Mineral wool ceiling tile waste collection logistics, closing the loop with manufacturers

Material and waste logistics is fundamental to improving the sustainability of UK construction. This case study examines the benefits resulting from the use of a variety of logistics options to return waste mineral wool ceiling tiles to manufacturers for closed loop recycling.

Mineral wool ceiling tile reverse logistics and closed loop recycling

The market for ceiling tiles in the UK has been calculated to be in the region of 150,000 tonnes per annum. A significant proportion of this tonnage finds its way into landfill via general waste disposal routes. This case study focuses on mineral wool ceiling tiles and how effective logistics to facilitate closed loop recycling can deliver financial and environmental benefits to construction companies (and ceiling tile manufacturers).

This case study summarises the findings of a desk based study into the various take back options for mineral wool ceiling tiles to manufacturers where they are recycled and turned into new ceiling tiles. The models identified include the direct return of tiles back to the manufacturer on delivery vehicles; the return of tiles via a ceiling tile distributor’s site and a logistics hub model. The direct return of tiles back to the manufacturer was tested through a demonstration trial with Armstrong at the London School of Economics (LSE).

Reverse Logistics trial business case

The demonstration trial collected 17.5 tonnes (3,283m$^2$) of mineral wool ceiling tile waste (and delivered between 8 and 10.6 tonnes (1,500m$^2$ to 2,000m$^2$) of new ceiling tiles). The trial demonstrated the benefits and business case for the return of waste ceiling tiles to the manufacturer not only in financial terms but also in environmental terms with CO$_2$ benefits. The trial showed savings of:

- Avoided costs by the construction site (at the LSE) between £2,273 and £2,797.
- Total materials to the value of £770.
- 5,142 kg CO$_2$e.

Types and sources of ceiling tiles

There are three main types of ceiling tiles used in the UK. The three main types (and quantities manufactured) are estimated by WRAP as being:

- Mineral wool ceiling tiles – 95,000 tonnes per annum;
- Metal ceiling tiles – 40,000 tonnes per annum; and
- Gypsum (and other) ceiling tiles – 15,000 tonnes per annum.

This case study focuses upon mineral wool as the other material types have established recycling supply chain infrastructure from construction sites, e.g. via metal skips and gypsum (plasterboard) take back schemes.

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1 AMA research for WRAP - Unpublished

2 Mineral wool ceiling tiles manufactured before 2000 are excluded from this study as they are not currently recycled back into mineral wool ceiling tiles.
Mineral wool ceiling tile waste arises through off-cuts generated from new installations and end-of-life tiles generated through refurbishments.

Logistics options (models)
The primary route for waste ceiling tiles from most construction projects is to landfill via general waste skips. Where this material passes through a construction waste Material Recovery Facility (MRF), it is still common for the ceiling tile fraction to end up in the residue stream, as alternative end use markets do not readily exist.

There are several key drivers for wanting to prevent ceiling tile waste, avoid landfill and to increase recycling including:

- Business commitments to reduce waste to landfill (including zero waste) and recycle more;
- The value of the ceiling tile material to the manufacturers;
- Reducing the increasing financial burden of waste disposal through avoided landfill tax, currently at £64 per tonne (2012) rising to £72 per tonne (April 2013); and
- Reduced carbon impacts associated with waste materials transport and extraction / processing of raw materials to produce new ceiling tiles.

There are currently limited UK manufacturing sites at which mineral wool ceiling tiles can be recycled through closed loop processes. Those sites that do offer this service only accept tiles of a known heritage from their own manufacturing process, i.e. they will not accept tiles from other manufacturers. Many (but not all) modern tiles (manufactured post-2000) can be identified by the manufacturer quality control stamps on the back of the ceiling tile. The identification of ceiling tiles is a key parameter within the recycling process for manufacturers who wish to capture their own ceiling tiles with a known composition.

