COLLECTION OF ALUMINIUM FROM BUILDINGS IN EUROPE

A Study by Delft University of Technology

EUROPEAN ALUMINIUM ASSOCIATION

Technische Universiteit Delft

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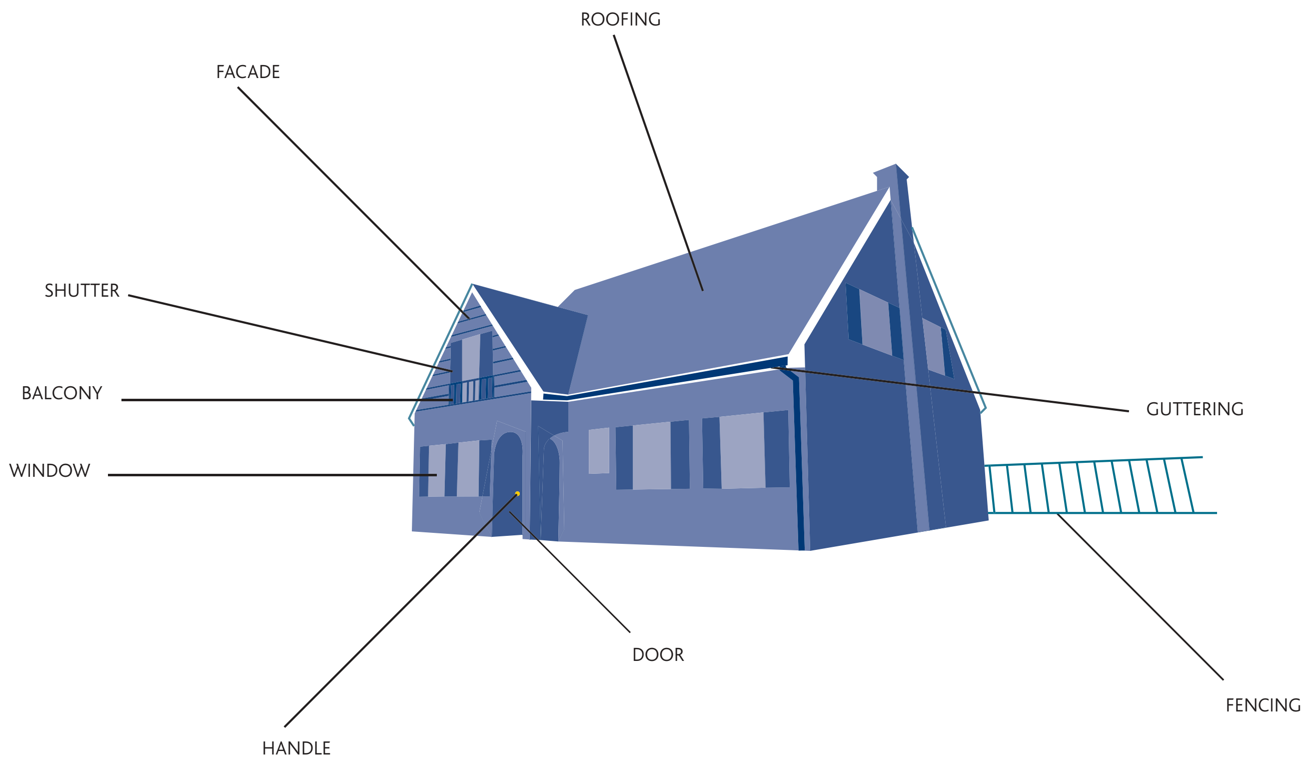
TYPICAL ALUMINIUM APPLICATIONS IN BUILDINGS



INTRODUCTION

With a view to raising awareness of the excellent recycling properties of aluminium and the extent of its scrap potential in the building sector, the European Aluminium Association commissioned Delft University of Technology to conduct a scientific study investigating aluminium content and collection rates in European buildings. This initiative was launched within the framework of its "Aluminium for Future Generations" programme, the industry's unwavering pledge to progress through dialogue. Though collection rates were previously suspected to be high, no firm evidence existed to this effect and it was felt that a broadly implemented study would serve to confirm aluminium's considerable collection efficiency and highlight its phenomenal recycling capacity due to its intrinsic economic value. **The demolition of a significant number of buildings in 6 European countries was closely monitored and comprehensive data were gathered. The collection rates of aluminium in this sector were found to vary between 92% and 98%, demonstrating aluminium's pivotal role in the pursuit of full sustainability.**

According to Professor Udo Boin and Associate Professor Jan van Houwelingen, experts in recycling engineering at Delft University of Technology, aluminium from buildings has long been an unknown efficient scrap resource, in spite of guaranteeing raw material availability and energy savings for the benefit of future generations. On account of its substantial inherent value and the fact that it can be recycled without any loss of quality, the optimal collection rates evidenced in the study provide strong incentives for the recycling of aluminium scrap from demolition sites.

