Bridge frame soil

Article Overview

The behavior of soil around bridge frames significantly influences structural performance, requiring careful modeling of soil-structure interaction to ensure stability and serviceability.

Soil-Structure Interaction in Bridge Frames

Bridge frames, particularly integral or jointless bridges, interact continuously with surrounding soil and backfill. This interaction affects internal forces, settlements, and lateral pressures on abutments. Soil is typically modeled as an elastic-plastic material, and its properties--stiffness, density, and stress history--directly influence the bridge's response to loads, thermal expansion, and cyclic effects .

Key Considerations

o Abutment and Backfill Behavior: Cyclic thermal deformations of the bridge can cause repeated compaction of granular backfills, leading to settlements ("ratcheting") over the bridge's design life. Lateral earth pressures on abutments increase with bridge length and backfill stiffness .
o Foundation Interaction: Pile-supported or spread foundations experience soil-structure interaction that affects bending moments, lateral forces, and potential pile fatigue. Neglecting soil effects can overestimate stiffness and natural frequencies of the bridge frame .
o Constitutive Soil Models: Common models include Mohr-Coulomb, modified Mohr-Coulomb, HSS, Drucker-Prager, and Cam-Clay. Selection depends on the soil type, stress history, and expected loading conditions. For example, the HSS model has shown good agreement with field monitoring data for railway frame bridges .

Modeling Approaches

o Soil Springs Method: Soil is often represented by vertical and horizontal springs attached to substructure elements. The stiffness of these springs depends on soil properties, bridge dimensions, and applied loads. This method allows integration of soil effects into structural analysis models .
o Finite Element Analysis (FEA): 2D and 3D FEA models simulate cyclic soil-structure interaction, capturing settlements, lateral stresses, and bending moments. Parametric studies can assess the influence of soil stiffness, backfill properties, and bridge geometry .

Practical Implications

o Accurate modeling of soil-structure interaction is essential to prevent excessive settlements, ensure serviceability, and avoid maintenance issues.
o Integral bridges benefit from reduced maintenance due to the absence of expansion joints, but soil effects are

amplified and must be carefully considered in design .
o Design guidelines in Germany, Austria, and the UK provide frameworks for incorporating soil-structure interaction, but numerical analysis is often required for complex or long-span bridges . In summary, bridge frame soil interaction is a critical factor in structural design, influencing abutment forces, foundation behavior, and long-term settlements. Proper selection of soil models and simulation methods ensures safe, durable, and cost-effective bridge performance.

Abstract. PD 6694-1:2011+A1:2020 provides UK guidance on how the interac-tion between soil and structure should be considered

Download scientific diagram | Soil properties of the four type of soils used for each bridge. from publication: A comparative study on

Discover the crucial role of soil mechanics in bridge engineering and how it impacts the stability and safety of bridges.

These issues complicate the geotechnical aspects of integral bridges. The aim of this paper is to present a

Determining constraints accurate layouts geometry - Introduction is central the drawings of bridge is fundamental bridge geometry

The seismic responses of rocking structures are significantly influenced by the soil-structure interaction and the soil characteristics. In

Issues including material properties, initial stress state and the incorporation of the effects of soil ratcheting are discussed and both

The Geosynthetic Reinforced Soil (GRS) Integrated Bridge System (IBS) provides an economical solution to

Frame bridges are often the most economical solution for smaller spans. Orthogonal and trapezoidal frames are particularly suitable

Bridges are among the most important transportation elements that may be damaged by earthquakes. An integral

This paper presents an efficient approach for the modal analysis of coupled soil-structure systems, for which the

Abstract Integral bridges with larger spans experience increased cyclic interaction with their backfill,

particularly due to

Integral bridges are structures without bearings and mechanical expansion joints, whereas the connection between the

Therefore, this paper presents a detailed numerical investigation on the cyclic interaction

Abstract Portal frame bridges are one of the most popular types of bridges in Sweden. These bridges consists of a framework

For this reason, the interplay between the bridge and the soil is usually disregarded. To address this limitation, a

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