

Jornada

Presentación del borrador del ANEJO NACIONAL Español del EUROCÓDIGO 7 de Segunda Generación

Madrid, 19 y 20 de noviembre 2025



EUROCODES

EN 1997

Geotechnical
design

UNE
Normalización
Española



GOBIERNO
DE ESPAÑA

MINISTERIO
DE TRANSPORTES
Y MOVILIDAD SOSTENIBLE

VICEPRESIDENCIA
TERCERA DEL GOBIERNO

MINISTERIO
PARA LA TRANSICIÓN ECOLÓGICA
Y EL RETO DEMOGRÁFICO

CEDEX

Jornada

Presentación del borrador del
ANEJO NACIONAL Español del
EUROCÓDIGO 7 de Segunda Generación

Parte 3: Capítulo 12 (Mejora del Terreno) y
13 (Medidas de Control del Agua del Terreno)

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Contenido

1. Objeto de la Presentación
2. Clasificación de las Técnicas de Mejora del Terreno (Capítulo 12)
3. Medidas de Control del Agua del Terreno (Capítulo 13)
4. Estadística de NDPs
5. NDPs
6. Conclusiones

CEDEX

UNE

1. Objeto de la Presentación

EN1997-3 2G (Estructuras Geotécnicas):

- ✓ Parte nueva del EC7 proporcionando normas específicas necesarias para el diseño y verificación de diferentes estructuras geotécnicas.
- ✓ Aplicación conjunta con EN1990, EN1997-1 y EN1997-2.

EN1997-3:2024
Estructuras geotécnicas

EN1997-3 2G:

- ✓ Capítulo 12: Mejora del terreno:
 - Aborda modificación de las propiedades del terreno mediante la aplicación de técnicas de tratamiento (mezclado, compactación) o mediante la adición de inclusiones en el terreno (columnas de grava, inclusiones rígidas, etc.).
- ✓ Capítulo 13: Medidas de control del agua del terreno:
 - Describe las medidas para prevenir estados límite de las estructuras geotécnicas debido al cambio del régimen del agua del terreno (métodos para el control de aguas subterráneas: reducción de permeabilidad, rebajamiento NF/infiltración, aplicación de barreras impermeables).

0	Introducción
1	Alcance
2	Normativas de referencia
3	Términos, definiciones y símbolos
4	Taludes, desmontes y terraplenes
5	Cimentaciones directas
6	Cimentaciones por pilotes
7	Estructuras de contención
8	Anclajes
9	Estructuras de suelo reforzado
10	Estructuras de suelo claveteado
11	Bulones en roca y ...
12	Mejora del terreno
13	Medidas de control del agua del terreno
	Anejos
A	Taludes, desmontes y terraplenes
B	Cimentaciones directas
C	Cimentaciones por pilotes
D	Estructuras de contención
E	Anclajes
F	Estructuras de relleno reforzadas
G	Estructuras de suelo claveteado
H	Bulones en roca y ...
I	Mejora del terreno
J	Medidas de control del agua del terreno
K	Diseño de estructuras termoactivas

1. Objeto de la Presentación



EN-1997-3:2024
Estructuras geotécnicas

Capítulo 12: Mejora del terreno

- 12.1 Alcance y campo de aplicación (5 párrafos, 1 tabla y 1 figura)
- 12.2 Bases de proyecto (36 párrafos y 1 tabla)
- 12.3 Materiales (12 párrafos)
- 12.4 Agua del terreno (2 párrafos)
- 12.5 Análisis geotécnico (18 párrafos y 1 figura)
- 12.6 Estado límite último (14 párrafos y 2 tablas)
- 12.7 Estado límite de servicio (2 párrafos)
- 12.8 Implementación de proyecto (11 párrafos)
- 12.9 Ensayos (15 párrafos y 1 tabla)
- 12.10 Informes (1 párrafo)

Anejo I: Mejora del terreno (informativo)

- I.1 Uso de este anexo (1 párrafo)
- I.2 Alcance y campo de aplicación (1 párrafo)
- I.3 Ejemplos de técnicas de mejora del terreno (2 tablas)
- I.4 Uso de la envolvente de tensiones para determinar los estados límite aceptables (3 párrafos y 1 figura)
- I.5 Modelos de cálculo para plataformas de transferencia de carga reforzadas sobre inclusiones discretas (1 párrafo y 1 figura)
- I.6 Rango indicativo para el desarrollo de la resistencia en el tiempo de materiales para mejoras del terreno clase II (1 figura)

CEDEX

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1. Objeto de la Presentación



EN-1997-3:2024
Estructuras geotécnicas

Capítulo 13: Medidas de control del agua del terreno

- 13.1 Alcance y campo de aplicación (3 párrafos y 1 tabla)
- 13.2 Bases de proyecto (17 párrafos y 1 tabla)
- 13.3 Materiales (4 párrafos)
- 13.4 Agua del terreno (1 párrafo)
- 13.5 Análisis geotécnico (11 párrafos)
- 13.6 Estado límite último (1 párrafo)
- 13.7 Estado límite de servicio (4 párrafos)
- 13.8 Implementación de proyecto (19 párrafos)
- 13.9 Ensayos (3 párrafos)
- 13.10 Informes (6 párrafos)

Anejo J: Medidas de control del agua del terreno (informativo)

- J.1 Uso de este anexo (1 párrafo)
- J.2 Alcance y campo de aplicación (1 párrafo)
- J.3 Ejemplos de medidas de control del agua del terreno (1 tabla)



1. Objeto de la Presentación



EN1997-3 (Estructuras Geotécnicas) 2G:

- ✓ Capítulo 12 y 13: capítulos nuevos en EN1997-3 2G.

