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Analysis of Reinforced Concrete Building With Different Plan Shapes Resting on Sloping Ground

Haider Abdulazeez Ibrahim
M.Tech, Structural Engineering,
Department of Civil Engineering,
College of Engineering, Jawaharlal Nehru Technological University Hyderabad, TS, India,
University of Technology, Baghdad, Iraq.

Dr.N.V.Ramana Rao
Professor,
B.E (OU), M. Tech (IIT Delhi),
Ph.D (UK), Post Doctorate (UK),
College of Engineering, Jawaharlal Nehru Technological University Hyderabad, TS, India.

ABSTRACT:

In this Study, a multi- storey reinforced concrete building has been modelled and performed by using software ETABS program with different plan shapes regular (Rectangular shaped) and irregular (U –shaped) and each shape has three different configurations like (setback building, step back building and set-step back building) and plane dimension (40 x 54) m with nine storeys resting on plan and on sloping ground (26.57°) with fixed length of short columns support for each models, the models have been conducted and analyzed in the ETABS program by using equivalent linear static method and response spectrum method for comparing and investigating the changes in structural behavior and the irregularity effect in plan and elevation on sloping ground.The result of the analysis for displacement and storey drift have been studied and compared with reference to the serviceability and the time period, storey shear, storey moment and storey torsion, have been studied and compared for different configurations structure models and it was presenting in graphical and tabular form.

INTRODUCTION:

An important feature in building configuration is its regularity and symmetry in the plane and elevation. Buildings on hill slope are highly irregular and asymmetric in plan and elevation. One of the major contributors to structural damage during strong earthquake is the discontinuities and irregularities in the load path or load transfer.

The lateral load such as earthquake is to be classified as live horizontal force acting on the structure depending on the building's geographic location, height, shape and structural materials. A building with an irregular configuration may be designed to meet all code requirements but it will not perform well as compared to a building with a regular configuration.

METHODOLOGY:

A software ETABS v 9.7.4 program has been used to study the changes of the Structural Behaviour for different shapes of R.C Building on plan and on sloping ground under the lateral load effect such as earthquake load, According to IS 1893:2002, Both the equivalent lateral force procedure (static method) and response spectrum analysis procedure (dynamic method) lead directly to lateral forces in the direction of the ground motion component. The main differences between the two methods are in the magnitude and distribution of the lateral load over the height of the building.

ABOUT THE STRUCTURE:

Two configurations: Rectangular shaped and U –Shaped and for each configuration, a three shapes have been modeled:

a.Setback building.
b.Step back building.
c.Set-step back building.

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BASIC DATA FOR BUILDINGS MODEL:

- Plan Dimension : (54 x 40) m
- Height of each storey : (3) m
- Number of storeys : 9 storeys
- Length of each bay(in X-direction) : (6)m
- Length of each bay(in Y-direction) : (5)m
- Dimension of Column : (600 X 600) mm
- Dimension of Beam : (230 X 495) mm
- Slab Thickness : (150) mm
- Walls Thickness : (230) mm thick brick masonry wall
- Grade of the concrete : M 25 ,M30
- Grade of the steel : Fe415
- Type of Soil : Type II, Medium Soil
- Seismic Zone : II
- Building Frame Systems : Ordinary RC moment-resisting
- Live Load on Typical Floor : (2.0) KN/m2
- Wind speed : (44) m/s
- Support : Fixed

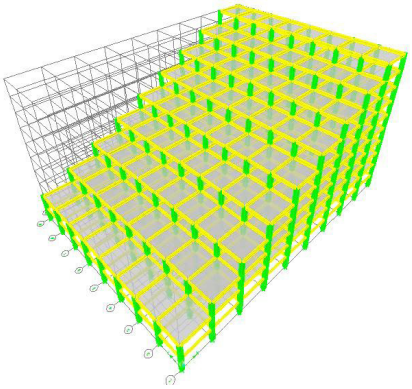

Figure 1 A 3-D View of 9th storeys Rectangular shaped setback building.