DEMOLITION DATA ON ALL BUILDINGS INVESTIGATED

Case study	Mass of building [tonnes]	Aluminium identified [kg]	Aluminium share [grammes per tonne]	Collection rate [%]
Pau - Elf Aquitaine office building (F)	10 659	6 826	640	92
Le Mans – apartment buildings (F)	9 243	165	18	31
Wuppertal – courthouse (D)	10 188	76 414	7 500	98
Frankfurt – department store (D)	12 000	21 000	1 750	98
Milan - Pirelli factory and offices (I)	142 753	61 384	430	94
Ridderkerk – apartment buildings (NL)	32 700	1 034	32	95
Eindhoven – terraced houses (NL)	37 500	1 853	49	95
Madrid – BNP Paribas bank (E)	23 000	92 000	4 000	95
London - Wembley Stadium (UK)	34 918	213 000	6 100	96
Average collection rate (%) for buildings investigated				95.7

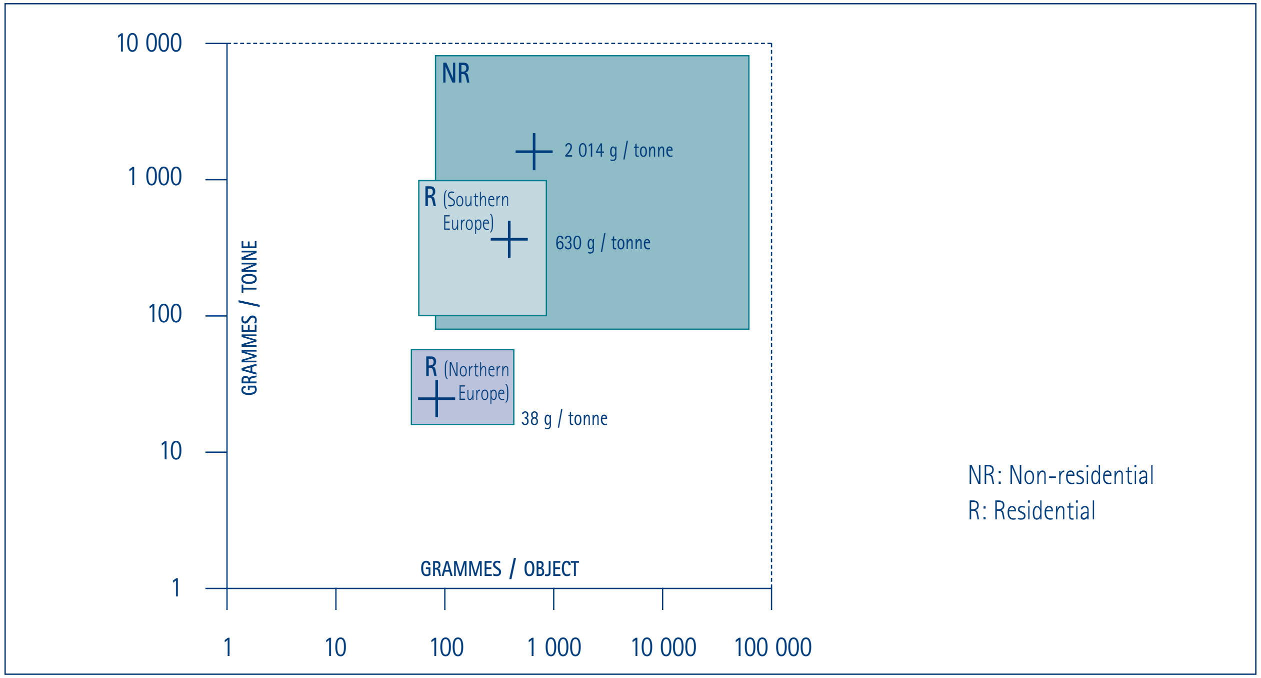
Furthermore, well-established and efficient recycling schemes already in place in different European countries allow its immediate resorption into the economic system.

Residential and non-residential buildings were chosen for investigation in 6 countries: France, Germany, Italy, the Netherlands, Spain and the United Kingdom. An innovative on-site bottom-up methodology was applied during demolition to investigate the selected parameters, including total aluminium content in relation to building mass, collection rate, component dimensions, specific application, type of building and demolition methods utilized. The successful implementation of such a challenging project depended largely on the good will and cooperation of local authorities, institutes and demolition companies.

