D7.4 Recommendations for updates of current European standards and national technical requirements

WP7

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Executive Summary

The main goal of task T7.2 *Standardisation* in WP7 *Life cycle assessment and economic evaluation, standardization and health and safety aspects* of the EnDurCrete project is to identify the barriers of existing technical specifications for the implementation of developed materials and technical solutions in everyday civil and building engineering practice. These materials are novel types of cement, nano-clay concrete admixture with corrosion-inhibiting properties and multifunctional coatings for surface protection of concrete.

The study evaluated European standards, including the harmonized standards, national implementation of the standards and other regulatory documents and guidelines. The evaluation was performed in two stages. In the first stage, the accessible documentation was inspected while the second stage comprised an online survey answered by the EnDurCrete partners and other relevant stakeholders.

In the first stage, 15 documents were examined while in the second stage responses from 21 stakeholders from 13 different countries were analysed. A good sample was obtained for cement related documentation with all respondents providing answers. The sample obtained for admixtures and coatings consisted of only three responses.

Overall, the following conclusions can be drawn:

(1) Cement, as the component of concrete impacting structural stability and durability of concrete structures, is subjected to national regulations to a much higher degree than admixtures and coatings;

(2) While the purpose of European standards is to address the needs of all stakeholders and thus render the need for national regulations and guidelines obsolete, in reality, technical committees have neither the mandate not the capacity to identify all applicable national regulations and thus verify the completeness of the standards they issue. As a result, a plethora of mandatory and non-mandatory national documents are being used in practice;

(3) In terms of cement and its use in concrete, the majority of European countries have put in place the implementation rules. These rules either enforce or recommend the use of certain cement types for a given exposure class. In both cases, the effect is the same, as practitioners opt for safe, well-known and proven solutions;

(4) Even if national implementation rules make provisions for novel materials to be used under the equivalent performance approach, this option is rarely used in practice. Reasons are probably twofold: costs associated with testing and direct responsibility of a decision-making engineer.

Based on these conclusions the following recommendations are drawn:

(1) Standard EN 206 should be revised once the new version of EN 197-1 is implemented;

(2) A more common approach how to introduce new cement types into the national application documents is needed;

(3) Information related to the performance of novel materials should be disseminated through workshops, publications and conferences. However, the information should be vetted before implementation recommendations are issued and care should be taken to eliminate pressure from circles with commercial interests.

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Abbreviations and Acronyms

CE	European Conformity mark
CEN	*European Committee for Standardization*
CENELEC	*European Committee for Electrotechnical Standardization*
CPR	Construction Products Regulation
EFTA	European Free Trade Association
EOTA	*European Organization for Technical Approvals*
EN	European Standard
EnDurCrete	Environmental friendly and Durable conCrete
EU	European Union
ETA	European Technical Assessment
hEN	Harmonized European Standard
NAD	National Application Documents
ITO	Indium Tin Oxide
TC	Technical Committee
UK	United Kingdom
WP	Work Package
ZAG	*Slovenian National Building and Civil Engineering Institute*

1 Introduction

EnDurCrete (*New Environmental friendly and Durable conCrete, integrating industrial by-products and hybrid systems, for civil, industrial and offshore applications*, [1]) is a research project funded through the Horizon 2020 [2] scheme. Its main objective is to develop a new cost-effective sustainable reinforced concrete for long-lasting and added-value applications. To achieve this goal the following technologies are adopted

- Cement with a high content of blast furnace slag, siliceous fly ash and limestone;
- Concrete coatings with microencapsulated epoxy and acrylic resins providing self-healing capacity;
- Nano-modified clays used as fillers incorporating steel corrosion inhibitors, and
- Micro-carbon fillers for improved mechanical properties and self-sensing capacity.

Research work is organised into nine work packages (WP) which are further broken down into tasks outlined in the project proposal [3]. This report is an outcome of task T7.2 *Standardisation* in WP7 *Life cycle assessment and economic evaluation, standardization and health and safety aspects*.

The main goal of this task is to identify the barriers of existing technical specifications for the implementation of developed materials and technical solutions in everyday civil and building engineering practice.

The work performed included three levels of documents, namely

(1) Eurocodes and national technical specifications,

(2) construction product standards including harmonized EU and national standards, and

(3) execution European standards and national technical requirements.

Review of design standards and codes pertaining to the design of concrete structures fed into WP1 and outcomes are included in reports D1.2-D1.3 [4]–[6]. The focus of this report is on any regulatory barriers that may hinder the penetration of novel technologies, developed within the EnDurCrete project, to the European markets.

To be placed on the common European market new products need to comply with the relevant EU legislation. This is demonstrated by conforming to the harmonized European standards (hEN) and by affixing the CE marking to a product and issue a declaration of conformity (sic) [7][1]. While the CE marking sanctions the distribution of the construction products to the retailers, there might be other barriers preventing the implementation of new materials in engineering/construction practice. Such barriers can be found in the national standards, policies, regulations, codes or technical guidelines directly prescribing or indirectly implying the use of certain materials. Besides, hENs may be issued with national annexes, supplements or implementation rules. It should also be noted, that products not covered by hEN can be placed on the market if they comply with relevant non-harmonized standards or national standards or specifications.

[1] Reference [7] still uses an outdated term “declaration of conformity” which was used in the now repealed Construction Product Directive [8]. The equivalent term in current Construction Product Regulation [9] is “declaration of performance.

The review presented in this report was performed in two stages. In the first stage, the accessible documentation was inspected by the lead partner, namely the *Slovenian National Building and Civil Engineering Institute* (ZAG) and the outcomes are presented in chapter 2 *Documentation review*. Based on the collected information an online survey was formulated and distributed to EnDurCrete partners and other relevant stakeholders. The survey and its findings are summarized in chapter 3 *Online survey*. Chapter 4 *Conclusions* recapitulates the main barriers identified in the previous chapters and forms a basis for recommendations to be put forward to standardization and regulatory bodies such as technical committees (TC) of the *European Committee for Standardization* (CEN) and the *European Organization for Technical Approvals* (EOTA).

2 Documentation review

In the first stage of documentation review documents listed in Table 2.1 were examined.

Table 2.1 – Documents examined in the first stage of the review.

Number	Title	Ref.
CEN 63623305522-13	Position paper on the implications of the Construction Products Regulation (Regulation (EU) No 305/2011) on the European Standardization System	[10]
CEN/TC 104/SC1	Survey of national provisions used in conjunction with EN 206-1:2000	[11]
FprCEN/TR 15868	Survey on provisions valid in the place of use used in conjunction with the European concrete standard and developing practice	[12]
EN 197-1	Cement. Composition, specifications and conformity criteria for common cements	[13]
EN 206	Concrete: Specification, performance, production and conformity	[14]
EN 934-1	Admixtures for concrete, mortar and grout. Common requirements	[15]
EN 934-2	Admixtures for concrete, mortar and grout. Concrete admixtures – Definitions, requirements, conformity marking and labelling	[16]
EN 1504-2	Products and systems for the protection and repair of concrete structures – Definitions, requirements, quality control and evaluation of conformity. Surface protection systems for concrete	[17]
EN 1992-1-1	Eurocode 2: Design of concrete structures. General rules. Rules for buildings	[18]
EN 1992-1-2	Eurocode 2: Design of concrete structures. General rules. Structural fire design	[19]
EN 1992-2	Eurocode 2: Design of concrete structures. Concrete bridges. Design and detailing rules	[20]
EN 1992-3	Eurocode 2: Design of concrete structures. Liquid retaining and containment structures	[21]
LNEC E 464	Betões. Metodologia prescritiva para uma vida útil projecto de 50 e de 100 anos face às acções ambientais | Eng.: Concrete. Prescriptive methodology for a design working life of 50 and of 100 years under the environmental exposure	[22]
EHE-08	Instrucción de Hormigón Estructural | Eng.: Code on Structural Concrete	[23]
SIST 1026	Beton. Specifikacija, lastnosti, proizvodnja in skladnost – Pravila za uporabo SIST EN 206 | Eng.: Concrete. Specification, performance, production and conformity – Rules for the implementation of SIST EN 206	[24]

