# ANALYSIS OF SOLID SHEAR WALLS WITH LOCAL OPENINGS

*M. SC. Thesis submitted by*

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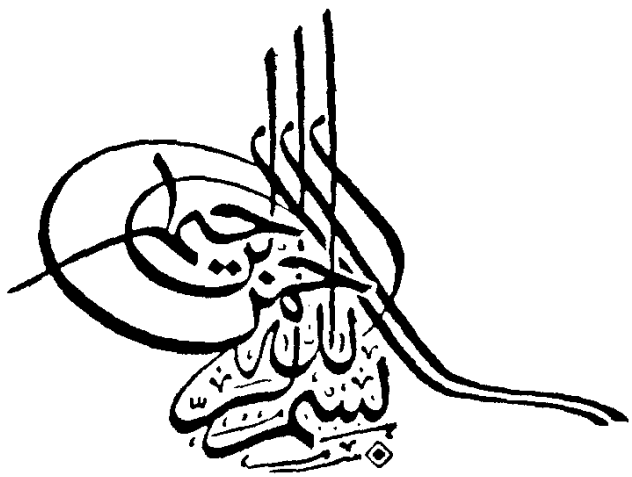
*A Thesis submitted in partial fulfillment for requirements of the Degree of*

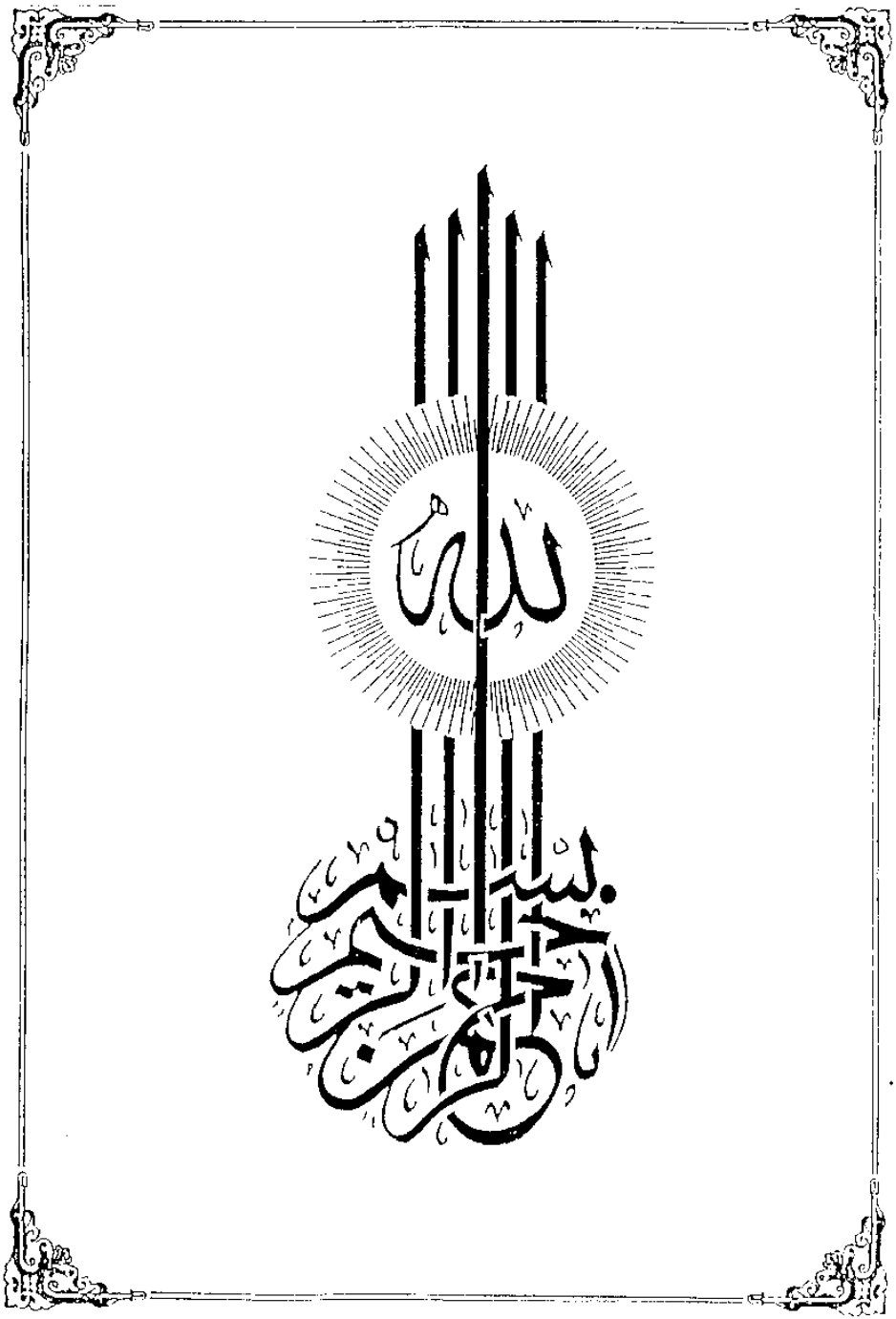
**MASTER OF SCIENCE IN STRUCTURAL ENGINEERING**