Capítulo 12: interacción con los demás Capítulos de EN1997-3 2G.

Aplicación de técnicas de mejora del terreno para las siguientes estructuras geotécnicas:

- ✓ Taludes, desmontes, terraplenes (Capítulo 4)
- ✓ Cimentaciones directas (Capítulo 5)
- ✓ Estructuras de contención (Capítulo 7)
- ✓ Estructuras de suelo reforzado (Capítulo 9)

Capítulo 6: Cimentaciones profundas:

- ✓ Cálculo capacidad portante y rigidez de las inclusiones rígidas (Clase BII Mejora terreno)

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2. Clasificación de las Técnicas de Mejora del Terreno

(2) Ground improvement shall be classified according to Table 12.1:

- diffused ground improvement (Classes AI and AII); or
- discrete ground improvement (Classes BI and BII).

NOTE 1 Examples of ground improvement techniques for these classes are given in Annex I.

NOTE 2 Groundwater control measures are given in Clause 12

BI – carácter discreto con IR con RCS no medible; el terreno mejorado ↑res al corte o rigidez
BII – carácter discreto con IR con RCS medible; el terreno mejorado ↑res al corte o rigidez

Table 12.1 — Classification of ground improvement

Class	A – Diffused	B – Discrete
I	AI – Diffused with no measurable unconfined compressive strength The improved ground has an increased shear strength or stiffness higher than that of the original ground. The improved ground can be modelled as a ground with improved properties.	BI – Discrete with non-rigid inclusions Inclusions, installed in the ground, with higher shear capacity and stiffness compared to the surrounding ground. The unconfined compressive strength of the inclusion is not measurable.
II	AII – Ground improvement zone with measurable unconfined compressive strength The improved ground is modified from its original natural state, has a measurable unconfined compressive strength and is significantly stiffer than the surrounding ground. Usually, it comprises a composite of a binder and ground.	BII – Discrete with rigid inclusions Rigid inclusions, installed in the ground, with unconfined compressive strength and significantly higher stiffness than the surrounding ground. The inclusions can be an engineered material such as timber, concrete/grout or steel or a composite of a binder and ground.

AI – carácter extenso con RCS no medible: el terreno mejorado ↑res al corte o rigidez; el terreno mejorado modelado con propiedades mejoradas

AII – carácter extenso con RCS medible: el terreno mejorado ↑res al corte o rigidez; el terreno mejorado modelado compuesto por suelo y ligante

Ejemplos de técnicas de mejora del terreno: Anexo I



2. Clasificación de las Técnicas de Mejora del Terreno

AI – carácter extenso con RCS no medible:
el terreno mejorado $\uparrow$ res al corte o rigidez;
el terreno mejorado modelado con propiedades mejoradas

AI –
inyecciones de compactación,
vibración profunda,
compactación dinámica,
compactación con rodillo de impacto,
compactación de impacto rápido,
microvoladuras,
sustitución del terreno,
calentamiento del terreno,
precarga con o sin drenes,
rebajamiento del agua del terreno,
consolidación por vacío,
soil-mixing.

Table 12.1 — Classification of ground improvement

Class	A – Diffused	B – Discrete
I	AI – Diffused with no measurable unconfined compressive strength The improved ground has an increased shear strength or stiffness higher than that of the original ground. The improved ground can be modelled as a ground with improved properties.	BI – Discrete with non-rigid inclusions Inclusions, installed in the ground, with higher shear capacity and stiffness compared to the surrounding ground. The unconfined compressive strength of the inclusion is not measurable.
II	AII – Ground improvement zone with measurable unconfined compressive strength The improved ground is modified from its original natural state, has a measurable unconfined compressive strength and is significantly stiffer than the surrounding ground. Usually, it comprises a composite of a binder and ground.	BII – Discrete with rigid inclusions Rigid inclusions, installed in the ground, with unconfined compressive strength and significantly higher stiffness than the surrounding ground. The inclusions can be an engineered material such as timber, concrete/grout or steel or a composite of a binder and ground.



2. Clasificación de las Técnicas de Mejora del Terreno

All – carácter extenso con RCS medible:
el terreno mejorado ↑res al corte y rigidez;
el terreno mejorado modelado compuesto por suelo y ligante

All –
inyecciones de impregnación,
jet-grouting,
relleno de huecos con mortero
o lechada,
congelación del terreno,
calentamiento del terreno,
soil-mixing.

