INTERNATIONAL JOURNAL OF CIVIL AND STRUCTURAL ENGINEERING
Volume 2, No 1, 2011

Research article ISSN 0976 – 4399

Formulating building response to Earthquake loading

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ABSTRACT

This paper presents a numerical method for the computation of building responses under earthquake loads using a simple closed-form equation, which takes into account the earthquake zone and the soil profile. The equation was developed using a power best fit regression using the response data of numerous buildings with different stiffness and heights; different earthquake zones; and different soil profiles. The closed-form equation can be used to compute the response of buildings at any desired level based on the building height, stiffness, earthquake zone, and soil profile. The response results, which were obtained using the closed-form response equation, were in close agreement with those obtained using the finite element program STAAD-PRO. The closed-form response equation was also able to accurately predict the actual top drift of the Bank of California building during San Fernando earthquake. The presented method represents a simple and practical tool for computing building responses in earthquake zones with different soil profile.

Keywords: Drift, Response, Numerical Formulation, Earthquake Zones, Soil.

1. Introduction

Structural response, such as building drift, is a key parameter that should be considered in the performance-based seismic design rather than strength, which is used in conventional design approaches. This is due to the fact that the building performance is characterized by its level of damage, which is directly related to its displacement (Mori, Yamanaka, Luco, and Cornell, 2006).

The relative lateral displacement of buildings is measured by an overall drift index that is the ratio of the maximum lateral displacement to the height of the building. The inter-story drift, a commonly used drift index, is defined as the ratio of the relative displacement of the floor to the story height at that level. When subjected to earthquake loading, the lateral displacement of a structural system must be limited to: 1) preserve its structural stability and architectural integrity and 2) reduce the structure members' damage and human discomfort. Drift limitations are commonly imposed by seismic design codes such as the Uniform building Code (UBC), the International Building Code (IBC) and many other codes around the world (Steven,L.K, 1967). The value of the drift index ranges between the values of 0.002 and 0.005 for conventional structures.

The determination of the expected response of a structure when subjected to seismic loading, is one of the most important task in seismic design. Once the maximum expected seismic response of the structure has been determined, the adequacy of all structural elements must be verified. The excessive lateral displacement or inter-story drift causes failure of both structural and non-structural element. Thus, the top and inter-story drifts at the final structural design stages must be checked not to exceed the specified index limits (James, A, 2006).