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Deterministic Analysis of Strength and Ductility of High- Strength Concrete Columns

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ABSTRACT

The study of stress-strain behavior of high strength concrete confined by transverse reinforcement has been widely considered by various researchers. As a result, various stress-strain relationships regarding columns made of high strength concrete have been presented. Since each suggested model is based on a limited number of experimental data of a researcher, it has often a good prediction on its experimental results but not on other data. In this study, all available models and experimental data presented by other researchers in the field of strength and ductility of columns made of high strength concrete have been collected. Based on the results of these studies and applying Operations Research(OR), an appropriate model is suggested. It is shown that the proposed model in comparison with other models has a very good agreement with experimental results, by using deterministic analysis.

KEYWORDS

High Strength Concrete, Ductility, Confined Concrete, Concrete Column, Deterministic Analysis.

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1- INTRODUCTION

The development of concrete technology has increased the use of high-strength concrete (HSC) in the construction industry. With the improvement in concrete technology, concrete compressive strengths exceeding 100 MPa can easily be attained. Experimental research related to the behavior of high strength concrete members has increased significantly. However, with the availability of data on higher-strength concretes, the applicability of the code equations need to be reevaluated and the extrapolation of equations from lower strength to high-strength concretes needs more experimental verification. The experimental data on HSC columns still remains limited and the applicability of code equations to members made of HSC needs more experimental verification. Many researchers such as Sun and Sakino, [8], Cusson and Paultre [1], Kappos and Konstantinidis [2] and Razvi and Saatcioglu [4] indicated that both the strength and ductility of confined concrete increase with increasing volumetric ratio of ties. In one of the earlier studies, Saatcioglu and Razvi [7] stated that the passive confinement pressure generated by steel is directly proportional to the volumetric ratio of transverse steel. More importantly, Saatcioglu and Razvi [6] showed that for columns with constant volumetric ratios of transverse reinforcement, the behavior improved as the yield strength of the ties increased. The improvement was more pronounced in columns with lower concrete strength. For ductile behavior, columns with high strength concrete would require higher confining pressure. Therefore, a non-dimensional parameter, $s\ f_{yh}\ /\ f'_c$, called the mechanical ratio, which includes the variables discussed above would be more appropriate in evaluating the test data. In the previous studies, Nagashima et al. [3] and Saatcioglu and Razvi [6] showed that the deformation capacity increases with increasing mechanical ratio. According to these studies, the mechanical ratio of transverse reinforcement should be approximately 0.2 in order to obtain a ductile behavior. However, there is no explicit and unique definition of ductile behavior in these papers.

2- METHODOLOGY

The study of stress-strain behavior of high strength concrete confined by transverse reinforcement has been widely considered by various researchers. As a result, various models for stress-strain relationships regarding columns made of high strength concrete have been presented by many researchers such as Saatcioglu and Razvi [7]; Kappos and Konstantinidis [2] and Razvi and Saatcioglu [5]. Since each suggested model is based on a limited number of experimental data of a researcher, it often has a good prediction of its experimental results but not on other data. In this study, all available models and experimental data presented by other researchers in the field of strength and ductility of columns made of high strength concrete have been collected. Different parameters such as the shape of column section, the maximum strain, spacing and configuration of transverse reinforcement, concrete strength and the mechanical ratio $sf_{yh}\ /\ f'_c$ have been considered.

3- CONCLUSIONS

Based on the results of the study and applying Operations Research (OR), an appropriate model is proposed. By applying a deterministic analysis on the test results reported by other researchers, the proposed model is evaluated. As shown in figures 1 and 2, it is concluded that the proposed model has a very good agreement with experimental results by using the deterministic analysis.

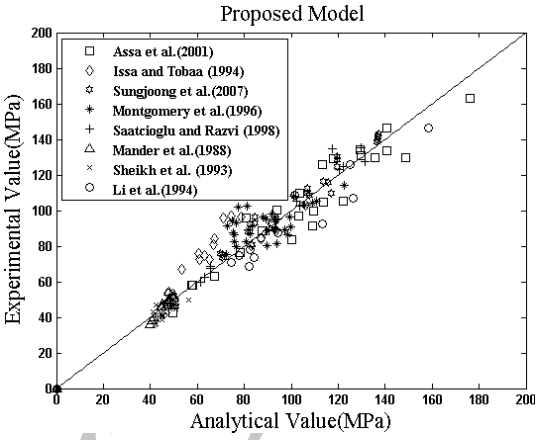

Fig. 1 Comparison between the proposed equation with different test results for confined concrete in circular columns

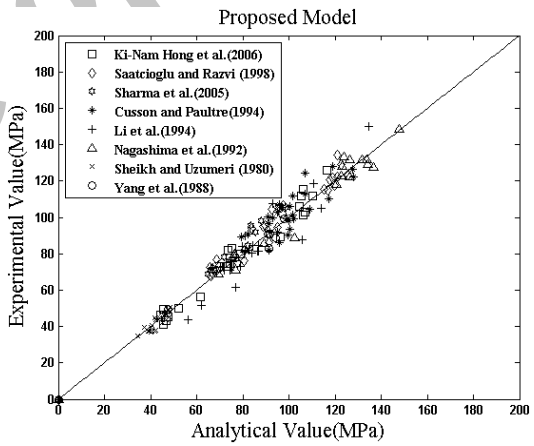

Fig. 2 Comparison between the proposed equation with different test results for confined concrete in square columns

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