

Shear band reflection from a rigid boundary

Andrea Nobili¹, Enrico Radi², Davide Bigoni³

¹*Dipartimento di Ingegneria "Enzo Ferrari", University of Modena and Reggio Emilia, Italy*
E-mail: andrea.nobili@unimore.it,

²*Dipartimento di Scienze e Metodi dell'Ingegneria, University of Modena and Reggio Emilia, Italy*
E-mail: enrico.radi@unimore.it,

³*Dipartimento di Ingegneria Civile, Ambientale e Meccanica, University of Trento, Italy*
E-mail: davide.bigoni@unitn.it

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A widespread opinion in the community of researchers working in the area of mechanics of materials is that shear bands are reflected by a rigid boundary. This opinion is based on some experimental results and a few numerical computations. However, whether this reflection may indeed be predicted theoretically, and which rules it follows remains an open question. Through the derivation of a new Green's function, valid for a prestressed elastic half-space with its straight boundary rigidly constrained, it is shown that shear bands are indeed reflected (see Fig. 1). Besides, reflection does not follow the usual Snell's law and, instead, shear bands maintain the inclination dictated by the constitutive equations of the material. This result, obtained within an incremental formulation [1] (valid for an incompressible elastic material deformed in plane strain), surprisingly leads to a closed-form solution and is illustrated with the J_2 -deformation theory of plasticity, designed to mimic the behavior of metals. Our results pave the way to new applications in the realm of wave guiding metamaterials that are capable of material instabilities.

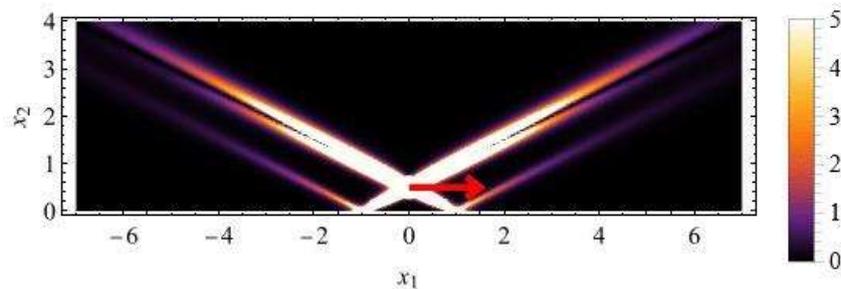


Figure 1: Strain distribution under a horizontal unit force.

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References

- [1] Radi, E., Bigoni, D., Capuani, D. (2002) Effects of pre-stress on crack-tip fields in elastic, incompressible solids. *International Journal of Solids and Structures*, **39**:3971–3996.