Table 12.1 — Classification of ground improvement

Class	A – Diffused	B – Discrete
I	AI – Diffused with no measurable unconfined compressive strength The improved ground has an increased shear strength or stiffness higher than that of the original ground. The improved ground can be modelled as a ground with improved properties.	BI – Discrete with non-rigid inclusions Inclusions, installed in the ground, with higher shear capacity and stiffness compared to the surrounding ground. The unconfined compressive strength of the inclusion is not measurable.
II	AII – Ground improvement zone with measurable unconfined compressive strength The improved ground is modified from its original natural state, has a measurable unconfined compressive strength and is significantly stiffer than the surrounding ground. Usually, it comprises a composite of a binder and ground.	BII – Discrete with rigid inclusions Rigid inclusions, installed in the ground, with unconfined compressive strength and significantly higher stiffness than the surrounding ground. The inclusions can be an engineered material such as timber, concrete/grout or steel or a composite of a binder and ground.

2. Clasificación de las Técnicas de Mejora del Terreno



BI – carácter discreto con IR con RCS no medible;
Inclusiones ↑res al corte y rigidez que el terreno circundante

Table 12.1 — Classification of ground improvement

BI –
soil-mixing,
columnas de grava-vibrosustitución,
columnas de arena y columnas de
arena compactada,
sustitución dinámica,
columnas de grava o arena
encamisadas con geosintéticos.

Class	A – Diffused	B – Discrete
I	AI – Diffused with no measurable unconfined compressive strength The improved ground has an increased shear strength or stiffness higher than that of the original ground. The improved ground can be modelled as a ground with improved properties.	BI – Discrete with non-rigid inclusions Inclusions, installed in the ground, with higher shear capacity and stiffness compared to the surrounding ground. The unconfined compressive strength of the inclusion is not measurable.
II	AII – Ground improvement zone with measurable unconfined compressive strength The improved ground is modified from its original natural state, has a measurable unconfined compressive strength and is significantly stiffer than the surrounding ground. Usually, it comprises a composite of a binder and ground.	BII – Discrete with rigid inclusions Rigid inclusions, installed in the ground, with unconfined compressive strength and significantly higher stiffness than the surrounding ground. The inclusions can be an engineered material such as timber, concrete/grout or steel or a composite of a binder and ground.

2. Clasificación de las Técnicas de Mejora del Terreno



BII – carácter discreto con IR con RCS medible;
el terreno mejorado ↑res al corte y rigidez que el terreno circundante
Inclusiones: madera, acero, hormigón, compuesto suelo-ligante

Table 12.1 — Classification of ground improvement

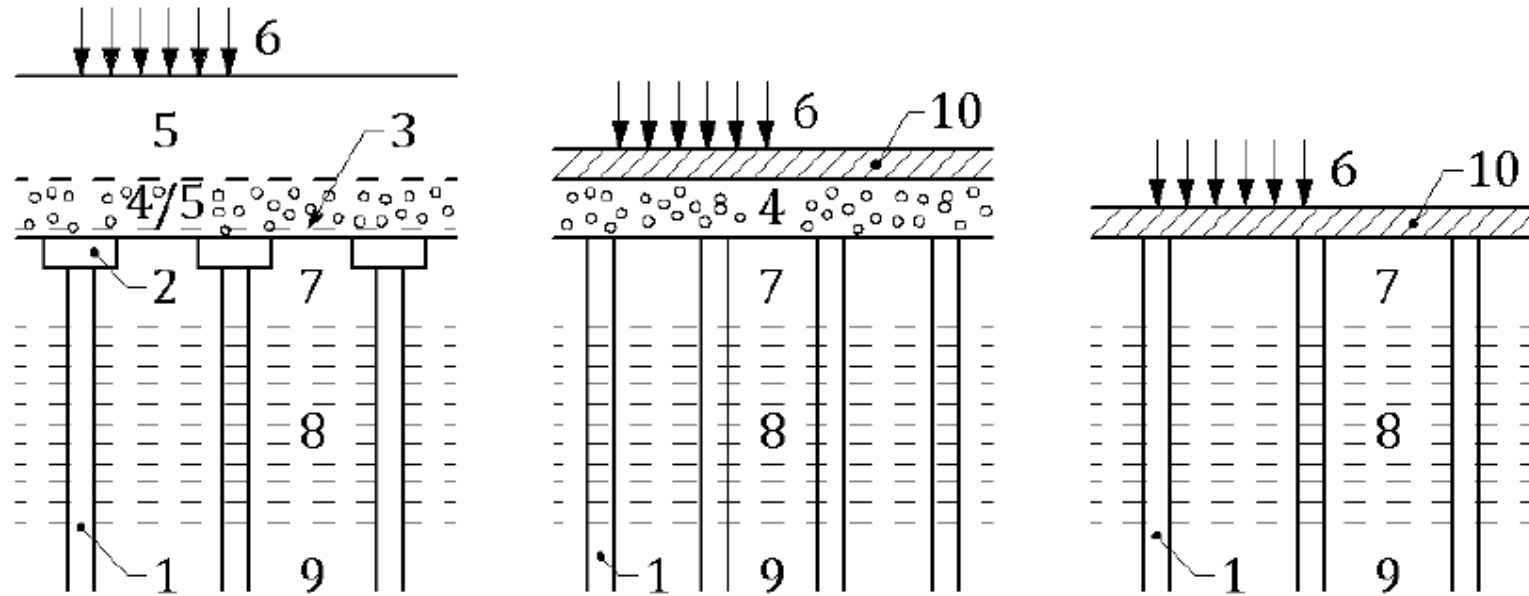
BII –
soil-mixing,
jet grouting,
inclusiones de acero o madera,
inclusiones de hormigón o mortero,
columnas de grava inyectadas,
inyecciones de compactación.

