

Plastic Flow and Fracture in a Torsionally Stressed Planetary Sphere

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Communicated by G. TEMPLE

1. Introduction. The present study is applicable to an analysis of fracture and flow in planetary bodies [1, 2]. The method of analysis follows closely that initiated and developed by T. Y. Thomas [3] and which has been applied by Sadia M. Makky [4] to a comparable problem of plastic flow and fracture in a round bar under pure torsion.

2. Surfaces of stability and instability. Following Thomas, we define a discontinuity $[v]$ in the velocity over a surface in a continuous medium to be a slip discontinuity if its normal component is equal to zero, *i.e.*

$$(2.1) \quad [v_i]v^i = 0,$$

where the $[v]$ are the components of the discontinuity and the v^i are the components of the unit normal ν to the surface. A surface over which a slip discontinuity exists, or is assumed to exist, is called a *slip surface* and results from a simple slip of the material particles over the surface Σ bearing the discontinuity, *i.e.* we must have $v_n = \bar{v}_n = 0$ where v_n and \bar{v}_n are the normal velocities on the two sides of the surface.

A fixed surface Σ is called a *surface of stability* if every slip discontinuity $[v]$ over Σ is damped out, *i.e.* if $[v_i] \rightarrow 0$ as the time $t \rightarrow \infty$, as a consequence of the equations governing the behaviour of the medium and the conditions of the problem under consideration, *e.g.* boundary and natural symmetry conditions. In particular the surface Σ is also referred to as a *surface of stability* if we must necessarily have $[v_i] = 0$ under the conditions of the problem.

If Σ is not a surface of stability it is said to be a *surface of instability* and over such a surface there must exist the possibility of a slip discontinuity $[v]$ which will not be damped out. If this slip discontinuity can be chosen so that at least one of the quantities.

$$(2.2) \quad [v_i] \rightarrow \pm \infty, \quad \text{as } t \rightarrow T,$$