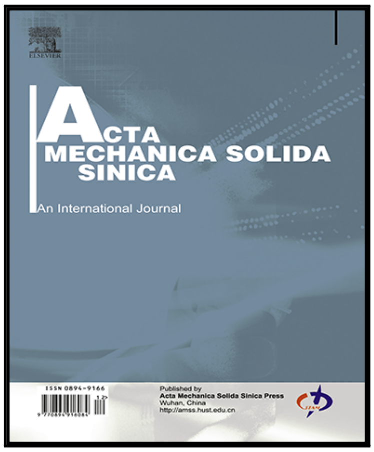
Accepted Manuscript



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PII: S0894-9166(17)30217-3
DOI: 10.1016/j.camss.2017.07.001
Reference: CAMSS 35

To appear in: *Acta Mechanica Solida Sinica*

Please cite this article as: A.K. Singh , A. Das , A. Lakshman , A. Negi , A. Chattopadhyay , Effects of irregularity and initial stresses on the dynamic response of viscoelastic half-space due to a moving load, *Acta Mechanica Solida Sinica* (2017), doi: 10.1016/j.camss.2017.07.001

Effects of irregularity and initial stresses on the dynamic response of viscoelastic half-space due to a moving load

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ABSTRACT

The present article deals with the stresses developed in an initially stressed irregular viscoelastic half-space due to a load moving with a constant velocity at a rough free surface. Expressions for normal and shear stresses are obtained in closed form. The substantial effects of influence parameters, viz., depth (from the free surface), irregularity factor, maximum depth of irregularity, viscoelastic parameter, horizontal and vertical initial stresses, and frictional coefficient, on normal and shear stresses are investigated. Moreover, comparative study is carried out for three different cases of irregularity, viz., rectangular irregularity, parabolic irregularity and no irregularity, which is manifested through graphs.

Keywords: Viscoelastic; Initial stress; Irregularity; Moving load; Frictional coefficient; Normal and shear stresses.

1. Introduction

The exploitation of road and bridge network with hefty and speedy conveyance, especially dynamically moving vehicles (loads), is an emerging matter of discussion. In addition to that, various fettling and materials endow the bridge with more meticulous, leaning and authentic figures, making the study extremely important for the design of bridges, including railway and highway bridges, suspension bridges, rails, sleeper, crane runways, cable railways, roadways, airport runways, pavements, underground railways, tunnels, pipelines, etc. Due to the time-varying and movable natures of vehicles, it is difficult to directly measure the interaction forces between the vehicles and bridge. Thus, it would be beneficial if response of the moving load over a surface could be calculated indirectly using the measured response data of bridges. The stress developed in the body (bridges) due to a moving load (vehicles) causing fracture is an interesting problem of mechanics because of its applicability towards the stability of the medium.

Recently, with the development of high-speed train networks, concern is expressed about the effects of moving load on the track, the embankment and the nearby structures. In some locations with soft ground conditions, very high levels of displacement are observed. Soft ground material may have viscoelastic property. Viscoelastic materials, as the name suggests, combine two different physical properties, namely ‘viscous’ and ‘elastic’. The term ‘viscous’ implies that they deform slowly when exposed to an external force. The term ‘elastic’ implies that once a deforming force has been removed, they return to their original configuration. The dual behavior of these materials allows them to resist shear flow as well as the strain. Elastic material, for example, may undergo strain when it is stretched to its elastic limit, but will return to its normal, resting state once that stress is removed. Viscosity, on the other hand, gives the material a little more stability and resists flowing.

Viscoelastic materials also help to deal with the concept of creep. Creep is the tendency of solid materials to move or to deform with certain stresses or properties. This deformation may be permanent and may also represent a potential or imminent failure, depending on the material that is represented. Creep is almost always more severe in the materials that are exposed to or subjected to heat for long periods. There are some materials where a fair amount of creep is considered to be a good thing. For an instance, in concrete roadways or sidewalks, a small amount of creep prevents stress buildup that otherwise, can cause cracks or even damage to concrete. Viscoelastic materials have been used in a number of different applications, including as a buffer under heavy loads to prevent or reduce the damage that can be seen by moving those items or operating them in place.

The presence of initial stresses in a body can have a substantial effect on their subsequent response to applied loads that is very different from the corresponding response in the absence of initial stresses. Initial stresses may arise due to applied loads, gravity, atmospheric pressure, creep or difference in temperature. It is a well-known fact that a large amount of initial stresses exist inside the earth. Here, the term initial stress is used in its broadest sense, irrespective of how the stress develops. This includes a situation where the stress is due to an applied load leading to an accompanying finite deformation from an unstressed configuration, in the same

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