International Journal For Technological Research In Engineering
Volume 8, Issue 2, October-2020 *ISSN (Online): 2347 - 4718*

ANALYSIS OF EARTHQUAKE RESISTANCE TALL STRUCTURE WITH LATERAL FORCE METHOD

Jagdish Kushwah[1], Prof Kapil Soni[2]
[1]Research Scholar, [2]HoD
Department of Civil Engineering, RNTU, Bhopal (M.P), India

Abstract: High intensity of earthquake has expanded causing extreme harm to human life and property. Most of us must have the personally experienced earthquakes, and aware of them earthquake is something which causes the shaking of the earth. All building and structures erected on the earth's surface start trembling and when a quake comes. Stadd Pro, which allows the processing of a structure prefrence to its construction. For high-rise buildings it is possible to use Stadd. Pro for consolidation and its integration as well as structural analysis and design-based design. Steel is the most widely used building materials in the world. In order to take advantage of these seismic resources, a design engineer must be familiar with the design features of the metal and the purpose for which they are coded.

The basic formation of the building framework presented for this project is based on IS 1893-2002 and IS 800. such as IS 800: 2007 .The building contains six stories and has three biscuits on the straight side and five bays on the back side. The selection of the choosing categories was made after the normal process. The two methods used for the analysis are the equivalent static measurement and the Response Spectrum .A comparative analysis of the results Found from both methods was performed based on migration, story distribution and clipping.

The result of a response spectrum analysis using the response spectrum from a ground motion is typically different from that would be calculated directly from a linear dynamic analysis using that ground motion directly, since phase information is lost in the process of generating the response spectrum.

Key Words: Earthquake Loading, Manual Calculation, STAAD Pro., analysis-design, wind effect.

I. INTRODUCTION

Seismic analysis is likely to be a groundbreaking factor that analyzes the structure and that is the calculation of the building's response to earthquakes. it is part of the architectural approach, seismic engineering or structural testing and for-profit in regions where earthquakes are prevalent.

The most important earthquakes are at the extremities of the earth's crust. These plates are usually at least partially aligned but are prevented from doing so by collision until the pressure between the plates below the epicenter point is so high that the movement occurs suddenly. this is usually an earthquake. Earthquakes cause waves inside the earth that fill the earth, causing movement in the foundations of buildings. The significance of the waves decreases with the space from the epicenter. Therefore, there is a planet region with a high or low earthquake risk, calculating its proximity to the tectonic plate border.Beside from the major earthquakes that occur along the boundaries of the tectonic plate, some have their origins within the innocent pairs. Called „intra plates" earthquakes, these forces are small, but they can still destroy within the area known as the epicenter.

[TejavatVenkatesh et.al (2019)] designed and analyzed the hospital's energy and wind power structure. The structure was analyzed for wind turbines using STAAD.Pro and seismic loads were analyzed with a uniform static and base shear criteria. The G + 4 structure is analyzed for structural strength relative to the assumed strength.

[MVK.Satish et.al (2019)] evaluated and designed the G + 3 hospital building and the design of its land acquisition structure was studied using STAAD. NSP), this study recommends the use of standard NSP instead of the original NSP mode because it provides a better result when comparing building structures.

[Safwanahmad et.al (2018)] designed the G + 2 hospital building using STAAD.Pro using appropriate loads and section details to include part of the main purpose of this feature was to review the validity of using STAAD.Pro for analysis.

[Dr. Ashokkumar et.al (2018)] designed the G + 3 hospital building using a stand-alone stand at STAAD.Pro the efficiency of the analysis using software in addition to the written method was analyzed and a comparative analysis was performed.

[Adiyanto (2018)] reviewed a 3-story building using STAAD Pro. Earthquakes were installed in the building. Dead loads and live loads were taken from BS6399: 1997 and the intensity of ground loads was defined by the same energy process at UBC1994. The result was that the building could withstand any earthquake. It means that the buildings had to be built anywhere near the quake.

