CYS National Annex to CYS EN 1998-1:2004

Eurocode 8:

Design of structures for earthquake resistance

Part 1:

General rules, seismic actions and rules for buildings

Prepared by Eurocodes Committee, Scientific and

Technical Chamber of

Cyprus under a Ministry of Interior's Programme

NATIONAL ANNEX

TO

CYS EN 1998-1:2004 Eurocode 8: Design of structures for earthquake resistance

Part1: General rules, seismic actions and rules for buildings

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 1998-1:2004

This National Annex gives:

(a) Nationally determined parameters for the following clauses of CYS EN 1998-1:2004 where National choice is allowed (see Section NA 2)

- 1.1.2 (7)
- 2.1 (1)P
- 3.1.1 (4)
- 3.1.2 (1)
- 3.2.1 (1), (2), (4) and (5)
- 3.2.2.1 (4),
- 3.2.2.2 (2)P
- 3.2.2.3 (1)P
- 3.2.2.5 (4)P
- 4.2.3.2 (8)
- 4.2.4 (2)P
- 4.2.5 (5)P
- 4.3.3.1 (4) & (8)
- 4.4.2.5 (2)
- 4.4.3.2 (2)
- 5.2.1 (5)
- 5.2.2.2 (10)
- 5.2.4 (1) & (3)
- 5.4.3.5.2 (1)
- 5.8.2 (3) to (5)
- 5.11.1.3.2 (3)
- 5.11.1.4 (1)
- 5.11.1.5 (2)
- 5.11.3.4 (7)e
- 6.1.2 (1)
- 6.1.3 (1)
- 6.2 (3) & (7)
- 6.5.5 (7)
- 6.7.4 (2)
- 7.1.2 (1)
- 7.1.3 (1), (3) & (4)
- 7.7.2 (4)
- 8.3 (1)
- 9.2.1 (1)
- 9.2.2 (1)

- 9.2.3 (1)
- 9.2.4 (1)
- 9.3 (2) to (4) (Table 9.1)
- 9.5.1 (5)
- 9.6 (3)
- 9.7.2 (1), (2)b, (2)c and (5)
- 10.3 (2)P

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

(c) References to non-contradictory complementary information to assist the user to apply CYS EN 1998-1:2004 (see Section NA 4).

NA 2 NATIONALLY DETERMINED PARAMETERS

NA 2.1 Clause 1.1.2 (7) Scope of CYS EN 1998-1:2004

Informative Annex A and Informative Annex B of CYS EN 1998-1:2004 may be used as Informative Annexes.

NA 2.2 Clause 2.1 (1)P Fundamental requirements

No-collapse requirement:

For the no-collapse requirement the reference probability of exceedance, P_{NCR}, is 10% and the reference return period, T_{NCR}, is 475 years. The corresponding design life of the structure, T_L, is 50 years [$T_R = -T_L / \ln(1-P_R)$].

Damage limitation requirement:

For the damage limitation requirement the probability of exceedance, P_{DLR}, is 41% and the return period, T_{DLR}, is 95 years. The corresponding design life of the structure, T_L, is 50 years [$T_R = -T_L / \ln(1-P_R)$].

NA 2.3 Clause 3.1.1 (4) Ground conditions

Ground investigations and/or geologic studies (additional to those necessary for design for non-seismic actions) for the determination of the seismic action may be omitted for importance classes I and II. They may be also omitted for classes III and IV whenever there is adequate information.

NA 2.4 Clause 3.1.2 (1) Identification of ground types

The ground classification scheme accounting for deep geology is not specified.

NA 2.5 Clause 3.2.1 Seismic zones

(1) The seismic zones are specified on the hazard map included in this National Annex

(2) The value of the reference peak ground acceleration on Type A ground, α_{gR}, for each seismic zone is specified on the hazard map included in this National Annex.

(4) A low seismicity case is defined as the case when the design ground acceleration on Type A ground, α_g, is not greater than 0,08 g (0,78 m/s^2)

(5) A very low seismicity case is defined as the case when the design ground acceleration on Type A ground, α_g, is not greater than 0,04 g (0,39 m/s^2)

NA 2.6 Clause 3.2.2.1 (4) General

The shape of the elastic response spectrum for the three components of the seismic action is defined by expressions 3.2 to 3.5 and it is shown in Figure 3.1 (CYS) which corresponds to Figure 3.1 of CYS EN 1998-1:2004.

