

Relationship between Moisture Content and Mechanical Properties of Gypsum Sheathing

Alex McGowan, P.Eng.
Levelton Consultants Limited
Victoria, British Columbia, Canada

BC Building Envelope Council
Annual General Meeting
25 May, 2006



Acknowledgements

- Concordia University
 - Dr. Dominique Derome, Ph.D., arch
 - Adam Neale, B.Eng.
- Levelton Consultants Ltd.
 - Russ Riffell, P.Eng.
 - Denis Michaud, A.Sc.T.
 - Des Guo
- Canada Mortgage and Housing Corporation
 - Silvio Plescia, P.Eng.

Problem Statement

Not a criticism!

Diagnostics for existing buildings:

- Use and accuracy of hand-held meters
- Appropriate m/c levels
 - analogous to 19% and 28% in wood-based products
 - subsequent XO investigation is required!

New Construction

- inappropriate designs
- inadequate protection



Objectives

PHASE I

Assess effect of moisture-content levels in gypsum-based sheathing on mechanical properties :

- Facer delamination
 - (glass-fibre, treated paper or untreated paper)
- Resistance to fastener pull-through; and
- Flexural strength
 - seismic considerations
 - index of overall mechanical integrity

PHASE II

Determine if wetted gypsum can be rehabilitated

Phase I, part one

- Defining saturation moisture-content levels
 - remainder of project to be "% of saturation"
- Evaluating accuracy of handheld meters
 - Comparison to gravimetric
 - Recommend alternatives or adjustments to existing procedures if necessary

Figure 1. Saturation of Gypsum Sheathing

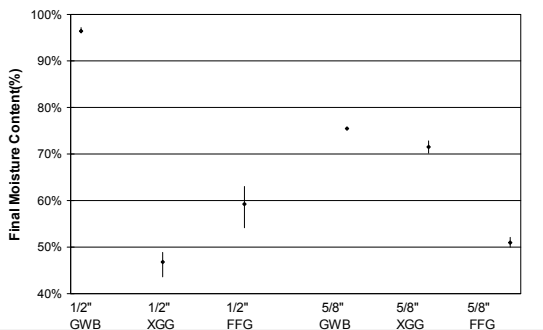
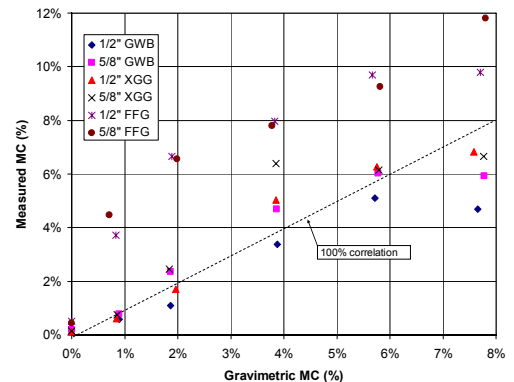


Figure 2. Moisture-meter Accuracy



Phase I, part two

- Fastener Pull-through Testing (ASTM C473)
- Flexural Strength Testing (ASTM C473)
 - Parallel vs. perpendicular
- Facer Delamination (Modified CSA A23.2-6B)

- All tests done on 1/2" and 5/8"
- GWB, XGG, FFG specimens
- 0%, 2%, 4%, 8% moisture content

