8th International Conference on Seismology & Earthquake Engineering
11-13 Nov. 2019, Tehran, Iran

SEISMIC PERFORMANCE OF FACADE MASS ISOLATION SYSTEM IN TALL BUILDINGS

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Keywords: Partial mass isolation, Facade mass isolation, Passive structural control, Double-skin facade, Tall buildings

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).

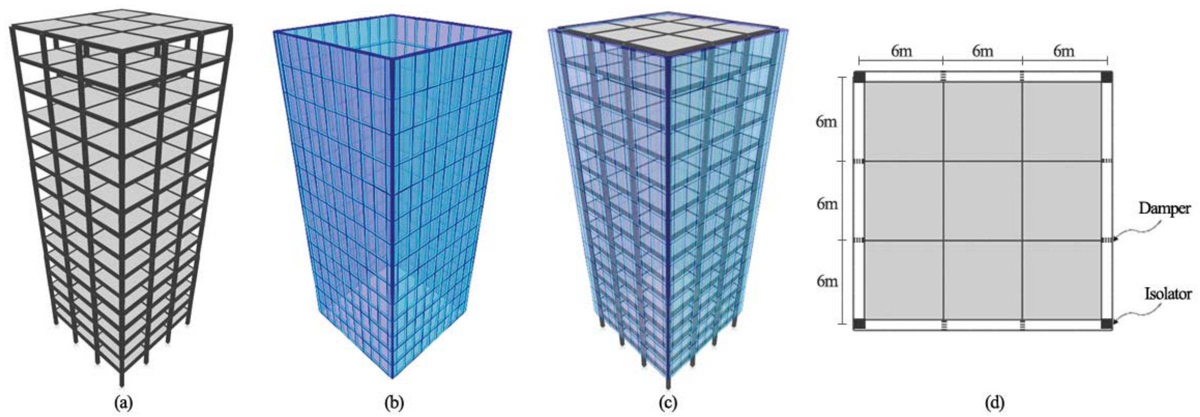

Figure 1. Reference building structure (a) Steel frame structure (b) Facade glazing (c) FMI system model (d) Typical plan of reference building.

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).

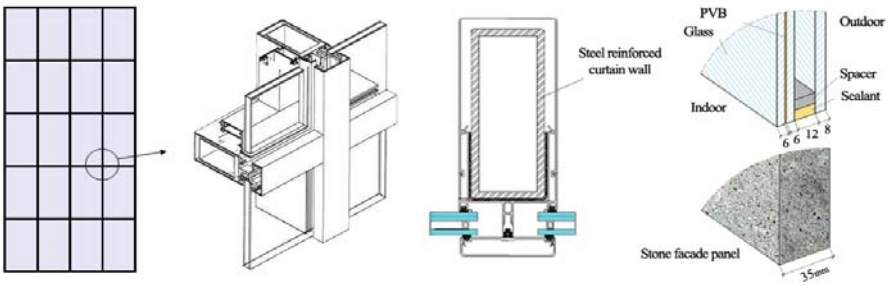

Figure 2. Glazing curtain wall details.

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 1. Average RMS inter-story drift of the FMI systems compare to uncontrolled structure.

Excitation		**Up-Down Model**		**Up-Mid-Down Model**		**Divided Facade Model**	
	Drift	Drift	Reduct.	Drift	Reduct.	Drift	Reduct.
El Centro	24.17	18.38	23.96%	18.37	24%	18.90	21.80%
Hachinohe	32.91	22.63	31.24%	22.15	32.67%	23.64	28.17%
Taft	12.24	10.26	16.16%	10.07	17.70%	10.32	15.70%
San Fernando	28.52	23.45	17.78%	22.94	19.57%	23.83	16.45%

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

Bedon, C. and Amadio, C. (2018). Numerical assessment of vibration control systems for multi-hazard design and mitigation of glass curtain walls. *Journal of Building Engineering, 15*, 1-13.

Fu, T.S. and Zhang, R. (2016). integrating double-skin facades and mass dampers for structural safety and energy efficiency. *Journal of Architectural Engineering, 22*(4), 189-202.

Moon, K.S. (2016). Integrated damping systems for tall buildings: tuned mass damper/double skin facade damping interaction system. *The Structural Design of Tall and Special Buildings, 25*, 232-244.

Ziyaeifar, M. and Noguchi, H. (1998). Partial mass isolation in tall buildings. *Earthquake Engineering & Structural Dynamics, 27*, 49-65.