

**Muratov, R. V.; Kudryashov, N. A.; Ryabov, P. N.**

**A finite volume method for numerical simulations of adiabatic shear bands formation.**  
(English) [Zbl 1468.74076](#)

*Commun. Nonlinear Sci. Numer. Simul.* 101, Article ID 105858, 16 p. (2021).

**Summary:** The aim of this paper is to develop an effective finite volume method for numerical simulation of the adiabatic shear bands (ASB) formation processes. A formation of ASB happens at high-speed shear strains of ductile materials. A numerical simulation of such problems using Lagrangian approach is associated with some problems, the main one of which is a mesh distortion at large deformations. We use Eulerian approach to describe a motion of the non-linear elasto-plastic material. More specifically, we consider a modification of a well-known hypoelastic Wilkins model. In this paper we suggest a numerical method for modeling of high-speed shear deformations on two-dimensional meshes. The method is verified on the three test problems suggested by other authors.

**MSC:**

**74S10** Finite volume methods applied to problems in solid mechanics

**74C15** Large-strain, rate-independent theories of plasticity (including nonlinear plasticity)

**Keywords:**

large strain elastoplasticity; Wilkins hypoelasticity; strain localization; infinite slab; finite volume method; Eulerian formulation

**Software:**

LS-DYNA

**Full Text:** [DOI](#)

**References:**

- [1] Schneider, J.; Nunes, J. A., Characterization of plastic flow and resulting microtextures in a friction stir weld, *Metall Mater Trans B*, 35, 777-783 (2004)
- [2] Seidel, T.; Reynolds, A., Visualization of the material flow in AA2195 friction stir welds using a marker insert technique, *Metall Mater Trans*, 32A, 2879-2884 (2001)
- [3] Rogers, H. C., Adiabatic plastic deformation, *Annu Rev Mater Sci*, 9, 283-311 (1979)
- [4] Wright, T. W.; Ockendon, H., A scaling law for the effect of inertia on the formation of adiabatic shear bands, *Int J Plast*, 12, 927-934 (1996) · [Zbl 0889.73021](#)
- [5] Molinari, A., Collective behaviour and spacing of adiabatic shear bands, *J Mech Phys Solids*, 45, 1551-1575 (1997) · [Zbl 0974.74560](#)
- [6] Walter, J. W., Numerical experiments on adiabatic shear band formation in one dimension, *Int J Plast*, 8, 657-693 (1992)
- [7] Khoei, A. R.; Gharehbaghi, S. A.; Tabarraie, A. R.; Riahi, A., Error estimation, adaptivity and data transfer in enriched plasticity continua to analysis of shear band localization, *Appl Math Model*, 31, 6, 983-1000 (2007) · [Zbl 1211.74201](#)
- [8] DiLellio, J. A.; Olmstead, W. E., Numerical solution of shear localization in johnson-cook materials, *Mech Mater*, 35, 571-580 (2003)
- [9] Batra, R. C.; Kim, C. H., The interaction among adiabatic shear bands in simple and dipolar materials, *Int J Eng Sci*, 28, 9, 927-942 (1990)
- [10] Batra, R. C.; Kim, C. H., Adiabatic shear banding in elastic-viscoplastic nonpolar and dipolar materials, *Int J Plast*, 6, 127-141 (1990)
- [11] Li, S.; Hao, W.; Liu, W. K., Mesh-free simulations of shear banding in large deformation, *Int J Solids Struct*, 37, 48-50, 7185-7206 (2000) · [Zbl 0995.74082](#)
- [12] Nesterenko, V. F.; Meyers, M. A.; Wright, T. W., *Collective behaviour of shear bands* (1995), Elsevier Science: Elsevier Science Amsterdam
- [13] Nesterenko, V. F.; Meyers, M. A.; Wright, T. W., Self-organization in the initiation of adiabatic shear bands, *Acta Mater*, 46, 327-340 (1998)
- [14] Wilkins, M. L., *Computer simulation of dynamic phenomena* (1999), Springer-Verlag: Springer-Verlag Berlin, Heidelberg;

