MEMO: To Ian Holyoake, Managing Director HITEX
SUBJECT: REVIEW OF LITERATURE FROM BRANZ
Date: 24th Oct 2003
From: Ken Holyoake

At the HITEX visit to BRANZ on the 8th August 2003, BRANZ said there was a lot of literature available that showed that "a 20mm cavity works in Canada" and that "building walls were able to be dried out". At our request BRANZ provided a literature list and then hard copies of some of these papers to support their statements. Copies of some other papers were obtained from the BRANZ Library. My review of the literature received follows.

REVIEW OF BRANZ SUPPLIED LITERATURE

(1) **History**: There are detailed resumes of the historical development of building walls in both North America and Europe (ref 6). It moves through building papers, insulation, vapour barriers, and air tightness. There is little to no mention of cavities. There are a lot of lessons to be learnt, and then these lessons need to be applied to the much milder climate here in New Zealand.

(2) **Masonry and Stucco:** By far the most attention throughout the majority of papers is given to masonry walls and to a lesser degree stucco walls. For masonry walls it is important to vent the cavity, as they are sensitive to inward vapour drives. With an unvented cavity moisture contents rose to over 18% and over the threshold for corrosion and mould growth (ref 2).

(3) **Canadian Cavity Requirement:** There seems to be a legal requirement for a cavity in Canada, but its dimensions do not seem to be stipulated. BRANZ cite City of Vancouver 's 1999 Building By-Law (ref 16) saying there is an intent to require a rainscreen, and then BRANZ say that elsewhere in the By-Law there is description of a 19mm cavity. I have not seen this reference. In reviewing the papers provided, it would seem that the recommended cavity dimensions vary as follows:

Wall Type	Recommended Cavity Width	Notes
Masonry	40 to 50 mm	(Ref 2)
Stucco	20 mm	Requires vented cavity (Ref 8)
EIFS	No recommendations	(Ref 4) Some less than 10mm
Vinyl Siding	20 mm	(Ref 10). Requires vented cavity (ref 8)

(4) **Building Wall Engineering:** There are frequent statements that say that each building wall needs to be properly engineered for each specific building:

- For the specific climate.
- For the specific location.
- For the specific building materials used.

In Canada the climate varies from the moist and wet west coast to the very cold interior, and different solutions are required in different places.

For example compare a masonry and EIFS system. The cavity recommendations are different, the amount of moisture that gets into a masonry cavity is far greater than that of an EIFS system, and the insulation is placed differently. The totally different walls need specific engineering. Straube (ref 12) writes “each specific problem and situation requires a unique analysis based on scientific principles not just tradition and common practice”.

(5) **Minimum Cavity Size:** For an air space to act as a capillary break the minimum width of the airspace needs to be 4-6 mm as the surface tension of water will not allow water to span a gap greater than this (ref 10). Note that there is mention in some places of using a textile type drainage material that is only a few millimeters thick (ref 4) instead of an air gap, and the Canadians appear to allow this as well. Straube states (ref 10) that the size of an airspace must be over 12 mm if one wishes to allow for ventilation air flow.

(6) **Air Barrier:** The biggest point that arose from the literature review is the need for an air barrier system in the building envelope. This is different to a vapour barrier. The purpose of the air barrier is to minimize the movement of air through a building wall from the outside. This air movement or infiltration is identified as the biggest problem in allowing moisture to enter the timber wall cavity. The requirements for an effective air barrier are detailed in a number of references. Straube (Ref 15) states the following requirements must be met by the air barrier system:

- Continuity – through windows, doors, penetrations, corners, etc.
- Strength – Handle the full wind load.
- Durability – for its service life.
- Stiffness – to control air movement by pumping, and ensure permeance is not changed by stretching.

In Canada in low rise buildings, the air barrier can be either the interior gib board, a polyethylene vapour barrier underneath the gib board, a layer of particle board outside the timber wall, or a building wrap, and any building may have two air barriers. Note that some air barrier systems by their nature and location restrict the drying of the internal wall to the outside.

