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Compliance of Rigid Arbitrary Shape Foundations Using 1 DOF BEM

Rahim Shahi[1], Asadolah Noorzad[2]

1- ***MS of Faculty of Eng. Tehran University, Iran***

2-Assistant Professor of Faculty of Eng. Tehran University, Iran

RahimShahi@yahoo.com
Noorzad@ut.ac.ir

Abstract

In this study the relationship between the dynamic force and displacement (impedance or compliance) is evaluated for rigid foundations with arbitrary shape resting on a half-space medium, consisting of homogeneous, isotropic, linear elastic materials with constant Boundary Element Method, (1 DOF). Green's function is computed for half-space and presented in explicit form. By using BEM formulation the stress beneath foundations and compliance of them are obtained. The vertical compliance of a rigid circular disc which is calculated by this method is compared by semi-closed form solution and verifies the accuracy and efficiency of this method. the vertical and rocking compliance functions for rigid rectangular and some arbitrary shape foundations are obtained. And also, the variation of stress distribution pattern beneath square and circular foundations with frequency is studied and these results are compared with the results of the other methods.

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KEY WORD: Green's function – stress distribution – 1 DOF BEM – Lamb's solution - Boussinesq's solution

1. INTRODUCTION

An important step in the study of the dynamic interaction between structures and the supporting medium is the evaluation of foundation compliance functions. These functions play a key role in the design of foundations for oscillatory machines and in computations of structural response to earthquake excitations. Some studies on the dynamic response of foundations have been restricted to analysis of rigid circular footings Veletsos and Y.T.Wei [19] , Luco and Westmann [14] or to the two-dimensional rigid strip foundation Karasudhi et,al [3] , Luco and Westmann [15]. In these cases the resulting mixed boundary value problems may be reduced by standard techniques to solution of Freehold integral equations. For other geometrical shapes of the foundations, the problem was approximately solved by defining an equivalent circular base, or by assuming a certain stress distribution in the contact plane between the foundation and the soil. Kobori and others was obtained the dynamic compliance functions for rectangular foundations Thomson and Kobori [18], Kobori and Suzuki [10].

In soil surface interaction of due to complexity of geometry and boundary conditions of this problem, the numerical approaches are used to analyze an arbitrary shaped rigid foundation. Most of the numerical methods are based on dividing the contact plane between the foundation and the ground surface into finite number of elements in which the stress distributed are assumed to be known but stress values are unknown. In these methods by using above assumptions and boundary condition and also equilibrium equation and compatibility of deformations, obtained a system of linear simultaneous equations. Solving this equations system obtained values of stress.

Wong and Luco [21] use above-mentioned approach, to evaluate compliance of arbitrary shape foundations. Their methods had two difficulties, First: influence function (equivalence with Green's function) used by them involve numerical double integration; whose one of its upper limits is infinite and a huge computation cost time need due to evaluating n^2 (n number of elements) influence function. Second: it is impossible to develop for other shapes of elements and higher orders elements; due to they doesn't using explicitly BEM formulation. Also they used a particular solution obtained by Thomson and Kobori [10], where evaluate the, occurring displacement at an arbitrary point, when a uniform harmonic stress acts on the surface of the rectangular element.