AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Structural Engineering

BEHAVIOR OF TALL RC CHIMNEYS SUBJECTED TO SEISMIC AND WIND LOADS

A Thesis

Submitted in partial fulfillment of the requirements of the degree of
Doctor of Philosophy in Civil Engineering
(Structural Engineering)

BY

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Master of Science in Civil Engineering
(Structural Engineering)
Faculty of Engineering, Ain Shams University, 2006

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STATEMENT

This thesis is submitted as a partial fulfillment of Doctor of Philosophy in Civil Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Abstract of the PhD Thesis Submitted by:
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Title of the Thesis:
Behavior of Tall RC Chimneys Subjected To Seismic and Wind Loads

Supervisors:
Prof. Dr. Ayman Hussein Hosny
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ABSTRACT

A chimney is a structure that provides ventilation for hot flue gases or smoke from a boiler, stove, furnace or fireplace to the outside atmosphere. It safeguards people at or close to the plant from high concentrations of those pollutants by providing dilution of the pollutants in the atmosphere. The typical applications of chimneys in industrial projects are Power Plants, Cement Plants, Petro chemical Stacks, Refinery stacks, and Solar Chimneys.

In Egypt, and in the last few years, the government started the construction of a plenty of power plants, either fossil, solar or wind farms. The design of a tall chimney, being slender structure, is very sensitive to wind and seismic forces.

The scope of this research is to study the behavior of tall reinforced concrete chimneys subjected to seismic and wind loads and the main objectives are; (a) to investigate the effect of changing chimney height and diameter on the stability, static and dynamic properties of chimneys, (b) to determine the optimum height / diameter ratio as well as the optimum shell thickness and its corresponding reinforcement ratio for the investigated

ranges and then widening it to the practical range of construction of R.C chimneys worldwide.

Three dimensional finite-element analysis software is used to investigate the static and dynamic behavior of frequently used chimneys in Egyptian power plants under seismic and wind loads. A comparison is made between the chimney section design strength using the simplified method suggested by the American concrete institute ACI 307-08 and the exact method by using interaction diagrams. Also, the chimney wind load is evaluated using the Egyptian Code for Calculation of Loads and Forces for Buildings ECP 201-2012 and the results are compared to ACI 307-08.

Three different chimney models are created for finite element analysis under seismic and wind loads. A beam model is denoted as simplified model and is mainly used for dynamic analysis, while the solid and shell models are denoted as detailed models and are used mainly for checking deflection and local stresses around openings. A comparison is made between the outputs of the three models.

An advanced Time History Analysis is introduced to simulate the variant dynamic component of the wind load at different chimney heights and the results are summarized and compared to the static analysis. A parametric study is conducted on El-SUEZ chimney Power Plant aiming at determining the optimum height/diameter ratio and the optimum shell thickness.

Keywords: Concrete chimney, Along-Wind, Across-Wind, Seismic, Slenderness ratio, Local Stresses.

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I would like to dedicate this work to the soul of my parents, who have encouraged me to accomplish my PhD research. May god relieve their souls and convey my prayers to them for all their support.

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