DEVELOPMENT OF DESIGN GUIDANCE FOR CIRCULAR REINFORCED CONCRETE COLUMNS INCORPORATING CRACK WIDTH

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The maximum crack width of Reinforced Concrete (RC) structures should be controlled for satisfying the serviceability and durability requirements of the civil engineering structures. Therefore, care must be taken at the initial design stages for maintaining the possible crack widths within a permissible range which has been specified under the design standards. However, the crack width analysis of RC structures is not easy because of the complexity of the parameters which affect the crack width. If crack width calculation is skipped, the width of the cracks in real concrete structures can be larger than the maximum limiting allowable value. Circular RC columns and piles are widely used structural components in modern civil engineering construction projects. As an example, circular RC piles and columns can be seen in many expressway construction projects in Sri Lanka to support viaduct structures. The main aim of this research is to develop design guidance for circular RC columns to estimate the crack width. In the Sri Lankan construction industry, there is no specific simplified guidance in terms of charts and tables for crack width estimations of circular RC columns. Hence, it is important to develop such design guidance for circular RC columns. Although there are a variety of applications of circular RC columns in the industry, this research deals with the crack width analysis of circular RC columns in straight viaduct sections. A comprehensive study was carried out regarding the behaviour of the cracks in circular RC columns in viaduct sections as per the design standard, BS 5400. Autodesk Structural Bridge Design software was used to perform crack width estimations, and MIDAS Civil software was used to do the Finite Element (FE) analysis and validation process. The crack width can be estimated to a 0.01 mm accurately by using the charts developed in this research. This design guidance is simple to understand, and use. Hence, engineers can perform their preliminary crack width estimations with less effort using correctly specified methods. Crack width estimation charts were developed for both uniaxial bending and biaxial bending cases of short circular RC columns with a diameter of 1.5 m, C 25/30 concrete, a nominal cover of 45 mm, and the main rebars all of the same diameter. According to the parametric study done for the circular RC columns subjected to uniaxial bending, the following details were found. Crack width reduces with increasing bar diameter and number of main rebars. Crack width is low in the columns with high-grade concrete. When the ratio of Mq/Mg as defined in BS 5400 is decreased, the crack width also decreases. A significant variation of the crack width can be seen in the cases where, the ratio, Axial load (ULS)/(Column diameter)^2 is in the range of 0.5 to 2.5 N/mm^2. The width of the crack is significantly higher in the case of having higher bending moments with low axial forces. This research can be extended to develop design guidance for estimating the crack width following latest standards such as Eurocodes and produce more charts by accounting for the requirements of the design engineers. The comprehensive design charts developed in this research will be useful in estimating the crack widths in circular RC columns without the need to follow time-consuming methods. Therefore, the findings of this research will be helpful to enhance the efficiency of the design work.

Keywords: design surface crack width; reinforced concrete; circular columns; finite element method; viaduct structures

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