

**NATIONAL ANNEX**  
**TO**  
**CYS EN 1993-4-1:2007 Eurocode 3: Design of steel**  
**structures**  
**Part 4-1: Silos**

**Public Enquiry Draft**

**Period of Enquiry**

**November 19<sup>th</sup> 2007 to January 14<sup>th</sup> 2008**

**Readers are advised that this is a draft document and subject to change**

**Prepared by: Eurocodes Committee**  
**Ministry of Interior / Technical Chamber of Cyprus**

## PUBLIC ENQUIRY DRAFT

National Annex to CYS EN 1993-4-1:2007 Eurocode 3: Design of steel structures  
Part 4-1: Silos

### 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 1993-4-1:2007

This National Annex gives:

(a) Nationally determined parameters for the following clauses of CYS EN 1993-4-1:2007 where National choice is allowed (see Section NA 2)

- 2.2 (1)
- 2.2 (3)
- 2.9.2.2 (3)
- 3.4 (1)
- 4.1.4 (2) and (4)
- 4.2.2.3 (6)
- 4.3.1 (6) and (8)
- 5.3.2.3 (3)
- 5.3.2.4 (10), (12) and (15)
- 5.3.2.5 (10) and (14)
- 5.3.2.6 (3) and (6)
- 5.3.2.8 (2)
- 5.3.3.5 (1) and (2)
- 5.3.4.3.2 (2)
- 5.3.4.3.3 (2) and (5)
- 5.3.4.3.4 (5)
- 5.3.4.5 (3)
- 5.4.4 (2), (3) and (4)
- 5.4.7 (3)
- 5.5.2 (3)
- 5.6.2 (1) and (2)
- 6.1.2 (4)
- 6.3.2.3 (2) and (4)
- 6.3.2.7 (3)
- 7.3.1 (4)
- 8.3.3 (4)
- 8.4.1 (6)
- 8.4.2 (5)
- 8.5.3 (3)
- 9.5.1 (3) and (4)
- 9.5.2 (5)
- 9.8.2 (1) and (2)
- A.2 (1) and (2)
- A.3.2.1 (6)
- A.3.2.2 (6)

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- A.3.2.3 (2)
- A.3.3 (1), (2) and (3)
- A.3.4 (4)

- (b) Decisions on the use of the Informative Annexes A, B and C (see Section NA 3)
- (c) References to non-contradictory complementary information to assist the user to apply CYS EN 1993-4-1:2007. In this National Annex such information is provided for the following clauses in CYS EN 1993-4-1:2007 (see Section NA 4)
- None

## **NA 2 NATIONALLY DETERMINED PARAMETERS**

### **NA 2.1 Clause 2.2 (1) Reliability differentiation**

No consequence classes for silos are defined.

### **NA 2.2 Clause 2.2 (3) Reliability differentiation**

No information on the consequence classes is provided.

### **NA 2.3 Clause 2.9.2.2 (3) Partial factors for resistances**

Table 2.1 (CYS) provides the numerical values of partial factors  $\gamma_{Mi}$ .

**Table 2.1 (CYS): Numerical values for the partial factors for resistance**

$\gamma_{M0} = 1,00$	$\gamma_{M1} = 1,10$	$\gamma_{M2} = 1,25$
$\gamma_{M4} = 1,00$	$\gamma_{M5} = 1,25$	$\gamma_{M6} = 1,10$

### **NA 2.4 Clause 3.4 (1) Special alloy steels**

No information is provided on appropriate values of relevant mechanical properties.

### **NA 2.5 Clause 4.1.4 (2) Allowance for corrosion and abrasion**

The value  $\Delta t_a$  is specified as  $\Delta t_a = 2$  mm.

### **NA 2.6 Clause 4.1.4 (4) Allowance for corrosion and abrasion**

No appropriate values for corrosion and abrasion losses for particular solids in frictional contact with defined silo wall materials are provided.

### **NA 2.7 Clause 4.2.2.3 (6) Consequence Class 2**

The value of  $n_{vs}$  is specified as  $n_{vs} = 5$ .

### **NA 2.8 Clause 4.3.1 (6) Modelling of the structural box**

The value of  $n_s$  is specified as  $n_s = 40$ .

### **NA 2.9 Clause 4.3.1 (8) Modelling of the structural box**

The value of  $n_{ew}$  is specified as  $n_{ew} = 16$ .

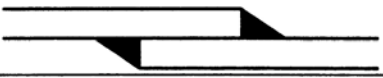
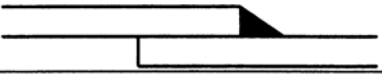
### **NA 2.10 Clause 5.3.2.3 (3) Plastic limit state**

The value of  $j_i$  for different joint configurations is specified as follows:

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**Joint efficiency  $j_i$  of welded lap joints**

Joint type	Sketch	Value of $j_i$
Double welded lap		$j_1 = 1,0$
Single welded lap		$j_2 = 0,35$

The single welded lap joint should not be used if more than 20 % of the value of  $\sigma_{e,Ed}$  in expression 5.4 of EN 1993-4-1:2007 derives from bending moments.

