SEISMIC PERFORMANCE OF FACADE MASS ISOLATION SYSTEM IN TALL BUILDINGS

Ali MOEINADINI
Ph.D. Candidate, Department of Structural Engineering, Science and Research Branch, Islamic Azad University, Tehran, Iran
a.moeinadini@srbiau.ac.ir

Mansour ZIYAEIFAR
Associate Professor, IIEES, Tehran, Iran
mansour@iiees.ac.ir

Masoud NEKOOEI
Assistant Professor, Department of Structural Engineering, Science and Research Branch, Islamic Azad University, Tehran, Iran
msnekooei@gmail.com

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Building facades are one of the largest and most important elements in the overall aesthetic and technical performance of a building. Development and implementation of innovative facade systems to enhance seismic response of building structures have been a topic of debate for structural and architectural engineers. Tall buildings have seen the application of several different facade systems, such as glass/metal curtain walls, stone panels, and precast concrete panels. Generally speaking, most of these systems are multi-layered, but conventionally no considerable gaps exist between the layers. Alternatively, a different system called Double Skin Facade (DSF) with a wide gap between the system layers has been recently proposed. DSF is termed as a pair of glass skin separated with air corridor that has main layer of glass usually insulating. There is an air space between the layer of glass which acts as insulation against wind, sound and temperature. The glass skins can be single or double glazing units with a distance from 20 cm up to 2 m.

In this paper, a seismic control method using a DSF system, as a partial mass isolation system (Ziyaeifar et al., 1998) is proposed in order to decrease the level of energy imparted to the main structure during seismic activities. Conventional facade brackets are replaced by isolators and dampers which can isolate facade during earthquake excitation. The feasibility and potential of Facade Mass Isolation (FMI) method to control and mitigate the maximum vibrations and stresses due to seismic events on tall buildings with glazing envelopes is investigated via numerical simulations using SAP2000 program. The structure used in our study is a 15-storey residential steel-framed building, has 18 x 18 m base dimensions, with 52.5 m the total height, and rectangular form in plan including three spans respectively in the two directions, longitudinal and transverse (Figure 1).
As external envelope, a DSF System with glazing curtain wall as an outer skin directly connected to the perimeter steelwork is considered. In accordance with Figure 2, total dimension of 3.5 x 2 m was considered for each facade modular unit with steel reinforced curtain wall system. The glass panels assembly consisted then of a monolithic, 8 mm in thickness annealed glass ply (outdoor side), plus a laminated glass panel obtained by assembling two 6 mm thick heat strengthened glass plies with 1.52 mm thick PVB foil (indoor).

A dynamic analysis of the response by time history is used for facade mass isolated structure. For numerical simulations, accelerograms related to horizontal component of the El Centro (PGA=0.35 g), Hachinohe (PGA=0.19 g), San Fernando (PGA=1.17 g) and Taft (PGA=0.19 g) are used. Two facade layouts are considered as a mass isolation system connected to the perimeter of structure. Besides, three different combinations of isolators and dampers were using in facade isolation system with various damping and stiffness properties. Table 1 shows the reduction in inter-story drifts. Three different DSF configurations were compared to the uncontrolled structure performed under the four scaled historic earthquake excitations.

<table>
<thead>
<tr>
<th>Excitation</th>
<th>Up-Down Model</th>
<th>Up-Mid-Down Model</th>
<th>Divided Facade Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>El Centro</td>
<td>24.17</td>
<td>18.38</td>
<td>23.96%</td>
</tr>
<tr>
<td>Hachinohe</td>
<td>32.91</td>
<td>22.63</td>
<td>31.24%</td>
</tr>
<tr>
<td>Taft</td>
<td>12.24</td>
<td>10.26</td>
<td>16.16%</td>
</tr>
<tr>
<td>San Fernando</td>
<td>28.52</td>
<td>23.45</td>
<td>17.78%</td>
</tr>
</tbody>
</table>

In this paper, the behaviour and performance of structures with DSF and facade mass isolation technique are investigated and compared with conventional earthquake-resisting structures. Results show suitable behaviour of structure and also reduction of deformations in the facade components.

REFERENCES


