Comparative Analysis of Behaiour of Multistorey Structures Under Lateral Loadings With Outrigger and Hexagrid Systems Using Etabs

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Abstract:

As advancement in structure engineering is taking place, innovation in analysis and designing resulting in safely design of complex structures. As in tall structures with the rise of storey height risk of more lateral forces increases which is required to be settle for safe designing. But as we all know ordinary moment resisting structures cannot withstand such cases thus there is a need of introducing special resisting frames. These techniques are unique and prove to be successful in resisting loading conditions.The effect of wind and earthquake become permissible.

In this study we are discussing two such technologies i.e. outrigger and hexa-grid techniques to counteract lateral forces. These technologies are resulting in formulation of stability of the structure under lateral pressure.

In this study we are utilizing etabs for analysis and performing comparative study of both the structure to determine the most suitable type of structure..

A comparison is prepared in comparison to forces, deflection, moment, torsion and displacement as per I.S code specifications and criteria.

Keywords:*hexa-grid, out-rigger, structure, forces, displacement, costing, detailing.*

Introduction:

Throughout the entire existence of constructions, possibly nothing is more astonishing than the human objective to make dynamically tall designs. Diverse social and monetary components, for instance, relocation of individuals from to metropolitan zones searching for better lifestyle and openings for work, the augmentation in land esteems in metropolitan districts and higher populace thickness, have incited a staggering expansion in the quantity of tall constructions everywhere on the world. As the tall construction is ideal to land use system in present time it can save a huge load of land, consequently the skylines of the world's metropolitan regions are interminably being penetrated by specific and unmistakable tall designs as incredible as mountain runs, and accomplishing more tallness continues being the test and objective. Nonetheless, there are some fantastic difficulties which are to be looked by the architect consistently to make these constructions a reality. Out of numerous difficulties, one is that of parallel burdens for example seismic burden and wind load. So there is a need to settle the tall structures against these horizontal burdens and to give solace to the inhabitants.

In numerous regards concrete is an ideal structure material, consolidating economy, flexibility of structure and work, and critical protection from fire and the attacks of time. The crude materials are accessible in essentially every country, and the assembling of concrete is moderately straightforward. It is little marvel that in this

century it has become an all inclusive structure material. Tall structures are the most perplexing assembled structures since there are many clashing necessities and complex structure frameworks to coordinate. The present tall structures are getting increasingly slim, prompting the chance of more influence in examination with prior tall structures. From the principal elevated structures built in the late 19thcentury until the advanced high rises, the construction has assumed a significant part in the general plan. Expanding tallness and slimness achieved an adjustment in the underlying designers center from static gravity burdens to even unique burdens produced by wind and quakes. Along these lines the effect of wind and seismic powers following up on them turns into a significant part of the plan. Improving the primary frameworks of tall structures can handle their dynamic reaction. With more fitting primary structures, for example, shear dividers and supported designs, and improved material properties, the greatest stature of solid structures has expanded in late many years. Along these lines, the time reliance of cement has become another significant factor that ought to be considered in examinations to have a more sensible and affordable plan.

In this investigation we are performing near examination of outrigger and hex network construction to decide the most reasonable kind of design and to plan it according to I.S. 456 : 2000. For examination and plan ETABS programming is received while for drafting AutoCAD device is utilized.

Literature Review:

Daliyaet. al. (2019)[9] Here author illustrated that hexa-grid structure can be utilize for analysis and examination to determine its enhancement and beneficiality. Etabs is an integrated tool which pefrom analysis and steps for designing as per Indian provision.

Considered C, L and T type frames considering 36 x 36 meter. Also considering G+30, G+40 & G+50 structure floor frame considrng loading condition as per indian provisions I.S. 456, 1893-I, and 13920 detailing code.

Here author concluded that T and L shape are observing same forces and stresses where as T type structure is observing comparatively low value. Expressed that hexa-grid structure is resisting lateral forces.

Manzoor and Singh (2019)[15] here the author perform examination of outrigger structure considering shear wall as a lateral load resisting member and determined the enhancement observed in structure as compared to hexa-grid structure. These structures are analysis using etabs software which is considerd as more advance analysis tool as compared to other tools. In this study forces, displacemet, moment, and stiffenss is considered as a output resultant for comparison.

