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Earthquake Analysis of Multi Storey Building

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Abstract

When earthquake strikes a multi-storey building and if it is not well designed and adequate strength is not gained after its construction tends to its total breakdown. Hence, to guarantee the safety of multi-storey structure against seismic forces , seismic analysis is to be done for designing of earthquake resistant structures. In the seismic analysis, the response reduction is to be considered for both of the two cases i.e. **SPECIAL MOMENT RESISTING FRAME(SMRF)** & **ORDINARY MOMENT RESISTING FRAME(OMRF)**. The main aim behind this paper is to contemplate the seismic analysis of structures in **SPECIAL MOMENT RESISTING FRAME(SMRF)** & **ORDINARY MOMENT RESISTING FRAME(OMRF)**. Response spectrum analysis & Equivalent static analysis are the methods utilized in seismic analysis of structures. We considered the Residential structure of G +15 storey structure for the seismic analysis and it is situated in zone II. The total structure is examined by PC with utilizing STAAD.PRO software.

Keywords – Response spectrum analysis , Equivalent static analysis, Special Moment Resisting Frame, Ordinary Moment Resisting Frame and STAAD.PRO V8i.

INTRODUCTION

In today's scenario individuals are confronting issues of land shortage and significant expensive land. The rapid industrialization prompted the mass migration of individuals from towns to urban zones , which urges the development of multi-storey structures both for private and official purposes. The tall structures are not appropriately designed to resist the lateral forces which causes their total failure. The earthquake resistant structures are designed, based on some factors like damping factor, type of foundation , natural frequency , ductility, and significance of the structure. The structure planned according to the ductility should have less lateral loads and have better moment distribution characteristics. This perspective accords with the Response Reduction Factor (R) for various types of structures. For its superior functioning throughout its life , the structure should be designed as a SPECIAL MOMENT RESISTING FRAME (SMRF) and it should be designed as an ORDINARY MOMENT RESISTING FRAME (OMRF) when it has to resist minimal forces.

MOMENT RESISTING FRAME

When the members and joints of a frame resist the forces primarily caused by flexure , are termed as moment resisting frame.

These are of two types

(a) **Special Moment Resisting Frame:** This type of moment resisting frames are designed to behave in ductile manner.

(b)**Ordinary Moment Resisting Frame:** When the moment resisting frames are designed without any special attention towards its ductile behaviour , are termed as ordinary moment resisting frames.

Types of Earthquakes

Design Basis Earthquake (DBE): When the probability of occurrence of earthquake is atleast one's during the design life of the structure is termed as design basis earthquake

Maximum Considered Earthquake (MCE): The earthquake that can occur in a particular area or region with maximum expected intensity is termed as maximum considered earthquake.

The design approach suggested by IS: 1893-2002 depends on the accompanying standards (clause 6.1).

a) The structure ought to be resistant to minor earthquakes less than **Design Basis Earthquake** with no damage.
b) The structure ought to have the ability of resistance against the earthquakes equal to **Design Basis Earthquake** without any critical damage to structure however non-structural type of some damage may occur.
c) The structure ought to be resistant to an earthquake equivalent to **Maximum Considered Earthquake** without any breakdown.

METHODS OF ANALYSIS

Equivalent Static Analysis:
This method is used for computing the seismic loads of low rise structures. Tall structures are not considered for the design, using this simple static method. Practically it doesn't consider the factors that are important for the foundation conditions. In this method, just one mode is taken into consideration for each direction. The equivalent static analysis method is sufficient for earthquake resistant designing of the low rise structures. High rise structures require a mass weight of every storey and multiple modes in each direction to design earthquake resistant structures. Therefore, the Dynamic Analysis method is to be utilized for high rise structures.

Response Spectrum Analysis:

When the tectonic forces strikes a structure , its foundation moves with the ground motion. In this way shaking of the structure is more than the ground motion. This shaking of the structure with respect to that of ground motion is known as the DYNAMIC AMPLIFICATION. It relies upon the damping, type of foundation, the natural frequency of vibration , and the method of detailing of the structure. The "response design acceleration spectrum" which is also known as maximum acceleration , is denoted by coefficient of spectral acceleration "Sa/g" , which is the function for a specified damping ratio for earthquake excitation at the base of the structure for a SINGLE DEGREE FREEDOM SYSTEM (SDOF)

The revised IS 1893-2002 uses the response spectrum for dynamic analysis of a structure. This method takes into account all the five important engineering properties of the structures.

01. The damping properties of the structure
02. Type of foundation provided for the building
03. Importance factor of the building

04. The vibration of the building represented by fundamental natural period (T in seconds)
05. The ductility of the structure represented by response reduction factor.

