International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 9
September 2017

Dynamic Analysis of Multistoried Regular Building

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Abstract: *Analysis and design of buildings for static forces is a routine affair these days because of availability of affordable computers and specialized programs which can be used for the analysis. On the other hand, dynamic analysis is a time consuming process and requires additional input related to mass of the structure, and an understanding of structural dynamics for interpretation of analytical results. Reinforced concrete (RC) frame buildings are most common type of constructions in urban India, which are subjected to several types of forces during their lifetime, such as static forces due to dead and live loads and dynamic forces due to the wind and earthquake.*

Here the present works (problem taken) are on a G+30 storied regular building. These buildings have the plan area of 25m x 45m with a storey height 3.6m each and depth of foundation is 2.4 m. & total height of chosen building including depth of foundation is 114 m. The static and dynamic analysis has done on computer with the help of STAAD-Pro software using the parameters for the design as per the IS-1893- 2002-Part-1 for the zones-2 and 3 and the post processing result obtained has summarized

1.0. INTRODUCTION

Nowadays, most buildings are delineated by irregular in both plan and vertical configurations. Irregularities in arrange and lack of symmetry might imply vital eccentricity between the building mass and stiffness centers, give rise to damaging coupled lateral response (Giordano,Guadagnuolo and Faella, 2008) [1]. Moreover to design and analyze an irregular building a significantly high level of engineering and designer effort are needed, whereas a poor designer will design and analyze an easy subject field options. In different words, damages in those with irregular options are over those with regular one. Therefore, Irregular structures would like an additional careful structural analysis to succeed in an acceptable behavior throughout a devastating earthquake (Herrera, Gonzalez and soberon, 2008).

Plan and also elevation irregularities in Indian standard code (IS 1893):

The irregularity of the structure might will classify in 2 sorts i.e. Plan and vertical, these are often characterized by 5 differing types like torsional, re-entrant corners, diaphragms separation, out of arrange offset and non-parallel system for plan irregularity likewise as vertical irregularity like stiffness (soft storey), mass, vertical geometric, in plane separation in vertical components resisting lateral force and separation in capability (weak storey) (IS 1893(Part I): 2002)

The code, IS 1893 (Part I): 2002 outlined the re-entrant corners irregularity:

Re-entrant corner irregularity arrange configurations of a building and its lateral force resisting system contain re-entrant corners, wherever each projections of the structure document is a template. An electronic copy can be downloaded from the Journal website. For questions on paper guidelines, please contact the journal publications committee as indicated on the journal website. Information about final paper submission is available from the conference website.

1.1. Objectives of the study

Main objectives of the thesis is to perform Dynamic analysis and to obtain Seismic performances of different shape of structures located in severe earthquake zone (V) of India and to evaluate lateral forces, overturning moment, deflections and storey drift.

1.2. Methodology

The method of analysis used for the present study are

1. Equivalent static force analysis
2. Response spectrum method

1) *Equivalent static force analysis:* The equivalent static force analysis for an earthquake is a exceptional concept which is used in earthquake resistant design of structure. This concept is useful since it converts a dynamic analysis into a partly static & dynamic analysis to evaluate the maximum displacements produced in the structure because of earthquake due to ground motion. For earthquake resistant design of structures, only these maximum displacements are of interest, but not the time history of stresses. Equivalent lateral force for an earthquake is defined as a set of static lateral forces which produces the similar peak responses of the structure as that have been produced in the dynamic analysis of the building under the similar ground motion. This concept has drawback since it uses only a single mode of vibration of the structure.

2) *Response spectrum method:* In this concept the multiple modes of vibration of a structure can be used. This analysis can be used in many building codes for all except for simple or complex structures. The vibration of a building is defined as the combination of many special modes that are in a vibrating string corresponding to the "harmonics". Computer aided structural analysis is used to determine these mode shapes for the structure. For every mode shape, from design spectrum responses are studied, with the help of parameters such as modal participation mass and modal frequency, and then they are combined to provide an evaluation of the total responses of the structure.

2.0. MODEL AND ANALYSIS

For the analysis of multi storied building following dimensions are considered which are elaborated below. In the current study main goal is to compare the Static and Dynamic Analysis of symmetrical (Rectangular) building.

Static and Dynamic Parameters:-

Design Parameters- Here the Analysis is being done for G+30 (rigid joint regular frame) building by computer software using STAAD-Pro.

