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Moisture Management:

Prediction of Response of Exterior Wall Elements to Climates

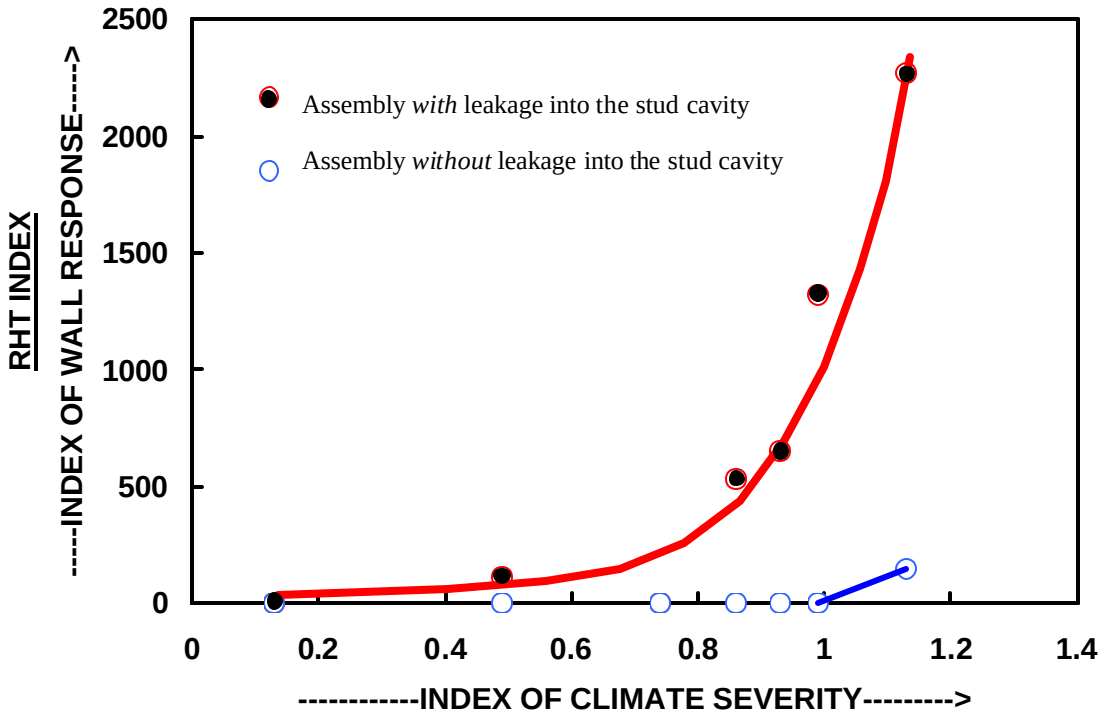
Effective moisture control by the building envelope has a direct impact on its service life. It requires both minimizing the entry of moisture into the system and maximizing the exit of any moisture that manages to enter, so that no element stays too wet for too long. In 1998, the National Research Council's Institute for Research in Construction (IRC) initiated a comprehensive research project to develop a method that would help product manufacturers and building designers to evaluate the ability of building elements and assemblies to effectively manage external moisture in any geographic location in North America. The project – called MEWS (Moisture Management for Exterior Walls Systems) – focussed on low-rise wood-frame wall assemblies with the following four cladding systems: stucco, EIFS, masonry and siding (wood and vinyl).

The project included the following tasks:

- review of current construction practices; this was done to select wall materials, assemblies and common deficiencies for investigation in the project.
- laboratory measurements of hygrothermal properties of materials.[1] These were required to provide input for the mathematical modelling of wall assemblies. From these measurements, a database of hygrothermal properties for 40 common building materials has been produced.
- development of an index to rate the severity of any outdoor climate based on annual precipitation (wetting potential) and relative humidity (drying potential). For example, Phoenix has a much drier climate than Ottawa and it is unlikely that a given wall assembly will behave the same way in these two locations.
- laboratory investigation of water leakage into 17 large-scale wall specimens exposed to water spray simultaneously with air pressures, simulating wind-driven rain. This was done to gain insight on the role of deficiencies in water penetration into walls. It determined how much water gets into the stud cavity of wall specimens with and without "planted" deficiencies, under a variety of environmental loads. This information was used in the mathematical modelling.
- investigation of mathematical models to predict damage to wood-based materials. This requires an understanding of the precise environmental conditions that lead to rotting of wood materials. Moisture levels and temperature histories of materials are some of the major elements in this regard.
- development of a numerical indicator of the severity of the moisture and temperature conditions a wall material is exposed to. This indicator was called the "RHT" index, as in Relative Humidity (RH) and Temperature (T). The index provides an indication of the duration *("how long*") and magnitude ("*how much*") of RH and T conditions above selected thresholds prevailing on a selected material within the wall assembly, once the wall is subjected to environmental loading (e.g., wind pressure, temperature and rain). The RH and T thresholds selected for the project were 95% RH and $5^{O}C$
- Computer simulations of over 400 wall assemblies with different material properties, subjected to actual climate loads recorded in seven North American locations, using IRC's advanced hygrothermal numerical model hygIRC. These simulations permitted

[1] Related to heat flow and moisture transport, such as thermal conductivity and water vapour permeability.

the researchers to compare the RH and T conditions prevailing at a selected location in the wall assembly, using the RHT index. The simulations assisted the researchers in predicting whether a given change in the material properties or in the assembly of the wall made some change in the hygrothermal response of the wall exposed to some climatic exposures of a wide range of severity. The figure below illustrates how the results can be expressed graphically.



Example of the predicted RHT response of a given wall assembly with and without leakage into the stud cavity (i.e. with and without deficiencies), as a function of the climate severity. The more severe the climate (the higher the value of the index on the X axis), the higher the "RHT" response (Y axis) for the wall with water leakage into the stud cavity.

The MEWS project will be completed this year. Reports will be posted on the IRC website at http://www.nrc.ca/irc/bes/mews/index.html as they become available. Several Construction Technology Updates (see current series at http://www.nrc.ca/irc/catalogue/ctu.html) will be produced in 2003 and technical information derived from this project will also be disseminated at conferences and seminars.

INDUSTRY PARTNERS

The following industry groups participated in the project: Louisiana-Pacific Corporation, Marriott International Inc., Fortifiber Corporation, EIFS Industry Members Association, E.I. DuPont de Nemours & Company, Canadian Wood Council, Canadian Fibreboard Manufacturers Association, Canada Mortgage and Housing Corporation, Forintek Canada Corporation, Masonry Canada, Canadian Plastics Industry Association.