**NA 2.11 Clause 5.3.2.4 (10) Buckling under axial compression**

The value of  $\psi_b$  is specified as  $\psi_b = 0,40$ .

**NA 2.12 Clause 5.3.2.4 (12) Buckling under axial compression**

The values of  $\alpha_L$ ,  $k_1$  and  $k_2$  are specified as follows:  $\alpha_L = 0,7\alpha$ ;  $k_1 = 0,5$  and  $k_2 = 0,25$ , where  $\alpha$  is given by  $\alpha_o$ ,  $\alpha_{pe}$ ,  $\alpha_{pp}$  as appropriate.

**NA 2.13 Clause 5.3.2.4 (15) Buckling under axial compression**

The values of  $\beta$  and  $\eta$  are specified as follows:  $\beta = 0,60$  and  $\eta = 1,0$ .

**NA 2.14 Clause 5.3.2.5 (10) Buckling under external pressure, internal partial vacuum and wind**

The value of  $\alpha_n$  is specified as  $\alpha_n = 0,5$ .

**NA 2.15 Clause 5.3.2.5 (14) Buckling under external pressure, internal partial vacuum and wind**

The value of  $k_1$  is specified as  $k_1 = 0,1$ .

**NA 2.16 Clause 5.3.2.6 (3) Membrane shear**

The value of  $k_s$  is specified as  $k_s = 0,10$ .

**NA 2.17 Clause 5.3.2.6 (6) Membrane shear**

The value of  $\alpha_r$  is specified as  $\alpha_r = 0,80$ .

**NA 2.18 Clause 5.3.2.8 (2) Fatigue, LS4**

The value of  $N_f$  is specified as  $N_f = 10\ 000$ .

**NA 2.19 Clause 5.3.3.5 (1) Membrane shear**

The value of  $k_s$  is specified as  $k_s = 0,10$ .

**NA 2.20 Clause 5.3.3.5 (2) Membrane shear**

The value of  $k_t$  is specified as  $k_t = 4,0$ .

**NA 2.21 Clause 5.3.4.3.2 (2) Unstiffened wall**

The value of  $\alpha_x$  is specified as  $\alpha_x = 0,80$ .

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**NA 2.22 Clause 5.3.4.3.3 (2) Stiffened wall treated as an orthotropic shell**

The value of  $k_{dx}$  is specified as  $k_{dx} = 7,4$ .

**NA 2.23 Clause 5.3.4.3.3 (5) Stiffened wall treated as an orthotropic shell**

The value of  $\alpha_x$  is specified as  $\alpha_x = 0,80$ .

**NA 2.24 Clause 5.3.4.3.4 (5) Stiffened wall treated as carrying axial compression only in the stiffeners**

The value of  $k_s$  is specified as  $k_s = 6$ .

**NA 2.25 Clause 5.3.4.5 (3) Buckling under external pressure, partial vacuum or wind**

The value of  $k_{d0}$  is specified as  $k_{d0} = 7,4$ .

**NA 2.26 Clause 5.4.4 (2) Discretely supported cylindrical shell**

The values of  $(r/t)_{max}$ ,  $k_1$ ,  $k_2$  and  $k_3$  are specified as follows:  $(r/t)_{max} = 400$ ,  $k_1 = 2,0$ ,  $k_2 = 1,0$  and  $k_3 = 1,0$ .

**NA 2.27 Clause 5.4.4 (3) Discretely supported cylindrical shell**

The value of  $k_s$  is specified as  $k_s = 0,10$ .

**NA 2.28 Clause 5.4.4 (4) Discretely supported cylindrical shell**

The value of  $k_L$  is specified as  $k_L = 4,0$ .

**NA 2.29 Clause 5.4.7 (3) Anchorage at the base of a silo**

The values for the harmonic coefficients of wind pressure  $C_m$  relevant to specific conditions for Class 1 and 2 silos are specified as follows:  $M = 4$ ;  $C_1 = + 0,25$ ;  $C_2 = + 1,0$ ;  $C_3 = + 0,45$  and  $C_4 = - 0,15$ . For Class 3 silos, the more precise distribution with  $M = 4$  for isolated silos and  $M = 10$  for grouped silos given in Annex C of EN 1993-4-1:2007 are adopted.

**NA 2.30 Clause 5.5.2 (3) Rectangular openings**

The value of  $k_{d1}$  is specified as  $k_{d1} = 0,02$ .

**NA 2.31 Clause 5.6.2 (1) Deflections**

The value of  $k_{d2}$  is specified as  $k_{d2} = 0,02$ .

**NA 2.32 Clause 5.6.2 (2) Deflections**

The values of  $k_{d3}$  and  $k_{d4}$  are specified as follows:  $k_{d3} = 0,05$  and  $k_{d4} = 20$ .

**NA 2.33 Clause 6.1.2 (4) Hopper wall design**

The value of  $\gamma_{M0g}$  is specified as  $\gamma_{M0g} = 1,4$ .

