iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 Issue: V Month of publication: May 2022

DOI: https://doi.org/10.22214/ijraset.2022.42322

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue V May 2022- Available at www.ijraset.com

Comparative Study of Linear Static and Linear Dynamic Method of Seismic Analysis of RCC Multistoried Building Using ETABS

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Abstract: As the modern buildings have been getting taller and narrower than before, the structural engineers have to perform both static and dynamic analysis for seismic loads that may affect on structures in order to make sure of the safety verifications and the optimal design requirements. Reinforced concrete (RC) building frames are the most common types of constructions in urban India. Throughout their lifetime, these are subjected to various types of forces such as static forces due to dead loads, live loads and dynamic forces due to earthquakes. In the present study, one tall RCC building of 10 stories is assumed to be situated in seismic zone 4 is analyzed using two different methods i.e., Equivalent static method (static) and response spectrum method (dynamic), using ETABS software. From analysis, the parameters like storey displacement, storey drift, base shear and time period and frequency are determined and also comparative study is done for both the methods
Keywords: {RCC Buildings, Equivalent static method, response spectrum method, storey displacement, storey drift, Base shear, time period.}

I. INTRODUCTION

Seismic examination is a subset of underlying Analysis and is the computation of the reaction of a structure (or non-building) design to Earthquakes. It is part of the process of structural design, earthquake engineering or Structural assessment and retrofit (see structural engineering) in regions where earthquakes are prevalent. Seismic design of tall buildings is primarily concerned with structural safety during major earthquakes; however, serviceability, human comfort and the potential for economic loss are also of concern Seismic investigation requires a comprehension of the primary presentation under enormous inelastic miss hapenings. This activity can be as burden because of the heaviness of things, for example, individuals, furniture, wind, snow and so on .Or some other kind of excitation such as earthquake, shaking of the ground due to a blast nearby, etc. Generally this multitude of burdens are dynamic including oneself load of the design in light of the fact that eventually in time these heaps were not there. The qualification is made between the dynamic and static examination based on whether the applied activity has sufficient speed increase in contrast with the design's regular recurrence. Assuming that a heap is applied adequately leisurely, the inactivity powers (Newton's second law of movement) can be overlooked and the investigation can be streamlined as static examination. Structural dynamics, therefore, is a type of structural analysis which covers the behavior of structures subjected to dynamic (actions having high acceleration) loading. Dynamic loads include people, wind, waves, traffic, earthquake, and blasts. Any construction can be exposed to dynamic stacking. Dynamic examination can be utilized to track down powerful removals, time history, and modular investigation. In the present comparative study, Response spectrum analysis is performed to compare results with static analysis

A. Multi-Storey Building

A multi-story building is a structure that upholds at least two stories over the ground. There is no formal restriction on the height of such a building or the number of floors a multi-story building may contain, though taller buildings do face more practical difficulties. But, from a structural engineer's point of view the tall building or multi-storeyed building can be defined as one that, by virtue of its height, is affected by lateral forces due to wind or earthquake or both to an extent that they play an important role in the structural design. Tall structures have fascinated mankind from the beginning of civilisation. The Egyptian Pyramids, one among the seven marvels of world, built in 2600 B.C. are among such antiquated tall designs. Such designs were built for protection and to show pride of the populace in their civilisation. The development in present day multi-storeyed structure development, which started in late nineteenth 100 years, is expected to a great extent for business and private purposes. The development of the high-rise building has followed the growth of the city closely. The process of urbanisation, that started with the age of industrialization, is still in progress in developing countries like India. Industrialization causes migration of people to urban centres where job opportunities are significant. The land available for buildings to accommodate this migration is becoming scarce, resulting in rapid increase in the cost of land. Thus, developers have looked up the sky to make profits. The result is multistoreyed buildings, as they provide a large floor area in a relatively small area of land in urban centres.

B. About ETABS

ETABS is an engineering software product that caters to multistory building analysis and design. Displaying apparatuses and formats, code-based load remedies, examination strategies and arrangement procedures, all direction with the lattice like calculation novel to this class of design. Fundamental or high level frameworks under static or dynamic circumstances might be assessed utilizing ETABS. For a refined appraisal of seismic execution, modular and direct-coordination time-history investigations might couple with P-Delta and Large Displacement impacts. Nonlinear connections and concentrated PMM or fiber pivots might catch material nonlinearity under monotonic or hysteretic conduct. Instinctive and coordinated highlights make uses of any intricacy functional to carry out. Interoperability with a progression of plan and documentation stages makes ETABS an organized and useful instrument for plans which range from straightforward 2D casings to expand present day tall structures.

