Changes in the Qualification of Prefabricated Shear Panels

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Prefabricated shear panels have become an important part of light-frame wood construction over the last decade, particularly for structures in Seismic Design Categories D and E. Manufacturers have introduced these products to fill a need created by Section 2305.3.4 of the 2006 *International Building Code* (IBC). This section limits the "aspect ratio" (wall height divided by wall width) of a field-built wood shearwall that can be considered to serve as part of the structure's lateral-force-resisting system. As architectural designs call for more window and door openings, prefabricated products provide a solution for wind or seismic design by resisting lateral loads while fitting within the narrow wall segments that remain. These products, because they are individually qualified and constructed under factory-controlled conditions, are permitted to be used in high aspect ratio applications.

Several manufacturers produce wood and steel prefabricated shear panels with ICC Evaluation Service (ICC-ES) report recognition. However, since these components are relatively recent additions to the marketplace, the rules by which they are qualified continue to evolve. This article provides an overview of recent changes in the qualification procedures for these products as ICC-ES progresses towards an evaluation process that is both consistent with the intent of the building code and improves uniformity of performance capability across the range of prefabricated shear panels in the market.

Qualification Process Prior to 2008

Almost ten years ago, ICC-ES established a formal acceptance criteria to be used as a consistent benchmark for reviewing prefabricated wood shear panels used in light-frame wood construction. Among other things, AC130, Acceptance Criteria for Prefabricated Wood Shear Panels, requires:

- that the prefabricated wood product be cyclically tested with an in-plane lateral load in applications that simulate the end use (i.e., supported upon a rigid foundation, placed upon a floor platform, etc); and
- a test-based design load derivation process that combines a minimum factor of safety with the initial stiffness of the panel, its displacement capacity and the design drift limits imposed by the 2006 IBC for light-frame wood structures.

While AC130 has provided consistent evaluation requirements for prefabricated wood shear panels for nearly a decade, steel panels have been introduced into the market without a similar formal acceptance criteria. Instead, design values and other performance factors for steel shear panels used in light-frame wood construction have been rationalized individually by each manufacturer and evaluated by ICC-ES on a case-by-case basis. As these and other product configurations are introduced it has become increasingly important that a consistent basis for review and recognition be developed for all products.

Over the last few years, ICC-ES has been working to develop an acceptance criteria specifically to address prefabricated steel shear panels used in light-frame wood or steel construction. AC322, Acceptance Criteria for Prefabricated, Cold-formed, Steel Lateral-Force-Resisting Assemblies, has been debated during several ICC-ES hearings. Some issues that have been particularly controversial are as follows.

- **One-third stress increase for "alternative" IBC load combinations.** Steel shear panels have historically included a one-third "overstress" increase in their published design values for use with the 2000 IBC's "alternative" load combinations. This controversial increase was not permitted for a site-built or prefabricated wood wall used in the same applications. It is also no longer permitted in the 2003 and later versions of the code.

- **Bearing wall performance.** Traditional wood shearwalls perform with a "division of labor" to resist combined gravity and lateral loads. The wood studs carry the vertical load. The sheathing and the sheathing attachment to the studs work to resist the lateral load applied parallel to the wall. Cyclic degradation of the wall under lateral forces is typically limited to the nailing and sheathing, which does not affect the vertical load carrying capacity of the studs. Thus, wood stud walls can be extensively damaged by earthquake response yet retain their ability to support gravity loads. Some prefabricated products configured differently but used in a bearing wall application can fail in a way under lateral load that also causes their vertical load carrying capacity to be reduced. All panels that carry gravity and lateral forces should perform in a manner that protects the combined vertical and lateral load reliability.
- **In-plane lateral load performance.** Proprietary shear panel products can differ from a field-framed wood shearwall when evaluated using a cyclic test that applies a lateral load parallel to the wall. If these response differences are significant, they must be addressed by the structural engineer as part of the design process.

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The last two issues have proved to be both related and difficult to address as they pertain to seismic/earthquake design. The 2006 IBC accounts for related performance differences between code-defined wall systems through the assignment of appropriate seismic design coefficients.

