DIN EN 15129:2010-06 (E)

Anti-seismic devices

Contents

Page

Foreword 6

1 Scope 7

2 Normative references 7

3 Terms, definitions, symbols and abbreviations 8
3.1 Terms and definitions 8
3.2 Symbols 14
3.2.1 Latin upper case letters 14
3.2.2 Latin lower case letters 14
3.2.3 Greek letters 14
3.2.4 Subscripts 14
3.3 Abbreviations 15
3.4 List of devices 16

4 General design rules 18
4.1 Performance requirements and compliance criteria 18
4.1.1 Fundamental requirements 18
4.1.2 Increased reliability of structural system 18
4.1.3 Functional requirements 19
4.1.4 Structural and mechanical requirements 19
4.1.5 Compliance criteria 19
4.2 Action effects on devices 20
4.2.1 Seismic design situations and seismic combinations of actions 20
4.2.2 Effects of actions 20
4.3 Conceptual design of the devices 20
4.3.1 Reliability of the devices' behaviour 20
4.3.2 Capacity design 20
4.3.3 Maintenance 20
4.3.4 Modification and replacement of devices 21
4.3.5 Device documentation 21
4.4 General properties 21
4.4.1 Material properties 21
4.4.2 Device properties to be used in the analysis 21
4.4.3 Re-centring capability 22
4.5 Constitutive laws 23
4.6 Validation of anti-seismic devices 23

5 Rigid connection devices 24
5.1 Permanent Connection Devices 24
5.2 Fuse Restraints 24
5.2.1 Performance requirements 24
5.2.2 Material properties 24
5.2.3 Design requirements 25
5.2.4 Type Testing 25
5.2.5 Factory production control tests 26
5.3 Temporary (dynamic) connection devices 26
5.3.1 Functional requirements 26
5.3.2 Material properties 27
5.3.3 Design Requirements 27
5.3.4 Type Testing 28

5.3.5 Factory Production Control Tests 30

6 Displacement Dependent Devices 30
6.1 General 30
6.2 Performance Requirements 31
6.3 Materials 33
6.3.1 General 33
6.3.2 Elastomer 33
6.3.3 Steel 34
6.3.4 Other materials (special steel, stainless steel, SMA, visco-elastic polymeric materials) 34
6.4 Testing 34
6.4.1 General 34
6.4.2 Type tests of materials 34
6.4.3 Factory production control tests of materials 36
6.4.4 Type tests of devices 37
6.4.5 Factory production control testing of devices 38

7 Velocity Dependent Devices 38
7.1 Functional requirements 38
7.2 Material properties 38
7.2.1 General 38
7.2.2 Materials 39
7.2.3 Active Surfaces 39
7.2.4 Viscous Fluid 39
7.3 Design requirements 39
7.3.1 General 39
7.3.2 Over velocity 40
7.3.3 Buckling 40
7.4 Testing 41
7.4.1 General 41
7.4.2 Type Testing 41
7.4.3 Factory production control 44

8 Isolators 44
8.1 General Requirements 44
8.2 Elastomeric Isolators 46
8.2.1 Requirements 46
8.2.2 Materials 52
8.2.3 Design 59
8.2.4 Testing 63
8.2.5 Manufacturing Tolerances 72
8.2.6 Marking and Labelling 72
8.3 Curved Surface Sliders 73
8.3.1 Requirements 73
8.3.2 Materials 77
8.3.3 Design 78
8.3.4 Testing 80
8.3.5 Manufacturing, Assembly and Tolerances 87
8.4 Flat Surface Sliders 88
8.4.1 Requirements 88
8.4.2 Materials 88
8.4.3 Design 88
8.4.4 Testing 88
8.4.5 Manufacturing, Assembly and Tolerances 88

9 Combinations of Devices 89
9.1 Requirements 89
9.1.1 General 89
9.1.2 Particular requirements 89
9.2 Materials 89
9.3 Design 89
9.4 Testing 90