[R.D. Deshpande et al., (2017)] said that systematic analysis can also be a branch that involves the design of construction work, thus predicting the actual construction response such as structures, bridges, trusses and more. This project makes an effort to look at the improvement of the performance of various materials within the multi-character building. The analysis, demolition and testing of the multi-character building is included under the Basement + G + 5 Building. is compatible with the physical structures where the load is calculated, live loads are taken from code IS875-part 2 and the piles are arranged according to the size of the ground protection. Column array and column layout has a country method used.

[Sankar. J et.al (2016)] designed and developed the G + 4 hospitals and designsits using STAAD.Pro. The effects of the earthquake load are calculated by calculating the base and displacement where the findings of the member study show differences between different areas using comparative analysis.

[B. Gireesh (2016)]A study of the structure and earthquake of the G + 7 building was studied using the Stadd.Pro software. During this study planning was funded by the following general Indian codes: IS 1893 (Part 1) - 2007, in base shear planning. IS 1893: 2002 in terms of seismic resistance which identified various analytical methods supporting the local Zone, high building value and building value.After starting the project a heavy load, live load, air load, snow load and earthquake load was placed for further analysis.

[Aman et.al (2017)] The analysis and style of C + G + 5 for residential real estate was supported by support of the standards defined by IS codes in the Stadd.Pro software. The crucified load was only dead and the maximum load so the total load was produced was 1.5 (D.L. + L.L.) which after which the structure analysis was completed by the Framework and shipping times and pastoral forces were studied. From the moment it was concluded that the horizontal deviation was within 20mm so the structure was safe and economical. And no significant differences were found between the results from Kani's way and Stadd.Pro

[Mahesh et.al (2017)] This study focused on structural analysis within the effect of air load on a sloping surface with software Stadd.Pro. air conditioning was supported by India's standard code IS 875 part- III. Studies have shown that because height increases arrival time, shear strength and shared displacement all show a direct relationship with the higher value. It has therefore been concluded that zone IV is the most important because the rates of bending, shear strength and joint migration were the highest in the IV zone and the minimum within Zone I.

II. METHODOLOGY

The first step is to design the design of the building framework. The process involved is the selection of parts for independent members. Since the consequences of aggressive actions are a function of the strength of the members, the unsafe approach involves a lot of tolerance.

An example discussed here includes a structure in which seismic resistance is provided by the resistance friction (MRF) in both x and y indicators. Temporary resistance frames (MRF) are known as flexible structures. Their structure is therefore often governed by the need to satisfy judgmental approaches under magnitude earthquakes, or the limitations of P outcomes - under earthquake load. For this reason it is very popular for strong communication. The first design has the following steps:

- Definition of beam sections, testing deviations and resistance under load gravity.
- Following the screening process, review the next steps until all the criteria have been met.

The scanning process can enable it to use a team-based team approach or a visual response approach.

1. Beam category selection.
2. The classification of columns assesses „weakness of solid column formation".
3. Check the compression / binding at low levels under download.
4. Calculation of seismic weight.
5. Strict analysis of structure 1 plane under lateral loads.
6. Strict analysis under load gravity.
7. Strength test using the results of P-Δ (parameter ϴ) within the context of an earthquake load.
8. Deflection check underground loading.
9. With the visual response of scene 5 it is replaced by the visual appearance of the plane of 1 plane to reciprocate the effects of earthquake actions.

Beam category selection:

The parameters to be used for this section are determined initially using two checks: Moment Resistance check and Deflection criteria.

Checks the deflection limit of Beam in x motion. Selecting the Beam category:

Total Dead load + Live load =51 KN/m = gravity load.

Now the code specifies maximum deflection limit as $\frac{1}{300}$where, l is the effective length of the section.

$$\text{So,}\quad \frac{1}{300} = \frac{Pl4}{384EI}$$

$$I_{\text{Required}} = \frac{300Pl3}{384E}$$

$$= \frac{300X51X83}{384X2.1X108}$$

$$= 9714.3\text{cm}^4$$

So section selected is ISMB 350

I_{zz}=13630cm^4 Area 66.7cm^2

Depth of section= 350 mm Breadth of flange =140 mm Thickness of flange=14.2 mm Thickness of Web=8.1 mm

Definition of Column Sections checking the 'weak beam strong column criteria'