Position paper CEN 63623305522-13 [10] published by CEN and the *European Committee for Electrotechnical Standardization* (CENELEC) in 2016 outlined the inconsistencies in EU regulations pertaining to construction materials. The paper points out that hENs are a vehicle for the free movement of construction products within the internal market. As such they should address the needs of all stakeholders and should not focus only on the mandatory regulatory elements. Namely, hENs can have a wider scope than the mandatory regulatory requirements which are identified in the Annex ZA. While this should remove the need for national regulations, the CEN TCs have neither the capacity nor the mandate to identify all applicable national regulations and thus verify the completeness of hENs [10, p. 10, pt. 2]. Furthermore, as opposed to other standards produced by CEN/CENELEC, which by definition are voluntary, standards under the Construction Products Regulation (CPR) [9] are mandatory. Namely, the manufacturers need to declare

- the essential product characteristics listed in Annex ZA – these are the requirements of the EU regulator[2]; as well as
- any other characteristics for which there are provisions[3] (i.e. regulations or technical rules) in relation to the intended use in the Member States where the manufacturer intends to place the product on the market [10, p. 7, pt. 4] – these are the requirements of the national regulators.

A *CEN TC 104/SC1 Survey of national provisions used in conjunction with EN 206-1* [11] conducted in 2005 examined the national requirements forming the basis of local concrete practice in 17 Member States. The survey included not only regulatory requirements but also guidelines and similar non-mandatory documents related to concrete products and concrete constituents. While this extensive document does not aim to analyse the responses it reveals that all responding states have a number of national documents – for cement alone about 30 national documents were listed.

A similar survey was conducted again by CEN TC 104 in 2018 [12]. All responding states listed at least one document containing national provisions or they were in the process of preparing such documents. Various annexes of EN 206 [14] have been made normative by different states [12, pp. 6–9, Table 2] while one state made normative their own version of Annex E – *Recommendations for the use of aggregates*. Seven states had national provisions in place for the use of cement, eleven states for the use of additions and four for admixtures.

It can, therefore, be concluded, that hENs, which are covered by the legal rules of the CPR [9], represent only a small portion of regulatory documents. To them, one needs to add a plethora of application standards, codes and non-mandatory documents underlying the national responsibility for construction safety and thus forming the basis for local practices.

[2] As explained in the Part 1of the Vademecum [25, Sec. 6.1] any standard produced in response to a standardisation request may also deal with other issues not covered by the request. Therefore, distinction must be drawn between specifications aimed at supporting Union legislation and other specifications. This is further explained in the Position paper recommendation [10, p. 8] and in discussion on classes and thresholds [10, p. 11, pt. 4].

[3] According to CPR [9, Preamble 4] laws, regulations, administrative measures or case-law established either at Union or Member State level are considered "provisions". Declaration of performance shall, amongst other, contain the performance of those essential characteristics of the construction product which are related to the intended use or uses, taking into consideration the provisions in relation to the intended use or uses where the manufacturer intends the product to be made available on the market [9, Article 6, paragraph 3.e].

2.1 Cement

Three new compositions of cement, proposed in the EnDurCrete project, are designed to comply with the upcoming version of prEN 197-1 [26]. The revised version of EN 197-1:2011 shall include new clinker reduced, environmental friendly cement types CEM II/C-M and CEM VI. Responsible CEN committee TC51 finalized the technical preparation of prEN 197-1 in 2015. However, since that time, the formal approval of that standard has been blocked by European Commission (like for many other hEN) because of various formal and legal reasons. Main aspects are the non-compliance of existing Mandates and the harmonized standards with CPR, especially considering that based on the so-called "James Elliott" judgemet of European Court, hEN are seen as part of the European legal system. Current discussions on the legal correctness of procedures and approaches of revising CPR there is limited perspective for getting prEN 197-1 formally approval during the next years.

These newly developed EnDurCrete cement compositions are shown in Table 2.2. Due to low clinker content, they are considered environmentally friendly. A detailed explanation of EnDurCrete cement composition is available in WP2 report D2.2 [27]. In addition to standard EN 197-1 [13], cement, as the essential structural component of concrete, is to some degree also covered by EN 206 [14] and EN 1992 (Eurocode 2) [18]–[21]. While these standards per se are not prescriptive they leave room for national regulators to implement provisions valid in the place of use.

Table 2.2 – Composition of three types of cement developed in EnDurCrete [1] project complying with prEN197-1 [26]. A detailed explanation of cement composition is given in D2.2 report [27].

Cement type notation	Composition (wt%)			
	Klinker (K)	Slag (S)	Limestone (LL)	Fly ash (V)
CEM II/C-M (S-LL)	50	40	10	---
CEM II/C-M (S-V)	53	32	---	15
CEM VI (S-V)	47	43	---	10

2.1.1 Provisions of EN 197-1

Types of cement for the EU market are classified in EN 197-1 [13]. This standard identifies the constituents of cement, such as clinker, fly ash and limestone and specifies the composition range for each type of the cement, allowing manufacturers to optimise their products within the given range. The standard also identifies the characteristics of cement and provides references to test methods defined in standard series EN 196 [28]–[37]. Since EN 197-1 [13] is a harmonized standard, cement manufacturers must carry out assessment and verification of constancy of performance, obtain a certificate of constancy of performance issued by a notified certification body, declare the performance of their products for the essential characteristics listed in Annex ZA and mark their product accordingly with the CE marking. As a component of concrete, cement is also subjected to the requirements of the concrete standard EN 206 [14].

For the three types of cement developed in the EnDurCrete project, four essential characteristics listed in prEN197-1 Annex ZA [26, Sec. ZA.1] apply, namely

- compressive strength (early and standard),
- initial setting time,
- soundness (expansion and SO_3 content), and
- chloride content.

These are the regulatory EU requirements which manufacturers must declare when putting their cement onto the European market. It can be concluded that the number of EU regulated characteristics is small. It is therefore likely that these characteristics are insufficient for specifiers and contractors to select cement fit for the intended use.

2.1.2 Provisions of EN 206 and national annexes

Standard EN 206 [14], on the other hand, is not harmonized. Thus, it does not contain Annex ZA. Chapter 5.1 of this standard defines concrete constituents. Cement is covered by clause 5.1.2 which states that general suitability of cement is established by conforming to EN 197-1 [13]. However, chapter 5.2 deals with the basic requirements for the composition of concrete. In particular, the selection of cement is covered by clause 5.2.2 where it is stated that "cement shall be selected from those for which the suitability is established". Conservative interpretation of "established suitability" can hamper actual use of new types of cement. The same wording is used in normative Annex D which deals with special geotechnical works and permitted types of cement are listed in D.2.1. Besides, Annex M lists over 30 clauses of the standard where provisions valid in the place of use are either required or permitted. In this respect, it should be noted that standard does not clearly differentiate between clauses which require (=must have) national provisions and those which permit (=may have) national provisions. As can be seen in the CEN TC 104 survey [12], half of the member states took upon this option and implemented the national provisions.

An example of national provisions is found in the Slovenian standard SIST 1026 [24] which provides Slovenian rules for the implementation of EN 206 [14]. Addendum to clause 5.2.2 provides an informative table shown in Figure 2.1, where the suitability of cement types is listed for all exposure classes. Since new types of cement are not included in the table and there is no evidence of suitability for use, local practitioners are not likely to embrace them.

