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Influence of Plan Iregularity on Sesimic Response of Buildings

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Abstract
In India various types of buildings such as ground plus 10 stories are constructed in seismic zones. The influence of plan irregularity is examined for 10 storey R.C.C. residential building with different plan configurations. To compare the responses a regular structure is also considered. For seismic analysis of building static analysis as well as dynamic analysis such as response spectrum and time history analysis has been carried out . in time history analysis 3 major Indian earthquakes are considered. The response of building in terms of member forces deflection of top joints are studied
Keywords— asymmetric building, seismic analysis, dynamic analysis, time history method

I. INTRODUCTION

The various types of buildings are constructed in the india are from the reinforced cement concrete. The I.S.-1893-2002 gives various methods such as static and dynamic methods The buildings constructed are highly asymmetric in plan as well as elevation, so dynamic method must be used for seismic analysis of the buildings. These methods are response spectrum method and time history method. In the response spectrum method the data such as zone factor, type of soil etc. are applied from I.S.-1893. In time history method the actual record of accelelogram is applied on the building and analysis of the building is carried out in software.

Time history method gives more realistic result compared to the response spectrum method because in time history the actual acceleration data of earthquakes are applied and response of building is studied. So in this work the data of 3 Indian earthquakes namely Bhuj, chamoli and utaarkashi earthquake are collected and it is applied on the building having 3 different plan shapes. To study the effects of seismic forces on plan irregularity 3 plan configurations as shown in fig.1 to fig.3 is considered. The various shape of buildings are rectangular shape as shown in fig.1, C shape as shown in fig.2 and L shape as shown in fig.3. The plan area of all the 3 buildings is kept same. Only shape of building in plan is changed. The buildings shape in plan is selected in such a way that the total area in plan remains same so that value of dead and live load remains almost same. But when the earthquake loads are applied it depends on the shape of building so we can study the plan iregularities of buildings.

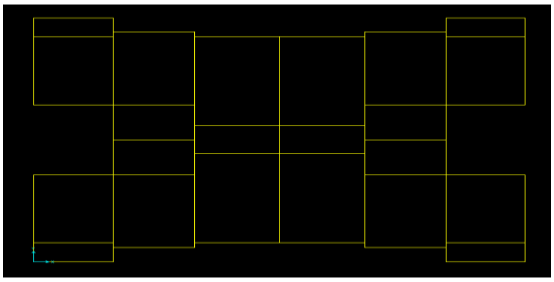

Fig.1 Rectangular shape building.

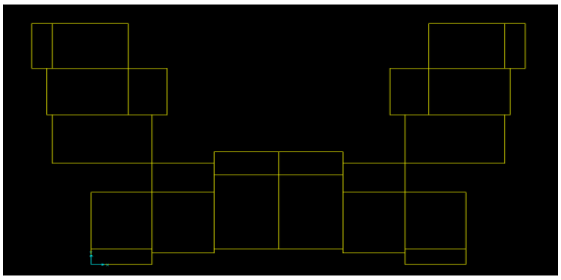

Fig.2 C shape building.

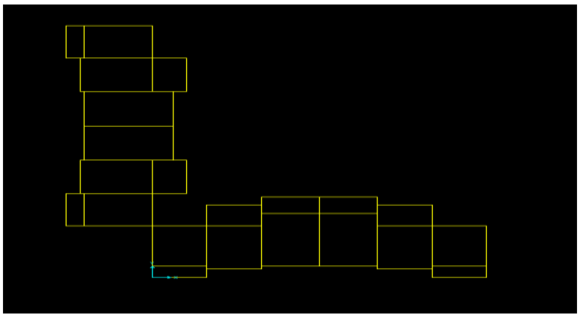

Fig.3 L shape building

II. MODELING AND ANALYSIS

In the present work the 3 different building with 10 storey is modelled in SAP 2000 software. The sizes of the various members are as under

(1) Size of column

500mmX5000mm from G.L to floor 4
(2) Size of column
400mmX4000mm from floor 5 to 7
(3) Size of column
300mmX3000mm up to floor 8 to 10
Size of beam is 230X400 and 230X750 depending on the span of beam.
(4) Thickness of slab 125 mm
(5) Floor finish load = 1KN/M2
(6) All the beams are loaded by 230 mm thick wall having height of 3.0 mt.
(7) M20 And FE415
(a) Live load on all floors = 3KN/M2

The slabs are modelled using shell element in the SAP software, necessary meshing is given to slab to transfer the slab load properly to adjacent beams. All the beams are loaded with 230 mm thick wall and wall load is applied uniformly on the beams. The slabs are loaded with floor finish of 1KN/M2. The live load applied on all the slab is 3 KN/M2 . The static analysis of the building has been carried out for the dead loads and live loads. Fig. 4 shows the 3D model of building prepared in SAP 2000 software.