Mc: moment of column

Mg : moment of beam

ΣMc = Mc1 +Mc2

ΣMg = Mg1 +Mg2

ΣMc ≥ 1.2 ΣMg (as per IS 800:2007)

Σfyc XΣ Zcolumn>1.2Σfyb X Zbeam

So,

2 X 250 X Zreq. = 1.2 X 250 X 1094.8 X 1000

$Z_{req.}$ =656.88 cm^3

So, therefore the selection of section is:I80012B50012.
There for calculation of the moment using the shown equations &the section of all column is found to be: I80012B50012

Check compression &buckling at ground floor level with under gravity loading.
Formated loaded area=8 X 6=48m^2.
Floor weight is taken as 5Kn/m^2,all included.

$Ground_{floor}$=48 X 5=240KN/storey
G_{walss}=(8+6) X 3=42 KN/storey
G_{frame}=18.5 KN/storey

Q=3 KN/m^2X 48=144 KN
1.35 X G +1.5 X Q =1.35 X 300.5 + 1.5 X 144=622 KN/storey

Compression in column for basement level: 6 X 622=3732 KN.
Approx. buckling length should=3.0 m
(equal to each storey height)
Now calculation for the column section of 180012B50012
Sectional area=387 cm^2
And I_{ZZ}=494454 cm^4
Rzz = 35.744 cm
λ =.48
χ =.85
Fcd= χ fy/γ_{mo} =.85 X 250/1.1=193.18 N/mm2
Pd= Fcd X A=193.18 X 38700=7476.136KN.>3732 KN
Where;Fcd is calculated as design compressive stress.
Where;Pd isiscalculated as design compressive strength.

Calculation of seismic mass
For the steel structure frame considered, the seismic calculation of mass in terms of joint weight & for the member weight of the steel frame:

Dead load is = 5KN/m^2,
Live load is = 3KN/m^2

Area load calculatedfor each beam is 30m^2,& there are 3 beams in each storey. Therefore total DL +LL for per each storey is calculated to be:
= 3 X 30 X (5 + 3) =720KN

Nodal loads apply as 144KN on both interior nodes & a nodal loadapply as72KN on the exterior nodes. Thus the total nodal load arecontribution for the seismic mass calculation is:
=144 X 2 + 72 X 2 = 432KN

Weight of wall (Dead Load) is also contributes as for the seismic mass.
Weight of the wall (Dead Load) is 3KN/m.
Thus total wall weight per storey is calculated as:
= 3×24 =72KN

So far; There for total seismic mass for calculation as per storey is given by
= 720+432+72 = 1224KN

III. LATERAL FORCEMETHOD

The seismic load of the whole apartment is calculated from its total load and the load set. the load of columns and walls in any storey must be properly separated on the upper and lower floors of the storey. Buildings designed for storage purposes are likely to have a high percentage of service load present during an earthquake. The load on the roof is not considered.
With the same static system that generates structural strength in the right way, the layout of the seismic foundation is determined by VB = Ah × W
The following considerations are involved within the same standing procedure

- Basic construction mode makes a pre-existing contribution to the lower shear
- The total amount of construction is taken into account when opposing the weight that can be used in a dynamic process. And both of those ideas are valid for low-rise and medium-sized buildings

The average natural vibration time in seconds, with a flash resistance frame without brick filling panels is provided by:
T_a=0.085$h^{0.75}$
for all other structureadded with brick infill,
$\text{Ta} = \frac{0.09h}{\sqrt{d}}$
Where, d is denote as dimension of the structure at the plinth level.
for buildings with concrete and masonry shear walls,
$\text{Ta} = \frac{0.075h}{\sqrt{Aw}}$
Aw;shows the total effective area of the walls potationto first storey of the building in sq. meters. In this case the value of:
T_a=0.09 18/√24=0.33 Hz.
After discovering the potential for seismic activity at different levels, forces and times for a few members are usually detected using any computer virus common to the various cargo compounds listed in the code. The structure must be rebuilt in order to withstand the extreme effects of gravity. And the planned flow, the strength of the members and the moment of appreciation for the performance of Pretta must be determined. 1893 stipulates that storey drift in any comfort with a small specified thanks to lateral loads, with an average rating of 1.0 should not exceed 0.004 times the full height.

