Behavior and Design of Steel Slit Panel Frames for Seismic Resistance

BY JUDY LIU, PH.D.

An update on what research is showing about this promising lateral force resisting system.

THE STEEL SLIT PANEL FRAME (SSPF) is a lateral force resisting system being developed for buildings located in seismic regions. Its main components are columns and beams, simply connected, and steel slit panels (SSP) as shown in Figure 1.

An SSP is a steel plate with vertical slits cut to create rows of flexural members, called links. The SSP is bolted at top and bottom to the beams. When the SSP is subjected to lateral deformations, the links behave as beams in double curvature, reaching their plastic moment capacity at both ends and dissipating energy. In addition, the panel has a pair of vertical edge stiffeners that are mainly for out-of-plane stability, but they also increase the panel's strength and stiffness.

The SSP has been adapted from steel slit walls developed and tested by Hitaka and Matsui in 2003, with two main differences. First, the aspect ratio is 1:2 for the SSP compared to 1:1 for the slit walls. The second difference has to do with the lateral forces the system is designed to resist. Slit walls have been used in dual systems and designed to resist 10% to 25% of the base shear. SSPs placed at selected bays can provide the entire design shear resistance and stiffness for the system.

The SSPF offers numerous advantages: the system is highly ductile; the panels allow for architectural flexibility; the SSP fabrication process is relatively simple; no field welds are required; the panels are easily field bolted in place and are easy to replace if damaged; and the system may be used to retrofit or strengthen existing structures.

The SSPF has been studied using a combined analytical and experimental research program. Major tasks to date include development of ideal configurations and design guidelines; analysis of system effects on the panel-frame response; design and nonlinear, dynamic analyses of three-story and 10-story prototype buildings using SSPFs; development of a simplified model for use in evaluation; ⅓-scale testing of three SSPs and five SSPF configurations following the lateral displacement loading protocol from AISC *Seismic Provisions*.

Experimental results show that SSPs are capable of interstory drift levels of at least 5% without loss of load carrying capacity below 80% of ultimate strength. The experiments also demonstrated that SSP capacity and stiffness can be predicted reasonably well by equations based on structural mechanics principles. MSC

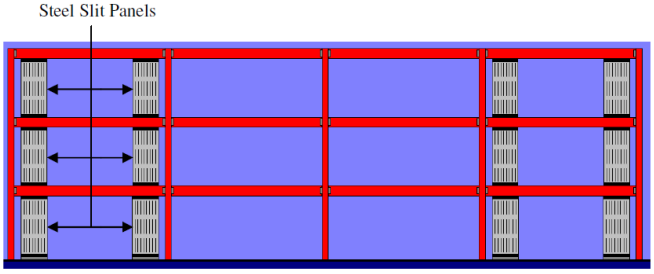

Fig. 1: Possible steel slit panel frame configuration.

Fig. 2: Two-story SSPF specimen at 2% drift.

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