Reverse logistics trial
In support of background research into the practical application of reverse logistics to return ceiling tiles back to manufacturers (including consideration of the regulatory controls that apply) a short trial was undertaken in March and April 2012. The trial tested the logistical model of directly returning primarily end-of-life ceiling tiles from a refurbishment project site (managed by Willmott Dixon Interiors) to the manufacturer. Figure 2 is a diagrammatic representation of a typical (direct) reverse logistics process.

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3 Concurrent with this study WRAP has funded a study (PRD100-106) into alternative end uses for ceiling tiles.

4 AIS formed CSP working group
http://www.ais-interiors.org.uk/
Armstrong provided the recycling facility (in Team Valley, near Newcastle-upon-Tyne) with suitable permits and licenses and facilitated a trial for the refurbishment (by Willmott Dixon Interiors) of the London School of Economics (LSE) – the Client. The LSE site required less new ceiling tiles than it generated as waste due to the unveiling of the old ceiling in the main hall that had been retained behind a false ceiling. Armstrong did not deliver the new ceiling tiles (via their logistics partner, Fergusons from the local distributor CPD) as the project required the ceiling tiles towards the end of the project.

‘Waste has always been a long-standing concern of Willmott Dixon and we continue to work towards our commitment to divert all construction, demolition and excavation waste from landfill by the end of 2012. As such, we were delighted to make use of the take back scheme offered by Armstrong.’

Claire Smith – Willmott Dixon Interiors

The strip out was completed by Chiltern Demolition and the re-fit by BPC Interiors. The two loads of waste ceiling tiles were collected from the LSE and transported to Team Valley (Armstrong’s manufacturing and recycling site) by Fergusons. The second load was a half load and the first load required some processing to remove scrim at the manufacturing site.

Storage space is required for keeping the palletised ceiling tiles while awaiting collection of a full load. The collection of the two loads of palletised and wrapped mineral wool waste ceiling tiles from the LSE were scheduled so that Fergusons could deliver new ceiling tiles from Armstrong to a distributor near to the LSE (and then collect waste ceiling tiles from the London School of Economics (LSE)) to utilise an indirect reverse logistics. The ceiling tiles from the LSE were loaded using a Moffatt fork lift truck (that is attached to the rear of the articulated vehicle trailer) to fill the vehicle on its return journey to Team Valley. The two loads were moved using a waste transfer note and a licensed waste carrier as required by the waste ‘Duty of Care’ legislation.

Figure 3 – The collection of the ceiling tiles using the Moffett fork lift truck

Recovered ceiling tiles should be kept dry whilst held on site. Keeping the ceiling tiles dry is important due to the recycling process that adds a pre-determined volume of water to the dry ceiling tile mix to then be moulded, dried (in ovens) and cut to the specified size. This requirement is included in an agreement (contract) from Armstrong to the site, which also includes the supply of waste transfer notes.

The recycling process for mineral wool waste ceiling tiles compared to the use of virgin materials differs only by the requirement for the ceiling tiles to be shredded prior to the material entering the manufacturing process.

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5 http://www.Armstrong-ceilings.co.uk
Key trial data and results
The following is a summary of the LSE trial data.
- 1,500 to 2,000m$^2$ / 7.97 to 10.63 tonnes of new ceiling tiles delivered;
- 3,283m$^2$ / 17.45 tonnes of waste mineral wool ceiling tiles collected;
- Each load was transported 275 miles to Team Valley in North East England;
- The cost of transport (including Moffatt) was £545;
- The cost of stripping the ‘scrim’ off the first load at the Team Valley site was £408;
- The estimated average cost of raw materials for the production of ceiling tiles is £0.13 per kilo (variable dependent upon the type of tile);
- Landfill gate fees range between £25 and £55 per tonne and are dependent upon local variations;
- Landfill Tax is at £64 per tonne (until April 2013);
- Skip transport to a local site is about £120 per load.

Financial Results
- Landfill costs avoided; gate fee between £436 and £960 and Landfill Tax of £1,117. Total Landfill costs avoided are between £1,553 and £2,077 (excludes transport costs);
- Waste transport costs were approximately 6 loads at £120 per load based upon the volume collected in the trial. Total transport costs circa £720;
- Costs avoided by the construction site (at the LSE) were between £2,273 and £2,797
- Handling of the material to a storage area should be considered and planned to minimise any additional handling
- Material requirement reduced by 17.45 tonnes at an estimated cost of £0.13 per kg; saved £2,269;
- Cost of the trial collections; 2 x £545 transport and £408 processing costs.
- Materials saving (£2,269 - £1,090 - £408) is £770.

Carbon Results
- Additional transport requirement (versus an estimated 30 mile requirement for local landfill disposal) is ((2 x 275) – (2 x 30) = 490 miles.
- Carbon calculation$^6$ for transport = additional 1,242 kg of CO$_2$e;
- The carbon saving$^7$ for closed loop recycling = 6,384 kg CO$_2$e;
- Saves 5,142 kg CO$_2$e compared to landfill.

Alternative models: collection hubs and interim storage
The return of mineral wool ceiling tiles directly to the manufacturer is a suitable logistics model for ceiling tile recycling where sufficient quantities are produced (i.e. over 2000m$^2$) at single sites. Where there are smaller quantities i.e. 100m$^2$ (or less) produced at multiple sites then an alternative logistical solution is commonly required (provided by manufacturers and other companies).

The interim storage option utilises the infrastructure of the distributors where they can backhaul small volumes of mineral wool ceiling tiles from multiple clients back to a distribution depot. Once there is a sufficient volume (circa 2,000m$^2$) to fill an articulated vehicle a collection can be requested. Through operating this system the mass of ceiling tiles disposed of by small refurbishments and new installation projects can be efficiently captured and returned to the manufacturers for recycling (subject to manufacturers receiving their own ceiling tiles). Figure 4 is a schematic flow chart of the distributor’s interim model.

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$^6$ Uses 100% full artic conversion of 1.40325 kg/CO$_2$/km from 2011 DEFRA/DECC Conversion Factors (table 9) and miles to km factor of 1.609.

$^7$ From 2011 DEFRA/DECC Conversion Factors; factor of -366 used (glass being nearest match).
A variation to the distributor model is the use of hubs for the efficient supply and collection of materials and waste from sites. One such scheme is currently being operated by Styles and Wood\(^8\) (construction and refurbishment specialists). Materials are supplied to the site and ceiling tiles returned to the hub to be bulked, palletised and returned to the manufacturer when a sufficient volume has been collected. Logistics hubs are more responsive to client’s needs by providing ‘just in time’ deliveries of small quantities of multiple materials to multiple sites. This is of particular importance when time is of the essence, such as with the refurbishment of high street stores. Hubs therefore offer a less wasteful option to the distributor networks, particularly for small refurbishment projects where small quantities of materials are required at specific times. The removal of waste in small quantities is equally time critical for these projects. According to Styles and Wood the hubs have reduced the carbon impact by 46% and the costs of transport by 76% for the supply and collection of materials in a recent study with a well known high street name.

Figure 5 is a schematic flowchart of the logistics hub model.

Within the distributor and the hub model many of the costs are shared or may be hidden, e.g. management and administration time, transport back to the distributor site and the opportunity costs of lost space at a distribution centre or depot. It is therefore difficult to assess which of the models is the most cost effective as many of the costs are not easily determined. Recent research for WRAP\(^9\) by AMA research indicated that 90% of the distribution market is dominated by three distributors (with a further five accounting for the remaining 10% of the market). If the main distributors were to offer an interim storage solution to their clients then a significant percentage of the UK ceiling tiles could be returned to the manufacturers for recycling. The provision of such a service would differentiate those distributors offering the ‘recycling service’ and it would provide a competitive edge to help secure and perhaps gain market share.

