Towards sustainable construction through minimising embodied CO_2 of structural concrete

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Abstract

Concrete is the most important building material in the world due to the fact that it is versatile and gives architectural freedom. For sustainable construction solutions concrete is the material of choice if the embodied CO_2 content is considered. In concrete, cement is the main constituent and due to the limit on the availability of natural minerals used, the energy released and the CO_2 emissions produced during its manufacture, it can be partially replaced using industrial by-products e.g. Pulverised Fuel Ash (PFA), Ground Granulated Blast furnace Slag (GGBS) and silica fume. Processing of these by-products into quality products avoids the need to landfill.

Early age strength of concrete containing GGBS and PFA is less than the PC concrete, which would prevent its use in the in the post tensioned concrete and in fast-track construction, where early removal of formwork, or early application of load to the structure are the main requirements. For this reason, and due to the demand of high strength concrete in construction, for its improved durability properties, concrete containing GGBS and PFA can be produced by keeping the water/cement ratio low and a superplasticiser can used to achieve the required workability. At low water/cement ratio, concrete containing GGBS up to 50 % and PFA up to 30 % can achieve the required early age strength for the removal of formwork if cured properly.

It is evaluated that for a concrete, designed for characteristic strength of 30 MPa, a reduction of 152 kg/m^3 of CO_2 and 0.65 GJ/m^3 of energy consumption can be achieved by replacing PC with 50 % GGBS and a reduction of 62.5 kg/m^3 of CO_2 and 0.27 GJ/m^3 of energy can be achieved by using 30 % PFA concrete.