NEW SEISMIC ISOLATION APPROACH: THE FOLDED CANTILEVER SHEAR STRUCTURE

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1. INTRODUCTION

When it comes to seismic isolation and seismic behavior of the multi-storey buildings, base isolation systems, supplemental damping devices and some other techniques such as coupling method have been widely used to upgrade the structural performance and withstand earthquake motions. Herein, a folded cantilever shear structure is proposed that combines the coupling method, the rubber bearing system and supplemental viscous dampers in one structure to overcome the detrimental effects of seismic loads on multi-storey structures and to acquire more seismic performance than the ordinary multi-storey buildings by extending its natural period and increasing damping ratio by attaching supplemental viscous dampers which mitigates the seismic response of the structure.

2. OVERVIEW OF THE VIBRATION MODEL

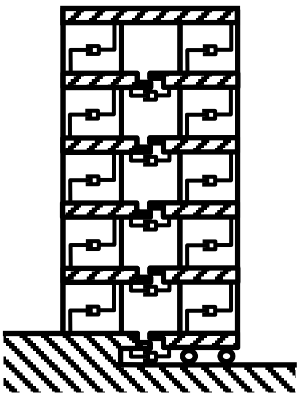

Fig 1 Framework of the vibration model

The proposed folded cantilever shear structure, **Fig 1**, is designed mainly composed of three parts, fixed shear sub-structure, movable shear sub-structure which is supported by roller bearings and the connection sub-structure that interconnects these sub-structures by a rigid connection beam at the top of the structure. Also the supplemental viscous dampers are attached to connect both sub-structures on the base of storey horizontally. To investigate the seismic behavior of the proposed structure, numerical and experimental studies are carried out, respectively. 15-storey of folded cantilever shear structure model and ordinary cantilever shear structure model are analyzed numerically due to four exemplary earthquake waves as El Centro, Miyagi, Hachinohe and Taft earthquakes. Then the experimental vibration test model of the proposed structure is performed through shaking table for the same earthquake waves and the seismic response diagrams are obtained.

3. ANALYSES RESULTS

3.1. Numerical Analysis

The numerical analysis was performed through three structural models, ordinary cantilever shear structure (OCSS), folded cantilever shear structure (FCSS) without and with dampers, to verify the seismic performance of the proposed structure.
According to the eigenvalue analysis results, the first natural period of the folded structure was obtained around 2.1 second, whereas the ordinary structure has around 1.0 second natural period. Which means the proposed structure is able to extend the natural period of ordinary structure almost two times. And the natural period of the folded structure without damper was obtained 2.3 second that clarifies the structure itself has an increasing effect on extending natural period. Besides, although the coefficient factor of folded structure is taken 10 times smaller than ordinary structure, the damping ratio is obtained around 33% whereas the ordinary structure has 2% damping ratio. In short, the period of the ordinary structure is extended almost 2 times by using proposed structure. And the damping ratio is increased around 16 times.

Then the numerical vibration models were subjected to elastic dynamic response analysis due to four earthquake wave namely, El Centro (1940), Taft (1952), Hachinohe (1968) and Miyagi (1978) earthquakes with adjusting the maximum acceleration to 300 gal for each earthquake waves.

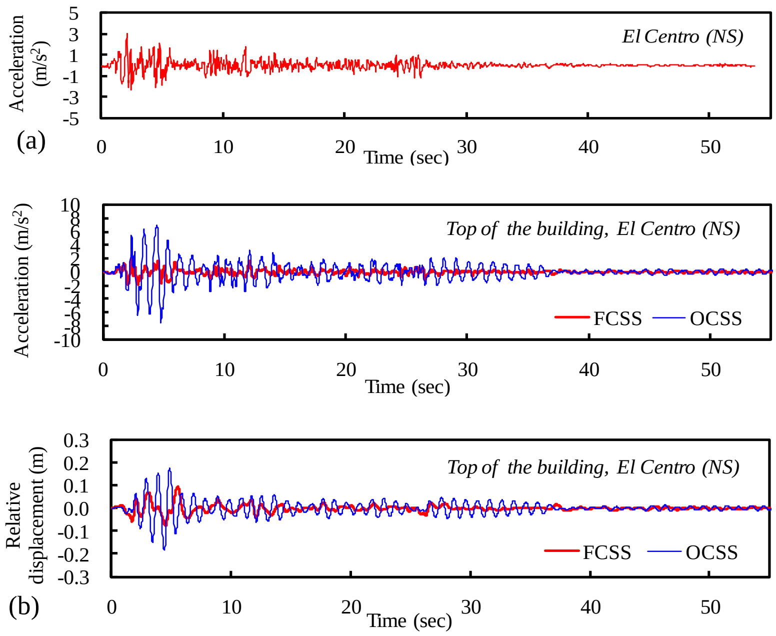

Fig 2 El Centro earthquake, (a) seismic wave; and (b) dynamic responses of FCSS with damper and OCSS damper

The acceleration response of the folded structure was decreased by 66% and displacement responses by 39% for the El Centro earthquake wave loading as seen in **Fig 2**.

3.2. Experimental Analysis

Three-dimensional vibration models of the FCSS without and with damper were tested experimentally to investigate the FCSS in terms of seismic characteristic behavior.

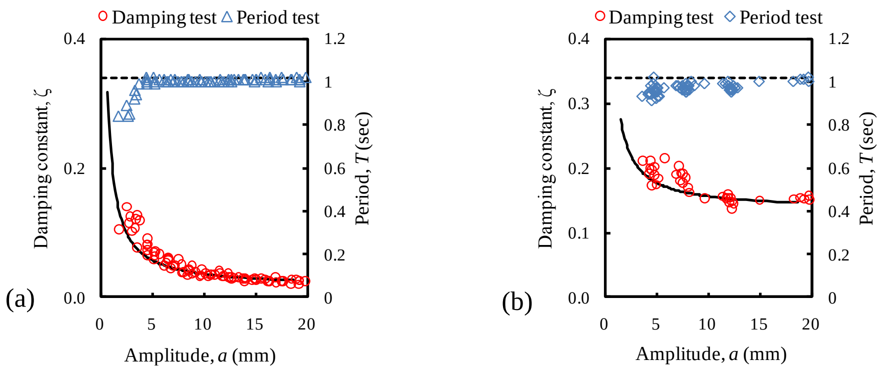

Fig 3 Natural period and damping tests of FCSS: (a) without damper; and (b) with damper

Fig 3 shows the damping and period test of without and with damper model. As is it seen, the damping ratio decreases as long as the amplitude increased. In spite of the amplitude value, the natural period changed in a small range. Also the damping constant of the additional viscous damper and the natural period were obtained around 14% with 1 sec natural period.

4. CONCLUSIONS

It is aimed to investigate the newly designed folded cantilever shear structure in terms of seismic behavior with the object of increasing seismic performance. The vibration model is tested through analytically and experimentally. Analytical and experimental analysis results are clarified that the proposed FCSS is performed an efficient role to increase seismic performance. The desired seismic performance for the proposed structure has acquired

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