

# **CYS National Annex to CYS EN 1998-2:2005**

## **Eurocode 8:**

### **Design of structures for earthquake resistance**

#### **Part 2: Bridges**

Prepared by  
Eurocodes Committee, Scientific and Technical  
Chamber of Cyprus under a Ministry of Interior's Programme



**NATIONAL ANNEX**  
**TO**  
**CYS EN 1998-2:2005 Eurocode 8: Design of structures for**  
**earthquake resistance**  
**Part2: Bridges**

**This National Annex has been approved by the Board of Governors of the  
Cyprus Organisation for Standardisation on 11/06/2010.**

## INTRODUCTION

This National Annex has been prepared by the Eurocodes Committee of the Technical Chamber of Cyprus which was commissioned by the Ministry of Interior of the Republic of Cyprus

## NA 1 SCOPE

This National Annex is to be used together with CYS EN 1998-2:2005

This National Annex gives:

(a) Nationally determined parameters for the following clauses of CYS EN 1998-2:2005 where National choice is allowed (see Section NA 2)

- 1.1.1 (8)
- 2.1 (3)P
- 2.1 (4)P
- 2.1 (6)
- 2.2.2 (5)
- 2.3.5.3 (1)
- 2.3.6.3 (5)
- 2.3.7 (1)
- 3.2.2.3
- 3.3 (1)P
- 3.3 (6)
- 4.1.2 (4)P
- 4.1.8 (2)
- 5.3 (4)
- 5.4 (1)
- 5.6.2 (2)P b
- 5.6.3.3 (1)P b
- 6.2.1.4 (1)P
- 6.5.1 (1)P
- 6.6.2.3 (3)
- 6.6.3.2 (1)P
- 6.7.3 (7)
- 7.4.1 (1)P
- 7.6.2 (1)P
- 7.6.2 (5)
- 7.7.1 (2)
- J.1 (2)
- J.2 (1)

(b) Decision on the informative use of Annexes A, B, C, D, E, F, H, JJ and K (see Section NA 3)

## NA 2 NATIONALLY DETERMINED PARAMETERS

### NA 2.1 Clause 1.1.1 (8) Scope of CYS EN 1998-2:2005

Annexes A, B, C and D of CYS EN 1998-2:2005 shall be used as Informative Annexes, whereas Annexes E, F, H, JJ and K of CYS EN 1998-2:2005 shall be used as Normative Annexes.

### NA 2.2 Clause 2.1 Design seismic action

(3)P The value for the reference return period  $T_{NCR}$  is set equal to 475 years.

(4)P Bridges are classified in three importance classes, as follows:

Importance class II comprises bridges of average importance with the exceptions noted below.

Importance class III comprises bridges of critical importance for maintaining communications, especially in the immediate post-earthquake period, bridges the failure of which is associated with a large number of probable fatalities and major bridges where a design life greater than normal is required.

Importance class I comprises bridges of less than average importance. A bridge shall be classified to importance class I when both of the following conditions are met:

- the bridge is not critical for communications, and
- the adoption of either the reference probability of exceedance,  $P_{NCR}$ , in 50 years for the design seismic action, or of the standard bridge design life of 50 years is not economically justified.

(6) The values of the importance factor  $\gamma_I$  for importance classes I, II, and III are defined as follows:

$\gamma_I = 0,85$  for importance class I

$\gamma_I = 1,00$  for importance class II

$\gamma_I = 1,30$  for importance class III

### NA 2.3 Clause 2.2.2 (5) No-collapse (ultimate limit state)

The seismic action shall not be considered as an accidental action under any conditions. Clauses 2.2.2 (3) and 2.2.2 (4) of CYS EN 1998-2:2005 are always applicable.

### NA 2.4 Clause 2.3.5.3 (1) Local ductility at the plastic hinges

The expression of the length of plastic hinges  $L_p$  for concrete members is given by equation E.19 of Annex E of CYS EN 1998-2:2005.