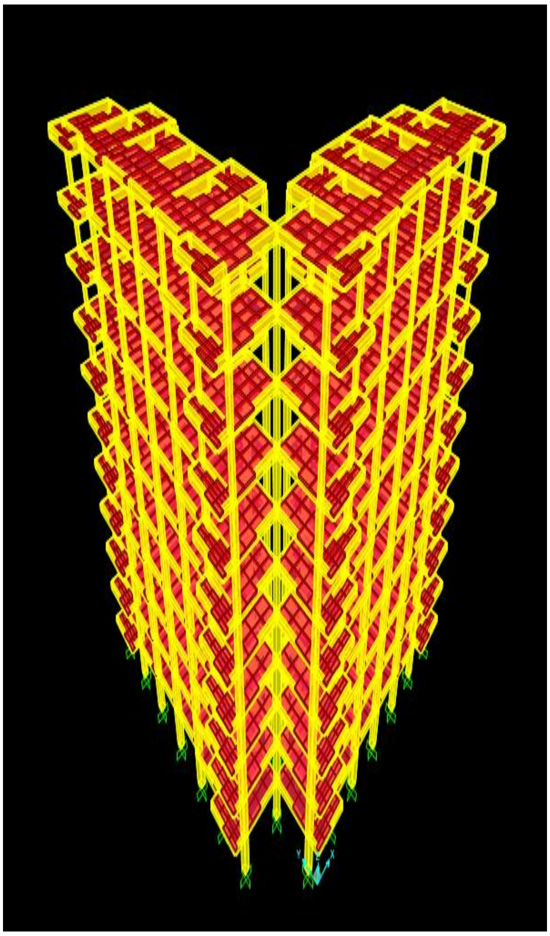

Fig. 4. Model of L shaped buildingund

In addition to dead load and live load the seismic load as per I.S.1893-2002 is considered the details are as under

Details of Earthquake load
(1) Seismic zone = Zone 5
(2) Type of soil : medium
(3) Importance factor=1
(4) Response reduction factor R =5
(5) Damping= 5 percentage

The earthquake loads applied on the building are static as well as dynamic that is response spectrum analysis

The necessary mass of the buildings are considered in the modal analysis of the buildings. The total number of modes is considered in such a way that modal participation factor is more than 90 percentages, and modal analysis considering 12 modes has been carried out.

The dynamic analysis has been done considering first 12 modes and time period, frequencies, static/dynamic participation factor and modal participation factor has been calculated.

The acceleration time history of 3 earthquakes namely bhuj, chamoli and uttarkashi is collected and applied on all the building. The details of the acceleration time history are as under.

a) Name of time history : chamoli
b) Magnitude : 6.6
c) Duration of earthquake: 25.42 second
d) Peak ground acceleration : 1.9507 m/sec2
e) Time for PGA : 4.8 second
f) Duration: short
g) Total no of acceleration records : 1270
h)Time step:0.02 second

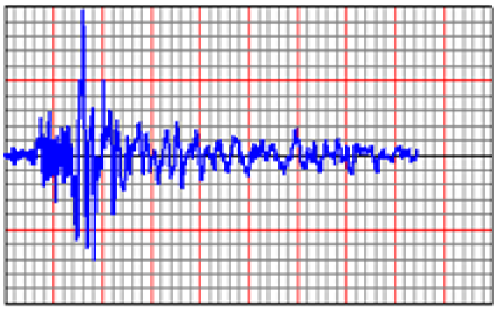

Fig. 5. Chamoli time history.

Details of uttarkashi time history.

a) name of time history : uttarkashi
b) Magnitude : 7.0
c) Duration of earthquake: 21.32 second
d) Peak ground acceleration : 2.48 m/sec2
e) Time for PGA : 4.26 second
f) Duration: short
g) Total no of acceleration records : 1808
h) Time step :0.02 second

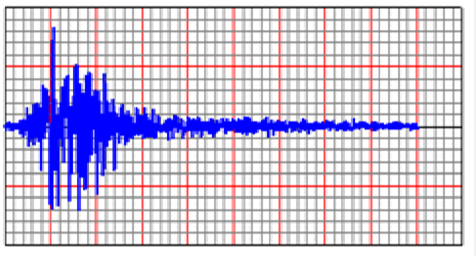

Fig. 6 Uttarkashi time history.