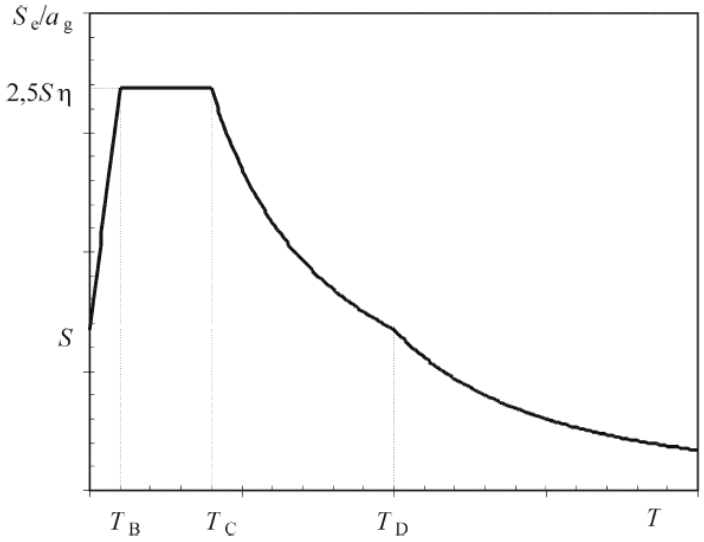


Figure 3.1 (CYS): Shape of elastic response spectrum

NA 2.7 Clause 3.2.2.2 (2)P Horizontal elastic response spectrum

The Type 1 elastic response spectrum, which is shown in Figure 3.2 (CYS) and corresponds to Figure 3.2 of CYS EN 1998-1:2004, is specified for ground types A to E to represent the horizontal components of the seismic action.

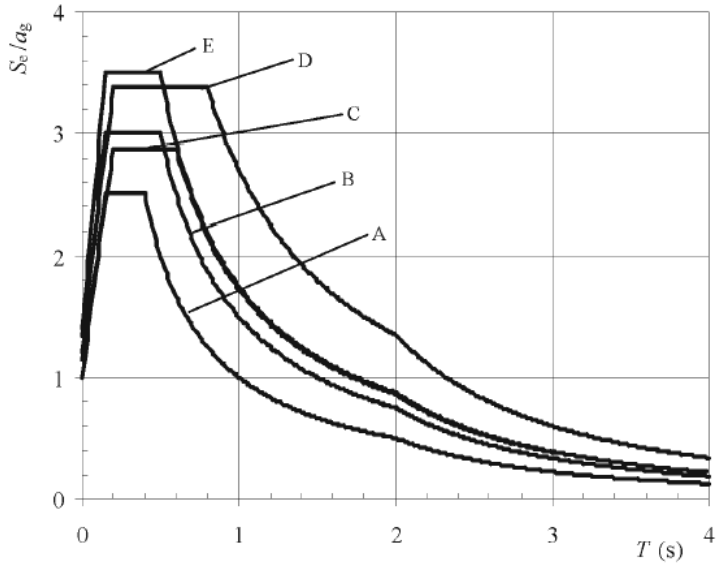


Figure 3.2 (CYS): Type 1 elastic response spectrum for ground types A to E (5% damping)

Table 3.2 (CYS) defines values for the symbols of Table 3.2 of CYS EN 1998-1:2004.

Table 3.2 (CYS): Values of the parameters describing the Type 1 elastic response spectrum

Ground Type	S	T_B (s)	T_C (s)	T_D (s)
A	1,0	0,15	0,4	2,0
B	1,2	0,15	0,5	2,0
C	1,15	0,20	0,6	2,0
D	1,35	0,20	0,8	2,0
E	1,4	0,15	0,5	2,0

NA 2.8 Clause 3.2.2.3 (1)P Vertical elastic response spectrum

The elastic response spectrum $S_{ve}(T)$ derived using expressions 3.8 – 3.11 of CYS EN 1998-1:2004 is specified to represent the vertical component of the seismic action.

The type 1 vertical spectrum is specified. Table 3.4 (CYS) defines values for the symbols of Table 3.4 of CYS EN 1998-1:2004, which specify the shape of the spectrum for ground types A to E.