ZONE FACTORS FOR DIFFERENT ZONES IN INDIA

Zone	Seismic coefficient of 1984	Seismic zone factor (z of 2002)
II	0.02	0.1
III	0.04	0.16
IV	0.05	0.24
V	0.08	0.36

Table.1 Seismic Zone factors

MODAL GENERATION AND ANALYSIS:

A residential building with 3BHK arrangement with y-axis comprised of **G + 15** floors was taken into consideration for this research work. Each of the floors had a height of 3 metres . At the base of the structure the supports were considered as fixed. The considered structure was subjected to dead load ,self-weight, and live loads values taken from section 1 and section 2 of IS 875 . The wind load values were inserted by STAAD.PRO software considering the given wind forces at various heights and carefully complying with the details under section 3 of IS 875. The calculations of Dynamic & Static analysis due to sesmic forces were done under the consideration of section 1 of IS 1893-2002.

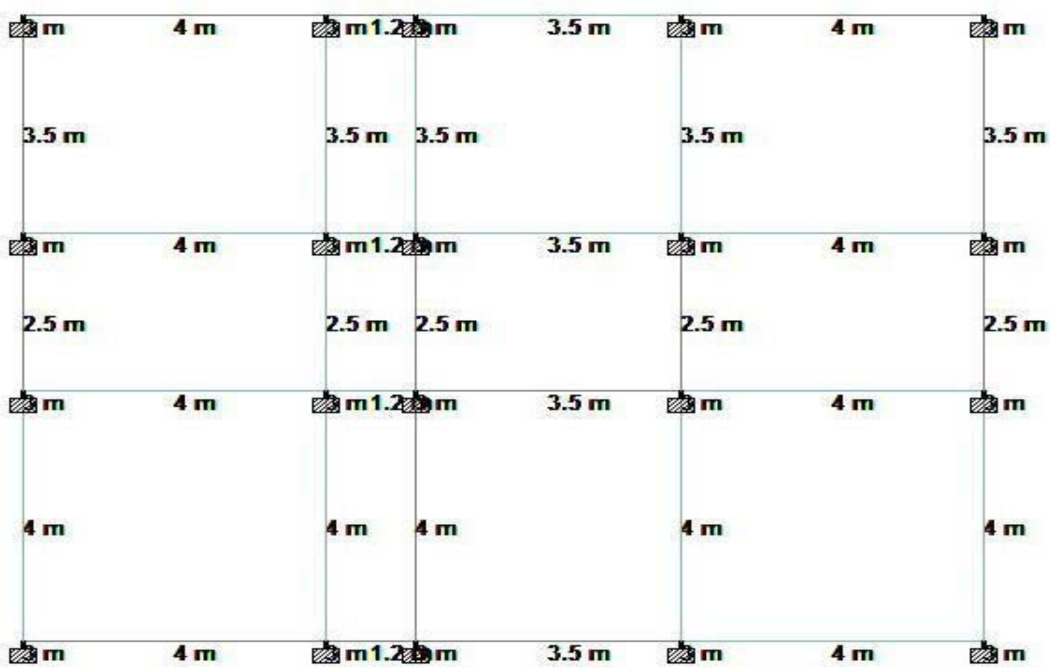

Fig.1 Positions of columns

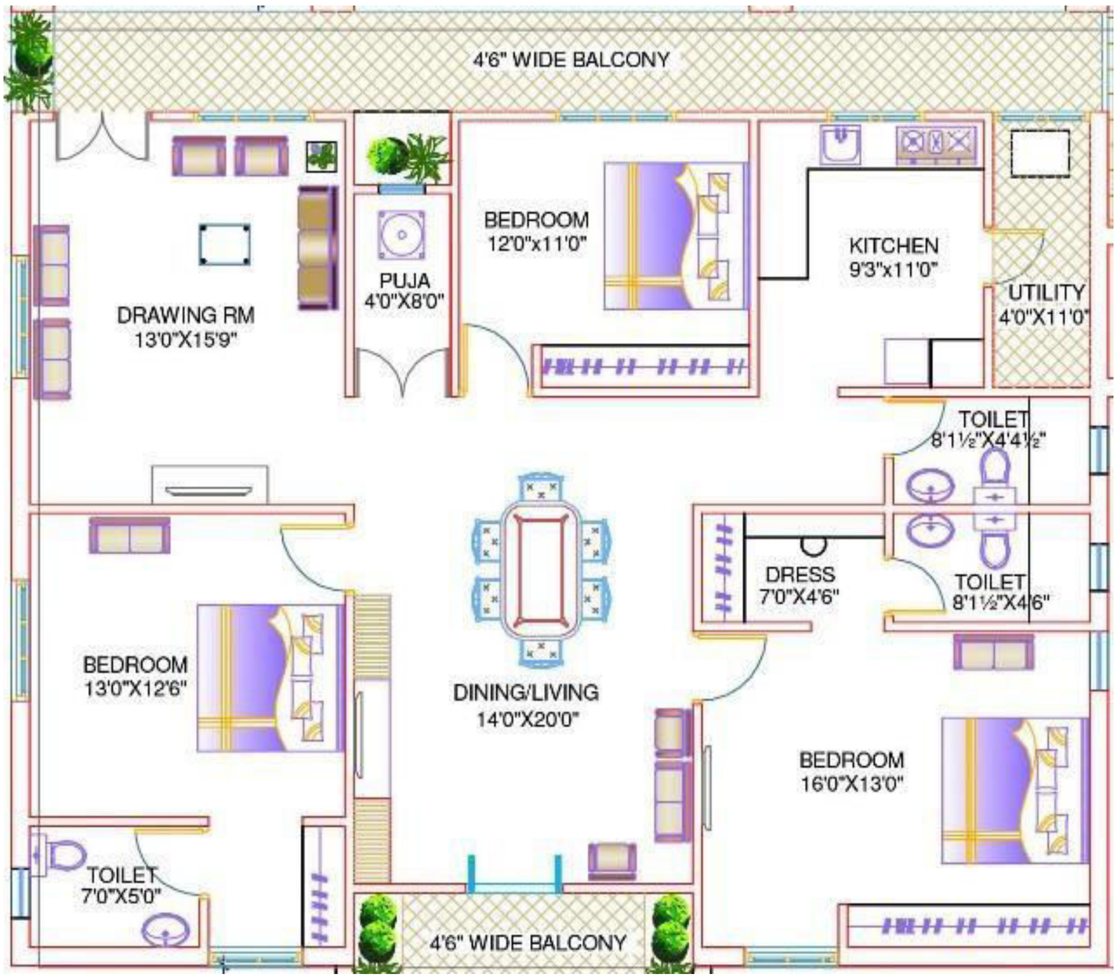

Fig.2 Plan Of G + 15 Residential Building

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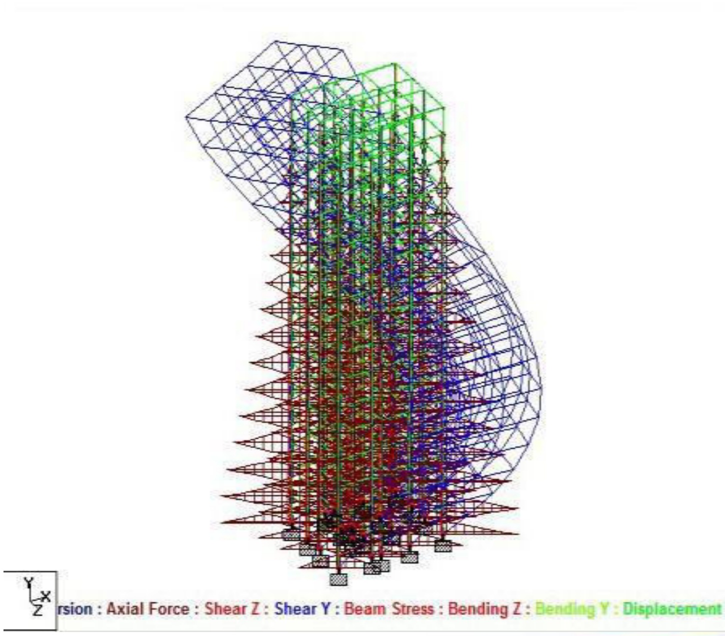
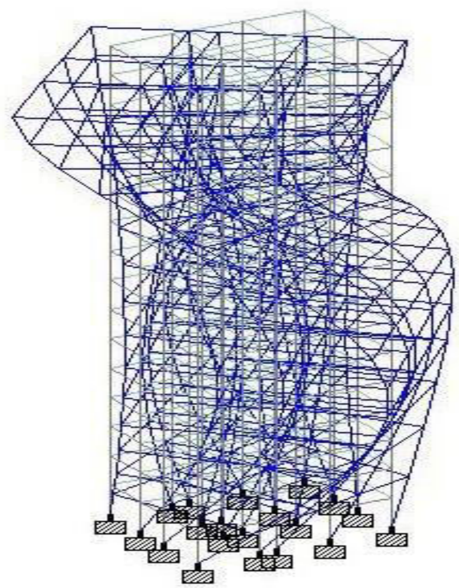




