Moving to performance-based cement and concrete standards in Europe

What lessons can we learn from other countries?

Brussels, February 2024

The challenge of cement decarbonisation

The cement and concrete industry is one of the most carbon-intensive industries, responsible for around 8% of global and 4% of European CO₂ emissions. The main source of these emissions is the production of Portland clinker, the main constituent from which traditional Portland cement derives its binding properties. Both at the level of cement and concrete, up to 90 percent of the embodied carbon can be attributed to traditional clinker.¹

With demand for concrete expected to further increase up until 2050, the need to decarbonise is urgent. Recent studies of the International Energy Agency (IEA) clearly show that the cement industry is “not on track” to meet its climate objectives². A similar conclusion is drawn in the State of Climate Action Report 2023³, which labels the industry as “well off track” in complying with the Paris Agreement.

Unfortunately, a similar picture emerges at the European level. Taking a closer look at both the total emissions from the industry, as well as the clinker-to-cement ratio, we see hardly any signs of decarbonisation (see figure 1 below). No structural emission reductions have been achieved – especially not in the last decade – and we see a trend of growing consumption of Portland clinker.

Considering that the clinker-to-cement ratio in Europe already sits well above the global average, much more effort will be needed to align European industry with the required 1.2% annual reductions recommended by the IEA.⁴

¹ Also known as clinker factor. This refers to the share of Portland clinker in cement. This indicator is important because clinker can be substituted by other materials without loss of performance or durability. The clinker-to-cement ratio or clinker factor can be calculated at the level of an individual cement, plant, company, or geography. In this paper, we focus on the global consumption of Portland clinker on the European market.
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With the current rate of change, European cement industry will fall short of meeting the 2030, 2040 and 2050 climate targets. Especially the lack of progress on the front of clinker substitution is problematic as this undermines the progress made in other areas, most notably in fuel switching.7

Standards as a key lever for decarbonisation

A fast-growing number of safe, scalable, and low-carbon cement and concrete technologies exist today to drive down emissions. These can be separated into two broad categories, respectively:

- Supplementary Cementitious Materials (SCMs) which allow for the replacement of (significant) shares of Portland clinker in traditional cement as well as cement in concreteii
- Other binder technologies, typically relying on different feedstock and production processes that generate fewer or no emissions compared to traditional Portland cement making.8

Importantly, there is widespread consensus that the above set of solutions are the most effective ways to achieve deep and fast emission cuts in the cement industry. According to the IPCC, it is the only readily available lever which can mitigate half of global cement emissions at near zero costs in the short term.9 A similar potential exists in Europe, as shown in recent studies.10

However, today’s recipe-based cement and concrete standards prevent these low-carbon solutions from entering the market at scale. This is because these standards – which are essential for the CE marking of construction products – are prescriptive in nature, restricting the composition of cement and concrete – both in terms of types of raw materials used as well as their respective share in cement and concrete mixes. This evidently hampers decarbonisation, as well as circularity (many low carbon solutions rely on local by-products) as legislation prevents the market entrance and uptake of these new innovations.11 Performance-based standards, in contrast, do not create such market distortions. As they only put forward performance requirements for the final product, they are technology neutral and an important driver of innovation.12

ii Depending on the market, different traditions exist as to the point at which SCMs are blended into, respectively, cement or concrete.
The current recipe-based standards are not only problematic in terms of climate protection - they also fail to provide a level-playing field for different technologies. The latter is problematic from a legal point as it conflicts with the Construction Products Regulation (CPR). Tasked with the creation of a strong internal market for construction products, the CPR lays down the rules for the marketing of products. According to the regulation, this needs to follow a performance-based logic, relying on standards which define the “harmonised rules on how to express the performance of construction products” (art. 1). This is widely praised by stakeholders, as it offers both “an excellent regulatory framework of product performance and guarantees a level playing field in the European market”\(^{13}\). In other words, the CPR – which has been in place for more than a decade – also forces European standardisation bodies to move away from prescriptive standards, finally creating the legal framework for a true internal market for cement and concrete in Europe. With the industry being a key driver of climate change, the time to act is now.

**Lessons from other countries**

Europe is in urgent need of performance-based cement and concrete standards. The ongoing CPR acquis process on cement offers a unique opportunity to tackle this challenge head on, turning existing cement standards into a driver of decarbonisation in compliance with the performance-based approach of the CPR.

Several countries have already made this transition. These findings are the result of desk research, interviews, and a literature study, conducted both by ECOS staff and cement and concrete experts. The following countries – and national standards – have been selected as particularly relevant for the ongoing reforms in Europe:

- **United States (ASTM C-1157)**: the US has a long tradition of performance-based cement standards, going back to 1992 when ASTM C-1157 was first developed. This is a **performance-based cement standard for hydraulic cements**. It exists alongside two prescriptive cement standards (ASTM C-150 and ASTM C-595), for hydraulic and blended cements respectively. The US system qualifies as a so-called **hybrid system (or dual approach)**. This comes with several drawbacks linked to the complexity of such a system. While ASTM C-1157 has proven its merits over time for the marketing of innovative/low carbon cements, the standard is not used widely. The US National Ready Mix Concrete Associations point out that the construction sector is characterised by many legacy project specifications which only list ASTM C150 (Portland cement) as project specifications are rarely updated.\(^{14}\) This is also why we see a growing trend in the US for **performance-based procurement**, e.g. by Departments of Transportations, as well as ongoing efforts to develop **performance-based standards for Supplementary Cementitious Materials** to both remedy the inertia of existing prescriptive standards and reduce the complexity of the existing system.\(^{15}\)