*From*

**FACULTY OF ENGINEERING, AIN SHAMS UNIVERSITY, CAIRO**

**September 1993**





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# STATEMENT

This dissertation is submitted to *Ain Shams University* for the degree of Master of Science in civil Engineering .

The work included in this thesis was carried out by the author in Department of Structural Engineering , Faculty of Engineering , Ain Shams University .

From To

No part of this thesis has been submitted for a degree or qualification
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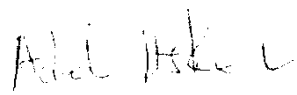
**Signature :** 
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# ACKNOWLEDGMENTS

The author would like to express his deepest thanks, gratitude and appreciation to **Prof. Dr. GAMAL ELDIN NASSAR** , Professor of theory of structures, Faculty Of Engineering, Ain Shams University, for suggesting and supervising the work and for his constructive criticisms and his sincere co-operation and support through his work.

The author is fully indebted to **Dr. IBRAHIM SHAWKY MOHARRAM** , Assistant. Professor of theory of structures, Faculty Of Engineering, Ain Shams University, for his supervising and guidance through this work, his suggestion of the problem, his follow up and his keen interest formed the back-bone of the study.

The author wishes also to express his deep gratitude and sincere appreciation to **Dr. KAMAL SAID ABDEL AZIZ** , Assistant. Professor of theory of structures, Faculty Of Engineering, Ain Shams University, Cairo, for his guidance supervision and his kind help during preparation of the thesis.

The author also wishes to extend his thanks to the staff of theory of structures department and computer center of Faculty Of Engineering, Ain Shams University, Cairo, for their contribution in the computation contained in this work.

# ABSTRACT

The present work is concerned with an analytical and theoretical study of coupled shear walls with one row of openings. The coupled shear wall is considered one of the main elements for bearing of high rise buildings and most resistant to the vertical and horizontal ( lateral ) loads that occur as a result of wind settlement at foundation levels and earthquakes .

The thesis also presents a mathematical model and a computer program based on " Transfer Matrix Method " to solve the coupled shear wall with one row of opening , and this model also gives accurate results for deflection , rotation , relative movement between the two wall braces ( slip ) , internal forces and normal stress in comparison with the " Finite elements method " .

In this thesis the effect of opening size , shape of wall section height of the wall , position of opening and the curtailment of a coupled shear wall with one row of opening is studied through a complete paramatric study .

# INDEX

# INTRODUCTION

The term shear wall is actually a misnomer as far as high-rise buildings are concerned. The analysis of shear walls in multistory buildings has received the attention of many civil engineers in recent years. Conventionally shear walls are introduced into tall buildings for the purpose of offering resistance to translator movements, e.g. those caused by winds and earthquakes. Many times, however, for either architectural or environmental reasons, engineers introduce a series of openings into the shear walls, thereby reducing their efficiency and altering their deformation characteristics.

Figure ( A ) illustrates various types of shear walls in multistory buildings. The Scheme( A-1 ) has shear walls without openings across the building with an access through a gallery running alongside the building. Each wall accepts a share of the lateral load proportional to its stiffness. The calculation of lateral stiffness is simple and stresses in such shear walls without openings involve simple bending theory only.

