RESEARCH in Progress

Coalition for Advanced Wood Structures
a university, industry, government partnership

Force Transfer around Openings: Phase II

The understanding of force transfer around openings (FTAO) is essential to the design of timber buildings that are safe against natural disasters such as earthquakes, tornados, and hurricanes. These disasters occur every year around the world and have resulted in billions of dollars in property damages and many unfortunate casualties (Fig. 1). A joint research project by the APA–The Engineered Wood Association; the USDA Forest Service, Forest Products Laboratory; and the University of British Columbia in 2010 (referred to as Phase I) identified the Diekmann method as the technique that seemed to best match laboratory observations (Fig. 2) and computer model simulations when compared with other methods (such as the drag strut, cantilever beam, and coupled beam techniques). The final Phase I report is available at www.apawood.org/pdfs/download_pdf.cfm?PDFFilename=managed/M410.pdf.

Background

The computer model used in the Phase I project appears to predict FTAO quite well in most cases, except when wall failure was associated with failure of framing members (end studs) or sheathing tearing. This represents a significant drawback for development of the FTAO methodology but can be overcome by incorporating lumber and sheathing property data into the computer model to simulate critical failure modes.

Objective

The objective of this project (referred to as Phase II) is to refine the computer model for predicting the lumber and sheathing failures of the FTAO. Additional full-scale shear wall tests will be conducted to confirm the model prediction and the FTAO results.

Figure 1. A residential house with large wall openings.

Approach

The project will be implemented in four tasks. During task 1, test data from the Phase I project will be reviewed to identify the wall configurations that failed in end studs. The candidate wall configurations will be limited to those detailed for FTAO (i.e., configurations 4 to 6 and 8 to 12; see Phase I final report) because other configurations did not provide an effective FTAO and the end studs were simply subjected to bending forces against the center pier, which acted as a monolith. During task 2, model analyses will use the experimental results from Phase I to determine the critical lateral force with which the end studs or sheathing start to fail. This critical force will be compared with published design values from the National Design Specification (NDS) and Panel Design Specification (PDS). A "calibration factor" for the computer model will be developed from this exercise. The possibility of force redistribution on the wall after the initial failure will be investigated using the computer model. During task 3, a minimum of three selected wall configurations will

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Figure 1. An FTAO wall configuration tested during Phase I.

be modeled to predict their FTAO performance. The same wall configurations will be constructed and tested full-scale to confirm the general applicability of the calibration factor. During task 4, a comprehensive final report will be prepared.

Expected Outcomes

The expected outcomes for this project include a computer model with properly calibrated adjustment factors that can predict the predominant failure mode of the wall and a reliable model that can be used to assist in the design of force transfer around openings.

Timeline

The project was initiated in September 2011 with a planned duration of 16 months. Task 1 (review of Phase I test data) is scheduled for completion in November 2011. Task 2 (modeling analyses) will start after Task 1 is completed and is scheduled for completion in March 2012. Task 3 (full-scale wall testing) is planned for January to May 2012. Task 4 (draft final report) will start after Task 3 testing is completed and is scheduled for completion by October 2012.

Cooperators

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