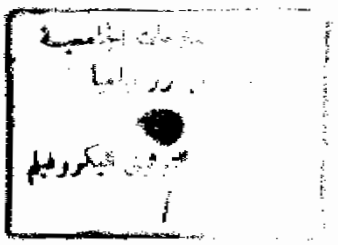
Ain Shams University
Faculty of Engineering

STABILITY OF THREE DIMENSIONAL STRUCTURES UNDER DYNAMIC LOADS

A THESIS

Submitted in Partial Fulfillment of
the Requirement for the Degree of
Master of Science in
Civil Engineering (Structural)



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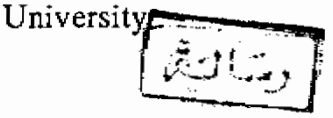

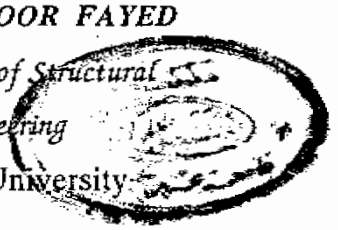

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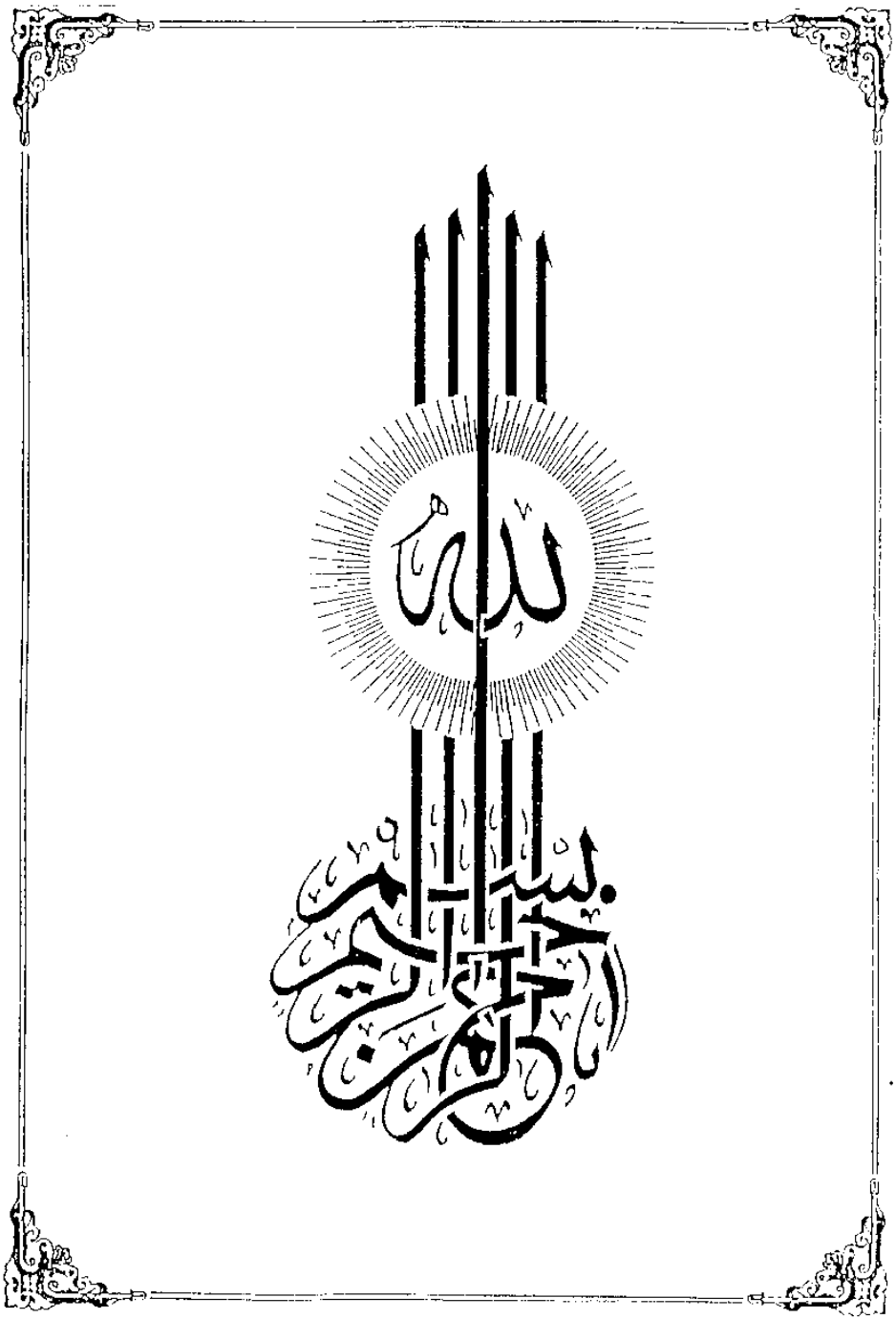

STATEMENT

This thesis is submitted to Ain Shams University for the Degree of Master of Science in Structural Engineering.

The work included in this thesis was carried out by the auther in the department of Structural Engineering, Ain Shams University, from Oct. 1984 to May 1994.

No part of this thesis has been submitted for a degree or a qualification at any other University or Institute except when due reference is made in text of thesis.

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1.1 BACKGROUND

Modern technology requires a more exact knowledge of the structure's behaviour, under severe loading conditions. The cost of a structural failure can be very high in the case of framed buildings, bridges, ... etc.. The nonlinear structural analysis serves the purpose of determining the type of failure and its causes. Using the nonlinear analysis is an important tool, to better understanding of the exact behaviour of the structures.

During the recent years, the possibility of practical static and dynamic nonlinear analysis of structures has progressed substantially due to the effective use of digital computers operating on finite element representations of the structures. To enable general nonlinear analysis, the development of versatile geometric and material nonlinear finite elements is in much need, and along these elements the use of an effective three dimensional beam and plate elements is very important.

The stability of structures under static loading has been the subject of considerable research during the past three decades [1-14]. However, the problem of nonlinear response and stability of these structures under dynamic loads has thus far received only limited attention [15-17]. Although the feasibility of performing nonlinear dynamic analysis of three-dimensional structures has been demonstrated by a number of previous researchers, the nonlinear response and stability of these structures under dynamic effects is not clearly understood, and the literature contains very

limited numerical data on the subject which can be used for design purposes.

The early works in structural mechanics which form the background of this research are in the areas of elastic and plastic analysis of structures and in the theory of stability and buckling. The former subject is summarized in, for example, the book by Hodge [18], while the latter is covered in the books by Timoshenko [19] and Bleich [20]. The theory of post-buckling behaviour of structures and the theory of limit states in the presence of plastic deformations and buckling are relatively newer developments [21, 22]. Significant progress in research in this field has been achieved during the past decade through the use of the finite elements method [23 - 27].

The finite element method [28] has proven to be a versatile method of analysis in the large deflection and elastic or plastic ranges of behaviour of structures with general shape and boundary conditions, including the elastic and plastic nonlinear analysis of beams and plates under both in plane and lateral loadings. Fabrication imperfections, such as residual stresses and deflections, which can have a great influence on the ultimate strength of compression members, can be easily accounted for. It is for these reasons that the finite element method is in widespread use for the buckling, post-buckling and ultimate strength analysis of plates [29 - 34].

1.2 THE PRESENT APPROACH

The basis of the formulation of the problem in this thesis is the Lagrangian continuum description of material bodies specialized to elementary thin plate theory and elementary beam theory. Displacement gradients (rotations) are assumed moderately large to preserve the validity