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Assessment and Design of Steel frame Structure, consists Performance of Connection Joints with Tekla & Staad Pro

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Abstract: Steel offer the range of advantages to the structure Industry. The erudition of steel gives architects, and the freedom was to achieve the most ambitious visions. Steel is also one of the most sustainable construction materials, building owners naturally value the flexibility of steel buildings in addition the value of benefits they provide. Steel is ideal for modernization, reconfiguring, extending or adapting with minimal disruption. The conception of design analysis as well as modelling of steel structures is the most up-to-date edition in the civil engineering field. It is necessary to model a steel structure but if it is also analysed during its modelling then there will not be any chances of failure. Tekla structures are powerful and flexible software for all structural projects. Flurry up our construction work with an enormous of standard connections for all structural projects. In construction field, we create a evident, constructible 3D model of any steel structure from everyday industrial and commercial buildings to stadiums and high rise buildings. This project dealing with manual connection designing by using of Standards (ISO, AISC, AWS etc..). As well as considering of OSHA rules. Implemented manual designing and modelling by using of Tekla software. And the connections are an important part of steel structure like beam to column connections, moment connections. And are designed more conventionally than any individual members. The aim of this project work is to analyse a 7-storeyed commercial building for different load combinations using STAAD Pro software. And behaviour of connection of bolts.

Key words: Behaviour of connections, Modelling in Tekla Structures, Standard Code books (IS:800-2007,IS:875 part 1,2,3), Steel manual design

I. INTRODUCTION

The speedy enhancement in people, poverty and high cost of land has more effect the construction industry. This has commanded to the construction of buildings higher. Better development in erection technology, constituents, and mechanical systems, besides assessment and design software expedited the development of tall buildings. As the elevation of structures more, seismic load resisting system becomes huge important than the structures, cut off partition, wall-frame, braced pipe arrangement, Beam arrangement and tube-shaped arrangement. Mechanical system that tolerate gravity loads. The earthquake load resisting arrangements that remain broadly recycled be situated unbending frame Steel is a material which is used for present trending structures, which is formed with a specific shape following Indian standards of chemical composition and strength. They can also be find as hot rolled steel products, with a cross section of special form like angles, channels and beams/joints. There has been any more insist for steel for construction purposes in the India. Dimension are been taken by the structural steel authority for instant possible available of structural steel on time for the different structural steel projects. The planning platform is the ultimate time to regard appearance such as accuracy and safety precautions as well as cost and appearance. The selection of materials chosen for beside the walls, at the roof space and foundations are basic information about steel structures. Steel-framing is day by day becoming increasingly more popular, with suggestions in the home building industry that these systems will protect a significant share of the domestic market sometime after the turn of the century. As well as suiting traditional choices in Layout and exterior finishes, steel framing can widen the options available. The unique behaviour of steel, such while its strength as well as light weight, lend themselves to innovative design ideas.

The people at every stage are working with great effort to substantiate the goal of producing steel on time, like, service centres, fabricators and erectors along with the general contractors, structural engineers and architects are all working hand in hand.

Steel has perpetually more leaned to concrete because steel offers extreme tension and compression thus resulting in lighter construction. Commonly structural steel uses three dimensional trusses hence preparing it huge property than its concrete correlative. There are contrasting inventive techniques which entitle the generation of a huge range of structures and shapes, the procedures following:

- High-precision analysis of stress
- Computerized analysis of stress
- Creative joint connections

Various types of steel sections and their specialized specifications according to standards as follows:

- Beams
- Channels
- Angles
- Flats

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Advantages of structural steel:

Currently a existence for the most component of the construction new as steel is a structural material compare toward concrete, shopping malls and communication line towers, stadiums, industrial sheds with structures etc.

- Together from differentcomparable in manufacture of vehicles, ships etc. Steel analysis gripping physical property that perform it major important corresponding capable construction while used in formation of dissimilar structures.
- It be enormous durability, high strength, equalization, less weight, natural of using, apart number of striking properties expose it so as to is range of dissimilar material for a range of structures such as steel bridges, more hei, towers, as well as other structure.

