CEMENT: CIVILIZATION WOULD BE NOTHING WITHOUT IT

Issues

- **Cement is a foundational infrastructure material.** *Cement underpins transportation networks, buildings, water systems, and energy infrastructure, including dams, thermal and nuclear facilities, and wind and solar foundations.*
- **Concrete structures are durable and economical.** *Few materials have all the characteristics of cement and concrete that make them so useful, durable, and economical at such large scale.*
- **Responsible mining, manufacturing, and innovation.** *Producing cement relies mainly on limestone plus silica-, alumina-, and iron-bearing materials. Kiln calcination forms clinker, which is then ground with gypsum to a very fine powder.*
- **Production is economical, but resource- and energy-intensive.** *Although cement has been used for centuries, opportunities remain to improve energy efficiency and water use and to reduce environmental impacts. This important material should be continuously evaluated for opportunities to improve.*

Background

Cement has supported industrial and economic development for millennia. Its predominant use is in concrete, which surpasses all other human-made materials in global volume. Early civilizations in the Middle East used hydraulic lime to build durable, waterproof underground cisterns. The Romans later advanced concrete by combining lime, aggregate, and volcanic ash to create enduring structures such as the Pantheon dome without steel reinforcement.[1, 2]

Cement is indispensable to modern living standards and economic progress, although environmental impacts remain part of cement production. Because of its importance, reducing impacts is more practical than curtailing production. Cement is a hydraulic binder that hardens; when combined with aggregates, water, and additives such as gypsum, it forms concrete. Concrete can be formed into nearly unlimited shapes and cut after curing, making it a highly versatile construction material. Calcium silicates formed during curing largely control strength and durability, supporting long service life in harsh environments.[3]

Production

Producing cement requires power, heat, and water and generates carbon dioxide, dust, and land disturbance from mining raw materials. Mitigation methods include dust capture and control, progressive mine reclamation, and water recycling. Additional innovations continue to be pursued:

- *Manufacturing efficiency has improved steadily over decades. Dry processing, equipment upgrades, precalciner kilns, and waste-heat recovery units have reduced fuel use and increased output.*
- *Decarbonization through increased use of supplementary cementitious materials can reduce clinker content.*

- *Other opportunities include improved fuel efficiency, alternative fuels, carbon capture, utilization and storage, alternative binders, expanded recycling, reclaimed concrete aggregates, and design for deconstruction.*
- *Mining activities support regional economies, especially in rural areas. According to the U.S. Bureau of Labor Statistics, mining and quarrying occupations often pay above median local wages and provide stable employment in sectors requiring skilled labor. Equipment suppliers, maintenance services, transportation networks, and local commerce also benefit. Raw-material and distribution locations influence the success of downstream construction.*
- *Policy considerations that may help address environmental concerns include carbon pricing, research incentives for next-generation materials, standards for alternative materials and binders, and international collaboration.*

SME Statement of Technical Position

- *Mining and production of cement and concrete are economic engines. These activities provide jobs, often in rural areas, support regional economies, strengthen regional economic competitiveness, and build essential infrastructure.*
- *SME supports the evolution, not curtailment, of cement production. Because of cement's widespread global use and economic importance, improving mature production and use technologies can significantly reduce environmental impacts.*
- *Responsible mining, manufacturing efficiency for cement and concrete, and product innovation can deliver significant global benefits.*
- *Research into alternative binders and emerging materials and methods holds promise for lower-emission products. Recycling materials from old pavements and structures for use as aggregates conserves raw materials and reduces quarrying demand.*
- *Carbon dioxide emissions are significant but addressable. Alternative fuels, fuel efficiency, dust control, and carbon capture provide substantial opportunities to improve emissions performance.*
- *Water recycling and dry cement processing support water conservation and reduced energy consumption.*
- *Policy can accelerate decarbonization. Recommended approaches include carbon pricing, research incentives, and guidance on the use of alternative materials. Policymakers should recognize the economics and life-cycle characteristics of cement, concrete, and alternative materials when developing policy.*

References

1. *International Energy Agency. (2022). Cement - Analysis. https://www.iea.org/reports/cement*

2. *CEMEX USA. History of Cement and Concrete. https://www.cemexusa.com/w/history-of-cement-and-concrete*

3. *Mindess, S., Young, J. F., & Darwin, D. (2003). Concrete (2nd ed.). Prentice Hall.*

4. *U.S. Environmental Protection Agency. (2021). U.S. Cement Industry Carbon Intensities. https://www.epa.gov*

5. *U.S. Bureau of Labor Statistics. (2023). Occupational Outlook Handbook: Mining and Geological Engineers.*