GGBS

by FRANCIS FLOWER

TECHNICAL DATA SHEET

WHAT IS GGBS?

Ground Granulated Blastfurnace Slag (GGBS) from Francis Flower is a partial cement-replacement which is manufactured from a by-product of the iron and steel industry.

GGBS is mainly used in the production of ready-mix concrete, pre-cast concrete, cement-based formulations and soil stabilisation. However, across the world there are many other diverse applications of GGBS.

The manufacture of GGBS produces less than 10% of embodied CO_2 compared to CEM I production. With GGBS able to replace more than 70% of the Portland cement content in a concrete mix, it significantly improves the environmental credentials of a mix, without compromising on quality.

GGBS is manufactured by grinding Granulated Blastfurnace Slag (GBS), a by-product of the iron making industry. GBS is formed in the blast furnace which has an operating temperature of over 1500 °C. A controlled blend of coke, iron ore and limestone are fed and a chemical reaction takes place between the three constituents to form iron. The iron sinks to the bottom of the furnace and a molten crust forms on top, called iron slag. At regular intervals the slag and molten iron are tapped off and separately drawn away from the blast furnace. Once removed from the furnace the slag is "quenched" to below 800°C by jetting it with cold water, forming granulated blastfurnace slag (GBS), a glassy, sand like material.

By drying and carefully milling the GBS through our grinding plant in Scunthorpe, we produce the off-white powder that is Scunthorpe GGBS.

TYPICAL CHEMICAL COMPOSITION OF FRANCIS FLOWER GGBS

SiO_2	Al_2O_3*	Fe_2O_3	CaO	MnO	TiO_2	S^{2-}	SO_3	Cl
36	12.5	0.5	40	0.5	0.9	0.8	0.1	0.02

*Francis Flower GGBS Alumina content does not exceed 14% qualifying it for use in +SR (Sulfate Resisting) with all CEM I cement combinations according to BS 8500-2.

TYPICAL PHYSICAL CHARACTERISTICS OF FRANCIS FLOWER GGBS

Activity Index		Glass Count	Fineness	Initial Setting	Relative	Bulk	Brightness
7 day	28 day	%	m^2/kg	Time mins	Density g/cm^3	Density Mg/m^3	L* Whiteness
63	85	90-100	490-540	180-220	2.9	1.033	80-90 %

Contact

t: +44 (0)800 2229111
e: ggbs@francisflower.co.uk
w: www.francisflowerggbs.co.uk

Francis Flower (Northern) Ltd,
Brigg Road, Scunthorpe
North Lincolnshire, DN16 1AW

Francis Flower (Northern) Ltd,
Percival Lane, Runcorn,
Cheshire, WA7 4UY

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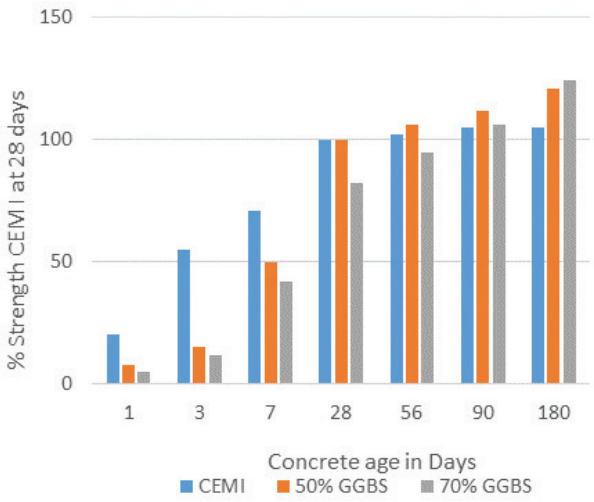
WHY USE GGBS?

GGBS has many benefits including its durability, sustainability and environmental credentials making it regularly a specified product used on projects by architects, structural engineers and project stakeholders.