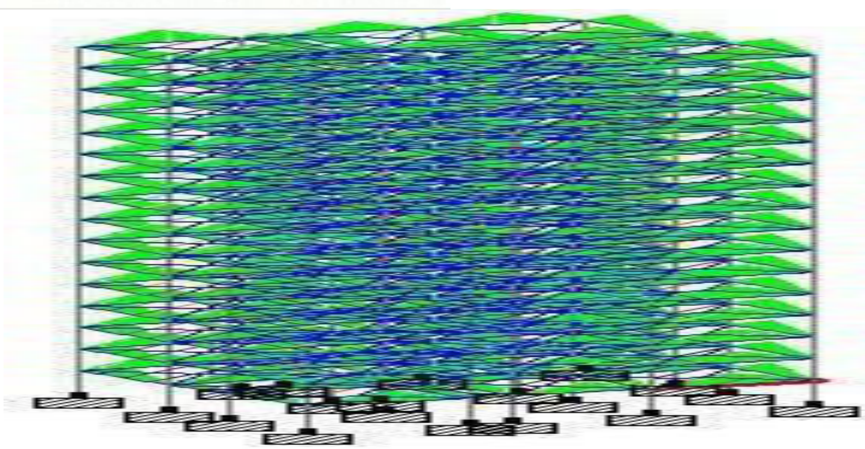
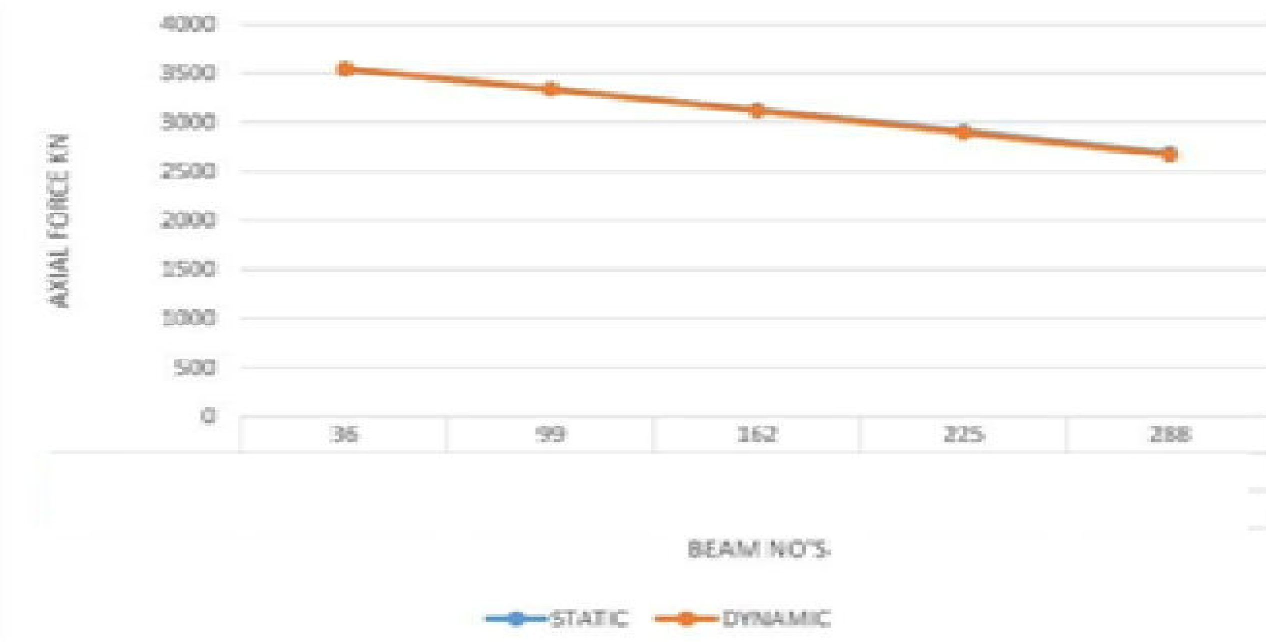


Fig.3 Live loads assigned in structure

Fig.4 Shear force, torsion force ,axial force, and displacement

Fig.5 Mode shape in dynamic analysis



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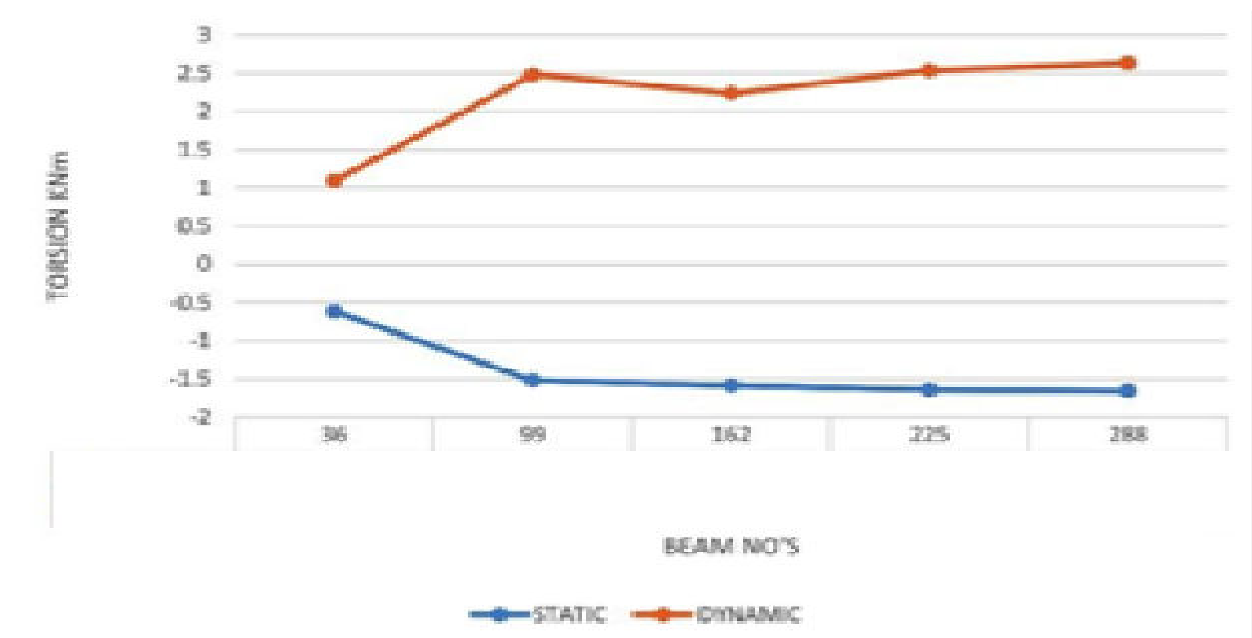
Graph 1 Analysis of Axial forces in OMRF