2.1.3 Provisions of EN 1992 Eurocode 2 and national codes

Exposure classes and characteristics of concrete are also included in design codes for concrete structures. In EU concrete structures are designed according to the standard series EN 1992 Eurocode 2: Design of concrete structures [18]–[21]. In principle, design codes are performance-based and therefore stipulate required characteristics without prescribing how they should be achieved. For properties of concrete Eurocode 2 refers to EN 206 [14]. However, coefficients used in design calculations may depend on the type of concrete constituents. For example, calculation of the compressive strength of concrete at various ages is estimated by the means of coefficient *s*, whose value depends on the type of cement [18, Sec. 3.1.2].

In general Eurocode 2 covers durability design in section 4. However, Portugal implemented national technical specifications concerning the durability design of concrete structures, namely LNEC E 464 *Concrete. Prescriptive methodology for a design working life of 50 and 100 years under environmental exposure* [22] (as discussed in [38]). As the title suggests, the methodology is prescriptive however, it allows the use of cement other than those presented in the prescriptive

approach through the application of the equivalent performance concept [38, Ch. 8.12.1]. Two models are available for the estimation of the reinforcement corrosion initiation period due to carbonation. One of the models is based on air permeability and makes use of coefficient *c* whose value depends on the type of cement as shown in Figure 2.2. Since values for the new cement types (e.g. CEM VI) are not provided, engineers are less likely to select such cement.

		Ni nevarnosti korozije ali agresivnega delovanja	Stopnje izpostavljenosti																				
			Korozija zaradi karbonatizacije				Korozija zaradi kloridov						Zmrzovanje/tajanje				Kemično agresivno okolje						Abrazija		
							Morska voda			Drugi kloridi							Sulfati (SO_4^{2-})			Druge kemične karakteristike					
		X0	XC1	XC2	XC3	XC4	XS1	XS2	XS3	XD1	XD2	XD3	XF1	XF2[2)]	XF3[2)]	XF4[2)]	XA1	XA2	XA3	XA1	XA2	XA3	XM1	XM2	XM3
1	CEM I	+	+	+	+	+	+	+[1)]	+[1)]	+	+	+	+	+	+	+	+[1)]	+[1)]	+[1)]	x	x	x	+	+	+
2	CEM II/A-S	+	+	+	+	+	+	-	-	+	+	+	+	+	+	+	+	-	-	x	x	x	+	+	+
3	CEM II/B-S	+	+	+	+	+	+	-	-	+	+	+	+	+	+	+	-	-	-	x	x	x	+	+	+
4	CEM II/A-D	+	+	+	+	+	+	-	-	+	+	+	+	+	+	+	-	-	-	x	x	x	+	+	+
5	CEM II/A-P	+	+	+	+	+	+	-	-	+	+	+	+	+	+	-	-	-	-	x	x	x	+	+	+
6	CEM II/B-P	+	+	+	+	+	+	-	-	+	+	+	+	+	+	-	-	-	-	x	x	x	+	+	+
7	CEM II/A-Q	+	x	x	x	x	x	-	-	x	x	x	x	x	x	x	-	-	-	x	x	x	x	x	x
8	CEM II/B-Q	+	x	x	x	x	x	-	-	x	x	x	x	x	x	x	-	-	-	x	x	x	x	x	x
9	CEM II/A-V	+	+	+	+	+	+	-	-	+	+	+	+	-	+	-	-	-	-	x	x	x	+	+	+
10	CEM II/B-V	+	+	+	+	+	+	-	-	+	+	+	+	-	-	-	-	-	-	x	x	x	+	+	+
11	CEM II/A-W	+	+	+	x	x	x	-	-	x	x	x	+	-	-	-	-	-	-	x	x	x	-	-	-
12	CEM II/B-W	+	+	+	x	x	x	-	-	x	x	x	x	-	-	-	-	-	-	x	x	x	-	-	-
13	CEM II/A-T	+	x	x	x	x	x	-	-	x	x	x	x	x	x	x	-	-	-	x	x	x	x	x	x
14	CEM II/B-T	+	x	x	x	x	x	-	-	x	x	x	x	x	x	x	-	-	-	x	x	x	x	x	x
15	CEM II/A-L	+	+	+	+	+	+	-	-	+	+	-	+	-	+	-	-	-	-	x	x	x	+	+	+
16	CEM II/B-L	+	+	+	+	+	+	-	-	+	-	-	+	-	-	-	-	-	-	x	x	x	+	+	-
17	CEM II/A-LL	+	+	+	+	+	+	-	-	+	+	-	+	+	+	-	-	-	-	x	x	x	+	+	+
18	CEM II/B-LL	+	+	+	+	+	+	-	-	+	-	-	+	-	-	-	-	-	-	x	x	x	+	+	-
19	CEM II/A-M	+	+	+	+	+	+	-	-	+	+	+	+	+	+	+	-	-	-	x	x	x	+	+	+
20	CEM II/B-M	+	+	+	+	+	+	-	-	+	+	+	+	+	+	-	-	-	-	x	x	x	+	+	+
21	CEM III/A	+	+	+	+	+	+	+[1)]	+[1)]	+	+	+	+	+	+	+	+[1)]	+[1)]	+[1)]	x	x	x	+	+	+
22	CEM III/B	+	+	+	+	+	+	+[1)]	+[1)]	+	+	+	+	+	+	+	+[1)]	+[1)]	+[1)]	x	x	x	+	+	+
23	CEM III/C	+	x	x	x	x	x	+[1)]	+[1)]	x	x	x	x	x	x	x	+[1)]	+[1)]	+[1)]	x	x	x	+	+	+
24	CEM IV/A	+	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
25	CEM IV/B	+	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
26	CEM V/A	+	+	+	+	+	+	-	-	+	+	+	+	+	+	-	-	-	-	x	x	x	+	+	+
27	CEM V/B	+	x	x	x	x	x	-	-	x	x	x	x	x	x	x	-	-	-	x	x	x	x	x	x

Legenda
+ Uporaba je primerna.
- Uporaba se odsvetuje in je mogoča le na podlagi dokaznih preiskav.
X Uporaba je mogoča na podlagi dokaznih preiskav.
1) Priporočljiva je uporaba sulfatno odpornega cementa.
2) Uporaba koncepta k-vrednosti z EF pepelom ni primerna.

Figure 2.1 – Table N.3 from Slovenian standard SIST 1026 [24]. Types of cement are listed on the left and exposure classes in the header row. Symbols denote suitability for use of cement for given exposure class where + means "suitable", - stands for "usage is not recommended and is possible only if there is evidence of suitability derived from testing" and × means that "usage is possible if there is evidence of suitability derived from testing".

On the other hand, Spain implemented their own EHE-08 *Code on Structural Concrete* [23] where chapter 6 deals with materials for concrete. Article 26 states the requirements for types of cement that can be used. Table 26 from EHE-08 [23] is reproduced in Figure 2.3. This table is interesting because it lists types of cement that cannot be used for mass and reinforced concrete while for pre-stressed concrete cement types that can be used are listed.

RH (%)	*m*	*p*	*c* (kg/m^3)		
			CEM I[a]	CEM II/III	CEM IV
60	1.00	0.51	460	350	230
65	0.737	0.5	460	350	230
70	0.534	0.48	460	350	230
75	0.382	0.45	470	358	235
80	0.256	0.42	485	365	240
85	0.184	0.37	510	388	253
90	0.117	0.32	535	410	265
95	0.057	0.25	570	430	285
100	0	0.19	615	470	310

[a]Also applicable to CEM II/A-L

Figure 2.2 – Values of parameters *m*, *p* and *c* used in the carbonation model for the durability of concrete structures as defined in LNEC E 464 *Concrete. Prescriptive methodology for a design working life of 50 and 100 years under environmental exposure* [22] (as shown in [38]).

