

# Portland Cement Concrete



Portland cement concrete used in runway application.

## Introduction

Everyone is familiar with Portland cement concrete. Concrete is used as a construction material in everything from sidewalks to bridges to skyscrapers, as well as concrete pavement. Concrete is made by combining coarse and fine aggregates, Portland cement and water. The water hydrates the cement to form a gel that holds all the aggregate together. The concrete can be modified in a number of ways, including the addition of cementitious materials other than Portland cement, or through the use of admixtures, which are materials that are added to the mixture to enhance the properties of the fresh or hardened concrete. IRC materials have successfully been used as aggregate, cement substitutes and admixtures in concrete, and concrete itself becomes an IRC material at the end of its project life.

## IRC Materials in Portland Cement

Blast furnace slag (BFS) has a number of different uses in concrete. Air cooled BFS and Pelletized BFS have been used as aggregate in concrete pavements and structures. Expanded BFS is used as aggregate to make medium to lightweight concrete. Pelletized BFS and granulated BFS can also be ground into a powder to make slag cement, which can be mixed with Portland cement as supplementary material and used to make concrete. Steel slag is also used to make slag cement for concrete, but its use as an aggregate is limited due to the expansion potential of the slag.

Coal combustion products also have long history of use in concrete. Class C fly ash has been used as substitute for cement in concrete, and Class F fly ash, while not cementitious, acts as a pozzolan to enhance the long term strength and durability of concrete. Fly ash and bottom ash can also be used as feed stock for producing Portland cement.

Foundry sands are essentially high quality natural sands, and have successfully been used as fine aggregate, while foundry slags, like other slags, can be used as coarse aggregate. Another aggregate source is actually old Portland cement concrete, which can be used as coarse or fine aggregate after crushing and processing.

## Benefits

The use of IRC materials in Portland cement concrete has significant environmental and performance benefits. The amount of natural materials required and the amount of landfill space used are both decreased, leading to cost savings. In addition, lightweight IRC aggregates such as expanded blast furnace slag have physical properties that are difficult to obtain with natural aggregates. Substituting one ton of coal fly ash or slag cement for one ton of Portland cement prevents almost one ton carbon dioxide emissions. Manufacturing slag cement uses only 15% of the energy needed to make Portland cement. Concrete made using slag cement and coal fly ash tends to be stronger, more durable and denser. Lastly, the concrete itself can be recycled, leading to a more sustainable approach to construction.