III. RESULT AND DISCUSSION

a) From the graph of time period we can observe that the time period is approximately same for first five modes but after 5 th mode its value changes and it depends on shape of buildings.
b) As the plan are of the building is same we are getting same value of dead load and live load in all the 3 buildings fig. shows that value of dead load and live load is same for 3 different plan configurations
c) Fig shows the deflection of top joint for different buildings from that we can observe that in the static method of analysis we are getting almost same and very less deflection in all the 3 buildings but L shape gives very high value of deflection compare to other plan shapes in time history analysis.
d) For all the 3 types of building we are getting higher value of storey shear by static method compared to response spectrum method because static method depends only on mass of structure it will not take the effect of dynamic properties of the building
e) As the bhuj earthquake has long duration and higher magnitude compared to other two earthquakes we are getting higher value of storey shear in bhuj time history in all 3 buildings.
f) The value of storey shear is higher in l shape building compared to c shape and rectangular buildings. As rectangular building is symmetrical shape it gives less storey shear in all the 3 time histories
g) We can say that l shape building gives higher storey shear and more deflection compared to other shapes.

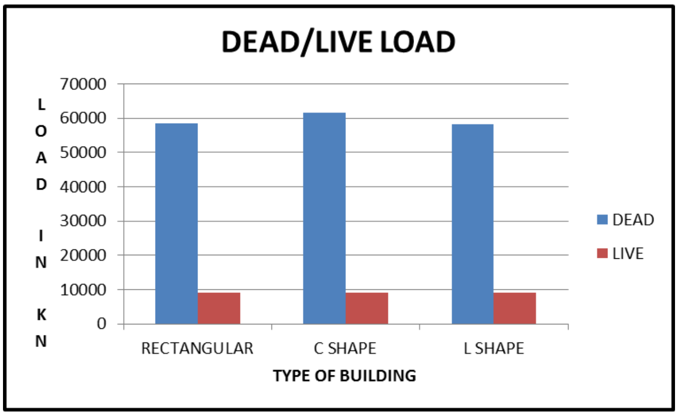

Fig.7 dead/live load for different buildings

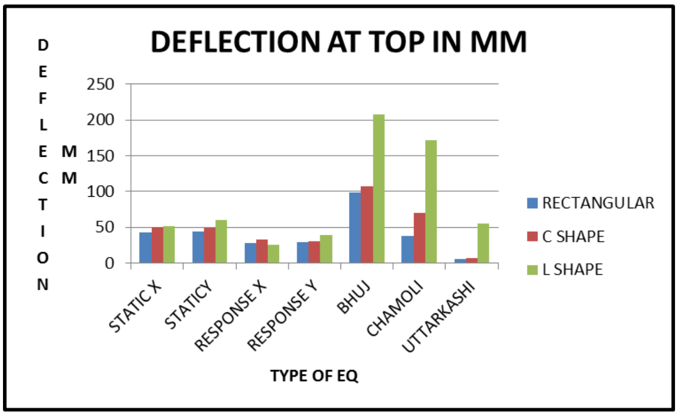

Fig 8 .deflection at top for different buildings

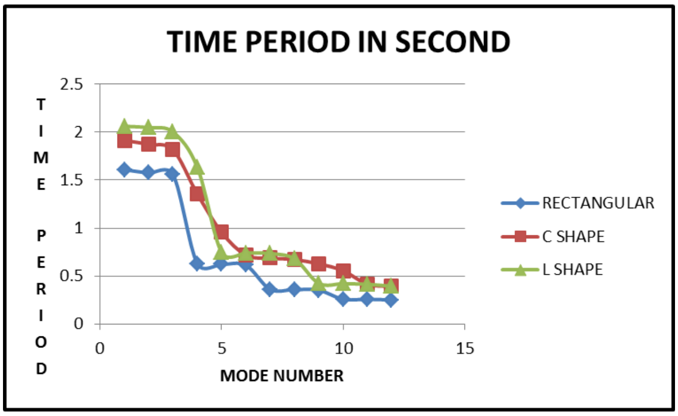

Fig.9 Time period in second

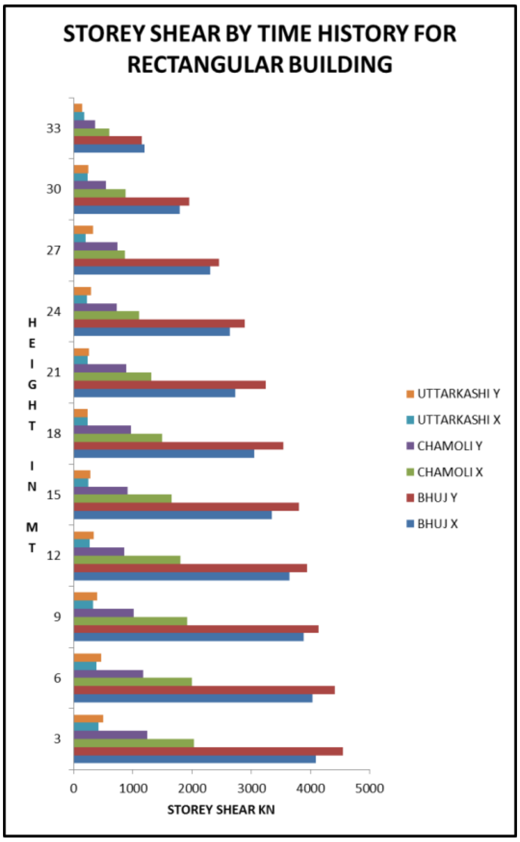

Fig. 10 storey shear by time history for Rectangular shape building

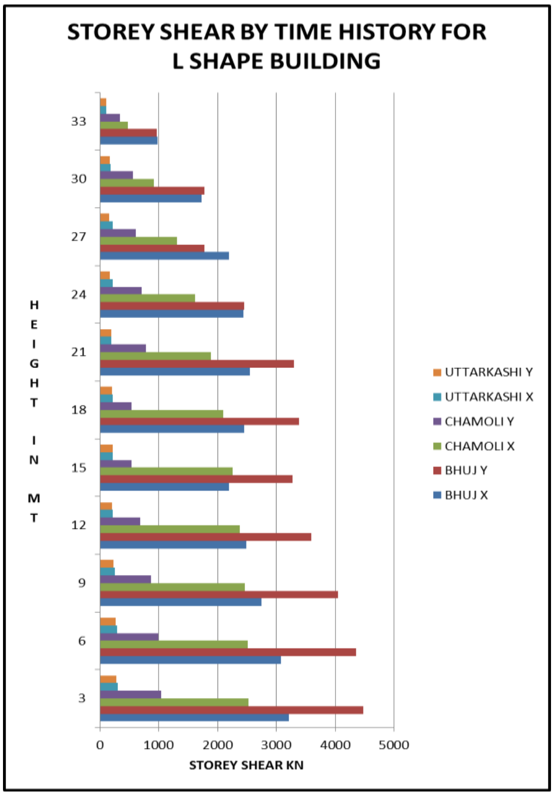

Figure 12. storey shear by time history for L shape building

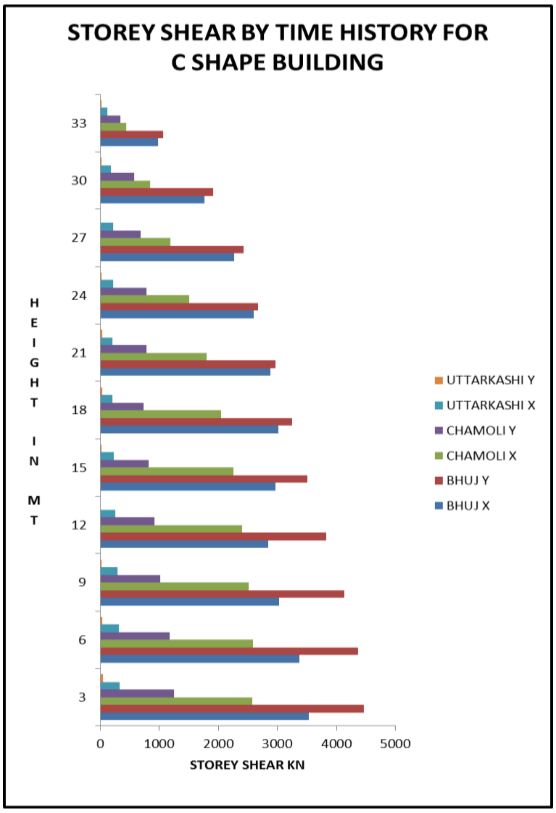

Figure 11. storey shear by time history for C shape building

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