C. Importance of Seismic Analysis

Seismic study is a very important study. It helps in understanding the behaviour of structures of various types subjected to earthquake loads, and how we can protect the inhabitants of that structure in the event of an earthquake Seismic concentrate additionally assists with understanding the different kinds of seismic waves that start, assisting us with planning the zones of continuous quakes and stable zones. The study of seismic activity of a particular zone helps in establishing minimum standards of safety for that zone, making life easier to continue post earthquake.

D. Different Seismic Zones in India

The four zones of earthquake in India, as follows :

1) *Seismic Zone II:* Zone II is delegated the low-harm risk zone. This is the least seismically dynamic zone, meaning the regions that fall under these zones in India have a slim likelihood of having a tremor.Zone II covers quake inclined regions, which are 41% of India. Here, the Indian Standard (IS) Code dispenses a zone component of 0.10.
2) *Seismic Zone III:* Seismic Zone 3/III is delegated the moderate harm risk zone. Here, the IS Code allocates 0.16 to this zone. Zone III, or moderate tremor zone, covers 30% of India.
3) *Seismic Zone IV:* Zone IV is viewed as the high-harm risk zone. The IS Code designates 0.24 to this zone. In addition, 18% of the complete region of the nation has a place with Zone IV.
4) *Seismic Zone V:* Zone V has the most noteworthy gamble of harming quakes. The IS Code has relegated a variable of 0.36 for this extremely high-risk harm zone. Around 11% of India falls under Zone V.

Note: There are no urban areas in India which fall under Seismic Zone I

E. Site Selection

The choice of reasonable site is a significant stage in the plan of a structure or arranging a settlement in a quake inclined zone. There are various tremor related risks which ought to generally be viewed as while picking a site, along with the impact of the ground conditions at the site on the ground movement which the structure might insight in a future Earthquake. An assessment of the extent of the earthquake hazard should always form a part of the overall site assessment and of the specification for the design of any structures to be built there. No site can be expected to be ideal in all respects the choice of site will of then involve a judgment about relative risks and the costs of designing to shield from them .But there can be a few locales which could be perilous to such an extent that they ought to be kept away from please, since the expense of building is probably going to be restrictive

II. AIM AND OBJECTIVE

The objectives are as listed below:

1) To prepare a 3D model of a multi-storey RCC building using ETABS software.
2) Analyse building for seismic analysis and Dead load, Live load and Earthquake load using static method and dynamic method structure.
3) Comparison of static and dynamic methods, displacement, story drift, base shear, time period and frequency

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III. METHOD OF ANALYSIS

Analysis methods are widely characterized as linear and nonlinear static and dynamic. Analysis methods are widely characterized as linear and nonlinear static and dynamic . Among them the direct static and dynamic techniques are reasonable when the primary burdens are little. The fundamental distinction between the same static methodology and dynamic investigation technique lies in the greatness and conveyance of parallel powers over the level of the structures. In the powerful investigation method the sidelong powers depend on properties of the regular vibration methods of the structure, not entirely settled by the dispersion of mass and solidness over level. In the same parallel power technique the extent of powers depends on an assessment of the basic time frame and on the circulation of powers as given by a straightforward recipe that is suitable just for standard structures.

A. Equivalent Static Analysis (static)

In the equivalent static analysis method, the response of the building is assumed as linear elastic manner. To calculate equivalent linear static the IS 1893 (Part I): 2016 has given a formula as below

$$V_B = A_H.W$$

Where,

$$A_H = ZIS_a/2Rg$$

Where Z - zone factor, I - importance factor, R - response reduction factor and Sa/g - average response acceleration coefficient which depends on the nature of foundation soil (rock, medium or soil site), natural period and the damping ratio of the structure IS 1893 Part I-: (2016). Z is the zone factor, I is the importance factor, R is the response reduction factor and Sa/g is the average response acceleration coefficient which depends on the nature of foundation soil (rock, medium or soil site), natural period and the damping ratio of the structure -IS 1893Part I-: (2016).

Analysis Method Adopted In Present Work

In the present study all the model are analysed in linear dynamic analysis method which is known as response spectrum method

B. Response Spectrum Method. (Dynamic)

In this method the load vectors are calculated corresponding to predefined number of modes. These load vectors are applied at the plan Centre of mass to ascertain the separate modular reactions. These modular reactions are then joined by SRSS or CQC rule to get the absolute reaction

From the essentials of elements it is very certain that modular reaction of the construction exposed to specific ground movement, is assessed by the blend of the aftereffects of static investigation of the designs exposed to comparing modular burden vector and dynamic examination of the relating single level of opportunity framework exposed to same ground movement. Static reaction of MDOF framework is then increased with the ghostly ordinate got from dynamic investigation of SDOF framework to get that modular reaction .Same procedure is carried out for other modes and the results are obtained through SRSS or CQC rule

Accordingly range examination the unearthly qualities are perused from the plan range which are straightforwardly increased with the modular burden vector and the static investigation is performed to decide the relating modular pinnacle reactions. This method is known as the CLASSICAL MODAL ANALYSIS.

