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RESPONSE SPECTRUM ANALYSIS OF UNSYMMECTRICAL MULTISTORY BUILDING

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***Abstract*: Suppose when a structure is subjected to earthquake, it responds due to vibration. This motion causes the structure to vibrate or shake in all three directions an earthquake force can be resolved into three mutually perpendicular directions- the two horizontal directions (x and y) and the vertical direction (z); the major direction of shuddering is horizontal. The grade of concrete and reinforcement detailing influences the behavior of the structure. The response of the structure is studied with Sway and non sway analysis has been done in this study. The main objectives of the present work is to study the performance of a multi storied Reinforced cement concrete building with irregular in shape subjected to earth quake load at different Zone condition by adopting Response spectrum analysis. The present study is restricted to Reinforced cement concrete multistory building with two different zones II and IV. The building model in the study has ten storey's with constant storey height of 3m and foundation of 1.5m height. The analysis is carried out with the help of ETABS.**

***Index Terms*: Ductile detailing, response spectrum, storey stiffness, storey drift, ratio of mass participation**

I. INTRODUCTION

It is uneconomical to design structures to withstand major earthquakes. However, the design should be done. So that the structures have sufficient strength and ductility. This lesson explains the requirements and advantages of ductility in the design of reinforced concrete members which can be expressed with respect to displacement, curvature or rotation of the member. The expressions of ductility of singly and doubly-reinforced beams with respect to curvature are derived. The influencing parameters of the ductility are explained. Several aspects of design for ductility are explained mentioning detailing for ductility, as stipulated in is 13920:1993, for flexural members and columns. Illustrative examples are solved to determine the ductility with respect to curvature of singly and doubly-reinforced beams. Moreover, numerical problems are solved to illustrate the design of beams, columns and beam-column joints. It is essential that an earthquake resistant structure should be capable of deforming in a ductile manner when subjected to lateral loads in several cycles in the inelastic range. In most structural applications of steel reinforced concrete, a large flexural stiffness is desirable in order to limit member deflections under service load conditions for which the elastic deflection limit can be small and must not be exceeded. In seismic resistant structures, however, inelastic deformations at particular locations of the structural system are intended to dissipate large energy, thereby reducing the effects of seismic excitation on the structure. In particular, moment resisting frames designed according to the strong column/weak beam concept are expected to undergo inelastic deformations by formation of plastic hinges in the beam members, while the columns remain elastic in order to maintain vertical load carrying capacity and prevent possible collapse.