The study revealed that, while the European building market consumes some 2 million tonnes of aluminium annually and boasts a total inventory of 30 million tonnes to date, the average aluminium content per building falls below 1% of the total mass, though this figure is on the increase according to global statistics. Despite the low individual building content, aluminium in the building sector still constitutes a vast volume for collection, with rates as high as 92% - 98%. The main influencing factor appears to be the number of large aluminium components as opposed to the multitude of smaller objects frequently found in buildings.

Peak collection rates are invariably found to be related to the collection of larger parts, such as windows, corrugated roof plates, curtain walls and thick exterior cladding plates, whereas aluminium losses are commonly incurred with small items like door handles. This is particularly apparent in the absence of mechanical processing with crushers and separation equipment where the cost of manual disassembly outweighs the value of the metal itself. Moreover, even where the recovery of aluminium scrap is well established with a solid collection and separation scheme, only parts weighing at least 100-200g should be separately collected for the metal cost to be efficiently recovered. What is left behind is often stripped by scrap dealers, routinely invited for this purpose, or even on-site workers who are well aware of aluminium's high scrap value.

ALUMINIUM CONTENT OF BUILDINGS IN EUROPE



Regarding the aluminium content of buildings in the 6 countries studied, there was found to be a north-south divide, essentially in the residential building market. While the commercial building sector behaves similarly across Europe, showing no significant difference in aluminium content nor collection rates during demolition between northern and southern Europe, the residential building market shows a clear split. Residential buildings in southern Europe tend to contain much greater quantities of aluminium than those in northern Europe due to climatic considerations and the influence of local habits. In these countries, aluminium is frequently used for doors, windows and roller shutters, which can be easily dismantled prior to demolition and then refurbished for reuse, or recycled. Thus, the southern European residential market behaves much the same as the pan-European non-residential market, with collection rates anticipated to be in the range of 95% - 98%.

In northern Europe, however, the residential market uses substantially less aluminium and mainly in the area of small objects, despite this market being by far the largest sector of the construction industry. In Germany, for example, 85% of buildings constructed in the last 4 years have been for residential purposes yet they account for only 3% of the total aluminium used in construction. The remaining 15% have been commercial buildings but they absorbed a massive 97% of the aluminium, principally for large components. This trend was consistently observed in northern countries and is reflected in the average aluminium content of a residential building in northern Europe, which is only 10-20 kg, compared to 7 000 kg in a non-residential building.

