Innovative Seismic Force-Resisting System used in Steel House Framing

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Summary

Full-scale testing of light gauge shear walls was conducted in this study to clarify the interaction of overturning moment and shear force. A total of seven specimens were prepared and tested. The tests produced the following results: (1) Overturning moment is mainly resisted by the coupled force of the studs, and shear force is mainly resisted by self-drilling screws that connect the structural plywood to the light gauge framing. (2) Strength interaction was not observed until the overturning moment exceeded 50% of capacity. This indicated that the sizes of shear wall members can be determined without considering the interaction between bending moment and shear force when the moment to which they are subjected is less than 50% of their capacity. This finding will simplify seismic design procedures for steel house framing. The findings also show that light gauge shear walls are more innovative than other seismic force-resisting systems.

Keywords: steel house framing; light gauge; shear wall; self-drilling screws; overturning moment; full-scale testing; seismic performance.

1. Introduction

Steel house framing (SHF) is the main structural system used for residential and commercial buildings in Japan. In this system, light gauge members and plywood and/or gypsum boards are used as structural elements. To resist horizontal forces (e.g., seismic forces), shear walls are installed into the framing. Shear walls used as horizontal force-resisting components are composed of structural plywood or gypsum boards, and the boards are connected to the framing by self-drilling screws. Therefore, the screws that connect the boards to the framing will resist the external horizontal forces [1]. In 2012, the building code for SHF was updated and designers are allowed to use this system in buildings up to four stories [2].

In SHF design, shear walls are treated as cantilever columns and the members are designed conservatively [1]. Following this design procedure, shear walls on the first story have to resist the overturning moment coming from the upper floors. This means that the amount of overturning moment to which the first story is subjected will be proportional to the number of stories. In low-rise buildings, the amount of overturning moment from the upper floors is limited, and the interaction between the overturning moment and shear force is not a major concern. However, the latest code allows the construction of four-story SHF buildings, and the shear walls will be subjected to a certain amount of overturning moment. In this situation, the interaction between the overturning moment and shear force will be a major concern in the design [3].

The purpose of this study is to clarify the interaction between the overturning moment and shear forces to which a light gauge shear wall is subjected. For this purpose, we conducted full-scale testing, in which bending moment and shear force can be applied simultaneously to the shear wall.

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