DIN EN 1993-1-6:2026-08 (E)

Eurocode 3 - Design of steel structures - Part 1-6: Strength and stability of shell structures

Contents

Page

European foreword 5

0 Introduction 7

1 Scope 10
1.2 Assumptions 11

2 Normative references 12

3 Terms, definitions and symbols 12
3.1 Terms and definitions 12
3.2 Symbols 22
3.3 Sign conventions 29

4 Basis of design 29
4.1 General rules 29
4.2 Types of analysis 30
4.3 Shell boundary conditions 33
4.4 Verification by the partial factor method 34

5 Materials and geometry 35
5.1 Material properties 35
5.2 Design values of geometrical data 36
5.3 Geometrical tolerances and geometrical imperfections 36

6 Structural analysis 37
6.1 Types of design 37
6.2 Stress resultants and stresses in shells 39
6.3 Ultimate limit states to be considered 43
6.4 Concepts for the limit state verifications 46

7 Plastic failure Limit State (LS1) 47
7.1 Design values of actions 47
7.2 Stress design 47
7.3 Design by computational MNA or GMNA analysis 49
7.4 Design using standard formulae 50

8 Cyclic plasticity Limit State (LS2) 50
8.1 Design values of actions 50
8.2 Stress design 51
8.3 Design by computational GMNA analysis 51
8.4 Design using standard formulae 52

9 Buckling Limit State (LS3) 52
9.1 Design values of actions 52
9.2 Special definitions and symbols 52
9.3 Buckling-relevant boundary conditions 53
9.4 Buckling-relevant geometrical tolerances 56
9.5 Stress design 66
9.6 Design using reference resistances 70
9.7 Design by computational analysis using LBA and MNA analyses 72

9.8 Design by computational analysis using GMNIA analysis 77

10 Fatigue Limit State (LS4) 84
10.1 Design values of actions 84
10.2 Stress design 85

(informative) Membrane theory stresses in unstiffened shells 89

A.1 Use of this Annex 89
A.2 Scope and field of application 89
A.3 General 89
A.4 Cylindrical shells 91
A.5 Conical shells 92
A.6 Spherical shells 94

(informative) Formulae for plastic reference resistances of unstiffened shells and circular plates ... 95

B.1 Use of this Annex 95
B.2 Scope and field of application 95
B.3 General 95
B.4 Uniform unstiffened cylindrical shells 96
B.5 Cylindrical shells with local ring stiffeners 99
B.6 Junctions between conical and cylindrical shells 101
B.7 Circular plates with axisymmetric boundary conditions 103

(informative) Formulae for linear elastic membrane and bending stresses in unstiffened cylindrical shells and circular plates 105

C.1 Use of this Annex 105
C.2 Scope and field of application 105
C.3 General 105
C.4 Clamped base cylindrical shells 106
C.5 Pinned base cylindrical shells 110
C.6 Internal conditions in cylindrical shells 114
C.7 Local ring stiffener on a cylindrical shell 117
C.8 Circular plates with simply supported boundary conditions 119
C.9 Circular plates with clamped boundary conditions 120

(normative) Formulae to determine the buckling resistance of unstiffened shells when using stress design 122

D.1 Use of this annex 122
D.2 Scope and field of application 122
D.3 Cylindrical shells of constant wall thickness: basic load cases 122
D.4 Cylindrical shells of constant wall thickness: combined cases 133
D.5 Cylindrical shells of stepwise variable wall thickness 138
D.6 Lap jointed cylindrical shells 147
D.7 Complete and truncated conical shells 149

(normative) Formulae to determine the buckling resistance of unstiffened shells when using reference resistance design 154

E.1 Use of this annex 154
E.2 Scope and field of application 154
E.3 Cylindrical shells under uniform global bending 154
E.4 Spherical dome shells 159

Bibliography 164