DIN EN 1090-2:2008-12 (E)

Execution of steel structures and aluminium structures - Part 2: Technical requirements for steel structures

Contents

Page

Foreword 9

Introduction 10

1 Scope 11

2 Normative references 12
2.1 General 12
2.2 Constituent products 12
2.2.1 Steels 12
2.2.2 Steel castings 14
2.2.3 Welding consumables 14
2.2.4 Mechanical fasteners 15
2.2.5 High strength cables 16
2.2.6 Structural bearings 17
2.3 Preparation 17
2.4 Welding 18
2.5 Testing 19
2.6 Erection 19
2.7 Corrosion protection 20
2.8 Tolerances 20
2.9 Miscellaneous 20

3 Terms and definitions 21

4 Specifications and documentation 23
4.1 Execution Specification 23
4.1.1 General 23
4.1.2 Execution classes 23
4.1.3 Preparation grades 24
4.1.4 Geometrical tolerances 24
4.2 Constructor's documentation 24
4.2.1 Quality documentation 24
4.2.2 Quality plan 24
4.2.3 Safety of the erection works 25
4.2.4 Execution documentation 25

5 Constituent products 25
5.1 General 25
5.2 Identification, inspection documents and traceability 25
5.3 Structural steel products 26
5.3.1 General 26
5.3.2 Thickness tolerances 28
5.3.3 Surface conditions 28
5.3.4 Special properties 29
5.4 Steel castings 29
5.5 Welding consumables 29
5.6 Mechanical fasteners 31
5.6.1 General 31
5.6.2 Terminology 31
5.6.3 Structural bolting assemblies for non preloaded applications 31

5.6.4 Structural bolting assemblies for preloading ... 31
5.6.5 Direct tension indicators ... 32
5.6.6 Weather resistant assemblies ... 32
5.6.7 Foundation bolts ... 32
5.6.8 Locking devices ... 32
5.6.9 Taper washers ... 32
5.6.10 Hot rivets ... 32
5.6.11 Fasteners for thin gauge components ... 33
5.6.12 Special fasteners ... 33
5.6.13 Delivery and identification ... 33
5.7 Studs and shear connectors ... 33
5.8 Grouting materials ... 34
5.9 Expansion joints for bridges ... 34
5.10 High strength cables, rods and terminations ... 34
5.11 Structural bearings ... 34

6 Preparation and assembly ... 34
6.1 General ... 34
6.2 Identification ... 35
6.3 Handling and storage ... 35
6.4 Cutting ... 37
6.4.1 General ... 37
6.4.2 Shearing and nibbling ... 37
6.4.3 Thermal cutting ... 37
6.4.4 Hardness of free edge surfaces ... 38
6.5 Shaping ... 38
6.5.1 General ... 38
6.5.2 Hot forming ... 39
6.5.3 Flame straightening ... 39
6.5.4 Cold forming ... 39
6.6 Holing ... 41
6.6.1 Dimensions of holes ... 41
6.6.2 Tolerances on hole diameter for bolts and pins ... 42
6.6.3 Execution of holing ... 42
6.7 Cut outs ... 43
6.8 Full contact bearing surfaces ... 44
6.9 Assembly ... 44
6.10 Assembly check ... 45

7 Welding ... 45
7.1 General ... 45
7.2 Welding plan ... 45
7.2.1 Requirements for a welding plan ... 45
7.2.2 Content of a welding plan ... 45
7.3 Welding processes ... 46
7.4 Qualification of welding procedures and welding personnel ... 47
7.4.1 Qualification of welding procedures ... 47
7.4.2 Welders and welding operators ... 49
7.4.3 Welding coordination ... 49
7.5 Preparation and execution of welding ... 51
7.5.1 Joint preparation ... 51
7.5.2 Storage and handling of welding consumables ... 52
7.5.3 Weather protection ... 52
7.5.4 Assembly for welding ... 53
7.5.5 Preheating ... 53
7.5.6 Temporary attachments ... 53
7.5.7 Tack welds ... 53
7.5.8 Fillet welds ... 54
7.5.9 Butt welds ... 54
7.5.10 Welds on steels with improved atmospheric corrosion resistance ... 55
7.5.11 Branch connections ... 55
7.5.12 Stud welding ... 55

7.5.13 Slot and plug welds 55
7.5.14 Spot welds for thin gauge components 56
7.5.15 Other weld types 56
7.5.16 Post-weld heat treatment 56
7.5.17 Execution of welding 56
7.5.18 Welding of bridge decks 57
7.6 Acceptance criteria 57
7.7 Welding of stainless steels 58
7.7.1 Amendments to EN 1011-1 requirements 58
7.7.2 Amendments to EN 1011-3 requirements 59
7.7.3 Welding dissimilar steels 60

