**Boussinesq method in seism analysis of a building structure using ANSYS program**

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**Abstract:** This paper presents the implementation of Boussinesq method in seism analysis of a 3d building structure in order to simulate the elastic foundation using Ansys program. The method used for seism analysis was the static equivalent forces method. The elasticity of the soil is considered in this analysis by modeling the soil as an elastic material with parameters determined with Boussinesq formula. This type of simulation is better then considering the foundation as a rigid body. The paper presents the moments and shear forces diagrams of the foundation beams of the building structure.

**Key-Words:** Foundation analysis, seism, Finite Elements Method, ANSYS, building analysis, elastic soil

1 **Introduction**

In the Romanian design building codes we have 2 different methods to simulate the elasticity of the soil: Winkler method and Boussinesq method.

Both methods are considering the elastic supports of the structure in the points of the contact of the building structure with the soil.

The elasticity of the foundation supports is important when we need to perform a very realistic seism simulation or when the soil has particular properties.

ANSYS program is not frequently used in foundation elastic supports analysis but it is a very complex program which can simulate a wide range of static and dynamic behaviors, and can be used to simulate the seismic behavior with elastic soil.

2 **Problem Formulation**

The foundation in this case consist in longitudinal and transversal beams under the columns.

![Fig. 2 The foundation of the building](image)

The elastic parameters of the soil are calculated depending of the bed coefficient of the soil determined by experiments.

The seism simulation method used is the equivalent static method which defines a series of forces acting on each floor.
Boussinesq method implies to model the soil under foundation as a 3d solid with particular elastic constants[8],[9].

For the beams and columns of the structure has been used 3DBeam finite elements and for the floors has been used SHELL elements. The foundation also has to be modeled using beam elements with the real section of the foundation beams.

The contact between the foundation beams and the soil model was simulated with contact elements CONTA172 which is a contact surface to surface finite element.

The simulation of the rigid supports is making possible to obtain the moments and shear forces diagrams used to dimension the reinforced bars of the foundation beams.

3 Problem Solution

For a complete analysis of the structure we have choose 3 load cases: case 1 - self weight, case 2 - Ox direction seism, case 3 - Oy direction seism.

The results are presented for the longitudinal and transversal foundation beam for all 3 load cases in [m] for displacements, kNm for moments and kN for shear forces.
An important element of implementation of Boussinesq method in ANSYS program is to determine the dimensions of the soil geometry model. In this paper we have done it by trying some versions starting from bigger dimensions of the soil model to smaller one in order to obtain the smaller dimensions for which the FEM results of the structure are not altered.
4 Conclusions
Using elastic supports in FEM simulation of the seismic is an important task in buildings design.

One of the methods used to simulate the elastic supports is Boussinesq method which considers the soil as a linear homogeneous solid with elastic real constants depending on the bed coefficient which is experimentally determined.

The implementation of Boussinesq method in ANSYS program has to be done with caution because the results depend on the soil model dimensions (height and width). The correct dimensions can be obtained by a convergence solution process.

In the simulation it is necessary to use contact elements between the foundation elements and the soil elements[10].

An advantage of this type of simulation is that we can obtain the moment and shear force diagrams for the foundation beams. These results are useful for the dimensioning of the reinforced bars of the foundation beams.

The simulation for seismic behavior with elastic supports can be made by equivalent static forces or by modal spectral analysis. The third method – time history analysis – is more difficult to be performed in ANSYS considering the elastic supports.

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