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Improving the End Anchorage of Strengthened Steel I-Beams Using Locally Available CFRP Laminates

By

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STATEMENT

This thesis is submitted to the Faculty of Engineering, Ain shams University, as a partial fulfillment for the degree of Master of Science in Civil Engineering (Structural Engineering). The work included in this thesis was carried out by the author, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Abstract of the M.Sc. Thesis Submitted by
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ABSTRACT

Recently, application of carbon fiber reinforced polymer (CFRP) laminates for strengthening of steel beams has been of wide interest. However, flexural strengthening of steel beam by using CFRP usually suffers serious problems in the form of peeling and debonding at the end of the CFRP laminates.This is normally attributed to the very high stress and strain intensity that occurs at the end of the CFRP laminates. To overcome these problems, some researchers have investigated different techniques of end-anchoring for strengthened steel beams in flexure.

The main objective of this research is to study the effectiveness of different mechanical techniques of end-anchoring by using steel plates and bolts to improve the end anchorage of locally available CFRP laminates used for strengthening steel beams in flexure. Moreover, the mechanical efficiency of the locally available bonding materials used for strengthening steel beams has been investigated.

The experimental test program was designed to achieve the research objectives of the study. The experimental program consists of two phases: Phase one was designed to studythe mechanical efficiency of the bonding materials of three companies available in the Egyptian market through conducting a set of standard tests.

Phase two was designed to study the effectiveness of different mechanical end anchorages for steel I-beam strengthened with CFRP laminates using the optimal bonding material based on phase I results. Five steel I-beams were tested in flexure. The first beam was not strengthened and was used as the control beam. The second beam was strengthened by CFRP laminates without any end-anchorage. The three other beams were strengthened by CFRP laminates with three different mechanical end-anchorages using steel plates and bolts.

The results of the experimental program showed that the application of steel plates and bolts is an effective technique for CFRP end-anchoring of steel I-beams. Using end anchorage significantly improved the load carrying capacity of the steel I-beam. CFRP end anchorage decreased the deformation and strain of the whole beam including the vertical deflection, lateral deflection, and the tensile strain on the CFRP laminates. In addition, the mode of failure was more ductile instead of brittle and sudden failure.

Keywords: Mechanical end anchorages, CFRP laminates, Steel I-beam, Flexural strengthening, Deflection, Tensile strain.

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