- **Canada (CSA A23.1)**: Canada has had a **performance-based approach** to concrete standards since 2009. According to CSA A23.1, concrete needs to be specified either completely by prescription or performance. If a buyer/owner opts for a prescriptive approach, they carry the full responsibility for the product. As a result, the Canadian concrete market is **de facto a performance-based one**, with a very limited number of projects still relying on prescriptive specifications. **Prior to the current situation, Canada followed a hybrid approach**, combining prescriptive and performance-based approaches at both the level of cement and concrete standards. **This approach was abandoned as it created an overly complex market**, with a lot of confusion about responsibilities between the different actors of the value chain.\(^{16}\)
• Colombia (NTC 121): In 2021, a new performance-based cement standard (NTC 121) was adopted in Colombia, marking the transition from a prescriptive to a performance-based regulatory system. ASTM C-1157 served as a blueprint for the new standard. The adoption of the new standard should be seen against both a long-standing culture of using low-clinker cements and SCMs in Colombia, as well as a desire to tidy up the increasingly complex prescriptive-based landscape. The transition to a performance-based system did not cause any market problems. A take-away from the Colombian case is that educational training on the key aspects and advantages of performance-based specifications is useful to maximise the full potential. It is widely perceived that the NTC 121 will allow Colombian industry to further lower its clinker factors in the short-term, which is highly relevant as the country today has one of world’s lowest clinker factors.17

• Ecuador (NTE INEN 2380): the shift to a performance-based cement system was already made in 2012 with the adoption of NTE INEN 2380, which is almost identical to ASTM C-1157. This makes Ecuador a very relevant case to assess the long-term impact of such a shift. An important finding is that manufacturers are incentivised to innovate and explore alternative green(er) cements. Cement producers, for example, have designed plants to operate with various clinker substitutes. Apart from lowering the industry’s footprint, this has contributed to a more resilient industry which can quickly adapt to changing market expectations and resource fluctuations. This responsiveness is seen a key advantage over prescriptive standards in the literature.18

• El Salvador (PNTS 91.86.01): in 2014, El Salvador shifted to an entirely performance-based system with the adoption of PNTS 91.86.01, inspired by ASTM C-1157. No market distortions were reported and the national cement market is perceived as performing well, producing cements at a competitive price in comparison to other countries in the region.19

• Guatemala (NTG 41095): inspired by ASTM C-1157, Guatemala transitioned from a prescriptive to a performance-based system in 2018 with the adoption of NTG 41095. The transition went smooth and in general Guatemala has a strong tradition of low-clinker cement plants. Furthermore, in contrast to other countries and regions, it has been an early adopter (and innovator) of innovations such as calcined clays, amongst others because the standards offered the space for innovation.20

• Peru (NTP 334.009/082/09): While formally the country still has a hybrid approach, with both prescriptive and performance-based cement standards, cement production in practice is increasingly following a performance-based approach. In doing so, the example set by ASTM C-1157 is followed. The main reason for this is – on top of accelerating decarbonisation – a general desire to increase the quality of construction works.21 According to Peruvian standardisation bodies, a transition to performance-based cement standards is needed to better protect consumers and ensure market fairness. Furthermore, the Peruvian cement market shows a rapid reduction of the clinker factor in recent years, and industry considers a performance-based approach as a key lever in reducing its footprint.22

In addition to the above list, a fast-growing number of countries are currently transitioning to a performance-based system. Most notably Mexico, with a cement industry advocating in favour of adopting a performance-based approach, inspired by the example set by other Latin American countries and ASTM C 1157.
Equally relevant is a growing debate within African countries, most notably Sub-Saharan Countries on the limitations presented by European cement and concrete standards. African standards have historically followed European prescriptive standards. In growing markets that have understood the need to decarbonise, there is increased appetite to move away from the European model unless European standards will at last transition to performance-based ones. These signals should not be taken lightly. At a time when Europe aspires itself a role a global standard-maker, it is key to have solid standards in place.

Key lessons from these countries for the ongoing work in the CPR acquis WG on cement:

- Many countries have **successfully transitioned from a prescriptive to a performance-based system, without creating market distortions**. Given that almost all European cement companies are active on global scale, including in the markets listed above, it is fair to assume that all of them have extensive expertise in operating in performance-based systems.

- **Hybrid systems** – referring to countries with prescriptive and performance-based standards exist alongside each other – are **evaluated as overly complex and underperforming**. For this reason, many hybrid systems are transitioning to performance-based systems.

- **Performance-based cement and concrete standards are a key driver of innovation.** It is noteworthy that many of the studied countries already have a strong tradition of clinker substitution, as reflected by their low clinker factors. Nonetheless, a shift to performance-based standards and specifications was deemed necessary to spur further innovation and decarbonisation of the industry. Therefore, if Europe continues to aspire itself a leading international role in standard setting and the development of low-carbon cements, it needs to lift prescriptive standards in a timely manner.

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5 EEA - emissions trading viewer - consulted on 12 January 2024.
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What lessons can we learn from other countries?

21 Dirección de Normatividad, (2020). Reglemento Técnico sobre Cemento Hidráulico utilizado en Edificaciones y construcciones de Concreto en General - Exposición de Motivos