Fastener Pull-through Tests



Fastener Pull-through Specimens

0%



2%



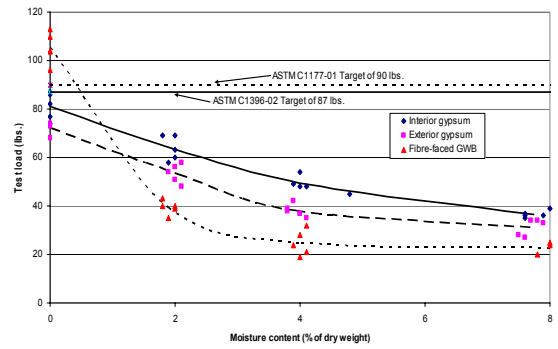
4%



8%



FIGURE 5. FASTENER PULL-THROUGH TESTS FOR 5/8" GYPSUM PANEL



Flexural Strength Tests



Flexural Strength Specimens

0%



2%



8%



FIGURE 10. FLEXURAL STRENGTH TESTS (PERPENDICULAR) FOR 5/8" GYPSUM PANEL

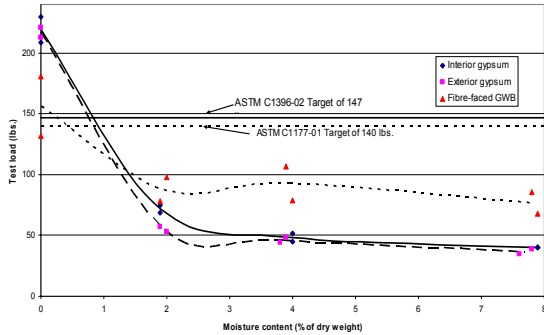
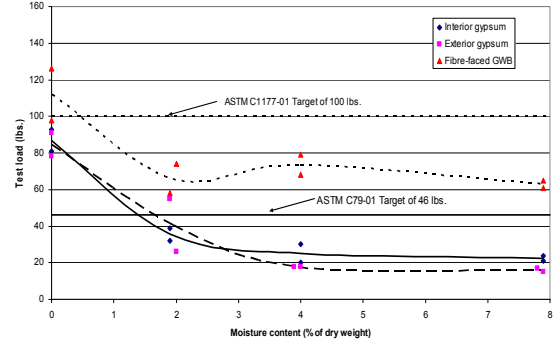
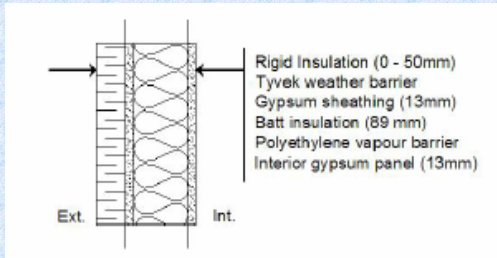


FIGURE 12. FLEXURAL STRENGTH TESTS (PARALLEL) FOR 5/8" GYPSUM PANEL



Phase I, part three

- Exposure to long-term humidity in environmental chamber
- Four panels tested (proof of concept)

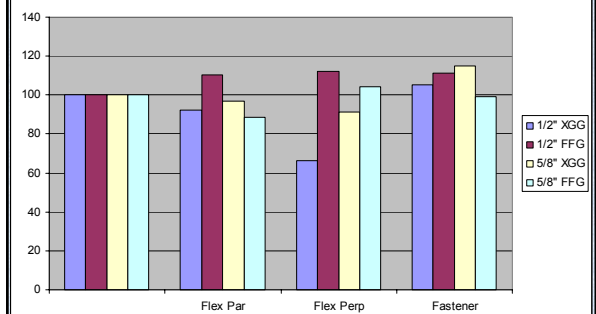
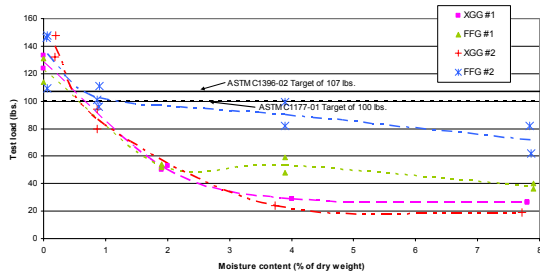


Phase II

Repeat testing protocol for:

- Flexural Strength Testing (ASTM C473)
 - Parallel vs. perpendicular
- Facer Delamination (Modified CSA A23.2-6B)
- 1/2" and 5/8" XGG, FFG specimens
- Pre-wet to 0%, 1%, 4%, 8%, 16%
- Test half, then oven-dry
- Test oven-dried specimens

FIGURE 5. FLEXURAL STRENGTH TESTS (PERPENDICULAR) FOR 1/2" GYPSUM PANEL.



Conclusions

- "% saturation" not practical
- handheld meters accurate to ~6% for paper-faced, 3-4% high for glass-faced
- facer delamination test gives no more information than fastener pull-through
- specimens all fall ASTM C1177 and C1396 above ~1% moisture content
- sheathing loses integrity at moisture content greater than ~4%
- C1177 and C1396 targets may require review
- Exposure to high-humidity levels can result in moisture contents of 8-10%
- Wetted/re-dried FFG specimens essentially recovered to their original values.
- Re-dried XGG sheathing recovered to ~94%, or 66% if facer adhesion was lost
- Resistance to fastener penetration unaffected in re-dried specimens
- 5/8" XGG sheathing took a long time to get wet, never dried out
- FFG specimens faster to take on water to the target values, faster to dry out
- Mould developed on all paper-faced samples; none on fibre-faced samples

Questions | Comments | Concerns

Relationship between Moisture Content and Mechanical Properties of Gypsum Sheathing

26 May, 2006