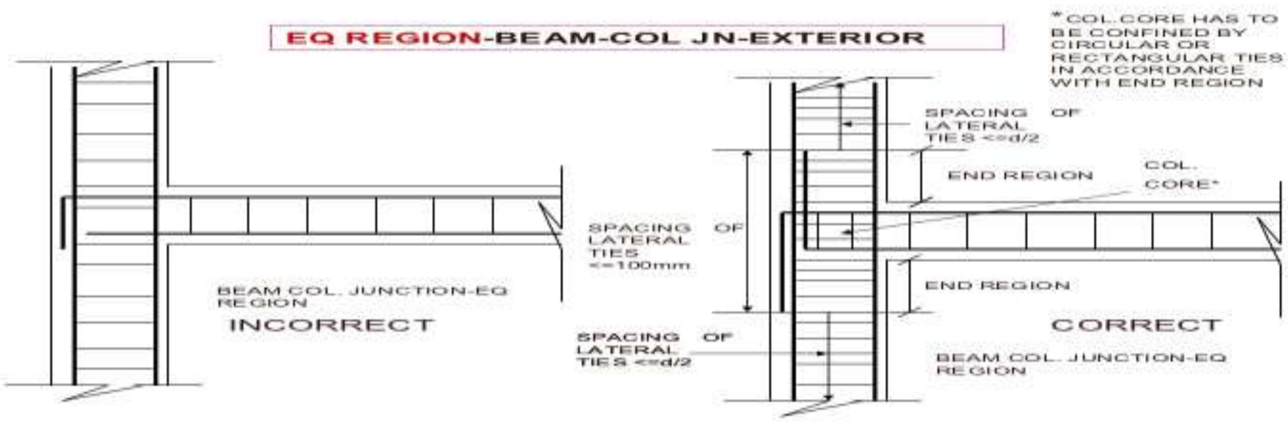


Fig.1. Beam-Column joint with Ductile Detailing

At a fixed concrete grade, the addition of compression reinforcement without increasing the tension reinforcement would produce a significant increase in flexural ductility but little increase in flexural strength. However, if accompanied by an increase in tension reinforcement, the addition of compression reinforcement could also produce a significant increase in flexural strength although the net increase in flexural ductility would be reduced. Its overall effect is best revealed by plotting the flexural ductility against the flexural strength for different compression steel ratios as in Fig. 1.5. From these curves, it is evident that, like the use of highstrength concrete, the addition of compression reinforcement could substantially extend the limit of flexural strength and ductility that could be simultaneously achieved. However, the addition of compression reinforcement would also lead to significant increase in the cost of construction, which may or may not be justified depending on the situation.

