Characterisation of Mineral Wastes, Resources and Processing technologies – Integrated waste management for the production of construction material

WRT 177 / WR0115

Case Study:

Mica Rich Waste from Clay Extraction in ‘Ecobond®’ Roofing Tiles

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Introduction

Clay Extraction Waste

The extraction of kaolinitic clays results is the production of a number of mineral based waste materials. These include silica sand and a mica rich sand. These are produced in large volumes. The silica sand can be used as normal fine grained aggregate in construction without incurring the Aggregates Levy. The mica rich material, due to its ‘flaky’ nature is not suitable for such purposes. It is the Mica that forms the waste material that is the focus of this case study. Figure 1 shows a settling pond that is used to separate process water from mica rich ‘waste’.

Figure 1: Mica rich clay extraction waste settling pond

Ecobond® Roofing Tiles

Ecobond is a company that is dedicated to producing a variety of construction products using hybrid water based resins as the binding agent. In their production large volumes of minerals wastes and by-products are needed. The construction products are normally external and internal facing materials that require a good aesthetic and finish as well as being very durable. Products include cladding panels, floor tiles and roofing tiles. The roofing tiles are the product that is the focus of this case study; however many of the characterisation requirements are similar as are the end product specification tests.

The Ecobond® process takes in mineral material, refines, classifies, dries and mixes it with resin to produce a material that once dried is a free flowing material that resembles sand. This material can be easily transported and conveyed (for instance by pneumatic methods) and is very suitable for moulding into the required shaped product. In the case of roofing tiles this is rectangular shape that meets construction industry standards. The fact that the product is moulded means that various surface finishes and aesthetics can be included. Once in the mould it is pressed and heated to between 100 - 200℃. The level of force used in pre ssing and the temperature of moulding depends on the required formulation of the resin and the mineral material being used and the end product desired. Figure 2 shows a flow diagram of the process. Figure 3 shows examples of the Ecobond product.

In developing the Ecobond products it was important to focus on the type and style of end product and the market for these products. The process is suited to the incorporation of numberour mineral based wastes - however the focus needs to be on selling the product - not ‘waste disposal’ or avoided disposal / handling costs of utilising waste.

