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Models for Evaluating Shear Strength on Members with Circular Cross Section

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Abstract

Solid circular columns are often used as structural supports in bridges, buildings and foundations due to their simplicity of construction and because their strength is similar in any direction. This deem them very suitable to resist wind and seismic loads. Hollow core circular concrete members are much less structurally used than solid circular cross sections. However, these can be found in concrete chimneys, concrete pipes and elevated water tanks, as well as in large bridge columns and offshore platforms. Codes do not usually propose specific formulations for evaluating the shear strength of such structural types or if they do, they do so in a very simplified manner.

Hence, an analytical model for evaluating the contribution of the transverse reinforcement in concrete members of solid and hollow circular cross section is presented in this paper. After a thorough bibliographic research on the previous studies on the matter, the shortage of work accomplished on the topic has been assessed and the unsolved problems identified. A formula for evaluating the shear transferred by spiral reinforcement in solid members is presented. A formula for the calculation of hollow core circular columns with both vertical and spiral reinforcement is also deduced. Assumptions made for the calculation of this formulation have been deduced theoretically and then checked empirically. Hence, shear tests on circular hollow core specimens will be also presented.

Keywords: circular members, shear truss analogy, circular cross section, reinforced concrete

1. Introduction

Even though shear transfer mechanisms are qualitatively well known, there is no agreement on the quantification of the shear strength of concrete members. Qualitatively, most of the researchers and codes [1, 2, 3, 4] state that the shear strength V_{Rd} of a beam is the combination of the contribution of the concrete (V_{cRd}) and the contribution of the shear reinforcement if present (V_{sRd}). V_{cRd} takes into account the shear stress transferred by the compressed zone of the element, the dowel action, the aggregate interlock and the arch effect. Its actual value depends on many factors such as the tensile longitudinal steel ratio, concrete grade, aggregate size or shear span, among others. Its evaluation is very controversial and always relies, somehow, on empirical methods. As the value of V_{sRd} can be easily calculated with rational models, such as the truss analogy proposed by Ritter (1889) and Moersch (1902), research focuses on the elaboration of methods for an accurate evaluation of V_{cRd}.

Traditionally, codes [1, 2, 3, 4, 16] have proposed empirical formulae for evaluating V_{cRd}, drawn from tests performed mainly on beams with rectangular