8 Mechanical fastening 60
8.1 General 60
8.2 Use of bolting assemblies 60
8.2.1 General 60
8.2.2 Bolts 61
8.2.3 Nuts 61
8.2.4 Washers 61
8.3 Tightening of non-preloaded bolts 62
8.4 Preparation of contact surfaces in slip resistant connections 62
8.5 Tightening of preloaded bolts 63
8.5.1 General 63
8.5.2 Torque reference values 65
8.5.3 Torque method 65
8.5.4 Combined method 65
8.5.5 HRC method 66
8.5.6 Direct tension indicator method 66
8.6 Fit bolts 67
8.7 Hot riveting 67
8.7.1 Rivets 67
8.7.2 Installation of rivets 67
8.7.3 Acceptance criteria 68
8.8 Fastening of thin gauge components 68
8.8.1 General 68
8.8.2 Use of self-tapping and self-drilling screws 69
8.8.3 Use of blind rivets 69
8.8.4 Fastening sidelaps 70
8.9 Use of special fasteners and fastening methods 70
8.10 Galling and seizure of stainless steels 70

9 Erection 71
9.1 General 71
9.2 Site conditions 71
9.3 Erection method 72
9.3.1 Design basis for the erection method 72
9.3.2 Constructor's erection method 72
9.4 Survey 73
9.4.1 Reference system 73
9.4.2 Position points 74
9.5 Supports, anchors and bearings 74
9.5.1 Inspection of supports 74
9.5.2 Setting out and suitability of supports 74
9.5.3 Maintaining suitability of supports 74
9.5.4 Temporary supports 74
9.5.5 Grouting and sealing 75
9.5.6 Anchoring 76
9.6 Erection and work at site 76
9.6.1 Erection drawings 76
9.6.2 Marking 77
9.6.3 Handling and storage on site 77
9.6.4 Trial erection 77

9.6.5 Erection methods ... 78

10 Surface treatment ... 79
10.1 General ... 79
10.2 Preparation of steel substrates ... 80
10.3 Weather resistant steels ... 81
10.4 Galvanic coupling ... 81
10.5 Galvanizing ... 81
10.6 Sealing of spaces ... 82
10.7 Surfaces in contact with concrete ... 82
10.8 Inaccessible surfaces ... 82
10.9 Repairs after cutting or welding ... 82
10.10 Cleaning after erection ... 83
10.10.1 Cleaning of thin gauge components ... 83
10.10.2 Cleaning of stainless steels components ... 83

11 Geometrical tolerances ... 83
11.1 Tolerance types ... 83
11.2 Essential tolerances ... 84
11.2.1 General ... 84
11.2.2 Manufacturing tolerances ... 84
11.2.3 Erection tolerances ... 84
11.3 Functional tolerances ... 86
11.3.1 General ... 86
11.3.2 Tabulated values ... 86
11.3.3 Alternative criteria ... 86

12 Inspection, testing and correction ... 87
12.1 General ... 87
12.2 Constituent products and components ... 87
12.2.1 Constituent products ... 87
12.2.2 Components ... 87
12.2.3 Non conforming products ... 87
12.3 Manufacturing: geometrical dimensions of manufactured components ... 88
12.4 Welding ... 88
12.4.1 Inspection before and during welding ... 88
12.4.2 Inspection after welding ... 89
12.4.3 Inspection and testing of welded shear studs for composite steel and concrete structures ... 92
12.4.4 Production tests on welding ... 92
12.5 Mechanical fastening ... 93
12.5.1 Inspection of non-preloaded bolted connections ... 93
12.5.2 Inspection and testing of preloaded bolted connections ... 93
12.5.3 Inspection, testing and repairs of hot rivets ... 96
12.5.4 Inspection of cold formed components and sheeting fastening ... 96
12.5.5 Special fasteners and fastening methods ... 97
12.6 Surface treatment and corrosion protection ... 97
12.7 Erection ... 98
12.7.1 Inspection of trial erection ... 98
12.7.2 Inspection of the erected structure ... 98
12.7.3 Survey of geometrical position of connection nodes ... 98
12.7.4 Other acceptance tests ... 99

Annex A (normative) Additional information, list of options and requirements related to the execution classes ... 100

A.1 List of required additional information ... 100
A.2 List of options ... 103
A.3 Requirements related to the execution classes ... 107

Annex B (informative) Guidance for the determination of execution classes ... 111

B.1 Introduction 111
B.2 Governing factors for choice of execution class 111
B.2.1 Consequence classes 111
B.2.2 Hazards connected with execution and use of the structure 111
B.3 Determination of execution classes 112

Annex C (informative) Check-list for the content of a quality plan 114

C.1 Introduction 114
C.2 Content 114
C.2.1 Management 114
C.2.2 Specification review 114
C.2.3 Documentation 114
C.2.4 Inspection and testing procedures 115