Design Characteristics: - The following design characteristics are considered for **Multistory rigid jointed plane frames**

Table 1 Design Data of RCC Frame Structures

S.No	Particulars	Dimension/Size/Value
1.	Model	G+30
2.	Seismic Zones	IInd , IIIrd
3.	Floor height	3.6M
4.	Depth of foundation	2.4M
5.	Building height	114M
6.	Plan size	25Mx45M
7.	Total area	1125Sq.m
8.	Size of columns	0.9Mx0.9M
9.	Size of beams	0.3Mx0.50M
10	Walls	(a)External-0.20M
		(b)Internal-0.10M
11.	Thickness of slab	125mm
12.	Earthquake load	As per IS-1893-2002
13.	Type of soil	Type -II, Medium soil as per IS-1893
14.	Ec	5000√fck N/ mm2(Ec is short term static modulus of elasticity in N/ mm2)
15.	Fck	0.7√fc k N/ mm2(Fck is characteristic cube strength of concrete in N/ mm2
16.	Live load	3.50kN/ m2
17.	Floor finish	1.00kN/ m2
18.	Water proofing	2.500kN/ m2
19	Specific wt. of RCC	25.00 kN/ m2
20.	Specific wt of infill	20.00 kN/ m2
21.	Material used	Concrete M-30and Reinforcement Fe-415(HYSD Confirming to IS-1786)
22.	Reinforcement used	High strength deformed steel Confirming to IS-786. It is having modulus of Elasticity as 2 00 kN/ mm2
23.	Static analysis	Equivalent static lateral force method.

24.	Dynamic analysis	Using Response spectrum method
25.	Software used	STAAD-Pro for both static and dynamic analysis
26.	Specified characteristic	compressive strength of 150mm cube at 28 days for M-30 grade concrete - 30N/ mm^2
27.	Fundamental natural period of building	Ta = 0.075 h0.75 for moment resisting RC frame building without infill's Ta = 0 .09 h /√d for all other building i/c moment resisting RC frame building with brick infill walls Where h = height of building d = base dimension of building at plinth level in m along the considered direction of lateral forces.
28.	Zone factor Z	As per Is-1893-2002 Part -1 for different. Zone as per clause 6.4.2.

Table 2 Zone categories

seismic zone	IIND	IIIrd	IVth	vth
Z	**0.1**	**0.16**	**0.24**	**0.36**
seismic intensity	**Low**	**moderate**	**severe**	**very severe**

3.0. PLAN DETAIL

The structure is 32m in x-direction & 24m in y-direction with columns spaced at 4m from center to center. The storey height is kept as 3m. Basically model consists of multiple bay fifteen storey building, each bay having width of 4m. The storey height between two floors is 3.0m with beam and column sizes of 0.45x0.45m respectively and also the slab thickness is taken as 0.125m.Shape of the building for all the cases is shown in figure.

A. The material properties and geometry of the model are described below

1) Length X width: 32m X 24m
2) Number of stories: 15
3) Support conditions: Fixed
4) Storey height: 3 m
5) Grade of concrete: 30 Mpa
6) Grade of steel: Fe415
7) Size of columns from 1-5 storey: 650mm x 650mm
8) Size of columns from 6-15 storey: 500mm x 500mm
9) Size of beams: 450mm x 450mm
10) Height of parapet wall: 0.9m
11) Thickness of main wall: 230mm
12) 12 Thickness of parapet wall: 115mm

