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Strain incompatibility as a source of residual stress in welding and additive manufacturing.
(English) [Zbl 1476.74026](#)

Eur. J. Mech., A, Solids 85, Article ID 104147, 9 p. (2021).

Summary: The accumulation of residual stress during welding and additive manufacturing is an important effect that can significantly anticipate the workpiece failure. In this work we exploit the physical and analytical transparency of a 1.5D model to show that the deposition of thermally expanded material onto an elastic substrate leads to the accumulation of strain incompatibility. This field, which is the source of residual stress in the system, introduces memory of the construction history even in the absence of plastic deformations. The model is then applied to describe the onset and the progression of residual stresses during deposition, their evolution upon cooling, and the fundamental role played by the velocity of the moving heat source.

MSC:

[74F05](#) Thermal effects in solid mechanics

[74K10](#) Rods (beams, columns, shafts, arches, rings, etc.)

[74C99](#) Plastic materials, materials of stress-rate and internal-variable type

Keywords:

welding; elastic rod; residual stress; strain incompatibility; thermal expansion

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

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