Table 4.1 : Analysis by lateral force method

Storey no.	Absolute displacement of storey D_i (m)	Design inter storey drift D_r (m)	Storey lateral force V_{tot} (KN)	Shear at storeyP_{tot} (KN)
1	0.003869	0.003869	1.969	179.201
2	0.012595	0.008726	7.951	177.232
3	0.023837	0.011242	17.83	169.281
4	0.035892	0.012055	31.657	151.451
5	0.047566	0.011674	49.212	119.794
6	0.058123	0.010557	70.582	70.582

RESPONSE & SPECTRUMANALYSIS:

In the field of seismic analysis this is often among the most used and calculating methods. using visual editing graphic to work. the concept used is that the weight is illuminated at diaphragm levels on the roof and at ground levels. Diaphragrams are considered immutable and as a result the column is not stable but later flexible. The rotating response of a mirror is represented by a type of weight-related migration illuminated by degrees of flexible flexibility (or vibration modes n) sufficient for the weight value.

Unstructured analysis of the structure is usually carried out in accordance with standard mechanical methods using the appropriate victim and the rigidity of the structural system, and as a result the natural time (T) and mode (Ø) of vibration methods are usually obtained. The distribution of weight and therefore the strength of the structure determines the composition of the mode.

Since the ground foundation is used under a multi-level system, the distorted structure is simply a mixture of all sorts of modes, which are usually achieved by vibrating vibrations of each illuminated sound. The modal analysis process is used to determine the dynamic response of the multi-degree-of-freedom system. Modal analysis as suggested by IS 1893 is discussed in this regard.

Each vibration mode has its own unique vibration time (with its own so-called status mode created by the detection of multi-diverted poles.)

The answer lies in the use of various combining methods such as the square-root-of-sum-of-square method (SRSS) or the entire quadratic method (CQC) used when the natural periods of the various methods are well divided (when they are 10% different of low frequency so the pumping rate does not exceed 5% .CQC may be the reporting method for modal integration methods recommended by IS 1893.

Table 4.2 : Analysis by response spectrum method.

Storey no.	Absolute displacement of storey D_i (m)	Design inter storey drift D_r (m)	Storey lateral force V_{tot} (KN)	Shear at storey P_{tot} (KN)
1	0.00491	0.00491	1.877	120.981
2	0.0115	0.0066	6.112	119.104
3	0.0161	0.0046	10.651	112.992
4	0.0196	0.0035	17.331	102.341
5	0.0219	0.0023	29.98	85.01
6	0.0234	0.0015	55.03	55.03

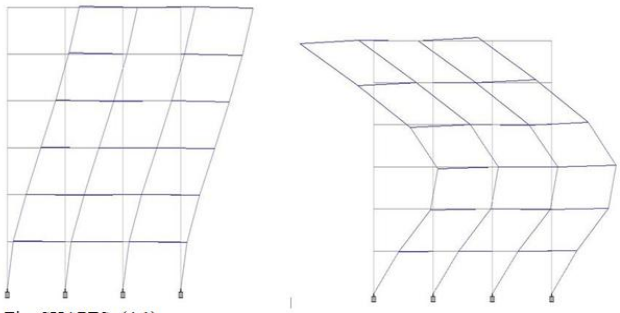
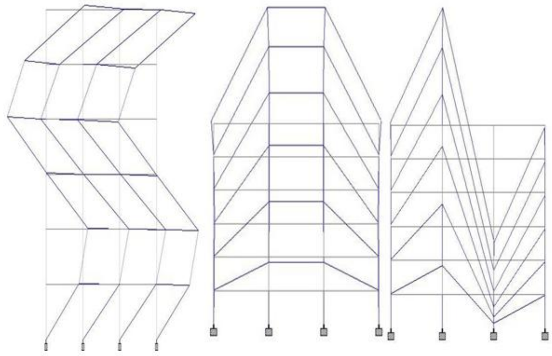


