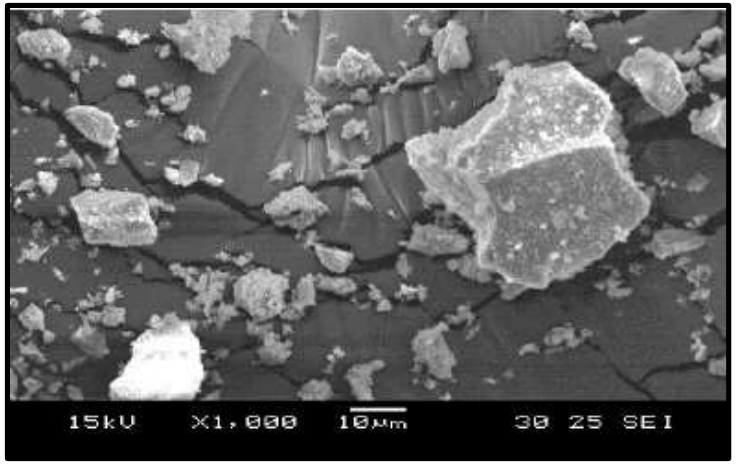
Ground granulated blast furnace slag

- This material is obtained by the heating of iron ore, limestone and coke at a temperature about 1500 degree Celsius. The process is carried out in a blast furnace. This glassy, granular product that is then dried and ground into a fine powder.

- The GGBS is obtained when the granulated slag is ground to a very fine powder with a specific surface area of 400-600m^2 /kg

- The main constituents of blast furnace slag are CaO, SiO2, Al2O3 and MgO. These are the minerals that are found in most of the cementitious substances.



Ground granulated blast furnace slag

- GGBS is used to make durable concrete structures in combination with ordinary portland cement and/or other pozzolanic materials. GGBS has been widely used in Europe, and increasingly in the United States and in Asia (particularly in Japan and Singapore) for its superiority in concrete durability, extending the lifespan of buildings from fifty years to a hundred years.

- Two major uses of GGBS are in the production of quality-improved slag cement, namely **Portland Blast furnace cement (PBFC)** and **high-slag blast-furnace cement (HSBFC)**, with GGBS content ranging typically from 30 to 70%; and in the production of ready-mixed or site-batched durable concrete.

- Concrete made with GGBS cement sets more slowly than concrete made with ordinary Portland cement, depending on the amount of GGBS in the cementitious material, but also continues to gain strength over a longer period in production conditions. This results in lower heat of hydration and lower temperature rises, and makes avoiding cold joints easier, but may also affect construction schedules where quick setting is required.

- Use of GGBS significantly reduces the risk of damages caused by alkali–silica reaction (ASR), provides higher resistance to chloride ingress — reducing the risk of reinforcement corrosion — and provides higher resistance to attacks by sulfate and other chemicals.

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Mineral	GGBFS	Portland Cement
CaO	30-50%	55-66%
SiO_2	28-40%	20-24%
Al_2O_3	8-24%	0-8%
MgO	1-18%	5%

Compound	Fly ash	GGBS
SiO_2	49.45	33.45
Al_2O_3	29.61	13.46
Fe_2O_3	10.72	0.31
CaO	3.47	41.7
MgO	1.3	5.99
Na_2O	0.31	0.16
K_2O	0.54	0.29
TiO_2	1.76	0.84
P_2O_5	0.53	-
Mn_2O_3	0.17	0.40
SO_3	0.27	2.74

Specific gravity - 2.90,

Bulk density - 1220 kg/m^3,

Surface area - 416 m^2/kg,

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Advantages of GGBFS in concrete

- The incorporation of ground granulated blast furnace slag in concrete manufacture gains many advantages which are mentioned below:
- GGBFS in concrete increases the strength and durability of the concrete structure.
- It reduces voids in concrete hence reducing permeability
- GGBFS gives a workable mix.
- It possesses good pumpable and compaction characteristics
- The structure made of GGBFS constituents help in increasing sulphate attack resistance.
- The penetration of chloride can be decreased.
- The heat of hydration is less compared to conventional mix hydration.
- The alkali-silica reaction is resisted highly.
- These make the concrete more chemically stable
- Gives good surface finish and improves aesthetics
- The color is more even and light.
- Lower chances of efflorescence
- The maintenance and repair cost of structures are reduced thus increasing the life cycle of concrete structures.
- Unlike cement, GGBFS does not produce carbon dioxide, sulphur dioxide or nitrogen oxides.