



Engineering Sciences Section – 2005

C35 Forensic Engineering Evaluations of Causes of Rapid Deterioration in Wood Frame Building Envelope and Relationship of Building Codes

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The goal of this presentation is to determine causes of the rapid deterioration of building envelopes and structural elements in wood frame structures and the contributing causes of materials and building codes.

This presentation will impact the forensic community and/or humanity by adding technical insight to the forensic community to facilitate investigations into the causation of the rapid rot and deterioration syndrome in modern wood frame construction

Wood frame structures constructed in accordance with recent building codes in the 1990s to present are sustaining dramatic and rapid deterioration and rotting of sheathing and structural elements. The conditions result from multiple elements of causation including leakage at clad windows coupled with high insulation levels and with sealing requirements required by modern building codes. This paper provides a summary of research conducted by Guy Engineering Corporation and a synopsis of field evaluations of hundreds of wood frame and primarily residential structures.

Laboratory research and testing was conducted by Guy Engineering Corporation into the causes of leakage at window areas using both wood windows and clad windows. The testing of windows in wall assemblies was conducted in accordance with ASTM 1105.00 protocol (Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Air Pressure Difference). This protocol requires application of water spray to the exterior of the assembly at the rate of 5 gallons per square foot per hour. A negative pressure was applied to the interior of the wall assembly in accordance of the protocol at a rate of .55 inches water column (14 mm). Wall assemblies were constructed in accordance with the building code requirements using 2 x 6 framing members and 7/16" OSB sheathing. Windows were installed in conformance with manufacturers' installation requirements. The building paper (weather resistive barrier) was installed in conformance with the 1997 UBC and in conformance with the industry standard/practice in place for residential stucco. All water applied to the exterior of the wall/window assembly was captured and quantified. The water was captured in specially constructed vessels on the interior of the wall assembly, exterior of the sheathing, and on the exterior of the building paper (weather resistive barrier). Results of the testing determined that water intrusion occurred at the integral nail flange/self flashed window at a rate in excess of 100 oz occurring within four 5 minutes cycles as called for in the referenced spray test protocol.

Testing was conducted without sealant at the perimeter of the window between the stucco siding and window assembly. Subsequent comparative tests with sealant applied at the perimeter of the window assembly were conducted. Data are presented which quantitatively show the amount of water intrusion at each surface of the building envelope. Identical tests were carried out using a wood window of similar dimensions.

The results of the testing found that the modern clad windows with nail flange/integral flashing elements sustain leakage rates in excess of an order of magnitude greater than those experienced by the traditional wood windows with brick mould. This element of substantial water intrusion into the building envelope is a major cause of rapid deterioration/rotting of structural elements. Other contributing elements relate to modern elements of both the Federal Energy Code and state versions of energy codes of which specifically have required increased levels of insulation, sealing vapor barriers on the interior of the envelope, and the addition of weatherresistive barriers which are sealed to rough openings and to windows. The combination of the above elements has resulted in water intrusion and accumulation in building envelopes and the requirements of the Codes do not permit drying of the building envelope, resulting in rapid deterioration. Properties of certain sheathing materials such as OSB and Bildrite with respect to water penetration and vapor permeance, combined with the similar properties in weather resistive barriers required in the modern building codes further contribute to retention of water in the building envelope. At northern latitudes/cold climates, the result is accumulation of ice and frost within the building envelope, which further reduces both the permeability, and vapor permeance of the building sheathing, which exacerbates the problem of rapid deterioration/rotting of sheathing and framing elements.

Outcome: the rapid deterioration of the building envelope has been found to relate to multiple causes including leakage at clad windows coupled with modern construction elements and changes in building sheathing and with multiple aspects of the Building Code including adverse effects of insulation levels and sealing of interior and exterior surfaces of the building envelope.

Clad Windows, Water Intrusion, Building Envelope