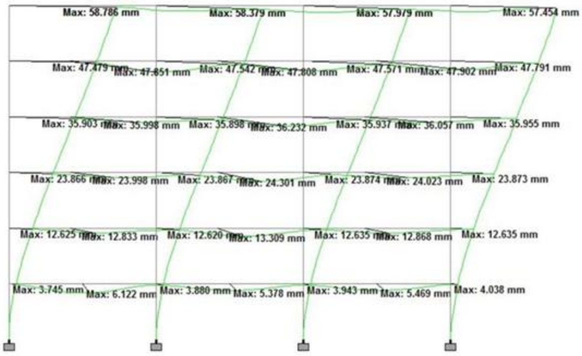
Fig. SHAPES: (4.1)
'Mode1'(1.592hz), MPFiz=85.33 'mode 2'(5.224hz), Modal &Participationfactor MPFiz=8.13



'Mode3'(9.525hz) MPF0 'mode4'(12.796hz) MPF0.01 'mode 5'(13.294hz) MPF2.04

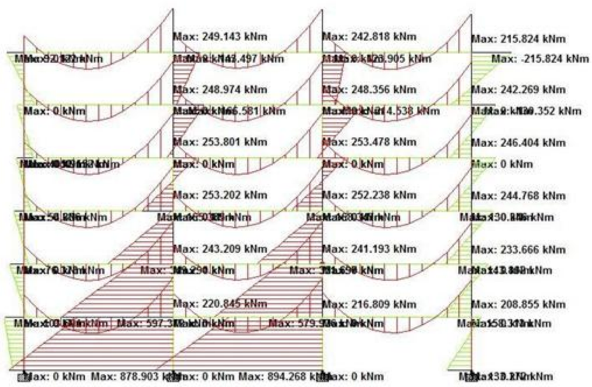
IV. RESULTS OF LATERAL FORCE METHOD

Max.bending moment, shear Force etc. Available in load combination1.7(EQ+DL)



FIG(6.1) Shows the Displacement Figure for load combination 1.7(EQ+DL)

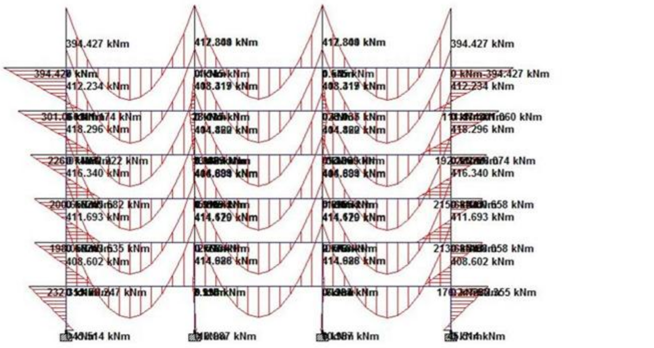
The inner center of the storey visible from the diagram above is within the limits of the collapse of the code i.e. is within .004 of storey height = 0.004X3000 = 12mm.



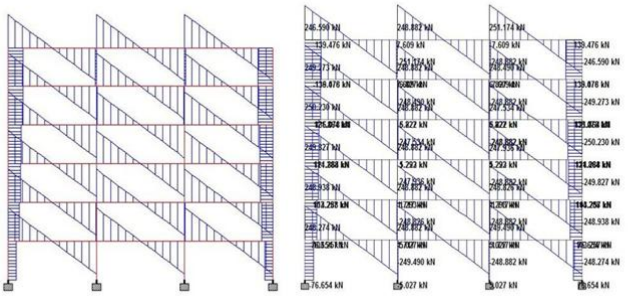
Shows the Bending moment Figure for load combination 1.7(EQ+DL)

RESULTS OF RESPONSE SPECTRUMANALYSIS:

Max bending moment, shear Force etc. Available in load combination1.3(DL+LL+EQ)



Fig(6.3) Shows the Bending moment figure for load combination1.3(DL+LL+EQ)