Scheme( A-2 ) and ( A-3 ) of figure ( A ) have interior corridors and interrupted by an opening on each floor and they are interconnected either by slabs or beams. The major shear walls are usually in the transversal direction of building, separating the individual apartments, stability in the longitudinal direction is normally provided by elevator shafts or some longitudinal shear walls. Such structural system as shown

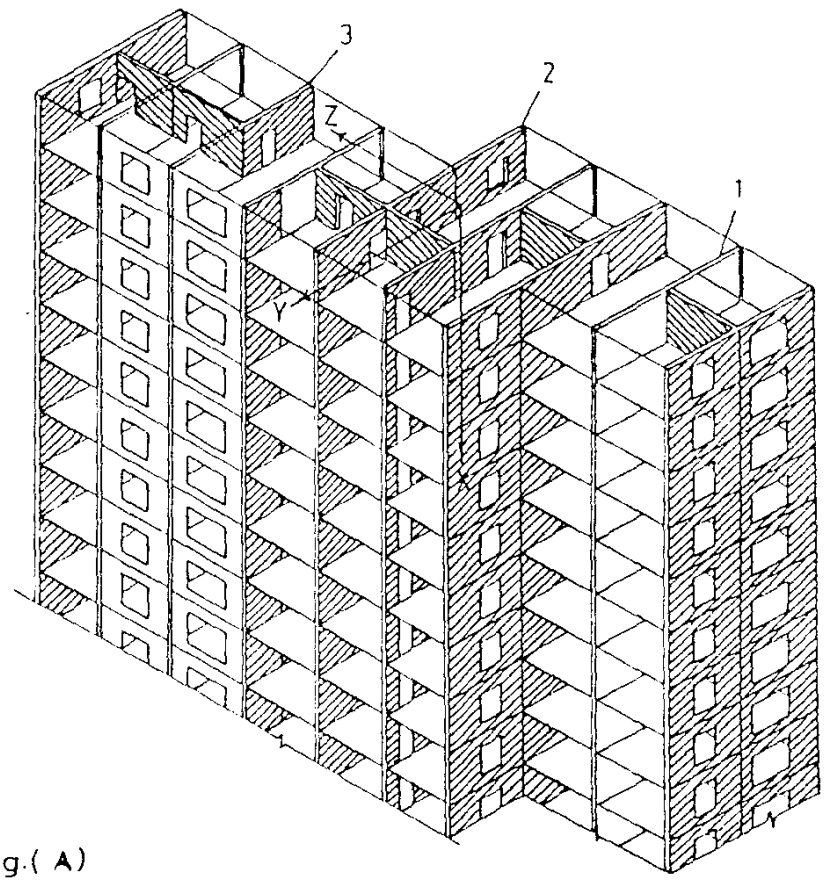


Fig.( A)

Schematic diagram of the bearing system of a multi_storey bulding

in Figure ( A ) are known as egg-crate or crosswall buildings; they are extremely rigid in the direction of the shear walls.

Shear walls with openings on each floor level present a much more complex problem to the analyst. Openings normally occur in vertical rows throughout the height of the wall and the connection between the wall sections is provided by either connecting beams which form part of the wall, or floor slabs, or a combination of both. The terms " coupled shear walls ", " pierced shear walls " and " shear wall with openings " are commonly used to describe such units as shown in figure ( B ).

If the openings are very small, their effect on the overall state of stress in a shear wall is minor. Larger openings have a more pronounced effect and, if larger enough, result in a system in which typical frame action predominates. From the standpoint of structural analysis, the problem is highly redundant, and a mathematical analysis for determination of stresses and deformations of the shear walls and connecting lintel beams is, therefore extremely complex. Since the 1960s a considerable amount of research information has become available, and a simplified and more accurate method of analysis of shear walls with openings have been suggested. These methods, in its most basic form, assumes that elastic structural properties of the coupled wall system remain constant throughout, that both walls are found in a common stiff footing, and that the points of contraflexure of all lintel beams are at midlength of lintel beams. In this method, the individual connecting beams of figure ( B-1 ) are replaced by a continuous connection of laminae as shown in figure ( B-2 ).

