Abstract

Elastic wave theory has been widely applied in many engineering fields. Meanwhile, with the development of material science, designing and producing composite materials with wave propagation properties becomes possible which is not easily achieved by traditional materials, which makes the research of wave propagation in inhomogeneous media a hot issue in the field of theory and engineering. Moreover, defects and structures with depression or convex on the surface are very common in natural media and artificial materials, while local defects or structures often cause wave scattering and affect wave energy distribution. Excessive aggregation of forces often leads to increased deformation or stress concentration for material failure. Therefor investigating the scattering by surface depression or convex in inhomogeneous media is of theoretical significance and practical engineering valueace. Based on the elastic wave theory, this thesis researches elastic waves scattering by surface depression and convex on the surface of the radially continuous inhomogeneous media with variable wave velocity and density by using the complex function method and emphatically analyzes the influence of the existence of the depression or convex on the surface and internal displacement distribution of the inhomogeneous media.

In this thesis, the complex function method is employs to transform the wave equation of the radial inhomogeneous media with density, and the standard Helmholtz equation that is available directly solved analytically is acquired, thus the expressions of the incident wave field and the scattering wave field in the semi-infinite space could be obtained. Meanwhile, the scattering wave field expression of SH wave in the semi-infinite space from the surface semi-cylindrical depression is ably constructed. By calculating the surface and inside displacement amplitude distribution under the action of various parameters, the influence of various parameters on the displacement distribution is discussed, and the surface depression amplification effect on the displacement distribution under the influence of inhomogeneous parameters is emphatically analyzed.

Considering the influence of surface convex on the dynamic response, this thesis investigates scattering SH wave by the surface convex and surface convex with cylindrical cavity in a density radially inhomogeneous media. The research region is

divided into suitable sub-regions which could be applied to construct wave field expressions by utilizing the region-matching technique (RMT) and the auxiliary boundary. Based on the surface depression scattering problem, the wave field expressions in each sub-region are constructed. Through the boundary conditions at the auxiliary boundary and the free boundary, the wave field expression in the whole research area is solved. The distribution of displacement amplitude and dynamic stress concentration coefficient under the action of various parameters are given. The influence of surface convex on the distribution of displacement amplitude and dynamic stress concentration coefficient (DSCF) under different inhomogeneous parameters is mainly analyzed.

Subsequently, the effect of research region range on the displacement amplitude of the surface under elastic wave incidence is considered, and the dynamic response to SH waves is demonstrates for two forms of density inhomogeneous wedge with vertex angle as cusp and cylindrical depression. The vertex angle is taken to be in the range from 0 to 2pi , which can describe a variety of region forms. Based on the acquired standard wave governing equations, the analytical solution of the free wave field expressions in the inhomogeneous wedge space is proposed based on the free boundary conditions at both boundaries and the Sommerfeld radiation conditions. Then, the scattering wave field expressions in the wedge region are constructed based on the previous research of surface depressions. The effects of inhomogeneous parameters on the displacement amplitudes inside the surface and wedge regions are calculated and discussed for the forms of cusp and cylindrical depressions at the vertex angle, respectively.

In addition, the finite element method (FEM) based on the Carrera Unified Formulation (CUF) framework is extended to the analysis and application of elastic wave problems in three-dimensional models in semi-infinite space. The Fortran program self-compiled by MUL2 is expanded to complete the establishment of artificial boundary, input of external waves, and research on wave propagation in layered media.