Hybrid RC Building Structures with Corrugated Steel Shear Panels

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Summary

This research aims to establish an economical seismic response controlling system of RC frames using corrugated steel shear panels (CSSP), which was originally proposed for building structures by Mo and Perng in 2000. The hybrid system with CSSP has large ductility and possibly decreases to construction cost by large amount. The advantage of using CSSP in described from the design view point. Then, the experimental work on two specimens is introduced to show the excellence of CSSP in resisting the seismic force. A stud-type anchorage was employed in two half-scale specimens to fix CSSP to the surrounding RC frame. The degradation of lateral load carrying capacity after the peak load was small compared to reinforced concrete shear walls (RCW) due to stable manner of yielding and buckling of CSSP. The final failure mode of the hybrid system was the tearing of CSSP and the formation of a collapse mechanism of the surrounding reinforced concrete frame.

Keywords: Corrugated steel shear panel (CSSP); damage control; shear wall; stud anchorage.

1. Introduction

Corrugated steel shear panels (CSSP) have been used in bridge structures since late 1980s. They weigh less and decease prestressing loss due to their negligible axial stiffness compared to flat steel shear panels reinforced with stiffeners. In 2000, Mo and Perng [1] reported a use of corrugated steel shear panels as a main lateral load carrying component for building structures. They reported that CSSP are effective to delay buckling of shear panels. However, bolt anchorage fastening CSSP to the surrounding RC frame was not very effective and a large slip took place at the interface resulting in pinched hysteresis loops with small energy dissipation. Their test results provided interesting information on the potential capability of CSSP but CSSP has not been used in practice

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as a main lateral load carrying component. This paper proposes the use of CSSP as shear walls instead of RCW by introducing the experimental work on RC portal frames with CPPS.

2. Use of corrugated steel shear panels in design

CSSP has many advantages over RCW if it is used as a main lateral load carrying component in building structures. When an RC frame with CSSP is subjected to lateral force, shear deformation dominates. Hence, CSSP deforms in shear and the whole panel evenly dissipate energy after yielding. Energy is dissipated even after the buckling of the panel. CSSP does not exhibit any noticeable damage until the buckling, which takes place at relatively large deformation. Uniform deformation of CSSP causes uniform stress distribution to the surrounding RC frame and damage does not localize in the RC frame either. Since the shear stiffness and strength of CSSP is about ten times higher than that of RCW and the density is about eight times larger, CSSP tends to weigh less than RCW if two components have equivalent shear stiffness and strength. One of the most attractive advantage of CSSP is its large energy dissipation capability after yielding. The energy dissipation capability does not degrade very much even after buckling.

Large ductility of CSSP produces another advantage in design as schematically shown. In **Error! Reference source not found.**, the required shear capacity, Qu, is divided by the elastic design shear force, Qe, for the ordinate. When RCW is incorporated in RC frames, required shear capacity becomes high because of the brittle failure mode of RCW. However, CSSP is incorporated in RC frames, the required shear capacity can be drastically decreased due to its ductility. In the figure, Qu/Qe is required to exceed 0.4 for RC frame with RCW but 0.3 for RC frame with CSSP. The reduced requirement on Qu for RC frame with CSSP decreases the design force on all structural members, leading to large cost saving. Following chapters show experimental works to demonstrate the data supporting interesting features of CSSP.

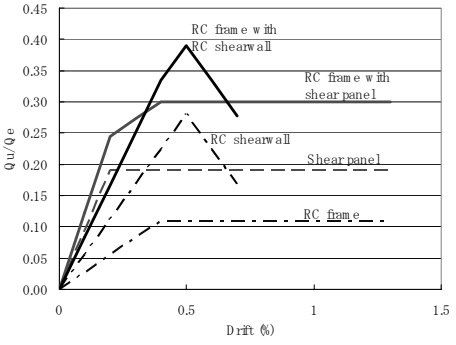

Figure 1. Required shear capacity - drift angle relation

3. Conclusions

A study was conducted on how to use corrugated steel shear panels (CSSP) as a main lateral load carrying component in building structures. The experiment on two RC frames reinforced with CSSP is introduced to demonstrate the advantage of CSSP.

[1] Mo, Y. L. and Perng, S. F., "Hybrid RC Frame-Steel Wall Systems," *Composite and Hybrid Systems*, ACI, SP-196, pp. 189 – 213, 2000.