Table 3.4 (CYS): Values of parameters describing the vertical elastic response spectrum

Spectrum	α_{vg}/α_g	T_B (s)	T_C (s)	T_D (s)
Type 1	0,90	0,05	0,15	1,0

NA 2.9 Clause 3.2.2.5 (4)P Design spectrum for elastic analysis

The value defined for symbol β is 0,2.

NA 2.10 Clause 4.2.3.2 (8) Criteria for regularity in plan

No reference is made to documents that might provide definitions of the centre of stiffness and of the torsional radius in multi-storey buildings, either for buildings that meet the conditions (a) and (b) of paragraph (8), or for those that do not.

NA 2.11 Clause 4.2.4 (2)P Combination coefficients for variable actions

Table 4.2 (CYS) defines values for symbol φ of Table 4.2 of CYS EN 1998-1:2004.

Table 4.2 (CYS): Values of φ for calculating ψ_{Ei}

Type of Variable action	Storey	φ
Categories A-C*	Roof Storeys with correlated occupancies Independently occupied storeys	1,0 0,8 0,5
Categories A-F* and Archives		1,0

* Categories as defined in EN 1991-1-1:2002

NA 2.12 Clause 4.2.5 (5)P Importance classes and importance factors

The values of the importance factor, γ_I, for importance classes I, III, and IV are defined as equal to 0,8, 1,2 and 1,4, respectively.

NA 2.13 Clause 4.3.3.1 General

(4) The nonlinear methods 4.3.3.1(4) may also be applied to non-base-isolated buildings, only in conjunction with the linear modal response spectrum analysis using the design spectrum specified in clause 3.2.2.5, for the purpose of obtaining a deeper understanding of the results of the linear modal response spectrum analysis. Under no circumstances these results may be reduced using more favorable results of the non linear method, except in the following cases:

- Base isolated buildings
- For modifying or checking the overstrength ratio α_u/α_l according to clauses 5.2.2.2, 6.3.2 and 7.3.2 of CYS EN 1998-1:2004
- For assessing the capacity of existing or retrofitted structures according to the provisions of CYS EN 1998-3:2005

The informative annexes A, B and C of CYS EN 1998-3:2005 may be used as complementary information for member deformation capacities (corresponding to the limit state of significant damage) and the associated safety factors, for the Ultimate Limit State verifications according to 4.4.2.2(5).

(8) The simplification of the analysis according to 4.3.3.1(8) is allowed for values of the importance factor, γ_I, less than or equal to 1.

NA 2.14 Clause 4.4.2.5 (2) Resistance of horizontal diaphragms

The value of symbol γ_d is set equal to 1,3 for brittle failure modes (such as in shear in concrete diaphragms) and 1,1 for ductile failure modes.

NA 2.15 Clause 4.4.3.2 (2) Limitations to interstorey drift

The values specified for symbol ν are 0,4 for importance classes III and IV and 0,5 for importance classes I and II.

NA 2.16 Clause 5.2.1(5) Energy dissipation capacity and ductility classes

Only buildings of importance class I may be designed using ductility class L (low), as prescribed in clause 5.2.1(2)P of CYS EN 1998-1:2004.

It is recommended that buildings of importance class IV are designed using ductility class H (high).

NA 2.17 Clause 5.2.2.2 (10) Behaviour factors for horizontal seismic actions

No increase to the values of q_o is allowed.

NA 2.18 Clause 5.2.4 (3) Safety verifications

The values of symbols γ_c and γ_s specified in the National Annex to CYS EN 1992-1-1:2004 for the persistent and transient design situations (e.g. gravity loads with wind), shall be used for the seismic design situation.

NA 2.19 Clause 5.4.3.5.2 (1) Shear resistance

The value of symbol $\rho_{w,min}$ is set equal to the minimum value for walls specified in CYS EN 1992-1-1:2004 and its National Annex.

NA 2.20 Clause 5.8.2 Tie-beams and foundation beams

(3) The value defined for symbol $b_{w,min}$ is 0,25 m and that for $h_{w,min}$ is 0,50 m for all buildings.

(4) The value defined for symbol t_{min} is 0,2 m and that for $\rho_{s,min}$ is 0,2%

(5) The value defined for symbol $\rho_{b,min}$ is 0,4%

NA 2.21 Clause 5.11.1.3.2 (3) Energy dissipation

Ductility class M (medium) is specified for all the types of precast concrete systems. The use of ductility class H (high) must be justified.