New York · [Zbl 0926.76001](#)

- [15] Udaykumar, H. S.; Tran, L.; Belk, D. M.; Vanden, K. J., An Eulerian method for computation of multi-material impact with ENO shock-capturing and sharp interfaces, *J Comput Phys*, 186, 136-177 (2003) · [Zbl 1047.76558](#)
- [16] Stein, E.; Ruter, M.; Ohnimus, S., Adaptive finite element analysis and modelling of solids and structures. Findings, problems and trends, *Int J Numer Methods Eng*, 60, 103-138 (2004) · [Zbl 1060.74642](#)
- [17] Hallquist, J. O., LS-DYNA theory manual (2009), Livermore Software Technology Corporation
- [18] Liu, G. R.; Liu, M. B., Smoothed particle hydrodynamics: a meshfree particle method (2003), World Scientific: World Scientific Singapore · [Zbl 1046.76001](#)
- [19] Cleary, P. W.; Prakash, M.; Das, R.; Ha, J., Modelling of metal forging using SPH, *Appl Math Model*, 36, 8, 3836-3855 (2012) · [Zbl 1252.74009](#)
- [20] Howell, B. P.; Ball, G. J., A free-Lagrange augmented Godunov method for the simulation of elastic-plastic solids, *J Comput Phys*, 175, 128-167 (2002) · [Zbl 1043.74048](#)
- [21] Schoch, S.; Bates, K. N.; Nikiforakis, N., An Eulerian algorithm for coupled simulations of elastoplastic-solids and condensed-phase explosives, *J Comput Phys*, 252, 163-194 (2013) · [Zbl 1349.74346](#)
- [22] Wilkins, M. L., Calculation of elastic-plastic flow, *Methods Comput Phys*, 3, 211-263 (1964)
- [23] Kudryashov, N. A.; Ryabov, P. N.; Zakharchenko, A. S., Self-organization of adiabatic shear bands in OFHC copper and HY-100 steel, *J Mech Phys Solids*, 76, 180-192 (2015)
- [24] Kudryashov, N. A.; Muratov, R. V.; Ryabov, P. N., The collective behavior of shear strain localization in dipolar materials, *Appl Math Comput*, 338, 164-174 (2018) · [Zbl 1427.74009](#)
- [25] Kudryashov, N. A.; Muratov, R. V.; Ryabov, P. N., On collective behavior of shear bands in dipolar HY-100 steel and OFHC copper, *AIP conference proceedings*, 2116, 270008-1-270008-4 (2019)
- [26] Tillotson J.H.. General Atomic Report. GA-3216; 1962.
- [27] Dobrev, V. A.; Kolev, T. V.; Rieben, R. N., High order curvilinear finite elements for elastic-plastic Lagrangian dynamics, *J Comput Phys*, 257, 1062-1080 (2014) · [Zbl 1351.76057](#)
- [28] Kulikovskii, A. G.; Pogorelov, N. V.; Semenov, A. Y., Mathematical aspects of numerical solution of hyperbolic systems (2001), Chapman and Hall · [Zbl 0965.35001](#)
- [29] Zhou, F.; Wright, T. W.; Ramesh, K. T., The formation of multiple adiabatic shear bands, *J Mech Phys Solids*, 54, 1376-1400 (2006) · [Zbl 1120.74355](#)
- [30] Batra, R. C.; Liu, D., The formation of multiple adiabatic shear bands, *J Appl Mech*, 56, 527 (1989)

This reference list is based on information provided by the publisher or from digital mathematics libraries. Its items are heuristically matched to zbMATH identifiers and may contain data conversion errors. It attempts to reflect the references listed in the original paper as accurately as possible without claiming the completeness or perfect precision of the matching.