

## Chapter 5 – Summary and Conclusions

The objectives of this project were:

- To measure strength and stiffness performance of cyclic moisture conditioned connections.
- To determine the effect of cyclic moisture exposure on connection performance.
- To evaluate the accuracy of the general dowel equations for estimating yield of connections and to observe post-yield failure modes.

### 5.1 – Summary

- ‘Mill A’ connection performance was adversely influenced by cyclic humidity exposure. Overall, it appears that as cycling time progressed the connections increasingly deteriorated and weakened.
- ‘Mill B’ connections were not significantly weakened to a point where the performance was compromised, but instead a gain in capacity was seen because of thickness swell of the face layers.
- ‘Mill C’ connection performance demonstrated only small reductions in performance as the cyclic conditions continued. The de-densification of the OSB face layers contributed to more side member failures (Mode III<sub>s</sub>), but also enhanced capacity performance as unrecoverable thickness swell occurred.
- ‘Mill D’ connection performance was greatly influenced by the treatment of cyclic relative humidity exposure. For the most part, it appears that as cycling time increased the samples lost stiffness and swelled significantly, losing necessary nail-holding abilities. Mode III<sub>s</sub> yields were increasingly observed at failure as cycling increased.
- ‘Mill E’ connection performance was not significantly influenced, either positively or negatively, by cyclic humidity conditioning. The configuration proved to be highly resistant to moisture infiltration.
- ‘Mill F’ connection performance was not significantly influenced by prolonged cyclic humidity exposure. In general, the cyclic humidity exposure caused

minimal reductions in stiffness and yield of the connections. The maximum loads increased only slightly as unrecoverable thickness swell was minimal.

## 5.2 – Conclusions

- The thinner OSB materials ('Mill A', 'B', 'C', and 'D' connection groups) showed moderate to extreme changes in response to cycling. Unrecoverable thickness swell was significant.
- The thicker OSB material ('Mill E') performed favorably at each cycle test period. This is likely the result of a unique wax and resin composition used in the production of this particular panel product. Unrecoverable thickness swell was not significant.
- The plywood connections ('Mill F') performed similarly to the thicker OSB with little to no effect observed. Unrecoverable thickness swell was not significant.
- Comparisons to the yield model were similar to the control values, but usually differed as cycling increased.
- Post-yield failure modes were limited to Modes III<sub>s</sub> and III<sub>m</sub>. The occurrence of Mode III<sub>s</sub> failures increased as cyclic exposure increased.

## 5.3 – Limitations of Study

The boundaries placed on this project's design were mostly logistical in nature as the primary purpose was to impose the maximum exposure possible within the timeframe allowed.

Herein, forty dry-to-wet-to-dry cycles were accomplished in approximately ten months. Given that climate chamber space was limited and testing times were lengthy, there was little practicality seen in collecting and storing embedment samples from each component of each individual failed connection. As a result, embedment specimens were only evaluated in the control state (zero cycles). Only materials purchased locally were used. Efforts were made to select an array of panel and nail sizes, which represented the products easily accessible to contractors and homeowners, especially in the New River Valley region of southeastern Virginia. In another geographical area, different products may be available, but this study tries to covers a range of possible sheathing choices.

Furthermore, the materials involved are not inclusive of all species utilized for stud-grade lumber or wood-based composites.

#### **5.4 – Suggestions for Future Research**

- A similar project in which constant lateral loads are applied to the connection samples during relative humidity cycling.
- Develop a conditioning regime specifically designed to mimic a particular geographical location. Use aged samples from in-service structures to validate the results.
- Resolve contributions of end fixity in single-shear connections as the general dowel equations do not account for this effect.
- Perform bearing resistance tests on cycled, or aged, connection materials to better evaluate the general dowel equations.