STABILITY OF SHEAR DIAPHRAGMS

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THESIS SUBMITTED TO
STRUCTURAL DEPARTMENT FACULTY OF ENGINEERING
AIN SHAMS UNIVERSITY (CAIRO)

FOR
DEGREE OF MASTER OF SCIENCE IN STRUCTURAL ENGINEERING

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بسم الله الرحمن الرحيم

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NOTATIONS

The following symbols are used in the present thesis. Other symbols not listed below are defined where they are used.

a	: Length of rectangular element parallel to corrugations.
b	: Depth of rectangular element perpendicular to the corrugations.
aa, bb	: Panel dimensions.
C	: Overall shear flexibility (mm/kg).
D_x, D_y, D_{xy}	: Bending stiffness of profiled sheets per unit length.
D	: Pitch of corrugation.
E	: Modulus of elasticity of steel.
G_{xy}	: Modulus of elasticity in shear.
H	: Height of sheet profile.
I_y	: Second moment of area about the neutral axis for a single corrugation.
K_e	: Element bending stiffness matrix.
K_g	: Element geometric stiffness matrix.
K_r	: Element stiffness matrix for plan stress.
$\overline{K}$	: Sheet constant for distortional flexibility
N_{cr}, N	: Critical value of shear buckling load.
L	: Width of corrugation crest.
Q	: Applied shear force on panel.

S	:	Perimeter length of a single corrugation.
t	:	Net sheet thickness excluding galvanising and coatings.
u	:	Nodal in-plane displacement in the x-direction.
v	:	Nodal in-plane displacement in the y-direction.
V	:	Poisson's ratio.
W	:	Deflection normal to plate mid surface.
B,	:	Panel dimensions perpendicular to corrugation and parallel to it.
$\theta_x, \theta_y, \theta_{xy}$,	:	Generalized nodal rotations.
λ	:	Shear buckling load factor.
σx, σy	:	Normal stresses in x and y directions.
τ_{xy}	:	Shear stress in xy plane.

To...

My Parents

ACKNOWLEDGEMENT

The author wishes to express his sincere gratitude to Professor Dr. Adel Helmi Salem, Professor of Mettallic constructions and Bridges, structural Engineering Department, Faculty of Engineering, Ain Shams University, Cairo, for his guidance, supervision and continicus encouragement.

The author is also wishes to express his deep gratitude to Dr. Mostafa Zidan, Assistant professor of structural analysis, structural Engineering Department, Faculty of Engineering, Ain Shams University, Cairo, for his guidance, supervision. Also, he devoted much of his precious time and effort in order to achieve this work in a successful form.

The author is deeply indepted to Professor Dr. Aly Abd-el Rahman Yousif Professor of Reinforced concrete, structural Engineering Department, Faculty of Engineering, Cairo University, Giza, for his valuable help and useful comments.

The author is also very thankful to Dr. Abdel Raouf Watson Beshara. Assistant Professor of structural analysis, structural Engineering Department, Faculty of Engineering, Ain Shams University, Cairo for his valuable help in presenting this work.

The author wishes to thank the staff of the scientific computation center of Cairo University and the scientific computation center of Faculty of Engineering, Ain Shams University, Cairo.

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INTRODUCTION

The corrugated metal sheet is a familiar structural element because of its frequent use as roofing and siding material in building construction. More recently it has also been used for the internal spar webs of high speed aircraft in order to avoid high thermal stresses due to temperature differences between the outer skin and the internal webs of air craft. one of the important loading conditions on the corrugated plate in these applications is the in-plane shear load which may be caused by wind forces, blast forces and seismic or earthquake forces.

As steel becomes increasingly expensive, it becomes more important to take into consideration-during building design-enormous structural potential in the steel skin of a building. To neglect its influence on performance of the structure as a whole is to waste a valuable asset.

The potential benefits of stressed skin diaphragm action first became apparent over 30 years ago when tests on actual buildings revealed stresses and deflections considerably smaller than those predicted by the usual design calculations. The increasing utilisation of the diaphragm effect has been accompanied by the appearance of several National and International Codes of Practice and other Codes are known to be in the course of preperation.

Internal forces (fastener forces and plate stresses), flexibility and critical shear buckling load are the main items required for building design.

In this thesis, shear buckling load of corrugated sheet panels is studied using Finite Element Method. A generalized computer program for dealing with these panels has been developed and the effect of section dimensions, thickness, and aspect ratio has been studied and compared with the results of the Eureopean Recommendation Formula. The well known program SAP IV is also used to study internal forces and flexibility of the corrugated sheet panels having openings with different sizes and positions.

The thesis is composed of five chapters:-

CHAPTER 1 :

In this chapter review of previous work, definitions and principles of diaphragm action are introduced. It describes the main methods used in dealing with the analysis of shear panels. These methods are experimental testing, expressions and finite element method. The development of shear buckling load formula of such panels is also introduced.

CHAPTER 2 :

It gives the outlines of the computer programs used in performing the present work. The first program, PBUK, is written for determining the buckling shear load of corrugated panels treated as orthotropic plates with different flexurl stiffness in two perpendicular directions. PBUK is written in Fortran IV and consists of main program and five subroutines. The second program is the SAP IV which is a structural analysis program for static and dynamic response of linear systems. This program is used to determine the panel flexibility and its internal actions.

CHAPTER 3 :

In this chapter the problem of determining the shear buckling load of corrugated sheet diaphragms is examined. Firstly, a parametric study on the shear buckling load formula recommended by the European Recommendations for Stressed Skin Design is carried out. PBUK program is used in studying the problem and to check this formula by comparing its results with those of the program. The study was carried out on a wide range of panel properties. A modification for the European Formula is proposed.

CHAPTER 4 :

In this chapter, the effect of openings on the stiffness and the internal forces of shear diaphragms is studied. The diaphragm with its different components is idealized structurally by using the technique of finite element method. This method is used in the analysis through the computer program SAP IV. Many practical examples of diaphragms with different numbers and positions of openings are investigated.

In CHAPTER 5 conclusions and results are presented.