CYS National Annex to CYS EN 1992-2:2005

Eurocode 2: Design of concrete structures

Part 2: Concrete bridges

Prepared by

Eurocodes Committee, Scientific and Technical Chamber

of Cyprus under a Ministry of Interior's Programme

NATIONAL ANNEX

TO

CYS EN 1992-2:2005 Eurocode 2: Design of concrete structures

Part 2: Concrete 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 1992-2:2005

This National Annex gives:

(a) Nationally determined parameters for the following clauses of CYS EN 1992-2:2005 where National choice is allowed (see Section NA 2)

- 3.1.2 (102)P
- 3.1.6 (101)P
- 3.1.6 (102)P
- 3.2.4 (101)P
- 4.2 (105)
- 4.2 (106)
- 4.4.1.2 (109)
- 5.1.3 (101)P
- 5.2 (105)
- 5.3.2.2 (104)
- 5.5 (104)
- 5.7 (105)
- 6.1 (109)
- 6.1 (110)
- 6.2.2 (101)
- 6.2.3 (103)
- 6.2.3 (107)
- 6.2.3 (109)
- 6.8.1 (102)
- 6.8.7 (101)
- 7.2 (102)
- 7.3.1 (105)
- 7.3.3 (101)
- 7.3.4 (101)
- 8.9.1 (101)
- 8.10.4 (105)
- 8.10.4 (107)
- 9.1 (103)
- 9.2.2 (101)
- 9.5.3 (101)
- 9.7 (102)
- 9.8.1 (103)
- 11.9 (101)
- 113.2 (102)

- 113.3.2 (103)

(b) Decisions on the use of the Informative Annexes A, B, D, F, G, H, J, KK, LL, NN, OO, and PP (see Section NA 3)

(c) References to non-contradictory complementary information to assist the user to apply CYS EN 1992-2:2005. In this National Annex such information is provided for the following clauses in CYS EN 1992-2:2005 (see Section NA 4)

NA 2 NATIONALLY DETERMINED PARAMETERS

NA 2.1 Clause 3.1.2 (102)P Materials - Concrete - Strength

The values of C_{min} and C_{max} are specified as C30/37 and C70/85 respectively.

NA 2.2 Clause 3.1.6 (101)P Design compressive and tensile strengths

The value of α_{cc} is specified as 0,85.

NA 2.3 Clause 3.1.6 (102)P Design compressive and tensile strengths

The value of α_{ct} is specified as 1,0.

NA 2.4 Clause 3.2.4 (101)P Reinforcing Steel - Ductility characteristics

The classes of reinforcement to be used in bridges are Class B and Class C.

NA 2.5 Clause 4.2 (105) Durability and cover Reinforcement - Environmental conditions

The exposure class for surfaces protected by waterproofing is XC3.

NA 2.6 Clause 4.2 (106) Environmental conditions

The value for distance x is set to 6m and the value for distance y is set to 6m.

The exposure classes for surfaces directly affected by de-icing salts are XD3 and XF2 or XF4, as appropriate, with covers given in Tables 4.4(CYS) and 4.5(CYS) for XD classes (CYS EN 1992-1-1:2004).

NA 2.7 Clause 4.4.1.2 (109) Concrete cover - Minimum cover, c_{min}

Provided that the following conditions are met, the cover needs only satisfy the requirements for bond (see 4.4.1.2 (3) of CYS EN 1992-1-1:2004):

- The existing concrete surface has not been subject to an outdoor environment for more than 28 days.
- The existing concrete surface is rough.
- The strength class of the existing concrete is at least C25/30.

NA 2.8 Clause 5.1.3 (101)P Structural Analysis - Load cases and combinations

No simplifications to the load arrangements for use are given in this National Annex.

NA 2.9 Clause 5.2(105) Geometric imperfections

The value of θ_0 is specified as 1/200.

NA 2.10 Clause 5.3.2.2 (104) Geometric data - Effective span of beams and slabs

The value of t is specified as the breadth of the bearing.