II. BEHAVIOUR OF CONNECTIONS

Historically, identical primary structural failures include been due to various work of connection failure. According amid the design as well as detailing needs for joints amid members. so as to connection elements include mechanism such as gusset, plates, and connectors such as bolts, welds. In structure the connections be shall exist designed so as to exist regular with the assumption through in the study of the structure and the necessities specific in this section. Connections shall exist able of transmitting the calculated plan actions. The ductility of steel assist the allocation of forces generate within a joint. possessions of residual stresses as well as stresses suitable to tapering of fasteners and usual tolerances of fit-up require not therefore be consider in connection design, provide ductile behaviour is ensure.

In this project I explained where the bolts are required, at which joint, which type of connections are required. And connections are one of the major important role in steel structures. Every element in a union shall be designed. So that the creation is capable of resisting the design actions. Connections and side region of the member shall exist designed with distribute the create action special effects such to facilitate the following requirements are satisfied.

Fitting together project be determined by resting on the engineer's assessment detailing the process the structure is analyse Simple connections as well as are exact as individuals connections so as to convey end shear only.This content underlie the project of the complete construction cutting-edge which the beams be considered since a basically support in addition to the columns be considered on behalf of axial load as well as moments induce by the end responses as of the beams. Cutting-edge repetition, though, the joints contain a measure of fixedness, steel frames are whole of beams and columns so as to are connected to each current by connection as well as connection is responsible for the reassign of forces as of the Beam towards column connections and withstand that forces.

The subsequent four primary procedures of simple joining remain consider now this section:

- Web cleats with double angle
- Flexible end-plates
- Fin plates
- Splice connections in columns and beams

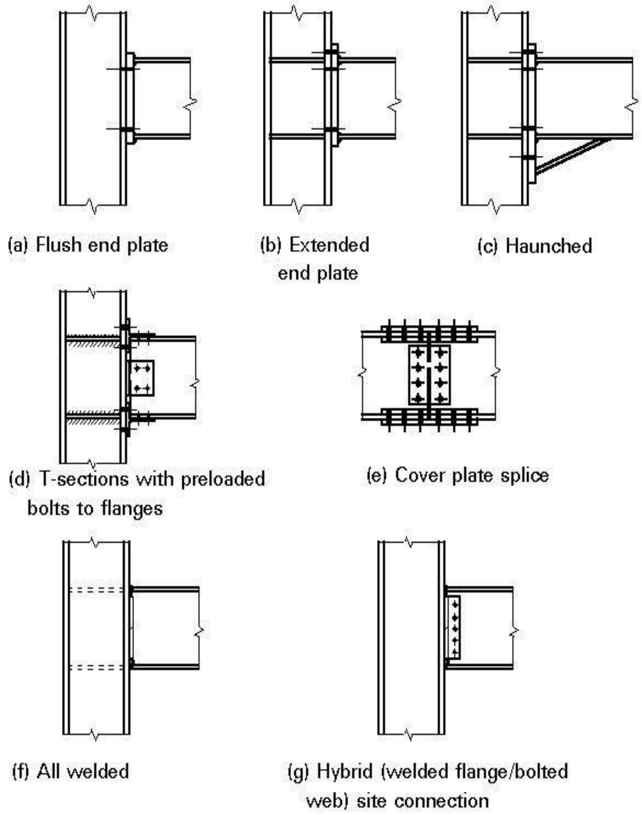

Fig 1: Type of Connections in Steel structures

III.COMPARISION OF MODELLING

This project is depends on software with standard codes and rules. And modelling completely based on design.

A. Tekla structures 21.0

- Modelling
- Erection (in this one we can show the plan view)

Following with standard Indian codes and rules. Model is done by Tekla software, and connections also plays a major role in this software.