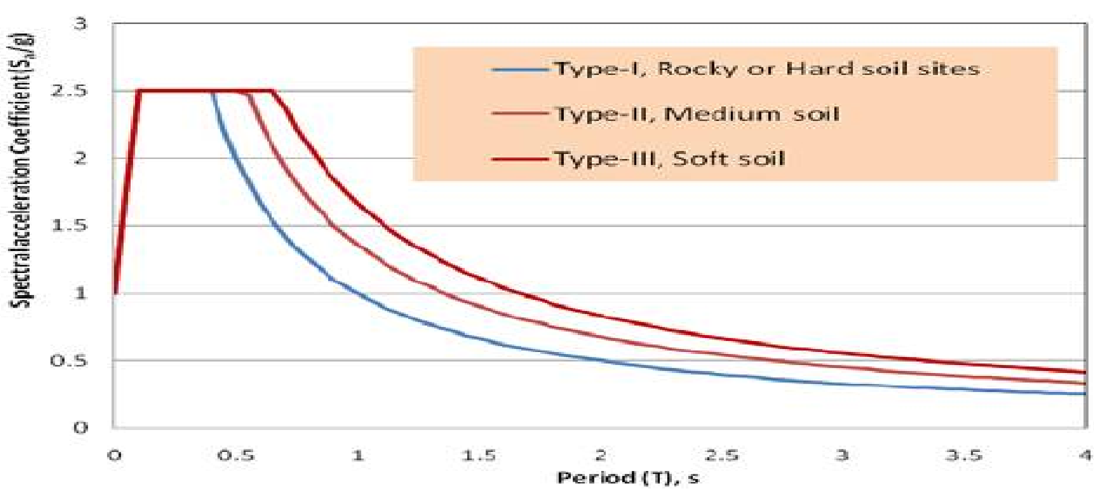

Fig-1. Response Spectra graph

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IV. MODELLING

A. *Building Description*

1) For this study, 10-storey building with a 3-meters height for each story, irregular in plan is modeled.
2) These buildings were designed in consistence to the Indian Code of Practice for Seismic Resistant Design of Buildings.
3) The buildings are assumed to be fixed at the base.
4) The sections of structural elements are square and rectangular.
5) Storey heights of buildings are assumed to be same including the ground storey.
6) The buildings are modeled using software ETABS 19. • G+10 Models are studied in IV zones an analytical approach to determine the vartion of equivalent static method and response spectrum method .
7) The problems will include comparative study of seismic analysis of building With Static Equivalent Method and Response Spectrum Method.

Table -1: Building Description

Name :	Size :
Concrete grade	M35
REINFORCEMENT GRADE	FE500
BEAM	500 X 600 MM
Column	600 X 600 MM
Slab	200 MM
Soil type	II MEDIUM
Zone	IV
Importance factor	1
Response reduction factor	5 SMRF
Plan Area	31.5 x 31.5 (m)

Table -2: Loading Data

Loads :	Units :
Live load on roof	1.5 KN /M2
Super imposed load on roof	4 KN/M2
Live load on floor	3 KN/M2
Super imposed load on floor	4 KN/M2
Wall load on top floor	13 KN/M
Wall load on story	4 KN/M