**NA 2.34 Clause 6.3.2.3 (2) Rupture at the transition junction**

The value of  $g_{asym}$  is specified as  $g_{asym} = 1,2$ .

**NA 2.35 Clause 6.3.2.3 (4) Rupture at the transition junction**

The value of  $k_r$  is specified as  $k_r = 0,90$ .

**NA 2.36 Clause 6.3.2.7 (3) Buckling in hoppers**

The value of  $a_{xh}$  is specified as  $a_{xh} = 0,10$ .

**NA 2.37 Clause 7.3.1 (4) Shell or unsupported roofs**

The value of  $a_p$  is specified as  $a_p = 0,20$ .

**NA 2.38 Clause 8.3.3 (4) Resistance to in-plane buckling**

The value of  $\beta_{lim}$  is specified as  $\beta_{lim} = 20^\circ$ .

**NA 2.39 Clause 8.4.1 (6) Uniformly supported transition junctions**

The values of  $\beta_{lim}$ ,  $k_L$  and  $k_R$  are specified as follows:  $\beta_{lim} = 10^\circ$ ;  $k_L = 10$  and  $k_R = 0,04$ .

**NA 2.40 Clause 8.4.2 (5) Transition junction ring girder**

The values of  $\beta_{lim}$ ,  $k_L$  and  $k_R$  are specified as follows:  $\beta_{lim} = 10^\circ$ ;  $k_L = 10$  and  $k_R = 0,04$ .

**NA 2.41 Clause 8.5.3 (3) Base ring**

The value of  $k$  is specified as  $k = 0,10$ .

**NA 2.42 Clause 9.5.1 (3) Forces in internal ties due to solids pressure on them**

The values of  $C_{sc}$  and  $C_{ss}$  are specified as follows:  $C_{sc} = 1,0$  and  $C_{ss} = 1,2$ .

**NA 2.43 Clause 9.5.1 (4) Forces in internal ties due to solids pressure on them**

The values of  $k_{Lf}$  and  $k_{Le}$  are specified as follows:  $k_{Lf} = 4,0$  and  $k_{Le} = 2,0$ .

**NA 2.44 Clause 9.5.2 (5) Modelling of ties**

The value of  $k_s$  is specified as  $k_s = 0,01$ .

**NA 2.45 Clause 9.8.2 (1) Deflections**

The values of  $k_1$  and  $k_2$  are specified as follows:  $k_1 = 0,02$  and  $k_2 = 10$ .

**NA 2.46 Clause 9.8.2 (2) Deflections**

The value of  $k_3$  is specified as  $k_3 = 0,05$ .

**NA 2.47 Clause A.2 (1) Action effect assessment**

The value of  $k_M$  is specified as  $k_M = 1,1$ .

**NA 2.48 Clause A.2 (2) Action effect assessment**

The value of  $k_h$  is specified as  $k_h = 1,2$ .

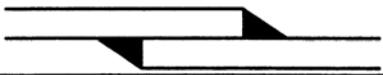
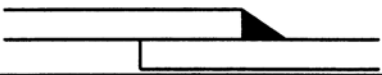
**NA 2.49 Clause A.3.2.1 (6) Plastic limit state**

The value of  $j_i$  for different joint configurations is specified as follows:

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**Joint efficiency  $j_i$  of welded lap joints**

Joint type	Sketch	Value of $j_i$
Double welded lap		$j_1 = 1,0$
Single welded lap		$j_2 = 0,35$

**NA 2.50 Clause A.3.2.2 (6) Axial compression**

The value of  $\gamma_{M1}$  is specified as  $\gamma_{M1} = 1,1$ .

**NA 2.51 Clause A.3.2.3 (2) External pressure, internal partial vacuum and wind**

The values of  $a_n$  and  $\gamma_{M1}$  are specified as follows:  $a_n = 0,5$  and  $\gamma_{M1} = 1,1$ .

**NA 2.52 Clause A.3.3 (1) Conical welded hoppers**

The value of  $\gamma_{M0g}$  is specified as  $\gamma_{M0g} = 1,4$ .

**NA 2.53 Clause A.3.3 (2) Conical welded hoppers**

The value of  $g_{asym}$  is specified as  $g_{asym} = 1,2$ .

**NA 2.54 Clause A.3.3 (3) Conical welded hoppers**

The value of  $k_r$  is specified as  $k_r = 0,90$ .

The value of  $\gamma_{M2}$  is specified as  $\gamma_{M2} = 1,25$ .

**NA 2.55 Clause A.3.4 (4) Transition junction**

The value of  $\gamma_{M0}$  is specified as  $\gamma_{M0} = 1,0$ .

**NA 3 DECISION ON USE OF THE INFORMATIVE ANNEXES A, B AND C**

**NA 3.1 Annex A**

Annex B may be used

**NA 3.2 Annex B**

Annex C may be used

**NA 3.3 Annex C**

Annex E may be used

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

None