B. Staad Pro

According to Indian standards, analysis and design of steel frame structure done by the StaadPro software.

Tekla software is an objective base system. The commands be as plain as possible. For illustration the software have now one copy command as an alternative of have divide end, bolt, and other copying commands.

Learn to use Tekla software is directly forward. "If you contain any practice on other 3D modelling system the foundations as well as move towards are now the similar, itssimply a folder of learn a new position of commands, and with Tekla these are reasonably easy to trail.

"Placing steel member anywhere you essentially need them is very simple and constant the mainly critical structures an exist modelled extremely quickly. The automatic connections are exciting. Through this software, Tekla drive the progress of digital in sequence models and therefore provides further and more reasonable advantage to the construction, communications and energy industries.

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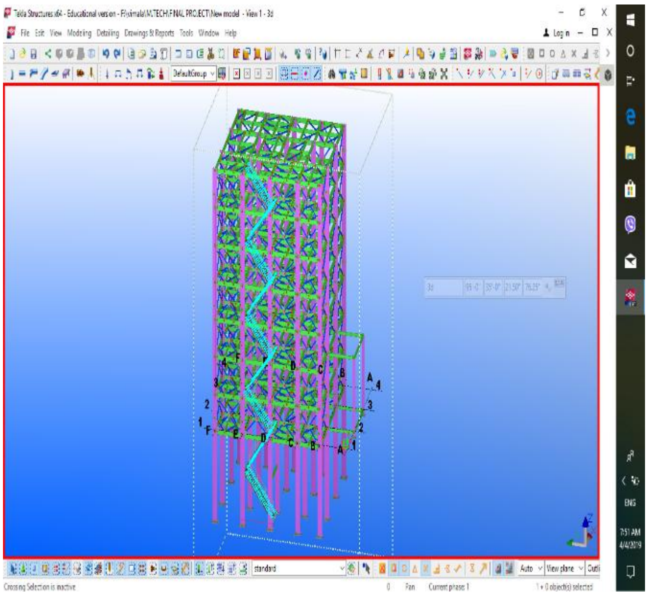

Fig 2 : Model in Tekla Software

For steel structure staad pro gives satisfactory results but in case of concrete structures the results are not economical ,which means for ex, for a beam if 250mm x 500mm is sufficient it provides say 250mm x 600mm which proves it uneconomical for concrete structures.

So it requires manual cross checking for dimensions and reinforcement.

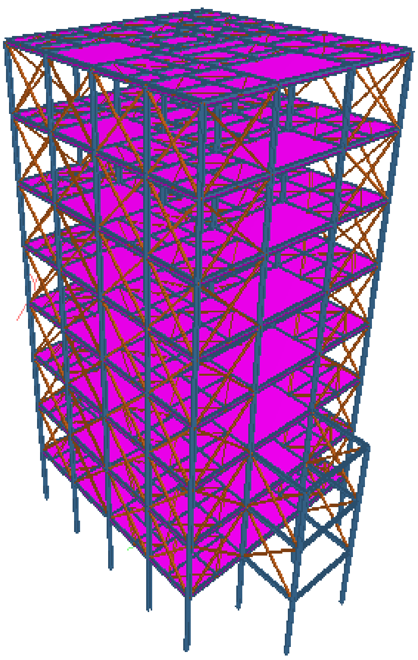

Fig 3: Model in Staad Pro

It has limitations in the model say example if there is a curvy boundary, a parabolic beam, etc., Can't be modelled effectively and analysed efficiently.

The generation of report needs more time to sort out things and no detailing (proper) report available.

IV. LITERATURE REVIEW

In the literature the study and Assessment of steel frame structures this project dealing with manual connection designing by using of Standards (ISO, AISC, AWS etc...). As well as considering of OSHA rules. Implemented manual designing and modelling by using of Tekla software. And the connections are an important part of steel structure like beam to column connections, moment connections. According to follow this journals.

