Abstract

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Effective Width of Insulated Sandwich Panels with Flexible FRP Shear Connectors Considering Partial Degree of Composite Action

Insulated sandwich panels consist of two layers of wythe separated by a foam insulation. Many different types of connectors have been used in the past to connect the two wythes, including steel ties, wire trusses, bent wires, truss-shaped connectors, and solid concrete zones. In recent years, fiber-reinforced polymer (FRP) materials, in both truss and mesh configurations, have begun to be incorporated as shear connectors, as they have a thermal conductivity about 14% that of steel, and can significantly reduce thermal bridging. Until now, there is no effective guidelines for the design of these panels. Generally, they are treated as rectangular beams, which is not reasonable since the longitudinal stress over the wythe section is non-uniform due to the in-plane shear flexibility of the wythe, which is called shear lag effect. Effective flange width has been used to describe the shear lag effect for a deck-on-girder composite beam system, reducing a three dimensional behavior of the composite beam system to the analysis of a T-beam section with a reduced width of deck. This paper extends the concept of effective flange width to insulated concrete sandwich panels. A shear lag model is initially developed to study the sandwich panel system, where partial Degree of Composite Action (DCA) due to flexible FRP shear connector is considered. The analytical model is then verified through close correlations between finite element and analytical results for a concrete sandwich panel with FRP shear connectors. Next, a parametric study is conducted using the analytical model to study the effects of deck stiffness and aspect ratio on effective flange width. Finally, a simplified method is proposed to calculate effective width.