CIRCULATING ELASTIC WAVES

ON BOREHOLES AND CAVITIES

by

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Summary

This thesis records an investigation into the circumferential propagation of elastic waves on boreholes and underground openings in rock.

Four approaches to the problem have been attempted:

(1) A theoretical analysis of the problem, starting with the development of a solution method for extracting the zeros (normal modes) of the frequency equation for surface waves on concave surfaces. This method is then extended to a Fourier-Bessel solution for the dynamic response of a borehole excited by a line-source acting on the bore-hole wall.

(2) A numerical model of the bore-hole response to a line-source based on the Dynamic Finite Element Method (DFEM).

(3) Small scale experiments in the laboratory on a 0.15m diameter bore-hole in a large granite block. Circumferentially propagating pulses were generated using piezo-electric elements bonded to the borehole wall. Frequencies were generated in the range 0 - 50kHz. Spectral ratio methods were used to obtain the bore-hole wall transfer functions and modal behaviour.

(4) Full scale experiments on test cross-sections of headings (tunnels) in underground mining environments. A shaker system was used for excitation with swept-sine input covering the frequency range 0 - 2kHz and, as in the laboratory experiments, spectral ratio methods were used for tunnel wall response.

Comparisons are made with the results of all four methods, in particular, the agreement between the analytical and DFEM methods is good. However, the experimental results, although reproducing the salient features of the theoretical approaches, reveal the inadequacies of the idealised models.

Declaration

I certify that the substance of this thesis has not already been submitted for any degree and is not being currently submitted for any other degree.

I certify that any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

A.F.Siggins

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