Charles W. Roeder, M.ASCE., et.al (2002) This paper illustrate an "Connection presentation for Seismic Design of Steel Moment Frames" Welded-flange-bolted-web connections be injured throughout the Northridge Earthquake, as well as the SAC Steel Project was underway to recover solutions to the effort cause by this damage. The Connection concert Team was one of quite a few groups effecting the project research, and this collection examine all connection concert issues. A numeral of connections be evaluated, and three strategies were use to progress the seismic presentation of dissimilar connections. An accepting of all defers mechanisms and collapse modes for every connection sort are essential for appliance of these development strategies.

Syed Firoz, S.Kanakambara Rao., et.al (2012) This paper illustrate an "Modelling conception of sustainable steel building by means of Tekla software" The mainly important element governing the option of steel (I-section)& appearance of construction designed for any constituent is its structural integrity. while high specific strength as well as well intended project with Tekla software. It is used to choose the steel I-Sections for strength and durability of the building to accept a range of type of dead loads, live loads and wind loads. Development for energy efficiency, water efficiency and to get better the indoor environment.

Salem R.S Ghdoura, Vikas Srivastava., et.al (2016) The central object of this thesis was "Analysis of Steel Framed Structure using STAAD Pro and ROBOT Software". We know so as to, restrictions on maximum permissible deflection. The high strength property of structural steel cannot always be utilized to best results. As a result several new method contain be purpose at maximize the stiffness of the steel members with no some increase in weight of the steel essential. Steel frame is a building method amid a skeleton frame of vertical steel columns as well as horizontal I-beams, construct in a rectangular grid to hold the floors, roof and walls of a building which are all attach to the frame.

ValeriiaLobanova., et.al (2017) The aspire of this thesis was "Comparison of structural modelling in open BIM projects". Tekla Structures as well as Revit, in order to recognize difference in open BIM IFC-models according to general BIM requirements 2012 and recover out benefits of modelling in every program. This theme is definite, as at the moment more consumers need information models of buildings, which hold all information concerning the facility. So have the idea of the difference and compensation of BIM projects, made by means of the help of different programs, will allow designers to decide the program so as to is the most appropriate for a certain case. The first element of the study was to produce structural models. For this reason the student's version of Revit 2017 and Tekla Structures 2017 be downloaded and considered.

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During the procedure of modelling, the variation in method of structural modelling in Tekla and Revit be analysed.

Madhurima Dutta., et.al (2017) This paper illustrate an "Wind analysis & Design of a multi storied structural frame believe use STAAD PRO"

STAAD Pro is extensively use software for structural designing intention. In this revise a tall G+28 storied building is designed as well as analyse by create software STAAD pro v8i.The arrangement of static and wind loads are occupied into account. The post processing results in conditions of bending moment, support reaction, shear force, axial force are analyse. Due to produce of wind load on the structure, the story wise difference of the effect with respect to dissimilar parameter are compare and a comprehensive design of reinforcement is also considered that will make sure the structural protection of the building.

Azizi Naserabad Alifaz, Ghasemi Mohammad Reza., et.al (2018) The major object of this view was "Evaluation of Beam-Flange (BF) Bolts on Behavior of New BBCC Connection through Preferred Support in Modularized Prefabricated Steel Structures" The designed prefabricated Bolted Beam-to-Column link (BBCC) have be initiate to eradicate the effort of continuous/box columns as well as to give details such merits while high-quality factory fabrication, easy transportation, erection, resumption, investment return, prefabrication, as well as modularization; this paper aim by numerically study the cyclic performance of this novel connection with a prefer support shape.

Dr.P.D. Hiwase,Miss. Aditi Joshi, Mr.AakashKeshariya., et.al (2018) This paper illustrate an "Comparison between Manual as well as Software Approach towards Design of Structural Elements".