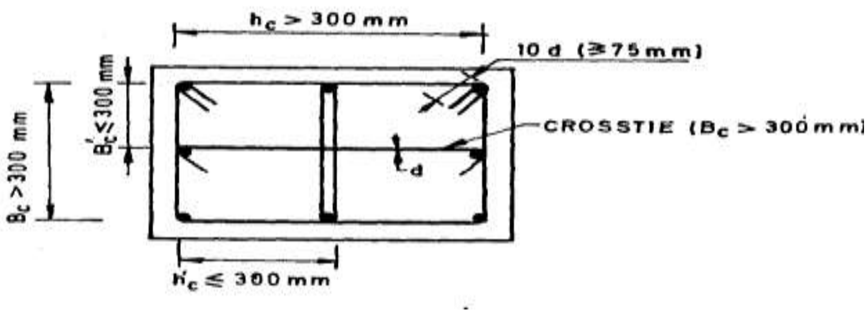


FIG. 2. TRANSVERSE STEEL IN COMPRESSION MEMBER

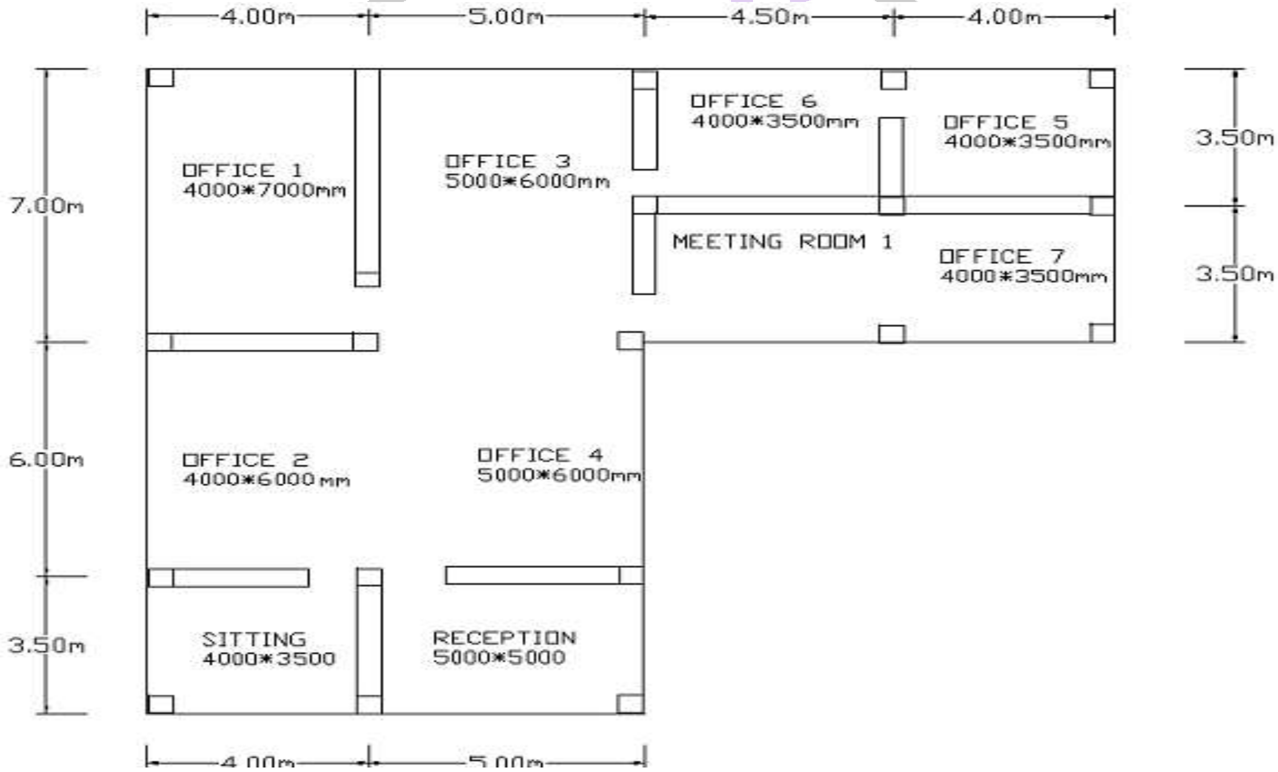
II. OBJECTIVES

The main objectives of present work are as follows

1) Analysis of multistorey building using E-TABS by considering Earthquake Zone -II and Zone –IV.

2) Comparison of storey stiffness, story drift and mass participation for conventional and ductile detailing building

III. AUTOCAD PLAN



Structural Data

Total height of structure: 31.5
Length along X-axis: 18.5m
Length along Y-axis:16.0m
Grade of concrete: M20 for Slab and Beam, M25 for Column
Grade of steel: Fe500

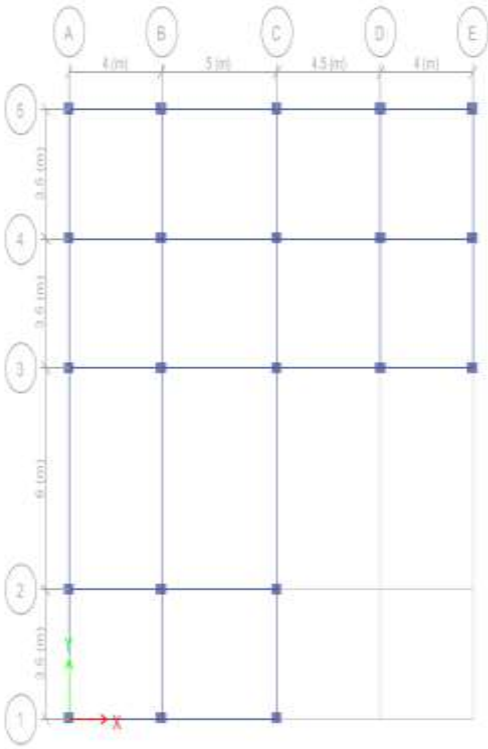
B. Member properties
Thickness of slab: OFFICE BUILDING - 150mm, Office - 170mm
Beam size: 0.35 x 0.45m
Column size: 0.45 x0.45m