### NA 2.5 Clause 2.3.6.3 (5) Control of displacements - Detailing

The value of fraction for the design seismic displacement  $p_E$  is set equal to 0.4, and for the thermal movement  $p_T$  is set equal to 0.5.

### NA 2.6 Clause 2.3.7 (1) Simplified criteria

Clause 2.3.7 (1) of CYS EN 1998-2:2005 is not applicable in Cyprus.

### NA 2.7 Clause 3.2.2.3 Near source effects

A seismotectonic fault is considered to be active when there is an average historic slip rate of at least 1 mm/year and topographic evidence of seismic activity within the Holocene times (past 11000 years).

### NA 2.8 Clause 3.3 Spatial variability of the seismic action

(1)P The value of the continuous deck limiting length,  $L_{lim}$ , is specified as

$$L_{lim} = \frac{L_g}{1.5}$$

where the length  $L_g$  is defined in clause 3.3 (6) Table 3.1N of CYS EN 1998-2:2005.

(6) The values of the distance  $L_g$ , beyond which ground motions are considered as completely uncorrelated, depending on the ground type are given in Table 3.1N (CYS):

**Table 3.1N (CYS): Distance beyond which ground motions are considered uncorrelated**

Ground Type	A	B	C	D	E
$L_g$ (m)	600	500	400	300	500

The factor accounting for the magnitude of ground displacements occurring in apposite direction at adjacent supports  $\beta_r$  is defined as follows:

$\beta_r = 0.5$  when all three supports have the same ground type

$\beta_r = 1.0$  when the ground type at one of the supports is different than at the other two.

### NA 2.9 Clause 4.1.2 (4)P Masses

The values of  $\psi_{21}$  factor for traffic loads assumed concurrent with the design seismic action are defined as:

$\psi_{21} = 0$  for bridges with normal traffic and footbridges

$\psi_{21} = 0,2$  for road bridges with severe traffic, and

$\psi_{21} = 0,3$  for railway bridges with severe traffic.

### NA 2.10 Clause 4.1.8 (2)P Regular and irregular seismic behaviour of ductile bridges

The upper limit for the value of  $\rho_o$  is set equal to 0,2.

### NA 2.11 Clause 5.3 (4) Capacity design

The value of the overstrength factor is set equal to

$\gamma_o = 1,35$  for concrete members, and

$\gamma_o = 1,25$  for steel members.

### NA 2.12 Clause 5.4 (1) Second order effects

Approximate methods for estimating second order effects in linear analysis under seismic actions are based on the assumption that the increase of bending moments of the plastic hinge section due to second order effects is

$$\Delta M = \frac{1+q}{2} d_{Ed} N_{Ed}$$

where  $N_{Ed}$  is the axial force and  $d_{Ed}$  is the relative transverse displacement of the ends of the considered ductile member, both in the design seismic situation.

**NA 2.13 Clause 5.6.2 (2)P b Structures of limited ductile behaviour**

The value of the additional safety factor against brittle failure  $\gamma_{Bd1}$  is set equal to 1,25.

**NA 2.14 Clause 5.6.3.3 (1)P b Shear resistance of members outside the region of plastic hinges**

To determine the value of the additional safety factor  $\gamma_{Bd}$  on shear resistance of ductile members outside the region of plastic hinges, equation (5.8b) is recommended since it is more conservative.

**NA 2.15 Clause 6.2.1.4 (1)P Required confining reinforcement**

All types of confinement reinforcement are allowed.

**NA 2.16 Clause 6.5.1 (1)P Verification of ductility of critical sections**

Clause 6.5.1 (1)P of CYS EN 1998-2:2005 is not applicable in Cyprus.

**NA 2.17 Clause 6.6.2.3 (3) Elastomeric bearings**

According to Clause 2.2.2 (5) of CYS EN 1998-2:2005, the seismic action shall not be considered as an accidental action under any conditions.