Graph 2. Anlysis of Torsion in OMRF

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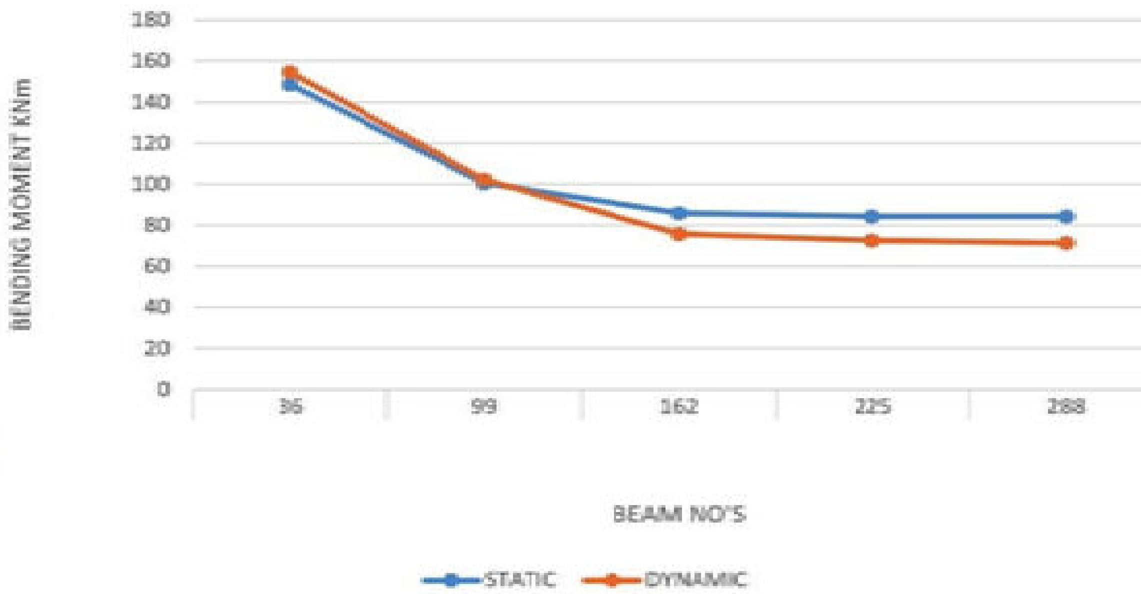
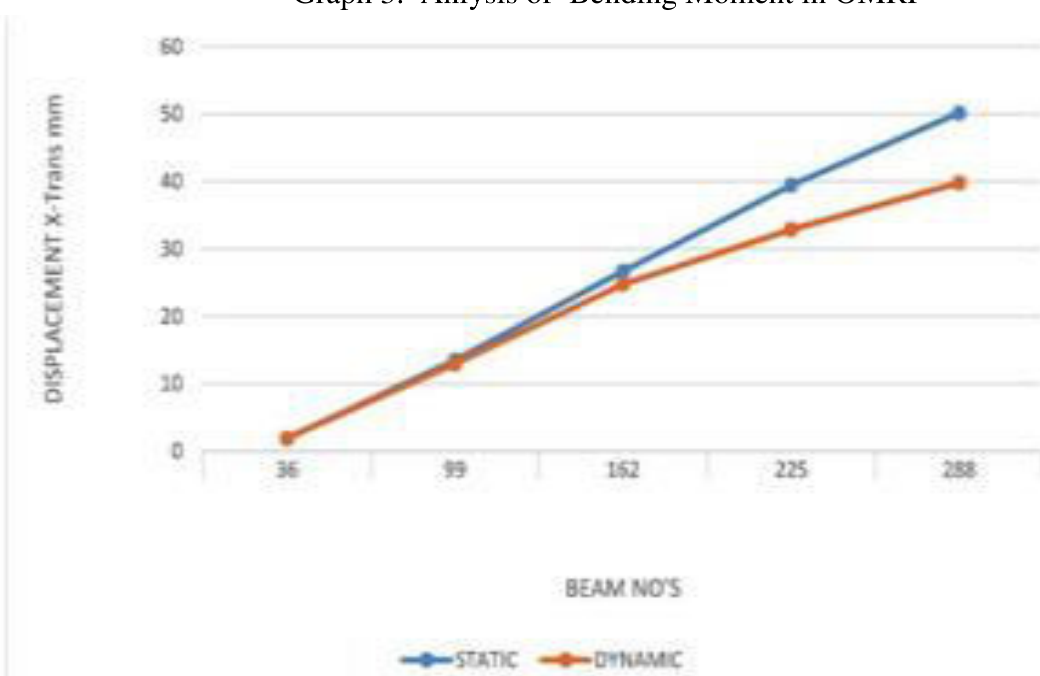
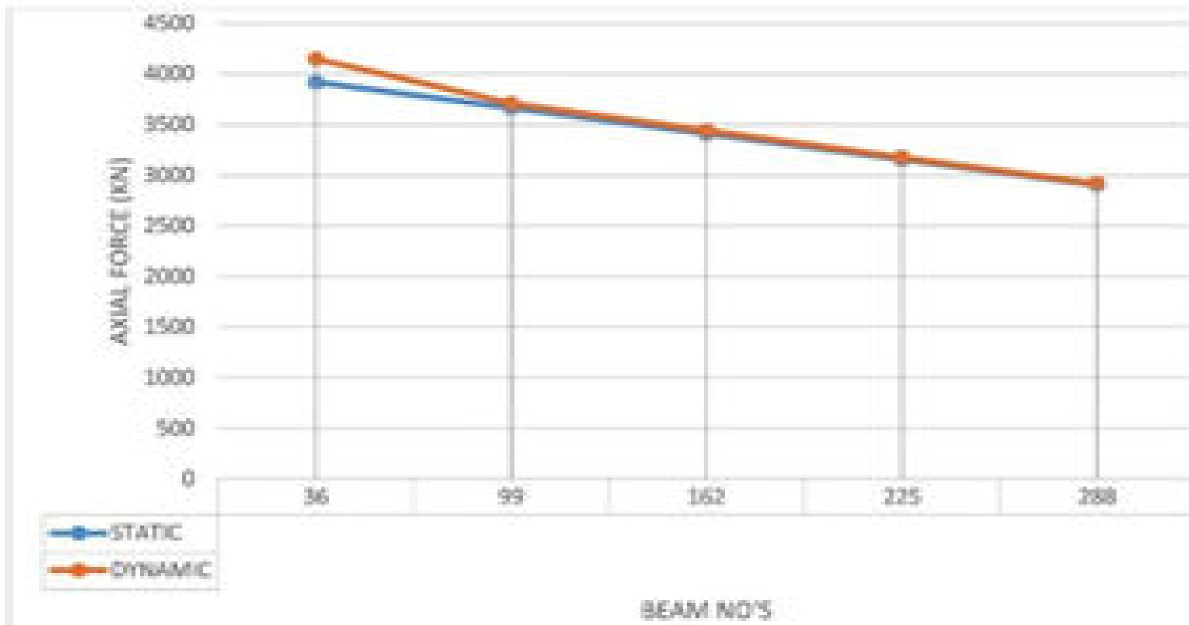