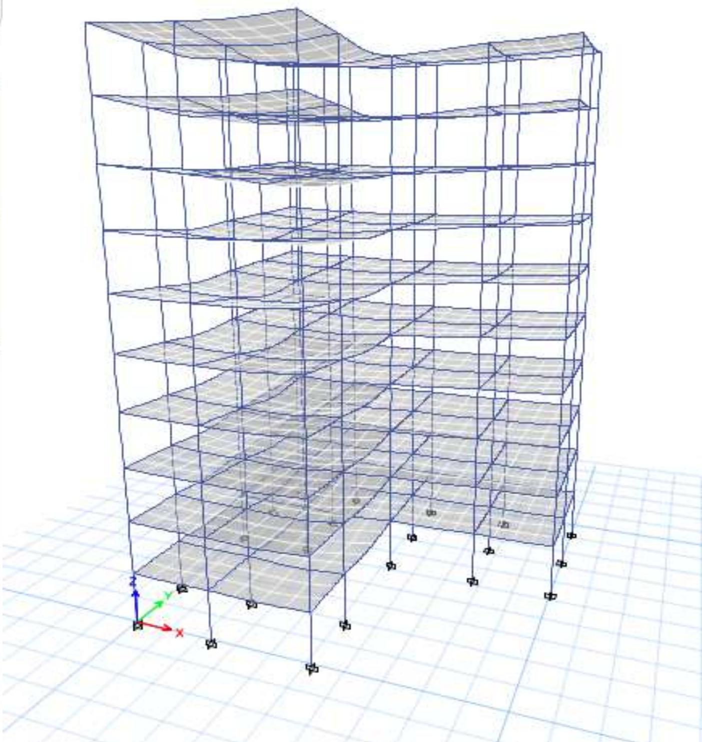
Wall thickness: 0.15m

C. Loads
Live load on floor: Residential - 3KN/ m2, Office - 4KN/ m2
Floor finish: 1.5KN/ m2

D. Seismic Load Patternas per the IS1893-2002 Part-1
Seismic Zone Factor, Z:, 0.24,
Response Reduction, R: 5
Importance Factor, I:

IV. ANALYSIS





By the overall analysis of unsymmetrical multistorey in zone IV the following parameter are defined,

Sufficient strength – capacity to resist earthquake forces,
Adequate stiffness – capacity to not deform too much,
Large ductility –capacity to stay stable even after a damaging
Good configuration – features of building size, shape and structural system that are not detrimental to favorable seismic behavior.

V. STORY DRIFT FOR THE BUILDING

Table.1: Values for Conventional Building at SDL

Story	Load Case/Combo	Drift mm	X	Y	Z
Story10	SDL	0.000011	9	0	29.9
Story9	SDL	0.000013	9	0	26.9
Story8	SDL	0.000012	9	0	23.9
Story7	SDL	0.000011	9	0	20.9
Story6	SDL	0.00001	9	0	17.9
Story5	SDL	0.000008	9	0	14.9
Story4	SDL	0.000006	9	0	11.9
Story3	SDL	0.000004	9	0	8.9
Story2	SDL	0.000001	17.5	16.5	5.9
Story1	SDL	0.000001	9	0	2.9

Table.2: Drift Values for Ductile Building at Spectrum X

Story	Load Case/Combo	Item	Drift mm	X	Y	Z
Story10	Spect X	Max Drift X	0.000048	17.5	16.5	29.9
Story9	Spect X	Max Drift X	0.000048	17.5	16.5	26.9
Story8	Spect X	Max Drift X	0.000045	17.5	16.5	23.9
Story7	Spect X	Max Drift X	0.000042	17.5	16.5	20.9
Story6	Spect X	Max Drift X	0.000037	17.5	16.5	17.9
Story5	Spect X	Max Drift X	0.000032	17.5	16.5	14.9
Story4	Spect X	Max Drift X	0.000027	17.5	16.5	11.9
Story3	Spect X	Max Drift X	0.00002	17.5	16.5	8.9
Story2	Spect X	Max Drift X	0.000014	17.5	16.5	5.9
Story1	Spect X	Max Drift X	0.000006	9	0	2.9

