MODEL STUDY OF SEISMIC EFFECTS
OF EXPLOSIONS IN PRESTRESSED MEDIA

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Seismic effects of explosions in two-dimensional prestressed models are investigated. This study differs from the conventional two-dimensional modeling in two aspects: (1) the medium is prestressed in uniaxial tension and (2) small amounts of chemical explosives are utilized to generate the seismic energy. This energy consists of the combined contributions of the energy in the explosion and the strain energy released from the existing strain field due to cavity formation. Model materials, Plexiglas and aluminum, were chosen on the basis of their widely different elastic properties and physical behavior. Cylindrical charges were detonated and the resulting seismic waves were detected either by capacitance pickups of SR-4 dynamic strain gages. These detectors were positioned so as to detect motions representitive of one full quadrant.

Plexiglas and aluminum sheets subjected to static loading exhibited a definite anisotropic effect, but this effect was not large enough to affect wave propagation in the range of the tensile loads applied.

An explosion in a prestressed medium releases a portion of the stored strain energy by one or more of the following mechanisms: (1) formation of directional cracking, especially in brittle material such as Plexiglas, (2) release of strain energy in the elastic zone outside the cavity and (3) rupture propagation. Phenomena associated with all of these mechanisms are observed in the present investigation; however, emphasis is placed on the first two mechanisms.

Straight and branching modes of moving cracks initiated from the explosions in prestressed Plexiglas are explained from the view point of stress distribution ahead of the crack tips.

Explosions in prestressed Plexiglas produce directional cracking, the intensity of which increases with the applied static stress; however, explosions in prestressed aluminum sheets exhibit no fracturing but rather plastic deformation about the explosion source.

Observed radiation patterns resulting from explosions in prestressed media indicate asymmetrical radiation fields which are a direct consequence of strain energy release for the case of aluminum and by the combined effects of directional cracking and energy release for the case of Plexiglas. Press and Archambeau's theory on the strain energy release is applied to estimate the magnitude of energy release due to the insertion of a cavity. The observed S-wave magnitude increases sharply with the level of the existing stress field for a given amount of strain energy release. This phenomenon is attributed to the effective conversion of energy release to seismic radiation at high stress fields. The effectiveness of S-wave generation if governed by the rapidity with which the existing strain energy is released. Thus, an additional factor representing the rate of energy release, which in turn depends upon the intensity of stress field, must be taken into consideration. An empirical relationship for S-wave amplitudes is obtained in terms of the energy release and the intensity of stress field using experimental results.