Response Spectrum Analysis of Asymmetrical Building

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ABSTRACT
In this project a parametric study on Reinforced Concrete structural walls and moment resisting frames building representative of structural types using response spectrum method is carried out. Here, the design spectra recommended by Indian Standard Code IS 1893-2002 (part I) and two other codes (Uniform Building Code, Euro Code 8) are considered for comparison. The objective of this study is to investigate the differences caused by the use of different codes in the dynamic analysis of multistoried RC building. To evaluate the seismic response of the buildings, elastic analysis was performed by using response spectrum method using the computer program SAP2000. It is observed from the comparative study that the base shear using IS code is higher in all the three buildings, when compared to that of with other codes which leads to overestimate of overturning moments in the building and hence heavier structural members. To experimentally verify the applicability of the proposed semi active control system to torsionally coupled responses of an asymmetric building, use of computer software was conducted using in a G+13 storey building model with asymmetric column distribution.

KEYWORDS
Response spectrum analysis, Elastic design spectra, RC building, IS code.

INTRODUCTION
Earthquake codes are periodically revised and updated depending on the improvements in the representation of ground motions, soils and structures. Moreover, these revisions have been made more frequently in recent years. The Indian Standard Code (IS 1893-2002 (Part-I)) was also revised in 2001 and has been in effect since 2002. This improvement was done followed to destructive earthquake occurred in Bhuj (Gujarat State, India) on 26th January, 2001 which resulted in more than 19,000 recorded death and 1,66,000 injuries. Preliminary indications are that 600,000 people were left homeless, with 48,000 houses destroyed and an additional 844,000 damaged. The Indian State Department estimates that the earthquake affected, directly or indirectly, 15.9 million people, nearly 50% of the population of Gujarat. More than 20,000 cattle were reported killed. Government estimates place direct economic losses at $1.3 billion, although more recent estimates indicate losses may exceed $5 billion. A number of separate teams from different bodies conducted damage surveys and reported some conclusions as briefly summarized below. Early reports stressed that quality of construction were poor and that there were many structural mistakes and deficiencies due to the non-compliance with the earthquake code. It was concluded that the nature of the strong-motion was also a major contribution factor to the level of damage. Under the light of observations and lessons from the 2001 earthquake and past earthquakes, many studies concerning to IS 1893-2002 have been carried out up to now and number of improvements are made. The influence of local ground conditions on the seismic action is considered depending on the ground types described in the various codes considered in the present study. That is why the emphasis has been given on the differences caused by the use of spectra given in IS Code and other well known codes such as UBC and Euro code in the seismic analysis of sample buildings.

Response Spectra
Response spectrum of any building gives us a plot of peak or steady state response(Displacement, Velocity or Acceleration) of a series of oscillators of a varying natural frequency, that are forced into motion by the same base vibration or shock. The resulting plot can then be used to pick off the response of any linear system, given its natural frequency of oscillation. Response spectrum analysis requires that isolator units be modeled using amplitude- dependent values of effective stiffness. The effective damping of the isolated modes of response is limited to 30 percent of critical. Higher modes of response are usually assumed to have five percent damping a value of damping appropriate for the superstructure, which remains essentially elastic. As previously noted, maximum and minimum values of effective stiffness are typically used to individually capture...
maximum displacement of the isolation system and
maximum forces in the superstructure. Horizontal
loads are applied in the two orthogonal directions,
and peak response of the isolation system and
other structural elements is determined using the
100 percent plus 30 percent combination method.
The basic mode superposition method, which is
restricted to linearly elastic analysis, produces the
complete time history response of joint
displacements and member forces. In the past there
have been two major disadvantages in the use of
this approach. First, the method produces a large
amount of output information that can require a
significant amount of computational effort to
determine all possible design checks as a function
of time. Second, the analysis must be repeated for
several different earthquake motions in order to
assure that all frequencies are excited, since a
response spectrum for one earthquake in a
specified direction is not a smooth function there
are computational advantages in using the response
spectrum method of seismic analysis for prediction
displacements and member forces in structural
systems. The method involves the calculation of
only the maximum values of the displacements and
member forces in each mode using smooth design
spectra that are the average of several earthquake
motions.

