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A DISCONTINUITY TRACKING ALGORITHM BASED ON ASSUMED ENHANCED MODES

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Numerical methods for predicting localized shear failure in elasto-plastic solids have experienced considerable achievement in the last decades and they are by now well developed. Among these approaches, the so-called "embedded" strong discontinuity method is often successfully used to accurately simulate the post-localization response with negligible dependence on the finite element discretization. However, it can be remarked that the employed discontinuity tracking strategy plays a crucial role in the successful localization analysis. This consideration applies to both the approaches using embedded discontinuity methods and extended finite elements.

Available discontinuity tracking algorithms are typically based upon local criteria for the discontinuity formation and direction. These relations are frequently obtained from a bifurcation analysis of the continuum model. The so-called "propagation" strategies [2] have proven to be effective for discontinuity tracking in 2D problems. In these algorithms, the discontinuity is progressively activated at the local level by means of element-wise segments, preserving its continuity across the common boundaries of traced finite elements. However, the extension of these algorithms to 3D problems is often difficult, motivating element traversing approaches based on the level set method as well as strategies involving the solution of a global elliptic problem [2] or using the so-called "strain injection" technique [3].

In this contribution, we propose a different strategy for global tracking of the discontinuity surface. It is based on exploiting information obtained from the enhanced modes employed in Assumed Enhanced Strain formulations [4, 6]. With respect to standard finite

elements, it has been shown that these enhanced strain element formulations methods are able to better capture localized shear deformations. These result can be explained as a consequence of the improved performance in bending [5]. We observed that the approximation of the strain jumps delimiting the shear band is connected with a deformation field characterized by opposite bending curvatures across these two discontinuities. Hence, in view of the relations existing between the kinematics of strong and weak discontinuities [2], we formulate a proper scalar function of the enhanced modes as the surface of potential strong discontinuity.
We remark the global character of this proposed novel approach, evaluating discontinuity surfaces which are continuous by construction through the elements, with a negligible computational cost. Furthermore, the proposed method employs the discontinuity orientation provided by the assumed enhanced strains, which is likely to be more accurate than the stress-based direction used in existing tracking path algorithms.
Finally, to illustrate the performance of the new tracking algorithm we employ it in combination with available strong-discontinuity formulations [1] to simulate representative problems involving strain localization.

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