Emerging since the olden times while the use of manual calculation was main, the use of a range of software's and learn of the same has turn into greatly easier and important. Big construction firms and ventures have switched their move towards and have started by them for design purpose. This paper mostly ponders ahead the evaluation of analysis procure from the design of regular multi-storeyed structures using these user friendly software's. In this manuscript, evaluation of software's effect with the instruction manual calculation of a example beam and column of the same structure calculated as per IS 456 has been completed.

V. METHODOLOGY

The theme of this project remains towards assessment the whole building with different load combinations in addition to design of structure in line for towards custom of steel for instance a material. Then the consequence of essential steel building reaction now various conditions.

- Dead load on the structure
- Live load on the structure
- Wind load on the structure
- Seismic load on the structure

Now a erection of structure binary most important aspects well thought-out remain protection in addition low-cost. Uncertainty the loads be there in sync besides taken complex at that moment economy remains affected. If economy stands reflected in addition loads remain taken reduced before the security remains compromised. Subsequently the approximation of a number of loads acting remains towards intended accurately. Indian Standard Code IS:875-2007.

A. Dead load of the structure :

Dead load remains taken by means of recommend by IS:875-1987 (part-1) code of preparation design of loads (further seismic activity) intended for buildings in addition construction.

Steel surface, finish level, channels & ceiling system= 47kg/m

Partitions	= 8kg/m
Total	= 47+8
	= 55 kg/m
	= 495 N/m.
And add unit weight of beam	= 452.056 N/m.
Total dead load	= 495+452.056
	= 950 N/m.

B. Live load of the structure:

Live load remains occupied as per prescribe by IS:875-1987 (part-2) code of practice for design of loads for buildings and structure.

Imposed loads for different occupancies

Commercial (or) office buildings	= $22x10^3$ N/m.
Design load 'W'	= $(22x10^3)+950$
	= $22.950x10^3$

C. Wind load of the structure :

The elementary wind speed intended on behalf of every site shall be there obtained from IS:875-1987 (part-3). It is 39m/s in addition shall be modified towards include the following effects towards get design wind velocity at any height (V_z) for the chosen the structure.

Risk level Terrain roughness, height in addition size of the structure, and level topography it be able to be mathematically expressed for example follows:

$V_z = V_b. k_1.k_2.k_3$

V_z = design wind speed at any height **z** in m/s.

k_1 =probability factor (risk coefficient)

(Refer 5.3.1 of IS:875(Part 3 -1987))

k_2 = terrain, height and structure size factor

(Refer 5.3.2 of IS:875(part 3-1987))

k_3 = topographic factor

(Refer 5.3.3 of IS:875(part 3-1987))

Wind coefficients

Wind speed	= 39m/s
Terrain category	=4
Structure class	=B
Risk coefficient (k1)	=1.0
Topography (k3)	=1

D. Seismic loading of the structure :

Now the present effort the building is located in kadapa which come from under zone- III, by means of the IS:1893-1984, the following remain the various values for the building considered.

Zone factor (Z):

This one remains a factor towards obtain the design spectrum depending proceeding The basic zone factors included now this standard remain reasonable assessment of effective peak ground acceleration.

Zone factor = 0.16 (Zone- III)

(from IS:1893-2002 part-1, Table-2)

Response reduction factor :

This one is the factor by means of which the actual base shear force that would be generated if the structure were to remain elastic during its response to the Design Basics Earthquake (DBE) shaking, shall by reduced to obtain the design lateral force

Response reduction factor = 5.0

(from IS:1893-2002 part-1, Table-7.1)

Importance factor :

This one is a factor used toward obtain the design seismic force depending proceeding the functional use of the structure, characterized by hazardous consequences of post-earthquake practical necessity, ancient value, otherwise economic importance

Importance factor = 1.0

(from IS:1893-2002 part-1, Table-6)

VI.MANUAL DESIGN OF STEEL STRUCTURES

A floor of a building measure 16x18m consists of 150mm thick R.C slab support on steel I-beams spaced 3m at a distance as shown in fig. The finishing load may exist taken as 2.2kn/m. and live load is 1.5kn/m2.