9.4.1 General 90
9.4.2 Type Testing 90
9.4.3 Factory Production Control testing 90

10 Evaluation of conformity 90
10.1 General 90
10.2 Type testing 91
10.2.1 Initial Type Testing 91
10.2.2 Further type-testing 95
10.3 Factory Production Control (FPC) 96
10.3.1 General 96
10.3.2 Raw materials and constituents 98
10.3.3 Equipment 101
10.3.4 Sampling 101

11 Installation 101

12 In-service inspection 102
12.1 General requirements 102
12.2 Regular inspection 102
12.3 Principal inspection 102

Annex A (informative) Commentary to Clause 1: Scope 103

Annex B (informative) Commentary to Clause 4: General design rules 104

B.1 Service life of a device 104
B.2 Basic requirements 104
B.3 Reliability differentiation 104
B.4 Increased reliability 104
B.5 Requirements at the ULS 105
B.6 Requirements at the SLS 105
B.7 Structural analysis 105
B.8 Material properties 105
B.9 Re-centring capability 106

Annex C (informative) Commentary to Clause 5: Rigid connection devices 107

C.1 Functional requirements 107
C.2 Material properties 107
C.3 Design Requirements 108
C.4 Testing 108
C.4.1 General 108
C.4.2 Low velocity test 109
C.4.3 Seal Wear Test 110
C.4.4 Impulsive Load Test 110
C.4.5 Overload Test 111
C.4.6 Cyclic Load Test 111

Annex D (informative) Commentary to Clause 6: Displacement Dependent Devices 112

D.1 Categories of Non Linear Devices (NLD) 112
D.2 Examples of linear devices -- Elastomeric shear-strained devices 114
D.3 Examples of non linear devices 114
D.3.1 Buffer 114
D.3.2 Steel hysteretic energy dissipating devices 114
D.3.3 Buckling Restrained Braces 114
D.3.4 SMA Re-centring Devices 115

Annex E (informative) Commentary to Clause 7: Velocity Dependent Devices 116

E.1 Functional requirements 116

E.2 Design Requirements 118
E.3 Testing 120
E.3.1 General 120
E.3.2 Low velocity test for Fluid Viscous Dampers 120
E.3.3 Low velocity test for Fluid Spring Dampers 121
E.3.4 Constitutive law test for Fluid Viscous Dampers 122
E.3.5 Constitutive law test for Fluid Spring Dampers 122
E.3.6 Damping efficiency test 123

Annex F (informative) Commentary to Clause 8: Isolators 125

F.1 Ageing conditions for elastomeric isolators 125
F.2 Low temperature crystallisation 125
F.3 Commentary on Basis of design 126
F.3.1 Shape Factor 126
F.3.2 Design shear strain due to compression by vertical loads 127
F.3.3 Isolator stiffnesses 127
F.4 Determination of the restoring stiffness by tests for curved and flat surface sliders 128

Annex G (normative) Equipment for combined compression and shear 130

G.1 General requirements 130
G.2 Data Acquisition 130
G.3 Combined compression and shear equipment 130
G.4 Load Platens 131
G.5 Data analysis 131

Annex H (informative) Design of Connections for Devices 133

H.1 Elastomeric Isolators 133
H.2 Sliders 133

Annex I (informative) Method for calculating pressure distributions on spherical surfaces 135

I.1 General 135
I.2 Modelling assumptions 135
I.3 Effects of vertical loads 135
I.4 Effects of horizontal loads 137
I.5 Combined loads 137

Annex J (informative) -FACTORS FOR COMMON ISOLATOR TYPES 139

J.1 max- values for elastomeric isolators 139
J.2 max- values for sliding isolator units 140

Annex ZA (informative) Relationship between this European Standard and the Essential Requirements of EU Directive 142

ZA.1 Scope and relevant characteristics 142

ZA.2 Procedure(s) for attestation of conformity of anti-seismic devices 149

ZA.2.1 System(s) of attestation of conformity 149

ZA.2.2 EC Certificate and Declaration of conformity 151

ZA.3 CE marking and labelling 153

ZA.3.1 Declaration of product properties 154

ZA.3.2 Declaration of compliance with given design specification 155

Bibliography 159