Wind Pressure Resistance of Walls with Exterior Rigid Foam:

Structural Performance Testing and Development of Design Specifications

Building America Stakeholder Meeting

February 2012

Gaps and Barriers

➢ Wind pressure resistance of multi-layered walls with exterior rigid foam

- Performance characteristics
- Capacity
- Limitations
- Design method
- Design specification

Market Implications

- Walls with exterior rigid foam
  - 2012 IECC – Climate Zones 3 and higher
- Wall systems:
  - Claddings and their attachments
  - Interior finishes
  - Air sealing, air barriers
  - Cavity insulation

Research Tasks

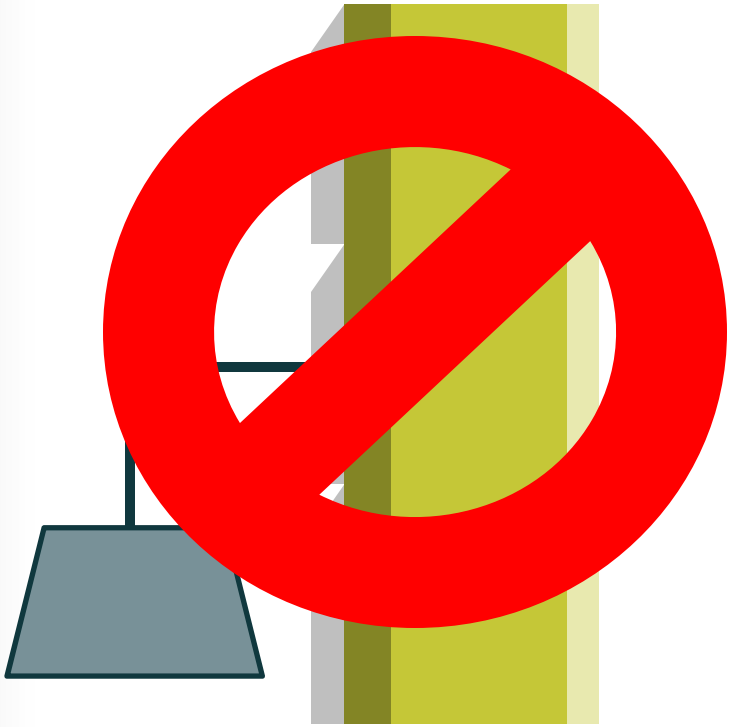
- Laboratory Testing of Wall Assemblies under dynamic wind pressures at the NAHB Research Center
  - NAHB/DOE/ACC
- Laboratory Testing of a One-story House in IBHS Wind Tunnel Facility
  - DOE/IBHS/ACC/FSC/VSI/NAHBRC

NAHB Research Center Testing

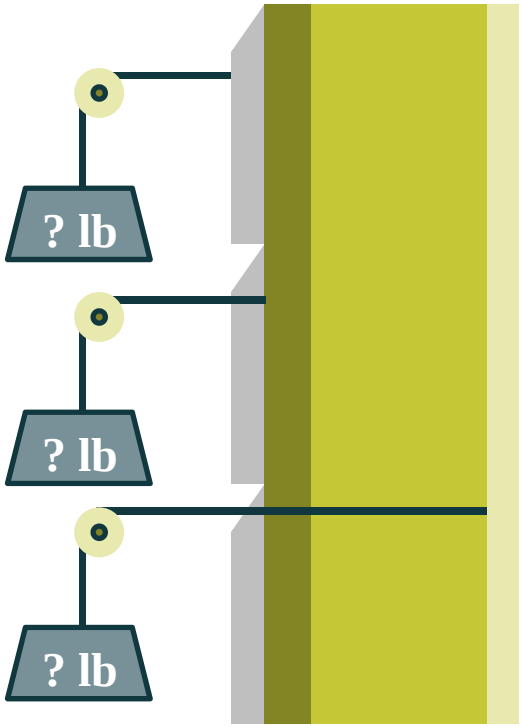
- Nominal wall specimen sizes
  - 4 to 9 feet tall
  - 4 to 12 feet long
- Data Acquisition (45 channels at 100 hz)
  - pressure sensors
  - deformation sensors
- Load applied using Pressure Loading Actuators (PLAs)
  - 11 Horsepower
  - PLA response 10 hz