Class	A - Diffused	B - Discrete
I	AI - Diffused with no measurable unconfined compressive strength The improved ground has an increased shear strength or stiffness higher than that of the original ground. The improved ground can be modelled as a ground with improved properties.	BI - Discrete with non-rigid inclusions Inclusions, installed in the ground, with higher shear capacity and stiffness compared to the surrounding ground. The unconfined compressive strength of the inclusion is not measurable.
II	AII - Ground improvement zone with measurable unconfined compressive strength The improved ground is modified from its original natural state, has a measurable unconfined compressive strength and is significantly stiffer than the surrounding ground. Usually, it comprises a composite of a binder and ground.	BII - Discrete with rigid inclusions Rigid inclusions, installed in the ground, with unconfined compressive strength and significantly higher stiffness than the surrounding ground. The inclusions can be an engineered material such as timber, concrete/grout or steel or a composite of a binder and ground.

2. Clasificación de las Técnicas de Mejora del Terreno

BII – carácter discreto con IR con
RCS medible

A, B – carga transferida a través de LTP
C – sin LTP, sin conexión estructural entre
IR y cimentación



A

B

C

Key

- 1 Rigid inclusions
- 2 Optional caps
- 3 Optional basal reinforcement
- 4 Load transfer platform
- 5 Embankment

- 6 Load
- 7 Working platform
- 8 Weak soil
- 9 Load bearing ground
- 10 Slab or spread foundation
- 11 No structural connection between 1 and 10 (Figure 11 c)

- a Embankment
- b Slab or spread foundation with a load transfer platform
- c Slab or spread foundation **without** a load transfer platform

Capítulo 6: Cimentaciones profundas:

- ✓ Cálculo capacidad portante y rigidez de las inclusiones rígidas (Clase BII)

3. Medidas de Control del Agua del Terreno

Clasificación de las medidas de control del agua del terreno:

Clases: 1 2 3

Objetivos

Medidas

Anexo J

Ejemplos de técnicas de control del agua del terreno

Table 13.1 — Classification of groundwater control measures

Class	Objective	Measures
1	Prevent (i.e. cut off) the water flow	Impermeable barriers ^a
2	Reduce water flow through ground	Reduction of hydraulic conductivity
3	Control the flow of groundwater and/or surface water	Dewatering/infiltration
^a The term "impermeable" is project specific. A project-defined low value of hydraulic conductivity is considered impermeable.		

Table J.1 — Examples of groundwater control measures

Class	Measures	Examples
1	Impermeable barriers ^a	Sheet pile, grouting, plastic and geosynthetic barriers, ground freezing, vertical and horizontal diaphragm walls.
2	Reduction of hydraulic conductivity	Grouting, soil mixing, use of natural clay layer.
3	Dewatering/infiltration	Drains, wells and other dewatering systems.
^a The term "impermeable" is project specific. A project defined low value of the hydrualic conductivity is considered as impermeable.		



4. Estadística de NDPs

0.5 National Annex for EN 1997-3

National choice is allowed in this standard where explicitly stated within notes. National choice includes the selection of values for Nationally Determined Parameters (NDPs).

The national standard implementing EN 1997-3 can have a National Annex containing all national choices to be used for the design of buildings and civil engineering works to be constructed in the relevant country.

When no national choice is given, the default choice given in this standard is to be used.

When no national choice is made and no default is given in this standard, the choice can be specified by a relevant authority or, where not specified, agreed for a specific project by appropriate parties.

National choice is allowed in EN 1997-3 through notes to the following clauses:

	12.2.2(2)	12.2.7.2(1)	12.5.4(2) – 2 choices
12.5.4(5)	12.5.4(6) – 2 choices	12.6.1(2)	12.6.3(1)
12.6.6(1) – 2 choices	12.9.2.1(1)	12.9.2.2(2)	13.2.7.2(1)
13.3(4)	13.8.3(1)	Annex I	Annex J



Capítulo 12: 10 párrafos
Capítulo 13: 3 párrafos
2 Anejos (Capítulos 12 y 13)



5. NDPs – Propiedades geométricas

12.2.2 Geometrical properties

(1) In addition to EN 1990:2023, 6.3 and 8.3.7, and FprEN 1997-1:2024, 4.3.3, acceptable deviations Δa of the geometrical properties shall be considered in ground improvement design.

(2) Acceptable deviations of the geometrical properties of the ground improvement shall be as specified in the relevant execution standard.

NOTE 1 In the absence of a relevant execution standard, acceptable deviations of the geometrical properties can be specified in the National Annex.

NOTE 2 When no national choices are made, the values of acceptable deviations of the geometrical properties can be specified by a relevant authority.

Propiedades geométricas:

Desviaciones admisibles de las propiedades geométricas especificadas en la norma de ejecución correspondiente.