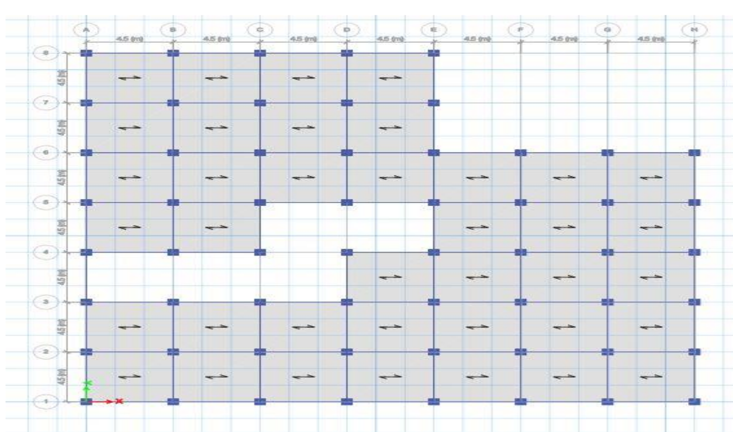

Fig -2. Plan View Of Building

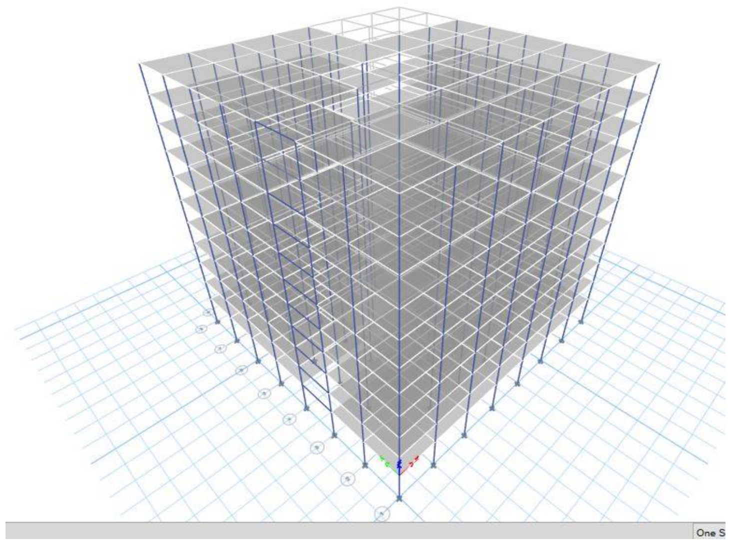

Fig -3. 3d view of building

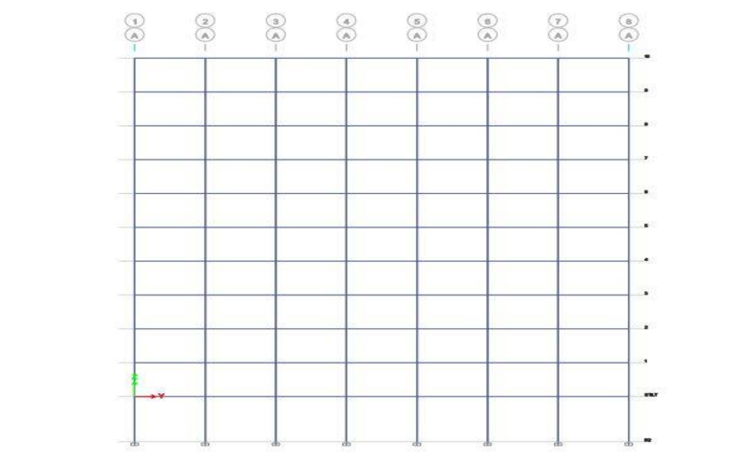

Fig -4. Elevation view of Building

V. ANALYSIS AND RESULTS

A. Base Shear

Dynamic analysis may be performed by either the Time History Method or the Response Spectrum Method. When both of the techniques is utilized, the plan base shear VB assessed will not be not exactly the plan base shear V B determined utilizing a key period Ta, where Ta is according to 7.6.2. Whenever VB is not exactly V B , the power reaction amounts (for instance part pressure resultants, story shear powers, and base responses) will be duplicated by V B VB . For quake shaking considered along,

Table -3 :

Elx (static)	3427.9555 kn	Factored =3427.9555/285.6846	=11.99
Rsx (dynamic)	285.6846 kn		
Ely (static)	3360.7868 kn	Factore =3360.7868/280.5218	=11.98
Rsy (dynamic)	280.5218 kn		