Wall System Response

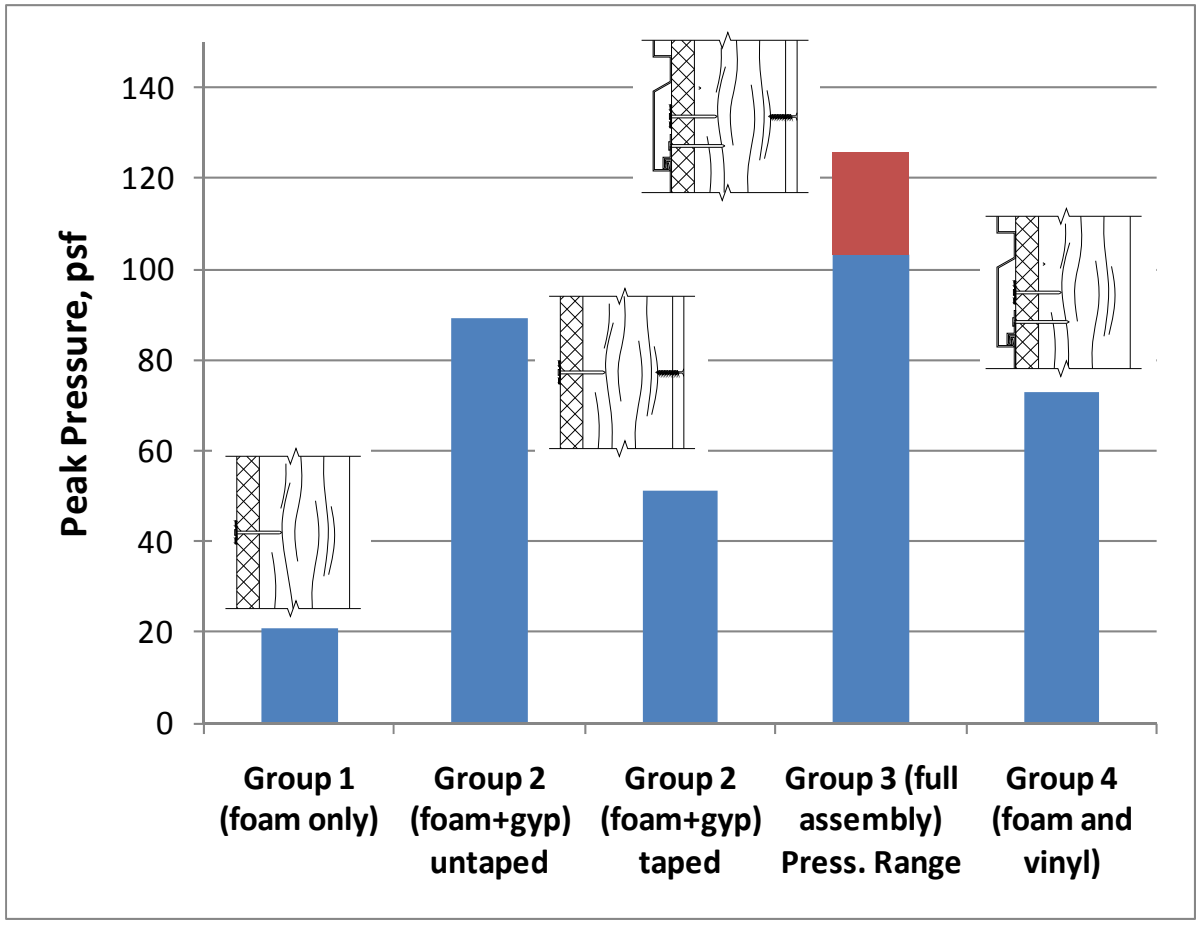
100% of pressure resisted by exterior sheathing layer



