DIN EN 1090-2:2011-10 (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 17
2.2.6 Structural bearings 17
2.3 Preparation 17
2.4 Welding 17
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 23
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 !Washers" 32
5.6.10 Hot rivets 33
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 34
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 35

6 Preparation and assembly 35
6.1 General 35
6.2 Identification 35
6.3 Handling and storage 35
6.4 Cutting 38
6.4.1 General 38
6.4.2 Shearing and nibbling 38
6.4.3 Thermal cutting 38
6.4.4 Hardness of free edge surfaces 39
6.5 Shaping 39
6.5.1 General 39
6.5.2 Hot forming 40
6.5.3 Flame straightening 40
6.5.4 Cold forming 40
6.6 Holing 42
6.6.1 Dimensions of holes 42
6.6.2 Tolerances on hole diameter for bolts and pins 43
6.6.3 Execution of holing 43
6.7 Cut outs 44
6.8 Full contact bearing surfaces 45
6.9 Assembly 45
6.10 Assembly check 46

7 Welding 46
7.1 General 46
7.2 Welding plan 46
7.2.1 Requirements for a welding plan 46
7.2.2 Content of a welding plan 46
7.3 Welding processes 47
7.4 Qualification of welding procedures and welding personnel 48
7.4.1 Qualification of welding procedures 48
7.4.2 Welders and welding operators 50
7.4.3 Welding coordination 50
7.5 Preparation and execution of welding 52
7.5.1 Joint preparation 52
7.5.2 Storage and handling of welding consumables 53
7.5.3 Weather protection 53
7.5.4 Assembly for welding 54
7.5.5 Preheating 54
7.5.6 Temporary attachments 54
7.5.7 Tack welds 54
7.5.8 Fillet welds 55
7.5.9 Butt welds 55
7.5.10 Welds on steels with improved atmospheric corrosion resistance 56
7.5.11 Branch connections 56
7.5.12 Stud welding 56

7.5.13 Slot and plug welds 56
7.5.14 Spot welds for thin gauge components 57
7.5.15 Other weld types 57
7.5.16 Post-weld heat treatment 57
7.5.17 Execution of welding 57
7.5.18 Welding of bridge decks 58
7.6 Acceptance criteria 58
7.7 Welding of stainless steels 59
7.7.1 Amendments to EN 1011-1 requirements 59
7.7.2 Amendments to EN 1011-3 requirements 60
7.7.3 Welding dissimilar steels 61

8 Mechanical fastening 61
8.1 General 61
8.2 Use of bolting assemblies 61
8.2.1 General 61
8.2.2 Bolts 62
8.2.3 Nuts 62
8.2.4 Washers 62
8.3 Tightening of non-preloaded bolts 63
8.4 Preparation of contact surfaces in slip resistant connections 63
8.5 Tightening of preloaded bolts 64
8.5.1 General 64
8.5.2 Torque reference values 66
8.5.3 Torque method 66
8.5.4 Combined method 66
8.5.5 HRC method 67
8.5.6 Direct tension indicator method 68
8.6 Fit bolts 68
8.7 Hot riveting 68
8.7.1 Rivets 68
8.7.2 Installation of rivets 68
8.7.3 Acceptance criteria 69
8.8 Fastening of thin gauge components 69
8.8.1 General 69
8.8.2 Use of self-tapping and self-drilling screws 70
8.8.3 Use of blind rivets 70
8.8.4 Fastening sidelaps 71
8.9 Use of special fasteners and fastening methods 71
8.10 Galling and seizure of stainless steels 71

9 Erection 72
9.1 General 72
9.2 Site conditions 72
9.3 Erection method 73
9.3.1 Design basis for the erection method 73
9.3.2 Constructor's erection method 73
9.4 Survey 74
9.4.1 Reference system 74
9.4.2 Position points 75
9.5 Supports, anchors and bearings 75
9.5.1 Inspection of supports 75
9.5.2 Setting out and suitability of supports 75
9.5.3 Maintaining suitability of supports 75
9.5.4 Temporary supports 75
9.5.5 Grouting and sealing 76
9.5.6 Anchoring 77
9.6 Erection and work at site 77
9.6.1 Erection drawings 77
9.6.2 Marking 78
9.6.3 Handling and storage on site 78
9.6.4 Trial erection 79

