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FLEXURAL SAFETY COST OF OPTIMIZED REINFORCED CONCRETE BEAMS

Mohammed S. Al-Ansari

Civil Engineering Department
QatarUniversity
P.O.Box 2713
Doha Qatar

ABSTRACT

This paper presents an analytical model to estimate the cost of an optimized design of reinforced concrete beam sections base on structural safety and reliability. Flexural and optimized beam formulas for five types of reinforced concrete beams, rectangular, triangular, inverted triangle, trapezoidal, and inverted trapezoidal are derived base on section geometry and ACI building code of design. The optimization constraints consist of upper and lower limits of depth, width, and area of steel. Beam depth, width and area of reinforcing steel to be minimized to yield the optimal section. Optimized beam materials cost of concrete, reinforcing steel and formwork of all sections are computed and compared. Total cost factor TCF and other cost factors are developed to generalize and simplify the calculations of beam material cost. Numerical examples are presented to illustrate the model capability of estimating the material cost of the beam for a desired level of structural safety and reliability.

Keywords: Margin of Safety, Reliability index, Concrete, Steel, Formwork, optimization, Material cost, Cost Factors.

INTRODUCTION

Safety and reliability were used in the flexural design of reinforced concrete beams of different sections using ultimate-strength design method USD under the provisions of ACI building code of design (1, 2, 3 and 4). Beams are very important structure members and the most common shape of reinforced concrete beams is rectangular cross section. Beams with single reinforcement are the preliminary types of beams and the reinforcement is provided near the tension face of the beam. Beam sizes are mostly governed by the external bending