Weight of R.C.C slab:

Weight of R.C.C slab = 0.1x4.5x25
= 16.875kn/m.

Finishing load = 2.2x4.5
= 9.9kn/m.

Self weight (assumed) = 1.0kn/m

Total dead load = 16.875+9.9+1.0
= 27.775kn/m.

Live load = 4.5x1.5
= 6.75kn/m.

Total factored load = 27.775+6.75
= 34.525kn/m.

Effective span of S.S.B=centre to centre distance of supports

Assuming width of support = 0.5m

Effective span = 5+0.5 =5.5m

Design moment, M = wl2/8
=34.525x5.52/8
= 130.547kn.

Design shear force, V = wl/2
=34.525x5.5/2
= 94.94kn.

Section modulus required, Zp = Mp/fy x γ m0
=109.27x106x1.25/250
= 546350mm3

As per IS:800-2007, γ m0 =1.25 (table-5, pg nu=30)

ISMB300 which has

Zp=651.74x103mm3. (From IS-800:2007, pg nu-138)

Properties of the section are as follow

Depth of section, h =300mm

Width of flange, b = 140mm

Sectional area = 5626mm2

Thickness of flange = 12.4mm

Thickness of web = 7.5mm

Depth of web, d = h-2(h2)

(h2=27, from steel tables)
= 400-2(27)
= 346mm

Moment of Inertia about Z-Z axis
ZZ =4860000mm4

Elastic section modulus
Ze= 573.6x103mm3

Out standing leg of compressive flange,
B =140/2
=70mm

A. Classification of section:

E = (250/fy)1/2
=(250/250)1/2
=1

b/tf =70/12.4 = 5.645<9.4E

d/tw = 346/7.5 = 46.133<84E

Hence the section is classifies as plastic section,
if we have to take another bay
in this one it change effective span.

Effective span =6m

Width of support =0.5m

Total length =6+0.5
=6.5m

Design moment, M = $wl^2/8$
=(28.9x6.52)/8
= 152.628kn-m.

Design shear force, V = wl/2
= (28.9x6.5)/2
= 93.925kn.

Section modulus required,Zp = (Mp/fy)x γ m0
=(152.628x106x1.25)/250
=76310mm3

Third bay:

Effective span = 5.5m

Assume width of support =0.5m

Total length =5.5+0.5
=6m

Design moment, M =$wl^2/8$
= (28.9x5.52)/8
=109.27kn-m

Design shear force, V = wl/2

= (28.9X5.5)/2

= 79.475kn

Section modulus required, Zp= (Mp/fy)x γ m0

= (109.27x106x1.25)/250

=546350mm3

B. Calculation of wind loads:

Pz =0.6VZ^2[as per IS 875 part 3]

P_Z =design wind pressure

V_Z =design wind velocity in m/s at height z.

Design wind speed VZ = Vb.K1.K2.K3

Vb = Basic wind speed

K1 = probability factor

K2 = Terrain, height, structure size factor

K3 = Topography factor

Vb= 39m/s [as per IS 875 part 3]

K1 = 1.0m/s

K2 = 0.83

K3 =1.0

Design wind speed VZ = 39x1.0x0.93x1.0

= 36.27 m/s.

P_Z = $0.6V_Z^2$

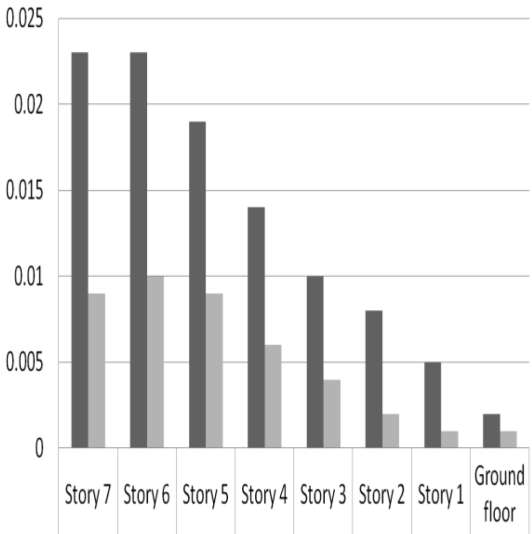
= 0.6x36.27

= 789.30774N/m2.