Kachchhi et. al. (2019) [5] Author illustrated the utilization of etabs software in analysis of a tall structure considering height of G + 10 stirey. Here trusses and outrigger technology is utiize simultaneously and combinely to determine the effect over a tall structure. Also diagrid are introduced at outer periphery to determine its positive effect and variation observed as per the codal regulations.

Here author utilize dead, live, seismic and superimposed loading condition to deerminethebfect for analysis response spectrum method is adopted. Zone V is considered

Here author concluded that variation in X direction is comparatively more a scompareed to variation in Y direction due to enhancement of geometry of the structure.

Objectives

1. To determine the stability of structure under lateral forces in terms of forces, moment, deflection.
2. To Analyze & Design the structure for Stability under lateral pressure.

Methodology:

Step-1 Initial step is assortment of information identified with outrigger and hexagrid structures thinking about programming usage.

The utilization of PCs in the investigation of construction empower the quick figuring of powers and minutes inside an intricate casing, by the thorough use of demonstrated hypothesis and science. Examination by PC offers benefits to the construction originator in speed and in precision of the math. there is, anyway a developing worry that dependence of PC examination can truly decrease the underlying creator's capacity to comprehend inutility the genuine conduct of a construction.

Fundamental examination is the path toward calculating the powers, second and redirection to which the layers in a construction are to be abused. There is a gigantic extent of examination instruments offering speed, precision and economy of plan; 3-D, FE illustrating, bespoke passage diagram, cell shaft or plate uphold structure writing computer programs are presently comprehensively open. Showing catenary exercises, cold outlined part execution or grillage examination - all these are at present common for structures, where hand assessment is impossible. Logically current assessment methods continue improving the precision with which the lead of designs can be expected.