**NA 2.18 Clause 6.6.3.2 (1)P Holding-down devices**

The value of the percentage of the compressive (downward) reaction  $p_H$  due to the permanent load that is exceeded by the total vertical reaction on a support due to the design seismic action, for holding-down devices is specified as follows:

$p_H = 80\%$  in bridges of ductile behaviour, where the vertical reaction due to the design seismic action is determined as a capacity design effect,

$p_H = 50\%$  in bridges of limited ductile behaviour, where the vertical reaction due to the design seismic action is determined from the analysis under the design seismic action alone (including the contribution of the vertical seismic component).

**NA 2.19 Clause 6.7.3 (7) Abutments rigidly connected to the deck**

The upper value of the design seismic displacement  $d_{lim}$  to limit damage of the soil or embankment behind abutments rigidly connected to the deck is given in Table 6.2N (CYS):

**Table 6.2N (CYS): Recommended limit value of design seismic displacement at abutment rigidly connected to the deck**

Bridge Importance class	Displacement Limit $d_{lim}$ (mm)
III	30
II	60
I	No limitation

### NA 2.20 Clause 7.4.1 (1)P Design spectra

The value of period  $T_D$  for the design spectrum of bridges with seismic isolation is specified as  $T_D = 2.5$  sec.

### NA 2.21 Clause 7.6.2 Isolating system

(1)P The value of the amplification factor  $\gamma_{IS}$  on design displacement of isolator units is specified at  $\gamma_{IS} = 1,50$ .

(5) The value  $\gamma_m$  for elastomeric bearings is specified at  $\gamma_m = 1,15$ .

### NA 2.22 Clause 7.7.1 (2) Lateral restoring capability

The values of factors  $\delta_w$  and  $\delta_b$  for the lateral restoring capability of the isolation system are set equal to:

$$\delta_w = 0,015$$

$$\delta_b = 0,5.$$

### NA 2.23 Clause J.1 (2) Factors causing variation of design properties

The value of minimum isolator temperature in the seismic design situation is given by:

$$T_{\min,b} = \psi_2 T_{\min} + \Delta T_1$$

where

$T_{\min}$  is the value of the minimum shade air temperature at the bridge location having an annual probability of (negative) exceedance of 0.02, in accordance with EN 1990-1-5:2007, 6.1.3.2.

$\psi_2 = 0.50$  is the combination factor for thermal actions for seismic design situation, in accordance with EN 1990:2002 – Annex A2 and

$\Delta T_1$  takes the following values depending on the material of the bridge deck, in accordance with Figure 6.1 of EN 19991-1-5:2003

**Table J.1N: Value of  $\Delta T_1$  for the determination of the minimum isolator temperature**

Deck	Concrete	Composite	Steel
$\Delta T_1$ (°C)	7.5	5.0	-2.5

### NA 2.24 Clause J.2 (1) Evaluation of the variation

The values of  $\lambda$ -factors for commonly used isolators are given in Annex JJ, which shall be used as Normative Annex.

## NA 3 DECISION ON THE INFORMATIVE OR NORMATIVE USE OF ANNEXES A, B, C, D, E, F, H, JJ AND K

### NA 3.1 Annex A Probabilities related to the reference seismic action. Guidance for the selection of design seismic action during the construction phase

Annex A may be used.

**NA 3.2 Annex B Relationship between displacement ductility and curvature ductility factors of plastic hinges in concrete piers**

Annex B may be used.

**NA 3.3 Annex C Estimation of the effective stiffness of reinforced concrete ductile members**

Annex C may be used.

**NA 3.4 Annex D Spatial variability of earthquake ground motion: Model and methods of analysis**

Annex D may be used.

**NA 3.5 Annex E Probable material properties and plastic hinge deformation capacities for non-linear analyses**

Annex E shall be used.

**NA 3.6 Annex F Added mass of entrained water for immersed piers**

Annex F shall be used.

**NA 3.7 Annex H Static non-linear analysis (pushover)**

Annex H may be used.

**NA 3.8 Annex JJ  $\lambda$ -factors for common isolator types**

Annex JJ shall be used.

**NA 3.9 Annex K Tests for validation of design properties of seismic isolator units**

Annex K shall be used.

**NA 4 REFERENCES TO NON-CONTRADICTORY COMPLEMENTARY INFORMATION**

None



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