9.6.5 Erection methods ... 79

10 Surface treatment ... 80
10.1 General ... 80
10.2 Preparation of steel !substrates for paints and related products" ... 81
10.3 Weather resistant steels ... 82
10.4 Galvanic coupling ... 82
10.5 Galvanizing ... 82
10.6 Sealing of spaces ... 82
10.7 Surfaces in contact with concrete ... 83
10.8 Inaccessible surfaces ... 83
10.9 Repairs after cutting or welding ... 83
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 ... 84
11.1 Tolerance types ... 84
11.2 Essential tolerances ... 84
11.2.1 General ... 84
11.2.2 Manufacturing tolerances ... 84
11.2.3 Erection tolerances ... 85
11.3 Functional tolerances ... 86
11.3.1 General ... 86
11.3.2 Tabulated values ... 86
11.3.3 Alternative criteria ... 87

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 ... 88
12.2.3 Non conforming products ... 88
12.3 Manufacturing: geometrical dimensions of manufactured components ... 88
12.4 Welding ... 89
12.4.1 Inspection before and during welding ... 89
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 ... 97
12.5.5 Special fasteners and fastening methods ... 97
12.6 Surface treatment and corrosion protection ... 98
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 ... 100

Annex A (normative) Additional information, list of options and requirements related to the execution classes ... 101

A.1 List of required additional information ... 101
A.2 List of options ... 104
A.3 Requirements related to the execution classes ... 108

Annex B (informative) Guidance for the determination of execution classes ... 112

B.1 Introduction 112
B.2 Governing factors for choice of execution class 112
B.2.1 Consequence classes 112
B.2.2 Hazards connected with execution and use of the structure 112
B.3 Determination of execution classes 113

Annex C (informative) Check-list for the content of a quality plan 115

C.1 Introduction 115
C.2 Content 115
C.2.1 Management 115
C.2.2 Specification review 115
C.2.3 Documentation 115
C.2.4 Inspection and testing procedures 116

Annex D (normative) Geometrical tolerances 117

D.1 Essential tolerances 117
D.1.1 Essential manufacturing tolerances - Welded profiles 118
D.1.2 Essential manufacturing tolerances - Press braked cold formed profiles 119
D.1.3 Essential manufacturing tolerances - Flanges of welded profiles 120
D.1.4 Essential manufacturing tolerances - Flanges of welded box sections 121
D.1.5 Essential manufacturing tolerances - Web stiffeners of profiles or box sections 123
D.1.6 Essential manufacturing tolerances - Stiffened plating 125
D.1.7 Essential manufacturing tolerances - Cold formed profiled sheets 126
D.1.8 Essential manufacturing tolerances - Fastener holes, notches and cut edges 127
D.1.9 Essential manufacturing tolerances - Cylindrical and conical shells 128
D.1.10 Essential manufacturing tolerances - Lattice components 129
D.1.11 Essential erection tolerances - !Columns of single storey buildings" 130
D.1.12 Essential erection tolerances - Multi-storey columns 131
D.1.13 Essential erection tolerances - Full contact end bearing 133
D.1.14 Essential erection tolerances - Towers and masts 133
D.1.15 Essential erection tolerances - Beams subject to bending and components subject to compression 134
D.2 Functional tolerances 135
D.2.1 Functional manufacturing tolerances - Welded profiles 136
D.2.2 Functional manufacturing tolerances - Press braked cold formed profiles 137
D.2.3 Functional manufacturing tolerances - Flanges of welded profiles 138
D.2.4 Functional manufacturing tolerances - Welded box sections 139
D.2.5 Functional manufacturing tolerances - Webs of welded profiles or box sections 141
D.2.6 Functional manufacturing tolerances - Web stiffeners of welded profiles or box sections 142
D.2.7 Functional manufacturing tolerances - Components 143
D.2.8 Functional manufacturing tolerances - Fastener holes, notches and cut edges 144
D.2.9 Functional manufacturing tolerances - Column splices and baseplates 146
D.2.10 Functional manufacturing tolerances - Lattice components 147
D.2.11 Functional manufacturing tolerances - Stiffened plating 148
D.2.12 Functional manufacturing tolerances - Towers and masts 150
D.2.13 Functional manufacturing tolerances - Cold formed profiled sheets 151
D.2.14 Functional manufacturing tolerances - Bridge decks 151
D.2.15 Functional erection tolerances - Bridges 153
D.2.16 Functional erection tolerances - Bridge decks (sheet 1/3) 153
D.2.17 Functional erection tolerances - Bridge decks(sheet 2/3) 154
D.2.18 Functional erection tolerances - Bridges decks (sheet 3/3) 156
D.2.19 Functional manufacturing and erection tolerances - Crane beams and rails 157
D.2.20 Functional tolerances - Concrete foundations and supports 158
D.2.21 Functional erection tolerances - Crane runways 160
D.2.22 Functional erection tolerances - Positions of columns 161
D.2.23 Functional erection tolerances - !Columns of single storey buildings" 162
D.2.24 Functional erection tolerances - Multi-storey columns 163
D.2.25 Functional erection tolerances - Buildings 164
D.2.26 Functional erection tolerances - Beams in buildings 166
D.2.27 Functional erection tolerances - Roof sheeting designed as a stressed-skin 167

