Faculty of Engineering
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Optimum Design of Reinforced Concrete Continuous Beams System Using Genetic Algorithms

A Thesis

submitted in partial fulfillment of the requirements for the degree

Of

Master of Science

In

Structural Engineering

By

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B. Sc. In Civil Engineering, 2016.

Faculty of Engineering, Alexandria University.

2023

ABSTRACT

Producing a structural design that fulfills strength, serviceability and design code requirements with the least cost is the goal of every engineer. The present research aims to apply the Genetic Algorithms (GA) to get the optimum design of reinforced concrete floors consisting of slabs and beams. The considered floor system consists of main continuous beams supported on columns and carrying a secondary system that is either one-way slabs or slabs with secondary beams. The main beams have variable locations of internal supports. The design variables include the main beam spacing, the outer-to-inner span ratio, the effective main beam depth, and the type of the secondary system. The objective of the optimization problem is to minimize the total cost of the beams including their slab systems satisfying all the code requirements. The present study considers the provisions of the American Concrete Institute Building Code Requirements (ACI 318 – 19) and the Egyptian Code for Design and Construction of Concrete Structures (ECP 203 – 2018). This work employs the implanted GA in MATLAB global optimization toolbox. The GA parameters have been tuned before starting the optimization process to obtain the global minimum solution. Two cases have been investigated, the first case study explored a floor system with three-span main continuous beams, and the second one looked into a floor system with four-span main continuous beams. The impact of the ratio between the cost of steel per ton and that of concrete per cubic meter, and the applied live load on the optimal solution has been studied. A comparison between the optimal results according to the ACI 318- 19 and the ECP 203 – 2018 is presented.

The results of the present study showed that the cost of the slab represents (45 – 64) % and (51-67) % of the total cost of the system according to ACI 318 – 19 and ECP 203 – 2018, respectively. Therefore, it is of great importance to consider the slab system in the optimization process. Ignoring slab systems in the beam optimization process may drive misleading results. For the studied cases, increasing the live load from (2 to 10 kN/m^2) leads to decreasing the main beam spacing gradually from 2.89 m to 1.84 m and from 3.25 m to 2.125 according to ACI 318 – 19 and ECP 203 -18, respectively. The optimal solution for the present case study is always achieved using the one-way slab with the maximum main beam spacing that ensures a minimum slab thickness and reinforcement required by the employed code. When dealing with high live load of 8 and 10 KN/m^2 and low steel to concrete cost ratios of (20 to 30), it is preferred to use beams with equal spans. The ratio between the obtained optimum and minimum main beam effective depth according to codes flexural design requirements lies between (1.3-1.56) and (1.17-1.48) using to ACI 318 – 19 and ECP 203 -18, respectively.

ACKNOWLEDGMENT

First of all, I would like to praise Allah, the Most Gracious, and the Most Merciful for His blessings, strength, and power given to me during my study and in completing this thesis.

I want to express my deepest appreciation and gratitude to my supervisors, Dr. Hazem Mohamed Farouk Elbakry and Dr. Muhammad Ahmad Muhammad Diab for providing continual support, encouragement, guidance, and feedback throughout this research. Especially for the instructions and directions and invested time to fulfill this study. Thank you for your valuable guidance, generous help, and your great support and comments during my study.

There are no words that can describe my feelings and gratitude towards my dear family and friends. My ultimate thanks are dedicated to my father and role model Dr. Ahmed Tarabia for being my forever support and for my mother who has assisted me and Mourad a lot during my research. Special thanks to my second mother for supporting us. Last but not least, my huge thanks go to my partner Kamal El-Shafey and my son Mourad for your patience and support in finishing this work. I simply couldn't have done this without you.

Finally, I have a great expectation that my study will be beneficial for anyone interested in reading this final project.