The present situation of the research on SH-wave in the past 2 decades

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Abstract

Scattering of SH-wave by an elastic half space is an active field in earthquake engineering. The conceptual framework and researching program of the past 20 years were introduced briefly in this article. Besides, scattering theory was reviewed. This report related to the study of SH-waves scattering in different landform including hills, canyons, linings, cracks and some kind of complex topography in the nearest 2 decades as well as a short summarize of the job of predecessors in this field.

Keywords: SH-waves

1 Introduction

The study of elastic wave has past almost 200 years since 1987. The foundation of the field was held by a sum of mathematicians. The primary research was started from 1821 to 1887. Fresnil was the first give the explanation to polarization phenomenon. Then the successful application of classical elastic wave theory in earthquake engineering field open the prologue to the scholars. Because of the announced use of elastic wave in the second world war since 1939, the study of elastic wave became activity. The scattering of elastic wave in dynamic half infinite length crack in 1948. Mauc and Dc-Hoop study the elastic wave scattering in infinite length crack respectively in 1953 and 1958. Increasingly, from 1978 to 1984 the issues of the scattering of elastic wave of many kinds of crack was come over by Achenbeach's leading. Pao and Mow make a summarization of research methods in this period, which are wave function expansion method, T matrix method, integral equation method and Match the gradual method. Many achievement were got in the mid late 20th century application of elastic wave in multiple layer media, in elastic-plastic media, infirmo viscosity media, infirmo elastic media and many other complex medias. Great achievement have been made in scattering of elastic wave in interlamination media as well as the media contains crack, elastic cylindrical inclusion or some other conditions. The study of elastic wave in survness situation has a primary achievement.

In the past 20 years, the theory of elastic wave get into actively in earthquake engineering. SH wave is one kind of elastic wave, whose wave form would not change when come up with boundary or hinder like P wave and SV wave. As a result, more achievements have been got than SV and P wave. SH wave is more suit in dealing with complex land form. The great answers are concentrated as follows. Then the achievements will be discussed as follows.

2 Scattering of SH-wave in hills and canyons and some complex landform

It is one of the most basic issue of earthquake to study the influence of different landform to the movement of land. The landform in the nature can be divided into hills and canyons briefly. The research methods to SH wave in the earthquake are numerical method and analytical method. The numerical is widely used in the scientist as well as engineering work, but it has less precision in compared with analytical method. The study of scattering of SH-wave in different land form in analytical method is actively and prosperous.

Trifunic was first do the research of scattering of SH-wave in different landforms in analytical method in 1973. Because of the difficulties in mathematic, the research on scattering of SH-wave advanced hardly long before wave function expansion method got developed and the partition method was discovered by LIU Diankui and some other scholars in the late 20th century. Presently, the scattering of SH-wave theory was developed deeply in the follow sides.

2.1 The influence of hills and canyons to the scattering of SH-wave

As a unique kind of landform, the research to the scattering of SH-waves in hills is always a remain a active position. The analytical method is based on the division idea in doing the research. A hill with an arc bottom is in use to fulfill the boundary condition. The scattering wave function is given by using the complex variable and conformal mapping methods. The conjunction boundary conditions are satisfied into the solution of a series of infinite algebraic equations. At last, numerical results of surface displacements of a cylindrical arc hill and of a semi-ellipse hill are obtained. DIU Diankui made the foundation of that method which is suit in solving the dynamical stress concentration issue with the SH-wave scattering. In 1996, DIU Diankui and LIU Hongwei supplied a new method in SH-wave research which a application of elastic wave research.In 1998,CUI Zhigang give an answer to scattering of SH-wave in arc hill. In 2001, CAO Xinrong study a way to solve the scattering of SH-wave in arbitrary shape. The answer was based on the methods of conjunction and division of solution zone. The scattering wave function is given by using the complex variable and conformal mapping methods. The conjunction boundary conditions are satisfied. Furthermore applying orthogonal function expanding technique, the problems can finally be summarized into the solution of a series of infinite algebraic equations. At last, numerical results of surface displacements of a cylindrical arc hill and of a semi-ellipse hill are obtained. Two numerical results of this method were given which show this method is workable. Since then the study of influence of scattering of SH- wave in particular hills was developed to arbitrarily type. But this method has a low precision when dealing with the triangle hills. And it would met difficulty in getting the function. But it is a sound method in engineering work. In 2006, QIU Faqiang give the antiplane response of isosceles triangular dike to incident SH-waves. The moving coordinate system is used. The answer of the problem is reduced to a series of algebraic equations and obtained numerically. The finally examples show difference to Abdul's Antifunac response of a dike with flexible soil-structure interface to incident SH-waves. Lv Xiaotang studied the ground motion when SH-waves influenced on a semi-cylindrical hill and a semi-cylindrical canyon. In 2007 LIU Diankui and LIU Xiaotang cooperate the research work on the scattering of SH-wave in the same landform. In 2009 DU Yongjun and LIU Diankui studied the situation when SH-wave scattering in two isosceles-triangular hills. In the real mountainous regions, it's hard to see a single hill. At least two hills next to each other in a particular reign is the most situation. As a result, the jop of DU Yongjun and LIU Diankui have more

