DRAFT

Behavior of Aluminum Screen Enclosures in Strong Winds

Presented to the

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

by

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Project Leads: Forrest Masters and Sungmoon Jung

1. Issues

- During the 2013-2014 research cycle, the Aluminum Association of Florida (AAF) requested a study on the comparative performance of two screen enclosure systems. The first system was based on signed and sealed, site-specific plans obtained from building code departments in NE Florida. This 'generic' system was based on conventional design practice, which is believed to represent the majority of designs outside of the HVHZ in Florida. The second system was identical to the 'generic' system except that the design conformed to requirements set forth in the 2010 AAF Guide to Aluminum Construction in High Wind Areas
- Both systems were tested in the full-scale test facility at the IBHS research center. Neither system exhibited the type of catastrophic failure observed in the 2004 hurricane season, however loss of screens, local buckling and material yielding were observed in isolated sections
- The study only considered one design option (a mansard roof with mechanically attached connections). Other options available to the consumer include hip roof configurations and systems that interconnect by 'snapping' and 'locking.' Thus additional full-scale testing is planned to evaluate other options
- Further, there are outstanding questions about the wind loading characteristics of the screen enclosure systems. Design pressure coefficients originate from a two interrelated studies performed at Clemson University and Virginia Tech (Reinhold 1999). The limited scope of the 2013-2014 testing did not allow for direct measurement of area-averaged pressures and reactions. Boundary layer wind tunnel modeling is planned to address this issue. The full-scale tests may also be designed to quantify loads and reactions; qualitative observations from the 2014 testing possibly indicate that the roof loading may differ from design values
- If time and budget allow, connection testing is also planned to assess the moment restraint provided by typical aluminum connections. These findings will inform design considerations for finite element modeling (i.e. choosing free, semi-rigid, or fixed ends)
- A companion study (Project 2 – Corrosion of roofing and screen enclosure fasteners) will assess the effect of corrosion on typical fastening systems used in screen enclosures systems

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

- 1622.1.2, Florida Building Code—Building
- 2010 AAF Guide to Aluminum Construction in High Wind Areas

3. Statement of Work

- Coordinate with stakeholder groups (e.g., Aluminum Association of Florida, Insurance Institute for Business & Home Safety) to finalize the testing matrix and protocols for full-scale testing of aluminum screen enclosures and boundary layer wind tunnel modeling
- Conduct experimental testing of additional screen enclosure structures at the IBHS Research Facility. These variations may include hip roof structures, 'snapping and locking' systems," or other options not assessed during the 2013-14 research
- Conduct boundary layer wind tunnel modeling of typical screen enclosure systems found on Florida homes to provide baseline results that can be compared with findings from the Virginia Tech and Clemson University studies performed in the early 2000s
- Interpret results, determine if the problem requires action (or not), and produce a report that explains the results and implications for the Code

4. Budget

Table 1. Budget

Budget	Amount
Salaries	$18,861
Fringe Benefits	$4,861
Equipment	$0
Utilities	$0
Travel	$2,500
Misc. (M&S, Tuition)	$96,093
Indirect Cost/Overhead	$12,231
TOTAL	$134,546

The miscellaneous cost includes $49,400 for full-scale testing at the IBHS Research Facility (see Appendix), $20,000 for conducting complementary boundary layer wind tunnel tests at the University of Florida wind tunnel (alternatively this funding can be used for mechanical testing of connections), $5,000 for an outside engineering consultant in the aluminum industry, and $21,2693 for Florida State University to assist with analysis and testing.

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	80	$73.18	$20	$0.00	$9	$8,231
D. Prevatt	0	$63.47	$18	$0.00	$8	$0
K. Gurley	0	$65.93	$18	$0.00	$8	$0
Lab Staff*	320	$29.19	$9	$0.00	$4	$13,541
Admin Asst	20	$23.30	$11	$0.00	$3	$746
Grad. Students	0	$21.00	$3	$10.90	$2	$0
Undergrad. Students	320	$10.00	$0	$0.00	$1	$3,576

*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

6. References

- Reinhold, T.A., J. Belcher, D. Miller and C. Everley, 1999: Wind loads on screen enclosures. Clemson University Wind Load Test Facility Report

7. Appendix. Letter from IBHS

July 30, 2014

Dr. Forrest Masters
Associate Professor of Civil and Coastal Engineering
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University of Florida, 365 Weil Hall, Gainesville, FL 32611

Subject: Proposed Pool Screen Enclosure Testing at the IBHS Research Center

Dear Forrest:

The Insurance Institute for Business & Home Safety (IBHS) is pleased to provide pricing information for the proposed additional pool screen enclosure testing. Based on our discussions about the project, which would be a follow on project to the work conducted this year, the expected cost for conducting the 2015 testing of two pool screen enclosures at IBHS is $49,400. Final approval for conducting the project in 2015 must be obtained from our Research Advisory Council (RAC), which meets on August 6th and again on September 17th before we can commit IBHS staff support. We anticipate approval from the RAC and are moving ahead with the planning of this project, which we anticipate would be conducted during the first or second quarter of 2015.

The quoted price includes the following:

- Testing of two pool screen enclosures described below, which will require two days of occupancy of the large test chamber. This testing is intended to identify the realistic wind loads acting on the structure for comparison with code requirements, and to identify the way the loads are distributed within a typical framework. At the current daily rate of $18,700, this testing plan equates to $37,400 of chamber occupancy.
    - A hip roof style pool screen enclosure which has been instrumented to provide member axial loads and bending moments in several locations, twice the number of sensors as on the previously instrumented screen enclosure
    - A hip roof style pool screen enclosure identical to the one above, except that each wall, trapezoidal roof section, and triangular roof section have

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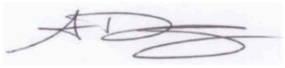
been effectively isolated from the others and instrumented to obtain the overall wind forces acting on that independent section of the enclosure.

- IBHS engineering support, including researchers assisting with the conduct of the test, review of the data collected, and review of the report. The cost for three days of engineering support, including senior level researchers is $5,500. IBHS will provide any additional support required beyond these hours free of charge.
- Travel costs for the crew to assemble the pool screen enclosures, which we estimate to be $3,000.
- Miscellaneous supplies needed to accomplish the work, including hardware to anchor the pool screen enclosures to the turntable in the IBHS Research Center test chamber, estimated at $3,500.

Sincerely,



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