



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

WRT 177 / WR0115

Case Study:

# Incinerated sewage sludge ash (ISSA) in autoclaved aerated concrete (AAC)

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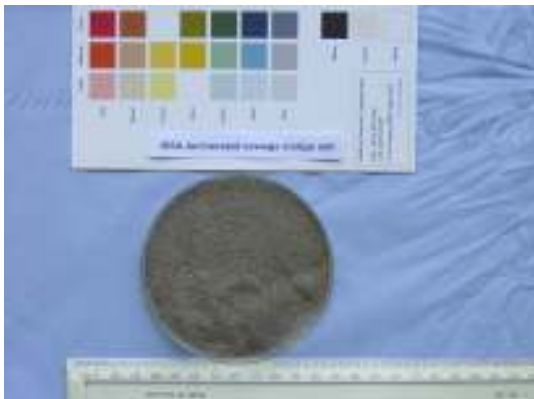
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# Introduction

## Incinerated sewage sludge ash (ISSA)

ISSA is an inorganic ash derived from the incineration of the residual stream of fine organic and inorganic solids (sewage sludge). This arises from municipal wastewater treatment works. The incineration process thermally destroys the organic matter. The total quantity of ISSA produced in the UK (through nine incinerators throughout England and one in Northern Ireland), is approximately 100,000 tonnes per annum. Less than a quarter of the sewage sludge produced is incinerated and there is a potential to increase to 450,000 tonnes if all the UK sludge were incinerated in the future. Recycling and disposal routes for sewage sludge itself are agriculture (54%), incineration - producing ISSA (22%), landfill (11%), land reclamation (5%) and other (8%). There is anecdotal evidence for a significant geographic variation in the composition of ISSA. A detailed report on ISSA and its potential use in construction products has been produced by CIRIA (1).



ISSA sample



“Jumbo” Aircrete blocks with tongue and groove features and hand grips (image, BRE Information Paper IP 7/05)

In functional terms, ISSA produced from a fluidised bed incinerator is a free-flowing silt/sand. It participates chemically when incorporated in the brick firing process and also has pozzolanic (reactive silica) properties which make it potentially useful in manufactured concrete products.

## **Potential applications for ISSA**

Potential uses of ISSA in construction products include aerated concrete (as aggregate), ceramic materials (as sand and clay replacement), cement (as cement replacement /filler), fine aggregate for concrete products, and the manufacture of synthetic coarse aggregate. Successful UK trials in the above applications have been conducted but there are not believed to be commercial plants operating in the UK. The main competitor wastes/by products meeting similar functions to ISSA in manufactured concrete products (including aerated concrete), ceramics, aggregates and cement is pulverised fuel ash (pfa). Other examples of competitors include ground glass and foundry sand.

## **Autoclaved aerated concrete (AAC)**

Autoclaved aerated concrete (AAC) is a factory produced product which is cured in an autoclave process during which the main ingredients (including the finely divided aggregates), react together chemically. Aerated concrete comprises cement, lime, fine aggregates, with a few per-cent of aluminium powder added to the mix to aerate the product. The aggregate comprises the major constituent of the mix. Manufacturers produce blocks, jumbo blocks and larger reinforced elements.

The AAC industry has a history and willingness to utilise by-products as fine aggregate the most common of which is pulverised fuel ash (pfa), which is widely available. Alternative wastes are sometimes sought where there is not a local source of pfa or natural fine aggregate. Aerated concrete manufacturers are keen to access to a wider source of fine aggregates, principally to minimise costs associated with transport of pfa from power stations and/or sand from quarries- which also attract the aggregates levy.

Most AAC factories are either within a moderate distance from major coal burning power stations or have their own source of natural sand nearby. Alternative sources of material have been explored in an attempt to reduce costs and provide greater flexibility in the sourcing of raw materials. ISSA, foundry sand and ground glass have all been tried by manufacturers. As a result of their own environmental policies, companies are actively seeking alternative raw materials. Individual waste holders or their intermediaries will typically approach the aerated concrete producers directly with details of possible alternative materials. In commercial arrangements, suppliers undertake to supply the aerated concrete producer (typically run-of-station pfa) within a certain envelope of chemical composition, moisture content and particle fineness.

