

DIN EN 1998-2 (9)

9i fcWtXYS, .8 Yg[[b'cZgffi Wi fYg'Z'f'YUfH ei U_Y'fYg]ghUbWWS! DUfH& '6f]X[Yg'
f]bWi XYg'5a YbXa Ybh5 %&\$-\$- 'Z'5 &.&\$%Z'7 cff][YbXi a '57.&\$%\$Ł

TABLE OF CONTENTS

	Page
FOREWORD TO EN 1998-2:2005	6
FOREWORD TO EN 1998-2:2005/A1:2009	6
FOREWORD TO EN 1998-2:2005/A2:2011	7
1 INTRODUCTION	12
1.1 SCOPE	12
1.1.1 <i>Scope of EN 1998-2</i>	12
1.1.2 <i>Further parts of EN 1998</i>	13
1.2 NORMATIVE REFERENCES	13
1.2.1 <i>Use</i>	13
1.2.2 <i>General reference standards</i>	13
1.2.3 <i>Reference Codes and Standards</i>	13
1.2.4 <i>Additional general and other reference standards for bridges</i>	13
1.3 ASSUMPTIONS	14
1.4 DISTINCTION BETWEEN PRINCIPLES AND APPLICATION RULES	14
1.5 DEFINITIONS	14
1.5.1 <i>General</i>	14
1.5.2 <i>Terms common to all Eurocodes</i>	14
1.5.3 <i>Further terms used in EN 1998-2</i>	14
1.6 SYMBOLS	16
1.6.1 <i>General</i>	16
1.6.2 <i>Further symbols used in Sections 2 and 3 of EN 1998-2</i>	16
1.6.3 <i>Further symbols used in Section 4 of EN 1998-2</i>	17
1.6.4 <i>Further symbols used in Section 5 of EN 1998-2</i>	18
1.6.5 <i>Further symbols used in Section 6 of EN 1998-2</i>	19
1.6.6 <i>Further symbols used in Section 7 and Annexes J, JJ and K of EN 1998-2</i>	21
2 BASIC REQUIREMENTS AND COMPLIANCE CRITERIA	24
2.1 DESIGN SEISMIC ACTION	24
2.2 BASIC REQUIREMENTS	25
2.2.1 <i>General</i>	25
2.2.2 <i>No-collapse (ultimate limit state)</i>	25
2.2.3 <i>Minimisation of damage (serviceability limit state)</i>	26
2.3 COMPLIANCE CRITERIA	26
2.3.1 <i>General</i>	26
2.3.2 <i>Intended seismic behaviour</i>	26
2.3.3 <i>Resistance verifications</i>	29
2.3.4 <i>Capacity design</i>	29
2.3.5 <i>Provisions for ductility</i>	29
2.3.6 <i>Connections - Control of displacements - Detailing</i>	32
2.3.7 <i>Simplified criteria</i>	36
2.4 CONCEPTUAL DESIGN	36
3 SEISMIC ACTION	39
3.1 DEFINITION OF THE SEISMIC ACTION	39
3.1.1 <i>General</i>	39
3.1.2 <i>Application of the components of the motion</i>	39
3.2 QUANTIFICATION OF THE COMPONENTS	39

3.2.1	<i>General</i>	39
3.2.2	<i>Site dependent elastic response spectrum</i>	40
3.2.3	<i>Time-history representation</i>	40
3.2.4	<i>Site dependent design spectrum for linear analysis</i>	41
3.3	SPATIAL VARIABILITY OF THE SEISMIC ACTION	41
4	ANALYSIS	45
4.1	MODELLING.....	45
4.1.1	<i>Dynamic degrees of freedom</i>	45
4.1.2	<i>Masses</i>	45
4.1.3	<i>Damping of the structure and stiffness of members</i>	46
4.1.4	<i>Modelling of the soil</i>	46
4.1.5	<i>Torsional effects</i>	47
4.1.6	<i>Behaviour factors for linear analysis</i>	48
4.1.7	<i>Vertical component of the seismic action</i>	51
4.1.8	<i>Regular and irregular seismic behaviour of ductile bridges</i>	51
4.1.9	<i>Non-linear analysis of irregular bridges</i>	52
4.2	METHODS OF ANALYSIS	52
4.2.1	<i>Linear dynamic analysis - Response spectrum method</i>	52
4.2.2	<i>Fundamental mode method</i>	54
4.2.3	<i>Alternative linear methods</i>	58
4.2.4	<i>Non-linear dynamic time-history analysis</i>	58
4.2.5	<i>Static non-linear analysis (pushover analysis)</i>	60
5	STRENGTH VERIFICATION	62
5.1	GENERAL	62
5.2	MATERIALS AND DESIGN STRENGTH	62
5.2.1	<i>Materials</i>	62
5.2.2	<i>Design strength</i>	62
5.3	CAPACITY DESIGN	62
5.4	SECOND ORDER EFFECTS.....	64
5.5	COMBINATION OF THE SEISMIC ACTION WITH OTHER ACTIONS	65
5.6	RESISTANCE VERIFICATION OF CONCRETE SECTIONS	66
5.6.1	<i>Design resistance</i>	66
5.6.2	<i>Structures of limited ductile behaviour</i>	66
5.6.3	<i>Structures of ductile behaviour</i>	66
5.7	RESISTANCE VERIFICATION FOR STEEL AND COMPOSITE MEMBERS	74
5.7.1	<i>Steel piers</i>	74
5.7.2	<i>Steel or composite deck</i>	75
5.8	FOUNDATIONS	75
5.8.1	<i>General</i>	75
5.8.2	<i>Design action effects</i>	76
5.8.3	<i>Resistance verification</i>	76
6	DETAILING	77
6.1	GENERAL	77
6.2	CONCRETE PIERS	77
6.2.1	<i>Confinement</i>	77
6.2.2	<i>Buckling of longitudinal compression reinforcement</i>	81
6.2.3	<i>Other rules</i>	82
6.2.4	<i>Hollow piers</i>	83

