Internal fractures in paraboloids of revolution due to stress wave focusing

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Abstract. Internal fractures in paraboloidal and hyperboloidal solids, subjected to explosive loading at the focus, are investigated. The initiation and growth of the fractures are associated with the focusing effect of P and S wavefronts reflected from the curved boundaries. The speed with which an axial fracture grows depends upon the geometry of the surface of the solid. Whilst, for example, it is finite in a hyperboloid of revolution, it is infinite in a paraboloid of the same general dimensions and material.

1. Introduction

The subject of spallation of bars and scabbing in plates due to stress wave reflection is well documented in the literature. Much work has been carried out on stress wave reflection from flat boundaries and, in consequence, the investigations were mainly concerned with fractures produced due to tensile stress produced by either the reflection of a single wavefront, or the interaction of two or more reflected wavefronts. Many examples of such work may be found in Johnson (1972), Rineheart and Pearson (1954), Kolsky (1963) and Al-Hassani *et al* (1972). Work concerned with fractures due to stress wave focusing, however, is rather meagre. Focusing of waves usually occurs as a result of reflection from or transmission across across a curved boundary.

The present authors have been studying the phenomenon of stress wave focusing in solids for the past few years. Studies on the internal fractures produced in a Perspex sphere subjected to localised shock loading at one pole have shown that by using the ray theory, commonly used in optics and acoustics, it was possible to predict the positions and extent of the internal fractures. In a sphere, the curved surface causes an incident spherical compressive stress wave to be reflected as tensile and shear waves, with their rays focusing in the interior of the sphere. At the locus of the foci of the reflected dilatational (P) and 'equivolumnal' shear (S) waves, the stresses become too high for the material to withstand. Consequently, fractures are produced on the surface which contains the locus of the focal points. For further experimental details on the effect of stress wave focusing on spheres, see Lovell *et al* (1974) and Silva Gomes *et al* (1976); for the application of the ray theory to study the fractural behaviour of spheres, see Silva Gomes and Al-Hassani (1977).

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