

## **Overall Themes – Building Scientists/Forensic Engineers**

- Designers, builders, and code officials should take the approach that all cladding systems will allow water through at some time so need to design to handle that water by balancing this wetting with drying and draining.
- Window installation and flashing are a primary source of problems.
- A variety of recommendations focused on addressing the general skill level of the workforce. Strategies included training, continuing education, third-party inspections, certification, and/or licensing.
- Building science has progressed to where we can and should take climatic considerations into the design.
- Oregon lacks standardized practices. Contractors rely on past practices that may not be appropriate for modern materials and building regulations.

### Dave Ricketts M.Sc., P.Eng., Principal – RDH Building Engineers

Mr. Ricketts provided an informative overview of the problems encountered in British Columbia. Based upon a wealth of research from B.C., climatic conditions alone are not the culprit. The problems are also a function of the buildings themselves in terms of lack of overhangs, the use of sensitive wall assemblies, and poor detailing. Traditional face-seal wall assemblies are problematic because you have to keep all the water out at the exterior. Therefore, Mr. Rickett's primary recommendation was to implement rainscreen technology because of improved drainage and drying capacities.

Drawing upon his experience in OR, WA, and B.C., Mr. Ricketts discussed strategies that could be used to address some of the underlying issues – training, guideline documents, improved detailing, and warranty and maintenance programs. From a technical standpoint, most of these issues are understood, but they are not implemented on the frontline in a consistent and informed manner. He recommended that accepted guidelines should be developed to address the lack of consistency in technical advice and standards.

### George Tsongas, Ph.D., P.E., Consulting Engineer/Building Scientist and Professor Emeritus of Mechanical Engineering, Portland State University

Dr. Tsongas testified that the primary cause of moisture problems is construction defects allowing excessive water into the building envelope. This is especially problematic around windows, decks, and the interface between the concrete slab. Water intrusion can lead to building component decay, mold, and other damage.

Dr. Tsongas believes mandated use of rainscreen technology would significantly reduce excessive wetting behind the exterior cladding system. He also suggested a number of code changes that would reduce the probability of water intrusion occurring in the first place. The greatest source of problems is around windows, and he suggested a number of steps to improve window installation and flashing techniques including training and certification.

Slab-on-grade construction can lead to a number of problems from moisture wicking from the soil through the concrete. In addition, the first year or two following new construction concrete needs to dry out. Dr. Tsongas suggested a number of code changes and enforcement actions to mitigate these problems.

Lastly, excessive indoor moisture can lead to mold growth. Mold growth requires abnormally high relative humidity (at least 80%) which are primarily caused by localized wetting or cold temperatures. Dr. Tsongas suggested a number of code changes to improve the ventilation of kitchens and baths (a prime locations for high relative humidity).

### Dr. Achilles Karagiozis, M.Sc., Ph.D., Senior Research Engineer - Oak Ridge National Laboratory

Dr. Karagiozis central thesis is that a safety factor needs to be incorporated into the design of the wall assembly. There are a growing number and sophistication of building materials to choose from. The designer's role is to select materials that not only meet the aesthetic and code requirements, but also take into account the climatic conditions and appropriate safety factor.

Dr. Karagiozis presented a wealth of information regarding our current understanding of the building science. While the science behind it is very complex, we now have computer models which have been validated with actual field results that can be used to predict the moisture load on the building envelope and its subsequent performance.

This computer model was used in a recent study in Seattle that predicted the moisture content of 35 different wall assemblies based on the material properties of the wall assembly and micro-climatic conditions. These walls were then ranked according to their relative performance on a mold growth index. Computer modeling can be used to screen out poorly matched designs and to quantify the amount of forgiveness a particular wall system has.

Additional Suggestions:

- Incorporate building science principles in training and education of designers, contractors, and inspectors.
- Require manufacturers to provide material properties so they can be fed into computer models.
- Develop a test facility to validate computer models and continue research.

John Lamb, Founder/Principal, Eric Hoff, Architect/Principal –  
Western Architectural – Building Science Consultants

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Mr. Lamb and Mr. Hoff's believe the current system lacks sufficient training and oversight. There is a lack of knowledge among architects and contractors about best practices related to the building envelope. In addition, no one inspects the flashing and waterproofing before it gets covered up. They confirmed previous presentations that roofing, windows, moisture barriers, and siding are particularly problematic.

Because of the growing complexity of the science and materials related to the building envelope, Mr. Lamb and Mr. Hoff suggested:

- A need exists for guidelines related to installation of building envelope components.
- Third-party inspectors who specialize in building envelopes be required to inspect the flashing and waterproofing before a home is finalized. Inspectors should be involved from design through completion. One concern they raised is how these inspectors will be regulated (licensed, training, etc.).

Joe Johnson, President, Johnson Construction Consulting

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Mr. Johnson echoed many of the comments of previous presenters in terms of the lack of standards for construction practices including installations especially in light of the growing complexity of materials. His presentation and suggestions focused on the following five areas:

- *Plans* – Building plans must address critical building envelope issues (e.g., window wrap, window/door pans, deck flashing, roof diverters) and should be reviewed during plan review. Project documentation should verify plans were followed by showing an “as built” condition.
- *Training and Certification* – Workforce skill level is a key issue. Contractors should be required to demonstrate knowledge of fundamental building envelope concepts as part of the existing licensing mechanism through CCB. In addition, training, and continuing education for front-line workers could be accomplished through some form of certification especially for sensitive components like window installation. Licensing/certification should require some form of practical demonstration.
- *Guidelines* – Develop performance guidelines and checklists for contractors. Coordinating the 30-50 individuals involved in a typically job would be facilitated by this step especially in the area of oversight and sequencing.
- *Maintenance* – A maintenance schedule should be disseminated directly to homeowners and, a Web site developed to present relevant, straightforward information targeted to homeowners.
- *Insurance industry practices* – Require a quality assurance/quality control plan and use audits, spot inspections, and annual review to verify implementation. Provide incentives to contractors through lower rates.