International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 06 | June 2019 www.irjet.net p-ISSN: 2395-0072

ANALYSIS AND DESIGN OF MULTI-STORIED BUILDING OF DIFFERENT PLAN CONFIGURATIONS USING ETABS

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Abstract – *ETABS is integrated software used for the structural analysis & design of buildings. This paper deals with the study of behavior of buildings under application of horizontal loads such as seismic loads & wind loads. The study focuses mainly on the effect of shape of a structure in resisting these lateral loads. Four different configurations are considered in this study namely: L-shape, I-shape, C-shape & rectangular shape. The analysis results of storey drift, storey shear, maximum storey displacement & over turning moment is noted down.*

1. INTRODUCTION

Buildings are the complex system and multiple items have to be considered at the time of designing them. Hence at the planning stage itself, architects and structural engineers must work together to ensure that the unfavourable features are avoided and good building configuration is chosen. If we have a poor configuration affects the performance of the building. Constructions can suffer damages when they are put under seismic excitations. Sometimes the shape of building catches the eye of visitor, sometimes the structural system appeals, and in other occasions both shape and structural system work together to make the structure a Marvel. However, each of these choices of shapes and structure has significant bearing on the performance of building during strong earthquake. So the symmetry and regularity are usually recommended for a sound design of earthquake resistant structure.

2. OBJECTIVES OF THE PROJECT

a. To calculate safe bearing capacity of the soil.

b. To calculate the overall building movements.

c. To analyze the models of different configurations.

d. To determine the base shear, overturning moment , storey displacement and storey drift of the building under seismic & wind loading of all the configurations.

e. Compare the values & graphs of base shear, overturning moment, storey displacement & storey drifts of all the configurations.

3. METHODOLOGY

Response spectrum is one of the most useful tools of earthquake engineering for analysing the performance of structures. A response spectrum is a plot of the maximum response amplitude (displacement. velocity or acceleration) versus period of many linear single degree of freedom oscillators to a given component of ground motion. A response spectrum is simply a plot of the peak or steady – state response (displacement, velocity or acceleration) of a series of oscillators of varying natural frequency, that are forced into motion by the same base vibration or shock.

4. PRELIMINARY TEST RESULTS

4.1. CORE CUTTER TEST:

Field density of soil = W/V=21.47KN/cum

Field moisture content =m =9.94%

Field dry density=19.52KN/cum

4.2 DIRECT SHEAR TEST:

TABLE 1: SHEAR TEST VALUES

NORMAL LOAD/STRESS(N/mm2)	DIVISIONS	SHEAR STRSS(Kg/ cm2)
0.4	30	0.24
0.9	60	0.48
1.4	92	0.736
1.9	121	0.968
2.4	146	1.168

4.3. SAFE BEARING CAPACITY OF SOIL: 154KN/m2

5. MODELLING OF RCC FRAMES

Modelling of the framed structures is done in ETABS by assembling & interconnecting beams, columns, slabs & foundation. All the configurations are analysed for G+5, G+10, G+15 storeys with 3m storey height.