Step-2 Geometry of structures

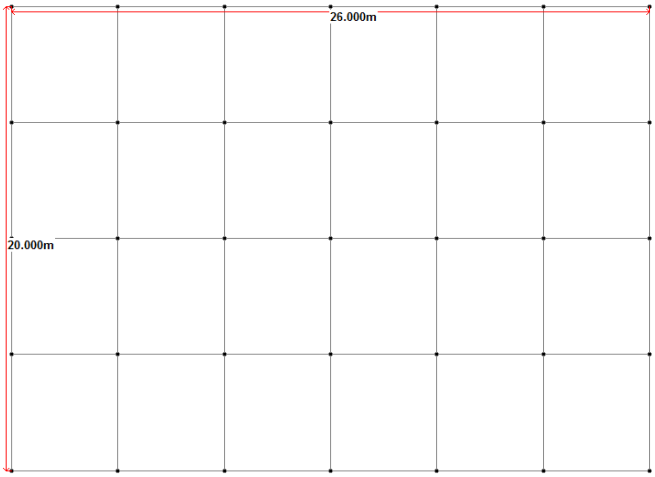

Figure 1Geometry using ETABS

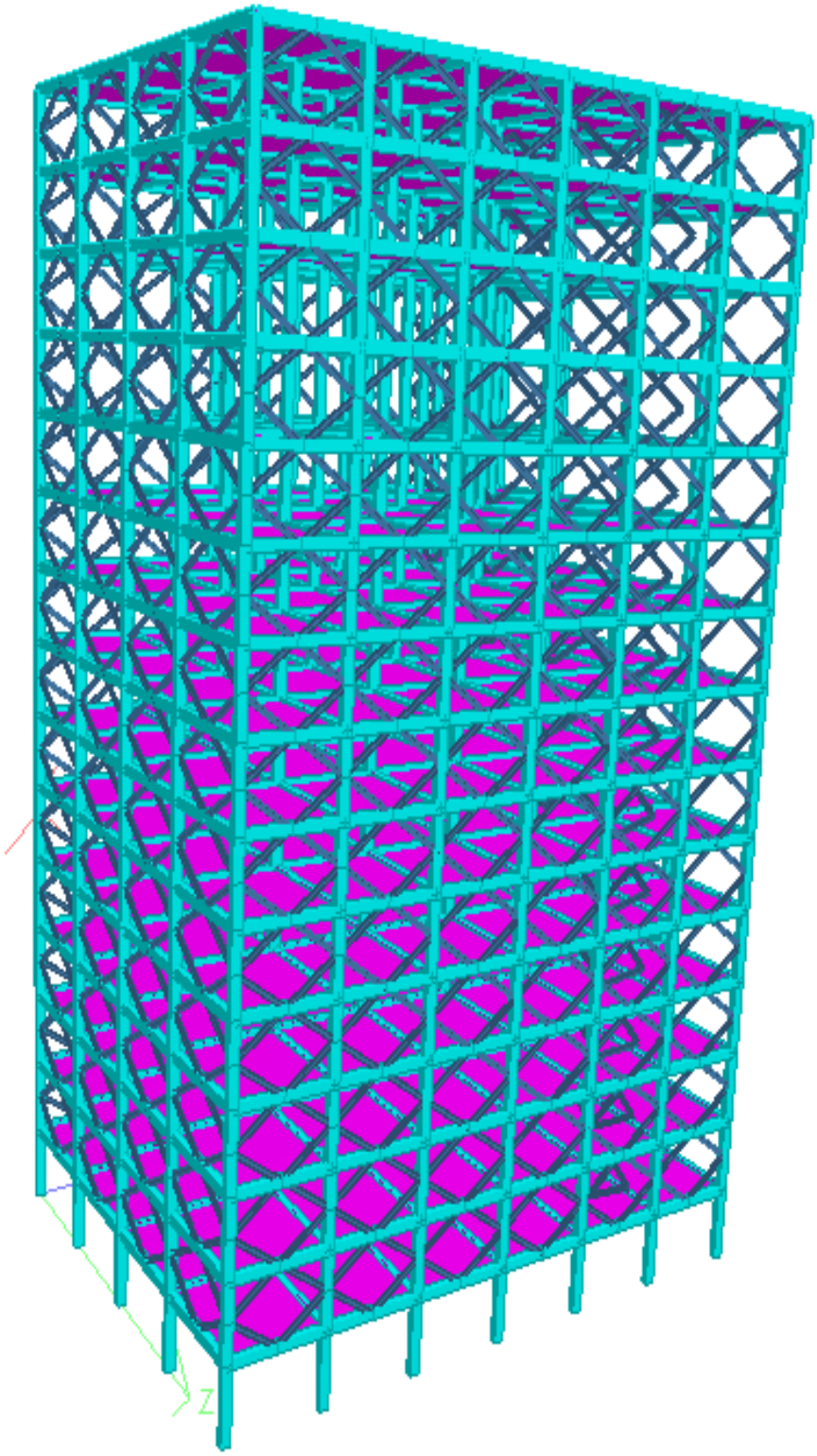

