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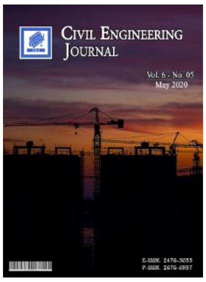
Civil Engineering Journal

Vol. 6, No. 5, May, 2020



Free Vibration of Tall Buildings using Energy Method and Hamilton's Principle

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Received 17 February 2020; Accepted 16 April 2020

Abstract

In a framed-tube tall building, shear wall systems are the most efficient structural systems for increasing the lateral load resistance. A novel and simple mathematical model is developed herein which calculates the natural frequencies of such tall buildings. The analyses are based on a continuous model, in which a tall building structure is replaced by an idealized cantilever beam that embodies all relevant structural characteristics. Governing equations and the corresponding eigen-problem are derived based on the energy method and Hamilton's principle. Solutions are obtained for three examples; using the separation of variables technique implemented in MATLAB. The results are compared to SAP2000 full model analysis; and they indicate reasonable accuracy. The computed natural frequencies for structures 50, 60 and 70 storey buildings were over-estimate 7, 11 and 14 percent respectively. The computed errors indicate that the proposed method has acceptable accuracy; and can be used during the initial stages of designing of tall buildings; it is fast and low cost computational process.

Keywords: Tall Building; Framed Tube; Shear Wall; Free Vibration; Natural Frequency.

1. Introduction

Tall building developments have been rapidly increasing worldwide. One of the most critical issues in tall buildings is choosing proper structural form to resist lateral loads. Lateral deformation must be severely controlled, that inhabitant feels comfort and to prevent damages to second-grade structural elements. Another vital point in tall buildings' design is the dynamic analysis of these structures that is very important because of their more flexibility and consequently increases of vibrational amplitude and the fact that the dynamic characteristic of structures is mainly governed by their natural frequencies [1-2]. Therefore, dynamic parameters calculation of tall buildings is essential for primary designing. Dynamic parameters such as vibrational frequencies and mode shapes can be calculated by numerical methods such as finite element. While these numerical methods are used for final designing, approximate methods are very effective for primary designing. Approximate methods can help the designer in cases such as initial design when dimensions of some constructional members are not specified, comparison of achieved results with more advanced numerical methods, and finally specifying of structural dynamic behaviour which leads to better designing.

One of the most ordinary approximate methods for dynamic parameters calculation of tall buildings is "continuum method" in which the tall building's structure is substituted by a continuum beam, adopting Euler–Bernoulli or Timoshenko beam theory as the design tool [3]. Considering different kinds of parameters in the substituted beam can help the designer to achieve natural frequencies and mode shapes with more accuracy. For resistant of high-rise

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http://dx.doi.org/10.28991/cej-2020-03091519