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لم ترد بالاصل

Ain Shams University
Faculty of Engineering

INELASTIC DYNAMIC RESPONSE OF LATTICED TOWERS SUBJECTED TO RANDOM LOADS

BY

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A THESIS

SUBMITTED IN PARTIAL FULFILLMENT FOR THE REQUIREMENTS OF THE DEGREE OF MASTER OF SCIENCE IN CIVIL ENGINEERING (STRUCTURAL)

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STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Master of science in civil Engineering (Structural Department)

The work included in the thesis was carried out by the author in the Department of Structural Engineering. Ain Shams University, from October 1986 to October 1995.

No part of this thesis has been submitted for a degree or a qualification at any other University or Institution

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ABSTRACT

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TITLE: "Inelastic dynamic response of latticed towers subjected to random loads "

For latticed towers ,diagonal steel bracing members are efficient elements in resisting seismic motion , and therefore , they are frequently used to control the lateral displacements of structures .When such structures are subjected to earthquake motion of even moderate intensity ,bracing members typically yield in tention and /or buckle in compression .The research contains an analytical procedures for the inelastic dynamic analysis of space trusses using the step-by-step implicit integration methods.Two methods for solving the dynamic governing equations are presented .These methods are the linear acceleration method and the constant average acceleration method .The formulation of displacement,velocity and acceleration are presented for each method. The above scheme of integration methods are explained and implemented in a computer program .The presented analytical procedure is used for the inelastic deterministic analysis , in time domain of structures subjected to seismic loads .The dynamic behaviour of a tower tank and a transmission Tower is investigated under EL-CENTRO earthquake for different cases. The elastic and inelastic responses are illustrated and compared for all different cases of loading . A brief summary , discussion of the results and conclussions are given. .

CONTENTS

CHAPTER (1)

INTRODUCTION

1.1 General

Latticed towers have different civil engineering applications, such as transmission towers, communication industry, wind mills, transmission of telephone signals over long distance .... etc. Dynamic conditions in these latticed towers are generally associated with wind or earthquakes. Their effects on the structural behavior can be reflected in response amplification through interaction with the natural dynamic characteristics of the structure. The latticed towers are also used as tower tanks. In U.S.A. reports of damage to latticed tower elevated water storage tanks within the past few decades[2] have revealed much more complex behavior than is implied by design assumptions. It has been observed after recent earthquakes that several tie rods and struts of braced towers have been permanently extended or buckled. Thus, special design considerations may have to be taken into account. In the current research, emphasis is placed on the inelastic behavior of a typical cross braced tower, as bracing members are known to be effective earthquake-resisting elements in steel supporting structures. The theoretical hysteresis behavior of these members is quite complex because of buckling combined with yielding. Towers pose a series of specialist design and construction problems generally related to their height and slenderness. They are vulnerable to earthquakes because they usually have only one line of defense, the failure of any one part of the structure resulting in spectacular failure. For towers of moderate size a dynamic earthquake analysis is highly desirable. Equivalent static loading of codes of practice is not well suited to modeling higher mode effects which can be significant in slender structures. The controlling design criterion may be deformation rather than stress. Diagonally braced towers usually have slender members which are assumed to carry zero load in compression.

Inverted pendulums consist of tower or column structures with a large concentrated mass at the top, and occur commonly in forms such as canopies, observation platforms , elevated restaurants and water towers. They may have one or more vertical supports which in some cases form frameworks. The large mass at the top makes such structures especially vulnerable to earthquakes because of the accompanying horizontal inertia forces and the so-called PX Δ effect. For this reason most codes of practice are appropriately even more conservative for inverted pendulums than for other towers.

Because of hydrodynamic effects it is convenient to consider elevated water tanks and other liquid containers as a special case of the inverted pendulum. These structures may be either supported on a single vertical member or a framework. If the liquid is completely contained to prevent vertical motion of the water surface (sloshing), the water tower may be treated as a normal inverted pendulum. Sloshing will usually act as damping, and may result in a useful reduction in seismic response of the structure compared with the contained liquid case. However , sloshing may damage the roof of the tank or cause spillage of toxic or other liquids [24].

Ductility may be described generally as the post-elastic behavior of a material. For steel it may be expressed simply from the results of elongation tests on small samples, or more significantly in terms of the