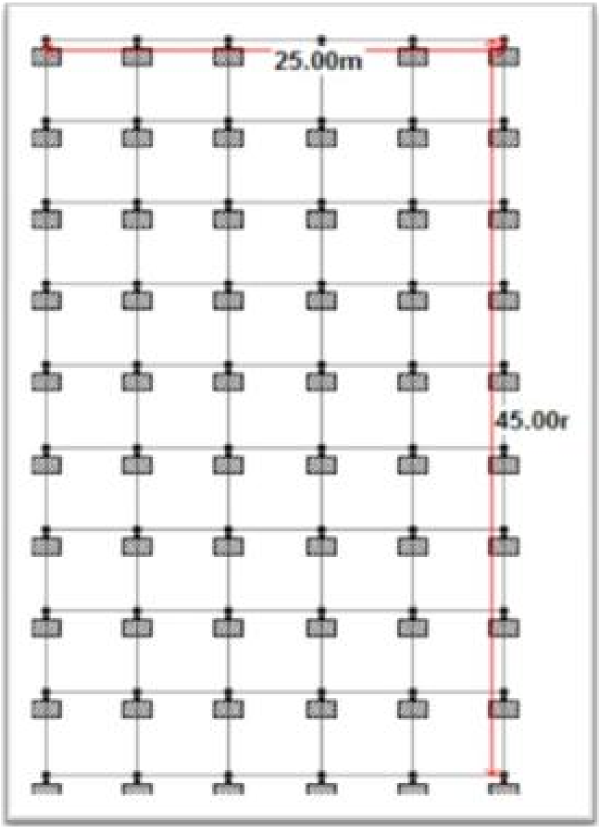

Fig. 1 Plan of Regular Building

Fig. 2: 3-D Model of Regular Building

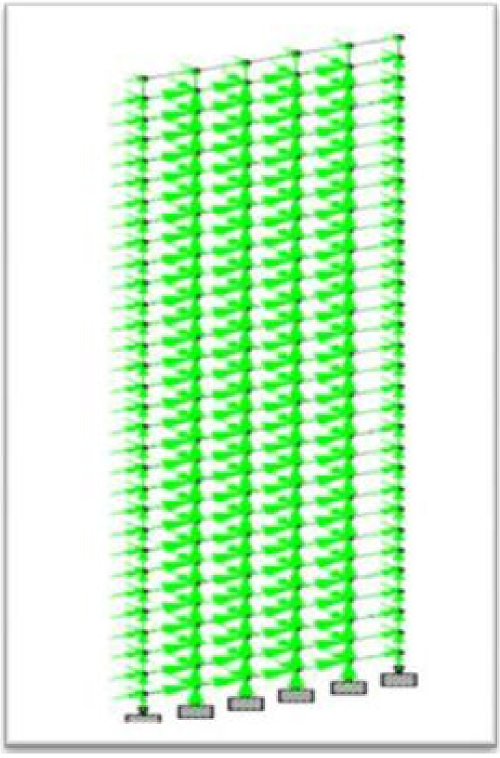

Fig.3: Response Spectrum loading (Dynamic Loading)

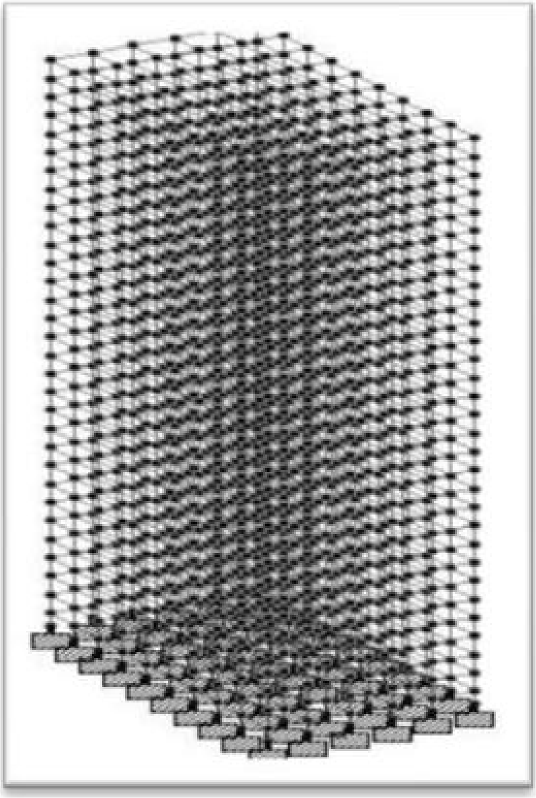

Fig. 2: 3-D Model of Regular Building

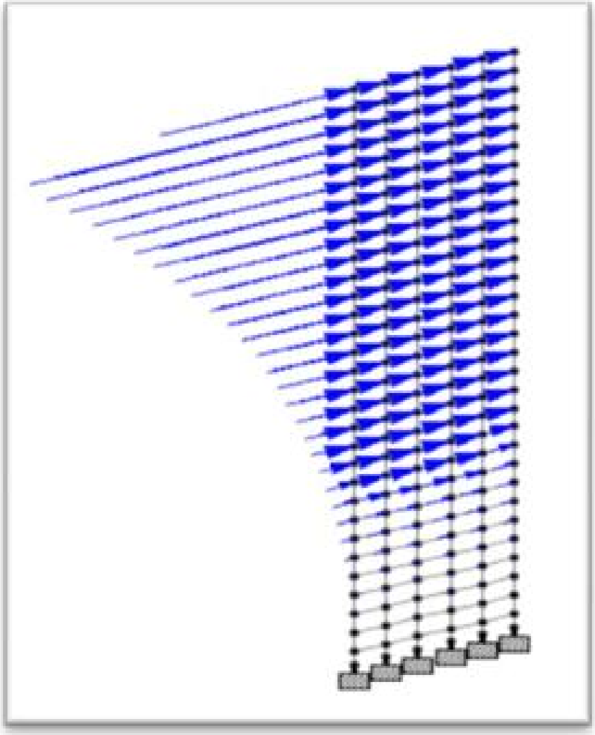

Fig.4: Earthquake Loading (Dynamic Loading)

