DRAFT

Investigation of Fastening of Wood Structural Panels for Opening Protection (Phase 2)

Presented to the

Florida Building Commission
State of Florida Department of Business and Professional Regulation

by

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1. Issues

The proposed research addresses low-cost options for windborne debris protection of openings in areas outside of the high velocity hurricane zone. During the FY2013-14 research cycle, it was found that:

1. Determination of wind loads for labeling and product approval of impact resistant coverings should be streamlined and made consistent with ASCE 7-10 Components and Cladding (C&C) load calculations. The current approach yields an ultimate load that is 90% of the ASCE 7-10 C&C counterpart. Further, the Code should explicitly define the relationship between ASD and LRFD (ultimate) pressures and the terminology incorporated in the testing application standards, which vary. We suggested that the Code allows a single prescriptive design and simplified guidance for designers seeking alternative fastening solutions
2. The wind-borne debris protection fastening schedule (Table 1609.1.2) for wood structural panels is not conservative, e.g. an 8 ft unsupported span of 7/16 OSB with 1 inch of spacing between the fastener and the panel edge will fail in strong winds
3. Structural wood panels are a good choice for a low-cost storm shutters outside of the HVHZ if the fastening schedule is adequate. A one-approach-fits-all, low-cost design was developed and tested for Group R-3 or R-4 occupancy buildings with a mean roof height of 45 feet or less in locations where Vult is 180 mph or less. The system did not exhibit failure during static and cyclic pressure tests derived from ASTM E330 and ASTM E1996. We believe this design reasonably complements the options for metal shutter products, which are generally rated for higher pressures with the tradeoff of increased cost

Suggested code modifications were tendered for light frame wood construction. The following items, which are the basis of the proposed study, were identified for additional study:

4. Predicting the catenary forces is not straightforward given the current knowledge base. The flexibility of 7/16 OSB causes large deflections (~L/15) that cause in-plane forces that combine with the withdrawal force induced by the out-of-plane wind loading. The lateral (shear) forces are dependent on a combination of factors, including flexural bending of the fasteners or other yield modes (crushing, rotating, hinging) and the free

translation of the panel caused by oversizing of the holes that receive the fasteners

5. Designers need conservative yet realistic closed-form solutions to calculate catenary loads in a rational engineering analysis, however the standard equations most likely to be used by a designer are expected to significantly overpredict the lateral forces. Additional experimental research is required to validate closed-form solutions and to establish baseline parameters (e.g. load/slip) for typical panel materials, thicknesses and physical properties (e.g., moisture content).
6. Other combinations of hardware and wall types should be studied to determine if the one-approach-fits-all approach proposed in the study is acceptable or requires modifications to achieve suitability. Time and budget precluded the investigators from evaluating other combinations that are prevalent in Florida, however the experimental configuration required to perform this testing is now in place
7. Developing recommendations for larger openings is warranted, especially given the widespread use of sliding glass doors in one- and two-story residential buildings. Additional research is required to develop a prescriptive design solution for large openings that require more than one panel. The APA T460 *Hurricane Shutter Design Considerations for Florida* provides a logical starting point for designing multi-panel configurations

This study will build upon the FY2013-14 research. Focus areas will include attachment methods for masonry wall systems (e.g., concrete-block-stucco and brick veneer) and large openings that require more than one panel. We anticipate working closely with multiple stakeholder groups, including the International Hurricane Protection Association (IHPA), APA, and the American Wood Council, to address these issues.

2. Relevant Sections of the Code (and related documents)

- Table 1609.1.2, Florida Building Code
- Table R301.2.1.2, Florida Building Code

3. Statement of Work

- Develop a rational engineering analysis method to calculate catenary (lateral) forces for flexible panel systems
- Determine prescriptive fastening requirements for structural wood panels attached to masonry wall systems and validate the design through experimental testing
- Design structural wood panel systems for large openings and validate the design through experimental testing. Evaluate APA T460 as a starting point for this design
- Interpret results, determine whether the problem requires action, and produce a report that explains the results and implications for the Code

4. Budget

Table 1. Budget

Budget	Amount
Salaries	$23,245
Fringe Benefits	$5,055
Equipment	$12,653
Utilities	$0
Travel	$0
Misc. (M&S, Tuition)	$20,000
Indirect Cost/Overhead	$6,095
TOTAL	$67,049

The equipment cost includes $12,653 for an AMI MC6-1K multi-component force transducer, strain gage signal conditioner/amplifier and cabling (or similar make/model). The miscellaneous cost includes $15,000 to construct test specimens and a test frame for wood frame, brick veneer and concrete block. The test frame will accommodate one- and two-panel systems.

Research personnel time and will be reported and certified using a “loaded” rate computed from the following table. Note that the indirect cost shown in Table 1 is computed from the indirect cost in Table 2 + the indirect cost associated with the travel and miscellaneous categories.

Table 2. Breakdown of the hourly compensation rate

Person	Hours	Hourly Rate	Fringe	Tuition	IDC	Total
F. Masters	160	$73.18	$20	$0.00	$9	$16,461
D. Prevatt	0	$63.47	$18	$0.00	$8	$0
K. Gurley	0	$65.93	$18	$0.00	$8	$0
Lab Staff*	160	$29.19	$9	$0.00	$4	$6,770
Admin Asst	20	$23.30	$11	$0.00	$3	$746
Grad. Students	0	$21.00	$3	$10.90	$2	$0
Undergrad. Students	640	$10.00	$0	$0.00	$1	$7,153

*Multiple lab staff may be used. Maximum anticipated hourly rate shown

The personnel time in Table 2 reflects the estimated time commitment to this deliverable, however the UF professors (Gurley, Masters, Prevatt) work in a team. These hours may be used to support other projects supported by the sponsor during 2014-2015.

5. Deliverables

- A report providing technical information on the problem background, results and implications to the Code submitted to the Program Manager by June 1, 2015
- A breakdown of the number of hours or partial hours, in increments of fifteen (15) minutes, of work performed and a brief description of the work performed. The Contractor agrees to provide any additional documentation requested by the Department to satisfy audit requirements