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Table -4 :Design base shear

Elx	3427.9555
Ely	3360.7868 kn

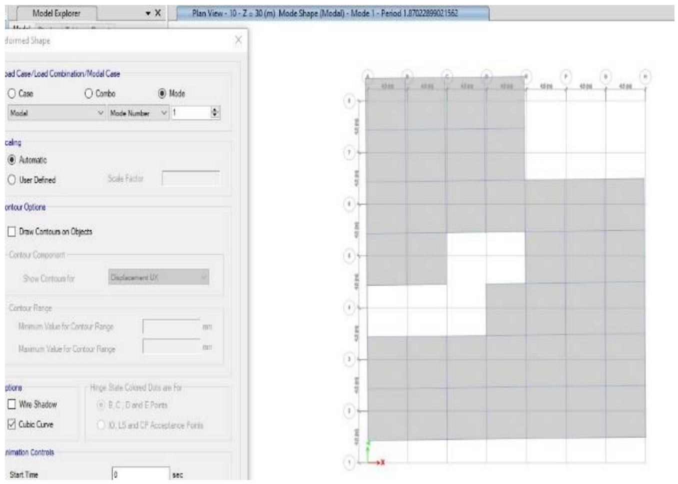

Fig -5. First mode deflected shape

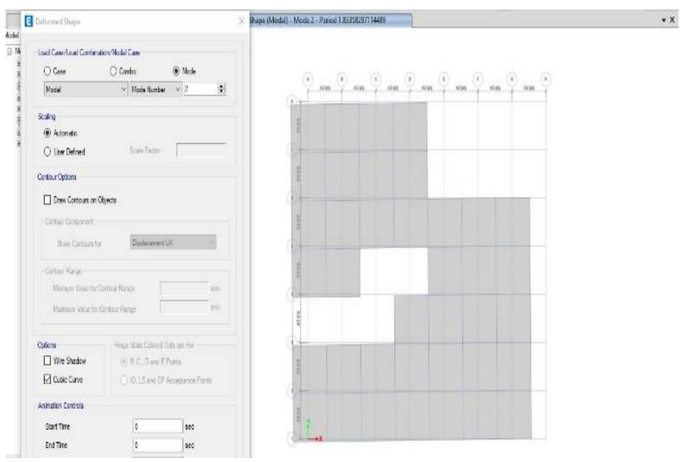

Fig -6. Second mode deflected shape

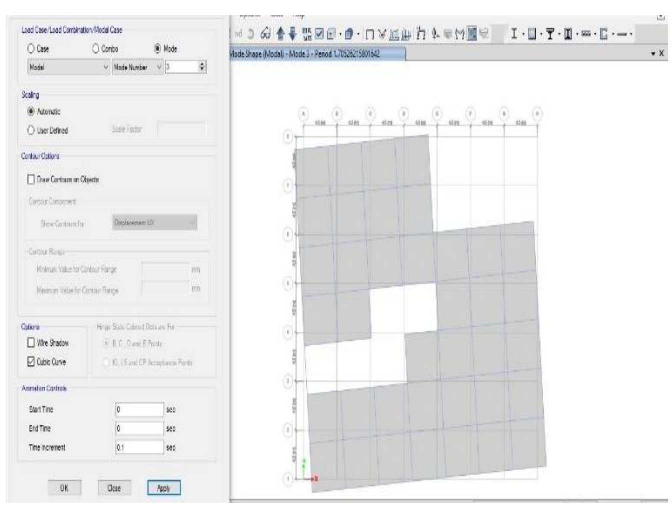

Fig -7. 3rd mode First mode deflected shape

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B. Number of Modes to be Considered

The quantity of modes Nm to be utilized in the investigation for quake shaking along a thought about bearing, ought to be with the end goal that the whole of modular masses of these modes considered is no less than 90% of the absolute seismic mass. If modes with natural frequencies beyond 33 Hz are to be considered, the modal combination shall be carried out only for modes with natural frequency less than 33 Hz ; the impact of modes with regular frequencies in excess of 33 Hz will be incorporated by the missing mass revision system following laid out standards of primary elements. In the event that defended by thorough investigation, fashioners might utilize a cut off recurrence other than 33 Hz

Table -5 : Modal Result and Time period

case	mode	period (sec)	Frequency (hz)	sum ux	sum uy	sum uz
Modal	1	1.87	0.535	0.0021	0.831	0.003
Modal	2	1.834	0.545	0.8339	0.833	0.007
Modal	3	1.705	0.586	0.8386	0.836	0.841
Modal	4	0.602	1.662	0.8388	0.932	0.841
Modal	5	0.591	1.693	0.9336	0.932	0.841
Modal	6	0.551	1.815	0.934	0.933	0.934
Modal	7	0.34	2.941	0.9341	0.965	0.935
Modal	8	0.335	2.984	0.9665	0.965	0.935
Modal	9	0.314	3.182	0.9666	0.966	0.967
Modal	10	0.228	4.389	0.9666	0.981	0.967

