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Strengthening of steel - concrete composite beams under load in a numerical and physical experiment

Abstract

The aim of the paper is to assess the effect of strengthening of a building construction under load. A simply supported, steel - concrete composite beam was investigated. Since a composite structure combines the advantages of typical steel and reinforced concrete structures, its strengthening methods inevitably involve technology used for steel and reinforced concrete structures. The study focused on strengthening through modifications of the cross - sectional area. Two cases were considered: extension of the compressed reinforced concrete part (a concrete overlay) and enlargement of the stretched steel section (sheet metal or a hot rolled profile welded to the bottom flange). The study examined how the given permissible stress limit affects the strengthening of a structure under load. Two possibilities were considered: the first one covered only the elastic range while the other enabled plasticity and redistribution of load between the strengthening and strengthened elements. Residual stress, observed as concrete shrinkage and residual welding stress, was analysed. Its effect on the load-bearing capacity, stiffness and displacement during and after reinforcement was presented.

The problem was examined in two ways. First, a numerical experiment was conducted in Abaqus environment. Second, a physical experiment was performed on large - scale technical models. Several next sections of the paper focus on experimental (numerical and physical) models, materials used in experiments, their numerical models, the effects of residual stress and experiments on welding of elements while under load conditions. The technical possibility of strengthening the beams and a method for optimum choice of strengthening element dimensions were discussed. The final section presents experimental investigations. Their results are compared to numerical data. A good structure of numerical models was confirmed by a good consistency of experimental and numerical results.

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