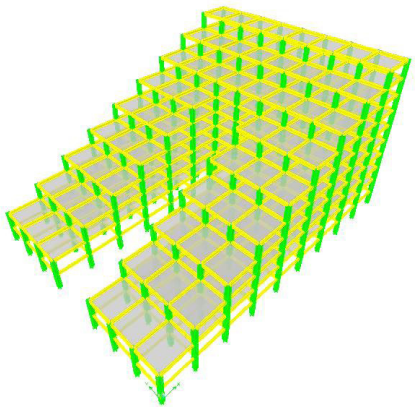

Figure 2 A 3-D View of 9th storeys U- shaped setback building.

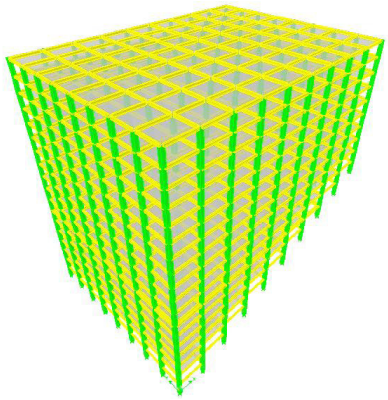

Figure 3 A 3-D View of 9th storeys rectangular shaped step back building.

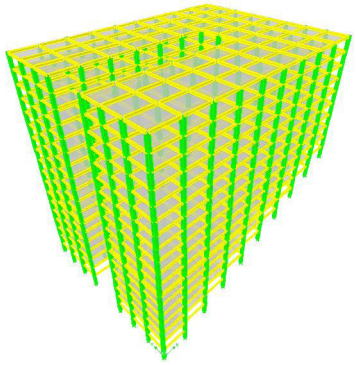

Figure 4 A 3-D View of 9th storeys U- shaped step back building.

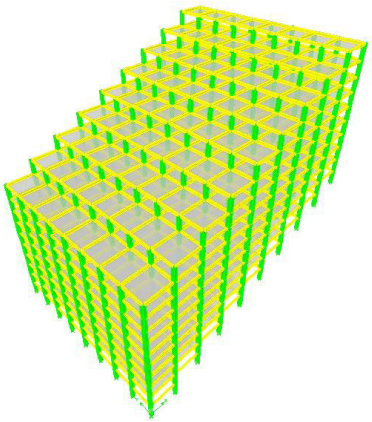

Figure 5 A 3-D View of 9th storeys rectangular shaped set-step back building.

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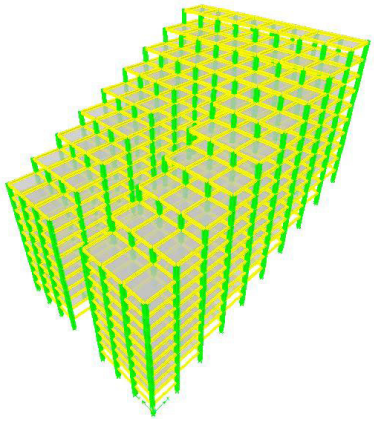

Figure 6 A 3-D View of 9th storeys U- shaped set-step back building.

LOADS AND FACTORES CALCULATIO:

Calculating the loads and factors values which are using in the software ETABS v 9.7.4 program:

A.Live Load: Live load for the Residential building in each storey = (2) kN/m2 as per IS: 875 (part 2) – 1987.
B.Dead loads: Dead loads which include Slabs, beams, columns, Floor finish and Wall Load are taken as prescribed by the IS: 875 -1987 (Part-1) Code of Practice Design Loads (other than earthquake) for Buildings and structure.
C.Seismic Loading: In the present work the building is located in Hyderabad which comes under -zone-II, Response reduction factor- 3, Importance factor- 1, Soil Type- medium, using the IS 1893 (Part-1) -2002 the following are the various values for the building considered.

ANALYZING:

A software ETABS v 9.7.4 program had been used for Modelling a multi- storey RC Buildings with different plan shapes (Rectangular & U –shaped), and each shape has three different configurations (setback building, step back building and step-set back building. And the Analysis Result for (time period, Base shear, displacement, storey drifts, storey shear force, storey Bending moment and storey torsion) have studied and compared.

