

TABLE OF CONTENTS

PREFACE	xi
ACKNOWLEDGEMENTS	xiii
SYMBOLS	xv

Chapter 1

INTRODUCTION	1
1.1 Numerical analysis of plated structures	1
1.2 Purpose of this book	2
1.3 Structure of this book	3

Chapter 2

AREA OF APPLICATION	5
2.1 Typical rectangular plates	5
2.1.1 Introduction	5
2.1.2 Tolerances	5
2.1.3 Structural behaviour and classification	7
2.2 Arbitrary geometries and boundary conditions	9

Chapter 3

CALCULATION METHODS AND SOFTWARE REQUIREMENTS	11
3.1 Overview of calculation methods	11
3.2 Linear analysis (LA)	13
3.3 Linear buckling analysis (LBA)	13
3.4 Material nonlinear analysis (MNA)	16
3.5 Geometric nonlinear analysis including imperfections (GNIA)	17
3.6 Geometric and material nonlinear analysis including imperfections (GMNIA)	18
3.7 Software requirements	20

Chapter 4

MODELLING (PREPROCESSING)	23
4.1 Material properties	23
4.2 Mesh discretisation	25

4.3	Boundary conditions	27
4.3.1	General	27
4.3.2	Definition of supports	28
4.3.3	Definition of loads	40
4.3.3.1	Load-controlled analysis	40
4.3.3.2	Displacement controlled analysis	44
4.4	Imperfections	45
4.4.1	Types of imperfections	45
4.4.2	Geometric imperfections	47
4.4.3	Residual stresses	49
4.4.4	Equivalent geometric imperfections	50

Chapter 5

SOLUTION SETTINGS		53
5.1	General	53
5.2	Importance of large deformations	54
5.3	Prestress effect	54
5.4	Solver selection	55
5.5	Setting the convergence criterion	57
5.6	Time increment settings	57
5.7	Overcome convergency problems	58
5.8	Solution printout	60

Chapter 6

EVALUATION AND VERIFICATION (POSTPROCESSING) AND INTERPRETATION OF RESULTS		61
6.1	Evaluation	61
6.2	Verification	62
6.3	Interpretation	64

Chapter 7

BENCHMARK EXAMPLES		67
7.1	Longitudinally stiffened panel under normal force	67
7.1.1	Overview	67
7.1.2	Experimental test	67
7.1.3	Imperfection	69

7.1.4	Element selection	73
7.1.5	Material model	74
7.1.6	Comparing the results from the tests and the modelling	75
7.2	Longitudinally stiffened panel subjected to shear force	77
7.2.1	Introduction	77
7.2.2	Geometrical and material data	79
7.2.3	Support condition and loading	82
7.2.4	Imperfections	82
7.2.5	Results	84
7.3	Web in bending with weak stiffeners	86
7.3.1	Laboratory tests	86
7.3.2	Numerical model development	88
7.3.3	Applied imperfections	90
7.3.4	Comparison of test and numerical results	92
7.4	Transversally stiffened steel plate girder subjected to patch loading	94
7.4.1	Experimental test	95
7.4.2	Assessment of numerical assumptions	97
7.4.3	Assessment of geometrical and structural conditions	100

Chapter 8

WORKED EXAMPLES 105

8.1	Bottom plate with trapezoidal stiffeners	105
8.1.1	Introduction	105
8.1.2	Finite element model and boundary conditions	106
8.1.3	Linear structural analysis (LA) and linear buckling analysis (LBA)	108
8.1.4	Nonlinear buckling analysis including imperfections (GMNIA)	110
8.1.5	Comparison with other methods from EN 1993-1-5	113
8.2	Web subjected to shear and bending	115
8.2.1	Introduction	115
8.2.2	Geometric properties of the model	117
8.2.3	Materials	118
8.2.4	Supports	119
8.2.5	Loads	119
8.2.6	Linear buckling analysis	119

8.2.7	Initial imperfections	122
8.2.8	Main results of nonlinear analysis	124
8.3	Patch loading verification of a box girder bridge	127
8.3.1	Introduction	127
8.3.2	Cross section dimensions	129
8.3.3	Static scheme, loads and supports	132
8.3.4	Materials	133
8.3.5	Linear buckling analysis	134
8.3.6	Initial imperfections	135
8.3.7	Nonlinear buckling analysis including imperfections	135
8.3.8	Interaction curve bending moment M and reaction R	137
SUMMARY AND CONCLUSIONS		139
BIBLIOGRAPHIC REFERENCES		141