NATIONAL ANNEX

TO

CYS EN 1991-4:2006 (Including AC:2012)

Eurocode 1: Actions on structures

Part 4: Silos and tanks

CYPRUS ORGANISATION FOR STANDARDISATION

NATIONAL ANNEX

TO

CYS EN 1991-4:2006
(Including AC:2012)

Eurocode 1: Actions on structures

Part 4: Silos and tanks

This National Annex has been approved by the Board of Directors of the Cyprus Organisation for Standardisation (CYS) on 24.01.2020.

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INTRODUCTION

This National Annex has been prepared by the CYS TC 18 Standardisation Technical Committee of the Cyprus Organisation for Standardisation. (CYS).

NA 1 . SCOPE

This National Annex is to be used together with CYS EN 1991-4:2006 including AC:2012. Any reference in the rest of this text to CYS EN 1991-4:2006 means the above document.

This National Annex gives:

(a) Nationally determined parameters for the following clauses of CYS EN 1991-4:2006 where National choice is allowed (see Section NA 2)

- 2.5 (5)
- 3.6 (2)
- 5.2.4.3.1 (3)
- 5.4.1 (3)
- 5.4.1 (4)
- A.4 (3)
- B.2.14 (1)

(b) Decisions on the use of the Informative Annexes A, B, F and H (see Section NA 3)

(c) References to non-contradictory complementary information to assist the user to apply CYS EN 1991-4:2006. In this National Annex such information is provided for the following clauses in CYS EN 1991-4:2006 (see Section NA 4)

NA 2 NATIONALLY DETERMINED PARAMETERS

NA 2.1 Clause 2.5 (5) Action assessment classification

The values defining the class boundaries are shown in Table 2.1 (CYS)

Table 2.1 (CYS) — Recommended classification of silos for action assessments

Action Assessment Class	Description
Action Assessment Class 3	Silos with capacity in excess of 10 000 tonnes Silos with capacity in excess of 1000 tonnes in which any of the following design situations occur: a) eccentric discharge with $e_o/d_c > 0{,}25$ (see figure 1.1b) b) squat silos with top surface eccentricity with $e_t/d_c > 0{,}25$
Action Assessment Class 2	All silos covered by this standard and not placed in another class
Action Assessment Class 1	Silos with capacity below 100 tonnes

NA 2.2 Clause 3.6 (2) Principles for design for explosions

No further guidance regarding the pressure exerted on structures near the silo as a result of an explosion within it is given in this National Annex.

NA 2.3 Clause 5.2.4.3.1 (3). Method for Action Assessment Class 3 Flow channel geometry

The values of k_1, k_2 and k_3 are 0,25, 0,4 and 0,6 respectively.

NA 2.4 Clause 5.4.1 (3) Retaining Silos-Filling loads on vertical walls

The method for determining the horizontal pressure p_h is given in expression (5.97):

$$p_h = \gamma K (1 + \sin\varphi_r)\, z_s \qquad \ldots (5.97)$$

where:

z_s is the depth below the highest stored solid contact with the wall (see Figure 5.8 CYS);

γ is the upper characteristic value of the unit weight of the solid;

K is the upper characteristic value of the lateral pressure ratio for the solid;

φ_r is the angle of repose of the stored solid

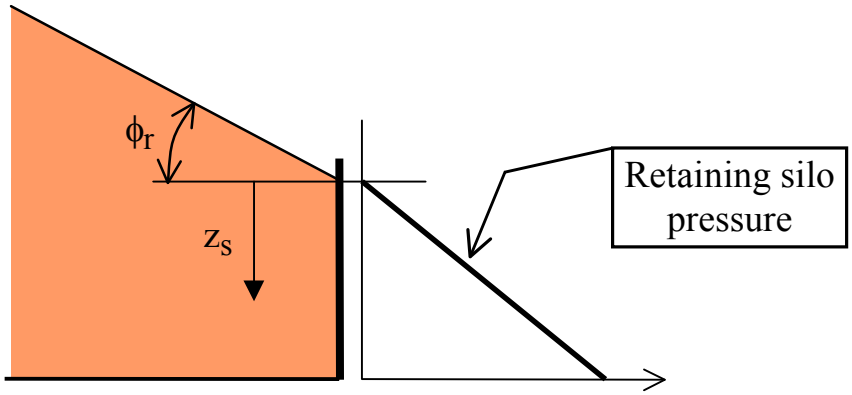

Figure 5.8 (CYS): Filling pressures in retaining silo

NA 2.5 5.4.1 (4) Retaining silos- Filling loads on vertical walls

The method to be used for determining the resulting vertical force n_{zSk} is given in expression (5.98):

$$n_{zSk} = (\gamma\mu K/2)\,(1+\sin\varphi_r) z_s^2$$

where μ is the upper characteristic value of the wall friction coefficient of the solid