VII. RESULTS

This chapter deals with analysis and design of steel frame structure with bracings and without bracings. At each storey of the structure with different load combinations.

A. Maximum displacement of structure with bracings and without bracings in X-direction designed for load combination 1.2(DL+LL+WX+) in Wind Load Zone-III.

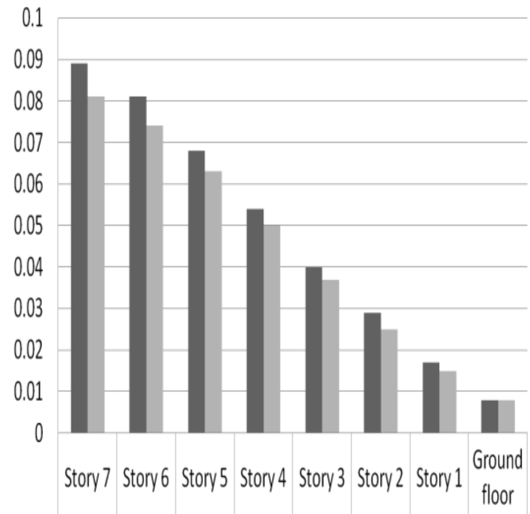


	Story 7	Story 6	Story 5	Story 4	Story 3	Story 2	Story 1	Ground floor
With Bracing	0.023	0.023	0.019	0.014	0.01	0.008	0.005	0.002
With out Bracing	0.009	0.01	0.009	0.006	0.004	0.002	0.001	0.001

Displacement

Maximum displacement of structure with bracings at height of 28m the displacement value is 0.023mm, without bracings at height of 28m the displacement value is 0.009mm now X-direction through load arrangement 1.2(DL+LL+WX+) in Wind Load Zone-III

B. Maximum displacement of structure with bracings and without bracings in X-direction for load combination 1.2(DL+LL+EX+) in Earth Quake Zone-III.

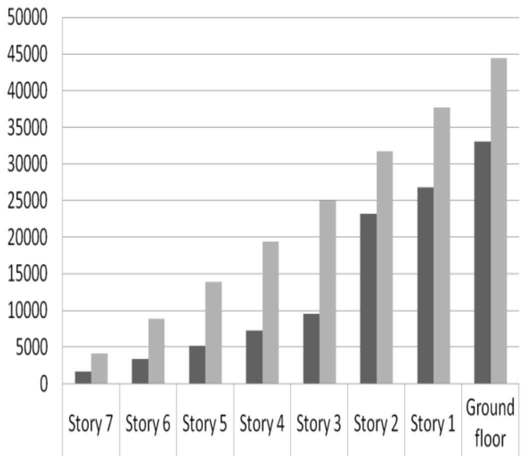


	Story 7	Story 6	Story 5	Story 4	Story 3	Story 2	Story 1	Ground floor
With Bracing	0.089	0.081	0.068	0.054	0.04	0.029	0.017	0.008
With out Bracing	0.081	0.074	0.063	0.05	0.037	0.025	0.015	0.008

Displacement

Maximum displacement of structure with bracings at height of 32m the displacement value is 0.089mm, without bracings at height of 32m the displacement value is 0.081mm in X-direction through load arrangement 1.2(DL+LL+EX-) in Earth quake Zone-III

C. Maximum axial force of structure with bracings and without bracings in X-direction designed for load combination 1.2(DL+LL+WX+) in Wind Load Zone-III.