Figure 2 Modelling of Hex-Grid

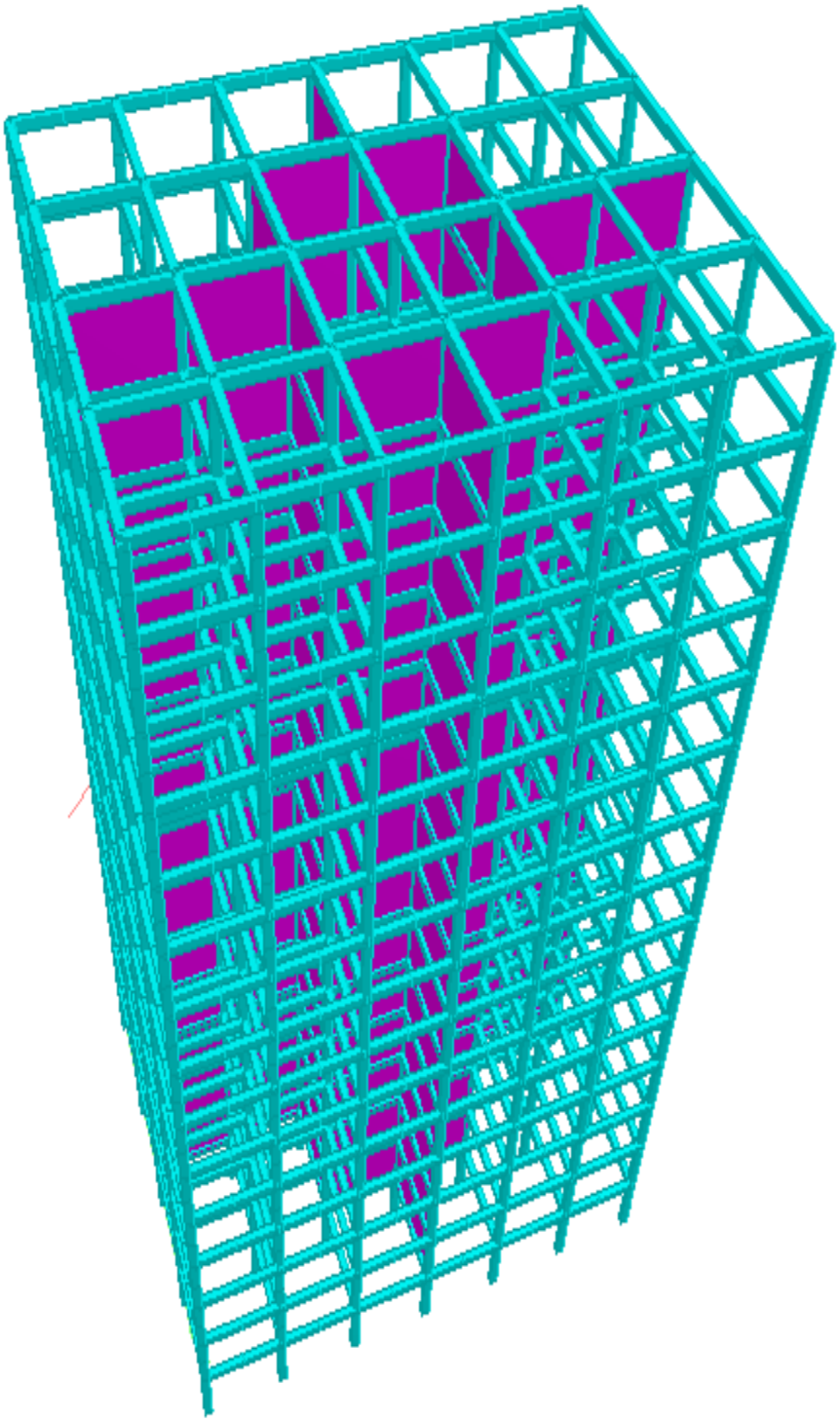

Figure 3 Modelling of Out-rigger

Step-3 To Assign Size and materails of members