NA 2.22 Clause 5.11.1.4 (1) Behaviour factors

The reduction factor k_p is specified as

$$k_p \begin{cases} 1{,}00 & \text{for structures with connection according to 5.11.2.1.1, or to 5.11.2.1.2, or to 5.11.2.1.3} \\ 0{,}50 & \text{for structures with other types of connections} \end{cases}$$

NA 2.23 Clause 5.11.1.5 (2) Analysis of transient situation

The value defined for symbol A_p is 30%.

NA 2.24 Clause 5.11.3.4 (7)e Precast large-panel walls

The value defined for symbol $\rho_{c,min}$ is 1%.

NA 2.25 Clause 6.1.2 (1) Design concepts

Table 6.1(CYS) defines values for symbol q of Table 6.1 of CYS EN 1998-1:2004.

Only buildings of importance class I may be designed using ductility class L (low), unless clause 4.4.1(2) applies.

It is recommended that buildings of importance class IV are designed using ductility class H (high).

Table 6.1(CYS): Design concepts, structural ductility classes and values of the behaviour factors

Design Concept	Structural ductility class	Range of the Reference values of the behaviour factor q
Concept a) Low dissipative structural behaviour	DCL(Low)	≤ 1,5
Concept b) Dissipative structural behaviour	DCM (Medium)	≤ 4 also limited by the Values of Table 6.2
	DCH (High)	only limited by the values of Table 6.2

NA 2.26 Clause 6.1.3 (1)P Safety verifications

The partial factor γ_s adopted for the persistent and transient design situations shall be used for the seismic design situation.

NA 2.27 Clause 6.2 Materials

(3) When condition a) of clause 6.2 (3) of CYS EN 1998-1:2004 is met, the overstrength factor shall be taken as $\gamma_{ov} = 1,25$.

(7) No additional information on how EN 1993-1-10 may be used in the seismic design situation is given.

NA 2.28 Clause 6.5.5 (7) Design rules for connections in dissipative zones

No references to complementary rules on acceptable connection design are specified.

NA 2.29 Clause 6.7.4 (2) Beams and columns

The value defined for symbol γ_{pb} is 0,3.

NA 2.30 Clause 7.1.2 (1)P Design concepts

Table 7.1(CYS) defines values for symbol *q* of Table 7.1 of CYS EN 1998-1:2004.

Only buildings of importance class I may be designed using ductility class L (low), unless clause 4.4.1(2) applies.

It is recommended that buildings of importance class IV are designed using ductility class H (high).

Table 7.1(CYS): Design concepts, structural ductility classes and values of the behaviour factors

Design Concept	Structural ductility class	Range of the Reference values of the behaviour factor q
Concept a) Low dissipative structural behaviour	DCL(Low)	≤ 1,5
Concept b) or c) Dissipative structural behaviour	DCM (Medium)	≤ 4 also limited by the Values of Table 7.2
	DCH (High)	only limited by the values of Table 7.2

NA 2.31 Clause 7.7.2 (4) Analysis

The value defined for symbol *r* is 0,5.

NA 2.32 Clause 8.3 (1) Ductility classes and behaviour factors

Table 8.1(CYS) classifies buildings to one of three ductility classes L, M or H and defines values for symbol *q* of Table 8.1 of CYS EN 1998-1:2004.

Table 8.1(CYS): Design concept, Structural types and behaviour factors for the three ductility classes

Design Concept and ductility class	q	Examples of structures
Lower capacity to dissipate energy – DCL	1,5	Cantilevers; Beams; Arches with two or three pinned joints; Trusses joined with connectors.
Medium capacity to dissipate energy – DCM	2	Glued wall panels with glued diaphragms, connected with nails and bolts; Trusses with doweled and bolted joints; Mixed structures consisting of timber framing (resisting the horizontal forces) and non-load bearing infill.
	2,5	Hyperstatic portal frames with doweled and bolted joints (see 8.1.3 (3)P).
High capacity to dissipate energy – DCH	3	Nailed wall panels with glued diaphragms, connected with nails and bolts; Trusses with nailed joints.
	4	Hyperstatic portal frames with doweled and bolted joints (see 8.1.3 (3)P).
	5	Nailed wall panels with nailed diaphragm, connected with nails and bolts.

