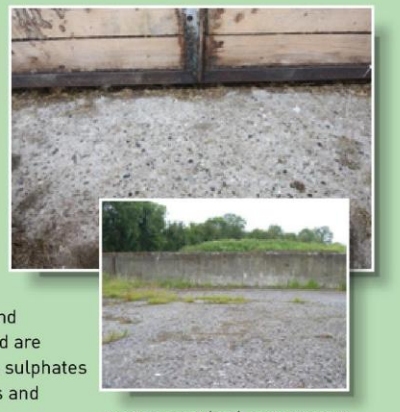
THE FARM ENVIRONMENT

The farm environment is very demanding on concrete. Exposure to silage effluent, slurry and cleaning fluids along with mechanical abrasion from farm vehicles often results in significant damage to concrete, requiring concrete to be repaired or replaced early in its service life.



Feed channel (top), and silage pit (above) where concrete has been damaged as a result of exposure to silage effluent acids.

The most common aggressive agents on the farm are acids and sulphates: lactic and acetic acid are present where silage is stored; sulphates are present in various effluents and manures.

The greatest amount of degradation tends to occur where there is a combination of both chemical attack and physical abrasion, such as silage pit aprons where tractors are handling silage, where animals are trafficking slabs, or where power-hosing washes acids onto concrete floors.

However concrete incorporating Ecocem GGBS cement, correctly placed and cured, provides additional protection to concrete from this damage and will extend the service life of farm concrete.

PROTECTIVE CHARACTERISTICS OF ECOCEM GGBS CEMENT

INCREASED RESISTANCE TO ACIDS: Concrete made with GGBS cement has a lower porosity and permeability than concrete made with Ordinary Portland Cement (OPC)* only. This reduces the rate of penetration of acids into the concrete, giving enhanced protection from acids, erosion and abrasion damage.

GREATER LONG TERM STRENGTH: Concrete made with GGBS has greater long-term strength than concrete made with OPC, due to the denser cement matrix of GGBS concrete. The same 28-day strength will be achieved in concrete with 50% GGBS as concrete made with 100% OPC. However beyond 28 days, GGBS concrete continues to hydrate and gain in strength more than concrete made only with OPC.

INCREASED RESISTANCE TO SULPHATES: Sulphates can be present in slurry, manure and wastewater. Sulphates react with C_3A present in OPC concrete, causing the concrete to expand and crack. GGBS has no C_3A and is a sulphate-resisting cement. Specifying GGBS at 50% or more content gives optimum protection against sulphate attack.

INCREASED RESISTANCE TO DE-ICING SALT: De-icing salts and seawater can cause corrosion of reinforcement in concrete leading to cracking of concrete. The presence of GGBS reduces the rate and degree to which chlorides penetrate through concrete, enhancing the service life of concrete exposed to these salts.

**The terms "Ordinary Portland cement", "OPC", and "ordinary cement" refer to the cement types CEM I or CEM II cements.*

ECOCEM GGBS CEMENT

Ground granulated blastfurnace slag (GGBS) cement is a by-product of the manufacture of iron. Because GGBS cement originates from burnt limestone, as does OPC, its chemistry is similar to OPC. These similarities permit GGBS cement to replace up to 70% of OPC in concrete, on an equal-part basis. The minor chemical differences between GGBS and OPC give enhanced durability to concrete made with GGBS.

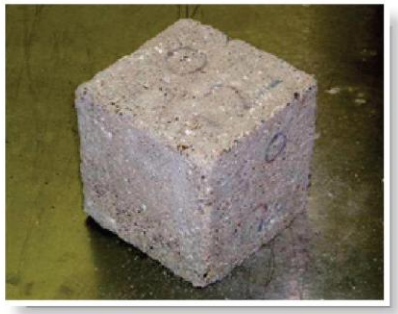
For most farm applications the most durable concrete will be obtained using a 50:50 blend of GGBS and OPC. In the most aggressive environments the use of 60-70% GGBS might be required.