NA 2.11 Clause 5.5(104) Linear elastic analysis with limited redistribution

The values of k_1, k_2, k_3, k_4 and k_5 are specified as follows:

$k_1 = 0{,}44$

$k_2 = 1{,}25(0{,}6+0{,}0014/\varepsilon_{cu2})$

$k_3 = 0{,}54$

$k_4 = 1{,}25(0{,}6+0{,}0014/\varepsilon_{cu2})$

$k_5 = 0{,}85$

NA 2.12 Clause 5.7 (105) Non-linear analysis

The details of acceptable methods for non-linear analysis and safety format to be used are as follows:

When using non-linear analysis the following assumptions shall be made:

- For reinforcing steel, the stress-strain diagram to be used shall be based on Figure 3.8, curve A (CYS EN 1992-1-1:2004). In this diagram, f_{yk} and kf_{yk} shall be replaced by $1{,}1f_{yk}$ and $1{,}1kf_{yk}$
- For prestressing steel, the idealised stress-strain diagram given in 3.3.6 (Figure 3.10, curve A, (CYS EN 1992-1-1:2004)) shall be used. In this diagram f_{pk} shall be replaced with 1.1 f_{pk}
- For concrete, the stress-strain diagram shall be based on expression (3.14) in 3.1.5. (CYS EN 1992-1-1:2004). In this expression, and in the k-value, f_{cm} shall be replaced by $\gamma_{cf}.f_{ck}$ with $\gamma_{cf} = 1{,}1.\gamma_S /\gamma_C$.

The following design format shall be used:

- The resistance shall be evaluated for different levels of appropriate actions which shall be increased from their serviceability values by incremental steps, such that the value of $\gamma_G.G_k$ and $\gamma_Q.Q_k$ are reached in the same step. The incrementing process shall be continued until one region of the structure attains the ultimate strength, evaluated taking account of α_{cc}, or there is global failure of the structure. The corresponding load is referred to as q_{ud}.

- Apply an overall safety factor γ_O and obtain the corresponding strength $R\left(\frac{q_{ud}}{\gamma_O}\right)$,

- One of the following inequalities shall be satisfied :

$$\gamma_{Rd}E(\gamma_G G + \gamma_Q Q) \le R\left(\frac{q_{ud}}{\gamma_O}\right) \qquad (5.102.aCYS)$$

or

$$E(\gamma_G G + \gamma_Q Q) \le R\left(\frac{q_{ud}}{\gamma_{Rd} \cdot \gamma_O}\right) \qquad (5.102.bCYS)$$

$$\text{(i.e.)} \quad R\left(\frac{q_{ud}}{\gamma_{O'}}\right)$$

or

$$\gamma_{Rd}\gamma_{Sd}E(\gamma_g G + \gamma_q Q) \le R\left(\frac{q_{ud}}{\gamma_O}\right) \qquad (5.102.cCYS)$$

Where:

γ_{Rd} is the partial factor for model uncertainty for resistance, $\gamma_{Rd} = 1{,}06$,

γ_{Sd} is the partial factor for model uncertainty for action / action effort, $\gamma_{Sd} = 1{,}15$,

γ_O is the overall safety factor, $\gamma_O = 1{,}20$.

Refer to Annex PP for further details.

When model uncertainties γ_{Rd} and γ_{Sd} are not considered explicitly in the analysis (i.e. $\gamma_{Rd} = \gamma_{Sd} = 1$), $\gamma_{O'} = 1{,}27$ shall be used.

NA 2.13 Clause 6.1 (109) Bending with or without axial force

Any one of the methods (a, b and c) is applicable and can be used.

- In method a, (iii) of CYS EN 1992-2:2005 the ultimate bending resistance shall be calculated using the material safety factors for accidental design situations given in Table 2.1(CYS) of 2.2.2.4 (CYS EN 1992-1-1:2004).
- In method b, the value of f_{ctx} is set equal to $f_{ctm.}$.

NA 2.14 Clause 6.1 (110) Bending with or without axial force

In case where method (b) in 6.1(109) of CYS EN 1992-2:2005 is chosen, the values of k_{cm} and k_p are specified as 2,0 and 1,0 respectively.

NA 2.15 Clause 6.2.2 (101) Shear – Members not requiring design shear reinforcement.

The value of $C_{Rd,c}$ is specified as $0{,}18/\gamma_c$, and that for k_1 is set equal to 0,15. The value for v_{min} is given by Expression 6.3(CYS).

$v_{min} = 0{,}035\, k^{3/2} \cdot f_{ck}^{1/2}$ (6.3CYS)

NA 2.16 Clause 6.2.3 (103) Shear – Members requiring design shear reinforcement.