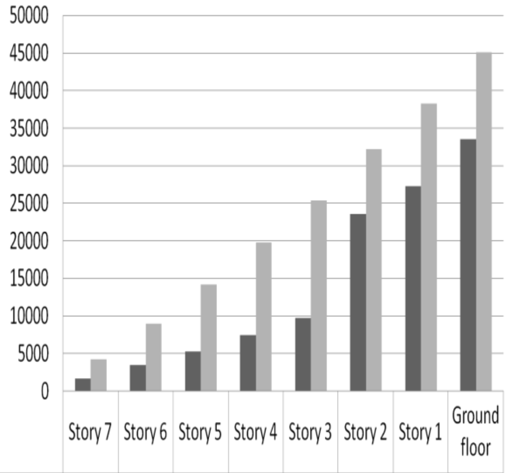
	Story 7	Story 6	Story 5	Story 4	Story 3	Story 2	Story 1	Ground floor
With Bracing	1671.30	3431.82	5197.00	7335.11	9567.41	23153.9	26811.0	33088.8
With out Bracing	4212.67	8885.95	13941.0	19416.5	24987.1	31702.1	37709.7	44429.0

Axial force

At ground floor maximum axial force of structure with bracings get the value is 33088.816kn, at height of 28m the value is 1671.308kn. At ground floor maximum axial force of structure without bracings the value is 44429.051kn, at height of 28m the value is 4212.679kn.

At X-direction for load arrangement 1.2(DL+LL+WX+) in wind load Zone-III

D. Maximum axial force of structure with bracings and without bracings in X-direction for load combination 1.2(DL+LL+EX+) in Earth Quake Zone-III.



	Story 7	Story 6	Story 5	Story 4	Story 3	Story 2	Story 1	Ground floor
With Bracing	1689.42	3481.71	5287.07	7470.98	9747.50	23583.9	27285.7	33566.9
With out Bracing	4270.91	9025.11	14175.0	19751.7	25418.9	32208.9	38276.2	45032.4

Axial force

At ground floor maximum axial force of structure with bracings get the value is 33566.934kn, at height of 28m the value is 1689.424kn. At ground floor maximum axial force of structure without bracings the value is 45032.457kn, at height of 28m the value is 4270.911kn. At X-direction for load arrangement 1.2(DL+LL+EX+) in Earth Quake Zone-III

VIII. CONCLUSION

- In connection with the handling of structures it is noticed that steel is the simplest material to model since it is isotropic.
- Results indicate that compared to without bracings, with bracings is the more effective in different loads and conditions.
- Maximum displacement of structure with bracings at height of 28m the displacement value is 0.023mm, without bracings at height of 28m the displacement value is 0.009mm in X-direction with load combination 1.2(DL+LL+WX+) in Wind Load Zone-III.
- At ground floor maximum axial force of structure with bracings get the value is 33088.816kn, at height of 28m the value is 1671.308kn. At ground floor maximum axial force of structure without bracings the value is 44429.051kn, at height of 28m the value is 4212.679kn. At X-direction designed for load combination 1.2(DL+LL+WX+) in wind load Zone-III.
- Horizontal bracings are used as alternative techniques.
- By using horizontal and vertical bracings displacement, moment, and shear force came to reduce. Results clearly shows huge difference of with bracings and without bracings.
- Manual design iterations are often and inefficient. Before comparison of members done manual design and follow IS Standard codes IS 800 :2007, IS 875 (Part 1), IS 875 (Part 2), IS 875 (Part 8), IS 1893:2002.It can get a long time, and engineers can in no way be assured of how extreme the design is since the true optimal solution. Automated design optimization can assist to considerably decrease design time, reduce costs, and enhance self-assurance in the design. In- terms of Design STAAD output will be as same as our hand out manual calculations.

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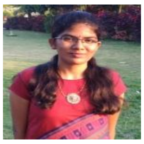

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