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Experimentally Comparative Study on Different Strengthening Methods of Reinforced Concrete Deep Beams

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Abstract

The aim of this study is to investigate the effect of strengthening reinforced concrete deep beams. An experimental study was done using six reinforced concrete deep beams have the same dimensions of 1150×800×150 mm, and subjected to mid-span concentrated load up to failure. Beams were different in the type, Location of strengthening and the ratio of reinforcement. Beams were divided into three groups. The first group included beams strengthened internally by single strut and either vertical or horizontal additional reinforcement. The second group included beams strengthened using double embedded strut or using CFRP as external strengthening. The third group included one beam strengthened using inclined stirrups. One of the specimens was tested without any strengthening and one specimen was strengthened by external CFRP sheets for comparison purposes the results of the experimental study shown remarkable improvement for using each type of strengthening. Results shown that using the mechanism of increasing stirrups by double rate and using single strut reinforcing is the optimum choice. This is due to the fact that this type of strengthening provides significant increase in the beam capacity in additional to the enhanced behavior of the beam. By this study comparison between each type of strengthening was done and the optimum type to be used in accordance with parameters of gained load capacity of tested deep beams.

Keywords: Strut and Tie; Inclined Stirrups; CFRP; Single Embedded Strut; Double Embedded Strut.

1. Introduction

Deep Beam is one of the most important structural elements used in the construction industry which has the ability to carry heavy loads in long spans. It has many applications such as high rise buildings and transfer girders. Nowadays strengthening of structural elements became an important issue. An Experimental study was done to investigate the effect of strengthening reinforced concrete deep beams internally and externally on the capacity of the beam section. The main parameters considered in this study were the type of strengthening whether adding single strut, double strut or inclined stirrups; and type of strengthening material whether steel or CFRP. All beams were subjected to mid-span concentrated load up to failure. Different ratios of steel bars and stirrups were used in the horizontal, vertical, and inclined directions to act as embedded strengthening struts. The results showed great improvement in the ultimate capacity of tested deep beams due to proposed strengthening methods and confirmed the ability to use CFRP sheets as external strengthening in case of retrofitting deep beams. A cost analysis was done in this research to calculate accurately

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