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Optimization by RSM of Reinforced Concrete Beam Process Parameters

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Abstract Reinforced concrete beams must have an adequate safety margin against bending and shear forces. Therefore, it will perform effectively during its service life. The aim of this work is to optimize the parameters of strength reinforced concrete beam, such as strength concrete, of stirrup spacing, and stirrup inclined presenting the techniques of characterization. An optimization of the reinforced concrete beam parameters was developed using the Response Surface Methodology (RSM). A flexural test was performed on reinforced concrete beam, and an empirical relationship was developed and used to predict the optimized strength reinforced concrete beam parameters.

Keywords: *reinforced concrete beam, stirrups spacing, shear, flexural, response surface methodology (RSM), mechanical properties*

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1. Introduction

Reinforced concrete beams are important structural elements; it will perform effectively during its service life only when there is sufficient safety margin against bending and shear forces. At the ultimate limit state, the combined effects of bending and shear may exceed the resistance capacity of the beam causing tensile cracks. The shear failure is usually sudden, without sufficient advanced warning [1]. Normally, the inclined shear cracks start at the middle height of the beam near support at approximately 45°and extend toward the compression zone. Any form of effectively anchored reinforcement that intersects these diagonal cracks will be able to resist the shear forces to a certain extent. In practice, shear reinforcement is provided in three forms; stirrups, inclined bent-up bars and combination system of stirrups and bent-up bars [2]. Noor et al. [3] presented several results of experimental investigation on six reinforced concrete beams in which their structural behavior in shear was studied. The research conducted about the use of additional horizontal and independent bent- up bars to increase the beam resistance against shear forces. The main objectives was to study the effectiveness of adding horizontal bars on shear strength in rectangular beams, the effectiveness of shear reinforcement, and determining the optimum amount of both types of shear reinforcement to achieve a shear capacity similar to that of a normal links system. From experimental investigation of the system, it was found that the use of independent horizontal and bent-up bars as shear reinforcement were stronger than conventional shear reinforcement system. Ahmed et al. [4] studied the effect of the size of specimen on the flexural tensile strength of concrete. They concluded that the concrete member size has a significant effect. They proposed an equation incorporating the effect of size of concrete for predicting the flexural tensile strength of concrete. Altun et al. [5] studied the mechanical properties of concrete with different dosage of steel fibers. Experimental tests indicated that beams with SF dosage of 30 kg/m^3 exhibited a remarkable increase in strength when compared to RC beams without steel fibers. The same study also showed that increasing the fiber dosage to 60 kg/m^3 adds only a small improvement to the beam toughness.

In present work, the aim is to optimize the parameters of strength reinforced concrete beam, such as strength concrete, of stirrup spacing, and stirrup inclined presenting the techniques of characterization. A flexural test was performed on reinforced concrete beam. An empirical relationship (RSM) was developed and used to predict the optimized strength reinforced concrete beam parameters.

2. Methods and Materials

2.1. Experimental Details

The details of the fabricated beams are shown in Figure 1. All beams were 200 mm of height, 150 mm of