D.2.28 Functional erection tolerances - Profiled steel sheeting 167

Annex E (informative) Welded joints in hollow sections 168

E.1 General 168
E.2 Guidance for start and stop positions 168
E.3 Preparation of joint faces 168
E.4 Assembly for welding 169
E.5 Fillet welded joints 177

Annex F (normative) Corrosion protection 178

F.1 General 178
F.1.1 Field of application 178
F.1.2 Performance specification 178
F.1.3 Prescriptive requirements 178
F.1.4 Work method 179
F.2 Surface preparation of carbon steels 179
F.2.1 Surface preparation of carbon steels prior to painting and metal spraying 179
F.2.2 Surface preparation of carbon steels prior to galvanizing 180
F.3 Welds and surfaces for welding 180
F.4 Surfaces in preloaded connections 180
F.5 Preparation of fasteners 180
F.6 Coating methods 181
F.6.1 Painting 181
F.6.2 Metal spraying 181
F.6.3 Galvanizing 182
F.7 Inspection and checking 182
F.7.1 General 182
F.7.2 Routine checking 182
F.7.3 Reference areas 182
F.7.4 Galvanized components 182

Annex G (normative) Test to determine slip factor 184

G.1 General 184
G.2 Significant variables 184
G.3 Test specimens 184
G.4 Slip test procedure and evaluation of results 186
G.5 Extended creep test procedure and evaluation 186
G.6 Test results 187

Annex H (normative) !Calibration test for preloaded bolts under site conditions" 189

H.1 Scope 189
H.2 Symbols and units 189
H.3 Principle of the test 189
H.4 Test apparatus 190
H.5 Test assemblies 190
H.6 Test set up 190
H.7 Test procedure 191
H.8 Evaluation of test results 192
H.9 Test report 193

Annex J (normative) Use of compressible washer-type direct tension indicators 194

J.1 General 194
J.2 Fitting 194
J.3 Checking 196

Annex K (informative) Hexagon injection bolts 199

K.1 General 199
K.2 Hole sizes 199
K.3 Bolts 199
K.4 Washers 200
K.5 Nuts 201
K.6 Resin 201
K.7 Tightening 201
K.8 Installation 201

Annex L (informative) Guide to flow diagram for development and use of a WPS 203

Annex M (normative) Sequential method for fasteners inspection 204

M.1 General 204
M.2 Application 205

Bibliography 207