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5. NDPs - Investigación geotécnica

12.2.7 Ground investigation

Tabla 12.2 (NDP): Profundidad mínima de investigación geotécnica para mejora del terreno: dependiente de la clasificación de mejora del terreno.

NCCI: complementar esta tabla con el Anejo H de la Parte 2 de EC7-2G en función del tipo de obra y documentos normativos españoles de práctica habitual.

12.2.7.2 Minimum extent of field testing

(1) In addition to FprEN 1997-2:2024, 5.4.3, the minimum depth of field investigation for ground improvement shall be determined.

NOTE 1 The minimum depth d_{min} of field investigation for ground improvement is given in Table 12.2 (NDP) unless the National Annex gives another value.

NOTE 2 FprEN 1997-2:2024, 5.4.3(3) and (4) give provisions for increasing or decreasing d_{min} depending on the ground conditions.

Table 12.2 (NDP) — Minimum depth of field investigation for ground improvement	
Ground Improvement Class	Minimum depth, d_{min}
AI	treatment depth + 5 m
AII	treatment depth + 5 m
BI	treatment depth + max{5 m; $3B_i$ }
BII	treatment depth + max{5 m; $3B_{ri}$ }
d_{min} is the minimum depth of field investigation from the ground surface B_i is the equivalent diameter of a non-rigid inclusion (Class BI) B_{ri} is the equivalent diameter of a rigid inclusion (Class BII) The equivalent diameter of an inclusion is determined from, $B = 2 \sqrt{A/\pi}$, where A is its horizontal cross sectional area.	

(2) The minimum depth can be reduced if a shallower investigation combined with comparable local experience allows the ground properties to be determined below the treatment depth in accordance with FprEN 1997-2, 5.4.3(4).



5. NDPs - Clase BII: Pandeo

12.5 Geotechnical analysis

12.5.3 Resistance of discrete (Class B) ground improvement

(4) The buckling resistance of Class BII inclusions subject to compression shall be verified.

NOTE Guidance on buckling is given in Annex C.13

(5) When one of the following conditions is met, verification of buckling of Class BII inclusions may be omitted:

- the diameter of the inclusions B_{ri} is greater than B_{ref}
- the thickness of any layers where c_u is less than $c_{u,ref}$ is smaller than h_{ref} .

NOTE The value of B_{ref} is 0,3 m, the value of $c_{u,ref}$ is 15 kPa and the value of h_{ref} is 1,0 m unless the National Annex gives different values.

Mejora del terreno discreta (Clase BII): Inclusiones Rígidas.

Pandeo: Anejo C.13 (Buckling and second order effects).

Parámetros necesarios para determinar el pandeo de acuerdo con el Anejo C.13



5. NDPs - Clase II RCS

12.5 Geotechnical analysis

Mejora del terreno (material Clase II): Resistencia a compresión simple.

Inclusiones de materiales no incluidos en:

- 12.3.3 (hormigón),
- 12.3.4 (metálicos),
- 12.3.5 (de madera).

Valor representativo RCS

12.5.4 (2): se aceptan los valores indicados en Nota 1 y Nota 3 en AN.

12.5.4 Unconfined compressive strength of Class II material

- (1) For materials not covered in 12.3.3, 12.3.4, and 12.3.5, this sub-clause applies.
- (2) Provided that at least N samples are tested, the representative value of the unconfined compressive strength ($q_{u,rep,imp}$) of Class II ground improvement material shall be determined from:

$$q_{u,imp,rep} = \eta_c \eta_t q_{u,imp,k} \quad (12.1)$$

where

$q_{u,imp,k}$ is the characteristic value of the unconfined compressive strength of the Class II ground improvement material, given in (5);

η_c is a conversion factor accounting for long term effects; and

η_t is a conversion factor accounting for the difference in time between testing (typically 28 days) and when the Class II ground improvement material is exposed to the designed stresses.

NOTE 1 The value of N is 10 unless the National Annex gives a different value.

NOTE 2 The conversion factor η_c is based on k_{tc} from EN 1992-1-1:2023, 5.1.6.

NOTE 3 For hydraulic binders and cement-based materials, the value of η_c is 0.85 for geotechnical structures and 1.0 for temporary geotechnical structures (see FprEN 1997-1:2024, 4.1.5) unless the National Annex gives a different value.

NOTE 4 The value of η_t is given in (4).



5. NDPs - Clase II RCS

12.5 Geotechnical analysis

12.5.4 Unconfined compressive strength of Class II material

(5) The characteristic value of the unconfined compressive strength $q_{u,imp,k}$ should be determined, according to FprEN 1997-1:2024, 4.3.2.2, as the P fractile of the dataset of the relevant statistical distribution.

NOTE 1 The value of P is 10 % unless the National Annex gives a different value.

NOTE 2 The characteristic value can be determined from the cumulative frequency curve of the dataset. The datasets for soils treated with binders typically correlate with the lognormal distribution.

Mejora del terreno
(material Clase II):
Resistencia a compresión
simple.

Valor característico RCS

12.5.4 (5): se acepta el valor indicado
para P (fractil de la base de datos de
distribución estadística considerada;
 $P=10\%$).

