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Concept of a Pseudo-Lower Bound Solution for Reinforced Concrete Slabs

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Abstract : In construction industry, reinforced concrete (RC) slabs represent fundamental elements of buildings and bridges. Different methods are available for analysing the structural behaviour of slabs. In the early ages of last century, the yield-line method has been proposed to attempt to solve such problem. Simple geometry problems could easily be solved by using traditional hand analyses which include plasticity theories. Nowadays, advanced finite element (FE) analyses have mainly found their way into applications of many engineering fields due to the wide range of geometries to which they can be applied. In such cases, the application of an elastic or a plastic constitutive model would completely change the approach of the analysis itself. Elastic methods are popular due to their easy applicability to automated computations. However, elastic analyses are limited since they do not consider any aspect of the material behaviour beyond its yield limit, which turns to be an essential aspect of RC structural performance. Furthermore, their applicability to non-linear analysis for modeling plastic behaviour gives very reliable results. Per contra, this type of analysis is computationally quite expensive, i.e. not well suited for solving daily engineering problems. In the past years, many researchers have worked on filling this gap between easy-to-implement elastic methods and computationally complex plastic analyses. This paper aims at proposing a numerical procedure, through which a pseudo-lower bound solution, not violating the yield criterion, is achieved. The advantages of moment distribution are taken into account, hence the increase in strength provided by plastic behaviour is considered. The lower bound solution is improved by detecting over-yielded moments, which are used to artificially rule the moment distribution among the rest of the non-yielded elements. The proposed technique obeys Nielsen’s yield criterion. The outcome of this analysis provides a simple, yet accurate, and non-time-consuming tool of predicting the lower-bound solution of the collapse load of RC slabs. By using this method, structural engineers can find the fracture patterns and ultimate load bearing capacity. The collapse triggering mechanism is found by detecting yield-lines. An application to the simple case of a square clamped slab is shown, and a good match was found with the exact values of collapse load.

Keywords : computational mechanics, lower bound method, reinforced concrete slabs, yield-line
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