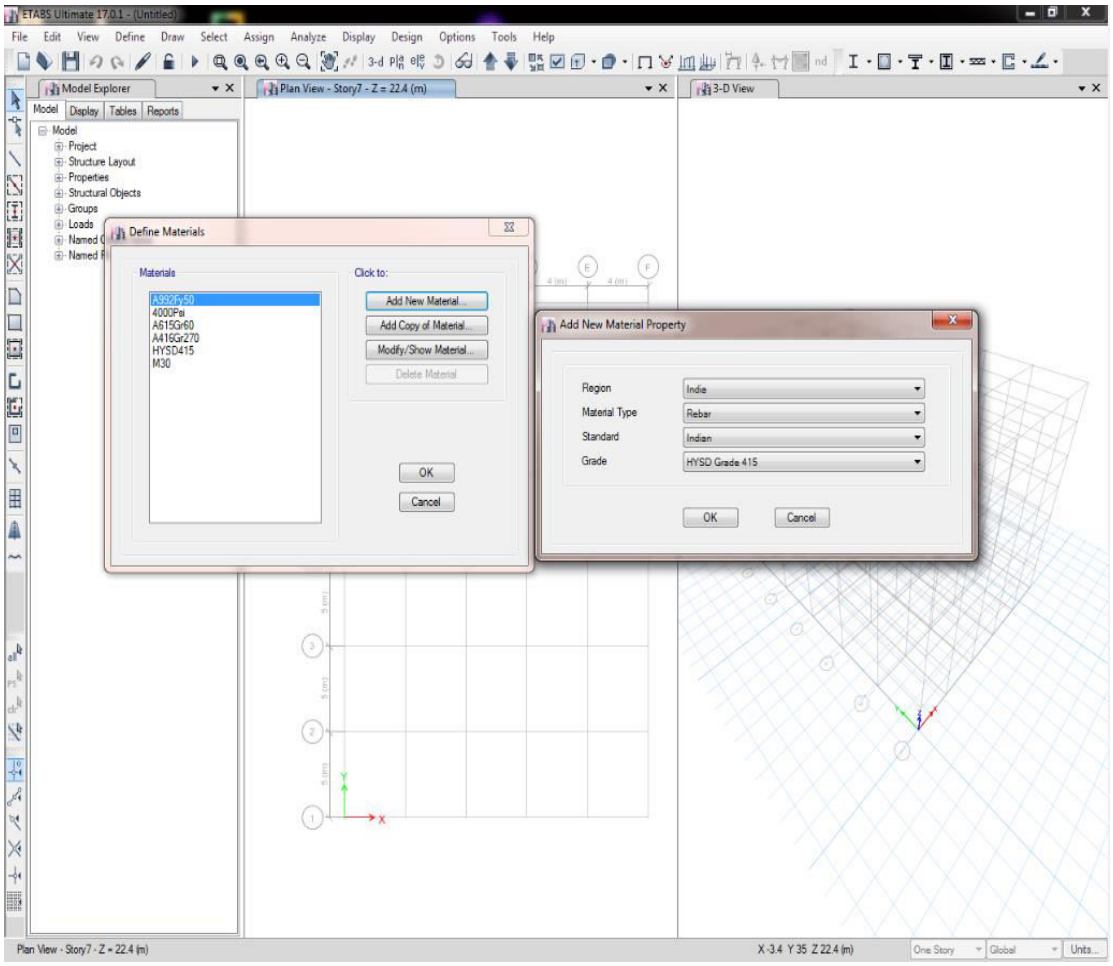

Figure 4Material

Step-Support condition

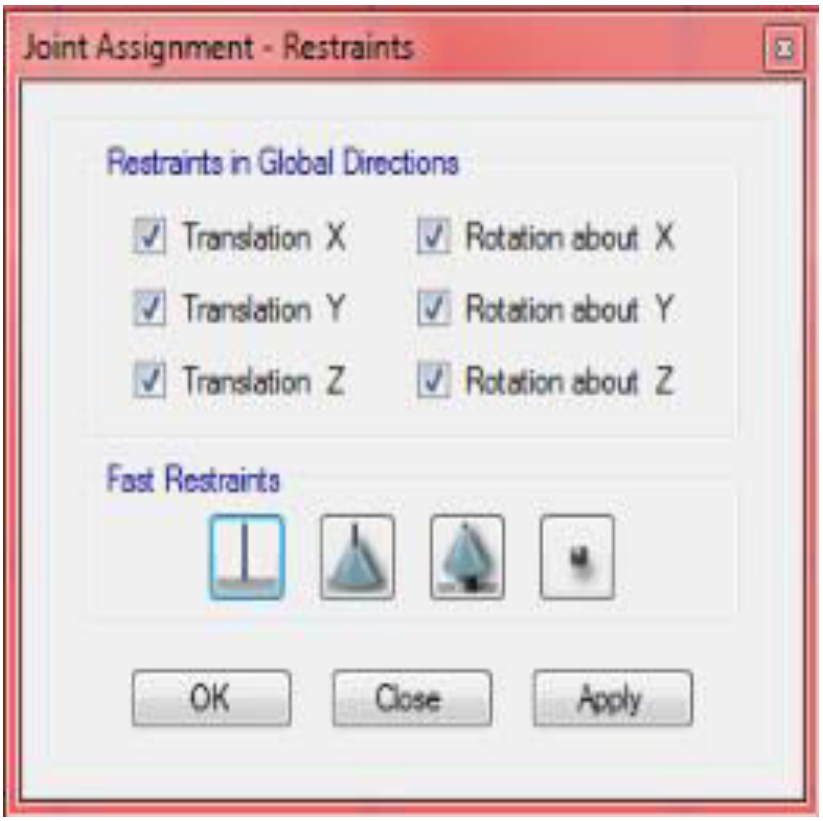

Figure 5Support condition

Step-5 Load combinations

Table 1: ULTIMATE LOAD

LOAD-CASE NO.	LOAD-CASES
1	D-L
2	L-L
3	T-H
4	(D-L+L-L)
5	(D-L+T-H)
6	1.5(D-L+L-L)
7	1.5(D-L+T-H)
8	1.2(D-L+L-L+T-H)

