

## ANALYTICAL SOLUTION OF BEAMS ON ELASTIC FOUNDATION

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**ABSTRACT:** The paper deals with a new manner of obtaining an analytical solution of the problem of bending of a beam on an elastic foundation. In the design of such structures, to describe the foundation response to applied loads, the mechanical model of Winkler is often used, for almost one and a half century. However, it has some shortcomings, mainly because it assumes no interaction between the adjacent springs and thus neglects the vertical shearing stress that occurs within subgrade materials. In this paper proposes a felicitous approach for solving the equilibrium equation and applying the boundary conditions, used to static analysis of beams resting on elastic foundations, is presented as an alternative to the classical Winkler and Vlasov models. The resolving equation of bending of a beam on an elastic foundation is obtained. The account of the elastic foundation is produced by means of parameter of flexural stiffness. This idealization provides much more information on the stress and deformation within soil mass compared to the well-known Winkler model, and it has the important advantage of eliminating the necessity of arbitrarily determining the values of the foundation parameters. The solutions of sample problems, obtained by using the new analytical model, are compared with results obtained by the Winkler and Vlasov models.

**Keywords:** beams, elastic foundations, Winkler model, Vlasov model, present model

### 1. INTRODUCTION

In geotechnical engineering, there are numerous situations where the designer has to use simple empirical procedures to size the footings to transfer the loads from the superstructure to the soil underneath. While spot footings are designed using an allowable bearing value approach, most engineers adopt a similar technique for the design of continuous footings also. When the continuous footings carry distributed and concentrated loads, the computation of the vertical displacements of the footing along the longitudinal direction becomes necessary to evaluate the possible differential settlements of the footing. If we assume that the continuous footing acts like a beam, then its analysis can be done using the concept of a beam on elastic foundation. Depending on the longitudinal stiffness of the beam, the loads on the beam are distributed from the beam and into the soil in a very complex manner. In other words, the behavior of the beam due to the loads depends on the material properties of the soil as well as its own stiffness characteristics. Such problems are called soil-structure interaction problems, and the beam on elastic foundation problem is one of them.

The concept of beam on elastic foundation is mathematically elegant; however, it is difficult to come up with the parameters that represent the behavior of the soil. The problem becomes extremely complex, when the deformation in the

soil becomes elastic and partly plastic.

The model consists of an elastic beam (Euler beam) resting on a linearly elastic soil medium. This concept has been extensively used by railroad engineers for many years, in order to design the railroad tracks. In the past, research has been undertaken to construct analytical models of beams on elastic foundations [1]. A review of foundation models was performed by Dutta and Roy [2]. Most probably, the oldest model used to simulate beams on elastic foundations is the Winkler model [3]. He assumed the soil to have linear elastic behavior, such that the pressure on the surface is proportional to the deflection of the soil surface in the region of the load. Since the foundation soil in the Winkler model is described by vertical springs only, we find that they carry the vertical loads without any mutual interaction. In other words, these springs are unable to represent the shear stresses in the subsoil. Shear stresses are developed in the subsoil if the vertical displacements between adjacent springs vary. One can see that if a uniform beam with free ends carries a uniformly distributed load, the solution obtained from the Winkler model is a rigid body displacement. In other words, the calculation will indicate that there is no bending moment in the beam. In reality, there will be some edge shear forces resisting the deformation of the soil which makes the beam to deform in a curved deflected

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