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TU Delft

COLLECTION RATES OF ALUMINIUM PRODUCTS IN BUILDINGS

Executive Summary

Study supported by the European Aluminium Association through the *Aluminium for Future Generations* Programme. It was conducted by Delft University of Technology, Prof. Udo M.J. Boin and Ir. J.A. van Houwelingen and co-ordinated by the EAA Alubuild Market Group.

This document presents the objectives, methodology, results and key conclusions of a project covering the inventory and the collection of aluminium during demolition of buildings in a selection of European countries: Germany, the Netherlands, France, United Kingdom, Italy and Spain.

Study objectives / methodology

- Select residential and non-residential buildings in each country to investigate and document their aluminium content.
- Monitor the collection of aluminium during demolition and establish a collection rate for those buildings.
- Identify the alloy type and the application of aluminium used and the influence of the climate on its use.
- Research the type of buildings in Europe and demolition methods used.

***Definition**: the collection rate percentage is restricted to the demolition site exclusively and is defined as the amount of aluminium that is sorted on the site to a category that is expected to be processed off site for the recovery of aluminium. Clean aluminium can be directly transported to the smelter. In other instances, however, the aluminium is mixed e.g. with waste wood that either is dumped (aluminium is lost) or processed to be prepared for plywood, in which case the aluminium is recovered.*

Results

- A comprehensive and detailed inventory of aluminium was established.
- Although some 2 million tonnes of aluminium are put onto the European building market every year, the average aluminium content in building is still below 1% of the total mass.
- The lowest aluminium content was found to be 18 grams per tonne for an old apartment building in Le Mans (F), in which aluminium was found in door handles and other small items.
- The highest content was 7500 grams per tonne for an office building in Wuppertal (D).
- In that building, windows, corrugated roof plates and 5mm thick exterior cladding plates were made from aluminium.
- The collection rates for the individual buildings vary from 92% - 98%. The exception was the Le Mans building with a rate of 31% being explained by the total absence of larger objects.

Table and detailed descriptions are provided in Annexe I.

Key Conclusions

- Generally, collection and recycling rates for aluminium are high at 92% to 98%.
- All other things being equal, the main influence on this is the amount of large aluminium components in a building rather than the myriad of smaller aluminium objects that are also found in buildings.
  - In Germany about 85% of all buildings newly constructed during the last 4 years have been residential buildings, but they have accounted for only 3% of the total aluminium used in the construction sector, mainly consisting of small objects. A similar division is seen in Spain if coastal apartments are placed in the commercial category.
  - The remaining15% commercial buildings used 97% of the aluminium. These are mainly large objects.
  - This is reflected in an average content of 38 kg for a residential building and 7000 kg for a commercial building in the Northern European countries.
  - In the Milan building, consisting of a factory and offices, over 5000 small objects with an average weight of 125 grams of aluminium were identified with a total weight of less than 1.0% of the total aluminium identified. Losses of aluminium are mainly incurred in the category of small objects; this in particular is the case in the absence of mechanical processing with crushers and separation equipment.
  - On the Eastern coast of Spain, semi residential buildings were also investigated and it was found that they contain large amounts of massive aluminium parts such as fences, doors, windows and roller shutters. These parts are dismantled prior to demolition and refurbished for re-use. Alternatively, they are collected for recycling similar to the practice for a commercial building.
  - The collection rate during demolition for commercial buildings shows no significant difference between South- and North- Europe. There are similar economic constraints and regulations.
- For the near future it is expected that EU Regulations will be extended to all Member States, both existing members and accession states. Availability of European landfill areas will shrink instead of expanding and landfill cost will increase on a long-term trend. This trend will also lead to different landfill gate fees for different waste categories. Collection rates (for Al) will therefore grow further rather than decrease. Although in France, Spain and Italy over 85% of construction waste is still dumped on disposal sites, a fierce discussion has started between demolition contractors and communities on how to handle this burden in the future.
- The combination of these regulations, measures and laws, together with the development and support of the collection and recycling infrastructure for aluminium will further increase the collection and recycling of aluminium.

A few considerations

Aluminium collection and subsequent recycling is supported by:

- The scrap value of aluminium where the recovery of scrap is well established and a solid collection and recycling is in place. In order to recover aluminium metal cost efficiently only parts weighing at least 100-200 g should be collected separately. Scrap dealers can strip metal parts weighing less than this.
- The level of workers' pay. Scavenging for metal parts by workers is often seen on sites, as it provides additional income.

- The shape, joining techniques / assembly methods, mass and amount of specific aluminium items. Plates, bars, profiles, strips are collected if large enough. Small plates are often neglected, unless the frequency is high.
- The implementation of EU regulations for hazardous waste. Two examples:
    - Where removal of fluorescent tubes is obligatory prior to demolition. Detail: the aluminium sockets (a very small amount) are recovered.
    - Where removal of mineral wool and asbestos around pipes is obligatory prior to demolition, the aluminium covers have to be disassembled to make this possible.

  Note: if hazardous materials are contained in rubble this may increase disposal costs.
- The implementation of EU regulations on the recycling and purity for all other materials from demolition:
    - Concrete rubble must be of a certain level of purity in order to be re-used or in many cases to be disposed: it must contain no hazardous materials, no wood, no metals.
    - The waste wood which is collected separately is either re-used and therefore needs to be clean, or is dumped at a different fee / collection cost (often very high). To reduce its total weight all foreign materials are removed.

  Such regulations are an important driver for a controlled approach to demolition, which in turn acts in favour of the collection of aluminium.
- The market potential of concrete rubble. The presence of a quarry nearby (as is often the case in southern countries) provides competitive building and construction materials, and therefore acts as a disincentive to the separate recycling of rubble. In northern countries the potential marketability of rubble is higher. Cleaned rubble improves indirectly the recovery of aluminium.
- Mechanical processing with crushers. To improve the marketability of waste wood and rubble, this can be cleaned up to varying degrees of purity. This separation process is beneficial to the recovery of aluminium, and can involve hand picking, magnetic separation, eddy current separation and other techniques. Specifically those small aluminium items weighing less than 100 g (which were ignored during demolition) are recovered in this way.

NB There are great differences between the countries investigated - in terms of the number of fixed and mobile crusher plants. Plant availability is a good measure of the recycling of concrete and brick, and consequently of the recycling and separation of aluminium.

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ANNEXE I

Detailed description of the buildings investigated

Table: Basic data of all buildings investigated (N=non-residential, R=residential)

	Location	N/R	Mass of building [tonnes]	Al [kg] identified [kg]	Aluminium content [gpt] or [ppm]*	Collection. Rate [%]
	1	2	3	4	5	6
1	Le Mans (F)	R	9,243	165	18	31
2	Ridderkerk (NL)	R	32,700	1,034	31	95
3	Eindhoven (NL)	R	37,500	1,853	49	95
4	Madrid (E)	N	23,000	92,000	4000	95
5	Milan (I)	N	142,237	61,384	430	93
6	Pau (F)	N	10,659	6,826	640	92
7	Frankfurt (D)	N	11,991	21,000	1750	98
8	Wembley (UK)	N	35,000	213,000	6100	96
9	Wuppertal (D)	N	10,147	76,414	7500	98

*gpt = gram aluminium per tonne of rubble or ppm = parts per million (1% = 10,000 ppm)

Guide to the table:

Column 1 and 2 give the location/country and type of building: R = residential and N = non-residential.

Column 3 gives the total mass of the building in tonnes

Column 4 gives the total aluminium content in kg

Column 5 refers to the content of aluminium in grams per tonne

Column 6 gives an estimate of the collection rate of aluminium for that particular building

- The residential buildings in Le Mans, Ridderkerk and Eindhoven are more than 30 years old and contain very low amounts of aluminium. The low collection rate for Le Mans is explained by the total absence of larger objects. It is observed that aluminium door handles are taken together with the wooden doors and windows to designated disposal areas.
- The building in Ridderkerk is an eighty-year-old residential site, which was demolished because of massive asbestos content. Accurate stripping and ultimate collection of aluminium.
- Seven apartment buildings in various stages of demolition in Eindhoven. Sequence of processing is clearly presented. Aluminium collection detailed and complete.
- Large seven story BNP-Paribas Bank in Madrid with massive exterior cladding and interior partition walls.
- Large Pirelli factory and office complex of 45,000 m^2. Factory with several km of insulated pipes, numerous plates on walls, windows, entrances and ceilings. The offices contain thousands of small aluminium items, such as nameplates, door numbers, switches etc. Windows, ceilings, partition walls are the main uses of aluminium.

- A former office building of Elf Atochem 13 floors high in Pau. The exterior consists of steel windows with aluminium profiles (2/3 of total aluminium). The lobby and entrance have aluminium windows and doors. The interior contains sun shielding (13% of total) and various small items such as ceiling strips, profiles to support wood cupboards, door handles, door closures, ventilation grids. It is observed during several visits that all these items are accurately collected.
- Frankfurt. Older department store in busy shopping street. Building was refurbished. The building contains:
    - 24% aluminium bus bars in the ceilings for lighting
    - 21% aluminium windows and doors
    - 17% aluminium exterior panels
    - 11% aluminium air conditioning tubes in the ceiling
    - 27% smaller aluminium parts for various applications
- A football stadium with offices in Wembley. Aluminium in corrugated roof plates (86% of total), windows, doors, and exterior cover plates.
- Wuppertal. The former Court House with 17 floors. Main use of aluminium is in massive exterior covering plates that form the envelope of the building (48.5%). Secondly the windows and doors (42.0%). The interior consists of numerous profiles, small items, nameplates, door handles etc.

Generalised concise de-construction sequence for buildings

- Contractors specialised in the removal of asbestos finish job before any further demolition takes place.
- Obligatory removal of mineral wool and gypsum plates.
- Lamps and lighting structures, electronic equipment and air conditioning equipment are removed.
- All wooden cabinets, structures, cupboards and shelves are removed and collected separately.
- Metals are recovered separately: steel, zinc, copper, cables, aluminium.
- PVC floor tiles fixed to the cement floor with an adhesive are removed.
- The remaining building is now fully stripped and demolished with a hydraulic rock breaker equipped with an extension boom backhoe. For high buildings diamond sawing is applied.

Climatic differences and the influence on aluminium use

While the non-residential market behaves similarly all across Europe, the residential market varies from North to South. Window size, glazing surface, sun shading devices are affected by climate and linked to the local behaviours.

- In the UK, the Netherlands and Germany residential buildings tend to have windows made of wood or PVC. Double-glazing is generally applied but roller shutters are rare.
- For Spain and Italy data have been recently collected for residential houses and apartments. The high content of aluminium in the Spanish apartments is explained by the large amount of windows, roller shutters, heating elements and fences, whereas small objects are hardly found. The residential market in South Mediterranean Europe tends to behave as the European non-residential market and consequently, collection rates are expected in the range of 95%-98%. In spite of common landfill practices in these countries, aluminium is collected and recycled thanks to its high scrap value.