THE EFFECT OF SILAGE EFFLUENT AND SLURRY ON CONCRETES

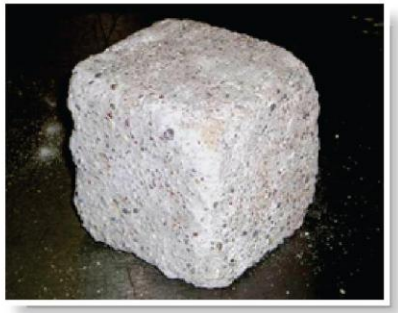
ACID ATTACK: Silage effluent is known to be corrosive to ordinary Portland cement concrete. This corrosion, combined with vehicle loads and mechanical abrasion can prematurely damage concrete silos or slabs, necessitating early repair or replacement.

However, concrete made with GGBS is more resistant to attack from silage acids than concrete made with OPC only. A recent study (2008) carried out in Trinity College Dublin[1] compared the durability of concretes exposed to silage effluent of pH 4.0. Concretes made with OPC only and with 50% GGBS were put through three 28-day cycles of exposure to silage effluent. Concrete deterioration was measured visually and by strength loss and mass loss.

The superior resistance of the 50% GGBS concrete is illustrated in the photos below:

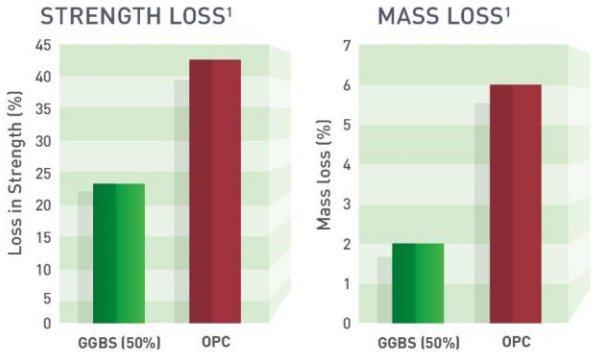


***50% GGBS concrete** after exposure to silage acid showing little deterioration*



***100% OPC concrete** after exposure to silage acid showing significant deterioration*

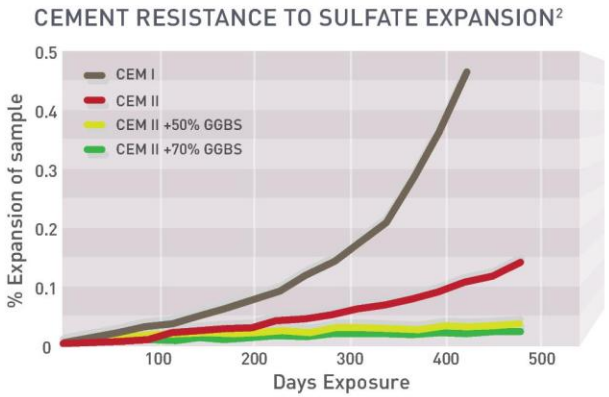
In addition, the GGBS concretes experienced significantly lower losses of compressive strength and mass after exposure to the silage effluent, as shown below:



The greater durability of concrete made with GGBS will extend the service life of concrete exposed to silage effluent, (see Farmers Journal of 9/8/2008, or online at www.farmersjournal.ie)

SULPHATE ATTACK: Concrete in livestock buildings is often subject to H_2S gas and sulphate concentrations that can corrode the concrete matrix. Sulphates react with C_3A and $Ca(OH)_2$ in concrete made with OPC, causing the concrete to expand and lose its strength. Because of the absence of C_3A and reduced content of $Ca(OH)_2$ in concrete made with GGBS, the use of GGBS provides the best protection against sulphate attack. This is demonstrated in a recent study (2009) carried out in University College Dublin[2] on sulphate attack on concretes:

The best protection against sulphate attack is provided by the use of 50% to 70% GGBS in concrete.



References

1. *Pavía, S and Condren, E , "Study of the Durability of OPC versus GGBS Concrete on Exposure to Silage Effluent", ASCE Journal of Materials in Civil Engineering, April, 2008.*
2. *O'Connell, M, McNally, C & Richardson, MG, "The performance of limestone cement with GGBS exposed to elevated sulfate environments", Proceedings: Bridge, Infrastructure and Concrete Research in Ireland, BCRI2010 Cork, Ireland, September, 2011.*