

Industry Assessment

Technical Brief

Lead Authors

Jason H. Ideker
Chris Ferraro
W. Jason Weiss
O. Burkan Isgor

Lead Institutions

Oregon State University
University of Florida

Supporting Institutions

Rutgers University, Center
for Advanced Infrastructure
and Transportation

New Jersey Institute of
Technology



Office of the
Assistant Secretary
for Science and
Technology (OST-R)

The Use of Slag as Feedstock for Clinker and/or Cement Production

Overview

This technical brief discusses the potential for iron or steel slag to be used as feedstock for clinker and/or cement production. Clinker production refers to the use of raw materials (usually rich in calcium, silica, and alumina) as part of the feedstock that goes into a rotary kiln and is heated to approximately 1450C. Cement is then produced by grinding clinker with gypsum. Cement may also be further processed by interblending or intergrinding with materials like limestone, fly ash, bottom ash, or blast furnace slag.

Key Takeaways

- In general steel slag can be used as a feedstock for producing clinker.
- Modest replacement amounts of steel slag for use in clinker production (e.g. 10-15%) produce a cement with similar performance to cement produced without steel slag as feedstock.
- The presence of iron in steel slag may lead to increased initial and final setting times of cement produced with this clinker.
- Compressive strengths are comparable to clinker produced without steel slag as feedstock.
- Processing of steel slags to remove iron or separate into finer size fractions can help improve its suitability for clinker feedstock. This varies based on the type of slag produced.
- The location of steel slag co-products can be a limiting factor as the transportation cost to a clinker production facility can be limiting.

Slag as Feedstock

Table 1 shows select raw materials in metric tons used as feedstock for clinker or cement production in 2022 and 2023 in the United States. The most used material containing calcium was limestone for both clinker and cement production at over 100,000 metric tons in both 2022 and 2023. Whereas the most used materials containing silica were sand, calcium silicates, fly ash, and other ash sources including bottom ash totaling under 7,000 metric tons in both years. Other materials including blast furnace slag, steel slag, and other slag were used to produce clinker.

USDOT Steel Slag Initiative

Industry Assessment

The Use of Slag as Feedstock for Clinker and Cement Production

August 2026



Office of the
Assistant Secretary
for Science and
Technology (OST-R)

While slag products were used as feedstock for either clinker or cement, the relative amounts were much lower than limestone or sand. Ground granulated blast furnace slag (GGBFS) was used mainly for cement production (slag cement) – though in 2023, one (1) metric ton was allocated to clinker. Steel slag was used in clinker production at 365 metric tons and 180 metric tons in 2022 and 2023, respectively.

Table 1: Raw materials used to produce clinker and cement in the United States in thousands of metric tons

values in thousands of metric tons for select feedstock materials	2022		2023	
	Clinker	Cement ^{&}	Clinker	Cement ^{&}
Limestone (aragonite, chalk, coral, marble)	108000	6060	107000	7110
Sand, calcium silicates	3360	--	3130	--
Fly ash, other ash (including bottom ash)	3590	94	3350	--
Granulated blast furnace slag*	--	213	1	143
Other blast furnace slag	200	--	180	--
Steel slag	365	--	274	--
Other slag	207	--	200	--

*includes ground and unground material

[&] includes portland, blended, and masonry cements.

Source: <https://www.usgs.gov/centers/national-minerals-information-center/cement-statistics-and-information>

Slag for use in Cement Production

Iron Slags

- Blast furnace slag can be used as kiln feed and 180 metric tons was used for this purpose in 2023. If blast furnace slag is rapidly cooled and finely ground it makes a reactive cementitious material known as ground granulated blast furnace slag (GGBFS) or slag cement. This material reacts in a hydraulic manner (like portland cement). It has been used extensively in concrete for many decades as a replacement for portland cement.

Steel Slag

Steel slags have not been used extensively in cement production due to their low reactivity even when finely ground.

- Ladle slag – While ladle slag may be low in iron (a positive), the soundness of the material is of concern for use as a supplementary cementitious material.

USDOT Steel Slag Initiative

Industry Assessment

The Use of Slag as Feedstock for Clinker and Cement Production

August 2026

Slag for use in Clinker Production

Iron Slag

- Blast furnace slag – This material’s composition (rich in CaO, SiO₂, Al₂O₃) is suitable for feedstock for clinker. In 2022, 200,000 tons were used for clinker production. However, this is relatively small compared to other materials.

Steel Slag

- Electric Arc Furnace (EAF) slag – has been used as feedstock to produce clinker. The free lime (CaO) content is important as too high an amount can lead to expansion which results in cracking, loss of material, and reduced integrity.
- Ladle slag – Limited studies have shown the potential for ladle slag to be used as feedstock for clinker in replacement amounts as high as ~40%. It may serve as a low-cost aluminate-bearing kiln feed component because it contains calcium aluminate phases and Al₂O₃, allowing it to partially replace higher-cost alumina sources such as bauxite, provided that its MgO, sulfur, alkalis, chloride/fluoride, moisture, and compositional variability are controlled.
- Basic Oxygen Furnace (BOF) slag – Magnetic separation can be used to remove a significant portion of the iron present in BOF slag. Provided this is done effectively, this can be a suitable feedstock material to produce clinker. Optimization of other components of the feedstock (e.g. limestone) should also be done to maintain performance in the final cement produced.
- Stainless and specialty steelmaking slags – Ladle slag from stainless steel manufacture has potential as a feedstock material for clinker production. However, the chromium content may present challenges. Separation can provide a low-cost, low-environmental impact beneficiation that provides better feedstock material. Replacement levels of up to 14% stainless steel ladle slag showed increased setting times but comparable compressive strength of concrete made from cement produced with this clinker.



Office of the
Assistant Secretary
for Science and
Technology (OST-R)

This brief summarizes findings on the Slag as Feedstock for Clinker and Cement Production as part of the Industry Assessment for USDOT-SLAG, “Research Initiative on the Use of Steel Slag in Concrete and Cement” under cooperative agreement 693JK42550005. Information supporting these findings can be found at: <https://cait.rutgers.edu/usdotsteelslag/>. Inquiries about this work can be sent to: usdotsteelslaginitiative@rutgers.edu.