(7) **Air Barriers to be Pressure Equalised:** One of the performance criteria for an air barrier system is for it to be pressure equalized, and so minimize the amount of wind driven rain entering the cavity. There is a huge amount in the literature on the size, shape and location of the vents required to achieve pressure equalization, and this is mainly concentrated on masonry (Ref 3). Some researchers say the vents should be at the top and bottom to obtain air flow. Other researchers say all the vents should be at the bottom of the cladding. Then there appears to be a requirement to compartmentalize the cavity to sizes of less than 1 square metre to provide high levels of dynamic pressure moderation in the field. And at the end of all this, Straube (Ref 15) says that drainage and proper flashings are far more important than pressure moderation.

(8) **Venting Air Cavities for Drying:** Burnett and Straube (Ref 3) write that the air in the cavity of a masonry wall system is almost always warmer and more moist than the outside air. Thus venting of the cavity is essential for drying the moisture from a masonry system. They detail the European and Canadian approaches. They also say that excessive ventilation can bring moisture into the cavity. Note that this is very different from EIFS systems in which the cavity is always dry unless there is a leak, ie in the normal course of events, unlike masonry and stucco, the cavity does not get wet.

(9) **Insulation for Moisture Control:** Straube writes (Ref 12, 15) that one of the most powerful moisture control products is insulated sheathing. He says that any insulated sheathing provided on the exterior of framed structures will provide better protection against air leakage condensation in cold weather than no insulation. Note that this is what EIFS does.

(10) **EIFS Systems:** There is relatively little documentation on EIFS systems. Bomberg and Kumaran (Ref 4) detail the history of EIFS and detail four types of moisture management systems used. They say that the "vented screen system" was found by others not to satisfy criteria for pressure equalization, but more than adequately managed water under all conditions. They also say that not much is known about the drying ability of the wall system containing EIFS cladding. Straube (ref 10) writes on EIFS "In practice these (EIFS) systems experience rain control problems at joints, windows and other penetrations, not in the field of the wall. Hence, these joints should be designed as drained screens, preferably pressure moderated and never as perfect barrier face-sealed systems." In comment on this, the HITEX Diamond system has the rows of vents right along the bottom together with the diamond pattern, and these probably act as good pressure moderaters, provide good drainage, and as Auckland University and field reports show offer drying as well.

(11) **Drying of Actual Building Walls.** There is very little in the literature on drying of actual building walls. The only major reference is to a project in Ontario by the University of Waterloo in 1990-1992 (Ref 7) who built full scale test walls and monitored the drying of these. A variety of constructions were tested. The details of the drawings are not clear, but some are masonry and some are vinyl siding, some have cavities and some don't, and there are a variety of air barrier systems. The interior of the building was kept at 20ºC and 50% relative humidity. The results noted that by the end of the third year all the walls had dried out to a timber moisture content in the range of 10% to 13%. They say that "no significant mold or fungal growth was detected". There is little detail. One of the findings was "It is recommended that sheathing with thermal insulating properties be used in winter construction in southwestern Ontario to avoid frost and condensation problems." Further research is also recommended. There are warnings on moisture uptake, ie the reversal of the drying process. Note that none of the walls were deliberately wetted to simulate a physical leak into the timber wall cavity,

so it is thought that the research centred around construction moisture or at least the trend of the moisture content of the wood following lining.

(12) **Annual Building Envelope Conferences:** There are annual conferences in North America and Europe on Building Envelopes and Building and Science Technology. Each conference issues detailed proceedings with many papers with lots of good scientific and engineering information. It would be worthwhile reviewing these papers.

(13) **Summary**: Straube summarized everything very well in the following quote from one of his many papers (Ref 14) . On the topic of designing better walls, he writes: “Each specific problem and situation requires a unique analysis based on scientific principles not just tradition and common practice.” This emphasizes that a single solution such as a standard 20mm cavity for all wall types and situations is not the answer, and the Canadians recognize this.

(14) **Recommendation:** It is my belief that HITEX research is well advanced for EIFS. I suggest that HITEX makes contact with a number of these researchers and have them review the HITEX Research system and effectively peer review it. I suggest that the starting point would be J.F. Straube at the University of Waterloo. I also suggest that we ask him to appraise the wall designs currently proposed by the BIA.

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