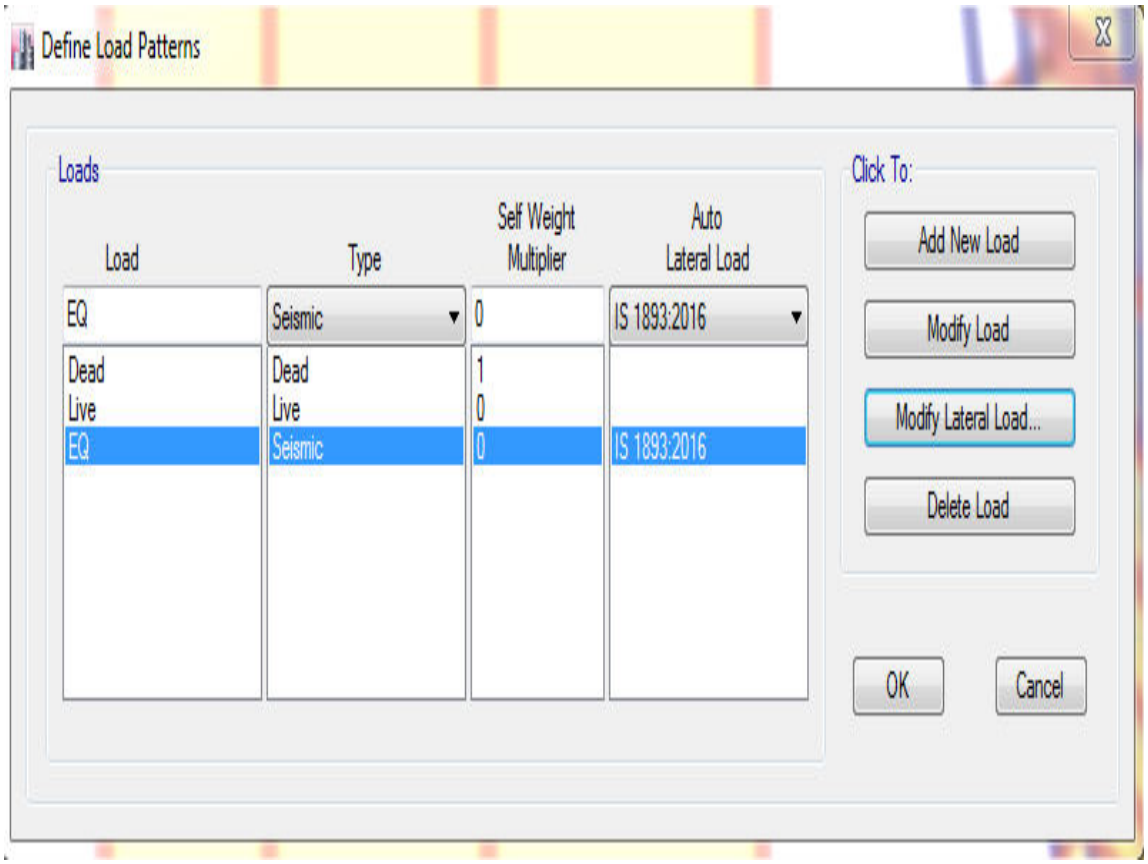

Figure 6 Load Condition

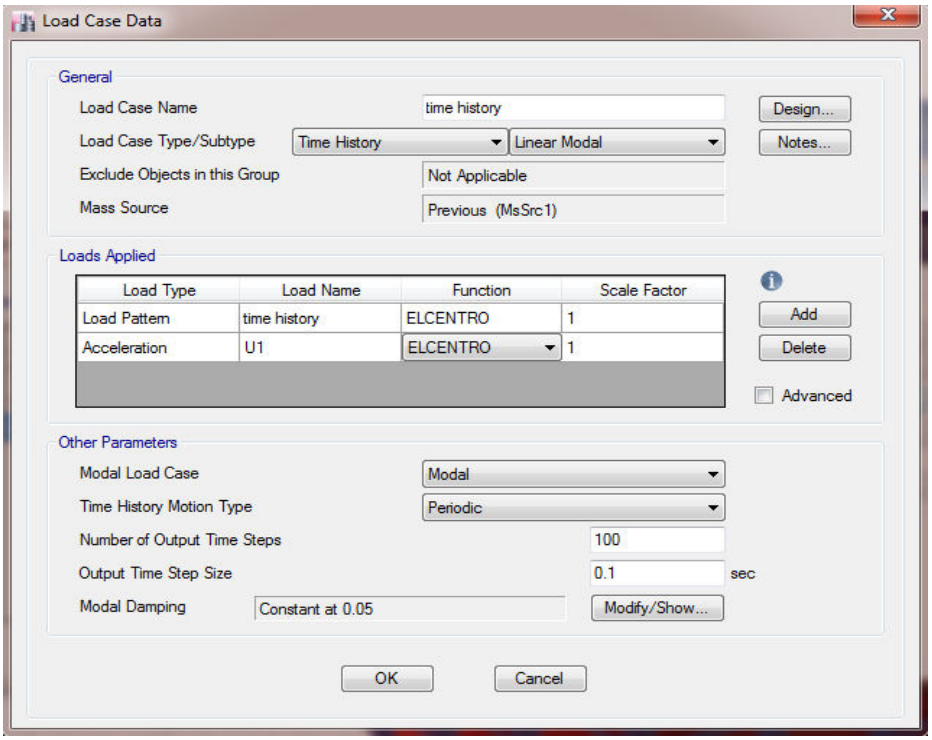

Figure 7Lateral load

Step-6 Analysis

The Finite Element Analysis (FEA) is the multiplication of some arbitrary actual wonder using the mathematical technique called Finite Element Method (FEM). Draftsmen use it to diminish the quantity of actual models and attempts and improve parts in their design stage to develop better things, speedier.

It is important to utilize arithmetic to thoroughly comprehend and evaluate any physical wonders, for example, auxiliary or liquid conduct, warm vehicle, wave engendering, the development of nat ural cells, and so forth. A large portion of these procedures are portrayed utilizing Partial Differe ntial Equations (PDEs). Nonetheless, for a PC to settle these PDEs, numerical procedures have be en created throughout the most recent couple of decades and one of the noticeable ones, today, i s the Finite Element Analysis.