- Pale colour gives an aesthetically pleasing appearance, which is also easier to pigment
- Resistance to sulfate and chloride chemical attack when specified in accordance with BS 8500-1, helping to improve the lifetime of structures
- Reduces the potential damage caused by alkali–silica reaction
- Reduced heat of hydration (reducing the risk of thermal cracking)
- Extended setting time (allowing for larger pours and reduced risk of cold joints especially in warmer weather)
- Strength gain is continued over longer periods of time, giving higher ultimate strengths (see graph 1)
- Lower environmental impact by producing low CO_2e concrete, with reduced mineral extraction
- Better workability helping concrete placement



Graph 1 - Comparative Strengths of CEM I, 50% and 70% GGBS Concretes

USING GGBS AS A CEMENT REPLACEMENT

GGBS is sold by Francis Flower as a separate product but can be added to concrete in the concrete manufacturer's batching plant along with CEM I, aggregates, water and admixtures.

The normal ratios of aggregates and water to cementitious material in the mix remain unchanged, but due to the slightly different chemistry admixture dosages (especially superplasticisers) may need to be adjusted.

GGBS directly replaces the CEM I by weight, although due to the slower strength gain, total powder contents may need to be increased with higher addition levels if 28 day strengths are the requirement. Addition levels for GGBS are usually between 6% to 70% and sometimes beyond in specialist applications. Typically 40% to 50% CEM I replacement is used in most ready-mix applications.

Cement Combination Designation
(Table 1 BS 8500-2)

BS 8500-2 Designation	GGBS Proportion %	
CII/A-S	6	20
CII/B-S	21	35
CIII/A+SR	36	65
CIII/B+SR	66	80

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THE ENVIRONMENTAL BENEFITS OF USING GGBS

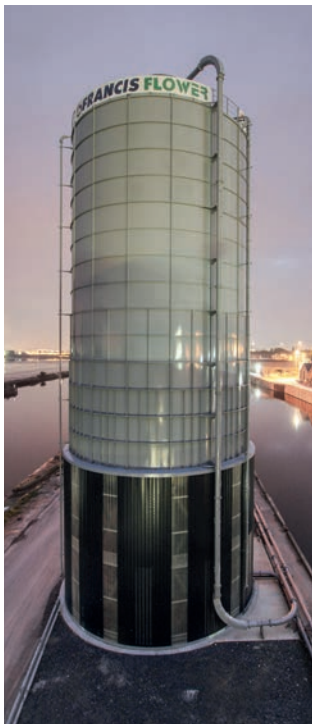
GGBS can make a significant contribution to reducing the environmental impact of concrete. The raw material is a by-product which, if not processed, might end up as landfill, and the manufacturing of GGBS utilises all of the slag, producing no waste. By utilising a by-product, GGBS requires no quarrying of virgin material or mineral extraction.

The embodied carbon of a ready-mixed concrete containing 50% GGBS can typically contain 510 kg CO_2e/tonne compared to a CEM I concrete containing 913 kg CO_2e/tonne, through reduction in energy usage and mineral extraction[1]. The more GGBS used, the lower the embodied CO_2.

ABOUT FRANCIS FLOWER

At Francis Flower we recover, reclaim and recycle mineral by-products from industry for the benefit of our customers and the environment.

We offer a range of products and services to our customers who are primarily in the construction and agriculture industries but increasingly in the paints, plastics and pharmaceutical sectors. We manufacture a range of high-quality anhydrite, marble and limestone-based products as well as GGBS. We also offer a variety of mineral services, including import and export, storage, stock management and mineral process



References:
[1]**Factsheet 18,** Embodied CO2e of UK cement, additions and cementitious material, MPA, CSMA & UKQAA Joint Publication. 2015
BS 8500-1:2015+A1:2016, Concrete. Complementary British Standard to BS EN 206. Method of specifying and guidance for the specifier, British Standards Institute. 2016
BS 8500-2:2015+A1:2016, Concrete. Complementary British Standard to BS EN 206. Specification for constituent materials and concrete, British Standards Institute. 2016

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