6.3	STEEL PIERS	83
6.4	FOUNDATIONS	83
6.4.1	<i>Spread foundation</i>	83
6.4.2	<i>Pile foundations</i>	83
6.5	STRUCTURES OF LIMITED DUCTILE BEHAVIOUR	84
6.5.1	<i>Verification of ductility of critical sections</i>	84
6.5.2	<i>Avoidance of brittle failure of specific non-ductile components</i>	84
6.6	BEARINGS AND SEISMIC LINKS	85
6.6.1	<i>General requirements</i>	85
6.6.2	<i>Bearings</i>	86
6.6.3	<i>Seismic links, holding-down devices, shock transmission units</i>	87
6.6.4	<i>Minimum overlap lengths</i>	89
6.7	CONCRETE ABUTMENTS AND RETAINING WALLS	91
6.7.1	<i>General requirements</i>	91
6.7.2	<i>Abutments flexibly connected to the deck</i>	91
6.7.3	<i>Abutments rigidly connected to the deck</i>	91
6.7.4	<i>Culverts with large overburden</i>	93
6.7.5	<i>Retaining walls</i>	94
7	BRIDGES WITH SEISMIC ISOLATION	95
7.1	GENERAL	95
7.2	DEFINITIONS	95
7.3	BASIC REQUIREMENTS AND COMPLIANCE CRITERIA	96
7.4	SEISMIC ACTION	97
7.4.1	<i>Design spectra</i>	97
7.4.2	<i>Time-history representation</i>	97
7.5	ANALYSIS PROCEDURES AND MODELLING	97
7.5.1	<i>General</i>	97
7.5.2	<i>Design properties of the isolating system</i>	98
7.5.3	<i>Conditions for application of analysis methods</i>	104
7.5.4	<i>Fundamental mode spectrum analysis</i>	105
7.5.5	<i>Multi-mode Spectrum Analysis</i>	108
7.5.6	<i>Time history analysis</i>	109
7.5.7	<i>Vertical component of seismic action</i>	109
7.6	VERIFICATIONS	109
7.6.1	<i>Seismic design situation</i>	109
7.6.2	<i>Isolating system</i>	110
7.6.3	<i>Substructures and superstructure</i>	111
7.7	SPECIAL REQUIREMENTS FOR THE ISOLATING SYSTEM	113
7.7.1	<i>Lateral restoring capability</i>	113
7.7.2	<i>Lateral restraint at the isolation interface</i>	116
7.7.3	<i>Inspection and Maintenance</i>	117
	ANNEX A (informative) PROBABILITIES RELATED TO THE REFERENCE SEISMIC ACTION. GUIDANCE FOR THE SELECTION OF DESIGN SEISMIC ACTION DURING THE CONSTRUCTION PHASE	118
	ANNEX B (informative) RELATIONSHIP BETWEEN DISPLACEMENT DUCTILITY AND CURVATURE DUCTILITY FACTORS OF PLASTIC HINGES IN CONCRETE PIERS	119

ANNEX C (informative) ESTIMATION OF THE EFFECTIVE STIFFNESS OF REINFORCED CONCRETE DUCTILE MEMBERS.....	120
ANNEX D (informative) SPATIAL VARIABILITY OF EARTHQUAKE GROUND MOTION: MODEL AND METHODS OF ANALYSIS	122
ANNEX E (informative) PROBABLE MATERIAL PROPERTIES AND PLASTIC HINGE DEFORMATION CAPACITIES FOR NON-LINEAR ANALYSES	129
ANNEX F (informative) ADDED MASS OF ENTRAINED WATER FOR IMMERSED PIERS	135
ANNEX G (normative) CALCULATION OF CAPACITY DESIGN EFFECTS	137
ANNEX H (informative) STATIC NON-LINEAR ANALYSIS (PUSHOVER)	139
ANNEX J (normative) VARIATION OF DESIGN PROPERTIES OF SEISMIC ISOLATOR UNITS.....	142
ANNEX JJ (informative) λ-FACTORS FOR COMMON ISOLATOR TYPES	144
ANNEX K (informative) TESTS FOR VALIDATION OF DESIGN PROPERTIES OF SEISMIC ISOLATOR UNITS.....	147