Licensing
The interim storage of mineral wool ceiling tiles can be licensed under an S2 exemption. An S2 exemption\(^10\) allows a site to store up to 100 tonnes (or 26,000m\(^3\)) of non-hazardous waste at any one time (up to one year) and it is free of charge via the Environment Agency. A similar exemption exists in section 17 of

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\(^8\) http://www.stylesandwood.co.uk/

\(^9\) AMA research for WRAP - Unpublished

\(^10\) http://www.environment-agency.gov.uk/business/topics/permitting/116089.aspx
the Waste Management Licensing (Scotland) Regulations 2011. Regulation 17 of The Waste Management Licensing Regulations (NI) 2003 provides for exemptions from waste management licensing. Sites should seek clarification from the relevant regulator and it should be noted that storing waste without a permit or registered exemption would be considered to be a breach of the regulations.

Potential benefits
The potential benefits for the UK from the collection of waste mineral wool ceiling tiles has been summarised below. It should be noted that the different types of tiles manufactured and distributed will impact upon the estimated benefits. The benefits have been calculated using trial data and market size data from WRAP as detailed earlier in this case study.

Armstrong is on target to recycle approximately 50,000m² (approx 195 to 225 tonnes) of ceiling tiles in 2012. The majority of this is expected to be collected directly from sites and returned to Armstrong’s site in Team Valley.

‘Armstrong is committed to increasing the volume of ceiling tiles that are recycled. The environmental benefits are clear and we encourage contractors to be responsible and seek to recycle our ceiling tiles with us.’
Roy Smith – Armstrong

The potential benefits for the UK shown below are calculated based upon the assumption that the key distributors controlling 90% of the market offer a recycling service and will collect 30% of the ceiling tiles that they distribute.

The potential market benefits are:

- Of the 95,000 tonnes of mineral wool ceiling tiles manufactured 90% (i.e. that controlled by the main distributors) is 85,500 tonnes;
- Should distributors set up systems and infrastructure to collect 30% of the 85,500 tonnes from clients this would represent 25,650 tonnes of material being recycled each year.

Financial Benefits

- Costs avoided by the construction industry are potentially between £3.3 million and £4.1 million per annum
- The total raw material savings are potentially £1.1 million per annum.

Carbon Benefits

- The above material diversion represents a potential annual reduction of 7,500 tonnes CO₂e compared with landfill as an alternative.

Summary

Returning off-cut or end-of-life mineral wool ceiling tiles back to the manufacturer for recycling can add real value to the supply chain. Site construction companies can avoid costly landfill gate fees and tax. Manufacturers can secure good quality feed stock and strengthen their supply chain relationships, whilst distributors could gain a competitive advantage.

The volume of the mineral wool ceiling tiles produced from individual sites is critical to the viability of ceiling tile recycling schemes and the optimum choice of logistics model. Sites requiring and producing in excess of 2,000m² of ceiling tiles have the option of directly returning tiles to the manufacturer. Where smaller volumes of ceiling tiles are produced, e.g. 100m² or less, then the application of interim storage at distributors or logistics hubs is the best option. Interim storage enables the volumes required to be consolidated over time (up to one year) for onward transport to the manufacturers for recycling.

The potential for financial savings are substantial as are the potential carbon benefits of avoiding sending ceiling tiles to landfill. To realise this potential benefit the ceiling tile industry should drive the recycling of ceiling tile best practice forward through organisations like the Ceiling Sustainability Partnership. Voluntary commitments and material protocols are tools that have been successfully used in the past to achieve more sustainable waste management practice. The requirement for such tools may be negated by the work currently being undertaken by the Ceiling Sustainability Partnership.

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11 http://search.sepa.org.uk/sepa?action=search&q=section%2017%20exemptions

Further Information

The Ceiling Sustainability Partnership, which is a working party of the AIS Technical Committee, delivers on the actions within the Mineral Wool Ceiling Tiles Resource Efficiency Action Plan (REAP).

This study was undertaken as one of the actions within the Mineral Wool Ceiling Tiles REAP. Further details can be found on the following link:


Details of recycling schemes offered by ceiling tiles companies represented on the Ceilings Sustainability Partnership can be found in Annex 1 of the Mineral Wool Ceiling Tiles REAP.

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