

Portland Cement Concrete Pavement



Portland cement concrete runway containing recycled materials..

Introduction

Portland cement concrete (PCC) pavement, or rigid pavement as it is sometimes called, refers to the rigid concrete layer of the pavement structure that is in direct contact with the traffic. Typical concrete is composed of coarse aggregate (crushed stone and gravel), fine aggregate such as sand, portland cement and water. 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. Once the concrete has been mixed, it is placed on a prepared base course and consolidated and shaped, typically using slip-form paving equipment. PCC pavements are subject to challenging environments and loads over their lifetimes, so the concrete must be strong and durable, yet cost effective and workable. IRC materials have successfully been used as aggregate, cement substitutes and admixtures in concrete, improving performance and cost effectiveness. And in the end, the concrete itself becomes an IRC material when the project is complete.

IRC Materials in Portland Cement

Coal fly ash (CFA) is often used in concrete pavements to improve the strength and durability of the pavement while reducing construction costs. Class C fly ash has been used as substitute for cement in the concrete, and Class F fly ash, while not cementitious, acts as a pozzolan to enhance the long term strength and durability of concrete. In addition, CFA increases the workability of the concrete and usually reduces the water demand. The resulting concrete typically has a higher ultimate strength, and is more dense, providing resistance to infiltration to deicers. CFA also provides protection against alkali-silica reaction, a chemical reaction with reactive aggregate that can significantly reduce the working lifetime of the pavement.

Blast furnace slag (BFS) has a number of different uses in concrete pavements. Air cooled BFS and pelletized BFS have been used as coarse aggregate in concrete pavements and structures. 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.

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 PCC pavements 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. 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.