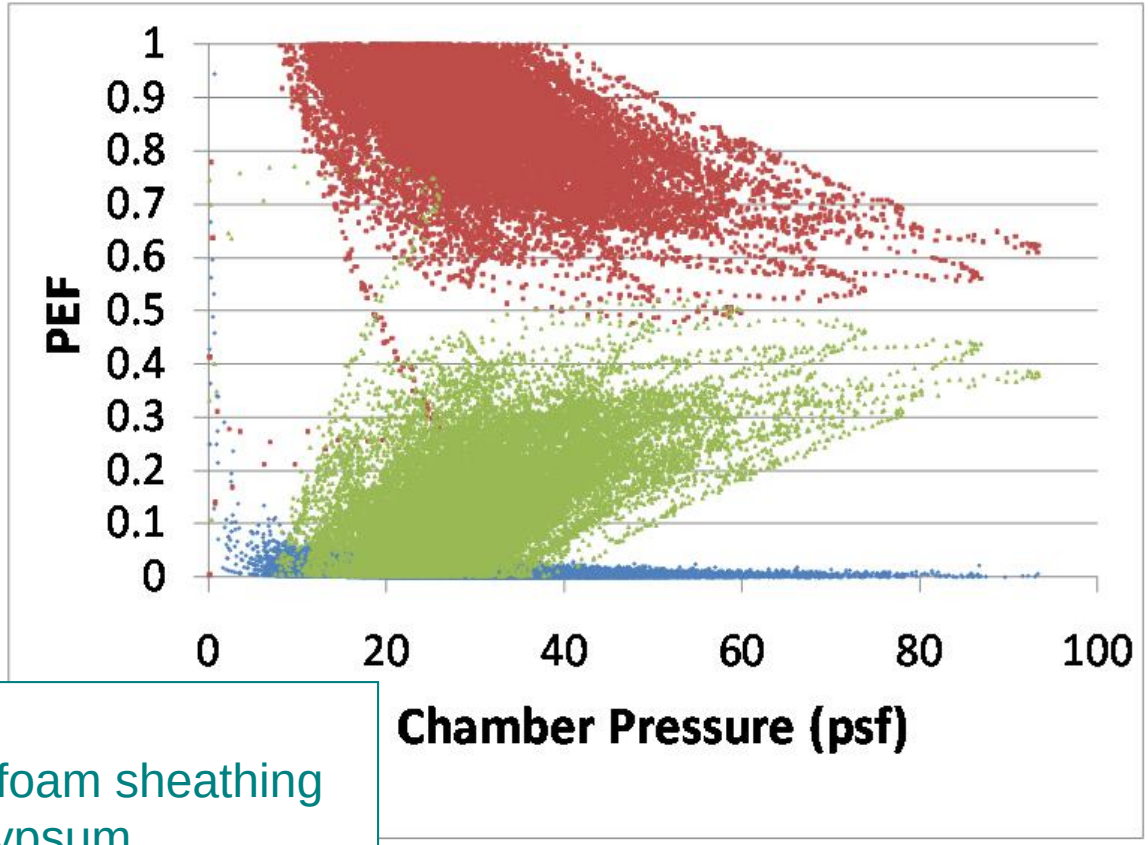
Pressure distributed across wall layers



Summary of Results (suction tests only)



Pressure Equalization (w/o house wrap)



Blue • – vinyl siding
Red • – taped rigid foam sheathing
Green • – interior gypsum

$$PEF_{Layer} = \frac{\Delta P_{Layer}}{P_{chamber}}$$

Key Observations

- Pressure is distributed between wall layers (pressure equalization)
- Gypsum is resisting large portion of the load under suction tests
- Location of air barrier(s) impacts the distribution of load between wall layers

Full-House Testing at IBHS

- Testing is complete
- Analysis of results
- Foam remained on walls wind speeds up to ~ 125 mph
  (standard Exposure C at 33’ height and 0^{o} wind angle relative to ridge)

Achieved so far

- Mechanism of how wind pressure is distributed and resisted is better understood
- PEF for all wall system layers (siding, exterior foam or OSB sheathing, and interior gypsum) has been enveloped for +/- wind pressures
- Interior gypsum sees less load and vinyl siding more load than observed in dynamic uniform pressure assembly tests; foam sheathing layer is similar in both cases

Next steps

- Final report with conclusions and recommendations forthcoming
- Correlation between full-scale and assembly level testing

Phase 2 ?

- Assembly test method modifications to better correlate with wind-tunnel performance
- Confirm effects of wall assembly variants (different sheathings, sidings, air sealing, etc.)
- Development of PEF modeling approach
- Implement for design of high performance multi-layered wall systems and other applications

Advancement of Code Requirements for Foam Sheathing

- New vinyl siding wind pressure rating requirements in 2009/2012 IRC Section R703.11.2 for use over foam sheathing
  - consistent with wind pressure and PEF testing to date for application with foam sheathing
  - Same provisions proposed for 2015 IBC

Code Advancements (cont'd)

- New ANSI standard FS 100
  - Wind pressure rating requirements for foam sheathing products
  - nearing completion (public ballot phase)
  - Proposed for 2015 I-codes (in progress)
- Other related topics (e.g., fastening requirements for cladding over foam sheathing)

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