MATERIALS AND METHODS
Non-symmetric Buildings Plan of G+13:-
The plan view of non-symmetric buildings is
shown in Figure 2. The structural system is
selected as concrete frames with identical columns
of 50/50 cm in size, and beams of dimension 40/70
cm. Each floor slab has 15 cm thickness and the
story height is 3 m. The critical damping ratio of
superstructure is taken as 2% for isolated cases.

MODES OF FAILURE
After the analysis of above plan using SAP2000
we got some result and mode of failure. Following
diagrams are nothing but the different modes in
which building gets buckled, bitter or collapse.
These 4 diagrams are nothing but the mode of
failure of the building. While analysis this
asymmetrical building by using computer software
SAP2000, it was observed that this building is
failed in first mode only. It means building is not
safe in seismic area and it could not stand at the
time of earthquake. So it is a need to provide a
shear wall to the building then only the chances of
failure of the structure can be minimised. There is
also a one figure of the building which is with
provided shear wall.
RESULT AND DISCUSSION

Comparisons between building with Shear Wall and without Shear wall

We have obtained the graph of base shear, deflection and storey drift after providing the shear wall in x-x direction and y-y direction which have been shown in above. Now combining the graph of x-x direction and y-y direction for both the structure i.e. for asymmetrical building with shear wall and without shear wall. Comparing both the graph we will get the respected result.

Following graphs are combined graph of base shear, deflection and story drift for the both building i.e. with shear wall and without shear wall.

<table>
<thead>
<tr>
<th>Code</th>
<th>TYPE 1</th>
<th>TYPE 2</th>
<th>TYPE 3</th>
</tr>
</thead>
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<tr>
<td>IS Code</td>
<td>580.565</td>
<td>759.925</td>
<td>915.808</td>
</tr>
<tr>
<td>EURO Code</td>
<td>549.395</td>
<td>549.395</td>
<td>549.395</td>
</tr>
<tr>
<td>UBC 94 Code</td>
<td>628.026</td>
<td>899.68</td>
<td>1367.461</td>
</tr>
</tbody>
</table>

Table 1 A: Base Shear for a building without Shear wall

<table>
<thead>
<tr>
<th>Code</th>
<th>TYPE 1</th>
<th>TYPE 2</th>
<th>TYPE 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS Code</td>
<td>1566.82</td>
<td>2031.21</td>
<td>2415.161</td>
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<td>EURO Code</td>
<td>1530.38</td>
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<td>1530.387</td>
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<tr>
<td>UBC 94 Code</td>
<td>1699.75</td>
<td>2396.01</td>
<td>3560.291</td>
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</tbody>
</table>

Table 2 A: Base Shear for a building with Shear wall

From the figure 6 & 7, it is observed that the base shear is reduces in X direction than that in Y direction which is about 35%.
From the comparison it can be concluded that response spectra analysis according to UBC 94 code gives satisfied result and most accurate for design than rest of the two codes. Also soil type 3 is good for design than other two types.

![Graph](image)

**Figure No. 8 Deflection without Shear wall Building**

From the comparison it can be concluded that response spectra analysis according to UBC 94 code gives satisfied result and most accurate for design than rest of the two codes. Also soil type 3 is good for design than other two types.

![Graph](image)

**Figure No. 9 Deflection with Shear wall Building**

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**CONCLUSION**

- After the all analysis of the asymmetrical building, from the result we concluded that it is better to provide shear wall to the asymmetrical building. It helps in prevention of the building from damage and collapse, increases the strength of the building. And also decreases the displacement and storey drift of the building.
- From the parametric study on Reinforced Concrete buildings the following conclusions are drawn as:-
  - IS code depict the higher values of base shear for similar ground types defined in the other codes which may lead to overestimate the overturning moment and could results in heavier structural members in the building.
  - For the buildings, UBC code gives the maximum and IS gives the minimum displacement values.

**Acknowledgement**

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