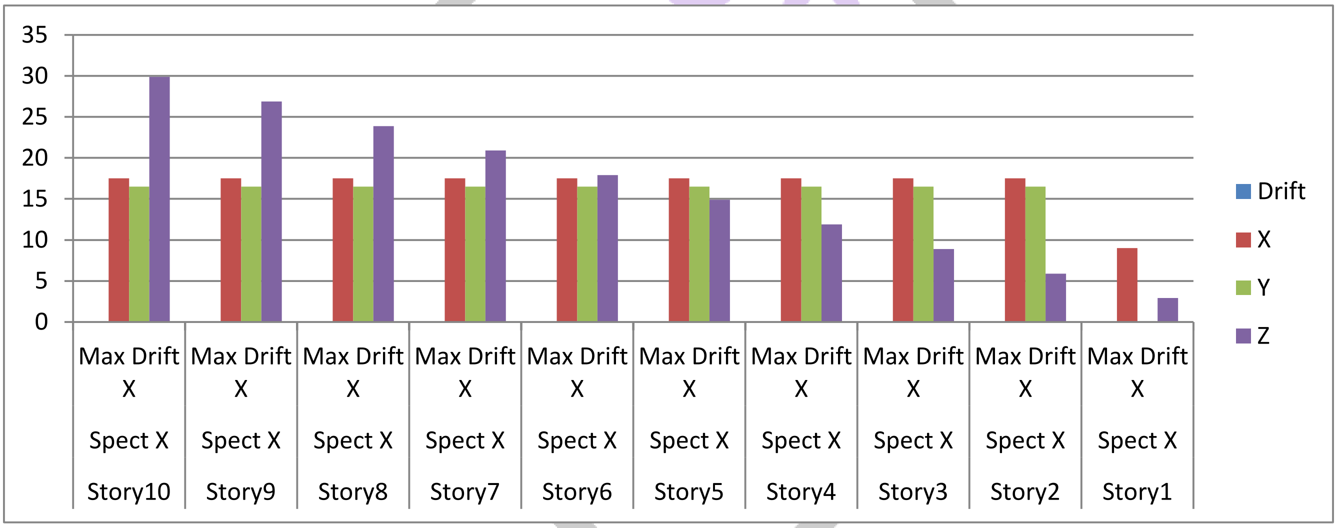


Fig.3. Graph showing the Values at Spectrum X [ZONE 4]

Table.3: Drift Values for Ductile Building at Spectrum Y

Story	Load Case/Combo	Item	Drift mm	X	Y	Z
Story10	Spect Y	Max Drift Y	0.000058	16	0	19.9
Story9	Spect Y	Max Drift Y	0.000058	16	0	16.9
Story8	Spect Y	Max Drift Y	0.000035	16	0	13.9
Story7	Spect Y	Max Drift Y	0.000032	16	0	12.9
Story6	Spect Y	Max Drift Y	0.000027	16	0	12.9
Story5	Spect Y	Max Drift Y	0.000022	16	0	12.9
Story4	Spect Y	Max Drift Y	0.000037	15.9	0	11.9
Story3	Spect Y	Max Drift Y	0.00002	14	0	11.9
Story2	Spect Y	Max Drift Y	0.000034	13.2	0	10.9
Story1	Spect Y	Max Drift Y	0.000006	13.2	0	9.9

