COMPOSITE ACTION EVALUATION FOR MODERN PREFABRICATED WOOD I-JOIST FLOOR SYSTEMS

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ABSTRACT: This study investigated the flexural stiffness increase provided to pre-fabricated wood I-joist floor systems by using a range of modern sheathing fasteners and sub-floor adhesives to induce “composite action” between the joists and the wood structural panel floor sheathing. The sheathing attachment schemes evaluated included 8d common nails, three different proprietary sheathing fasteners, one solvent-based adhesive, one latex-based adhesive, and one foaming polyurethane adhesive. A total of 48 floor assemblies and their constituent materials were non-destructively stiffness tested as a means to evaluate the degree of composite action provided to the system by the sheathing-to-joist attachment.

KEYWORDS: prefabricated wood I-joists, composite action, floors, subfloor adhesives, sheathing fasteners

1 INTRODUCTION

The North American engineered wood products industry routinely relies upon the composite action provided by “glued-nailed” attachment of wood structural panel sheathing to prefabricated wood I-joist framing as a means to improve floor assembly stiffness and vibration characteristics [1]. Historical floor assembly testing and analysis [2,3,4] has been used to develop design guidance to account for the imperfect, partial composite action provided by glue-nailed attachment between the sheathing and the joists. It is typically assumed by the Wood I-Joist Manufacturer’s Association (WIJMA) membership that the glue-nailed sheathing-to-joist attachment provides 45% of the shear stiffness required to join the sheathing and joists into a series of rigidly attached composite “T” sections [1].

Sub-floor sheathing adhesive and fastening systems have evolved in the decades since the WIJMA composite action design guidance was developed. In many markets, latex-based “green” adhesives and foaming polyurethane adhesives have replaced the solvent-based subfloor adhesives that were once prevalent. In addition to a new generation of sub-floor adhesives, innovative sheathing fasteners have also been developed in recent years. These fasteners are sometimes marketed as superior alternatives to code-prescribed sheathing fasteners. In light of the higher lateral and withdrawal design values sometimes assigned to these proprietary sheathing fasteners, some manufacturers and builders have questioned whether they might be capable of providing the composite action of a glue-nailed floor without the expense and difficulty associated with installing sub-floor adhesive.

The objective of this study was to conduct a series of component and floor assembly tests with OSB sheathing and I-joist floor framing to compare the flexural stiffness increase provided by a range of modern floor sheathing attachment schemes to that of a traditional glue-nailed floor.

2 EXPERIMENTAL DESIGN

Composite action improves floor performance for a wide spectrum of floor sheathing and I-joist framing combinations. A sensitivity analysis was used to select the two floor assembly types evaluated in this study. The primary type combined a relatively flexible I-joist (241 mm deep with a small laminated veneer lumber flange), wide spacing (610 mm on center), typical residential floor sheathing (18.3 mm thick), and representative span (4.9 m). A limited number of similarly configured tests were also completed using 302 mm deep joists with larger, higher grade flanges.

A range of sheathing-to-framing attachment schemes were tested that included three different subfloor adhesive types, 8d common sheathing nails, and three different proprietary sheathing fasteners. All assemblies were constructed using a fastener spacing of 305 mm. Each floor assembly was non-destructively stiffness tested twice: once with tight tongue-and groove sheathing joints and once with gapped sheathing. While all of the assembly types were conducted using 4-joist floor systems, the glued floors with 241 mm
deep joists were also ripped down into three, two, and one-joist floors to investigate the impact of the test floor width on the measured composite action. All together, a total of 48 floor assembly stiffness tests were conducted.

3 METHODS

Prior to the floor assembly stiffness tests, the following component properties were measured using standardized test methods: joist flexural stiffness, sheathing axial stiffness and sheathing flexural stiffness in the weak orientation. Each component was tracked so that the actual component properties could be used to back-calculate the composite action achieved by each sheathing attachment type.

Figure 1 illustrates the typical 4-joist assembly test configuration which applied a single line load at mid-span of each floor. The floors were instrumented to measure the applied load, reaction, vertical mid-span deflection, and vertical deflection at each reaction.

4 RESULTS

Figures 2 and 3 summarize the results from the floor composite action assessment.

In these plots, the measured stiffness increases for the composite floor assemblies are provided relative to the constituent components. The degree of stiffness increase expected with the standardized 45% composite action is also illustrated for comparison purposes.

5 CONCLUSIONS

In general, tests conducted with 8d common sheathing nails and solvent or latex based subfloor adhesives consistently verified the 45% composite action factor assumed by the I-joist industry. Floor sheathing adhered with the foaming polyurethane subfloor adhesive performed with a lower degree of composite action. For the assemblies with 241 mm deep joists that had the most to gain from composite action, the proprietary sheathing fasteners typically provided less composite behaviour than an 8d common nail. When used without subfloor adhesive, the proprietary sheathing fasteners supplied significantly less composite action than that of a traditional glue-nailed floor system having solvent-based adhesive and 8d common nails.

REFERENCES