INVICTA
CEMENTITIOUS SOLUTIONS

Invicta Terminal, Great Basin Road, Port of Sheerness, Kent ME12 1RS
01795 418630 | invictasolutions.co.uk

Ground Granulated Blast Furnace Slag, GGBS

Invicta GGBS is produced for the ready-mixed concrete and concrete product industries. GGBS is used in concrete, mortar, and grout as a part of the cement to enhance both fresh and hardened properties. Invicta GGBS is manufactured and supplied in accordance with BS EN 15167-1, the European standard for ground granulated blast furnace slag.

Manufacture
Blast furnace slag is a by-product of iron manufacture. Iron ore, limestone and coke are fed into a blast furnace that operates at temperatures around 1500°C. The molten iron is tapped off to be further processed into iron and steels production. The molten slag, the raw material for GGBS, is rapidly quenched producing a granulate. The rapid cooling produces a glassy material with optimal cementitious properties when dried and ground to a fine powder.

Reducing the carbon footprint of the concrete.
Based on MPA Cement Fact Sheet 18 values when 40-60% GGBS is used to replace CEM I in cement, the carbon dioxide equivalent, CO_2e, emissions of concrete may be reduced by 30-50%. The use of the 70-80% GGBS may enable CO_2e emission to be reduced by as much as 65%.

Enhanced durability – chloride ingress
GGBS concrete is significantly more resistant to chloride diffusion than Portland cement concrete of the same nominal strength. Reinforced concrete structures exposed to chloride ingress, such as marine works, highway structures and car parks, benefit as this increases the design working life.

Enhanced Durability – sulfate attack
Sulfates in ground water can attack concrete.The use of GGBS in concrete reduces permeability to sulfate and also decreases the hydration phases that are susceptible to attack. Limiting values of composition and properties of concrete to resist sulfate attack are given in BS 8500-2, and comprehensive background and guidance is set out in BRE Special Digest 1 *Concrete in aggressive ground*.

Enhanced durability – resistance to alkali silica reaction, ASR.
Alkali silica reaction is where excess alkalis react with certain aggregates in the presence of moisture to form an expansive product that may result in cracking. In accordance with BS 8500-2 for normal reactivity aggregates the alkali equivalent, Na_20eq shall be less to than or equal to 3.5 kg/m^3. For high reactivity aggregates the limit is less to than or equal to 2.5 kg/m^3. Where a combination of 40% or more GGBS is used with Portland cement then the alkali contribution from the GGBS is considered zero, and therefore using GGBS means that keeping the Na_20eq content less to than or equal to 2.5 kg/m^3 is readily achievable.

Thermal Cracking
The hydration of cement incorporating GGBS evolves less heat than that generated by Portland cement. The use of GGBS, particularly at 70% of total cement, can significantly reduce the temperature rise in thick sections of concrete. The reduction in temperature reduces temperature gradients and so minimises the risk of differential early age thermal shrinkage and associated cracking.

Curing
Adequately cured GGBS is generally more durable than the same strength class of Portland cement concrete. The water in GGBS concrete takes slightly longer to combine chemically to form hydration products makes GGBS concrete more sensitive to lack of curing. However, properly cured GGBS concrete continues to gain strength after 28 days so although the early age strength is below that of Portland cement concrete it can result in higher strengths at later ages.

Improved surface finish of the completed structure.
Compared to Portland cement concrete, GGBS concrete hardens to a lighter colour than Portland cement concrete or fly ash concrete.

Workability
Fresh concrete containing GGBS has improved plastic properties. For the same slump, GGBS concrete can exhibit a greater flow value than Portland cement concrete. As the setting time of GGBS based cements is greater than Portland cement then consistence retention will be increased with greater potential for bleed, although the rate of bleed is normally lower due to the fineness of GGBS.

Admixtures
The chemical composition of GGBS has many similarities with Portland cement, as shown in the table, and is compatible with all common chemical admixtures used to enhance the properties of concrete, mortar, and grout.

Oxide composition	GGBS	Portland cement
Calcium, CaO	35-45	60-70
Silicon, SiO2	30-40	17-25
Aluminium, Al2O3	11-13	3-8
Iron, Fe2O3	0-2	0.5-0.6
Magnesium, MgO	5-9	0.5-4
Alkalis, Na2Oeq	0.5-0.7	0.3-1.2

Applications
Invicta GGBS may be combined with CEM I, CEM II/A-L or LL, or CEM III/A in accordance with the conformity procedures for combinations specified in **BS 8500-2**. These combinations produce cementitious binders with equivalent performance to **BS EN 197-1:2011**, **BS EN 197-5**, and **BS EN 14216** cements of the same nominal proportions.

Certification
Invicta GGBS holds UKCA certification in compliance with the Construction Products (Amendment etc.) (EU Exit) Regulations 2020, ensuring independent third-party verification of product conformity. Quality is maintained by systematic statistical monitoring, involving regular testing of autocontrol samples collected at each GGBS production site.

Technical guidance
MPA Cement Fact Sheet 18. Embodied CO_2 of UK cements. April 2025.
BRE Special Digest 1:2005. Concrete in aggressive ground. Building Research Establishment.
BRE Digest 330: 2004. Alkali-silica reactions in concrete.

- Part 1 Background and guidance notes.
- Part 2 Detailed guidance for new construction.
- Part 3 Worked examples.
- Part 4 Simplified guidance for new construction using normal reactivity aggregates.

Technical Standards
BS EN 15167-1: **2015** Ground granulated blast furnace slag for use in concrete, mortar and grout — Part 1: Definitions, specifications and conformity criteria for ground granulated blast furnace slag.
BS EN 197-1:**2011** Cement - Part 1: Composition, specifications and conformity criteria for common cements.
BS EN 197-5: 2021 Cement - Part 5: Portland composite cement CEM II/C-M and Composite cement CEM VI.
BS EN 14216: 2015 Cement - Composition, specifications and conformity criteria for very low heat special cements.
BS 8500-2:2023 Concrete - Complementary British Standard to EN 206. Part 2: Specification for constituent materials and concrete.

Manufacturing Standards
Invicta products are supplied in accordance with BS ISO 9001, BS ISO 14001 & BS OHSAS 18001.

Logistics
Invicta supplies Fly Ash to its national customer base in pressurised road tankers.

COSHH data
Materials Safety Data Sheet on Invicta GGBS is available on request.

Technical support
Contact details:
A: Invicta Terminal, Great Basin Road, Port of Sheerness, Kent, ME12 1RS
T: 01795 418630
E: info@invictasolutions.co.uk

Invicta is the trading name for Brett Nova UK Limited, a joint venture between Medcem and Brett Group