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Creep Performance of SIPs

For Structural Insulated Panels (SIPs) used in roof and floor applications, designers must account for several different load cases. In addition to designing the SIPs to withstand gravity loads in transverse bending and to function as diaphragms to resist lateral loads from wind or seismic events, the designer must consider the effects of sustaining long-term duration gravity loads which contribute to creep. Creep is the continued deflection of a structural member under a permanent static load. Because creep can adversely affect otherwise acceptable designs, an understanding of the creep performance of SIPs is critical. Some SIPA member manufacturers address creep by limiting the permanent loads (sometimes referred to as dead loads) in their transverse bending load/span tables published in ICC-ES ESR code evaluation reports to not more than 50 percent of the total design load.

Industry-wide information on the creep performance of SIPs under long duration gravity loading is limited. To better understand the creep performance of SIPs under long duration gravity loading, a joint study sponsored by the USDA Forest Products Laboratory (FPL) and the Structural Insulated Panel Association (SIPA) was completed with the physical testing conducted at the FPL.

For this study, SIPs were evaluated to determine the creep performance of SIPs in a moment critical design situation. All test specimens used 7/16-inch OSB facers and an EPS foam core. The SIPs were first tested in static bending to failure to determine their short duration ultimate strength. To address the typical range in depths for SIPs used in these applications, 28 specimens were 12 inches wide by 12-1/4 inches deep by 19 feet long and the other 28 specimens were 12 inches wide by 6-1/2 inches deep by 10 feet long. The average maximum load at failure, Pmax, was used to determine a design creep test load based on Pmax/3 in accordance with accepted industry practice. Dividing ultimate strength by a factor of safety of 3 is the basis for establishing design loads for SIPs based on ICC-ES AC04 *Acceptance Criteria for Sandwich Panels.*

A matching set of 56 SIPs were instrumented to measure deflection and subjected to 90 days of constant static load using the test load of Pmax/3. They were then monitored unloaded for 30 days to assess deflection recovery. The testing was conducted under the general provisions of ASTM D6815 *Standard Specification for Evaluation of Duration of Load and Creep Effects of Wood and Wood-based Products* with the loads applied symmetrically about the center of the SIPs with a load span one-third of the total span. The results of this study are reported in FPL-RP-697 *Evaluation of Creep Performance of Structural Insulated Panels (SIPs)* and are summarized as follows.

The time/deflection curves for all specimens followed the general profile for wood-based products with no significant additional deflection observed after 90 days of loading. The average short duration ultimate strength of post-creep specimens vs. the initial control specimens was 90 percent for the 12-1/4-inch-deep SIPs and 100 percent for the 6-1/2-inch-deep SIPs, a result that indicates there was no significant loss in load capacity after the 90-day loading cycle. The creep deflection as a percentage of total deflection was approximately 25 percent for both SIP depths.

The initial elastic deflection recovery after removal of the long-term load as compared to the initial elastic deflection at the start of the creep test was 97 percent for the 12-1/4-inch-deep SIPs and 99 percent for the 6-1/2-inch-deep SIPs indicating full elastic recovery. The creep deflection recovery as a percentage of the creep test deflection when the applied load was removed and the

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SIPs were allowed to rest for 30 days with no load ranged from 50 percent for the 12-1/4-inch-deep SIPs to 60 percent for the 6-1/2-inch-deep SIPs. The total deflection recovery as a percentage of the total creep test deflection ranged from 82 percent for the 12-1/4-inch-deep SIPs to 90 percent for the 6-1/2-inch-deep SIPs. This indicates that the long-term creep deflection performance of the SIPs was representative of a partially elastic response.

These results are supported by the results of a previous study of the creep performance of SIPs sponsored by the FPL, APA and SIPA that used test loads that represented a range of loads from full design loads to one-third of the full design load as would be representative of dead loads only. In that study published as FPL-RN-0332 *Creep Behavior of Structural Insulated Panels (SIPs) Results from a Pilot Study* the test SIPs recovered 100 percent of their bending capacity and 80 percent of their creep deflection after the 90-day load cycle followed by a 30-day recovery period.

The National Design Specification (NDS) provides creep factors for designers to use to estimate the expected total long-term deflection of a bending member by multiplying the calculated dead load deflection by the creep factor and adding that to the short duration load deflection. These creep factors are 1.5 for lumber, glulam and SCL and 2.0 for wood structural panels (plywood and OSB). The results of the two FPL studies support the use of a creep factor of 2.0 for SIPs which utilize OSB as the facers.

The FPL reports referenced above can be downloaded at no charge from the FPL website (fpl.fs.fed.US) .

These and other test reports can also be downloaded from the SIPA website's technical resources.