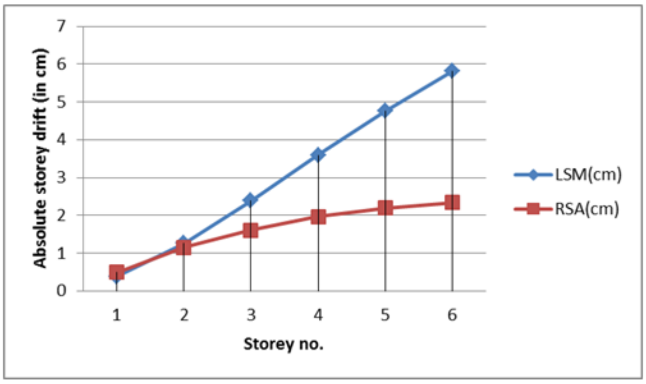


shows the 'shear forcediag.inX-axis' **'shear force diag. in Y-axis'**

The Load combination is same asboth cases of Load 'case1.3(DL+LL+EQ)'

Comparison analysis of the absolute storey drift in both methods: (table 6.1)

Storey no.	Storey height	LSM(cm)	RSA(cm)
1	3	0.3869	0.491
2	6	1.2595	1.15
3	9	2.3837	1.61
4	12	3.5892	1.96
5	15	4.7566	2.19
6	18	5.8123	2.34

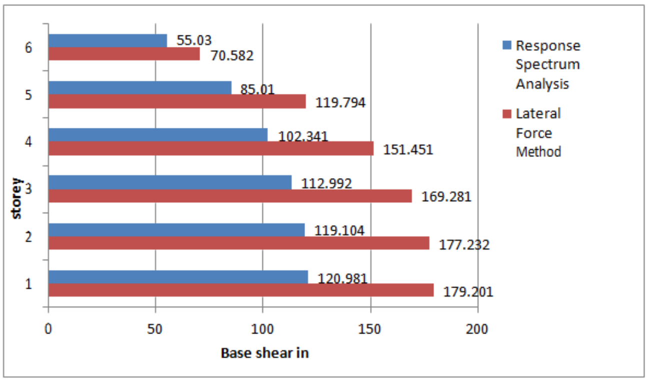


Fig(6.5) Graph of comparison no of absolute storey drift

Comparison analysis of thestorey shear: (using both LSM and RSA)

Storey no.	Storey height	LSM (KN)	RSA (KN)	Difference in %
1	3	179.201	120.981	28.91
2	6	177.232	119.104	32.79
3	9	169.281	112.992	33.25
4	12	151.451	102.341	32.42
5	15	119.794	85.01	28.99
6	18	70.582	55.03	22.033

It is found that the extreme shear difference of these methods is approximately 29.73% somewhere in each yard.



Graph of the comparison of shear storey

Final results with compared to initial design result:

Drift: By Lateral Force Method

Storey no.	Pre design drift (cm)	Post design drift(cm)	Difference in %
1	0.3869	0.2056	46.85
2	1.2595	0.5472	56.55
3	2.3837	0.9052	68.11
4	3.5892	1.2561	65
5	4.7566	1.5729	66.93
6	5.8123	1.8012	69.05

It is evident that the variability in design and pre-delivery variations is approximately 62.08% in the individual retail space.

V. CONCLUSION

1. To compute the seismic forces- story shears, base shear and lateral forces easily by the use of equivalent lateral force method and Response spectrum method.
2. The shear obtained by the physical means of the method is smaller than that obtained by the lateral force method.
3. Differences in the results of the expression of the response and the effect of the force of force are attributed to certain common assumptions within the lateral force path. Of course:
a. the initial mode mode makes a very important contribution to the lower shear.
b. the total weight of the construction is considered to be the opposite of the weight used in the process used. Both considerations are allowed in low and medium-sized buildings.
4. As seen within the above results the values obtained according to the force analysis are smaller than those of the lateral force method. this is very common because the duration of the main mode with a powerful analysis is 0.62803 is greater than the 0.33 s estimate of the lateral force method.
5. The analysis also shows that the basic modal weight is 85.33% of the seismic weight. The second modal is 8.13% of the total seismic mass m so the time frame is 0.19s.
6. By comparison of both methods equivalent lateral force varies on the computations of natural periods and basic formulae for carried out the forces. On the other hand response method or modal method varies on the mode shapes, frequencies and fundamental periods of the different mode of ground motion.