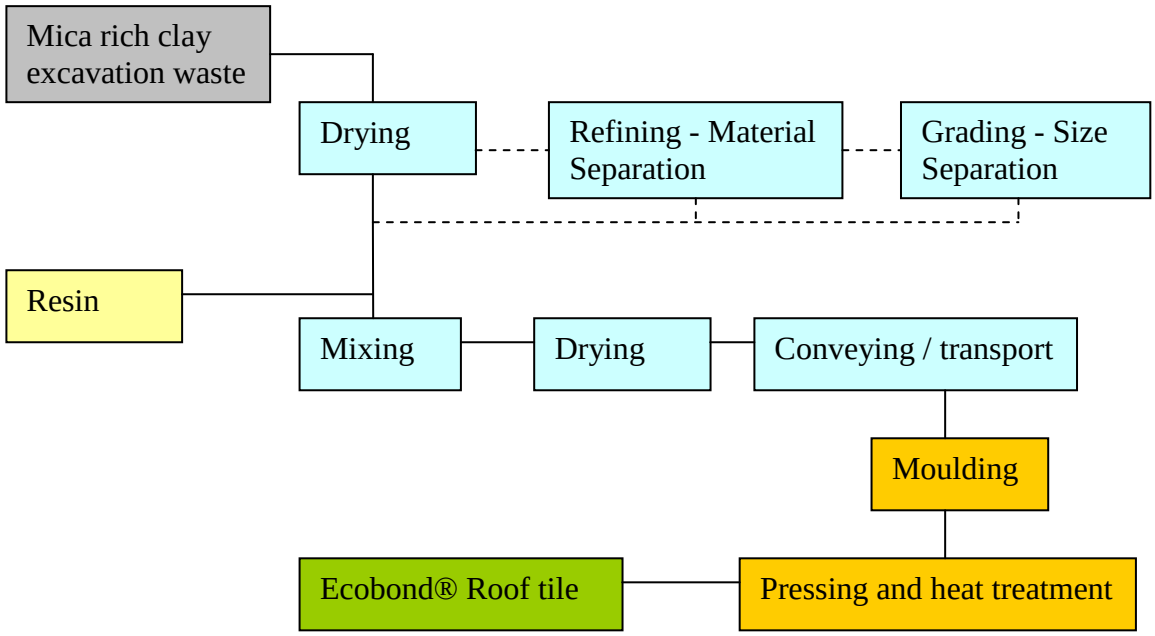

Figure 2: Process flow diagram of the Ecobond® Process for Roof tile production

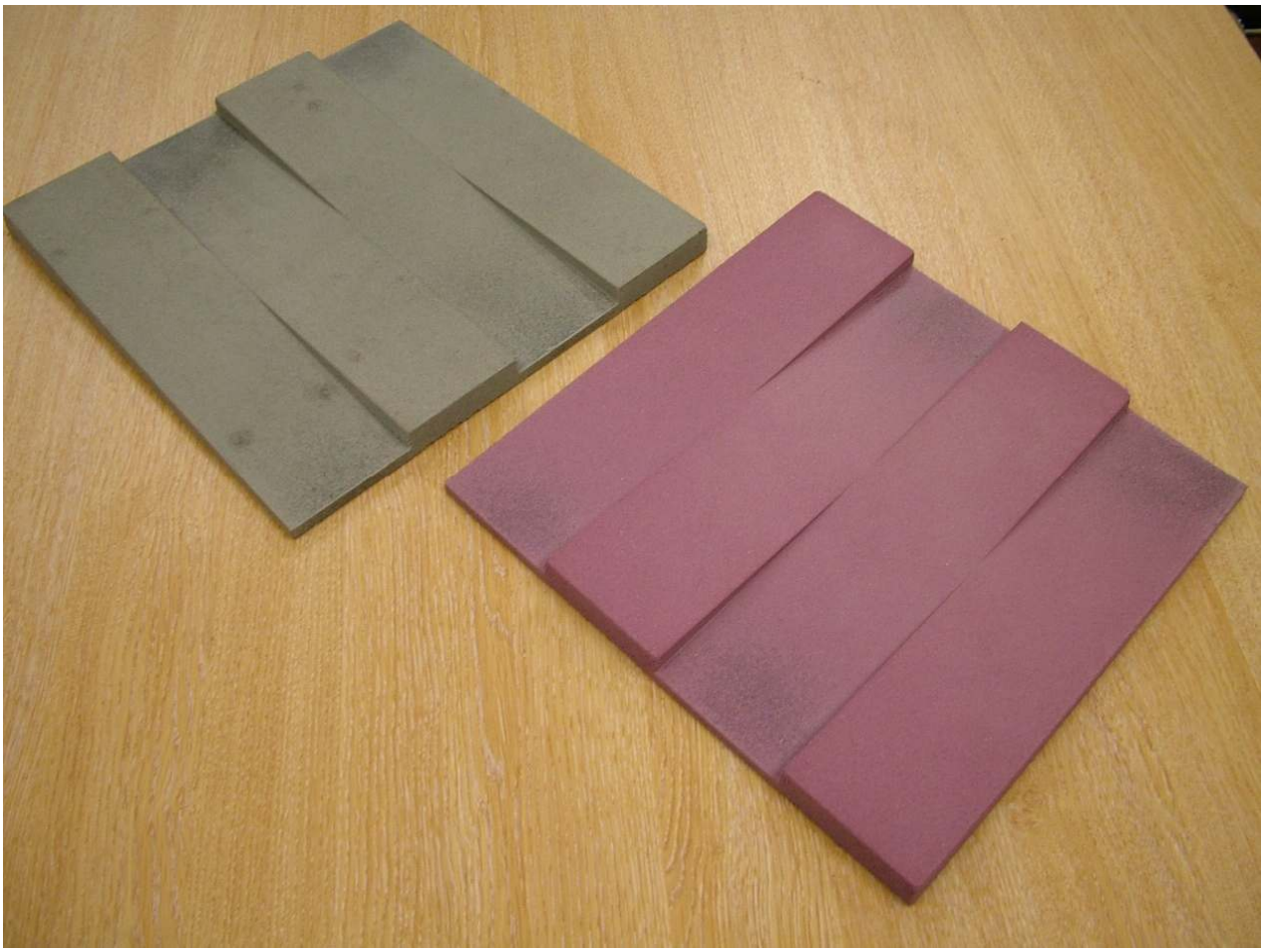

Figure 3: Ecobond® tile products

Barriers and Benefits

A commentary on generic constraints and benefits of using mica waste in ecobond® roofing tiles using the characterisation headings used in the project are as follows:

- Material related
    i. Use of large volumes of waste material
    ii. Material ideal in terms of composition and particle size
- Economic
    i. Avoided costs of disposal and storage of wastes
    ii. Cheaper raw materials
    iii. Lower density product in comparison to equivalent - transport savings
- Environmental
    i. Production of a durable product with low embedded energy costs
    ii. Lower density product in comparison to equivalent - reduced transport fuel
- Organisational
    i. Shows commitment to utilising more sustainable resources in a product and ultimately in a building

Specific materials characterisation results

Chemical Composition - especially for contaminants	Actual composition is not so important - but contaminants from heavy metals is important. General inofrmation on percentaegs of SiO_2, Al_2O3, FeO/Fe_2O_3, CaO, MgO
Particle Size Distribution	A well graded distribution is ideal for strength requirements. Maximum size is over 2mm - but would give a 'coarse' finish.
Particle shape	Useful to know to determine resin addition - different shape will give different product performance
Organic content	% weight is required. Useful to know if concentrated in a particular size range
Water absorption	Crucial do determine drying
Colour	Important for aesthetics

Results of Laboratory / Pilot product demonstration test-work

The use of the mica waste with an addition of approximately 10% resin is sufficient top produce a roofing tile that meets all the required product standards. The majority of the these tests are physical properties of the product. Of the most important of these tests are freeze-thaw testing (BSENOISO 10545-12) and water absorption and permeability. The tiles produced showed no defects after a 100 freeze-thaw cycles and maintained consistent measured water absorption (< 5%). In addition a consistent colour is also required as although the addition of dyes is possible this adds to the cost and processing requirements.

Conclusions and further work required

It is apparent that mica waste is very suitable for incorporation into roofing tiles, as are numerous other high volume mineral wastes and by-products. The further work required are demonstration buildings where specifiers can see the products in use.

References

http://www.ecobond-international.co.uk/

BSENOISO 10545-12 - 1997 Water immersion by total impregnation method