NA 2.6 Clause A.4 (3) Design situations and action combinations for Action Assessment Classes 2 and 3

The values and combinations of ψ are given in Tables A.1 (CYS), A.2 (CYS), A.3 (CYS), A.4 (CYS) and A.5 (CYS), with Accompanying Actions 2 and 3 reduced by their appropriate combination factors ψ.

Table A.1 (CYS): Design situations and action combinations to be considered

Short title	Design situation / Dominant action 1	Permanent actions	Accompanying Action 2	$\psi_{0,2}$	Accompanying Action 3	$\psi_{0,3}$
D	Solids discharge	Self weight	Foundation settlement	1,0	Snow or wind or thermal	0,6
					Imposed loads or deformation	0,7
I	Imposed loads or deformation	Self weight	Solids filling	1,0	Snow or wind or thermal	0,6
S	Snow	Self weight	Solids filling	1,0		
WF	Wind and full	Self weight	Solids filling	1,0		
WE	Wind and empty	Self weight	Solids empty	0,0		
T	Thermal	Self weight	Solids filling	1,0		
F	Foundation settlement	Self weight	Solids discharge	1,0	Snow or wind or thermal	0,6
				$\psi_{2,2}$		$\psi_{2,3}$
E	Explosion	Self weight	Solids filling	0,9	Imposed loads or deformation	0,3
V	Vehicle impact	Self weight	Solids filling	0,8	Imposed loads or deformation	0,3

NOTE 1: This table refers to terms in the load combination rules of Section 6 in EN 1990.

NOTE 2: The subscripts of ψ have the following significance: first subscript is for the type of design situation: normal combination values are 0; frequent values are 1; quasi-permanent values are 2. The second subscript refers to the load number in the combination.

Table A.2 (CYS): "Ordinary" ultimate limit state ("Ordinary" ULS) - design situations and action combinations to be considered

Short title	Design situation / Leading variable action	Permanent actions		Leading variable action		Accompanying variable action 1 (main)		Accompanying variable action 2		Accompanying variable action 3, 4, etc.	
		Description	ξ_1	(See next column, "main")		Description	$\psi_{0,1}$	Description	$\psi_{0,2}$	Description	$\psi_{0,3}$ $\psi_{0,4}$ etc
D	Solids discharge	Self weight	0,9			Solids discharge	1,0	Foundation settlement	0,7	Snow, wind, thermal	0,6
										Imposed loads, imposed deformation	0,7
I	Imposed deformation	Self weight	0,9			Solids filling	1,0	Imposed deformation	0,7	Snow, wind, thermal	0,6
										Imposed loads	0,7
S	Snow	Self weight	0,9			Solids filling	1,0	Snow	0,6	Imposed loads	0,7
WF	Wind and full silo	Self weight	0,9			Solids filling, full silo	1,0	Wind	0,6	Imposed loads	0,7
WE	Wind and empty silo	Self weight	0,9			Solids, empty silo	0,0	Wind	0,6	Imposed loads	0,7
T	Thermal	Self weight	0,9			Solids filling	1,0	Thermal	0,6	Imposed loads	0,7
NOTE: Table A.2 should be used with expressions (6.10a) and (6.10b) in EN 1990, 6.4.3.2.											

Table A.3 (CYS): "Accidental" ultimate limit state ("Accidental" ULS) - design situations and action combinations to be considered

Short title	Design situation / Leading variable action	Permanent actions		Leading accidental action		Accompanying variable action 1 (main)		Accompanying variable action 2		Accompanying variable action 3, 4, etc.	
		Description		Description		Description	$\psi_{1,1}$ or $\psi_{2,1}$	Description	$\psi_{2,2}$	Description	$\psi_{2,3}$ $\psi_{2,4}$ etc
E	Explosion	Self weight		Blast pressure		Solids filling	0,9 or 0,8	Imposed deformation	0,3	Imposed loads	0,3
V	Vehicle impact	Self weight		Vehicle impact		Solids filling	0,9 or 0,8	Imposed deformation	0,3	Imposed loads	0,3
NOTE: Table A.3 should be used with expression (6.11b) in EN 1990, 6.4.3.3.											

