

## Alternative binders

Reducing the environmental impact of concrete and combating climate change is becoming increasingly urgent. With rising cement prices, it is also lucrative to apply alternative binders. In this one-pager, we outline the pros and cons of three alternatives. We use, among other things, the CO<sub>2</sub> impact and the MKI (environmental cost indicator). The CO<sub>2</sub> impact directly leads to climate change, and the MKI encompasses all environmental effects in one score, expressed in euros.

### Pros and cons of (cementtypes with) alternative binders

Below are the pros and cons of alternatives binders, with Portland cement (CEM I) as the reference.

#### CEM II / CEM III/A

- + Lower CO<sub>2</sub> emissions (20% to 50% reduction possible)
- + No adjustments in the production process
- + Can also be used for medium to high strength classes
- + Ultra-high frost-thaw salt resistance
- Availability depends on by-products and the steel industry

#### CEM III/B

- + Lower CO<sub>2</sub> emissions (40% to 60% reduction possible)
- + Relatively few adjustments in the production process
- + High frost-thaw resistance
- + Suitable for preventing alkali-silica-reaction or sulfat attack
- Availability depends on by-products and the steel industry
- More difficult to apply with initial strength requirements

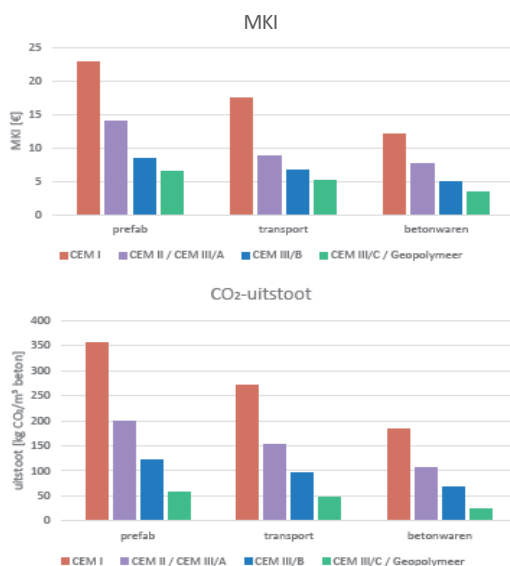
#### CEM III/C / Geopolymer

- + Very low CO<sub>2</sub> emissions (60% to 85% reduction possible)
- + CEM III/C has the same workability as Portland cement (except self-compacting)
- Different shrinkage, creep, and cracking behaviour
- Not yet standardized (innovative phase)
- Adjustments needed in the production process
- Less frost-resistant
- Availability depends on by-products and the steel industry

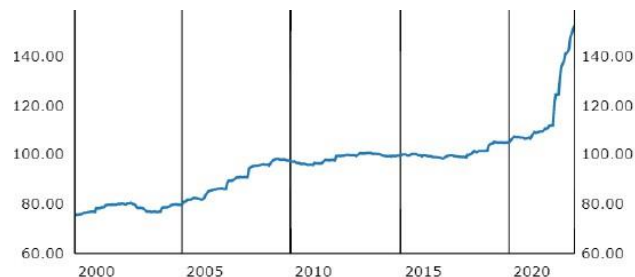
The European Central Bank has outlined the price increase in €/ton of Portland cement from 2000-2022 in the graph (right). Prices are expected to rise further due to increasing CO<sub>2</sub> taxes or costs for CO<sub>2</sub> capture.

1e graphic: effect on CO<sub>2</sub> emissions and the MKI

2e graphic: CO<sub>2</sub> emissions



Price development of cement



Graph assumptions (left)

- Values are based on leading values
- CO<sub>2</sub> is expressed in kg per m<sup>3</sup> of the introduced concrete mix, MKI is expressed in €
- For concrete products, 200 kg of binder is used with standard industry sand and gravel
- For ready-mix concrete, 300 kg of binder is used with standard industry sand and gravel
- For precast concrete, 350 kg of binder is used with standard industry sand and gravel
- CEM I = 100% Portland cement
- CEM III/A = 36-65% Portland cement and 35-64% blast furnace slag/fly ash/limestone powder
- CEM III/C / Geopolymer = 0-19% Portland cement and 81-100% blast furnace slag + alkaline activation



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