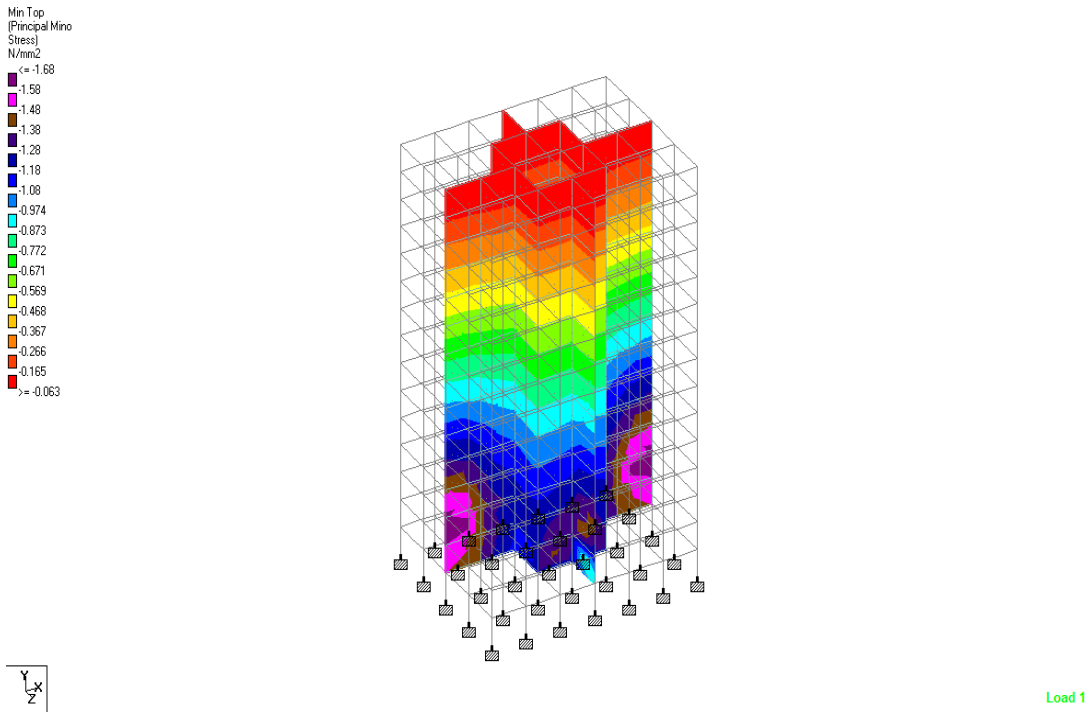

Figure 8 Analysis output

Step-7 Prepare comparison

Step-8 Conclude study

Table 2 Geometrical properties of the structure

1	**Floors_**	**G- + 15 st,orey**
2	Floor-height	3.30 m.
3	Footing bed	-1.50 m

4.	Concrete - Grade	M-30
5.	Reinforcement- details	H.Y.S.D.-500
6.	Steel Sections	Fe 345
7.	Time-history	El-centrino
8.	Length-Width	20.0 x 26.0 m

Table 3 Load description

S.No.	Load-Type	As per- Code I.S.
1	Self-Load	875-I
2	Live-Load	875-II
3	Time-history-Analysis	1893-I-16

Analysis Result:

Table 4 Maximum-Bending Moment

Max. Bending moment (kN-m)		
Bare frame	Hexagrid	Out-rigger
226.78	225.95	215.43

Table 5 Maximum Shear-force

Max. ShearForce (kN)		
Bare frame	Hexagrid	Outrigger
827.06	920.87	871.65

Table 6 Maximum Axial_Force

Max. Axial Force (kN)		
Bare frame	Hexagrid	Outrigger
2218.87	2218.98	2218.67

Table 7Storey Displacement

Storey Displacement (mm) in X direction			
Stori,es	Bare-fame	Hexagrid	Outrigger
Story,15	47.25	38.4	29.22
Story14	44.28	36.1	27.23
Story,13	41.25	33.28	25.24
Story,12	37.25	30.25	23.25
Story,11	34.25	28.12	21.26
Story,10	31.22	25.29	19.27
Story,9	28.25	23.26	17.28
Story,8	24.2	20.2	15.29
Story,7	21.25	17.2	13.2
Story,6	15.5	15.27	11.2
Story,5	14.25	12.24	9.2
Story,4	12.3	9.21	7.2
Story,3	8.129	7.28	5.24
Story,2	5.2	4.25	3.225
Story,1	2.1	2.22	1.26
Base,	1.4	0	0

Conclusion:

Following points can be observe:

In this study we observed that out-rigger structure is observing low moment relatively 15% comparing to hexa-grid which can be said that it will be more economical in comparison to all other cases.

In case of unbalance forces it can be concluded that value of manual design is comparatively here manual design structure is observing low value comparatively 23% less due to no resisting frame structure thus distributing load to the column causing more reinforcement requirement. Whereas outrigger and hexa-grid are observing comparatively stable values.

Displacement can be said as the deflection causing due to lateral forces in X and Z direction. Here in this case values observed in out-rigger and hexa-grid are 29mm and 34 mm respectively which is safe as per permissible value of the structure as per 1893-part-I: 2016 codal criteria.

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