Simplified Irregular Beam Analysis and Design

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Abstract

This paper presents simple method to estimate the strength design of reinforced concrete beam sections based on structural safety and reliability. Irregular beam shaped sections are commonly used nowadays in the construction industry. This study reveals the simplified method to analyze and design the different irregular shaped beam sections. In this study, the selected irregular beam shaped sections are divided mainly into three groups, beams with straight edges, beams with sloped edges and circular beams. Each group contains the most commonly used beam shaped sections in that category. Six beams sections (B-1 to B-6) are selected for group-1 whereas five beam sections (B-7 to B-11) and a circular beam section (B-12) are chosen for group 2 and 3 respectively. Flexural beam formulas for three groups of reinforced concrete beams are derived based on section geometry and ACI building code of design. This study also analyzed numerical examples for some of the sections in each group category using the proposed simplified method to determine the strength design of the irregular beams. The results obtained using simplified method for all of the three groups are compared with the finite element software (SAP v2000). The percentage difference of simplified method with the finite element software ranges within 5% to 10%. This makes the simplified method for irregular shaped beam sections quite promising.

Keywords: Reinforced Concrete Beams; Irregular Shaped Beam Cross Section; Circular Beams; Sloped Edged Beams; Internal Compressive Force.

1. Introduction

Beams are very important structure members and the most common shape of reinforced concrete beams is rectangular cross section. Safety and reliability are 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]. Lu et al. (1994) worked on the evaluation of time-invariant reliability for designing of reinforced concrete under ACI building code [2]. Their study concluded that the reliability indices are most critical to live load, uncertainties of models and the strength of materials. Investigation of the reliability of reinforced concrete beams for high rise buildings based on the New ACI 318-05/ASCE 7-05 are done by Baji et.al and their study indicates that the different limit states at the controlling stations are not consistent for low values of wind to dead load ratios [3].

Beams with single reinforcement are the preliminary types of beams and the reinforcement is provided near the tension face of the beam [4]. Beam sizes are mostly governed by the external bending moment Mc. The flexural beam formula for the rectangular shaped beam sections are derived in several books [5-6]. These also includes the detailed design of singly and doubly reinforced rectangular and T-shaped section beam sections. The analysis and design of irregular shaped sections are not illustrated in detail in these books. Several studies were also conducted on the design and analysis of irregular shaped sections subjected to flexure but are limited to certain shaped beam sections.