-1.460	0.000	52.642	0.000	0.00
Min X	105	6 1.5(DL+LL)	**-0.154**	-2.879	0.000	2.883	0.000	0.00
Max Y	103	12 1.5(DL-EQ	52.524	**2.965**	-0.000	52.607	-0.000	0.00
Min Y	103	6 1.5(DL+LL)	0.000	**-5.118**	0.000	5.118	0.000	0.00
Max Z	33	13 1.5(DL+E	0.000	-1.460	**52.622**	52.642	0.002	-0.00
Min Z	173	6 1.5(DL+LL)	0.000	-2.879	**-0.154**	2.883	-0.001	-0.00
Max rX	13	13 1.5(DL+E	0.000	-0.751	16.630	16.647	**0.004**	0.00
Min rX	173	6 1.5(DL+LL)	0.000	-2.879	-0.154	2.883	**-0.001**	-0.00
Max rY	66	11 1.5(DL+E	52.124	-1.457	0.034	52.144	0.000	**0.00**
Min rY	32	13 1.5(DL+E	0.034	-1.457	52.124	52.144	0.002	**-0.00**
Max rZ	105	6 1.5(DL+LL)	-0.154	-2.879	0.000	2.883	0.000	0.00

Table 4: Maximum and Minimum Displacement Values

			Horizontal	Vertical	Horizontal	Moment		
	Node	L/C	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	71	6 1.5(DL+LL)	18.211	1222.719	0	0	0	-18.292
Min Fx	74	11 1.5(DL+EQX)	-59.643	1251.461	0	0	0	153.651
Max Fy	73	6 1.5(DL+LL)	0	2160.996	0	0	0	0
Min Fy	74	12 1.5(DL-EQX)	-59.151	-1260.19	0	0	0	152.832
Max Fz	3	6 1.5(DL+LL)	0	1222.719	18.211	18.292	0	0
Min Fz	108	13 1.5(DL+EQZ)	0	1251.461	-59.643	-153.651	0	0
Max Mx	3	6 1.5(DL+LL)	0	1222.719	18.211	18.292	0	0
Min Mx	108	13 1.5(DL+EQZ)	0	1251.461	-59.643	-153.651	0	0
Max My	2	14 1.5(DL-EQZ)	-0.151	-923.891	-55.776	-149.199	0.206	0.263
Min My	36	12 1.5(DL-EQX)	-55.776	-923.891	-0.151	-0.263	-0.206	149.199
Max Mz	74	11 1.5(DL+EQX)	-59.643	1251.461	0	0	0	153.651
Min Mz	71	6 1.5(DL+LL)	18.211	1222.719	0	0	0	-18.292

Table 5: Maximum and Minimum Forces and Moments of sample Node

		FX	FY	FZ	MX	MY	MZ
j oint 1	1 EQX	-30.191	-102.277	-0.007	-0.018	-0.133	91.491
	2 EQZ	-0.007	-102.277	-30.191	-91.491	0.133	0.018
	3 DL	4.043	324.14	4.043	4.061	0	-4.061
	4 LL	2.828	152.244	2.828	2.841	0	-2.841

Table 6: Forces and Moments of sample joint.

Sr.No.	Material	Quantity	
1	Volume of Concrete	253.00 m3	
2	Weight of Steel	8mm dai	44993 N
		16mm dai	159741N
		20mm dai	92931N
		25mm dai	31044N
		Total steel	328710N

Table: 7 Total Quantities of G+5 Building

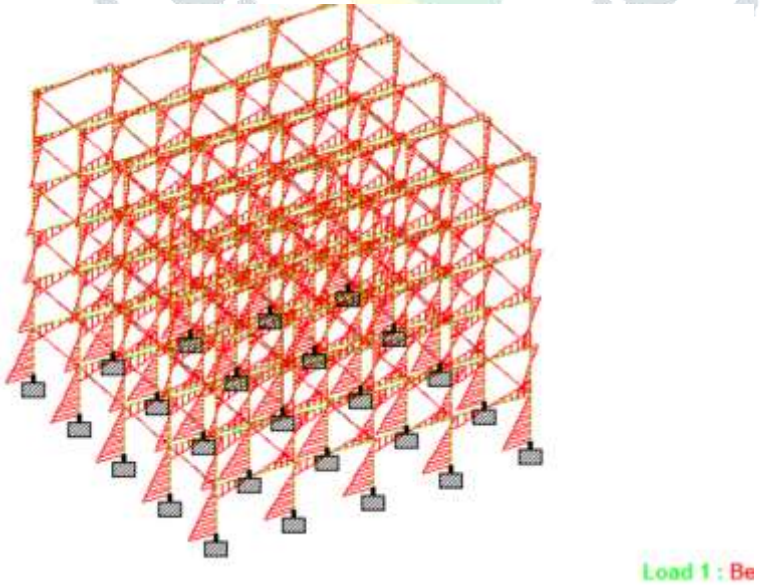

Fig. 10- Bending Moment of the Structure

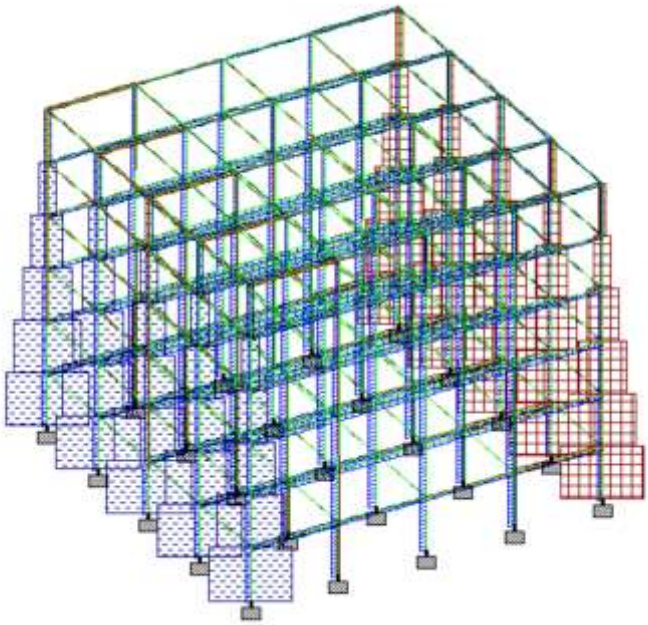

Fig. 11- Shear Force of the Structure

5. CONCLUSION:

The analysis has been done with the help of STAAD Pro. The response of (G+5) story Reinforced Concrete building under seismic load as per IS1893:2005 has been studied and found safe against all possible loadings and deflection. STAAD-Pro gives result very fast as compared to manual derivation. Designing using Software like Staad Pro. Reduce lot of time in design work or job. All other specifications like section properties, material constants, support load, analysis and design requirements, printing, plotting facilities are available. We can conclude that the results from Staad Pro V8i are much accurate and the structure is safe in analyzing and designing. The base shear, Lateral load, Joint displacement, member forces, horizontal and vertical reactions for all the joints of a building also has been calculated in STAAD output view file.

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