REFERENCES

[1] Subramanian N., Design of steel structures, Oxford University Press,7th edition,2011,173- 209
[2] NegiLS,Design of Steel Structures, Tata Mc-Graw Hill Publishing Company Limited,,2nd edition,1997,
[3] Punmia. P. C, 'Design of Concrete Structure', Lakshmi publications.
[4] Dhirajlal. A 'Design of RC Elements (Limit State Method)'.
[5] DUTTA, 'Estimation and cost', VSP Publications.
[6] IS Code of manual calculation for plain & reinforced concrete (fourth revision) IS:456 (2000). Methods of Indian standards, July 2000, New Delhi.
[7] IS code of practices sp 16-1999 Methods of Indian Standards March 1999, New Delhi.
[8] Minister of health section 44, ACT 1997.
[9] AgarwalPankaj and Shrikhande Manish, Seismic Design of Buildings, Prentice Hall of India Limited, July 2006,251-336.
[10] J. Sankar, E. V. RaghavaRao, N. Chennakesavulu, Design of G+4 structure for earthquake resistant, IJES&RT, December 2016.
[11] M. I. Adiyanto, M. I. Adiyanto, T. A. Majid, Malaysia S. S. Zaini, Analysis & Design of 3 Storey Hospital Structure Subjected to Seismic Load Using STAAD PRO ,2008.
[12] 'Dr. Ashok kumar N', 'Navaneethan M', 'Naviya B', 'Gopalakrishnan D', 'Atun Roy Choudhury'; Planning-Analysis & Design of Hospital BuildingS Using Staad Prov8i., 2017
[13] D.R. Deshmukh.et al. Int. Journal of Engineering Research and Application www.ijera.com ISSN: 2248-9622, Vol. 6, Issue 7, (Part -1) July 2016, pp.17-19
[14] Krishna Raju. N, "Design of Reinforced Concrete Structures" CBC Publishers & Distributors, New Delhi
[15] Design Example byArcelor-Mittal.(www.arcelor-mittal.org)
[16] IS 800:2007, Third Revision, General Construction in Steel –Code ofPractice.
[17] IS 1893:2002, Fifth Revision, Criteria For Seismic Design of Buildings, Part-1 General Provisions &Structure.
[18] Dr. H. J. Shah and Dr. Sudhir Jain, Design example of six storey building, IITK-GSDMA Project on Building Codes,13 February 2013
[19] Dr. V. L. Shah and Dr. S. R. karve, Design of RCC structures 8th ed., Jal – Tarang, 36 Parvati, Pune 411 099
[20] Indian standard plain and RC concrete - performance code (Fourth Review) IS 456-2000. Bureau of Indian Standards. 2000
[21] Custom code of India for cargo projects (excluding earthquakes) for building and dead-load construction (Second Edition) IS 875: 1987 (Part I). Bureau of Indian Standards. 2002
[22] India's custom code for project loads (excluding earthquakes) for construction and structural load (Second Revision) IS 875: 1987 (Part II). Bureau of Indian Standards. 2002
[23] Indian Land Standards for Land Standards (5th Review) IS 1893 (Part 1) Bureau of Indian Standards. 2002
[24] Establishing Limitations and Practical Issues in the Opposition and Response to Earthquakes. INTERNATIONAL ASSEMBLY FOR ENERGY ENGINEERING AND ENGINEERING (IJCIET), Volume 5, Complaint 6, June (2014), p. 89-93
[25] A Comparison of the Impact of Building Structures Using the STAAD Software and ETABS, WORLD CONSTITUTION OF CONSTRUCTION AND PLANNING, Volume 2, No 3, 2012
[26] Analysis of multi-storey building with full wall. INTERNATIONAL DEPARTMENT OF CONSERVATION AND SKILLS DEVELOPMENT, Volume 4, No 2, 2013
[27] Analysis and height of stores against a certain level of energy.INTERNATIONAL JOURNAL OF RESPONSIBLE engineering, Volume 3 Complaint 4 April 2014.
[28] Review of Shear Wall Lateral and Concrete Braced Multi-StoreyMuly-Storey Multi-Storey for Athor of Ground Soft Storey. INTERNATIONAL CYCLE OF INFORMED SCIENCE AND HIGHER LEARNING, Vol. 2, Index 09, 2014.
[29] Behavior of a multi-material structure under air capacity. INTERNATIONAL CYCLE OF INFORMED SCIENCE AND HIGHER LEARNING, Vol. 1, Figure 4, 2012.
[30] IS 875 (Part 2): Code of Practice for Building Structures (Except for Earthquakes) for Buildings and Buildings. Part 2: Released Loads (Second Review) (1987)
[31] D.Ramya, A.V.S.Sai Kumar "Comparative Study of Construction and Analysis of Multiple Complete Buildings (G + 10) By STAAD.Pro and Etabs Software's." IJESRT, ISSN: 2277-9655 (I2OR), (October, 2015)
[32] Mital N. Desai, Prof Roshni John "Comparative Study of the Construction of Different Spots and Different Isolators.", JIRSET (An ISO 3297: 2007 Certified Organization) Vol. 4, Issue 8, and ISSN (Online): 2319-8753, ISSN (Print): 2347-6710, (JULY 2015).
[33] Jenish M Mistry, ChintanKhatri, Anuj. K. Chandiwala "A Review of Design Based on Multi-Story Structures." IJAERD, Volume 2, and Issue 12Sci Science Journal (December 2015)
[34] Syed Rehan, S. H. Mahure "Study of Seismic and Wind Effect Multi Multiy R.C.C. Steel Structure and Combination. "IJEIT, Volume 3, Reference 12, ISSN: 2277-3754 ISO 9001: 2008 Certified. (June 2014)
[35] Arunkumar N pattar, Sunil kumarchavan, MuralidharRaje, Professor Vishwanath B Patil "Analysis and beauty of Multi Storied Structural

