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Composite Steel-Concrete Beams With Corrugated Steel Webs

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STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Master of Science in Structural Engineering.

The work included in this thesis has been carried out by the author in the department of Structural Engineering, Ain Shams University, from June 2015 to April 2018.

No part of this thesis has been submitted for a degree or a qualification at any other university or institution.

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ABSTRACT

Corrugated steel web beams are widely used in structural engineering applications, and are sometimes more preferred than the flat web steel beams especially in the slender web, due to their aesthetic appearance and high strength-to-weight ratio. In many cases, the maximum capacity of such beam is governed by the geometry of the corrugation profile. Merging a composite action with the accordion effect in one beam is considered as a modern technique of construction.

This research program investigates new composite steel-concrete beams with corrugated steel web. The research focused on composite beams of zigzag-corrugated web subjected to two-point loading flexure test simply supported.

The study includes a numerical model using finite element analysis, the model was verified against experimental results. FEM was carried out to investigate the behaviour of composite steel-concrete beams with corrugated web including local & global behaviours, and to examine a wide range of parameters such as the corrugation angle, corrugated web depth, panel width and thickness, in addition to concrete slab width. Results are presented in terms of load-deflection, load-concrete strain, load-steel strain plots and deformed shapes of girders at ultimate loads. The finite element model also investigates the effect of the corrugated web geometry on the strength, stiffness, and ductility. It was found that corrugated steel web enhances the efficiency of the composite steel-concrete beams.

Based on the research outcome, combining composite action with accordion effect is proven numerically to be an effective structure design technique. Panel width and corrugation angle affect largely on the buckling strength, stiffness, and ductility of beams. Effect of panel width on strength is cleared more in case of slender web.

A high buckling resistance could be reached at angles larger than 25° and at 60° the buckling could be prevented. From the analysis of the effect of corrugation on the ductility and stiffness, beams with corrugation angles range from 25° to 60° achieve maximum ductility and minimum rate of stiffness reduction. Larger corrugation width and depth, in view of bigger plate slenderness, has been observed to result in a drop in ultimate shear strength. It is, therefore, necessary to arrive at optimum values for the corrugation width and depth in order to achieve an efficient design. The study revealed also guidelines for the choice of the corrugated web geometry limited to the studied parameters. Effective concrete width is highly influenced by corrugation profile of the web.

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