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5. NDPs - Clase II RCS

12.5.4 Unconfined compressive strength of Class II material

12.5 Geotechnical analysis

(6) The nominal value of the unconfined compressive strength $q_{u,imp,nom}$ should be determined as the minimum of the following values:

- the minimum value of q_u measured in all the unconfined compressive strength (UCS) tests;
- the arithmetic average value of all results of the UCS tests multiplied by a reduction value k ; and
- a maximum value $q_{u,max}$.

NOTE 1 The value of k is 0,7, unless the National Annex gives a different value.

NOTE 2 The value of $q_{u,max}$ is 12 MPa, unless the National Annex gives a different value.

Mejora del terreno
(material Clase II):
Resistencia a compresión
simple.

Valor nominal RCS

12.5.4 (6): valor de
reducción k ($k=0.7$) y valor
 $q_{u,max}=12\text{MPa}$ se aceptan.

5. NDPs – ELU

12.6 Ultimate limit states

Métodos para verificar ELU de diferentes clases de las técnicas de mejora del terreno (Tabla 12.3).

12.6.1 General

- (1) FprEN 1997-1:2024, Clause 8 shall apply to ground improvement.
- (2) Methods used to verify ultimate limit states for different classes of ground improvement should be selected according to Table 12.3.

NOTE Table 12.3 (NDP) gives appropriate verification methods unless the National Annex gives different methods.

Table 12.3 (NDP) — Methods used to verify ultimate limit states of ground improvement

Class	A – Diffused	B – Discrete
I	1. Determine improved ground properties according to 12.3.2 and FprEN 1997-1:2024, 4.3.2 2. Verify ULS according to 12.2.5.1, 12.5.2 and the appropriate clauses in this document	1. Determine properties of non-rigid (Class BI) inclusions according to 12.3.2 and FprEN 1997-1:2024, 4.3.2 2. Verify ULS of the system using separate ground and inclusion properties; 3. Verify ULS according to 12.2.5.1, 12.5.3 and the appropriate clauses in this document 4. Verify compression and shear resistance in inclusions and the ground 5. For geotextile encased inclusions, determine the strength of the reinforcing element according to 9.6
II	1. Determine properties of Class AII improved ground according to 12.3.2 2. Verify ULS according to 12.2.5.1, 12.5.2 and 12.5.4 and the appropriate clauses in this document. 3. Verify structural resistance	1. Determine properties of Class BII inclusions according to 12.3.2.2. 2. Verify ULS according to 12.2.5.1, 12.5.3 and 12.5.4 and the appropriate clauses in this document. 3. Verify structural resistance of the rigid inclusions

5. NDPs – ELU

12.6 Ultimate limit states

12.6.3 Resistance of discrete (Class B) ground improvement

(1) The design resistance of Class BI ground improvement ($R_{sys,d}$) may be determined from:

$$R_{sys,d} = \frac{R_{sys,rep}}{\gamma_{R,sys}\gamma_{Rd,sys}} \quad (12.3)$$

where

$R_{sys,rep}$ is the representative value of the total resistance of the ground improvement system with inclusions;

$\gamma_{R,sys}$ is a partial factor for the inclusion system, given in 12.6.6; and

$\gamma_{Rd,sys}$ is a model factor.

NOTE The value of $\gamma_{Rd,sys}$ is 1,0 unless the National Annex gives a different value.

Resistencia mejora del terreno discreta (Clase B).

Coeficientes parciales para determinar la resistencia de diseño

Resistencia de diseño ($R_{sys,d}$)

Factor parcial sistema de inclusión ($\gamma_{R,sys}$)

Factor modelo ($\gamma_{Rd,sys}$) (AN)

Este Anejo Nacional acepta el valor indicado en la Nota para el factor de modelo.

5. NDPs – ELU

12.6 Ultimate limit states

12.6.6 Partial factors

(1) Partial factors for the verification of ground improvement at the ultimate limit state shall be determined according to FprEN 1997-1:2024, 4.4.1, using either the Material Factor Approach or the Resistance Factor Approach.

- NOTE 1 The National Annex can specify which factor approach to use.
- NOTE 2 Values of the partial factors for ground improvement are given in Table 12.4 (NDP) for persistent and transient design situations unless the National Annex gives different values.

Factores parciales para determinar resistencia última de mejora del terreno: situación de diseño fundamental (persistente y transitoria).

Este Anejo Nacional permite el uso de los dos enfoques de factor.

Este Anejo Nacional acepta los valores de los factores parciales indicados en la Tabla 12.4.