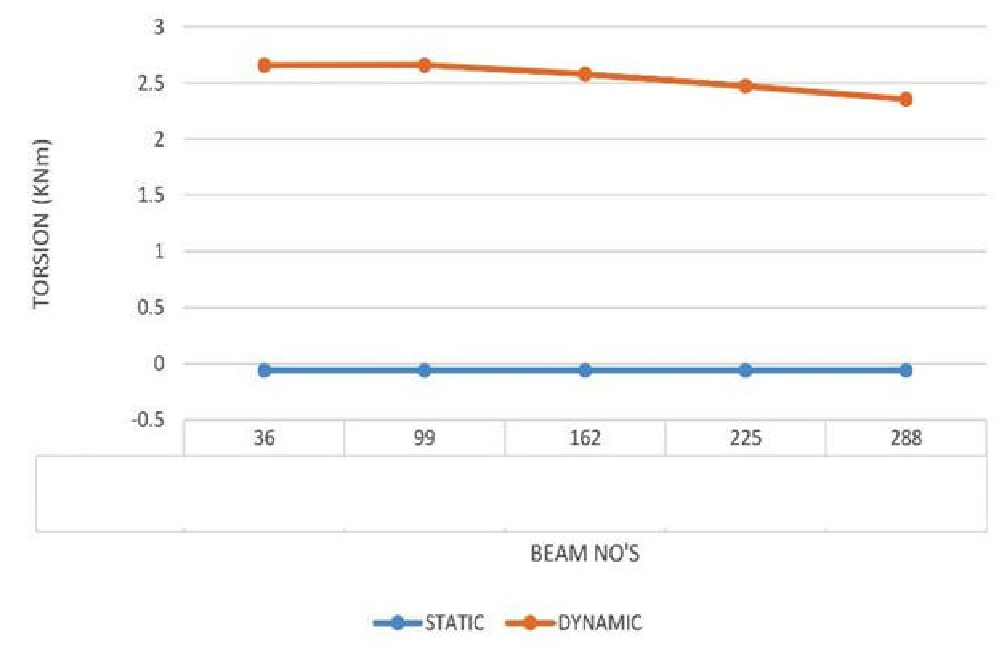
Graph 3. Anlysis of Bending Moment in OMRF