RESULT AND DISCUSSION:

The static and dynamic analysis have been carried out using both linear static method and response spectrum method for all the models with different shapes building supported with fixed length columns on plan ground (0^o) and on sloping ground (26.57^o) and the results have been presented in graphical and tabular as follows:

TIME PERIOD:

As Time period Ta(sec) depend on the (mass, stiffens and the dimension of building) the analysis results values for different shapes building model has obtained and shown below:

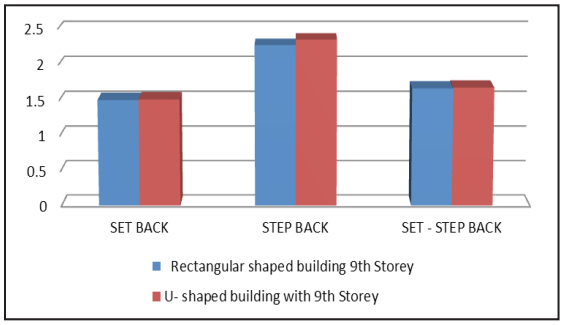

Figure 7 Max Time period for 9th storeys Rectangular and U- shaped buildings with different configurations

CENTER OF MASS AND CENTER OF RIGIDITY:

TYPE	Rectangular SHAPED			
	CENTER OF MASS		CENTER OF RIGIDITY	
	XCM	YCM	XCR	YCR
SET BACK	27.232	20.207	27.295	20
STEP BACK	27	20	36.414	20
SET STEP BACK	27.244	20	37.879	20

Table1. Center of mass and Center of rigidity for 9th Storeys Rectangular shaped buildings.

TYPE	U-SHAPED			
	CENTER OF MASS		CENTER OF RIGIDITY	
	XCM	YCM	XCR	YCR
SET BACK	28.504	20.231	28.791	20
STEP BACK	28.232	20	37.98	20
SET STEP BACK	28.503	20	39.455	20

Table2. Center of mass and Center of rigidity for 9th Storeys U- shaped buildings

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BASE SHEAR:

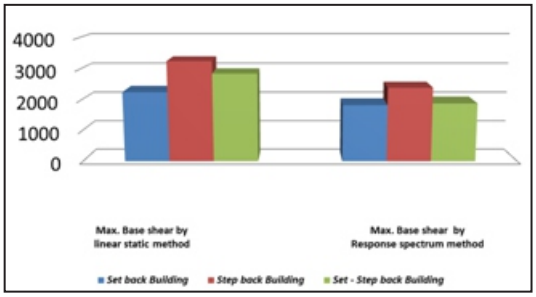


Figure 8 Max. Base Shear (KN) by (Static & Dynamic) for 9th storey Rectangular buildings with different shapes.

STOREY DISPLACEMENT:

Story Displacement UX (mm) in X- direction for different shapes building model has obtained from the analysis results as below:

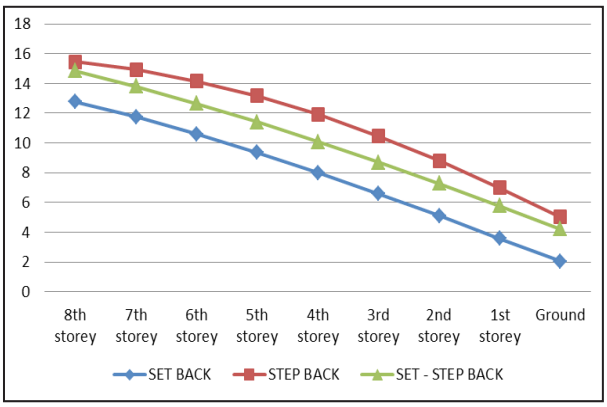


Figure 9 Storey Displacement in X- direction for 9th storeys Rectangular shaped building.