EHE-08 [23] also defines its own exposure classes in chapter 2. Exposure classes are used in chapter 7 in connection with types of cement to prescribe minimum reinforcement covering – as an example Table 37.24.1.b from the *Code* is reproduced in Figure 2.4. As argued above, lack of

information and the fact that novel cements are not mentioned in the *Code* will make practitioners reluctant to use them.

Table 26 Types of cement that can be used

Type of concrete	Type of cement
Mass concrete	Ordinary cements apart from types CEM II/A-Q, CEM II/B-Q, CEM II/A-W, CEM II/B-W, CEM II/A-T, CEM II/B-T and CEM III/C ESP VI-1 cements for special purposes
Reinforced concrete	Ordinary cements apart from types CEM II/A-Q, CEM II/B-Q, CEM II/A-W, CEM II/B-W, CEM II/A-T, CEM II/B-T, CEM III/C and CEM V/B
Pre-stressed concrete	Ordinary cements of types CEM I and CEM II/A-D, CEM II/A-V, CEM II/A-P and CEM II/A-M(V,P)

Figure 2.3 – Types of cement that can be used according to Spanish EHE-08 *Code on Structural Concrete* [23].

Table 37.2.4.1.b Minimum covering (mm) for general exposure classes III and IV

Concrete	Cement	Useful structural life (t_g) (years)	General exposure class			
			IIIa	IIIb	IIIc	IV
Reinforced	CEM III, CEM IV, CEM II/B-S, B-P, B-V, A-D or concrete with micro-silica	50	25	30	35	35
		100	30	35	40	40
	Other useable cements	50	45	40	*	*
		100	65	*	*	*
Pre-stressed	CEM II/A-D or with silica fume additive of more than 6%	50	30	35	40	40
		100	35	40	45	45
	Other useable cements according to Article 26	50	65	45	*	*
		100	*	*	*	*

Figure 2.4 – Minimum reinforcement covering according to Spanish EHE-08 *Code on Structural Concrete* [23].

2.2 Admixtures

Nano-modified clays to be used as fillers incorporating steel corrosion inhibitors were developed in WP3. Clays, which consist of silicate layers separated by the water molecules, are treated with alkoxysilane modifiers to increase the distance between silicate layers thus providing space for corrosion inhibitors. Corrosion inhibitors, these being amino and carboxylate compounds, bind to the alkoxysilane modifiers from where they are slowly released during the life span of concrete. A detailed description of nano-modified clays is available in EnDurCrete report D3.4 [39]. Furthermore, it follows from EnDurCrte report D3.7 [40] that the quantity of nano-clay to be used in concrete is up to 1 % by mass of cement and can, therefore, be considered admixtures for concrete.

Admixtures are covered by the standards series EN 934 *Admixtures for concrete, mortar and grout*. General requirements are covered by EN 934-1 [15] and specific requirements for concrete are covered by EN 934-2 [16]. According to the latter, admixtures for concrete are “materials added during the mixing process of concrete in a quantity not more than 5 % by mass of the cement content of the concrete, to modify the properties of the mix in the fresh and /or hardened state” [16, Ch. 3.2.1]. The standard continues to specify types of admixtures and specific requirements for each type with none of the types covering corrosion inhibitors.

Furthermore, EN 934-2 [16] is an hEN with the mandatory essential characteristics listed in Annex ZA. The following characteristics apply to all admixtures

- chloride ion content,
- alkali content,
- corrosion behaviour,
- compressive strength, and
- air content.

Corrosion behaviour is specified in EN 943-1 [15] where the test method is prescribed. However, the standard also states that no testing for corrosion behaviour is required for admixtures containing only substances on the approved list. It is clear from the wording of these two standards that corrosion behaviour refers to the undesired side effects of concrete admixtures rather than to beneficial action of admixtures with corrosion-inhibiting properties. Therefore, acquisition of the CE marking for nano-clays will most likely have to follow the European Technical Assessment (ETA) pathway [41].

While EN 934-1 [15] and EN 934-2 [16] do not explicitly exclude admixtures not covered by the specific types this can be the case in national codes. For example, EHE-08 [23] considers only five types of admixtures included in Table 29.2 which is reproduced in Figure 2.5. Hence, even if EN 943-2 were updated or ETA issued, the national rules for use admixtures in structural concrete could dissuade engineers from using corrosion inhibiting admixtures.

Table 29.2 Types of admixtures

TYPE OF ADMIXTURE	MAIN FUNCTION
Water reducers/plastifiers	To reduce the water content of a concrete without modifying its workability or increase workability without modifying the water content.
High-range water reducers/ superplastifiers	To significantly reduce the water content of a concrete without modifying its workability or significantly increase workability without modifying the water content.
Accelerators and retarders	To modify a concrete's setting time.
Air-entraining agents	To produce a controlled volume of fine air bubbles which are uniformly distributed in the concrete in order to improve frost resistance.
Multi-functional	To modify more than one of the main functions defined above.

Figure 2.5 – Types of admixtures considered by Spanish EHE-08 *Code on Structural Concrete* [23].

2.3 Surface protection

Multifunctional coatings developed in the WP3 of the EnDurCrete project consist of either polyurethane or acrylic resin containing self-healing, self-cleaning, anti-moulding and light-reflective agents. So far the best results were achieved with

- microencapsulated polyurethane paint as a self-healing agent,
- titanium dioxide as a self-cleaning agent,
- combination of silver ions, titanium dioxide and antibiotic as an anti-moulding agent, and
- Indium Tin Oxide (ITO) as a light-reflective agent.

Details are available in EnDurCrete D3.6 report [42].

Protective coatings for concrete are covered by standard EN 1504-2 [17]. According to the standard, intended uses of coatings are

- ingress protection,

- moisture control,
- physical resistance,
- chemical resistance, or
- increasing resistivity by limiting moisture content.

Since this is a harmonized standard the mandatory essential characteristics for each intended use are listed in Annex ZA. All five intended uses of protective coatings for concrete require the declaration of the following characteristic

- adhesion strength by pull-off test,
- capillary absorption and permeability to water,
- reaction to fire,
- dangerous substances,
- linear shrinkage*,
- coefficient of thermal expansion*,
- thermal compatibility*,
- cross-cut*,
- crack bridging ability*,
- skid resistance*,
- artificial weathering*,
- antistatic behavior*, and
- adhesion on wet concrete*,

where the asterisk (*) marks the characteristics that must be declared only "where relevant"[4]. There are additional characteristics that apply to a specific use. While EnDurCrete multifunctional coatings are a novel product not envisaged by the standards, the essential characteristics listed above would apply.

In the first stage of documentation review, no national specifications were found.

[4] According to CPR [9, Article 6, paragraph 3.f] letters "NPD" (No Performance Determined) shall be used in declaration of performance for those essential characteristics for which no performance is declared.
Performance of the characteristics without asterisk (*) must be declared. Characteristics with the asterisk (*) are at the discretion of a manufacturer. In cases where all essential characteristics listed by hEN are marked "where relevant" (or similar), manufacturers shall declare "the performance of at least one of the essential characteristics of the construction product, relevant for the declared intended use or uses" [9, Article 6, paragraph 3.c].

3 Online survey

It was established during the inspection of the accessible documentation that mandatory and non-mandatory national documentation that can impose barriers to market penetration is diverse and knowledge of local practice is needed to find it. Thus, an online *EnDurCrete Project Survey* [43] was created to collect information from the EU and the European Free Trade Association (EFTA) Member States. The online study was developed using an open-source platform *Google Forms*. The front page of the survey is shown in Figure 3.1. It has been distributed to all EnDurCrete partners with a request to complete it and to forward it to other potential stakeholders. Besides, it was sent to the secretaries of CEN TC 104 and CEN TC 51 requesting them to forward it to members of their committees.