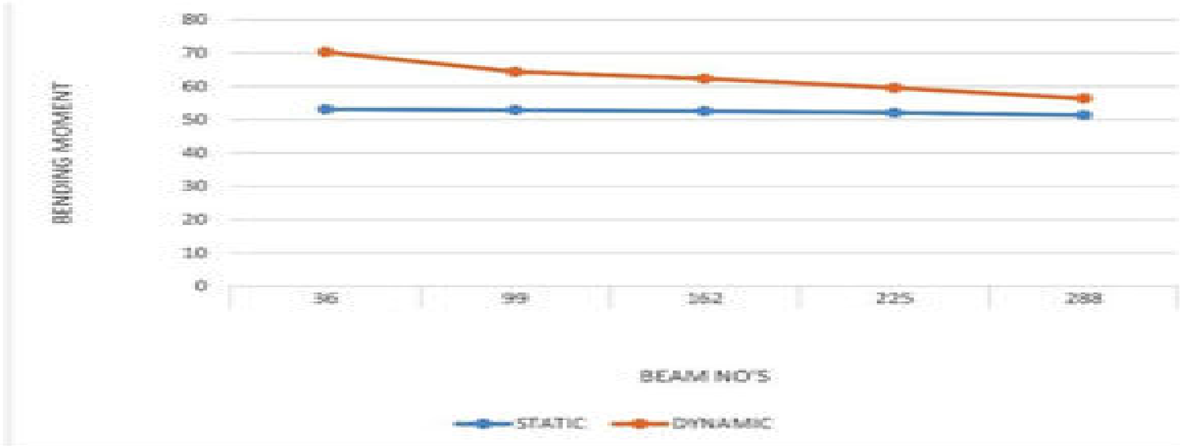
Graph 4. Anlysis of Displacement in OMRF



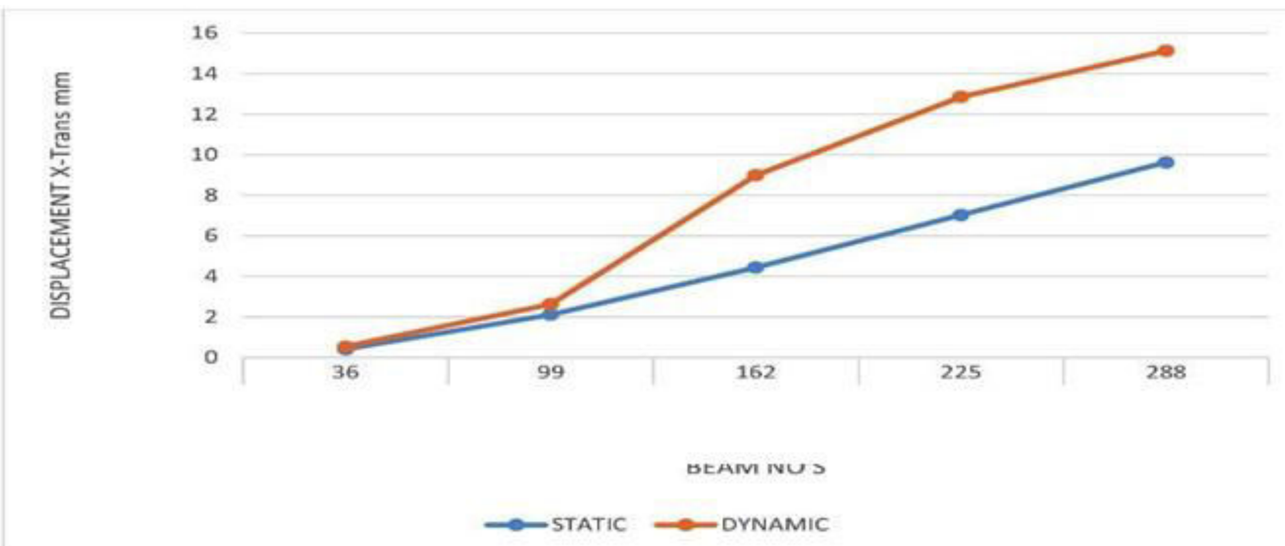
Graph 5. Anlysis of Axial forces in SMRF



Graph 6. Anlysis of Torsion in SMRF



Graph 7. Anlysis of Bending Moment in SMRF



Graph 8. Displacement in SMRF

Static Analysis			
		Axial Force KN	
BEAM	L/C	OMRF	SMRF
36	E.Q+X	3536.9	3915.5
99	E.Q+X	3338.9	3662.5

162	E.Q+X	3128.3	3410.3
225	E.Q+X	2907.9	3155.8
288	E.Q+X	2688.0	2904.6

Table 2. Axial forces in Static Analysis

Static Analysis			
		Torsion KNm	
BEAM	L/C	OMRF	SMRF
36	E.Q+X	-0.618	-0.057
99	E.Q+X	-1.521	-0.058
162	E.Q+X	-1.585	-0.058
225	E.Q+X	-1.644	-0.057
288	E.Q+X	-1.659	-0.059