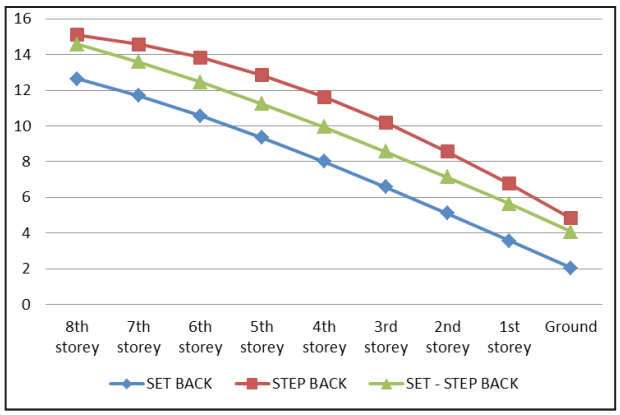
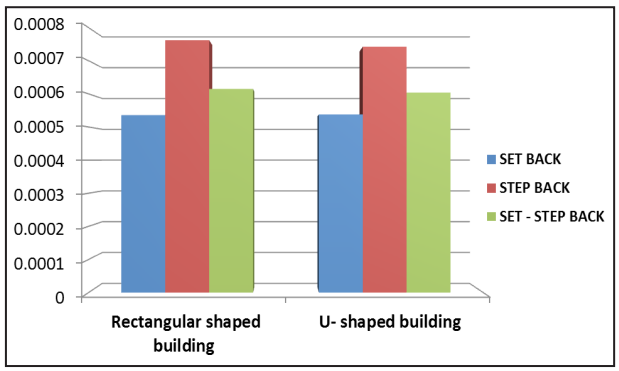


Figure 10 Storey Displacement in X- direction for 9th StoreysU- shaped building.

STOREY DRIFT:

Story Drift (mm) in X- direction for different shapes buildings has obtained from the analysis results as below:



Figures 11 Storey Drift in X- direction for different shaped buildings .

STOREY SHEAR:

Storey shear (KN) in X- direction for 9th Storeys Rectangular Shaped buildings has obtained from the analysis results as below:

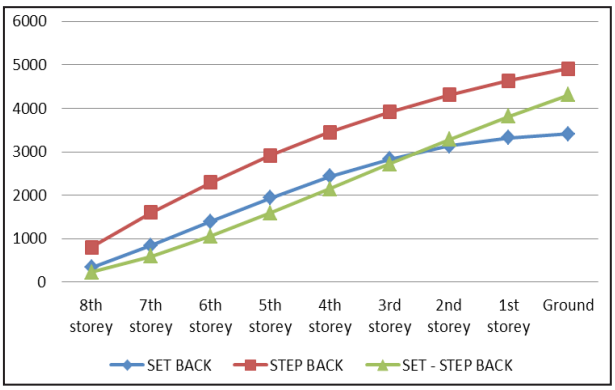


Figure 12 Storey shear (KN) in X- direction for 9th Storeys Rectangular Shaped buildings.

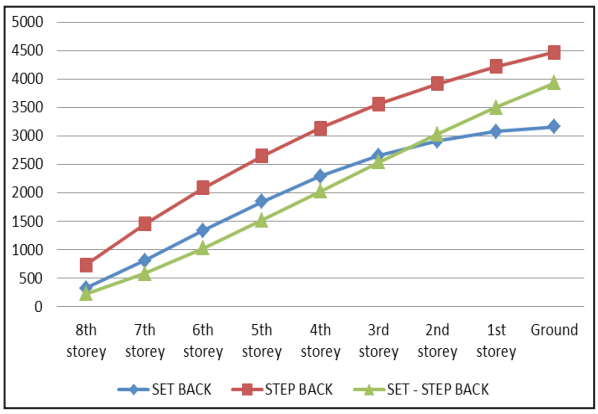


Figure 13 Storey shear (KN) in X- direction for 9th Storeys U- Shaped buildings.

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STOREY MOMENT:

Storey moment (KN.m) about Y - axis for different Shapes buildings has obtained from the analysis results as below:

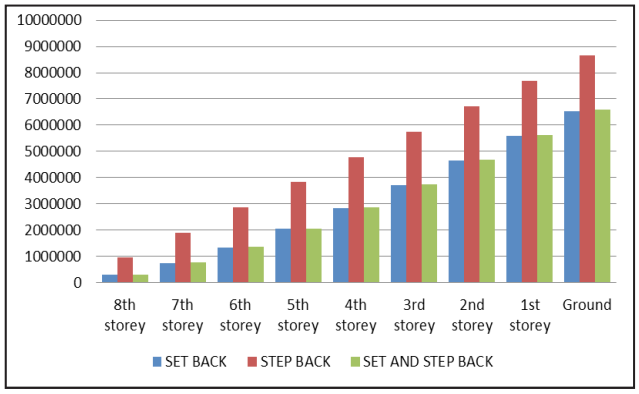

Figure 14 Storey moment (KN.m) about Y - direction for 9th Storeys Rectangular Shaped buildings.