Seismic Coefficient Evaluation

The 2006 IBC assigns seismic coefficients to various defined wall systems in recognition of their seismic performance attributes. Structural engineers use these to calculate design loads and estimate the structural response. As a code-defined system, light-frame wood shearwalls with wood structural sheathing have assigned seismic coefficients. For a variety of reasons, designing a building for earthquake loads is easier if a prefabricated shear panel is assigned the same seismic coefficients as the light-frame wood shearwall that it replaces. However, that assignment carries with it a responsibility for the prefabricated product to perform in a manner consistent with a wood sheathing/stud wall system as described by the 2006 IBC. How to make this determination for a prefabricated component is not clearly defined.

A group of interested parties met in May of 2007 to discuss this issue. Representatives from prefabricated shear panel manufacturers, related wood and steel trade associations, consulting engineering firms, academia, the Federal Emergency Management Agency (FEMA), and ICC-ES were present. The group expressed agreement that the seismic design coefficients for defined lateral systems in the 2006 IBC and earlier codes were not derived by calculation based upon cyclic shearwall test data or other means. Rather, they were developed over a period of many years by committee, with judgment based largely upon historical performance, limited test data and comparison with other code-defined systems.

The group also reviewed a procedure, currently under development by the Applied Technology Council (ATC) under FEMA sponsorship, that uses cyclic test data and nonlinear analysis of representative structures to define seismic coefficients. They concluded that while the ATC-63 procedure seemed desirable for assigning seismic design coefficients to new structural systems, it is currently too complex and is not geared toward qualifying products that are components of a seismic-force-resisting system that contains other elements such as site-built walls.

The group decided that the most practical method for assigning seismic coefficients to these new systems was to use an “equivalence” approach. A consensus task group of seismic design/consulting experts, university professors, trade associations and prefabricated panel manufacturers (wood and steel) was formed and over the next few months:

- developed a database of cyclic test results to define the benchmark performance of field-constructed light-frame wood stud/sheathing wall systems,
- determined which performance attributes from those systems should be used to evaluate prefabricated products used in similar applications, and
- established targets for those parameters to ensure that the prefabricated product performs within the expected range for the code-defined wood sheathing/stud wall system.

The task group recommendations related to seismic equivalence were submitted to ICC-ES for inclusion in AC130 and AC322. The recommendations received support from FEMA as a reasonable interim approach while the ATC-63 Project is still underway.

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It should be noted that AC322 was revised to also permit the use of a prefabricated steel panel in light-frame structures with either wood or steel framing. Although the task group had attempted to define separate equivalency targets for systems used with steel stud framing, this effort did not reach a conclusion. Even though they share the same seismic coefficients, the available data indicated that the steel stud systems had significantly lower performance parameters for ductility and drift capacity when compared to wood structural panel/stud systems. However, at the ICC-ES hearing in October 2007 a letter was presented from three steel trade associations acknowledging the performance difference and requesting that the parameters for the wood-frame benchmark be applied to the steel stud systems.

What Does This Mean to the Code Official?

The ICC-ES committee adopted a revised AC130 and AC322 with effective dates of November 1, 2007 and March 1, 2008, respectively. Among other things, these parallel acceptance criteria now include uniform provisions to:

- eliminate the one-third allowable design load increase sometimes applied to steel shear panels;
- require that all shear panel products, wood or steel, be cyclically tested to characterize their performance;
- require that the performance of a shear panel under combined vertical and lateral loads be more carefully scrutinized; and
- establish minimum targets to justify the assignment of the seismic coefficients for light-frame wood construction.

As might be expected, these new seismic performance requirements are likely to change both the available product offerings and design information. Code officials should be aware that these new provisions have only been applied to products with explicit ICC-ES report recognition of compliance with the 2006 or later versions of the IBC. Recognitions for earlier versions of the IBC or *Uniform Building Code* will not include consistent consideration of seismic compatibility using the new procedures.

Overall, building officials can be assured that proprietary shear panel products recognized for the 2006 IBC have been subjected to a consistent review of cyclic test data using these new, state-of-the-art methods. Going forward, building officials can have confidence that these products—wood or steel—have been consistently evaluated for seismic compatibility to the rest of their light-frame building. ◆

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