Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

COMPARATIVE ANALYSIS OF A PRESSURE VESSEL

Finite Element Analysis versus Speckle Photography

ZUPING WANG

1994

A thesis presented in fulfilment
of the requirements for the degree of
Master of Technology
Massey University

CONTENTS

Abstract 1
Acknowledgements 2

1 Introduction 3

2 Literature Survey 8
2.1 History of Finite Element Method 8
2.2 A brief survey of Speckle Photography 10

3 Finite Element Computations 12
3.1 Finite Element Computational Model 12
3.2 MYSTRO and LUSAS Programs 14

4 Pressure Vessel Model 18
4.1 Configuration 18
4.2 Features and Attributes 19
4.3 Meshes 24
4.4 Geometry, Materials, Support and Loading 31

5 Running LUSAS 44
5.1 Running LUSAS 44
5.2 Running expose 47

6 Results Analysis 51
6.1 Displacement 52
6.2 Deformation 56
6.3 Stress 58
6.4 A summary of the results from FEM 62
6.5 Results from the pressure vessel design formulas 77

6.6 Results from Laser Speckle Photography Experiment 78
6.7 Comparison of displacements and stresses determined by FEA, LSP and the pressure vessel design formulas 80

7 Conclusions 85

8 Thoughts on further work 87

9 References 89

10 Index 92

Appendices A1
Appendix I Equilibrium, Compatibility and the Stress/Strain law A1
Appendix II Input data list A3
Appendix III Output data list A20

ABSTRACT

A detailed explanation and analysis are presented of the Finite Element Method used to solve the stress/strain situation in a small pressure vessel. A pressure vessel was modelled whose displacement characteristics were previously analysed using speckle photography. The Mystro/Lusas finite element software was used on a PC 486 computer system. A linear and static analysis was made. Contour plots of direct stress and shear stress distribution are presented which also show the highest stress areas. A comparison of the results from Finite Element Method and Speckle Photography Method as well as the pressure vessel design formulas are presented. Advantages of the Finite Element Method are discussed.

ACKNOWLEDGEMENTS

I would particularly like to express my gratitude to my supervisor Dr.E.W.Smith for his guidance, advice, valuable suggestions, constructive criticism and encouragement during all my work.

I wish to express my special thanks to Mr.Len Chisholm, System programmer, Department of Production Technology, for his specialised expertise and skill in computer systems.

I would like to thank Mr.Farshad Nourozi, Electronics/Software Technical Officer and Mrs. Vicki Spagnolo, Computer Programmer, for providing me with skilled assistance for the Macintosh computer and laser printer. I also would like to thank Miss Heather North, Graduate Assistant, Department of Production Technology, for sharing her knowledge in Laser Speckle Photography and providing encouragement.

I am indebted to the New Zealand government and Massey University for the award of a MERT scholarship whilst carrying out this study.

I also wish to take the opportunity to express my deepest gratitude to my parents and my family, as well as those who have loved, cared and helped me.

Words are inadequate to express my profound gratitude.

ZUPING WANG