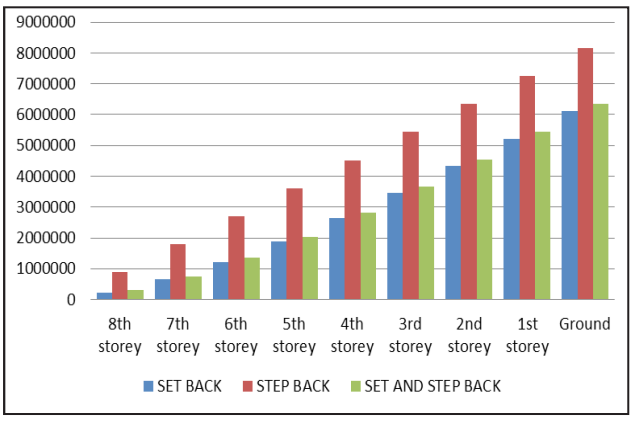

Figure 15 Storey moment (KN.m) about Y - direction for 9th Storeys U- Shaped buildings

STOREY TORSION:

Storey torsion (KN.m) for 9thStoreys Rectangular Shaped buildings has obtained from the analysis results as below:

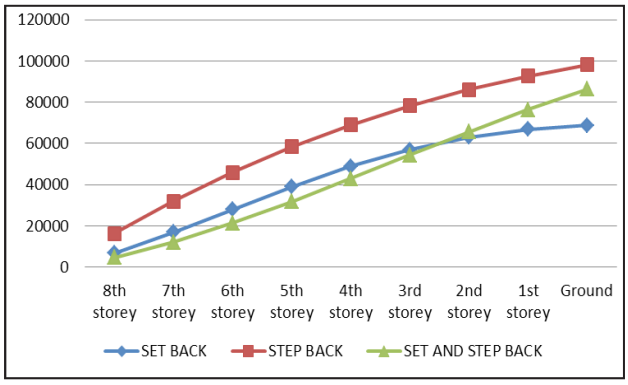

Figure 16 Storey torsion (KN.m) for 9th Storey Rectangular Shaped buildings.

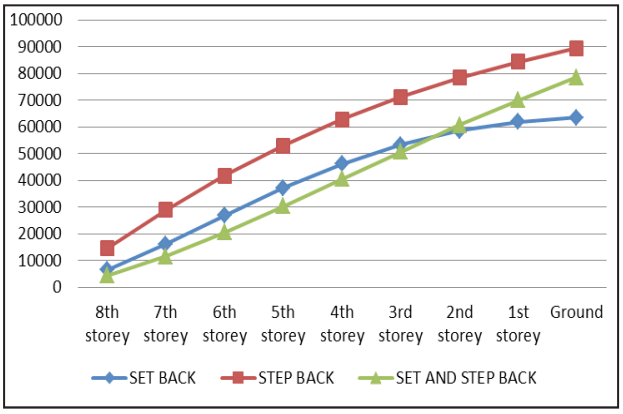

Figure 17 Storey torsion values (KN.m) for 9th Storeys U- Shaped buildings.

CONCLUSION:

The following conclusions from this study are:

1.The performance of irregular plan shaped building with vertical irregularity could prove more vulnerable than the regular plan shaped building with vertical irregularity.

2.On plan ground, setback building attract less action forces as comparing with other configurations on sloping ground which make it more stable and it would not suffer more damages due to the lateral load action.

3.On sloping ground set-step back building attract less action forces as comparing with step back building but if the cutting cost of sloping ground is with acceptable limits then setback building may be preferred.

4.In step back building, the development of storey shear and moment and torsion were more than other configuration which found to be more vulnerable.

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5.The effect of overall building torsion in step back and set-step back building was more than the setback building, as the building gets more unsymmetrical on sloping ground.

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Author 1:

Haider Abdulazeez Ibrahim,
M.Tech, Structural Engineering, Department of Civil Engineering, College of Engineering, Jawaharlal Nehru Technological University Hyderabad, TS, India, University of Technology, Baghdad, Iraq.

Author 2:

N. V. Ramana Rao,
Professor, B.E (OU), M. Tech (IIT Delhi), Ph.D (UK), Post Doctorate (UK), College of Engineering, Jawaharlal Nehru Technological University Hyderabad, TS, India.