Annex D (normative) Geometrical tolerances 116

D.1 Essential tolerances 116
D.1.1 Essential manufacturing tolerances - Welded profiles 117
D.1.2 Essential manufacturing tolerances - Press braked cold formed profiles 118
D.1.3 D.1.4 Essential manufacturing tolerances - Flanges of welded box sections 120
D.1.5 Essential manufacturing tolerances - Web stiffeners of profiles or box sections 121
D.1.6 Essential manufacturing tolerances - Stiffened plating 123
D.1.7 Essential manufacturing tolerances - Cold formed profiled sheets 124
D.1.8 Essential manufacturing tolerances - Fastener holes, notches and cut edges 125
D.1.9 Essential manufacturing tolerances - Cylindrical and conical shells 126
D.1.10 Essential manufacturing tolerances - Lattice components 127
D.1.11 Essential erection tolerances - Single storey columns 128
D.1.12 Essential erection tolerances - Multi-storey columns 129
D.1.13 Essential erection tolerances - Full contact end bearing 130
D.1.14 Essential erection tolerances - Towers and masts 130
D.1.15 Essential erection tolerances - Beams subject to bending and components subject to compression 131
D.2 Functional tolerances 132
D.2.1 Functional manufacturing tolerances - Welded profiles 133
D.2.2 Functional manufacturing tolerances - Press braked cold formed profiles 134
D.2.3 Functional manufacturing tolerances - Flanges of welded profiles 136
D.2.4 Functional manufacturing tolerances - Welded box sections 137
D.2.5 Functional manufacturing tolerances - Webs of welded profiles or box sections 138
D.2.6 Functional manufacturing tolerances - Web stiffeners of welded profiles or box sections 139
D.2.7 Functional manufacturing tolerances - Components 141
D.2.8 Functional manufacturing tolerances - Fastener holes, notches and cut edges 142
D.2.9 Functional manufacturing tolerances - Column splices and baseplates 143
D.2.10 Functional manufacturing tolerances - Lattice components 144
D.2.11 Functional manufacturing tolerances - Stiffened plating 145
D.2.12 Functional manufacturing tolerances - Towers and masts 147
D.2.13 Functional manufacturing tolerances - Cold formed profiled sheets 148
D.2.14 Functional manufacturing tolerances - Bridge decks 148
D.2.15 Functional erection tolerances - Bridges 150
D.2.16 Functional erection tolerances - Bridge decks (sheet 1/3) 151
D.2.17 Functional erection tolerances - Bridge decks(sheet 2/3) 152
D.2.18 Functional erection tolerances - Bridges decks (sheet 3/3) 154
D.2.19 Functional manufacturing and erection tolerances - Crane beams and rails 155
D.2.20 Functional tolerances - Concrete foundations and supports 156
D.2.21 Functional erection tolerances - Crane runways 158
D.2.22 Functional erection tolerances - Positions of columns 159
D.2.23 Functional erection tolerances - Single storey columns 160
D.2.24 Functional erection tolerances - Multi-storey columns 161
D.2.25 Functional erection tolerances - Buildings 162
D.2.26 Functional erection tolerances - Beams in buildings 163
D.2.27 Functional erection tolerances - Roof sheeting designed as a stressed-skin 164
D.2.28 Functional erection tolerances - Profiled steel sheeting 164

Annex E (informative) Welded joints in hollow sections 165

E.1 General 165

Essential manufacturing tolerances - Flanges of welded profiles 119
E.2 Guidance for start and stop positions 165
E.3 Preparation of joint faces 165
E.4 Assembly for welding 166
E.5 Fillet welded joints 173

Annex F (normative) Corrosion protection 174

F.1 General 174
F.1.1 Field of application 174
F.1.2 Performance specification 174
F.1.3 Prescriptive requirements 174
F.1.4 Work method 175
F.2 Surface preparation of carbon steels 175
F.2.1 Surface preparation of carbon steels prior to painting and metal spraying 175
F.2.2 Surface preparation of carbon steels prior to galvanizing 176
F.3 Welds and surfaces for welding 176
F.4 Surfaces in preloaded connections 176
F.5 Preparation of fasteners 176
F.6 Coating methods 177
F.6.1 Painting 177
F.6.2 Metal spraying 177
F.6.3 Galvanizing 177
F.7 Inspection and checking 178
F.7.1 General 178
F.7.2 Routine checking 178
F.7.3 Reference areas 178
F.7.4 Galvanized components 178

Annex G (normative) Test to determine slip factor 180

G.1 General 180
G.2 Significant variables 180
G.3 Test specimens 180
G.4 Slip test procedure and evaluation of results 182
G.5 Extended creep test procedure and evaluation 182
G.6 Test results 183

Annex H (normative) Test to determine torque values for preloaded bolts under site conditions ... 185

H.1 Scope 185
H.2 Symbols and units 185
H.3 Principle of the test 185
H.4 Test apparatus 185
H.5 Test assemblies 186
H.6 Test set up 186
H.7 Test procedure 187
H.8 Evaluation of test results 187
H.9 Test report 188

Annex J (normative) Use of compressible washer-type direct tension indicators 189

J.1 General 189
J.2 Fitting 189
J.3 Checking 190

Annex K (informative) Hexagon injection bolts 192

K.1 General 192
K.2 Hole sizes 192
K.3 Bolts 193
K.4 Washers 193
K.5 Nuts 194
K.6 Resin 194
K.7 Tightening 194
K.8 Installation 195

Annex L (informative) Guide to flow diagram for development and use of a WPS 196

Annex M (normative) Sequential method for fasteners inspection 197

M.1 General 197
M.2 Application 198

Bibliography 200