Table 12.4 (NDP) — Partial factors for the verification of ultimate resistance of ground improvement for fundamental (persistent and transient) design situations

Verification of	Partial factor on	Symb ol	Material Factor Approach , both combinations (a) and (b)		Resistance Factor Approach
			(a)	(b)	
Overall stability	See Clause 4				
Compressive and transverse resistance of diffused (Class A) ground improvement	Actions, Effects of actions ^a	γ_F, γ_E	Refer to other clauses as appropriate		
	Ground properties ^b	γ_M			
	UCS of Class II materials	γ_M	1,5		
	UCS of concrete, steel, and timber	γ_M	EN 1992-1-1, EN 1993-1-1 and EN 1995-1-1		
Compressive and transverse resistance of discrete (Class B) ground improvement	Actions, Effects of actions ^a	γ_F, γ_E	VC1 or VC4	VC3	VC1 or VC4 ^c
	Ground properties ^b	γ_M	M1	M2	Not factored
	UCS of Class II materials	γ_M	1,5		
	UCS of concrete, steel, and timber	γ_M	EN 1992-1-1, EN 1993-1-1 and EN 1995-1-1		
	Overall system resistance (Class BI)	$\gamma_{R,sys}$	Not factored		1,4
	Resistance of rigid inclusion system (Class BII)	$\gamma_{R,ri}$	Not factored		1,4
	Resistance of treated ground (Class BII)	γ_{Rtg}	Not factored		1,4
	Transverse resistance	γ_{Rt}	Not factored		Refer to other clauses as appropriate
^a Values of the partial factors for Verification Cases (VCs) 1, 3, and 4 are given in EN 1990:2023, Annex A					
^b Values of the partial factors for Sets M1 and M2 are given in FprEN 1997-1:2024, 4.4.1.3					
^c Always use VC1 except for the computation of the effects on actions due to an embankment					

5. NDPs – Ensayos

12.9.2 Material control tests

12.9.2.1 General

- (1) Material control tests shall be performed to verify that representative properties of the improved ground are achieved.

NOTE The minimum frequencies for material control test for each ground improvement class are given in Table 12.5 (NDP) unless the National Annex gives different values.

12.9 Testing

Ensayos de control (frecuencia de los ensayos de control de materiales del terreno mejorado).

No hay práctica española consolidada a este respecto, por lo que se aceptan los valores de referencia indicados en la Tabla 12.5.

Table 12.5 (NDP) Testing frequency for ground improvement (control tests)

Class	Type of test	Number of tests
AI	Field and laboratory testing to the full depth of the zone of treatment	As per FprEN 1997-2:2024, 5.4.2 and 5.4.3
AII	UCS tests on extracted samples of treated-ground	In the absence of a material standard that specifies otherwise: 1 test per 125 m ³ (minimum 4 tests) per treated geotechnical unit, conducted on samples representative of the whole treatment depth.
BI	Field and laboratory testing to the full depth of the ground improvement zone, inside the inclusions and/or in-between	As per FprEN 1997-2:2024, 5.4.2 and 5.4.3
BII	UCS test on extracted samples of treated ground or installed material	In the absence of a material standard that specifies otherwise: 1 test per 125 m ³ (minimum 4 tests) of rigid inclusion volume, conducted on samples representative of the whole treatment depth.

5. NDPs - Ensayos



12.9.2.2 Unconfined compressive strength

12.9 Testing

- (1) The unconfined compressive strength should be determined on undisturbed cylindrical samples with a height to diameter ratio of two.
- (2) Where the sample dimensions differ, the unconfined compressive strength may be multiplied by a scale factor k_{ucs} .

NOTE For prisms and cylinders with height to diameter ratio of one, the value of k_{ucs} is 0,8, unless the National Annex gives a different value.

Influencia de tamaño de probeta para determinar resistencia a compresión simple

RCS realizada sobre probetas cilíndricas.

Introducción del factor de corrección en el AN.

Este Anejo Nacional acepta el valor indicado en la Nota para el factor de escala k_{ucs} , para determinar la resistencia a compresión simple en muestras prismáticas y cilíndricas con una relación altura/diámetro igual a uno ($k_{ucs} = 0,80$).

5. NDPs - Anejo I



Annex I (informative)

Ground improvement

I.1 Use of this annex

- (1) This informative annex provides complementary guidance to that given in Clause 12 for ground improvement.

NOTE National choice on the application of this informative annex is given in the National Annex. If the National Annex contains no information on the application of this informative annex, it can be used.

Este Anejo Nacional mantiene el carácter informativo del Anejo I, por lo que su contenido puede usarse a criterio del proyectista.





5. NDPs - Investigación geotécnica

Profundidad mínima de investigación geotécnica para proyectos de medidas de control del agua del terreno.

13.2.7 Ground investigation

13.2.7.2 Minimum extent of field investigation

(1) In addition to FprEN 1997-2:2024, 5.4.3, the minimum depth of field investigation for groundwater control measures shall be determined.

NOTE 1 The minimum depth d_{min} of field investigation is given in Table 13.2 (NDP) unless the National Annex gives another value.

NOTE 2 FprEN 1997-2:2024, 5.4.3(3) and (4) give provisions for increasing or decreasing d_{min} depending on the ground conditions.

Table 13.2 (NDP) — Minimum depth of field investigation for groundwater control measures

Application	Minimum depth	Illustration
Prevention of water flow	d_{min} = 2 m below the surface of the layer with very low conductivity beneath the proposed barrier	
Reduction of water flow	d_{min} = 2 m below the layer, which hydraulic conductivity is to be adjusted	
Control of water flow	d_{min} = 2 m into the aquitard, beneath the aquifer	

Información Complementaria No Contradictoria (NCCI) sobre la amplitud de la campaña de investigación geotécnica:
En la Tabla AN-H.2 del Anejo Nacional Español de EN1997-2 se recogen, como referencia, una serie de documentos normativos españoles en los que se proporcionan criterios sobre la amplitud de la campaña de investigación geotécnica, en función del ámbito de actuación de cada proyecto.