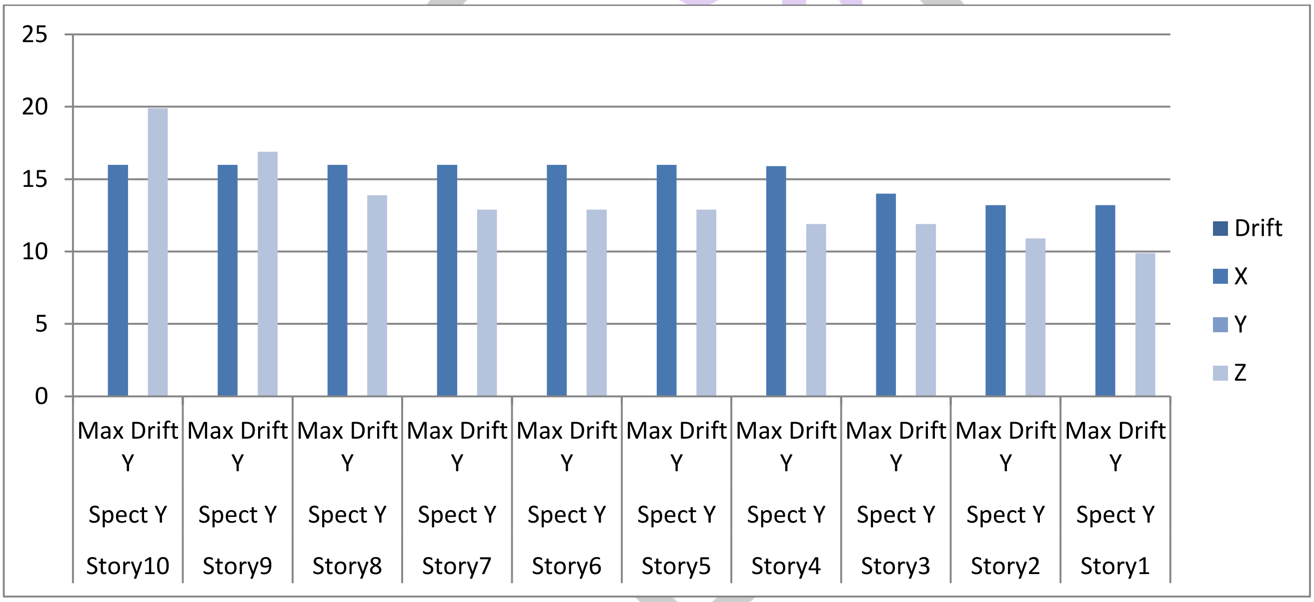


Fig.4. Graph showing the Values at Spectrum Y [ZONE 4]

VI. STORY STIFFNESS FOR THE BUILDING

Table.4. Shows Stiffness Values for Conventional Building at SDL

Story	Load Case	Stiffness N/m
Story10	SDL	80347.521
Story9	SDL	81568.645
Story8	SDL	82050.375
Story7	SDL	83835.651
Story6	SDL	84950.527
Story5	SDL	86519.315
Story4	SDL	88023.550
Story3	SDL	90577.685
Story2	SDL	91574.389
Story1	SDL	94484.041