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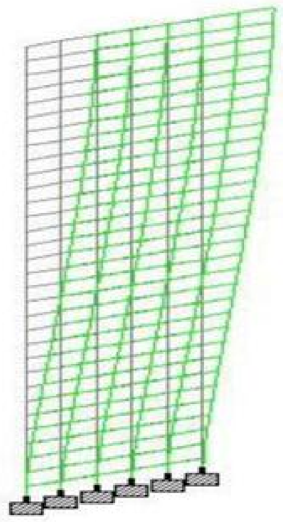

Fig.4: Deflection diagram (Dynamic Loading)

TABLE :1 COMPARISION OF AXIAL FORCES FOR VERTICAL MEMBER

		STAIC ANALYSIS		DYNAMIC ANALYSIS		
		Zone II	Zone III		Zone II	Zone III
Node	L/C	Axial Force kN	Axial Force kN	L/C	Axial Force kN	Axial Force kN
301	1 EQX	918.53	1032.884	1REX	1065.099	1124.085
302	1 EQX	210.962	244.333	1REX	243.985	265.202
303	1 EQX	40.298	47.845	1REX	46.666	51.996
304	1 EQX	40.298	47.845	1REX	46.666	51.996
305	1 EQX	210.961	244.333	1REX	243.985	265.201

TABLE : 2 COMPARISION OF TORSION FOR VERTICAL MEMBER

		STAIC ANALYSIS		DYNAMIC ANALYSIS		
		Zone II	Zone III		Zone II	Zone III
Beam	L/C	Torsion kNm	Torsion kNm	L/C	Torsion kNm	Torsion kNm
301	1 EQX	-0.445	-0.433	1REX	2.689	2.625
302	1 EQX	-0.246	-0.239	1REX	1.642	1.597
303	1 EQX	-0.268	-0.261	1REX	1.737	1.692
304	1 EQX	-0.268	-0.261	1REX	1.737	1.691
305	1 EQX	-0.246	-0.239	1REX	1.642	1.597

TABLE :3 COMPARISION OF MOMENT FOR VERTICAL MEMBER

		STAIC ANALYSIS				DYANAMIC ANALYSIS
		Zone II	Zone III		Zone II	Zone III
Beam	L/C	Moment-Z kNm	Moment-Z kNm	L/C	Moment-Z kNm	Moment-Z kNm
301	1 EQX	86.59	93.887	1REX	106.054	108.466
302	1 EQX	163.584	177.025	1REX	208.093	212.348
303	1 EQX	170.362	184.488	1REX	215.817	220.316
304	1 EQX	170.362	184.488	1REX	215.817	220.316
305	1 EQX	163.584	177.025	1REX	208.093	212.348

TABLE :4 COMPARISION OF DISPLACEMENT FOR VERTICAL MEMBER

		STAIC ANALYSIS				DYANAMIC ANALYSIS
		Zone II	Zone III		Zone II	Zone III
Beam	L/C	X-Trans mm	X-Trans mm	L/C	X-Trans mm	X-Trans mm
301	1 EQX	31.376	33.881	1REX	43.372	43.996
302	1 EQX	31.377	33.882	1REX	43.373	43.997
303	1 EQX	31.378	33.883	1REX	43.374	43.998
304	1 EQX	31.378	33.883	1REX	43.374	43.998
305	1 EQX	31.377	33.882	1REX	43.373	43.997

4.0. CONCLUSION

The results as obtained zone II and zone III using STAAD PRO 2006 for the Static and Dynamic Analysis are compared for different categories under different nodes and beams.

- As per the results in Table No 1 zone II and zone III, we can see that there is not much difference in the values of Axial Forces as obtained by Static and Dynamic Analysis of the RCC Structure.
- As per the results in Table No 2 zone II and zone III, we can see that the values for Torsion at different points in the beam are negative and for Dynamic Analysis the values for Torsion are positive.
- As per the results in Table No 3 zone II and zone III, we can see that the values for Moment at different points in the beam are 10 to 15% higher for Dynamic Analysis than the values obtained for Static Analysis for the Moment at the same points.
- As per the results in Table No 4 zone II and zone III, we can see that the values for displacement

at different points in the beam are 17 to 28 % higher for Dynamic Analysis than the values obtained for Static Analysis for the displacement at the same points.

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