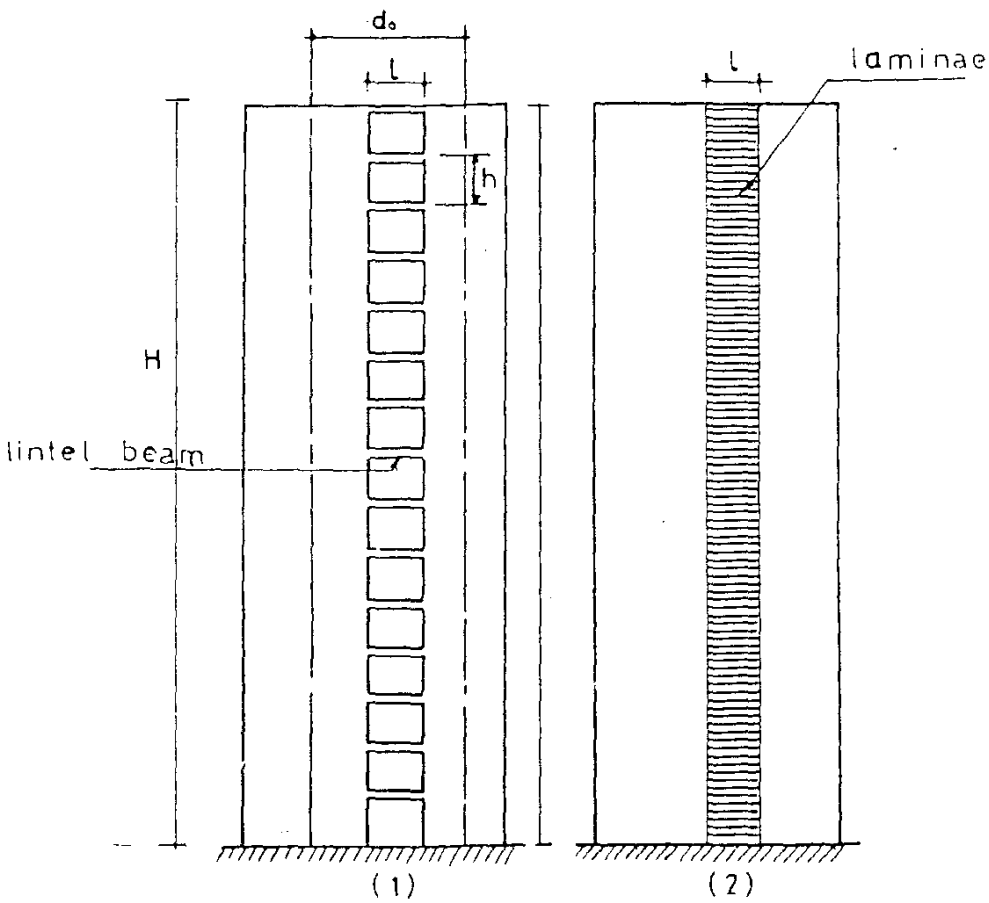


Fig:(B) Coupled shear walls

Analytical methods employing computerized frame analysis are not only more accurate but are considerably more flexible and can take into account many more variables than the continuum approach which was originally developed for manual operation.

For analysis of multistorey shear walls with openings, a good computer program considers a frame with finite joints in which the wall is analyzed as a frame except that the finite width of the columns in comparison with the lintel beam is recognized. The analogy, in which the beams are assumed to be infinitely stiff from the centerline of the column ( wall ) to the edge of the actual opening, is illustrated in figure ( C ). The calculation can take into account changes in wall thickness, storey height and concrete strength at various locations within the height of the building.

Width of slab to be considered in frame action between wall and slab has received by far insufficient research using reinforced concrete specimens despite this important aspect of shear wall design; in fact, available test experience is contradictory. Values less than the full width, equal to the full width, and greater than the full width have all been shown to be valid under different circumstances on elastic models and analytical studies. Clearly, there are many factors affecting the behavior of more complex wall systems which cannot yet be handled easily by theoretical means. The consequences of choosing an effective width should be full understood by the designer.