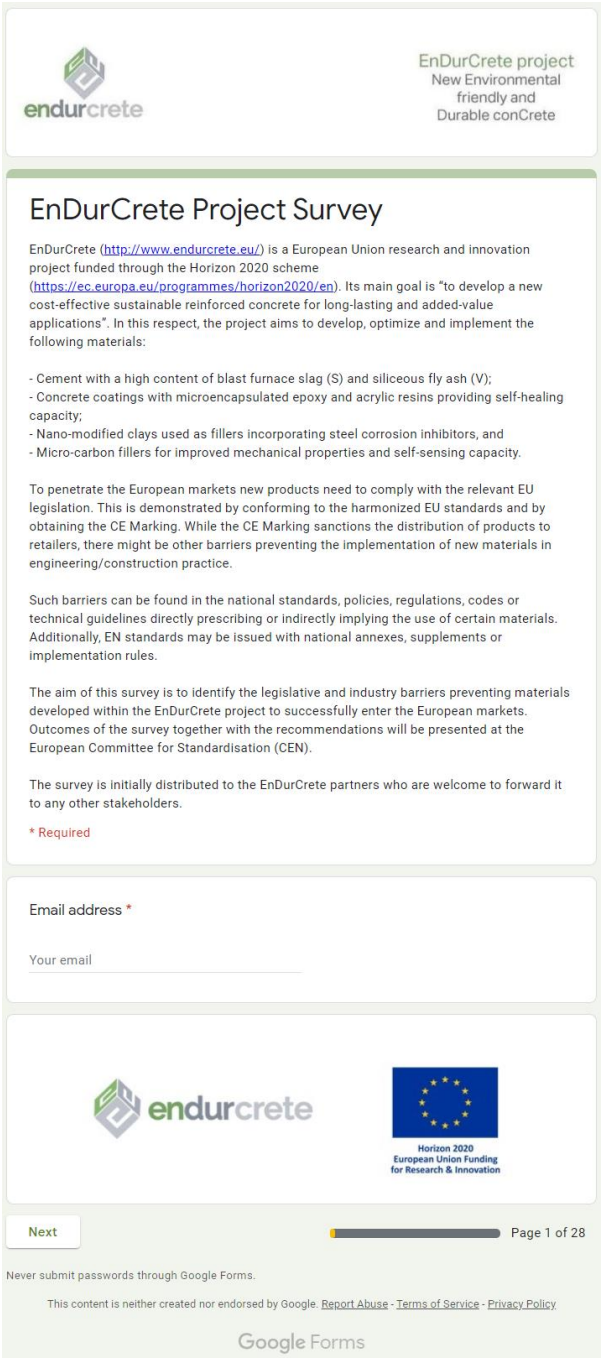

Figure 3.1 – Front page of the online EnDurCrete Project Survey [10] aiming to identify regulatory barriers hindering penetration of novel EnDurCrete applications to the European markets. The survey was developed using the *Google Forms* platform.

The survey consisted of five sections as shown in Figure 3.2. The first section aims to establish the background of the respondents while the other four sections ask respondents to provide information on perceived regulatory barriers to the use of novel EnDurCrete materials in the field of

- cement and mineral additives,
- concrete and concrete structures,
- concrete admixtures and
- materials used for surface protection of concrete.

While the background section was compulsory for all respondents, other sections were optional. Thus, respondents were able to skip sections and navigate to questions within their field of expertise.

The survey opened on 20 November 2019 and closed on 15 March 2020.

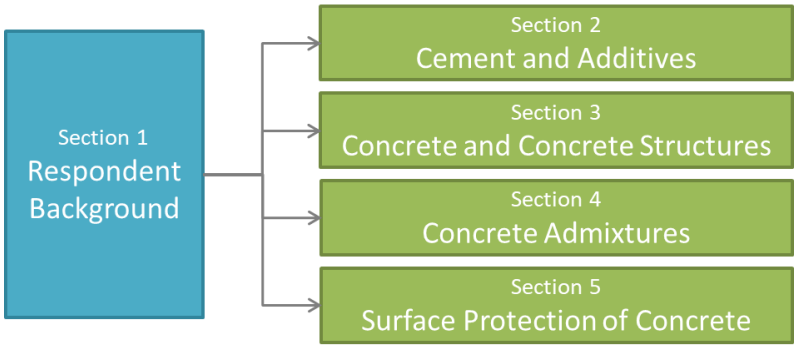

Figure 3.2 – Structure of the online EnDurCrete Project Survey [9].

3.1 Background information

By 15 March 2020, the survey received 21 responses with 24 % of respondents operating primarily in Slovenia. Germany, Italy, Norway and Spain are covered by 9 % each while Belgium, Croatia, France, Greece, Netherlands, Romania, Sweden and Switzerland were covered by one respondent each which amounts to ~5 % per country as shown in Figure 3.3.

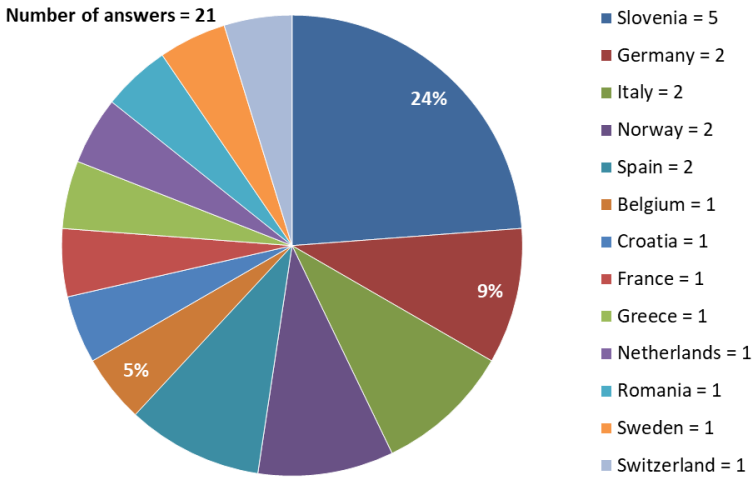

Figure 3.3 – Survey respondents: Primary country of business operations.

In addition to the primary country of business operations, the survey respondents were asked if they operate in any other EU/EFTA country. It should be noted that at the time the study was released, the United Kingdom (UK) was still a member of the EU. As can be seen in Figure 3.4, all EU/EFTA countries are covered with at least one respondent. Thus, it may be assumed that collectively survey respondents have some insight into national regulations of EU/EFTA countries.

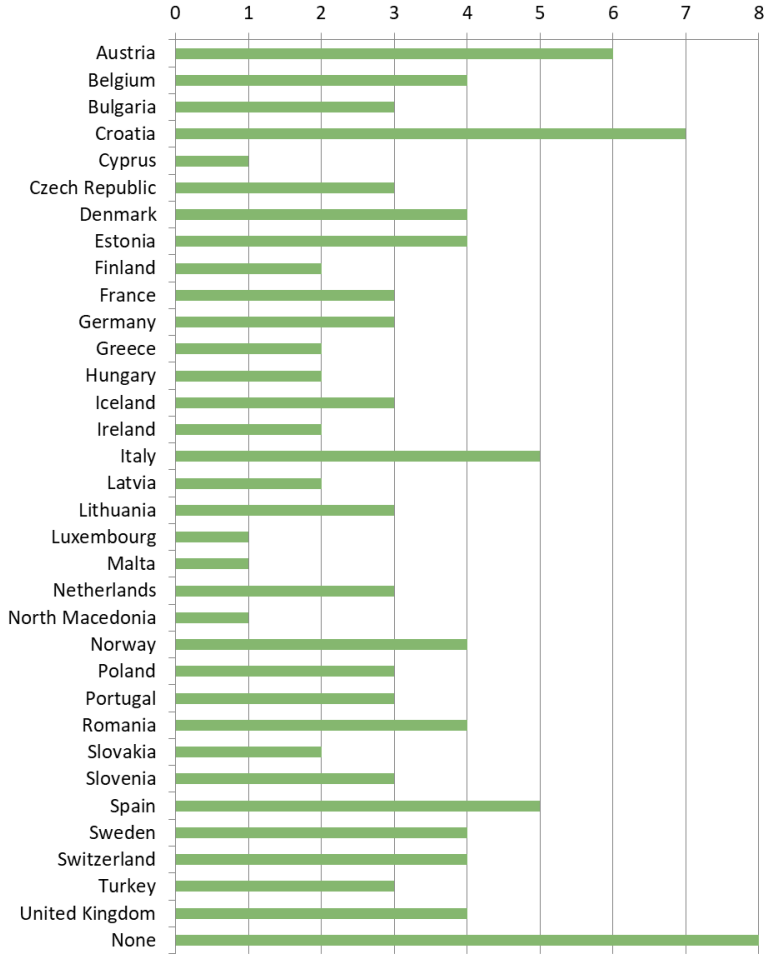

Figure 3.4 – Survey respondents: Secondary country of business operations.

