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Design of non-linear slope profiles to prevent road-related landslides

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The majority of natural slopes manifest non-linear profiles such as concave and convex. However, many artificial slopes such as for open cast mines, embankments and cuttings are designed with linear profiles. Theoretical studies based on upper bound limit analysis suggest that such linear profiles neither maximise stability nor minimise erosion. Alternative profiles such as S shaped can improve stability by up to 49% for the same average inclination. Re-profiling of road-cut slopes and artificial embankments to their optimal non-linear profile for stability has great potential as a cheap measure to increase the safety of a slope enough to prevent several landslides. This re-profiling would be feasible for road cuttings in soil (rather than rock) and would allow increased mechanical stability for cuttings of the same average depth, meaning no additional space is required. After a failure occurs, in constructing the optimal profile for remediation, less debris has to be removed as it can be used in the re-profiling. Here we extend the theoretical work using limit analysis and numerical modelling to further constrain the shape of optimised stability non-linear slope profiles and its changes with the addition of different environmental conditions (e.g. seepage). The upper bound limit analysis formulation can compute the stability factors for slopes of any arbitrary shape. To assess the behaviour of optimal profiles under various common hydrogeological conditions, Finite Element (FE) Method seepage analysis is run followed by stability analysis using a FE strength reduction technique.