Area	152.5 Sqm
Beam dimensions	230*450
Column dimensions	230*450

RECTANGULAR CONFIGURATION

Area	196.5 Sqm
Beam dimensions	230*450
Column dimensions	230*450

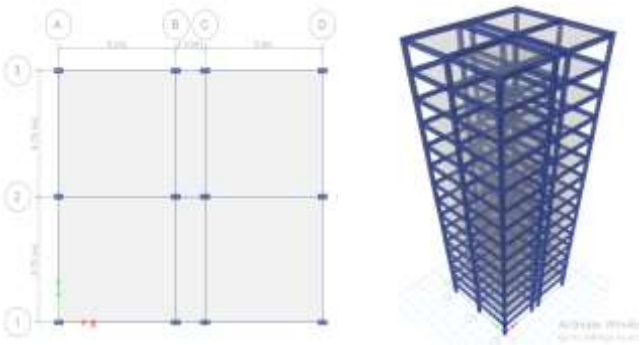
L-SHAPE CONFIGURATION

Area	74 sqm
Beam dimensions	230*450
Column dimensions	400*450

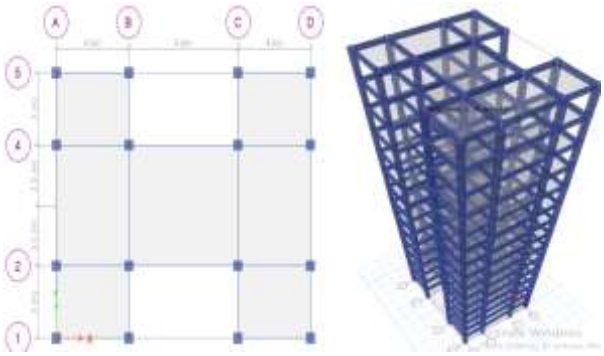
I-SHAPE CONFIGURATION

Area	129.42 sqm
Beam dimensions	230*450
Column dimensions	230*450

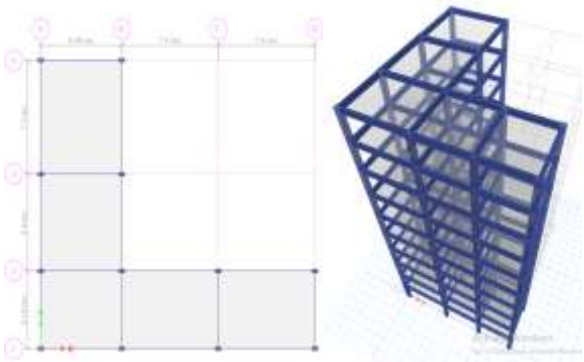
C-SHAPE CONFIGURATION



RECTANGULAR CONFIGURATION



I SHAPE CONFIGURATION



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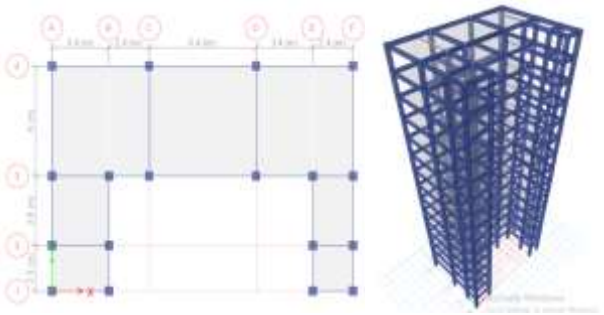


C-SHAPE CONFIGURATION

6. LOADING COMBINATIONS

6.1. LOAD PATTERN

1. Self weight is of the weight of the beams, columns & slabs of the frame.
2. Dead load is of the floor finish acting on the beam (IS 875 part 1) = 1 KN/m
3. Live load acting on slab acting on the slab (IS 875 part 2) = 3KN/m
4. Seismic load: zone II (Z= 0.10) & zone V (Z=0.36), soil type I, importance factor: 1, Response reduction factor: 5, damping: 5%
5. Wind loads: wind speed= 50 m/s, terrain category= 2, structure class= B, risk coefficient (K1 factor) =1, topography (K3 factor) =1

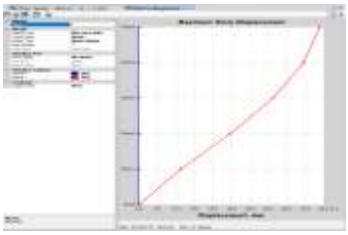
Earthquake loads are acting in both the directions EQX & EQY, wind loads are also acting in both the directions windx & windy

6.2 load combinations

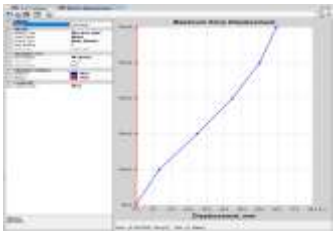
Name	Load Combo	Scale Factor
DCon1	Dead	1.5
DCon2	Dead+ Live	1.5
DCon3	Dead+ Live+ windx	1.2
DCon4	Dead+ Live	1.2
DCon5	Dead+ Live+ Windy	1.2
DCon6	Dead+ Live	1.2
DCon7	Dead+ Windx	1.5
DCon9	Dead+ windy	1.5
DCon10	Dead	1.5

7. RESULTS

7.1. STOREY DISPLACEMENT



RECTANGLE PLAN



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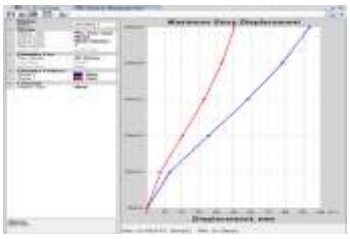
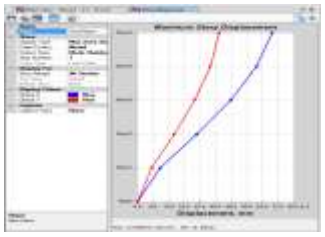
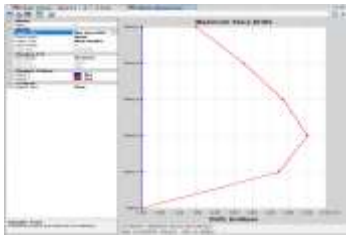