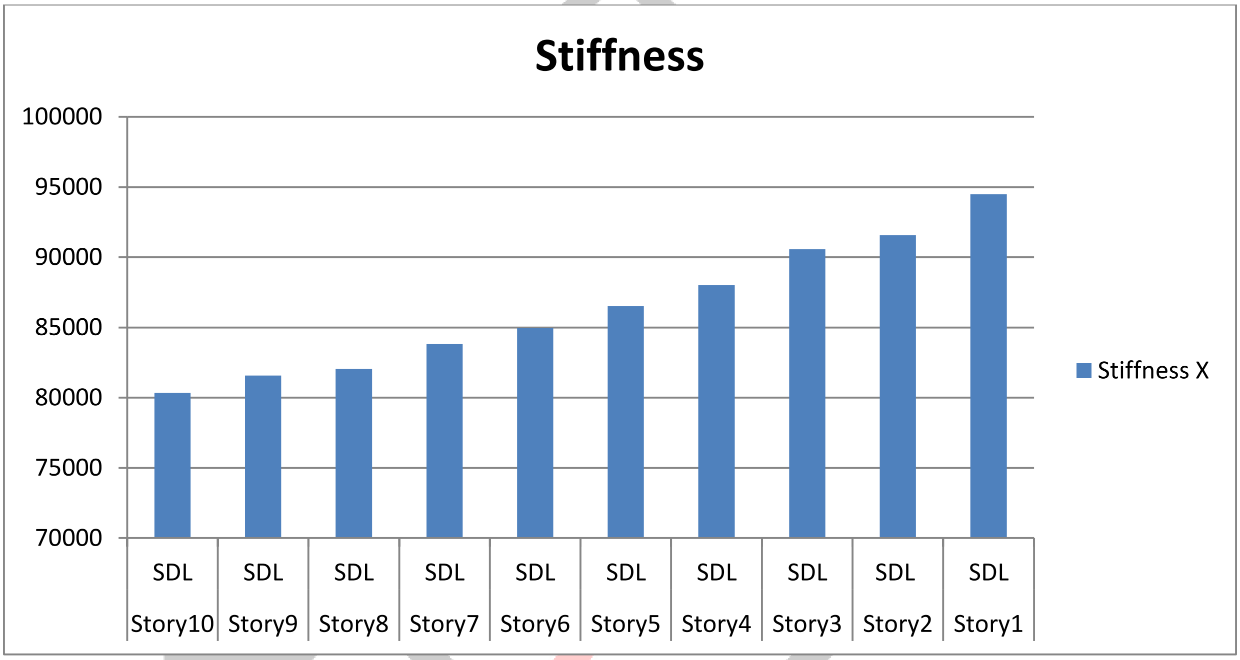


Fig.5. Graph showing the Values at Stiffness at SDL

Table.5. Shows Stiffness Values for Spectrum X

Story	Load Case	Stiffness X N/m
Story10	Spect X	223347.22
Story9	Spect X	252568.643
Story8	Spect X	261050.385
Story7	Spect X	265835.901
Story6	Spect X	269950.907
Story5	Spect X	272519.315
Story4	Spect X	276023.550
Story3	Spect X	280577.685
Story2	Spect X	391104.389
Story1	Spect X	404474.941

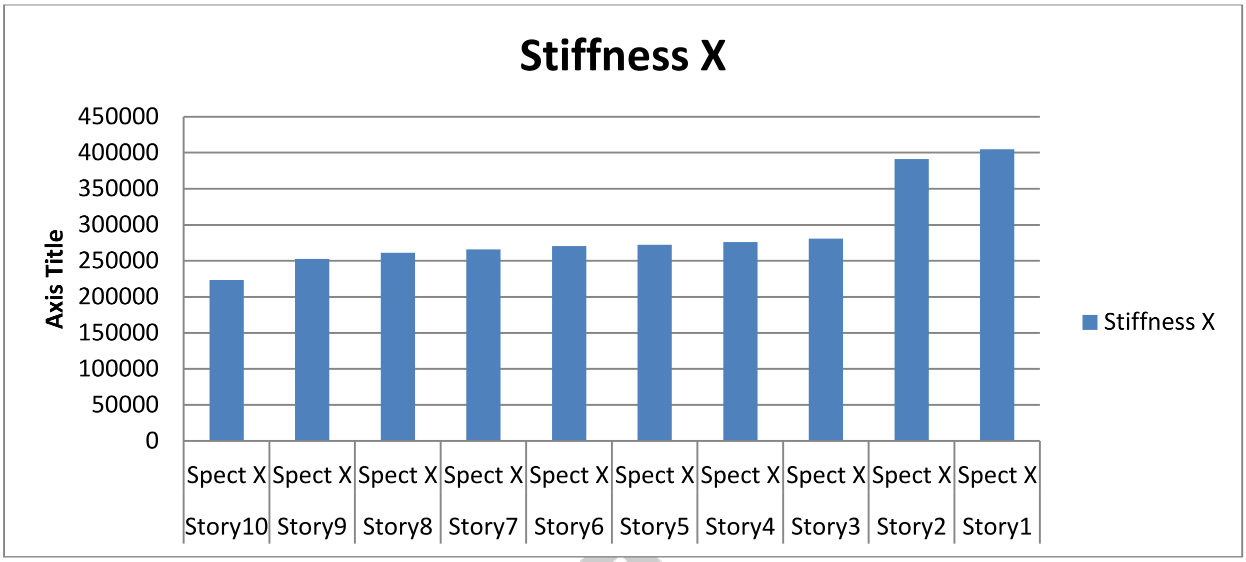


Fig.6 Graph showing the Stiffness Values at Spectrum X

Table.6. Shows Stiffness Values at Spectrum Y

Story	Load Case	Stiffness Y N/m
Story10	Spect Y	263567.009
Story9	Spect Y	262558.743
Story8	Spect Y	271980.995
Story7	Spect Y	276535.701
Story6	Spect Y	270050.007
Story5	Spect Y	282339.215
Story4	Spect Y	286023.335
Story3	Spect Y	291397.665
Story2	Spect Y	298804.389
Story1	Spect Y	386674.981

