Advances in Science and Technology
ISSN: 1662-0356, Vol. 156, pp 3-13
doi:10.4028/p-5KGuD9

Submitted: 2024-03-28
Accepted: 2024-05-18
Online: 2024-09-09

Effective Application of Numerical Approaches and Green Functions for the Process of Modelling Spheres

Viktoriya PASTERNAK[1,a*], Artem RUBAN[2,b], Oleksandr BILOTIL[3,c] and Daryna KARPOVA[3, d]

[1]Lesya Ukrainka Volyn National University, Voli Avenue 13, 43025 Lutsk, Ukraine

[2]Lviv State University of Life Safety, Kleparivska str., 35, 79007 Lviv, Ukraine

[3]National University of Civil Defence of Ukraine, 94 Chernishevska str., 61023 Kharkiv, Ukraine

[a]Pasternak.Viktoriia@vnu.edu.ua, [b]a.ruban@ldubgd.edu.ua, [c]abelotel1968@nuczu.edu.ua, [d]kdarinka170798@nuczu.edu.ua

Keywords: finite element method, boundary element method, modelling, Green's theory, element dynamics, initial data, three-dimensional space, potential, point vectors.

Abstract. The research work is devoted to the study of the stress-strain state of a structure comprising a cylinder with a sphere using numerical approaches and Green's functions. The results obtained include the analysis of stress distribution, study of deformations and determination of stress concentration zones. Safety factors are assessed and the influence of boundary conditions on the behaviour of the structure is revealed. The application of numerical methods allowed for a detailed study of the interaction of the sphere, providing an opportunity to analyse the exact properties and assess the influence of various factors in complex structures. It should be noted that the results obtained, which were evaluated taking into account all factors, affect the real system and can be predicted with a deviation error of 1%.

1 Introduction

Usually, a system of numerical approaches and partial differential equations is used to describe physical phenomena and processes by a mathematical model, taking into account all possible relevant boundary conditions, as well as the initial data [1, 2, 3]. It should be noted that the possibility of analytically finding the final calculations by numerical methods for the modelling process is limited only in certain cases [4, 5, 6, 7]. Modern engineering approaches and their structures have a complex heterogeneous geometric shape and are mainly made of heterogeneous materials, composites, and nanocomposites [8, 9, 10]. Therefore, the possibility of obtaining simple elementary formulas, or modelling, or using special functions to find qualitative calculations is somewhat limited [11, 12, 13].

The current stage of designing various structures requires an increasing use of computer-based approaches and technologies [14, 15]. The basic idea of computer calculations and the modelling process is to build specific discrete systems [16, 17], use modern Green's functions [18, 19, 20], use differential equations [21, 22], and apply finite element or boundary element methods [23, 24] to simulate the behaviour of these materials and structures in real conditions [25]. It should be noted that the use of numerical methods and basic Green's approaches for the modelling process allows for virtual experiments and quick obtaining of high-quality results. Currently, the most widely used and popular methods are finite element methods and boundary element methods based on the Green's context.

The main advantage of Green's boundary element methods (BEMs) and finite element methods (FEMs) is to provide an efficient and accurate numerical approach for solving differential equations and boundary value problems in the modelling process. The main goals of such a numerical approach include: