

Valorisation of EAF and BOF slags: next-generation feedstock

As traditional SCMs become more difficult to source, new feedstocks are needed to replace them and ensure sustainability. Extensive simulation and testing suggests Cemvision's valorisation process can unleash the potential of newer SCMs.

■ by **Cemvision**, Sweden

The global cement industry continues to face an acute challenge: how to reduce CO₂ emissions from clinker production while maintaining material performance and supply stability. For decades, supplementary cementitious materials (SCMs) such as fly ash and ground granulated blastfurnace slag (GGBS) have provided an effective route to lower clinker content and, in turn, reduce the CO₂ footprint of cement. Yet the availability of both materials is now in steep decline as coal-fired power and traditional blastfurnace steelmaking give way to cleaner technologies.

The rise of electric arc furnace (EAF) steelmaking – which relies primarily on recycled scrap, DRI/HBI, and renewable electricity – is producing a different class of metallurgical by-products. These slags, rich in calcium, silicate and aluminate phases, represent an untapped opportunity to close the loop between steel and cement production, and fill the void left by the phase-out of fly ash and GGBS. With proper processing, they can become high-performance SCMs capable of replacing clinker at scale while helping steel mills achieve full circularity.

Cemvision's process transforms EAF into a high-quality SCM



EAF slag is emerging as a viable alternative to GGBS



EAF slag differs from blastfurnace slag in several key aspects. Its composition can vary with input scrap quality and furnace operation, and its cooling and solidification history strongly affects its mineralogy. Paired with a very high FeO content, these factors have historically limited its use in cement, as raw EAF slag may contain unstable phases such as free lime or periclase, which can lead to volumetric

expansion in hardened systems. Therefore, the technical challenge lies in removing the metals, stabilising the slag and unlocking its latent hydraulic potential.

Benefication

Recent advances in

slag beneficiation have demonstrated that these obstacles can be overcome. Controlled re-heating and conditioning of EAF slag, combined with granulation or rapid cooling, promote the formation of a fine-grained glassy matrix similar to that of GGBS. In parallel, re-melting and metal recovery steps allow for the removal of excess iron and the stabilisation of reactive silicate and aluminate phases. The resulting material exhibits both chemical and physical characteristics suitable for use as an SCM in blended cements and as feedstock in Cemvision's Re:ment products.

The concept of slag valorisation is central to future-proofing the steel industry. The days are gone when steel producers could generate hundreds of thousands of tonnes of residues destined for landfill. Today, securing environmental permits requires a clear strategy for resource recovery and circularity. By recovering valuable metal fractions and transforming the remaining non-metallic portion into a high-reactivity, amorphous

material, steel mills can turn what was once an industrial waste or byproduct into a valuable secondary raw material for low-carbon construction.

In pilot-scale testing, valorised EAF slag has shown a glass content of around 97–99 per cent and reactivity values exceeding 500J/g (ASTM C1897-20 R³ test), performance comparable to, or better than, high-quality blast-furnace slag. These results confirm that the “glassy”, amorphous phase formed through controlled processing provides the necessary reactivity for cementitious hydration.

Compressive strength testing under EN 197-1 conditions reinforces these findings. Blended cements containing valorised EAF slag (CEM III-type formulations) achieved 5.4MPa after one day, 12.6MPa after two days, 43.7MPa after seven days and 58.5MPa at 28 days. This corresponds to a Slag Activation Index (SAI) of approximately 112 per cent (Grade 120) relative to a CEM I reference cement.

Comparable trials using basic oxygen furnace (BOF) slag yielded an SAI of 105 per cent. This demonstrates that, once stabilised, both EAF and BOF slags can achieve or surpass the reactivity thresholds required for use as high-grade SCMs.

Long-term durability

Beyond mechanical performance, the hydration behaviour of valorised slag exhibits favourable kinetics. The fine amorphous phase ensures rapid nucleation of calcium silicate hydrates (C-S-H) and calcium aluminosilicate hydrates (C-A-S-H), resulting in dense microstructures and refined pore systems. These characteristics improve long-term durability, including resistance to sulphate attack and chloride ingress, while maintaining consistent workability and setting behaviour in concrete mixes.