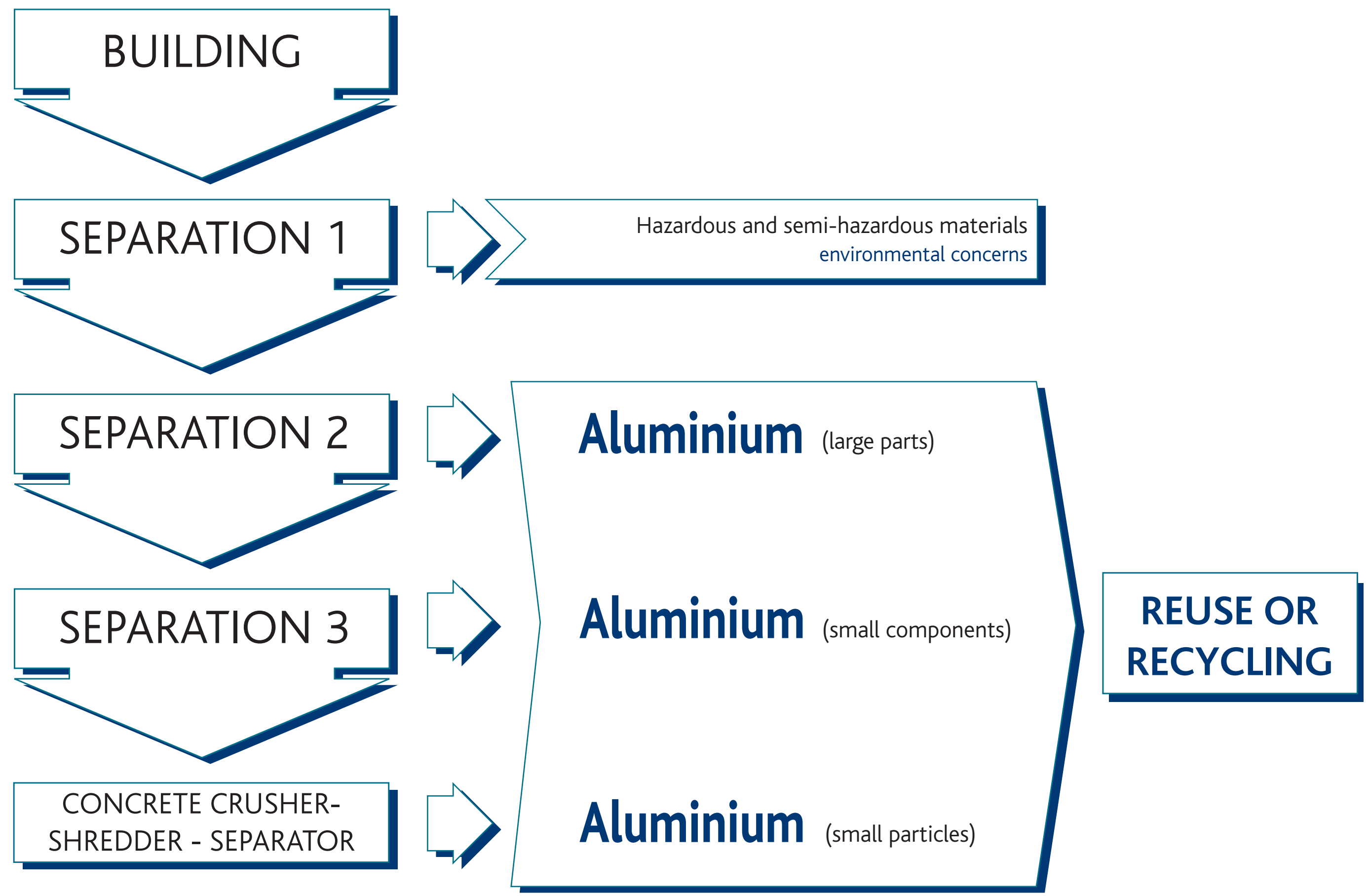
With the extension of European Union regulations on the purity and recycling of materials from demolition, as well as the implementation of laws governing the availability of landfill areas and the disposal of hazardous waste, aluminium collection and recycling rates are set to rise even further, with calls for an increasingly controlled approach to demolition. Hazardous materials like fluorescent tubes, asbestos and air conditioning fluids, for example, must be separately removed prior to demolition, which automatically releases quantities of aluminium for collection that may otherwise have been discarded due to elevated costs. Concrete rubble must also be of a certain level of purity, containing no hazardous waste, wood nor metals, in order to be disposed of or reused. Indeed, cleaned rubble has extensive market potential, backed by legislation and disposal bans, particularly in northern countries where there are fewer quarries providing competitive building materials. Similarly, waste wood is stripped of all aluminium elements for the production of chipboard or prior to incineration.

The separation process, involving hand picking, magnetic separation, eddy current separation or mechanical processing with specialized equipment, inevitably leads to the recovery of ever-greater quantities of aluminium, optimizing recycling rates in line with the industry's commitment to the principles of sustainable development. Furthermore, with the enforced reduction of European landfill areas and the introduction of increased landfill gate fees according to different waste categories, collection rates will keep on growing as communities, companies and demolition contractors are made to recognize environmental and social obligations.

Having identified exceptional collection rates, this study has manifestly confirmed aluminium's considerable recycling potential due to its high intrinsic value. It has also consolidated its key role in the creation of a vast energy bank, tapping into the perpetually increasing aluminium inventory in buildings, conserving raw materials and energy resources for generations to come. The European aluminium industry is wholly and unreservedly committed to ensuring continued improvements in aluminium applications and industry operations in Europe, with particular emphasis on enhanced environmental performance through all the stages of the life cycle of this unique and extraordinary metal.

ALUMINIUM COLLECTION IN THE DECONSTRUCTION AND DEMOLITION OF BUILDINGS AND FINAL ALUMINIUM DESTINATIONS

SIMPLIFIED SCHEME



The deconstruction and demolition of buildings in Europe must be executed in a highly organized manner according to strictly regulated procedures, implemented as a result of both local initiatives and, increasingly, European Union directives. Extensive regulations focus primarily on the separation and handling of hazardous materials, recycling policies and disposal issues. Demolition companies are commonly large contractors operating with a number of subcontractors, employed to perform a variety of tasks in the deconstruction process before the actual demolition can take place. In all the 6 countries investigated in this study, a similar approach and similar methods were applied.

The first stage of the process involves the mandatory stripping of all hazardous materials from the entire building. A subcontractor specialized in the removal of asbestos is usually engaged to remove all traces of this toxic material prior to any further disassembly. Lamps and lighting structures are subsequently retrieved, as mercury-bearing tube lamps are frequently encountered. Other hazardous materials, such as mineral wool and air conditioning fluids, are also separately collected.