The value of the strength reduction factor for concrete cracked in shear, $v_{1,}$ is set equal to v where v is given by Expression 6.6(CYS) of CYS EN 1992-1-1:2004.

- If the design stress of the shear reinforcement is below 80% of the characteristic yield stress f_{yk}, v_1 may be taken as:

  $v_1 = 0{,}6$ for $f_{ck} \leq 60$ MPa (6.10.aCYS)
  $v_1 = 0{,}9 - f_{ck}/200 > 0{,}5$ for $f_{ck} \geq 60$ MPa (6.10.bCYS

The value of α_{cw} is specified as follows:

$\alpha_{cw} = 1$	for non-prestressed structures	
$\alpha_{cw} = (1 + \sigma_{cp}/f_{cd})$	for $0 < \sigma_{cp} \leq 0{,}25\, f_{cd}$	(6.11.aCYS)
$\alpha_{cw} = 1{,}25$	for $0{,}25\, f_{cd} < \sigma_{cp} \leq 0{,}5\, f_{cd}$	(6.11.bCYS)
$\alpha_{cw} = 2{,}5\,(1 - \sigma_{cp}/f_{cd})$	for $0{,}5\, f_{cd} < \sigma_{cp} < 1{,}0\, f_{cd}$	(6.11.cCYS)

where:

σ_{cp} is the mean compressive stress, measured positive, in the concrete due to the design axial force. This shall be obtained by averaging it over the concrete section taking account of the reinforcement. The value of σ_{cp} need not be calculated at a distance less than $0.5d \cot \theta$ from the edge of the support.

NA 2.17 Clause 6.2.3 (107) Shear – Members requiring design shear reinforcement.

No additional guidance on the superposition of different truss models is given in this National Annex.

The guidance given in this National Annex is as follows:

- In the case of bonded prestressing, located within the tensile chord, the resisting effect of prestressing may be taken into account for carrying the total longitudinal tensile force. In the case of inclined bonded prestressing tendons in combination with other longitudinal reinforcement/tendons the shear strength may be evaluated, by a simplification, superimposing two different truss models with different geometry (Figure. 6.102CYS); a weighted mean value between θ_1 and θ_2 may be used for concrete stress field verification with Expression (6.9) of CYS EN 1992-2:2005.

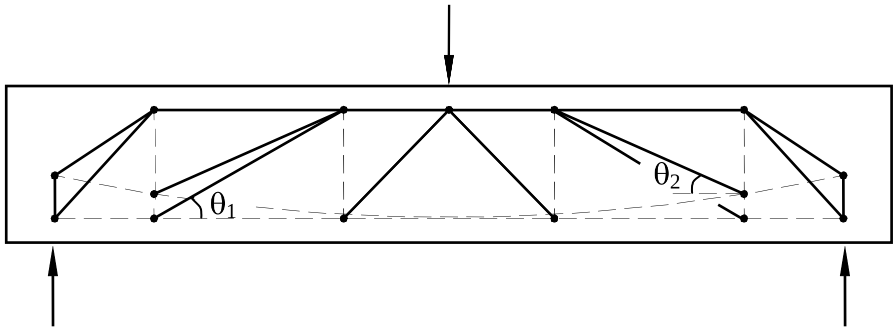

Figure 6.102(CYS): Superimposed resisting model for shear

NA 2.18 Clause 6.2.3 (109) Shear – Members requiring design shear reinforcement.

The absolute minimum value for h_{red} is specified as 0,5h.

NA 2.19 Clause 6.8.1 (102) Fatigue – Verification conditions

No additional rules for fatigue verification are defined in this National Annex.

NA 2.20 Clause 6.8.7 (101) Fatigue – Verification of concrete under compression or shear

The value of k_1 is specified as 0,85.

NA 2.21 7.2 Stresses

The value of k_1 is specified as 0,6 and the maximum increase in the stress limit above k_1f_{ck} in the presence of confinement is set to 10%.

NA 2.22 Clause 7.3.1 (105) Crack control - General considerations

The value for w_{max} and the application of the decompression limit are given in Table 7.101(CYS). The definition of decompression is noted in the text under the Table.