5. NDPs - Materiales



13.3 Materials

13.3 Materials

- (1) FprEN 1997-2:2024, Clause 7 to 12 shall apply to groundwater control measures.
- (2) EN 1538 should apply to diaphragm walls.
- (3) In addition to FprEN 1997-1:2024, 5.3, ISO/TS 13434 may be applied for geomembrane, geosynthetic or plastic barriers.
- (4) Materials that are not specified in (1) to (3) may be used provided they comply with a relevant material standard.

NOTE The relevant material standard can be specified in the National Annex.

Normativa de los materiales a incluir.

Este Anejo Nacional no proporciona normas adicionales, relativas a materiales, a las indicadas en los párrafos 13.3 (1) a 13.3.(2) de EN 1997-3.



5. NDPs - Auscultación

13.8.3 Monitoring

(1) In addition to FprEN 1997-1:2024, 10.4 the Monitoring Plan should, as applicable, include monitoring of groundwater conditions within the zone of influence.

NOTE 1 Legislation can necessitate additional requirements.

NOTE 2 Table 13.3 (NDP) gives measures to check the groundwater conditions within the zone of influence, unless the National Annex gives different measures.

Table 13.3 (NDP) — Measures for checking groundwater conditions within the zone of influence

Geotechnical Category	Measures / measurements
GC3	All the items given below for GC2 and, in addition: - more detailed examination that includes additional measurements and observations.
GC2	All the items given below for GC1 and, in addition: - measurements of groundwater levels and groundwater pressures; - measurements of groundwater flow and chemistry, if they affect the method of construction or the performance of the structure.
GC1	All the items given below: - direct observations; - documented comparable experience; - any other relevant evidence.

Medidas de control del agua del terreno en la zona de influencia.

5. NDPs - Anejo J



Annex J (informative)

Groundwater control measures

J.1 Use of this annex

- (1) This informative annex provides complementary guidance to that given in Clause 13 for groundwater control measures.

NOTE National choice on the application of this Informative Annex is given in the National Annex. If the National Annex contains no information on the application of this informative annex, it can be used.

Este Anejo Nacional mantiene el carácter informativo del Anejo J, por lo que su contenido puede usarse a criterio del proyectista.



5. Conclusiones

EC1997-2G es una evolución de EC1997-1G, abarcando el proyecto de Mejora del Terreno (Capítulo 12) y Medidas de Control del Agua del Terreno (Capítulo 13):

- ✓ EC1997-3-2G introduce la clasificación de las técnicas de mejora del terreno en 4 clases según la distribución extensa o discreta, y según la posible medición de RCS, presentado numerosos ejemplos de las técnicas de mejora del terreno en cada clase.
- ✓ Se indica la conexión del Capítulo 12 con los demás capítulos de EC1997-3-2G dependiendo del tipo de estructura geotécnica.
- ✓ Se introduce el concepto de la capa de transferencia de carga y los métodos indicados para su análisis (Clase B).



CEDEX

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5. Conclusiones

En el Anejo Nacional respecto al Capítulo 12 se permite la modificación de:

- ✓ Desviaciones aceptables de las propiedades geométricas (12.2.2(2)).
- ✓ Profundidad mínima de las investigaciones del terreno para mejora del terreno (12.2.7.2(1)).
- ✓ Parámetros necesarios para determinar el pandeo de acuerdo con el Anejo C.13 (12.5.3(5)).
- ✓ Los parámetros para determinar $q_{u,rep,imp}$ (12.5.4(2)), el valor característico $q_{u,imp,k}$ (12.5.4(5)), el valor nominal $q_{u,imp,nom}$ (12.5.4(6)) del material de Clase II .
- ✓ Métodos de verificación ELU de las 4 clases de las técnicas de mejora del terreno (12.3.1(2)).
- ✓ Coeficientes parciales para determinar la resistencia de diseño (12.6.3(1)).
- ✓ Coeficientes parciales para verificación de resistencia última de mejora del terreno (12.6.6(1)).
- ✓ Frecuencia de los ensayos de control de materiales (12.9.2.1(1)).
- ✓ Influencia de tamaño de probeta para determinar resistencia a compresión simple (12.9.2.2(2)).
- ✓ Anejo I (informativo).



5. Conclusiones

En el Anejo Nacional respecto al Capítulo 13 se permite la modificación de:

- ✓ Profundidad mínima de investigación geotécnica (13.2.7.2(1)).
- ✓ Normativas de los materiales a incluir (13.3(4)).
- ✓ Medidas de control del agua del terreno en la zona de influencia (13.8.3(1)).
- ✓ Anejo J (informativo).



CEDEX

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Jornada

Presentación del borrador del
ANEJO NACIONAL Español del
EUROCÓDIGO 7 de Segunda Generación

Parte 3: Capítulo 12 (Mejora del Terreno) y
13 (Medidas de Control del Agua del Terreno)

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