

Ain Shams University
Faculty of Engineering

BEHAVIOUR AND ANALYSIS OF FLAT SLAB

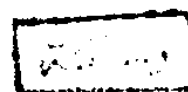
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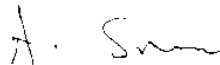
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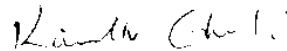
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STATEMENT

This dissertation 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 author in the Department of structural Engineering, Ain Shams University, From 1983 to 1990.

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

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BEHAVIOUR AND ANALYSIS OF FLAT SLAB

M. Sc. Thesis in Civil Eng.

Dept. of Structural Eng., Ain Shams University

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ABSTRACT

A general finite element analysis is developed to analyze reinforced concrete slabs. The nonlinear analysis includes the composite nature of reinforced concrete, stress-strain relationships for the concrete and reinforcement, anisotropy arising from unequal Young's moduli in the principal directions due to the different stress levels, changes caused by the development of cracks and tension stiffening effects of concrete.

A layered quadrilateral isoparametric element is used to obtain accurate results, and a general computer program was developed. The validity of the program was tested by comparing its results from several numerical examples with those obtained experimentally and analytically by other researchers.

A numerical example of flat-plate floor was solved by different "National Building Codes", (Egyptian, American, Canadian, Australian, Indian, British and German), as well as by the finite element analysis to show the differences, also to explain the effect of including some logical concepts in the design.

Some factors were studied by the finite element analysis to investigate the behaviour of flat-plate structures such as the effects of different loading stages, the effects of the span-column ratios, and the effects of the length of the cantilever slab on the behaviour of flat-plate structures.

Keywords: Flat Plate, Finite Element, Nonlinear Analysis, Reinforced Concrete, Stress-Strain Relationship, Layered Quadrilateral Isoparametric Element, Cantilever Slab.

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TO MY FAMILY

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Table of Contents

TABLE OF CONTENTS

	PAGE
CHAPTER 1 INTRODUCTION	
1.1 General Remarks	1
1.2 Historical Background	4
1.3 Purpose and scope of the present study	7
CHAPTER 2 DIFFERENT METHODS FOR SOLVING PLATES	
2.1 Introduction.....	9
2.2 Classical Plate Bending Theory.....	10
2.3 Strain Energy Method.....	21
2.4 Strip Method.....	25
2.5 Finite Difference Method.....	28
2.6 Grid Method.....	35
2.7 Yield Line Method.....	38
CHAPTER 3 FINITE ELEMENT ANALYSIS	
3.1 General.....	47
3.2 Variational Formulation and Approximation	48
3.3 Ritz Method Solution Techniques	49
3.4 Interpolation functions	51
3.5 Numerical Integration.....	53
3.6 Isoparametric Elements	57
3.7 Bending of Elastic Plates.....	59
3.8 Procedure of the Finite Element Analysis.....	64
3.8.1. Computer Implementation.....	66
3.8.2. Numerical Results	68

CHAPTER 4 NONLINEAR F.E. ANALYSIS

4.1 Material Properties of Reinforced Concrete.....	73
4.1.1 Previous Studies.....	74
4.1.2 Concrete.....	77
4.1.2.1 Stress-Strain Relationship.....	77
4.1.3 Steel.....	87
4.1.3.1 Stress-Strain Relationship.....	88
4.2 Layered Discretization.....	88
4.2.1 Evaluation of the Element stiffness.....	89
4.2.2 Evaluation of Layer Strains and Stresses.	90
4.3 Concrete Cracking.....	91
4.4 Solution of the Nonlinear Equations	96
4.5 Computer Program	99

CHAPTER 5 COMPARISON BETWEEN ANALYTICAL AND EXPERIMENTAL RESULTS

5.1 General	103
5.2 Simply Supported Beam.....	103
5.3 One Way Slab.....	109
5.4 Two Way Slab.....	113
5.5 Corner Supported Slab.....	122

