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Research article

Analytical solution of the explosion-induced wave propagation in rock using elastodynamic theory

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English Extended Abstract

Summary

In this study, an analytical solution has been introduced to solve the explosion-induced wave propagation phenomenon in rock using elastodynamic theory.

Introduction

The explosion of explosives in the blast-hole can apply very high pressure to the surrounding rock media. The pressure can cause to propagate cracks and fractures and eventually fragment and destroy them. Rock blasting, like other dynamic phenomena, needs to propagate waves and dynamic stresses through the body. Therefore, the study of the propagation of waves is of great importance in understanding the subsequent effects of rock blasting. For this purpose, an analytical algorithm is used to obtain the appropriate Green functions to achieve the best description of the problem. To solve the blast-induced wave propagation problem.

Methodology and Approaches

A two-dimensional elastodynamic Green's function has been analytically derived. Firstly, Navier's equations of motion and explosion equations have been used as governing equations. Then, using the Helmholtz theory, the Navier equations have been separated into two scleral and vector fields in terms of displacement. Explosion pressure as a body force has been added to the equations using the Poisson function. After performing the relevant calculations and solving the above equations, the corresponding Green function in terms of displacement is obtained. Moreover, a time-dependent green function is developed for the particle velocity using the basic functions and the resulting green function. After finding the appropriate Green functions, a typical problem consisting of a blast-hole in an elastic homogenous isotropic infinite rock media has been investigated and modeled. Finally, to validate, a real problem has been analytically modeled and solved using the proposed solution.

Results and Conclusions

Its results have been compared with results from a finite element-discrete element numerical method and the explosion reality results. Based on the results of the comparison, there is a good agreement between the analytical, experimental, and numerical results at different distances from the blast-hole. A good match between the analytical results of this study and the experimental and numerical results of previous studies shows the validity of the proposed method and confirms the Green function obtained in this study. In general, it can be said that this method can be used to study the propagation of elastic waves in rock and rock-like materials. Also, it can be utilized from the resulting Green functions in other methods for different purposes as an input dynamic function.

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