## **Barriers and Benefits (extracted from waste product pairing database)**

A commentary on generic constraints and benefits covering the five main topic headings is as follows:

- Material related

Mixing and water demand variability is different to the mainstream materials (such as pfa) for which ISSA would substitute.

- Legal

ISSA is defined as a waste and therefore subject to waste management regulations

- Economic

ISSA has to compete against other competitor non-primary materials (such as pfa) which are of low cost, widely available, have a long track record and are also not subject to the Aggregates Levy.

- Environmental

ISSA is widely available, non-hazardous. Heavy metals may be present in some cases.

- Organisational

The greatest barrier to the utilisation of ISSA is probably public perception of sewage sludge and its derivatives.

## **Specific materials characterisation results**

Materials characterisation data for ISSA are available in reference (1) including specific gravity, pH, grain-size, typical oxide analysis. Silicate content can be as low as 25% of the total solids, calcium oxide as high as 33% and phosphate as high as 20%. ISSA generally meets the waste acceptance criteria for “inert waste” within the meaning of the Waste Framework Directive (2, 3, and 4). However, sources must be judged on a case-by-case basis.

No standards exist for ISSA for use in construction. However, standards have been written for pfa (5). Aerated concrete product producers also provide a compositional “envelope” for acceptable raw materials. A quality protocol is currently being produced for pfa (6). This defines compositional and quality requirements and sources of pfa that meet its requirements are expected to be regarded as “by-products” rather than “waste”. No such scheme is yet developed or is being considered for ISSA.

Results of basic waste analysis undertaken by BRE to assess waste for use in this product sector are as follows:

Material source:	Knothrop, Leeds
Mineral phases	Silica (two types), calcium magnesium hydrogen phosphate
Visual description	Medium grey, free flowing powder
Particle size distribution and/or specific surface area	2.5 microns to 250 microns
Acid soluble chloride (%)	0.008
Total sulphur (%)	0.40
Moisture content (%)	0.36
Loss on ignition (%)	1.43

## Results of Laboratory / Pilot product demonstration test-work

Trials have been conducted by at least two of the main AAC producers using ISSA as a partial substitute for pfa, with some success. The ISSA was found to fall within the compositional “envelope” for raw materials produced by the supplier. Blocks were successfully produced. However, the trials showed that the ISSA had a variable demand for water which was also higher than that of pfa and natural sand. As a result, an additional hopper, feed mechanism and variable water addition would be required for the ISSA to be used in the process, which would make its use uneconomic.

## Conclusions and further work required

- Characterisation data and trial results indicated that ISSA could be suitable for use in aerated concrete
- ISSA is only expected to be considered for use in aerated concrete products if alternatives (pfa or natural sand) are not available or un-economic

## References

- 1) Gunn, AP. Et al. 2004. Use of sewage sludge in construction. CIRIA Publications, Pp 28. (C608).
- 2) Office of Public Sector Information, "The Landfill (England and Wales) Regulations 2002", Statutory Instrument 2002 No. 1559, OPSI (online). Last accessed 25 March 2006 at [www.opsi.gov.uk](http://www.opsi.gov.uk)
- 3) Office of Public Sector Information, "The Landfill (England and Wales) (Amendment) Regulations 2004", Statutory Instrument 2004 No. 1375, OPSI (online). Last accessed 25 March 2006 at [www.opsi.gov.uk](http://www.opsi.gov.uk)
- 4) Office of Public Sector Information, "The Landfill (England and Wales) (Amendment) Regulations 2005", Statutory Instrument 2005 No. 1640, OPSI (online). Last accessed 25 March 2006 at [www.opsi.gov.uk](http://www.opsi.gov.uk)
- 5) BS EN 450:1995 Fly ash for concrete. Definitions, requirements and quality control.
- 6) Protocols for the recovery of waste (EA) <http://www.environment-agency.gov.uk/subjects/waste/1019330/1334884/>