Short-term deflection of RC beams using a discrete rotation approach

ABSTRACT

Quantifying the deflection of RC beams has been performed traditionally using full-interaction moment–curvature methods without considering the slip that takes place between the reinforcement and the surrounding concrete. This was commonly carried out by deriving empirically based flexural rigidities and using elastic deflection equations to predict the deformation of RC structures. However, as flexural and flexural/shear cracks form in RC beams with increase in applied load, the reinforcement steel begins to slip against the surrounding concrete surface causing the cracks to widen and ultimately increasing the deflection at mid-span. Current design rules cannot cope directly with the deformation induced by the widening of cracks. Because of that, this study focused on predicting the non-time dependent deflection of RC beams at both service and ultimate limit states using a mechanics-based discrete rotation approach. The mechanics-based solution was compared with experimental test results and well-established code methods to which a good agreement between the results was observed. The method presented accounts for the non-linear behavior of the concrete in compression, the partial-interaction behavior of the reinforcement, and the deflection was computed while considering the rotation of discrete cracks. Due to its generic nature, the method presented does not require any calibration with experimental findings on the member level, which makes it appropriate to quantify the deflection or RC structures with different types of concrete and novel reinforcement material.

Keyword: Reinforced concrete; Partial-interaction; Size-dependent concrete properties; Concrete softening; Moment-rotation; Discrete rotation deflection