CHAPTER 6 DESIGN OF FLAT-SLABS

6.1 Development of Code Design Methods	128
6.2 Comparison between Different National Building Codes.....	129

6.3 Solved Example.....	134
6.3.1 Comparison between the Results.....	138
6.3.2 Discussion of General Remarks.....	145
6.4 Suggested Logical Concepts.....	150
 CHAPTER 7 PARAMETRIC STUDIES	
7.1 General Remarks.....	156
7.2 Behavior of Flat-Plate through the History of Loading	156
7.2.1 Analysis of the Results.....	157
7.2.2 Discussion of the Results.....	158
7.3 Effect of Span-Column Ratios.....	161
7.3.1 Analysis of the Results.....	161
7.3.2 Discussion of the Results.....	162
7.4 Effect of Cantilever Slabs on Flat-Plate Structure	163
7.4.1 Analysis of the Results.....	164
7.4.2 Discussion of the Results.....	165
 CHAPTER 8 CONCLUSIONS	
8.1 Summary.....	199
8.2 Conclusions.....	202
8.3 Suggestions for Further Studies.....	206
 REFERENCES	207

Chapter 1

Introduction

CHAPTER 1

INTRODUCTION

1.1 GENERAL REMARKS

Flat-slab and flat-plate floors are characterized by the absence of beams along the interior column lines, but edge beams may or may not be used at the exterior edges of the structure. Flat-slab floor differs from flat-plate floor in that, the either or both of the following; (1) drop panels ; or (2) column capitals, but in flat-plate floor a uniform slab thickness is used. Flat-plate system is used when the spans are small and the loads are not so heavy. For larger spans and heavier loads the flat-slabs can be used.

Nowadays, flat-plates are becoming more popular. Such floor systems, which consist of a reinforced concrete slab supported directly on columns, have several features which make them attractive in terms of construction, time and the overall economy.

For instance, the most important of their advantages may be enumerated as the following;

- 1- The cost of form work and workmanship for placement of the reinforcement are substantially reduced.
- 2- From architecture point of view, flat-plate floors are favoured since they provide a smooth ceilings.

- 3- The system provides a great flexibility in locating the interior partitions.
- 4- The floor systems require lesser depth because there are no beams. Hence, there will be a reduction in the story height, which leads to the smaller total building height.
- 5- The flat-plate floor, owing to the lack of many sharp corners, is better in resisting continued exposure to fire than the beam and girder floor.^[40]
- 6- Windows can be extended up to the underside of the slab, and there are no beams to obstruct the light and the circulation of air. So, the illumination and ventilation are better.

As the flat-plates have extensively been used, their correct design is of primary interest to the designer to ensure safety, as well as, an economical design. The most important methods which are used for the analysis of plates are the following;

- 1- Direct design method or empirical method.
- 2- Equivalent frame method.
- 3- Classical plate bending method.
- 4- Strip method.
- 5- Finite difference method.
- 6- Grid method.
- 7- Yield line method.
- 8- Finite element method.

The most practicing engineers, whose experience are limited to use the advanced methods of analysis, normally use the different codes for design such a structural element. It should be realized that the code provisions are based on a combination of experience, judgement, tests and theoretical analysis.

With the increasing use of the ultimate load methods in the analysis, and design of reinforced concrete slabs, it becomes necessary to trace the complete response history of the structure through, pre and post cracking ranges, until failure. So, the true factor of safety against failure is assessed and serviceability requirements as regards deformations and cracking are ensured. Such response can be correctly predicted by taking into consideration the following items;

- (1) The composite nature of reinforced concrete.
- (2) Nonlinear material characteristics.
- (3) Anisotropy arising from unequal Young's moduli in the principal directions due to different stress levels reached under increasing load.
- (4) Changes caused by the development of cracks.

Yield line theory for slabs estimates only the ultimate loads. The finite element method provides a good technique for such analysis. This method has been developed