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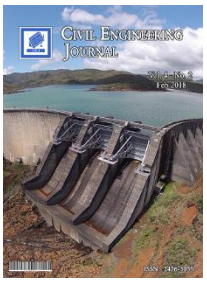

# An Analytical Model for Estimating the Vibration Frequency of Structures Located on the Pile Group in the Case of Floating Piles and End-bearing Pile

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**Abstract**

Exact estimation of vibration fundamental period of structures plays a vital role in their designing procedure. The proposition of a relatively exact expression which considers the effects of a pile group on the fundamental period of the structures was of less interest to previous researchers. This study aims to propose an analytical model and expression so as to estimate the free vibration period of the structures located on a pile group. To reach the objectives of this study, several numerical analyses has been carried out using the method of equivalent spring which takes into account the effects of soil-pile-structure interaction on the fundamental period of the structures. In the next step of the study the effects of a pile group on the fundamental period of the structures have been analyzed analytically. In this analytical study two cases have been considered for the piles which are end-bearing and floating piles. In the case of floating piles a five degrees-of-freedom analytical model and its corresponding expression have been proposed considering the soil-pile-structure system. The numerical modelling has been performed using the direct method due to the neglect of the soil in analytical expression and the results have been compared with those of the proposed analytical expression. The soil mass participation coefficient (λ) has been obtained using the discrepancy between the results of the two different methods to modify the analytical expression. In the case of end-bearing piles an analytical model with three degrees-of-freedom and its corresponding expressions has been proposed. Then the soil has been neglected and a new analytical expression has been proposed using the mass participation coefficients adopted from other researches to calculate the fundamental period of the structures. The comparison between the results of the proposed expression and those of case and numerical studies confirms that the proposed expressions benefit from a relative accuracy and can be used as an initial criterion in designing procedure.

*Keywords:* Soil-Pile-Structure Interaction; Frequency of Free Vibration; Analytical Formula; Steel Frame; Numerical Study.

## 1. Introduction

The seismic assessment of steel frame buildings is typically based on the assumption that they are mounted on a rigid medium and that the effects of the Soil-Structure Interaction (SSI) can be ignored. In contrast, the SSI phenomenon can affect the response of structures tremendously. The fixed-base assumption is inappropriate for many structures, and structural systems that incorporate stiff vertical elements for lateral resistance (e.g., shear walls and braced frames) could be very sensitive to the small translational and rotational movements that are disregarded in the fixed-base assumption.

Lessons learned from recent earthquakes show that fixed-base assumption could be misleading, and neglecting the influence of SPSI could lead to unsafe design, particularly for structures founded on soft soils. The seismic design of

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