C. Storey Displacement

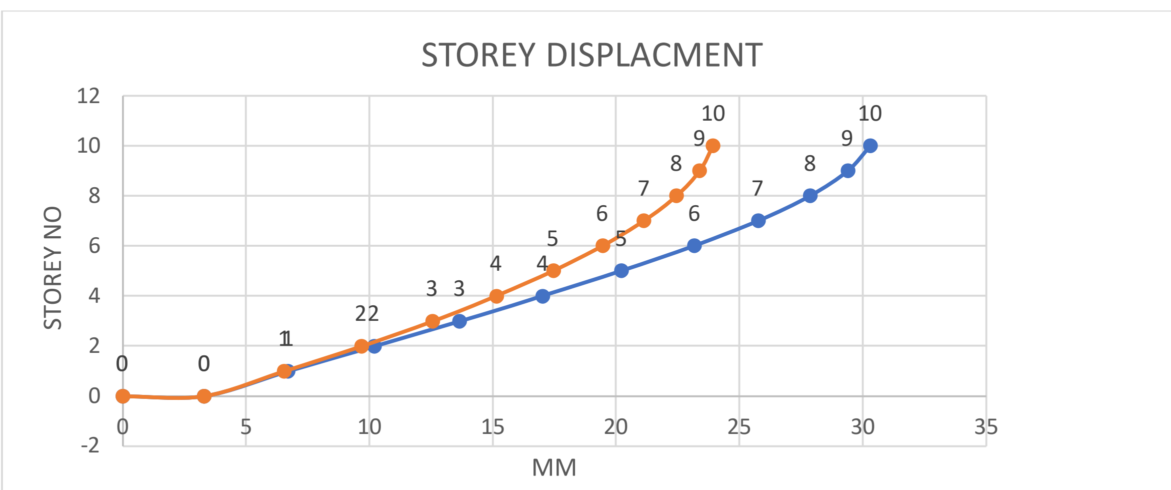


Fig -8. variation of displacement of building considering equivalent static methos (RED) and response spectrum method (BLUE). It is observed by using response spectrum method shows max value

Table -6 : Storey Displacment

	elx	rsx
10	30.296	23.926
9	29.386	23.38
8	27.863	22.454
7	25.753	21.133
6	23.169	19.456
5	20.224	17.455
4	17.022	15.151
3	13.652	12.555
2	10.188	9.677
1	6.701	6.551
STILT	3.3	3.298
B2	0	0

D. Storey Drift Ratio

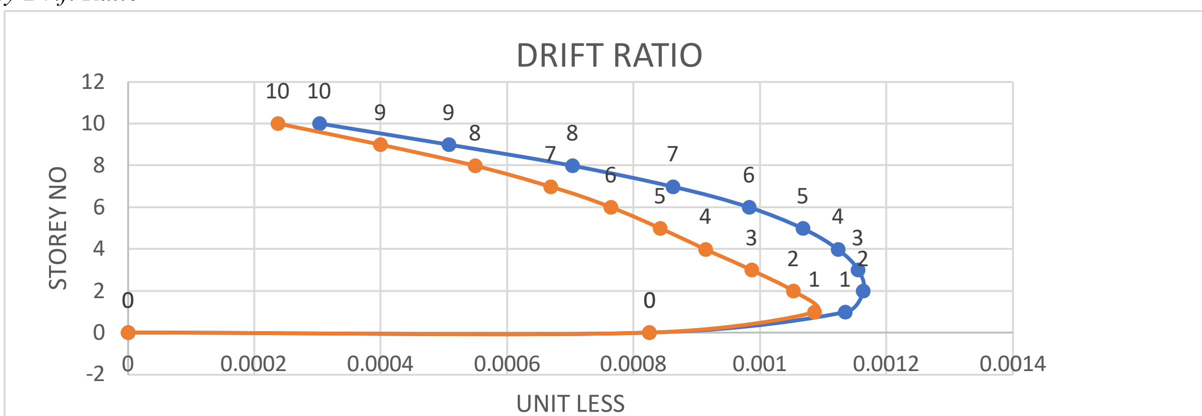


Fig -9. variation of story drift of building considering equivalent static methos (RED) and response spectrum method (BLUE). It is observed by using response spectrum method shows max value

Table -7 : Storey Drift Ratio

10	0.000303	0.000237
9	0.000508	0.000399
8	0.000703	0.000549
7	0.000862	0.000669
6	0.000982	0.000764
5	0.001067	0.000842
4	0.001123	0.000914
3	0.001155	0.000986
2	0.001163	0.001052
1	0.001134	0.001086
STILT	0.000825	0.000825
B2	0	0