Table A.4 (CYS): "Seismic" ultimate limit state ("Seismic" ULS) - design situations and action combinations to be considered

Short title	Design situation / Leading variable action	Permanent actions		Leading seismic action		Accompanying variable action 1 (main)		Accompanying variable action 2		Accompanying variable action 3, 4, etc.	
		Description		Description		Description	$\psi_{2,1}$	Description	$\psi_{2,2}$	Description	$\psi_{2,3}$ $\psi_{2,4}$ etc
SF	Seismic action and full silo	Self weight		Seismic action (earthquake)		Solids filling, full silo	0,8	Imposed deformation	0,3	Imposed loads	0,3
SE	Seismic action and empty silo	Self weight		Seismic action (earthquake)		Solids, empty silo	0,8	Imposed deformation	0,3	Imposed loads	0,3
NOTE: Table A.4 should be used with expression (6.12b) in EN 1990, 6.4.3.4 and those of EN 1998-1 and EN 1998-4.											

Table A.5 (CYS): Serviceability limit state (SLS) - design situations and action combinations to be considered

Short title	Design situation / Leading variable action	Permanent actions		Leading variable action		Accompanying variable action 1 (main)		Accompanying variable action 2		Accompanying variable action 3, 4, etc.	
		Description		(See next column, "main")		Description	$\psi_{1,1}$ or $\psi_{2,1}$	Description	$\psi_{0,2}$ or $\psi_{2,2}$	Description	$\psi_{0,3}$ $\psi_{0,4}$ or $\psi_{2,3}$ $\psi_{2,4}$ etc
D	Solids discharge	Self weight				Solids discharge	0,9 or 0,8	Foundation settlement	0,7 or 0,3	Snow, wind, thermal	0,6 or 0,0
										Imposed loads, imposed deformation	0,7 or 0,3
I	Imposed deformation	Self weight				Solids filling	0,9 or 0,8	Imposed deformation	0,7 or 0,3	Snow, wind, thermal	0,6 or 0,0
										Imposed loads	0,7 or 0,3
S	Snow	Self weight				Solids filling	0,9 or 0,8	Snow	0,6 or 0,0	Imposed loads	0,7 or 0,3
WF	Wind and full silo	Self weight				Solids filling, full silo	0,9 or 0,8	Wind	0,6 or 0,0	Imposed loads	0,7 or 0,3
WE	Wind and empty	Self weight				Solids, empty silo	0,0	Wind	0,6 or 0,0	Imposed loads	0,7 or 0,3
T	Thermal	Self weight				Solids filling	0,9 or 0,8	Thermal	0,6 or 0,0	Imposed loads	0,7 or 0,3

NOTE: Table A.5 should be used with expressions (6.14b), (6.15b) and (6.16b) in EN 1990, 6.5.3 as follows:

Characteristic combination, expression (6.14b):
The characteristic combination is normally used for irreversible limit states.

Frequent combination, expression (6.15b):
The frequent combination is normally used for reversible limit states.

Quasi-permanent combination, expression (6.16b):
The quasi-permanent combination is normally used for long-term effects and the appearance of the structure.

NA 2.7 Clause B.2.14 (1) Accidental actions

The loads should include the consequences of events such as external blast, impact, adjacent external fire, explosion, leakage from the inner tank, roll over and overfilling of the inner tank.

These loads are not specified in the National Annex. They may be specified by the client for the individual project.

NA 3 DECISION ON USE OF INFORMATIVES ANNEXES

NA 3.1 Annex A

Annex A is informative and may be used.

NA 3.2 Annex B

Annex B is informative and may be used

NA 3.3 Annex F

Annex F is informative and may be used

NA 3.4 Annex H

Annex H is informative and may be used

NA 4 REFERENCES TO NON-CONTRADICTORY COMPLEMENTARY INFORMATION

None

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NA to CYS EN 1991-4:2006 (Including AC:2012)

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