Table 7.101(CYS) Values of w_{max} and relevant combinations rules

Exposure Class	Reinforced members and prestressed members with unbonded tendons	Prestressed members with bonded tendons
	Quasi-permanent load combination	Frequent load combination
X0, XC1	0,3[a]	0,2
XC2, XC3, XC4	0,3	0,2[b]
XD1, XD2, XD3 XS1, XS2, XS3		Decompression

[a] For X0, XC1 exposure classes, crack width has no influence on durability and this limit is set to guarantee acceptable appearance. In the absence of appearance conditions this limit may be relaxed.

[b] For these exposure classes, in addition, decompression shall be checked under the quasi-permanent combination of loads.

The decompression limit requires that all concrete within a certain distance of bonded tendons or their ducts shall remain in compression under the specified loading.

The value of the distance considered to be used is set equal to 100 mm.

NA 2.23 Clause 7.3.3 (101) Control of cracking without direct calculation

Details of a simplified method for control of cracking without calculation are given in 7.3.3(2) to (4) of CYS EN 1992-1–1:2004.

NA 2.24 Clause 7.3.4 (101) Calculation of crack widths

A recognised method for crack width control is given in detailing in 7.3.4 of CYS EN 1992-1–1:2004.

NA 2.25 Clause 8.9.1 (101) Bundled bars – General

No additional restrictions on the use of bundled bars are given in this National Annex.

NA 2.26 Clause 8.10.4 (105) Anchorages and couplers for prestressing tendons

The values of X and the maximum percentage of tendons to be coupled at a section are specified as 50 % and 67 % respectively.

The value of the distance “*a*” is given in Table 8.101(CYS).

Table 8.101(CYS): Minimum distance between sections at which tendons are joined with couplers

Construction depth h	Distance a
≤ 1,5 m	1,5 m
1,5 m < h < 3,0 m	$a = h$
≥ 3,0 m	3,0 m

NA 2.27 Clause 8.10.4 (107) Anchorages and couplers for prestressing tendons

No additional rules relating to the provision of openings and pockets on the upper side of carriageway slabs are recommended in this National Annex.

NA 2.28 Clause 9.1 (103) General

No additional rules concerning the minimum thickness of structural elements and the minimum reinforcement for all surfaces of members in bridges, with minimum bar diameter and maximum bar spacing for use are recommended in this National Annex.

NA 2.29 Clause 9.2.2 (101) Beams – Shear Reinforcement

The forms of shear reinforcement permitted for use are:

- Links enclosing the longitudinal tension reinforcement and the compression zone (see Figure 9.5 of CYS EN 1992-1-1:2004);
- A combination of links and bent-up bars.

NA 2.30 Clause 9.5.3 (101) Columns – Transverse reinforcement

The values of minimum diameter of transverse reinforcement are specified as ϕ_{min} = 8mm and $\phi_{min,mesh}$ = 8mm respectively.

NA 2.31 Clause 9.7 (102) Deep beams

The maximum spacing of adjacent bars s_{mesh} is specified as the lesser of the web thickness or 300mm.

NA 2.32 Clause 9.8.1(103) Foundations – Pile caps

The value of the minimum bar diameter d_{min} is specified as 12mm.

NA 2.33 Clause 11.9 (101) Lightweight aggregate concrete structures - Detailing of members and particular rules

The use of bundled bars in LWAC shall be avoided.

NA 2.34 Clause 113.2 (102) Design of the execution stages – Actions during execution

The value of x is set equal to 200 N/m^2.

NA 2.35 Clause 113.3.2 (103) Design of the execution stages – Serviceability limit states

The value of k is specified as 1,0.

NA 3 DECISION ON USE OF THE ANNEXES

NA 3.1 Annex A

Annex A may be used

NA 3.2 Annex B

Annex B may be used

NA 3.3 Annex D

Annex D may be used

NA 3.4 Annex F

Annex F may be used

NA 3.5 Annex G

Annex G may be used

NA 3.6 Annex H

Annex H may be used

NA 3.7 Annex J

Annex J may be used

NA 3.8 Annex KK

Annex KK may be used

NA 3.9 Annex LL

Annex LL may be used

NA 3.10 Annex NN

Annex NN may be used

NA 3.11 Annex OO

Annex OO may be used

NA 3.12 Annex PP

Annex PP may be used

NA 4 REFERENCES TO NON-CONTRADICTORY COMPLEMENTARY INFORMATION

None

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