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Numerically Computing Dislocation Segment Stress Fields in Anisotropic Elastic Media Using Angular Dislocation Stress Factors and The Stroh and Integral Formalisms

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The numerical simulation of the behavior of large numbers of dislocations in deformable solids is now well-documented. Inclusion of the effects of elastic anisotropy is possible, since the underlying framework for such computations has been available in the literature for almost forty years. The simplest method of accounting for dislocations of rather arbitrary shapes is to approximate the dislocation loops as polygonal loops, not necessarily planar, composed of straight dislocation segments. Thus, the elastic field of any particular loop is merely the sum of the fields of its segments, and the segment fields become the essential building blocks of the computations. These segment fields may be computed using elastic Green's functions (Mura, Willis and Steeds), definite integrals (the integral formalism of Swanger, Barnett, and Lothe), or matrix methods (the formalism of A. N. Stroh).

In this work we give a brief introduction to the integral and the Stroh formalisms and compare implementation of these methods to the construction of the fields of infinite straight dislocation lines, finite dislocation segments, polygonal dislocation loops, and even differential dislocation segments. Within the context of the integral and the Stroh formalisms, it turns out that the key ingredients required for dislocation segment field construction are the so-called angular dislocation stress factors which appear in what is now known as the Lothe-Brown-Indenbom-Orlov theorem; thus we devote some effort to acquainting the audience with this beautiful field theoretic structure, which appears not to be well-known either inside or outside the dislocation community. Ultimately, of course, the user determines the method by which his or her computations should be done, and this talk is to acquaint the audience with the methods available toward that end, as well as the accuracy and numerical efficiency one can expect to achieve. We remark that it is indeed true that the field of a dislocation segment is non-unique, in that any quantity which sums or integrates to zero around a complete loop may be added to each segment field; this presents no real problem and, in fact, offers the user a useful choice of segment formulae to adopt.

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