In respect to the nature of the business, Figure 3.5 shows that 43 % of respondents are clinker and cement manufacturers. Consultancy firms and research institutions are represented with 14 and 9 % respectively. The rest of the respondents are either certification bodies, construction contractors, designers of off-shore structures, manufacturers of chemical admixtures for concrete, manufacturers of precast concrete elements, concrete plants or universities, each of them represented by one respondent or 5 %.

A majority of ~85 % of the respondents primarily deals with cement and concrete. Only one respondent stated that their main focus is either on concrete admixtures, protective coatings or construction materials in general as shown in Figure 3.6.

Considering the nature of business and material mainly dealt with, one can expect the survey sections on cement and concrete to receive the bulk of answers – 62 % of respondents chose to answer the section on cement an additives and 76 % chose to answer the section on concrete and concrete structures while only 15 % chose to answer either section on concrete admixtures or section on surface protection of concrete.

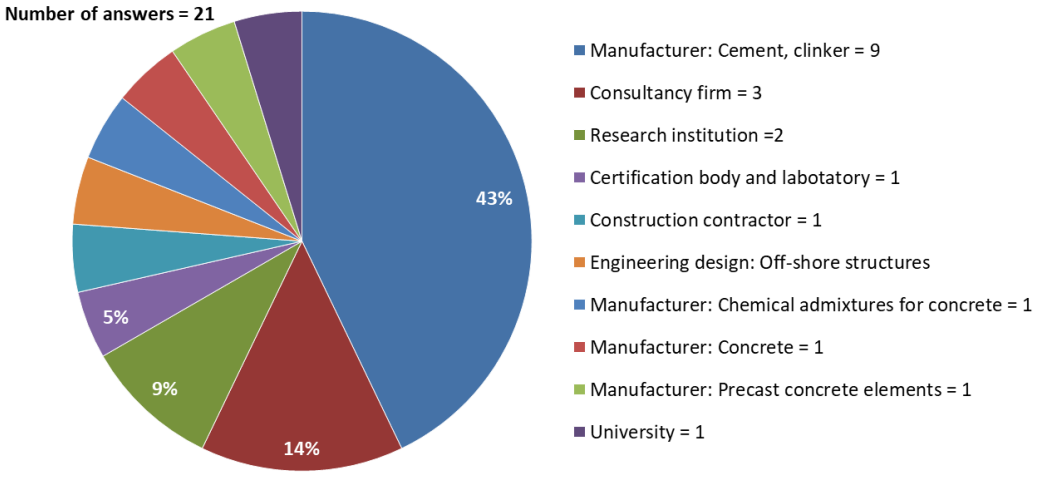

Figure 3.5 – Survey respondents: Nature of business.

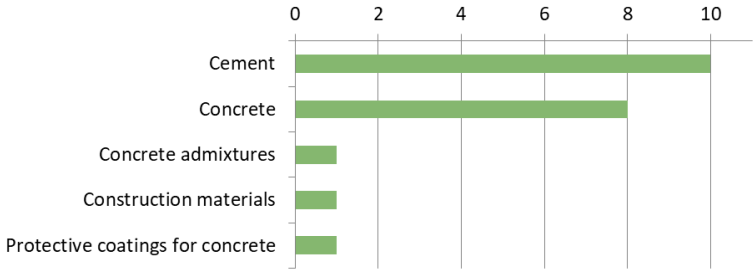

Figure 3.6 – Survey respondents: Material of main interest.

Overall, it can be concluded that a reasonably good sample was obtained for cement and concrete. It covers industry as well as research and development with operations across the EU/EFTA countries. It should be noted that in their answers respondents were referring to the country where they are located. Nevertheless, a sample of about one-third of the countries can be considered indicative of the general situation. Samples obtained for concrete admixtures and surface protection of concrete are insufficient to draw any conclusions.

General feedback and observations are summarized in Table 3.1.

Table 3.1 – Survey feedback and general observations

Country	Survey feedback and general observations
Belgium	National mirror committees of CEN/TC 104 (controlling national annexes of EN 206-1) should be involved and asked to consider specification of the new cements.
Italy	Evaluate nanoclays impacts on employees during mixing production.
Netherlands	Very good initiative to get a general view of legislation in the different European countries.
Norway	We will probably address opportunities of Technical Approval as a means to introduce new constituents. Less than 50/55% clinker is not likely, except for perhaps (already existing) CEM III.

Continues on the next page.

Country	Survey feedback and general observations
Continues from the previous page.	
Romania	Vertical transfer of know-how is recommended (reports, surveys, visits ...) from EnDurCrete Project Management to different countries identified technical decisional makers. Horizontal transfer - between countries - of know-how is recommended ("success stories....) too.
Spain	Our construction company works for governments, the projects are planned by their engineers 2-3 years (or more) before starting works. Only cements included in standards are considered in the projects, and no changes are usually accepted. It takes a long time to use new materials.
	As additions for concrete, in Spain we can only use fly ash and silica fume, under restricted conditions defined in EHE-08, Spanish Structural Code.
Germany	Introduction of Performance Concepts including test methods and criteria needed.

3.2 Cement

Questions related to cement were covered in two sections of the survey, namely in section 2 – *Cement and Additives* and section 3 – *Concrete and Concrete Structures*. The former was tailored more to cement related industry and research while the latter was customized for structural designers, construction contractors and concrete industry and research. All 21 survey respondents chose to answer either one or both sections. The answers from these two sections were collated and answers are presented in Table 3.2.

It follows from Table 3.2 that almost all countries have implemented a national supplement or implementation rules to the standard EN 206 [14] with some of them still referring to the old version of the standard EN 206-1. The most relevant point in terms of cement usage is the definition of exposure classes and specifications on which types of cement can be used for a given exposure class. In some cases, national documents are mandatory (e.g. implementation rules) while in other cases they are not mandatory (e.g. guidelines). In principle, national documents are stricter than standards themselves. While some countries allow the use of other, non-specified types of materials under the equivalent performance approach, this is not often used in construction practice. There are concerns about a lack of experience with new materials and insufficient data about their performance in a harsh environment.

Table 3.2 – Summary of 21 responses to the EnDurCrete survey related to the implementation of novel types of cement. Comments marked (1) are made by survey respondents and comments marked (2) are made by the survey analysts – *Slovenian National Building and Civil Engineering Institute* (ZAG).

