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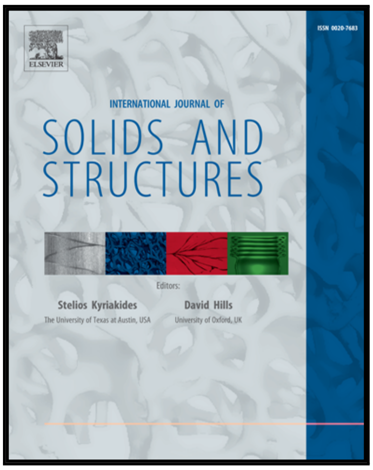

Solution of half-plane contact problems by distributing climb dislocations

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Solution of half-plane contact problems by distributing climb dislocations

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Abstract

We derive a novel method for addressing half-plane contact problems by using distributions of climb dislocations over the contact patch to balance the relative overlapping profile of the contacting bodies. Using this technique, we are able to forgo inverting a singular integral equation, simplifying the analysis. We illustrate the method by deriving the associated contact pressures, external forces and applied moments for several examples of both symmetric and non-symmetric indenters.

1 Introduction

The standard way to solve contact problems is to write down a formulation based on the surface displacements caused by a unit normal force applied to the surface, and then to use this as a Green's function so that the bodies may be made to conform over a region (the contact patch) while the contact pressure is in equilibrium with the external normal load [1]. If the contact initially conforms, for example in the case of a complete contact, an alternative strategy is to start with a domain which is the combination of the two bodies, and to analyse the internal state of stress subject to the applied loads as if the interface was continuous and everywhere adhered. If both (a) the direct traction across the interface line is everywhere negative, and (b) the ratio of the magnitude of the shear to direct traction is everywhere less than the coefficient of friction then the solution already found is, indeed, correct. However, if there are local regions of violations of these conditions - for example if there are regions where the traction ratio exceeds the coefficient of friction, then by using the solution of a glide edge dislocation in the combined bodies it is easy to insert extra tangential displacements to represent the effects of slip and to restore the Coulomb (for example) friction condition. Equally, if there are also regions of interfacial tension, climb edge dislocations may be inserted to relieve the tension and permit separation. One property of an edge dislocation in plane form is that it is Volterra in character and so one does not need to be worried about the line of the path cut which was used to form it: it may always be assumed to lie along the contact interface.

Here a form of this idea is applied to *incomplete* contacts. We assume that the contacting bodies are sufficiently large to be approximated by half planes, and that they are made from the same material so that the effects of direct and shear loading are uncoupled. We solve the normal contact problem alone (we have recently looked at the corresponding tangential loading/slip problem [2, 3]). Suppose that we bring together the two half-planes and bond them over a region $[-b\ a]$, which will become the contact patch. We now insert climb dislocations within that interval whose Burgers vectors sum to form the profile of the bodies actually brought into contact but are of opposite sign. Provided that there are no regions of tension within the putative contact, nor regions of interpenetration external to it (that is, the Signorini conditions hold), we will have solved the contact problem correctly.