System on the effects of air loads using Staad Pro and E-Tabs.", JIRT Volume 2 Issue 1 ISSN: 2349-6002. (June 2015).

[36] Shashank B. S, S. Raghunath "Analysis and aesthetics of a fully-fledged consignment building with aRcc structure built into the frame." IJRET volume: Special issues 03:06, ISSN: 2319-1163 pISSN: 2321-7308. (May 2014).

[37] Ashok Thakur, Arvinder Singh "Comparative Analysis of the Residential Building of Full Standards and Exterior Shear Wall using STADD Pro." IJRRA ISSN: 2349-7688, Vol. 1, Index 1, p. 54-57. (June 2014)

[38] R R. S. Malik, S. K. Madam, V. K. Sehgal "The Result of the Rise in the Turning of the Combined Concrete Buildings Collected by the Joint Wall of the Boat." Journal of Engineering and Technology, Vol. Problem 1 (Jan-Jun 2011).

[39] Limit theory state and Design- Karve and Shah, building publishing, Pune Limit State Design for reinforced concrete- P. C. Varghese, Prentice Hall, New Delhi

[40] Rich Design- B. C. punmia- Laxmi publishes New Delhi. Datta and S. Ghorai, "Multistoreyed Residential Building (B + G + 20) Built with Metal Structures", Center for Metal Development and Growth; Publication number: INS / PUB / 117, 2010.

[41] T.K. Bandyopadhyay, "basic concepts in composite structures", revives the construction of composite using steel, organized by the Institute for Steel Development & Growth (INSDAG) and Jadavpur University, Kolkata, 2000.

[42] nR. Narayanan, "Integrated Metal Buildings", Development, Design and Construction, Elsevier, Engineering, UK, 1987.

[43] Study Report, "Metal-Structured Metal Buildings", Construction Economy within the uk, CONSTRADO, (2), 1985,

[44] R Narayanan, "Stainless Steel Building", Teaching Tool: Volume I, II & III: INSDAG Publications Prepared by IIT Madras, Anna University and the Structural Engineering Research Center (SERC), Chennai.

[45] UD. Datta no-A. Guha, “Composite Deck Design Manual”, Metal Development and Growth Center; Publication number INS / PUB / 079, 2005.