Country	Document code (Year of publication)	Document title	Comments: Document specific (1) by survey respondents, (2) by survey analysts
Belgium	NBN B 15-001 (2018)	*Beton - Specificatie, eigenschappen, vervaardiging en conformiteit - Nationale aanvulling bij NBN EN* **Eng.:** *206 Concrete - Specification, performance, production and conformity - National supplement to NBN EN 206*	(1) specifies what cement can be used for what concrete environmental class / the cement should be specified in this standard / any new cement needs specification for use in different concrete environmental classes, this is country dependent. (2) Source: https://www.nbn.be/en
Croatia	HRN EN 206 (2016)	*Beton -Specifikacija, svojstva, proizvodnja i sukladnost* **Eng.:** *Concrete - Specification, performance, production and conformity*	(2) Source: https://www.hzn.hr/
France	FD P18-011 (2016)	*Béton - Définifion et classification des environnements chimiquement agressifs - Recommandations pour la formulation des bétons* **Eng.:** *Concrete - Definition and classification of chemically aggressive environments - Recommendations for concrete mix design*	(2) Source: https://www.afnor.org/en/
		RSI, ASR guidelines	
Germany Continues on the next page.	DIN 1164		(2) There are three parts of DIN 1164 *Special cement*, dealing with *Composition, specification and conformity evaluation for cement with* • low effective alkali content (Part 10, 2013); • short setting time (Part 11, 2003); and • higher quantity of organic constituents (Part 12, 2005). (2) Source: https://www.din.de/en

Country	Document code (Year of publication)	Document title	Comments: Document specific (1) by survey respondents, (2) by survey analysts
Germany Continues from the previous page.	DIN 1045		(2) There are five parts of DIN 1045 • Concrete, reinforced and pre-stressed concrete structures (Parts 2, 3 and 4); • Design of concrete structures (Parts 100 and 101)
	DIN 1045-2 (2008)	*Tragwerke aus Beton, Stahlbeton und Spannbeton. Beton - Festlegung, Eigenschaften, Herstellung und Konformität - Anwendungsregeln zu DIN EN 206-1* **Eng.:** *Concrete, reinforced and prestressed concrete structures. Concrete - Specification, properties, production and conformity - Application rules for DIN EN 206-1*	(2) Source: https://www.din.de/en
	DIN 1045-3 (2012)	*Tragwerke aus Beton, Stahlbeton und Spannbeton. Bauausführung - Anwendungsregeln zu DIN EN 13670* **Eng.:** Concrete, reinforced and prestressed concrete structures. Execution of structures - Application rules for DIN EN 13670	(2) Source: https://www.din.de/en
		other national standards	
	Comments: (1) Technical approval necessary. Performance concepts not available and not allowed at the moment. Needed in the future as soon as possible. | Adoption of new EN 197-1, national amendments and experiences with low clinker cements/concretes. | Existing experiences with low-clinker cements and concretes.		

Country	Document code (Year of publication)	Document title	Comments: Document specific (1) by survey respondents, (2) by survey analysts
Italy	UNI 11104 (2016)	*Calcestruzzo - Specificazione, prestazione, produzione e conformità - Specificazioni complementari per l'applicazione della EN 206* **Eng.:** *Concrete. Specification, performance, production and conformity - additional provisions for the application of EN 206*	(2) Source: https://global.ihs.com/
	NTC (2018)	*Norme tecniche per le construzioni*	(1) Cements have to be CE marked according to UNI 197-1 or to ETA and complying with Italian law 26 maggio 1965 n. 595 (2) Source: https://www.gazzettaufficiale.it/eli/gu/2018/02/20/42/so/8/sg/pdf
	Legge 26 Maggio 1965 n.595 (1965)	*Caratteristiche tecniche e requisiti dei leganti idraulici*	(2) Source: http://www.edizionieuropee.it/LAW/HTML/26/zn4_10_013.html#_ART0001
		National guidelines on structural concrete	
	Comments: (1) EnDurCrete cements are classified as CEM VI, out of the border of the actual EUROPEAN certification. this could be the technical barrier for the use of the EnDurCrete cement in concrete. (2) CEM VI will be included in the new version of hEN 197-1. See prEN197-1 [26].		
Netherlands Continues on the next page.	NEN 8005 (2017)	*Nederlandse invulling van NEN-EN 206: Beton - Specificatie, eigenschappen, vervaardiging en conformiteit* **Eng.:** *Dutch supplement to NEN-EN 206: Concrete - Specification, performance, production and conformity*	(2) Source: https://www.nen.nl/Home_EN.htm

Country	Document code (Year of publication)	Document title	Comments: Document specific (1) by survey respondents, (2) by survey analysts
Netherlands Continues from the previous page.	CUR Recommendation 48	Equivalent concrete performance concept	(2) Dutch guideline for testing the performance of cements in concrete (CUR 48, 1999)
	Comments: (1) The technical barrier will be that we have to show the equivalent performance of the new cement compared to the `well-tried`, well-established cements		
Norway	DNV-OS-C502	**Eng.:** Offshore concrete structures	(1) Gives guidelines that sometimes overrule EN standards (more strict). (2) Source: http://www.antaresoffshore.com/internal/engineering/stds/dnv/os/DNV-OS-C502.pdf
	Comments: (1) National application rules for cement in "NAs"/national stds of national EN 206. | NAs and/or national stds related to use of the product in concrete acc to EN 206. | The EN206 must be updated accordingly. | Application rules of cement in LT partially on ministry level. | National annex for Exposure class XS1/XS2/XS3 - max vc-ratio = 0.40. | Systems for demonstrating fitness for use (durability) contains restrictions regarding types and amounts of cement constituents. | Testing methods for such demonstration may not be adequate (i.e. they discriminate on unfair or non-proven basis). | General concerns related to e.g. content of trace elements.		
Romania Continues on the next page.	CP 012/1 (2007)	*Cod de practică pentru producerea betonului* **Eng.:** Code of practicefor concrete production	(1) Still based on EN 206-1:2000. (2) Source: http://magazin.asro.ro/ro/catalog-standarde
	SR 13510 (2006)	*Beton. Partea 1: Specificaţie, performanţă, producţie şi conformitate. Document naţional de aplicare a SR EN 206-1* **Eng.:** *Concrete. Specification, performance, production and conformity - National document for application of SR EN 206-1*	(2) Source: http://magazin.asro.ro/ro/catalog-standarde
	NE 012/2 (2010)	**Eng.:** Practice code for concrete structure execution	(1) Mostly regarding execution, only few aspects regarding concrete composition.

Country	Document code (Year of publication)	Document title	Comments: Document specific (1) by survey respondents, (2) by survey analysts
Romania Continues from the previous page.	GP 115 (2011)	**Eng.:** Design guidelines for the control of cracking in solid elements and structural walls made of reinforced concrete due to restrained shrinkage	
	CR 0 (2012		(1) National Annexes (standards) for Eurocode 2 implementation. | National obligatory regulation.
Slovenia	SIST 1026 (2016)	*Beton - Specifikacija, lastnosti, proizvodnja in skladnost - Pravila za uporabo SIST EN 206* **Eng.:** *Concrete - Specification, performance, production and conformity - Rules for the implementation of SIST EN 206*	(2) Source: http://www.sist.si/
	SIST EN 13670 (2017)	*Izvajanje betonskih konstrukcij - Nacionalni dodatek* **Eng.:** *Execution of concrete structures - National Annex*	(2) Source: http://www.sist.si/
		Road guidelines	
	Comments: (1) No evidence of long-term durability in some of the exposure conditions. | Slow implementation/approval of upcoming EN 197-1 revision. | Limited concrete technology expertise in the concrete industry.		
Spain Continues on the next page.	RC-16 (2016)	*Instrucción para la recepción de cementos*	(1) In Spain, we can only use cement included in RC-16, Spanish cement code. (2) Source: https://www.librosingenieriacivilonline.es/ingenieria_civil_Normativa_de_construccion__Instruccion_para_la_recepcion_de_cementos__RC_16-5572.php

Country	Document code (Year of publication)	Document title	Comments: Document specific (1) by survey respondents, (2) by survey analysts
Spain Continues from the previous page.	EHE 08	*Instrucción de Hormigón Estructural* **Eng.:** *Code on Structural Concrete*	(1) Indicates type and quantity of cement for manufacturing concrete, depending on the exposure class. | Defines concrete composition. | This standard is mandatory, but you can give different solutions under your own responsibility, and this is not often used. (2) Source: https://www.mitma.gob.es/organos-colegiados/mas-organos-colegiados/comision-permanente-del-hormigon/cph/instrucciones/ehe-08-version-en-ingles
	Comments: (1) Projects only consider cements included in the current standards. | EN 206 is not implemented in Spain.		
Sweden	SS 137003 (2015)	*Betong - Användning av EN 206 i Sverige* **Eng.:** *Concrete - Application of EN 206 in Sweden*	(1) Lists which cement types which are proven suitable in different exposure classes. (2) Source: https://www.sis.se/en/
	(1) Lack of longtime experience when it comes to harsh environments. | Technical barrier could e.g. be insufficient freeze-thaw resistance and lack of long time experience.		

