

Digest

Applications, performance characteristics and environmental benefits of alkali-activated binder concretes

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The production of alkali-activated binders uses less energy and produces less carbon dioxide than conventional Portland cement (PC). These binders also offer flexibility in materials sourcing and can also give better durability to sulfates and acid than PC.

This Digest summarises the state of the art in this emerging area of construction technology. It draws on BRE's expertise in the area and provides an introduction to these new binders, their use in concrete production and their performance and durability. It is aimed at specifiers of concrete products, concrete product producers and those with an interest in the applications and materials performance of low-carbon concrete products.

A brief introduction to alkali-activated binder concretes

Alkali-activated (AA) binder concretes comprise a single mineral binder or blend of binders, which is 'chemically activated' by adding a highly alkaline activator solution (generally based on sodium silicate) to the binder (Figures 1 and 2). The high-alkali environment in the solution breaks down the chemical bonds in the glassy component of the binder. These components then become available for chemical reactions with the alkali in the liquid to produce 'inorganic polymers' and other binder components. The concrete mixture, which also includes conventional construction aggregates, sets and hardens over a period of time roughly equivalent to that seen for conventional concrete mixes. During this process, the liquid activator is consumed in the reaction. In chemical terms, the binder phases are mainly aluminosilicates. Examples of suitable binders include fly ash from coal-fired power generation (also known as 'pulverised-fuel ash' or pfa) and thermally treated clays. Ground granulated blastfurnace slag (ggbs) – in combination or alone – may also be used. A cement kiln (such as that used for PC production) is not required. Production and materials

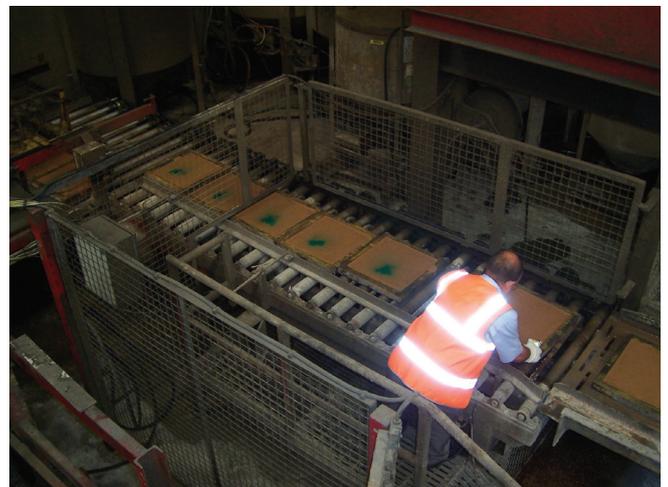


Figure 1: Pavers being produced from AA binder concretes in an industrial trial

costs of these formulations could potentially become roughly comparable to those of conventional PC-based concretes.

This Digest reviews the state of the art with AA binders in the context of the UK construction industry. The work on which it is based was supported by the Technology Strategy Board (TSB) and BRE Trust.

Raw materials

Binders

The term 'alkali-activated binders' (or 'alkali-activated materials' as they are also known) encompasses a range of finely divided silicate and aluminosilicate materials:

- so-called 'geopolymers', which are based on metakaolin (a relatively pure, thermally activated aluminosilicate clay), although the term 'geopolymer' is sometimes used more loosely to refer to all AA binder systems