L SHAPE PLAN



C SHAPE PLAN

7.2. STOREY DRIFT



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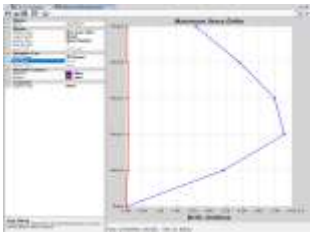

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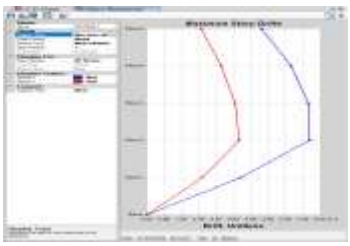
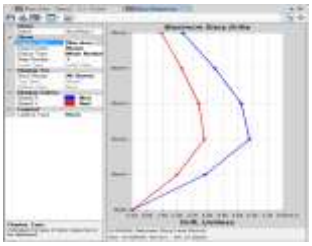
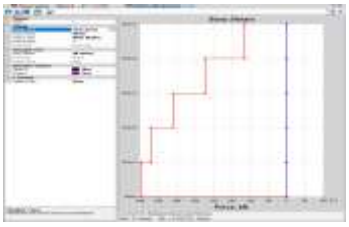
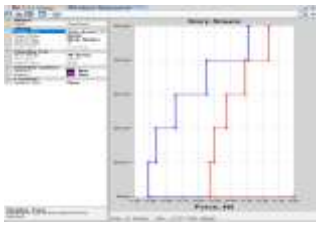
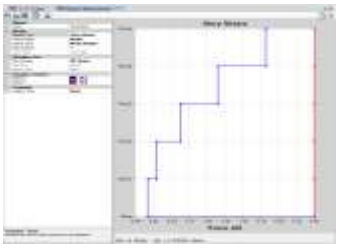
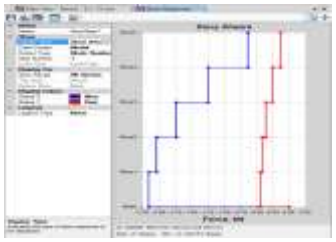



L SHAPE PLAN C SHAPE PLAN

7.3. STOREY SHEAR

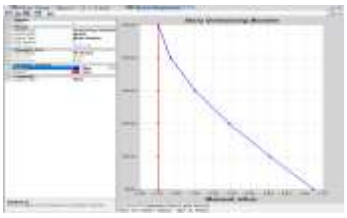
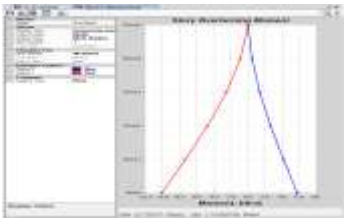



RECTANGLE PLAN L SHAPE PLAN

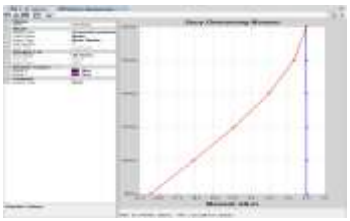
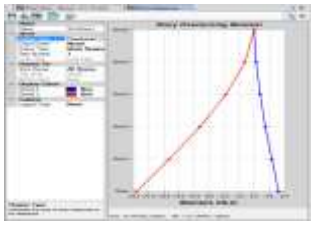



I SHAPE PLAN C SHAPE PLAN

7.4. OVER TURNING MOMENT

RECTANGLE PLAN L SHAPE PLAN

I SHAPE PLAN C SHAPE PLAN

8. COMPARISION & DISCUSSION

TABLE 2: RESULTS

CONFIGURATION	RECTANGLE	I SHAPE	L SHAPE	C SHAPE
STOREY SHEAR (KN)	4.5	-2.32	-0.91	-1.48
MAX STOREY DISPLACEMENT (mm)	0.042	63.55	93	70.33
OVER TURNING MOMENT(KN-m)	-0.22	0.070	5.73	3.55
STOREY DRIFT	0	0	0	0

The graphs & values show that maximum storey displacement & over turning moment is higher in case of L shape configuration which is of irregular configuration but base shear is maximum in rectangular that is symmetrical configuration & where as storey drift remains zero for all the 3 cases of G+5, G+10 & G+15 storey.

9. CONCLUSION

1 .The Regular building frames posses high shear force compared to irregular frames.
2. According to results of analysis the stiffness irregular building experienced larger inter storey drift as compare to regular frame.
3. It is seen that storey displacement of top storey is maximum among all the frames.
5. The seismic performance of regular frame is found to be better than corresponding irregular frame in nearly all the cases, thus it should be constructed to minimize the seismic effect.

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