

New and Unusual Products & Services

Prefabricated Shear Panels

Building a Better Structure

By Matt Meyers, P.E. and Scott Soule, P.E., S.E.

You've just specified a prefabricated shear panel for a residential structure. Your decision to use a prefabricated panel was probably due to the architectural considerations and limited space for site-built walls. You have checked that the allowable in-plane shear load for the panel is greater than your design load, but have you considered how the panel works with the rest of your structure? Specifying a prefabricated shear panel should be more than just a quest for supporting allowable lateral load – it should be a quest to build a better, more reliable structure.

Changes in the 1997 Uniform Building Code placed restrictions on aspect ratio for site-built shear walls. These code changes were precipitated by observations of the performance of narrow site-built walls during the 1994 Northridge earthquake in California. Specifically, high aspect ratio walls were overly flexible and unreliable resulting in increased structural damage. These site-built weaknesses were due to a variety of reasons including hold-down slip, lumber shrinkage, sill plate crushing, and field construction variability. Prefabricated shear panels were developed to address these concerns.

Current trends in the maturing prefabricated panel market are resulting in higher capacity and narrower walls to resist wind and seismic loads. Does this approach provide designers the best solution for the structure? There is a lot more to a good lateral design than just checking the allowable lateral load capacity.

Specifying prefabricated shear panels requires a designer to evaluate two additional considerations. First, the designer must assess compatibility of a prefabricated shear panel with the rest of the structural design. Second, the designer must become familiar with the design and detailing requirements of the prefabricated shear panel that are often buried in the footnotes of the manufacturers' code reports and literature.

Assessing compatibility of a structural system involves evaluating ductility, redundancy, post-peak performance, overstrength, and damping. These system attributes are generally addressed in the R (response modification coefficient) selected for the design depending on the basic structural system (*Uniform Building Code 1997*, Table 16-N; *International Building Code 2003*, Table 1617.6.2).

Designers often rely on a prefabricated shear panel manufacturer's recommendation of R to determine if the product is compatible with the basic structural system. But most designers are not aware that manufacturers and code officials do not follow a standard testing or analysis procedure for determining R. It's the role of designer's to assess compatibility considering the following:

- Beneficial redundancy may be reduced or eliminated with fewer walls.
- Effectiveness of using site-built walls and prefabricated shear panels in the same shear-force resisting line.
- A prefabricated shear panel in a shear force resisting line may not perform compatibly with the rest of the structure.
- Critical load path elements, such as anchorage to concrete and drag struts, must be sized to accommodate prefabricated shear panel loads.

In addition to compatibility considerations, a designer must become intimately involved in the details and footnotes in a prefabricated shear panel manufacturer's code reports and literature. The following considerations often surprise designers when sizing a prefabricated shear panel:

- Lateral load applied to a prefabricated shear panel combined with overhead loading (gravity loads) can exceed the capacity of the panel and the concrete.
- Lateral load applied to a prefabricated shear panel can exceed the capacity of the



manufacturer's recommended anchorage, even if the manufacturer specifies an anchor that is code-accepted.

• One interpretation of the 1997 *Uniform Building Code* may allow a one-third increase in allowable stress for steel panels when using the Alternate Basic Load Combinations of section 1612.3.2. But both Basic Load Combinations (1997 UBC section 1612.3.1) and Alternate Basic Load Combinations result in the same controlling load for typical bearing wall systems. More recent codes (IBC 2003, ASCE 7-02, and AISC 335-02) include load combinations that apply a reduction to combined transient loads instead of increasing allowable stress. Specifying prefabricated shear panels without including the one-third increase meets the intent and is and consistent with modern codes.

The best resources for a designer are the manufacturers' code reports, governing model codes, and the manufacturers' technical representatives. All these resources can help a designer sort through the design considerations associated with prefabricated panels.

The changes to the 1997 building code have resulted in better products for high aspect ratio applications. What began as an effort to eliminate the problems



associated with site-built narrow walls has evolved to high-capacity walls that potentially alter the overall structural response during a load event. Design professionals must answer the following questions: Does a prefabricated shear panel act like a wood shear wall, a steel column, or something in between? Do the published design properties match the designer's assumptions and design philosophy? Does the concrete design accommodate the loads induced by the prefabricated panel?

Ultimately, it's the designer's responsibility to determine the compatibility of prefabricated panels in the overall structural system accounting for ductility, redundancy, post-peak performance, over-strength, damping, foundation design, and other aspects of design. ■

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Publisher's Note

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We are pleased to announce that November 2005 will be our 10th Anniversary issue. Although STRUCTURE has been in print for more than 10 years in one format or another (including a newsletter), we are celebrating 10 years in "magazine" format. We are working on ideas for inclusion in that special issue, and your input is welcome!

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JUNE	STEEL	Light Gage Metal Framing Wood Construction
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