NA 2.33 Clause 9.2.1 (1) Types of masonry units

Only masonry units of group 1 and 2 of Table 3.1 of EN 1996-1-1:2005 may be used.

NA 2.34 Clause 9.2.2 (1) Minimum strength of masonry units

The value defined for symbol $f_{b,min}$ is 5 N/mm^2 and that for $f_{bh,min}$ is 2 N/mm^2.

NA 2.35 Clause 9.2.3 (1) Mortar

The value defined for symbol $f_{m,min}$ for unreinforced or confined masonry is 5 N/mm^2 and that for $f_{m,min}$ for reinforced masonry is 10 N/mm^2 .

NA 2.36 Clause 9.2.4 (1) Masonry bond

Only class a) of perpend joints is allowed

NA 2.37 Clause 9.3 Type of construction and behaviour factors

(2) Unreinforced masonry that follows the provisions of EN 1996-1-1:2005 alone are allowed only for Importance class I buildings (Table 4.3).

The values defined for symbol $t_{ef,min}$ are those in the 2nd column, 2nd and 3rd rows of Table 9.2(CYS).

(3) The value of symbol $\alpha_{g,urm}$ is set to 0,20g to be consistent with the values adopted for the minimum strength of masonry units, $f_{b,min}$, $f_{bh,min}$, and of mortar, $f_{m,min}$ defined in NA 2.34 and NA 2.35.

(4) Table 9.1(CYS) defines values for symbol q of Table 9.1 of CYS EN 1998-1:2004 for construction types a) to c).

No specific values are specified for q for buildings constructed with masonry systems which provide an enhanced ductility of the structure. Such systems may be used

provided that their enhanced ductility and related values for q are verified experimentally.

Table 9.1(CYS): Types of construction and behaviour factors

Type of construction	Behaviour factor q
Unreinforced masonry according to EN 1996 alone	1,5
Unreinforced masonry according to CYS EN 1998-1:2004	1,5
Confined masonry	2,0
Reinforced masonry	2,5

NA 2.38 Clause 9.5.1 (5) General

Table 9.2 (CYS) defines values for the symbols of Table 9.2 of CYS EN 1998-1:2004.

Table 9.2(CYS): Geometric requirements for shear walls

Masonry type	$t_{ef,min}$	$(h_{ef}/ t_{ef})_{max}$	$(l/ h)_{min}$
Unreinforced, with natural stone units	350	9	0,5
Unreinforced, with any other type of units	240	12	0,4
Unreinfoced, with any other type of units, in cases of low seismicity	170	15	0,35
Confined masonry	240	15	0,3
Reinforced masonry	240	15	No restriction
Symbols used have the following meaning: $t_{ef,min}$, thickness of the wall (see CYS EN 1996-1-1:2005); h_{ef} effective height of the wall (see CYS EN 1996-1-1:2005); h greater clear height of the openings adjacent to the wall; l length of the wall.			

NA 2.39 Clause 9.6 (3) Safety verification

The partial factor γ_m for masonry properties is specified as 2/3 of the value specified in CYS EN 1996-1-1:2005 and its National Annex, but not less than 1,5. The partial factor γ_s for reinforcing steel is specified equal to 1,0.

NA 2.40 Clause 9.7.2 Rules

(1) Table 9.3(CYS) defines values for the symbols of Table 9.3 of CYS EN 1998-1:2004 based on a minimum unit strength of 12 N/mm^2 for unreinforced masonry and 4 N/mm^2 for confined and reinforced masonry.

Table 9.3(CYS): Allowable number of storeys above ground and minimum area of shear walls for "simple masonry buildings."

Acceleration at site $\alpha_g.S$		≤0,07.g	≤0,10.g	≤0,15.g	≤0,20.g
Type of construction	Number of storeys(n)**	Minimum sum of cross sections areas of horizontal shear walls in each direction, as percentage of the total floor area per storey ($p_{A,min}$)			
Unreinforced masonry	1	2,0%	2,0%	3,5%	n/a
	2	2,0%	2,5%	5,0%	n/a
	3	3,0%	5,0%	n/a	n/a
	4	5,0%	n/a*	n/a	n/a
Confined masonry	2	2,0%	2,5%	3,0%	3,5%
	3	2,0%	3,0%	4,0%	n/a
	4	4,0%	5,0%	n/a	n/a
	5	6,0%	n/a	n/a	n/a
Reinforced masonry	2	2,0%	2,0%	2,0%	3,5%
	3	2,0%	2,0%	3,0%	5,0%
	4	3,0%	4,0%	5,0%	n/a
	5	4,0%	5,0%	n/a	n/a
* n/a means "not acceptable." ** Roof space above full storeys is not considered in the number of storeys.					

