SESMIC DISPLACEMENT AND VILOCITY BEHAVIOUR OF EXTERIOR R.C. BEMA COLUMN JOINT USING RESPONSE SPECTRUM FUNCTION

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ABSTRACT

The beam columns joints are crucial zones in a reinforced concrete frame. In reinforced concrete Structure, the common region of intersecting of column and beam at their connection point are called Beam-column joint. A beam column joint is a very critical region in reinforce concrete framed structure where the elements intersect in all three directions. Joint ensure continuity of a structure and transfer forces that are present at the ends of the members. In reinforced concrete structures. During the past decades, significant amount of research has been conducted to investigate the behavior to reinforced concrete beam-column joints. In this study, behavior of exterior R.C beam-column joint was investigated according to FEMA with a macro model using SAP 2000 using nonlinear analysis procedure.

Keyword: Beam-column joint, reinforce concrete, finite element models (SAP 2000; seismic loading)

1. INTRODUCTION

Understanding the response of beam-column joints in reinforced concrete building frames during loading is crucial to the development of and overall efficient and safe structure. A beam-column joint is a very critical zone in reinforcement concrete framed structure where the elements intersect in all three directions. Joint ensure continuity of a structure and transfer forces that are present at the ends of the members1. In reinforced concrete structures, failure in a beam often occurs at the beam-column joint making the joint one of the most critical section of the structure. Sudden change in geometry and complexity of stress distribution at joint are the reasons for their critical behavior. In early days, the design of joints in reinforce concrete structures was generally limited to satisfying anchorage requirements2. In succeeding years, the behavior of joints was found to be dependent on a number of factors related with their geometry; amount and detailing of reinforcement, concrete strength and loading pattern3.

In case of earthquake, many destruction and damage of structure due to joint failures has been witnessed in past. Earlier it was considered that beam-column joint behaves as a rigid joint without contributing any deformation. Therefore for many decades it has not been considered as the area of research4. When subjected to dead load and live load, the problem doesn’t arise in beam-column joint. But when subjected to lateral loads, i.e. seismic loads, it becomes the critical problem which has not been solved till date completely5. Many researches have been made in understanding the behavior of beam-column joint, especially for shear force and deformation6. But still we don’t have clear vision in this area. Practically it is not possible to construct the earthquake-proof structure, so there should be a way out to this problem. Also it has been seen from past experience that exterior joint is more susceptible to damage as compared to other types of joint, because having congestion in the joint core it is less confined and is subjected to large shear forces. Therefore in the present study analysis of behavior of exterior joint is considered being more critical as compared to the other joints7. To get the way out, first the behavior of joint must be studied and same has been discussed in the following paragraphs8. During the past decades, significant amount of research has been conducted to investigate the behavior of steel-reinforced beam-column joint. these joints are studied due to its critical influence on the overall behavior of RC moment-resisting frames subjected to seismic loads Hanson and Connor 9 had conducted the first experiment on exterior
beam column joints reinforced with steel. Since then, many researchers have been involved in studying the behavior of the beam-column connections through analytical models and experimental tests. These researchers were able to provide knowledge on how beam column joints work and what are the main parameters that affect their performance, however, there is a lack of data and test results still exist on such connections.

2. AUTHOR WORK AND CHART

During earthquake loading, the beams are subjected to moments in same direction (clockwise or anticlockwise). Due to these moments, the top and bottom bars in the joint are pulled in the opposite direction as shown in figure 2. As a result beam-column joint is subjected to large shear forces due to pulling and pushing of the top and bottom rebar’s respectively, or vice versa. If there is insufficient grip of the concrete over the steel bars then bar slipping occurs inside the joint region. The beams lose its capacity of carrying load which makes the beam-column joint more susceptible to damage. As the failure is mainly shear failure, which is brittle in nature so this type of failure must be avoided in the earthquake resistant building.10

The main objectives of present analytical study are the following:

➢ To analyses the behavior of a reinforced concrete exterior beam-column joint under seismic loading.
➢ To work out the stresses and displacements in the beam column joint.

Followings are the scope of present work:

➢ The present study aims to study the behavior of an exterior beam-column joint analytically under the seismic loading.
➢ It is obvious that confining the bond prevents the damage due to slip of rebar, but bond slip has not considered.
➢ To model the beam-column joint in SAP 2000 to study the behavior.

Modelling and Analysis of an Exterior Joint

Figure 1(RC building frame modeled in SAP2000 showing exterior beam-column joint)

3. GRAPH AND METHODS

The methodology of the present work has been given below:

- A RC frame structure with same dimensions of beams and columns is modelled in SAP-2000 and seismic loading is applied to work out the maximum forces in the different sections of the whole assembly due to earthquake.
- Conclusion of all force in response spectrum function.
- These forces are applied to the beam column joint modelled in SAP 2000.
- Behavior of the beam column joint with the applied forces is analyzed.

3.1. Result

- In this section, and exterior beam column joint is analyzed and the results are presented in the form of stresses and displacements. The proposed models are developed using the FE software package SAP 2000. Dad load and live load load are applied to simulate the earthquake loading. For the validation purpose, the results obtained from SAP 2000 are compared with published results.
Table 1. Joint Displacement

<table>
<thead>
<tr>
<th>Work done</th>
<th>A. Nagaraju and P. Pravenkumar</th>
<th>Present work</th>
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<tr>
<td>Software Program</td>
<td>SAP 2000 (ISSN2321-8665)</td>
<td>SAP 2000</td>
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<td>Average displacement</td>
<td>2.579377</td>
<td>2.42851</td>
</tr>
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</table>

Table 2. Joint Velocities

<table>
<thead>
<tr>
<th>Work done</th>
<th>U1 mm/sec</th>
<th>U2 mm/sec</th>
<th>U3 mm/sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software Program</td>
<td>SAP 2000</td>
<td>SAP 2000</td>
<td>SAP 2000</td>
</tr>
<tr>
<td>Max. Velocities</td>
<td>2.579377</td>
<td>2.42851</td>
<td>2.42851</td>
</tr>
</tbody>
</table>

Table 3. Joint Accelerations

<table>
<thead>
<tr>
<th>Work done</th>
<th>U1 mm/sec²</th>
<th>U2 mm/sec²</th>
<th>U3 mm/sec²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software Program</td>
<td>SAP 2000</td>
<td>SAP 2000</td>
<td>SAP 2000</td>
</tr>
<tr>
<td>Max. Accelerations</td>
<td>2936.17</td>
<td>4030.98</td>
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</tr>
</tbody>
</table>

4. CONCLUSION

A simple and computationally efficient finite element model created in SAP 2000 for analysis of beam-column joint was carried out in the study. For beam column joint results were carried out separately and compared with each other.

Following points were noted down from the study and can be concluded as:

- FE model created in SAP 2000 was able to predict the behavior of beam-column joint efficiently.
- Convergence study has been done to predict the accurate behavior of structure.
- Maximum shear stresses were seen in the core region of the joint.
- Displacement can be controlled by confining the joint.

REFERENCES

[2] Eugenio Onate (2009); Structural analysis with the finite element method: linear static Vol. 1: basic and solids; Springer