Shear Behavior of short Eccentric Link Subject to Seismic Loads

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ABSTRACT

The energy is absorbed by link and/or columns deforming inelastically. For the three models and
the various lengths of link limits, three sets of results are considered. In the eccentric braced
frames it was forced that yielding of plastic capacity was achieved.

KEYWORDS

Link deforming; Length of Link; eccentric link; plastic capacity; shear mechanism

INTRODUCTION

Concentrically braced frames are limited in their ability to absorb energy during an earthquake.
However by placing the bracing members eccentric to the beam column joints, as shown in Fig. 1
(a), an energy absorbing link unit is produced (James R.Libby). The energy is absorbed by the

Eccentric link are usually introduced at both ends of a bracing member as it produces a
minimum energy loss conditions. Also the shorter the link lengths the more efficient the energy
absorption. Also the stiffness of the eccentrically braced frame will be virtually the same as the
braced frame (Charles W.Roeder, 1989).

MODELS

Three models of a multistorey structure, shown in Fig. 2, were analysed using DRAIN - 2D
computer program. Three link lengths were used in the analyses, 7, 11 and 15 inches. The
structural sections used are shown in Fig. 2.

The earthquake record applied to each model was the first seven seconds of the El centro N - S
record. This was scaled to produce a peak acceleration of 0.45 G. The dynamic properties of the
section were taken as 80% of the static properties (John M. Biggs, 1982).
RESULTS

For the three models and the various lengths of link limits three sets of results are considered:

(a) Overall Drift
(b) Yielding pattern of Members
(c) Associated Shear and Moment Values.

Overall Drift

A maximum displacement of 100 inches was specified for all the models, the limits taken to exceed this maximum value is in Table 1. The variation of displacements with time are shown in Fig. 3 and Fig. 4.

With one exception it can be seen that fixing the bases enables the structure to stay within the overall drift limit longer than the pinned bases. Overall the double eccentricity models stay within the limits longer than the single eccentricity models.

Table 1. Collapse Time of Each Time

<table>
<thead>
<tr>
<th>link length</th>
<th>single Eccentric</th>
<th>double Eccentric</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>fixed feet</td>
<td>pinned feet</td>
</tr>
<tr>
<td>7</td>
<td>3.76</td>
<td>2.09</td>
</tr>
<tr>
<td>11</td>
<td>3.45</td>
<td>3.69</td>
</tr>
<tr>
<td>15</td>
<td>3.45</td>
<td>2.1</td>
</tr>
<tr>
<td>0</td>
<td>7.0</td>
<td>5.26</td>
</tr>
</tbody>
</table>

Yielding pattern of Models

Fixed Feet Models

For all nine models, as can be seen in Fig. 5. Yielding starts in the left hand base column, then moves progressively up the model. The pattern is the same for each system of eccentricity. The eccentric frame yields progressively with time in all members up to the eighth floor level. For the single eccentricity frame, five of the column lengths have not yielded, but only one column in the double eccentric models. In all three models none of the bracing members have yielded.

Pinned Feet Models

The yield patterns for three models are shown in Fig. 6. This time the yielding starts at the first floor level and continuous only to the second floor level. The yielding then starts again at the fifth floor level for two or three storeys. Therefore for the pinned base structures two distinct regions of yielding are produced. Again no yielding is present in the bracing members.
The earthquake record applied to each model was the first seven seconds of the EI centro N-S record. This was scaled to produce a peak acceleration of 0.45 G. The dynamic properties of the section were taken as 80% of the static properties (John M. Biggs, 1982).

Fig. 1 (a) Typical Elastic Beam Link
(b) Behavior of Ideal Plastic Shear Link

Fig. 2 Analytical Model
Fig. 3  Shear Graph

Fig. 4  Shear Graph
Fig. 5 Shear Graph

Fig. 6 Displacement Graph
Fig. 7 Time - Dependent Mechanism of Vp & Mp Graph

Fig. 8 Time - Dependent Mechanism of Vp & Mp Graph
Shear and Moment Values

The shear - moment relationship for an ideal shear link is shown in Fig. 1(b). In all models the right hand link at the second floor level has yielded. The values of shear and moment in this link are used for the comparison. The variation of shear force in this, during the loading, is shown in Fig. 3 and Fig. 4. Fig. 5. The up value of the link is taken as 80% of the static shear capacity. The actual values obtained in the links are shown in Table 2.

<table>
<thead>
<tr>
<th>Table 2. V at Frame Failure (Kips)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed Eccentricity</td>
</tr>
<tr>
<td>single Eccentricity</td>
</tr>
<tr>
<td>link-15</td>
</tr>
<tr>
<td>link-11</td>
</tr>
<tr>
<td>link- 7</td>
</tr>
<tr>
<td>0</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Pinned Eccentricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>single Eccentricity</td>
</tr>
<tr>
<td>link-15</td>
</tr>
<tr>
<td>link-11</td>
</tr>
<tr>
<td>link- 7</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>
It can be seen from the results that the shear values for a II the eccentric frames is close to the yp value. For the concentric frames the shear values is considerably lower, about 34% of the shear capacity.

DISCUSSION

The yield patterns are shown in Fig. 5, 7, 8 and 9. However it is interesting to note the relative values of shear force and moment obtained. In the eccentric braced frames it was forced that yielding of the links occurred when both plastic moment capacity shear plastic capacity were achieved.

REFERENCES


Kazuhioko kasai and egor p.popov,(1983) on seismic design of eccentrically braced steel Frames, EERC report Earthquake Engineering Research Center, Univ. of California, Berkeley, pp387-394


APPENDIX

![Experimental Set up](image-url)