(2)b The value defined for symbol λ_{min} is 0,25.

(2)c The value defined for symbol p_{max} is 15%.

(5) The value of the symbols $\Delta_{m,max}$ and $\Delta_{A,max}$ are both specified as 20%

NA 2.41 Clause 10.3 (2)P Fundamental requirements

The value defined for symbol γ_x is 1,2.

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

NA 3.1 Annex A

Annex A may be used

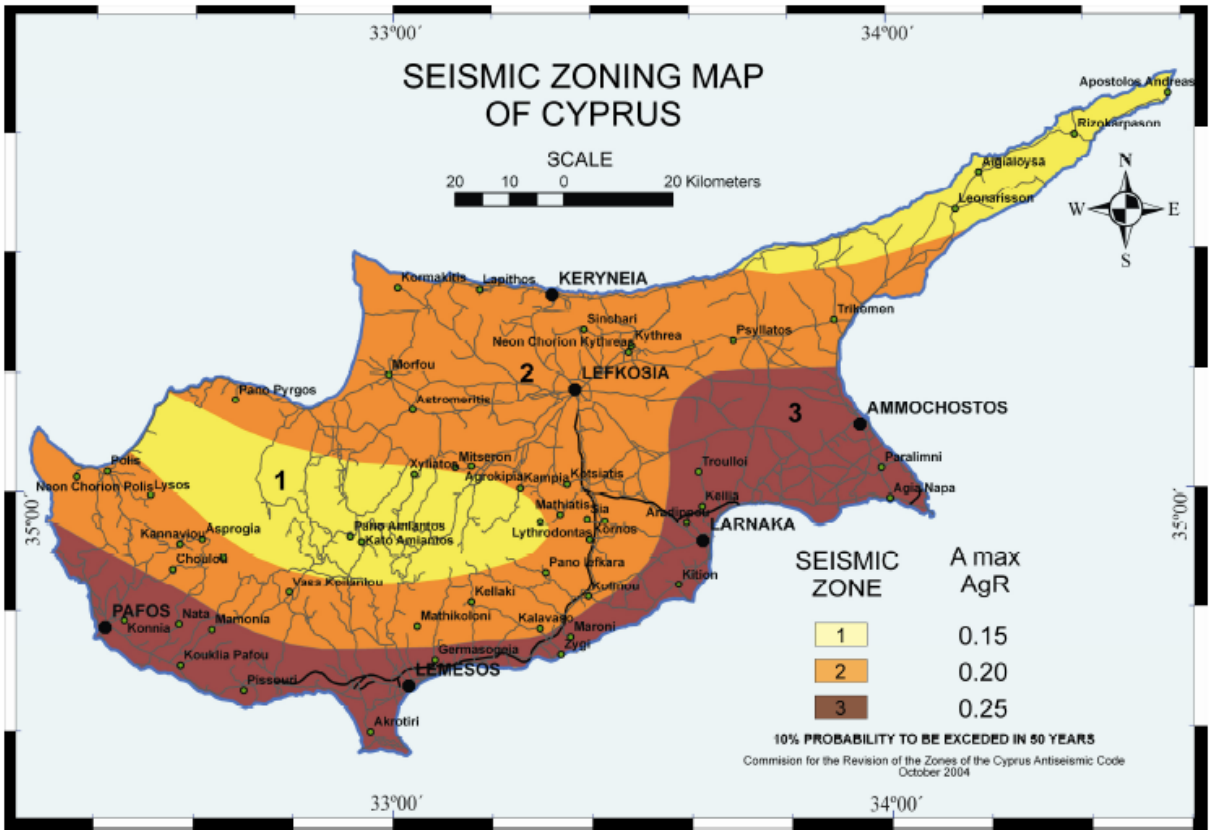
NA 3.2 Annex B

Annex B may be used

NA 4 REFERENCES TO NON-CONTRADICTORY COMPLEMENTARY INFORMATION

Zonation Map

Definition of reference peak ground acceleration on Type A ground, α_{gR}.



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