

## Pulverised Fuel Ash in Aircrete blocks

### Introduction

The UK market for precast concrete masonry units is approximately 8.6 million m<sup>3</sup> (DETR). Of this total market approximately 24% were lightweight aggregate blocks in the density range 1000 - 1500kg/m<sup>3</sup> (see datasheet 7.0) and 31% were autoclaved aerated concrete (AAC) blocks, also known as "Aircrete" within the UK, in the range 400-800kg/m<sup>3</sup>. Aircrete blocks have high levels of thermal insulation, a high strength/weight ratio and the ability to meet acoustic and fire insulation requirements. The blocks, which conform to UK standards, contribute overall cost savings arising from a number of secondary savings. Lighter foundations and structural frames result and the need for less insulation all produce real benefits. They are easily cut, worked and laid, with minimum maintenance and low handling costs.

### Manufacture of Aircrete

Aircrete is a lightweight building product used in the construction of domestic dwellings and commercial buildings. It is manufactured as blocks or steel-reinforced panels. Characterised by its fine cellular structure, with air pores ranging from 0.1 to 2mm, Aircrete has a high ratio of compressive strength to density. This property allows Aircrete to be used as a load-bearing unit where efficient thermal insulation is required. Within the United Kingdom, Aircrete is manufactured under quality management systems certified in accordance with BS EN 9002.

### Typical Aircrete blocks produced with fly ash

Aircrete is made by reacting together finely divided calcareous and siliceous raw materials in saturated steam at temperatures above 100°C (hydrothermal conditions). Steam curing of specimens within pressure vessels (autoclaves, as shown to the right) at several times atmospheric pressure ensures hydrothermal conditions are maintained. The curing process is termed autoclaving. The calcareous raw material is normally quicklime (calcium oxide), or a combination of quicklime and Portland cement. The siliceous component can be finely divided quartz, amorphous silica, or aluminosilicate glass. Fly ash, from coal burning power stations, is largely composed of aluminosilicate glass and is therefore a suitable raw material for the manufacture of Aircrete.



### The use of fly ash in Aircrete block production

Most Aircrete made in the UK uses fly ash as a siliceous raw material. There are several advantages associated with the use of fly ash for the manufacture of Aircrete. Environmental benefits are achieved by using a by-product material, as an alternative to a primary aggregate such as sand. The autoclaved matrix that results from the use of fly ash, because of the influence of aluminium ions, has a high resistance to sulphate attack. A low thermal conductivity can be achieved for Aircrete made with fly ash, due to the low conductivity of the fly ash itself.

Manufacture of Aircrete is unlike that of conventional concrete or mortar. The raw materials are fine powders, without aggregate particles of any significant size and the starting point is water-based slurry. Three aspects of the process differentiate it from other concrete pre-casting methods. There is an initial "aeration" stage in which the slurry expands to form a stable cellular mass. Once stiffening of the mix has occurred and sufficient "green strength" achieved, the cellular mass is cut into individual masonry units. Finally, autoclaving at elevated temperatures (180 to 200°C) promotes hydrothermal reactions, thereby forming a stable high-strength intercellular matrix.

## Fly Ash

Generally unprocessed fly ash, either dry or conditioned with fresh water, is used for the manufacture of Aircrete. The fineness specifications of BS EN 13055: Part 1, or EN 450 are of limited relevance to autoclaved products. It is possible to use relatively coarse fly ash, because of the elevated temperatures and high alkalinity within the autoclaves. These conditions ensure the rapid dissolution of the aluminosilicate particles and increase the availability of silica for the formation of calcium silicate hydrates.

## Properties of Aircrete

BS EN771 Part 4<sup>a</sup> is the harmonised European specification for Aircrete masonry units, providing their characteristics and performance requirements and is not prescriptive in terms of raw materials allowing siliceous material such as fly ash to be used.

The thermal conductivity ( $\lambda$ ) of Aircrete is directly related to density. Typically,  $\lambda$  values range from 0.1 to 0.2 W/m.K, within the density range of 400 to 800 kg/m<sup>3</sup> commonly produced in the United Kingdom. The high degree of thermal insulation provided by Aircrete enables the stringent energy efficiency requirements of the new Building Regulations to be achieved.



The compressive strength of Aircrete, as tested in accordance with BS EN772<sup>b</sup>, ranges from 2.9 N/mm<sup>2</sup> to over 9.0 N/mm<sup>2</sup>, depending on density. This satisfies the structural requirements of a wide range of building types. The drying shrinkage of Aircrete is tested in accordance with BS EN680.

Aircrete blocks are resistant to frost damage and sulfate attack and have British Board of Agrément approval for use below DPC level in foundations. Soil or groundwater conditions, defined by BRE Special Digest 1<sup>c</sup> up to Class DS 4 can be tolerated.

Aircrete is fire-resistant because of its calcium silicate hydrate matrix and is classified as non-combustible in accordance with the Building Regulations.

Manual handling guidelines prepared by the Construction Industry Advisory Committee specify block weights less than 20kg. Due to their lightweight structure, standard size Aircrete blocks are all within the limit.

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a BS EN77-4: Specification for masonry units Part 4: Autoclaved Aerated Concrete Masonry Units

b BS EN772-1: Methods of test for masonry units Part 1: Determination of compressive strength.

c Concrete in aggressive ground, BRE Special Digest 1, August 2001

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In general usage the term 'fly ash' is used for pulverized coal ash but it can also cover ash from burning other materials. Such 'fly ash' may have significantly differing properties and may not offer the same advantages as ash from burning pulverized coal. UKQAA datasheets only refer to PFA / fly ash produced from the burning of coal in power stations.