Based on the comments the following recommendations can be drawn: Firstly, in Europe, construction safety is and will remain in the responsibility of the member states. This includes structural design and concrete codes. Existing Eurocodes and the concrete standard EN 206 are European documents giving common guidance for more harmonized approach. However, in many clauses, reference is made to national rules which usually are introduced by National Application Documents (NAD), the national concrete codes amending EN 206. This freedom is necessary to be able to adjust the concretes code according the local conditions (e.g. construction traditions, climate, legal framework, availability of materials, etc.). Based on this approach also the rules how cements can be applied in the design of concrete remains in the responsibility of the national standardization bodies. As consequence for new concrete constituents like new cement types, it is necessary to introduce the products into the national concrete standard/code country-by-country. The individual national procedures for technical verification and approval have to be followed. A more common, coordinated approach, without circumventing the national responsibility would be helpful in reducing the big, fragmented efforts in future.

Secondly, information on the performance of novel types of cements should be distributed through workshops, publications and conferences. If TCs, on national and CEN level, are provided with sufficient evidence that novel cement types meet requirements for a given exposure class, such information could be included in the standard itself. This would take the responsibility off of the individual practitioner and enable wider use.

3.3 Admixtures

Questions related to cement admixtures were covered in section 4 – *Concrete Admixtures*. Only three survey respondents chose to answer this section, those being from Switzerland, Germany and Spain. Questions were as follows:

- Are you aware of any national documents such as technical guidelines or rules for implementation related to standard EN 934-2? If so, please provide details;
- Are you aware of any national documents (e.g. technical guidelines) related to standard EN 206 and concerned with concrete composition, particularly with the selection of admixtures? If so, please provide details;
- Are you aware of any national codes, policies, regulations or technical guidelines addressing the use of concrete admixtures? If so, please provide details;
- Do you perceive any legislative or technical barriers regarding the use of new concrete admixtures? If so, please provide details.

Only one response to these questions was affirmative, namely response from Spain to question 2 where EHE-08 [23] was identified. While the respondent provided no further comments, the provisions made by EHE-08 [23] were already discussed in chapter 2.2.

3.4 Surface protection

Questions related to surface protection were covered in section 5 – *Surface Protection of Concrete*. This chapter too attracted only three survey respondents, namely from Greece, Slovenia and Spain. Questions were as follows:

- Are you aware of any national documents such as technical guidelines or rules for

implementation related to standard EN 1504-2? If so, please provide details;

- Are you aware of any national documents (e.g. technical guidelines) related to EN 206 or Eurocode 2 (EN 1992) and concerned with the use of concrete coatings? If so, please provide details;
- Are you aware of any national codes, policies, regulations or technical guidelines addressing the use of concrete coatings? If so, please provide details;
- Do you perceive any legislative or technical barriers regarding the use of new concrete coatings? If so, please provide details.

There were no affirmative answers to any of these questions.

4 Conclusions

The main goal of task T7.2 *Standardisation* in WP7 of the EnDurCrete project is to identify the barriers of existing technical specifications for the implementation of developed materials and technical solutions in everyday civil and building engineering practice [3]. These materials are novel types of cement, nano-clay concrete admixture with corrosion-inhibiting properties and multifunctional coatings for surface protection of concrete.

The first level of the evaluation, which encompassed Eurocodes and national design specifications, fed into WP1 and outcomes are presented in reports D1.2-D1.3 [4]–[6]. This report covers the evaluation of EN standards, including hEN, national implementation documents of the standards and other regulatory documents and guidelines.

The evaluation was performed in two stages. In the first stage, the accessible documentation was inspected by the lead partner ZAG. In the second stage, an online survey was formulated and distributed to EnDurCrete partners and other stakeholders.

In the first stage, 15 documents were examined while in the second stage responses from 21 stakeholders from 13 different countries were analysed. These stakeholders operate across the EU/EFTA Member States. A good sample was obtained for cement related documentation with all respondents providing answers. Questions related to admixtures and coatings were answered only by three respondents from three different countries and none of them provided any new information.

Overall, the following conclusions can be drawn:

(1) The application of cement, as the component of concrete impacting structural stability and durability of concrete structures, is subjected to national regulations to a much higher degree than admixtures and coatings;

(2) The European cement standard EN 197-1 is a worldwide well-established standard covering a broad range of cement types. Following the ongoing developments, the implementation of new cement types enabling further options in reducing the clinker content in cement within that standard would be an ideal document in supporting the establishment of new products and their market introduction. However, the approval of needed changes and revision of EN 197-1 (but also of many other hEN) is blocked by European Commission for mostly formal and legal reasons. At the date of preparing this report, no short term solution of these problems is visible because very general aspects like a revision of CPR and the system of harmonized EN standards is under general discussion without clear view on the possible future approach. Before that background, a revision of hEN's like EN 197-1 seems to be unrealistic during the next years. Realizing the need for standardizing new cement types, pragmatic alternative solutions have to be found (e.g non-harmonized EN, national standards, European Technical Assessments (ETA) etc.). Furthermore, according on the current state of discussion, there is the risk that harmonized product standards following a new revised CPR do not satisfy anymore the demand on technical specifications which are needed for practical work and application of the products;

(3) While the purpose of EN and hEN standards is to address the needs of all stakeholders and thus render the need for national regulations and guidelines obsolete, in reality, CEN TCs have neither the mandate not the capacity to identify all applicable national regulations

and thus verify the completeness of the standards they issue;

(4) In terms of cement and its use in concrete, the majority of EU countries have put in place the implementation rules. These rules in several cases add to the explanation of exposure classes and either enforce or recommend the use of certain cement types for a given exposure class. In both cases, the effect is the same, as practitioners opt for safe, well-known and proven solutions;

(5) Even if national implementation rules make provisions for novel materials to be used under the equivalent performance approach, this option is rarely used in practice. Reasons are probably twofold: costs associated with testing and direct responsibility of a decision-making engineer.

Based on these conclusions the following recommendations are drawn:

(1) Once the new version of EN 197-1 (currently prEN 197-1 [26]) is implemented, CEN TC 104 should revise EN 206 [14]. It should be noted that it is not realistic according to the current status that we will get EN 197-1 revised within the next 5 to 10 years;

(2) A more common approach how to introduce new cement types into the national application documents is needed;

(3) Information related to the performance of novel materials should be made available to the members of TCs and to practising engineers. This can be done through workshops, publications and conferences. However, the information should be vetted before implementation recommendations are issued and care should be taken to eliminate pressure from circles with commercial interests.

5 References

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[4] RINA, FENIX, GEO, SIKA, and NTS, 'D1.2 Design requirements for concrete structures exposed to marine environment', D1.2, 2018.

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