E. Storey Stiffness

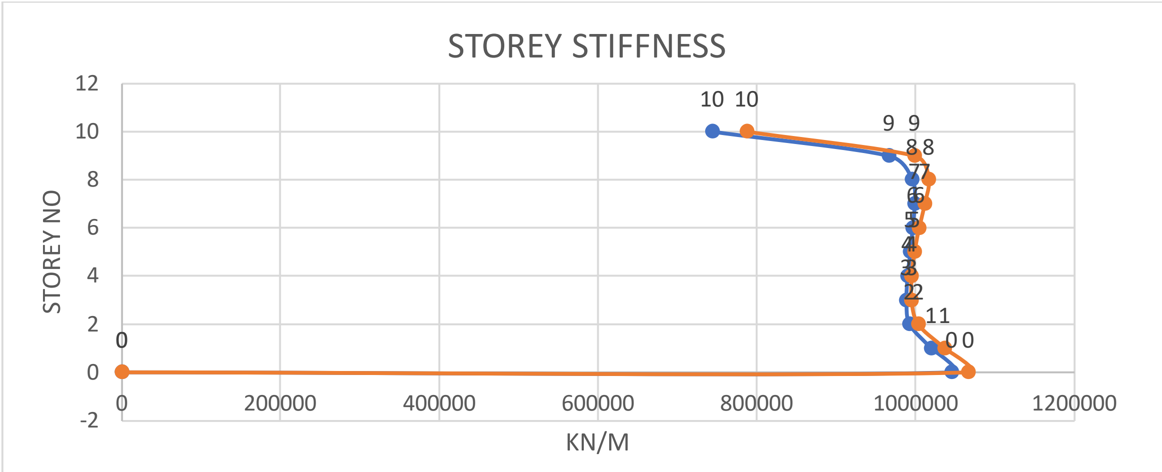


Fig -1o. variation of story stiffness of building considering equivalent static methos (RED) and response spectrum method (BLUE)
It is observed by using response spectrum method shows max value

Table -8 : STOREY STIFF

storey stiff		
10	744312	787375.2
9	966795.6	998588.7
8	995796.6	1016315
7	998590.3	1011509
6	996418.5	1004375
5	993199.9	998452.8
4	990137.7	994940.1
3	988499.3	995157.5
2	992591	1003339
1	1019577	1036336
STILT	1045305	1066124
B2	0	0

VI. CONCLUSIONS

The research presents a review of the comparison of static and dynamic analysis of multistoried building. Design parameters such as Displacement, Base shear, Storey drift, were the focus of the study. It was from the overall comparison following conclusions are listed

1) Irregular shapes are seriously impacted during tremors particularly in high seismic zones.
2) The irregular shape building goes through additional miss happening and subsequently normal shape building should be liked.
3) Static investigation isn't adequate for tall structures and giving unique analysis is fundamental.
4) The base shear values ought to be same for static and dynamic examination is practically same according to IS1893
5) The distinction of values of displacement among static and dynamic analysis is inconsequential for lower stories yet the thing that matters is expanded in higher stories and static investigation gives higher qualities than dynamic investigation.
6) The time period for static and dynamic examination is exactly.
7) This is because of the way that, time span just relies upon model math other than kind of examination.

8) When contrasted with sporadic arrangement the story drift esteem is more in the normal design. Story float is expanded as level of building expanded.
9) In comparison between static and dynamic, drift values are higher in static analysis.

VII. ACKNOWLEDGEMENT

We thank the capable faculty of ISL ENGINEERING COLLEGE for providing us with an opportunity to conduct major project work in college.

We express our deep sense of gratitude towards CHAIRMAN SIR, PRINCIPAL SIR for tremendous support, encouragement and inspiration.

We are thankful to Dr. MOHAMMED MASOOD, Principal of ISL ENGINEERING COLLEGE.

We convey our deep sense of gratitude to Asst Prof. Kanchala Nanchari, Head of the Department of Civil Engineering in ISL ENGINEERING COLLEGE for her valuable guidance, inspiration and encouragement associated to the major project work.