use for reference.They divided the infinite semi-space into three parts for the first. This divisional idea had great reference to following works. In 2010,HAN Feng finished the research of scattering of SH-waves on the triangular hill joined by semi-cylindrical canyon. The interact of triangular hill and a semi-cylindrical canyon when SH-waves incidented was studied. How well will the distance between the hill and canyon influence the answer was given. Based on this method, YANG Zailin and XU Huanan simulate the real situation with two isosceles triangle hills and a semi-cylindrical canyon successfully. The research on hills and canyons draw great attention of scholars all over the world. It's a classic field but booming a field. New method and new sides are wanted.

2.2 Scattering of SH-wave on complex hills and canyons

In earthquake engineering works, the research of more complex landform is important. In 1997, HAN Feng and LIU Diankui use the conforma mapping method to analyze and evaluate the ground displacement and scattering of incident SH-waves on the surface of semi-canyon topography of arbitrary shape with lining in anisotropic media . This method has great reference to cannal engineering. In 2005 DU Yongjun analysis the dynamic analysis for subsurface cavity near semi-cylindrical hills impacted by SH-wave. By means of complex function, multi-polar coordinates as well as "conjunction" idea. He divided the model into two domains domain 1 was several circle including boundary of the hill, and the rest was regarded as domain 2, which was an elastic half-space including semi-cylindrical canyons whose boundaries were the shared lines of the domains and the subsurface circular cavity. Standing waves satisfying the zero-stress condition at the horizontal surface was constructed in the other domain. By employing zero-stress condition around the circular cavity and displacement-stress continuity on the domain's shred lines, the problem was solved. But the most pity is this method would not work when the general boundary is too close to the conjunctional boundary. In 2006, LIU Diankui and LIU Gang both had talk about the scattering of SH-wave in landforms contain a subsurface cavity in their papers. But the situation when the distance between the general boundary and the conjunctional boundary is too close or the general boundary next to the congjunction boundary, this method still useless. Almost 10 years past the analytical method in dealing with this condition is still a margin.

3 Scattering of SH-wave incident in interface

With the comprehensive application of new materials, interface fracture means has attracted considerable attention. With the increasing dynamic problems of IFM, interface dynamic fracture was set up. For the dynamic problem, the singularity is the same as that of the static problem. In 2002, WANG Zhiwei got a study on the scattering of SH-wave by interface circular lining. LIU Diankui and WANG Yan advanced the study. LIU Diankui provide a new method for analyzing scattering and dynamic stressconcentration of plan SH-waves by interface. The integral equation obtained in his paper can be transferred into algebraic equations and solved numerically.The great improvement held a foundation for scholars for further research. WANG Yan analysis the dynamic issue for shallow-embedded lining structure. The achievement in her paper shows the relationship between the stress and thickness as well as hard of the structure. A year later, QI Hui studied on the shallow-embedded lining structure develop an analytic method for the problem of dynamic stress concentration of a shallow-embedded circular lining structure impacted by the steady SH-wave.

4 Scattering of SH-wave influenced by crack

It is hard to avoid various defects when working with the manual materials and structures, such as non-crack defect and crack defect. In the study of the scattering of elastic wave by cracks, cracks always appear in the shape of straight line or circular arc. When dynamic load is applied to the material containing the composite defect, crack defect must influence the characteristic of the non-crack filed originating at the boundary. In order to satisfy the theoretical and engineering needs, many researches in this field have been carried out in recent decades, and many valuable results have been obtained. Meanwhile, it also carried much information on the material by investigating the scattering field of waves, such as the location of defects, the shape and the size of the defects. So it is helpful for the research on inverse problems of the elastic wave, and it is meaningful for the site survey and prospecting, seismic research, underwater detection and target identification, nondestructive testing, etc.

As the simplest one among the scattering problems of elastic waves, SH-waves scattering problem has relative mature theories. However, there are still many boundary value problems unsolved. Fewer papers were given to the scattering problem by defects near the bi-material interfaces in half-space, although many valuable results have been obtained on interfacial dynamic, most of which belong to the global space problems of interface. In this article, the scattering problem of SH-waves by circular elastic inclusions of arbitrary positions near the bi-material half-space with interfacial crack have been investigated. To solve the problems, the Green's function and complex function methods are used here, and the "image" method is used to construct the displacement expressions of scattering wave field. Finally, the dynamic stress concentration factors around the circular elastic inclusion III are given. Meanwhile, the correctness and validity of the methods are proved. The numerical results show that DSCF are influenced in some degree by the interfacial crack, the circular inclusion IV and the free interface.

Acknowledgements

The study of scattering of SH-wave is a historical and actively branch in mechanics.Great achievement need to be studied .

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