From a process standpoint, the valorised slag can be ground efficiently using existing ball mills or vertical roller mills. Grinding energy demand aligns closely with that of GGBS and target fineness levels are achieved without abnormal wear or process modifications. This operational compatibility is critical to enabling widespread industrial adoption.

The circular potential of this approach extends beyond cement performance. By integrating slag beneficiation directly into steel mill operations, the process enables recovery of metallic fractions – up to 97 per cent of the iron content – which are

Figure 1: Cemvision’s beneficiation process upcycles EAF and BOF

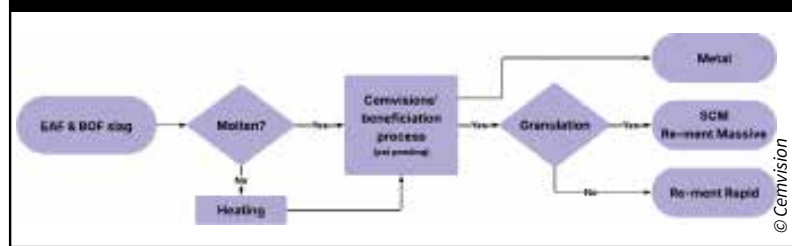


Figure 2: reactivity and glass content of valorised EAF and BOF using the Cemvision process

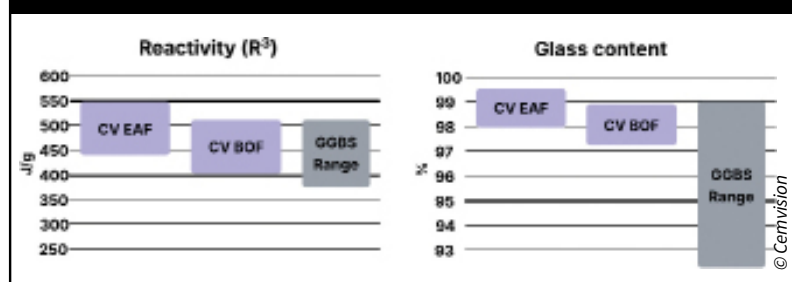


Table 1: performance of valorised BOF and EAF relative to reference cement

Binder	1d (MPa)	2d (MPa)	7d (MPa)	28d (MPa)	SAI (%)
CEM I	13.7	26.4	41.9	52.4	100
CV BOF (CEM III)	7	16	36.9	54.9	105
CV EAF (CEM III)	5.4	12.6	43.7	58.9	112

reintroduced into the melt shop for new steel production. The remaining non-metallic fraction becomes a consistent, glass-rich SCM feedstock. This closed-loop model effectively transforms steelmaking residues from a disposal liability into a valuable construction resource.

Such integration can fundamentally reshape the material relationship between the steel and cement industries. As next-generation steel plants shift toward EAFs powered by renewable energy, their by-products can directly feed low-carbon cement production, reducing the need for newly-quarried raw materials such as limestone and clay. Each tonne of slag diverted to this pathway contributes to circularity, lowers CO₂ emissions from clinker manufacture and reduces industrial waste volumes.

Scalability and optimisation

Thermodynamic simulations and pilot-scale trials have confirmed the reproducibility of this process. Between 2023 and 2025, multiple trials have validated the slag transformation route and its scalability. Continued testing under industrial conditions aims to further optimise energy input and cooling profiles

to maximise glass-phase formation while ensuring optimal product chemistry and metal recovery efficiency.

This work represents an important bridge between metallurgical process engineering and cement materials science. By applying beneficiation and phase control techniques traditionally confined to metal production, the pathway opens a new class of SCMs derived entirely from recycled industrial by-products.

In essence, valorised EAF slag can serve as a post-blastfurnace-era feedstock – a high-quality, low-carbon material produced in tandem with circular steelmaking. Its adoption will help decouple cement decarbonisation from fossil-dependent industries and provide a scalable route toward meeting global CO₂ reduction targets.

As the steel industry continues its transition to electrified, scrap-, DRI/HBI-based production, the volume of available EAF slag will rise steadily. With beneficiation processes now able to stabilise and activate this material, the next generation of steel mills will not only produce green steel but also enable the creation of green cement, forming a truly circular industrial ecosystem. ■