Table 3. Torsion in Static Analysis

Static Analysis			
		Bending moment-KNm	
BEAM	L/C	OMRF	SMRF
36	E.Q+X	149.72	54.142
99	E.Q+X	100.57	51.919
162	E.Q+X	84.99	53.021
225	E.Q+X	83.28	51.994
288	E.Q+X	84.27	52.010

Table 4. Bending Moment in Static Analysis

Dynamic Analysis			
		Axial Force KN	
BEAM	L/C	OMRF	SMRF
36	E.Q+X	3542.0	4147.9
99	E.Q+X	3336.7	3706.9
162	E.Q+X	3116.8	3441.0
225	E.Q+X	2893.9	3177.3
288	E.Q+X	2669.4	2916.4

Table 5. Axial forces in Dynamic Analysis

Dynamic Analysis			
		Torsion KNm	
BEAM	L/C	OMRF	SMRF
36	E.Q+X	1.093	2.658

99	E.Q+X	2.486	2.662
162	E.Q+X	2.239	2.582
225	E.Q+X	2.533	2.475
288	E.Q+X	2.631	2.632

Table 6. Torsion in Dynamic Analysis

Dynamic Analysis			
		Bending moment KNm	
BEAM	L/C	OMRF	SMRF
36	E.Q+X	154.740	70.312
99	E.Q+X	102.289	64.389
162	E.Q+X	75.820	62.309
225	E.Q+X	72.650	59.566
288	E.Q+X	71.410	56.378

Table 7. Bending Moment in Dynamic Analysis

Static Analysis			
		Displacement X-Trans	
BEAM	L/C	OMRF	SMRF
36	E.Q+X	1.850	0.458
99	E.Q+X	13.452	2.108
162	E.Q+X	26.685	4.435
225	E.Q+X	39.457	7.026
288	E.Q+X	50.161	9.625

Table 8. Displacement X-trans in Static Analysis

Dynamic Analysis			
		Displacement X-Trans	
BEAM	L/C	OMRF	SMRF

36	E.Q+X	1.908	0.535
99	E.Q+X	12.940	2.624
162	E.Q+X	24.770	9.001
225	E.Q+X	32.880	12.860
288	E.Q+X	39.789	15.123

Table 9. Displacement X-Trans in Dynamic Analysis

CONCLUSIONS

The results obtained from dynamic & static analysis in OMRF and SMRF are analyzed for different columns under bending moments ,axial, torsional,and displacement forces.

i. There are equivalent values obtained from axial forces in dynamic & static analysis of OMRF structure as represented in Graph 1.
ii. The values acquired from torsional forces in the static analysis are negative and dynamic investigation values are positive represented in Graph 2.
iii. The values obtained from bending moments in dynamic analysis are initially high for columns and decreases gradually when contrasted with that of static analysis as represented in Graph 3.
iv. The values obtained from displacement in static analysis of OMRF values are more as compared with that of values of dynamic analysis of similar sections as represented in Graph 4.
v. The values obtained from axial forces in the dynamic analysis of SMRF structures are high as compared to static analysis as represented in Graph 5.
vi. The values obtained from torsional forces in the static analysis are negative and values of dynamic analysis are positive with great difference between the both as represented in Graph 6.
vii. The values of bending moments in dynamic analysis are more when contrasted with that of static analysis of SMRF structure as represented in Graph 7.
viii. The values of displacement in dynamic analysis of SMRF increases gradually when contrasted with that of static analysis of similar sections as represented in Graph 8.

The values of static and dynamic analysis of OMRF and SMRF are observed. Finally, it is concluded that the outcomes from Dynamic analysis in **Ordinary Moment Resisting Frame** and **Special Moment Resisting Frame** are higher when compared with that of Static analysis in **Ordinary Moment Resisting Frame** and **Special Moment Resisting Frame** . Thus the performance of dynamic analysis of SMRF structure is quiet good in resisting the earthquake forces as compared to that of the static analysis of OMRF & SMRF

REFERENCES

[1] Mohit Sharma, Dr. Savita Maru. *IOSR Journal of Mechanical and Civil Engineering, Volume 11, Issue 1. Ver. II (Jan-2014), PP 37-42*.
[2] IS: 1893-2002 (part-1) "*criteria for earthquake resistant design of structures*" fifth revision, Bureau of Indian Standards, New Delhi.
[3] IS: 456-2000 *(Indian Standard Plain Reinforced Concrete Code of Practice)* – Fourth Revision.
[4] IS: 875-1987 (part-1) for *Dead Loads, code of practice of Design loads* (other than earthquake) for buildings and structures.
[5] IS: 875-1987 (part-2) for *Live Loads or Imposed Loads, code of practice of Design loads* (other than earthquake) for buildings and structures.
[6] IS: 875-1987 (part-3) for *Wind Loads, code of practice of Design loads* (other than earthquake) for buildings and structures.
[7] IS 13920-1993 for *Ductile Detailing Reinforced Concrete Structures subject to seismic forces*, Bureau of Indian Standards, New Delhi.
[8] Dr. S.K Duggal, *Earthquake Resistance Design of Structure*.
[9] P. C. Varghese, *Advanced Reinforced Concrete Design,* Second Edition.