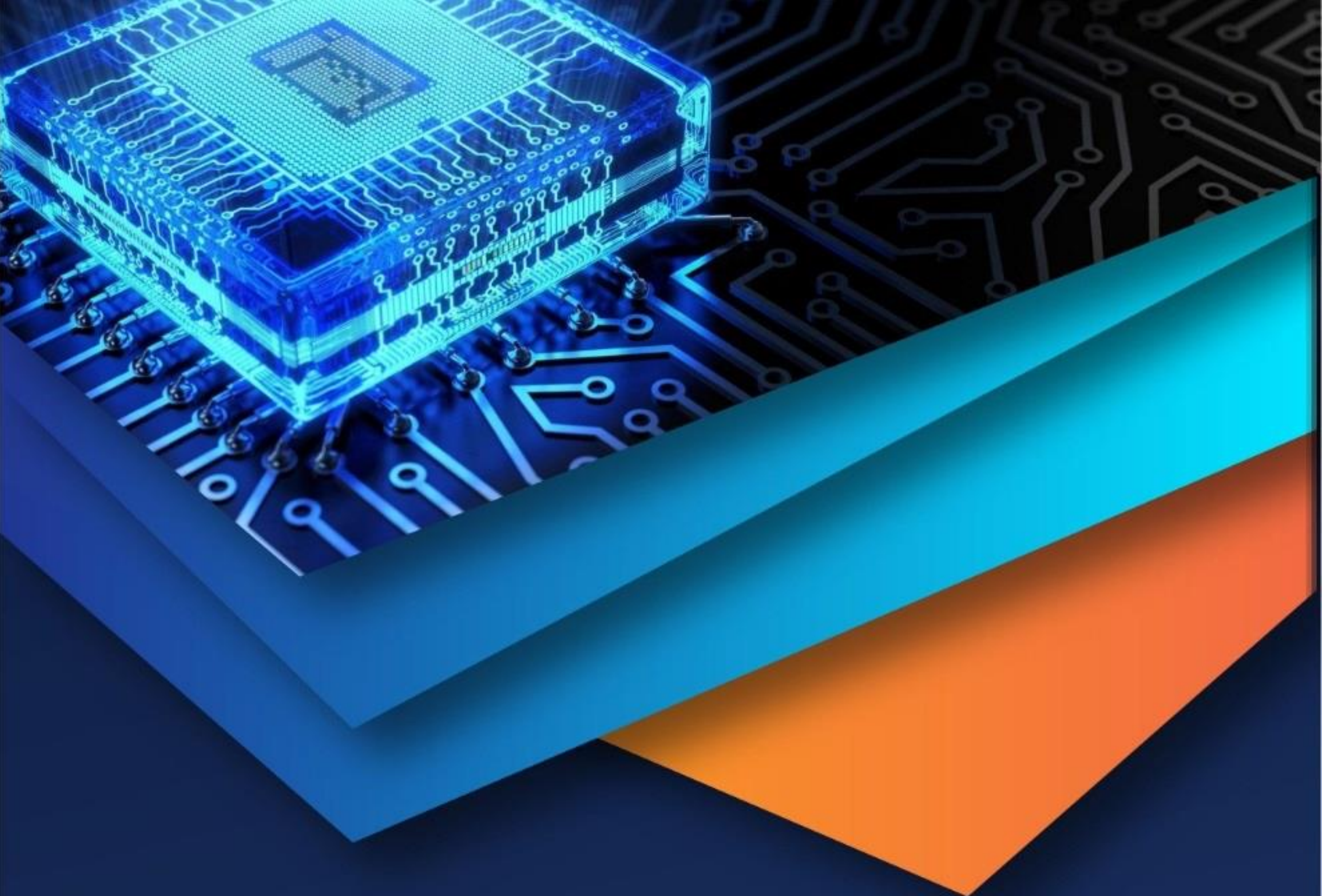
We are very thankful to immense support and guidance by Mrs. KANCHALA NANCHARI, Project Coordinator in Department of Civil Engineering.

We whole heartedly thank all staff members of Department of Civil Engineering of ISL ENGINEERING COLLEGE for their support.

Lastly, we are thanking full to all those who helped us directly and indirectly with this major project work which turned out to be very successful, and I finally thank our beloved parents and family for their extreme support throughout the major project.

REFERENCES

[1] Balaji.U and Selvarasan M.E “Design And Analysis of Multi Storied Building Under Static And Dynamic Loading Condition Using ETABS.” International Journal of Technical Research and Applications Volume 4, Issue 4. (July-Aug, 2016)
[2] Anirudh Gottala, Dr.shaik Yajdhani “Comparative Study of Static and Dynamic seismic Analysis of Multistoried Building.” IJSTE - International Journal of Science Technology & Engineering | Volume 2 | Issue 01 | July 2015.
[3] T.Mahdi, V.Soltangharaie “Static and Dynamic Analyses of Asymmetric Reinforced Concrete Frame”2012
[4] Mohit Sharma, Dr. Savita Maru “Dynamic Analysis of Multistoried Regular Building.” IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 11, Issue 1 Ver. II (Jan. 2014).
[5] A.M. Mwafy, A.S. Elnashai(2000), “Static pushover versus dynamic collapse analysis of RC buildings”, Engineering Structures, Issue. 23, pp. 407-424.
[6] E.Pavan Kumar,A.Naresh “Earthquake Analysis of Multi Storied Residential Building - A Case Study” E. Pavan Kumar et al Int. Journal of Engineering Research and Applications ISSN : 2248-9622, Vol. 4, Issue 11(Version 1), November 2014, pp.59-64
[7] “1893 (Part 1) : 2002” Criteria for earthquake resistant design of structures: Part l General provisions and buildings.
[8] 4326:1993 Earthquake resistant design and construction of buildings — Code of practice (second revision)
[9] 456:2000Code of practice for plain and reinforced concrete (fourth revision)
[10] Mahesh N. Patil, Yogesh N. Sonawane “Seismic Analysis of Multistoried Building”, International Journal of Engineering and Innovative Technology (IJEIT), Volume 4, Issue 9, March 2015.
[11] Mohammed Rizwan Sultan, D. Gouse Peera “Dynamic Analysis Of Multi-storey building for different shapes”, International Journal of Innovative Research in Advanced Engineering (IJIRAE), Issue 8, Volume 2 (August 2015)



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