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A two-yield-criteria limit analysis approach for steel-reinforced concrete slabs

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In the framework of reinforced concrete (RC) structures, ductile behaviour, which is an essential requisite for applying limit analysis theory, is guaranteed by the confining effect of steel reinforcement bars (re-bars) which mitigate many complex post-elastic phenomena (i.e. fracturing or damaging mechanisms), thus making a limit analysis approach both applicable and effective. On the other hand, at ultimate limit state yielding of steel re-bars might occur for under reinforced RC elements. In such circumstances the RC elements fail in a more ductile manner, despite the brittle nature of plain concrete. In these cases steel re-bars play a significant role in determining the plastic behaviour of the RC element as a whole.

In the present work a limit analysis methodology, recently developed by the authors and successfully applied to RC elements (see [1], [2]), is further refined for a better modeling of the post-elastic behaviour of steel and concrete. In particular, to deal with possible steel bars yielding at incipient collapse a FE formulation is adopted, where concrete is described by the Menétrey–Willam-type yield criterion endowed with cap in compression, and steel re-bars are handled by a von Mises-type yield criterion. This modification seems more adequate to describe the limit-state solution of RC elements as it considers simultaneously both the plastic behaviour of concrete and of the yielded re-bars. The reliability of the promoted methodology is verified by comparison between numerical results and experimental findings on large-scale RC slabs tested in laboratory [3].

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