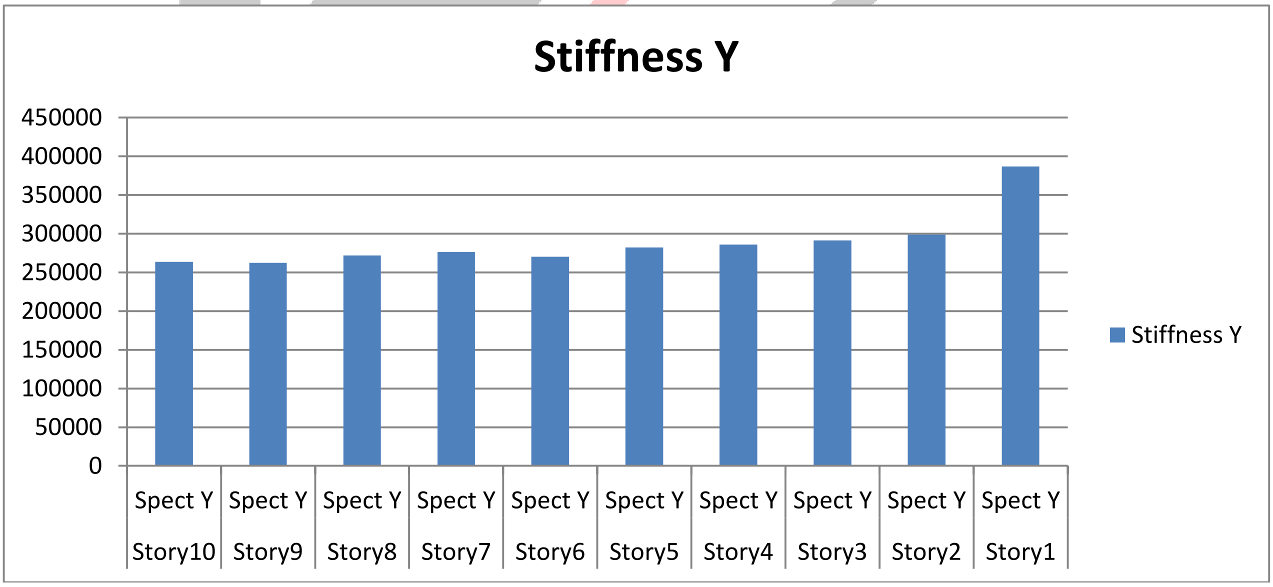


Fig.7. Graph showing the Stiffness Values at Spectrum Y

VII. CONCLUSIONS

A). The ordinary design of building gives more stiffness. So the building effected by seismic force, normal factor to see in structural design, ductile design helps designer to safely carry the process as so that the building placement like zone and terrain difficulties may easily eradicated .

B). Ductile design reduces the stiffness of building by 30-50%, the flexibility or the freedom for movement when earthquake or any loading happens , building won't absorb the lesser force. So its necessary to go with ductile design, the structural stability increases within the design parameters.+

C)The main factor to work out while design carried out without making the structural elements be stressed abundantly, area of rebar in ductile factor is more compared to normal design. That may gives cost effective design. But the stabilized design obtained from the ductility parameter incorporation in the specifications as per standards.

D), For the different zones observed that necessary to implement ductile design for easy performance based on storey drift factor noted from ETABS. Mainly we have considered Zone IV {severe} condition to see the specific behavior for the earthquake that's going to happen in the same region.

E) Obviously the deflection factor reduces by 40% after the ductility design as per IS standards IS 13920 and IS 1893. Variation mainly observed in building analysed in 4th Zone and compared with values with conventional building. Different parameters studied mainly drift and stiffness have been noted for further studies.

F) The values of spectrum X region is more compare to Y about 20,000 variation. May be the seismic expected to more at region mainly in X region at earthquake region so that the column position expected to parallel to X region and mainly ductile factor and detailing done considering the region where possible earthquake at direction which happens.

g) The stiffness more in bottom stories , as we know the ductile detailing can reduce the stiffness and gives safe structure. So the building movement will be easy and safe.

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