

## Simulation of Strong Tangential Discontinuity for XFEM Shear Band Evolution

**A.R. Daneshyar**

School of Civil Engineering, University of Tehran, Tehran, Iran, a.daneshyar@ut.ac.ir

**S. Mohammadi**

School of Civil Engineering, University of Tehran, Tehran, Iran, smoham@ut.ac.ir

**Key Words:** *extended finite element method, shear bands, strain localization.*

### ABSTRACT

The shear band is a thin region of high sheared materials, which is developed during severe plastic deformation of solids. Once a shear band takes place, the region within the band undergoes considerable large plastic shear straining which leads to fracture. The outside region, however, behaves in an almost rigid manner. As a result, a clear slipping of two sides of this region in the opposite directions can be observed.

Numerical simulations of shear bands with conventional finite element formulation are fraught with serious difficulties. Shear bands cannot be accurately captured because of the directional dependency of finite element approximation, so the band is forced to follow predefined directions such as the element edges or diagonals. Furthermore, the width of the shear band is far smaller than the characteristic dimensions of the structure, so it decreases with the mesh refinement. Therefore, the classical finite element method suffers from severe mesh dependency in the analysis of shear bands.

This paper presents a strong tangential discontinuity formulation for shear band formation and propagation in the formwork of the extended finite element method (XFEM). Shear banding is associated with material instability which can occur in a plane with nearly zero plastic moduli. As a result, the loss of stability of the boundary value problem is used as a criterion for shear band initiation and its direction. This paper introduces a new enrichment function for the shear band by adding the tangential extra degree of freedom to the classical finite element nodal displacements. This enables the elements to deform freely along the band direction. A proper traction-separation law is used to capture the real phenomena. This helps the model to simulate the dissipated energy within the band in the plastic deformation procedure and reproduces the correct fields in its vicinity. Finally, examples of shear band development are presented to demonstrate the capabilities of the proposed method.