DURABLE MEDIUM-DENSITY FIBRE CEMENT COMPOSITE

This application is a National Phase application under 35 U.S.C. §371 of International Application No. PCT/AU2003/001315, filed Oct. 7, 2003, which claims the benefit of U.S. Application No. 60/417,076, filed Oct. 10, 2002 and Australian Application No. 2003901529, filed Mar. 31, 2003.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to fibre reinforced cement products and methods for modifying the properties of those products for particular purposes.

2. Description of the Related Art

Any discussion of the prior art throughout the specification should in no way be considered as an admission that such prior art is widely known or forms part of common general knowledge in the field.

Generally, fibre reinforced composites may be divided into three groups based on their density.

High density reinforced composites have a density range above 1.6 to about 1.9 g/cm^3. These composites may be formed in a conventional fashion involving matting of fibres, catchment of slurried fines and dewatering, eg the Hatschek process followed by compression of up to 30 MPa pressure to the desired thickness.

Such high density FRC materials have high structural strength, high stiffness and a smooth finish. One particularly desired advantage of high density products is their ability to resist moisture ingress thereby retain as-manufactured physical or chemical properties in service.

Unfortunately, however, many high density FRC products do not have good handlability, nailability and can be difficult to score and snap. There is also a high capital and maintenance cost involved in the production technique.

Medium density FRC products with a density from about 1.2 to 1.6 g/cm^3 overcome some of the difficulties mentioned above. Even though they are normally formed in a conventional fashion, eg Hatschek process, they can be produced for relatively low cost compared with high density FRC products, have improved workability, ie handleability, score-snap, nailability and provide adequate structural strength and stiffness for most applications. Further, they generally have acceptable in service performance.

Conventional medium density FRC products, however, may not generally have the same level of resistance to moisture ingress and ability to maintain in-service performance as high density products. Further, they may not provide the flat smooth surface produced on high density products without additional coating and/or sanding.

Low density fibre reinforced composites with a density of around 0.8 to 1.1 g/cm^3 are also formed in a conventional fashion, e.g. Hatschek and normally incorporate a density modifier.

These low density products have excellent workability, i.e. handleability, score and snap and nailability due to their low density. They provide acceptable in-service performance and have adequate stiffness.

Such low density products, however, generally have lower structural strength and stiffness. Ability to maintain physical and chemical properties in service is generally lower and once again, surface flatness could be improved. Due to the specialised formulation of most low density fibre reinforced composites, they are produced at a relative high cost.

Accordingly, it will be appreciated by persons skilled in the art that it would be useful to be able to modify the properties of a medium or low density product such that they retain their advantageous properties, eg workability relatively low cost etc, but improve other properties, eg ability to maintain as-manufactured properties, resistance to moisture ingress, structural strength and stiffness and surface flatness.

Performance in extreme climactic conditions is a particularly difficult area. For example, in many geographical locations, the FRC product may be subject to many freeze/thaw cycles during its life. Some conventional medium density FRC material produced may suffer from delamination, softening or chipping when exposed to freeze/thaw cycles.

Loss of as-manufactured physical or chemical properties can also be triggered by internal factors such as imperfections relating to the material heterogeneity, eg air pockets, segregation of constituents. In the case of fibre reinforced composite materials, imperfections such as poor bond at the matrix-fibre interface and fibre clumping may render such materials more susceptible to loss of durability.

It is an object of the present invention to overcome or ameliorate at least one of the disadvantages of the prior art, or to provide a useful alternative.

SUMMARY OF THE INVENTION

In a first aspect, a method of modifying the properties of a low or medium density FRC product comprises providing the low or medium density FRC product with a predetermined pore size distribution such that in particular critical zones of said distribution, the pore volume is substantially equivalent to or less than the pore volume in a respective critical zone of a conventional high density FRC product.

In a preferred embodiment, the predetermined pore size distribution is obtained by chemical modification, physical modification, or a combination of chemical and physical modification.

In another aspect, the pore size distribution is obtained by including a predetermined quantity of pore modifying components into the cementitious formulation. In one embodiment, the pore modifying components include lignocellulosic fibres treated with a water repellent agent and microfine siliceous material such as silica fume.

Alternatively, or in addition to such chemical alteration of the pore size distribution, the low or medium density FRC product may be subjected to a light press to provide the required predetermined pore size distribution. The pressure applied to the low or medium density FRC product is sufficient to provide the desired predetermined pore size distribution and provide a density of no greater than about 1.6 gms per cm^3. Preferably, the density of the resultant FRC product is between about 1.1 and 1.55 grams per cm^3.

The present applicants have found that there are a range of properties of the low or medium density FRC product which may be altered by controlling the pore size distribution of the resultant product. They have also discovered that it is not necessary to control the entire pore size distribution but rather said distribution in critical zones, eg in the region of 1 to 10 microns mean pore diameter size and in the region of 10 to 100 microns mean pore diameter size. These regions, sometimes referred to as the fibre pore and air pore regions, are critical to some of the resultant properties of the low or medium density FRC product. The applicants have found that it is possible to provide a pore volume in these critical regions which is no greater than around 150% of the pore volume in a corresponding pore size range of a conventional high density FRC product while still maintaining a low or medium