Next, attention is directed towards the removal of semi-hazardous materials like gypsum board, often used for the interior partitioning walls of buildings, as well as ceilings. These elements have to be separated from the side walls and concrete ceilings, or detached from metal frameworks.

Once these first two steps of the process are complete, the rest of the demolition process ensues, generally from the top floor downwards, beginning with the recovery of the various metals contained within the interior of the building. Aluminium, steel, copper and zinc, utilized for a diversity of applications, are carefully collected before the dismantling of large interior structures, including cabinets, shelves, cupboards and doors, which also incorporate additional metal fixtures to be retrieved. Indeed, many of these items bear aluminium components such as door handles, name plates and locks, to name but a few. Aluminium radiators, poles and profiles are also easily recovered.

Apartment building in Le Mans during deconstruction and demolition

The deconstruction now moves to the exterior. The roofs of buildings usually comprise numerous structures covered with materials like tar, peat or cork composite, to which metal sheets, commonly aluminium, are affixed to confer added protection. Aluminium strips are regularly found around chimneys, and elevator cabins contain a multitude of aluminium assembly parts. The individual materials must be separately removed, leaving the roof stripped clean.

The outer walls must be similarly stripped of all attached elements such as light domes, exterior profiles and cladding, routinely made of aluminium. Aluminium is also widely used for windows and doors, which are either removed whole for immediate resale, or dismantled for subsequent recycling. All waste glass is then collected in special containers and the metal components are recovered.

The final stage of the deconstruction phase involves the stripping of floors, frequently covered with PVC tiles fixed to the cement with adhesives. Strictly speaking, these also constitute hazardous materials but, for obvious reasons, they cannot be removed until the building has been emptied. They are carefully retrieved and sorted to a category for incineration, while the cement rubble contaminated with adhesive is also separately removed.

Diamond sawing in Wuppertal

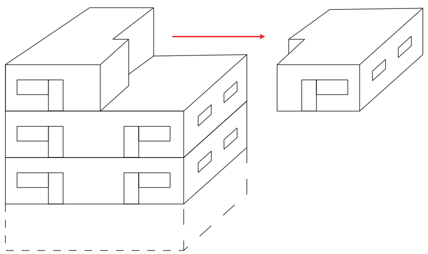
Now that the deconstruction is complete, the demolition of clean concrete and brick can commence. Anything above the seventh floor is generally diamond-sawed into manageable pieces and lifted down with a crane. The lower levels, up to and including the seventh floor, are crushed between the claws of a hydraulic rock breaker and broken down into rubble. In some cases, an alternative method is applied where there are still considerable quantities of metal to be collected from exterior profiles. The walls of the building are then "folded" inwards, rather like the sides of a box, ensuring optimal recovery of aluminium. Finally, the site itself is checked for soil contamination and decontaminated, as necessary.

The aluminium collected from a building goes to one of several destinations. Some components are immediately sold for reuse in their original application. Some of the metal goes directly to the aluminium recycling plant to be treated and melted down, yielding a recovery rate approaching 100%. Some needs to be processed with a shredder for mixed scrap to recover the aluminium before re-melting. Only a small percentage is lost unless a recovery system is in place at the disposal site or incineration unit.

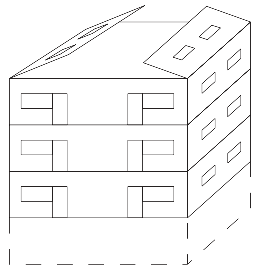
The study has clearly demonstrated the remarkable efficiency of aluminium collection within the stringently applied deconstruction process.

Hydraulic crushing in Wuppertal

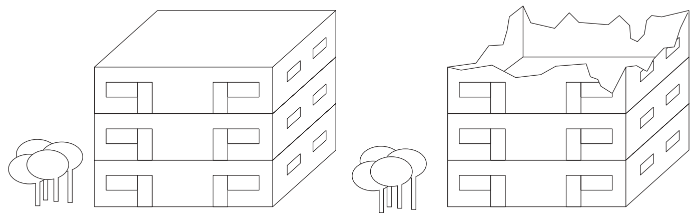
DEMOLITION METHODS INVESTIGATED IN THE STUDY



Diamond sawing
Above the 7th floor



Inward folding of walls
Alternative method to ensure optimal aluminium recovery



Hydraulic crushing
Up to and including the 7th floor

CASE STUDIES

France

In France, 2 different categories of buildings were chosen for investigation, a 13-storey commercial building, the Elf Tower, in Pau and 2 residential buildings from a series of 5 identical apartment blocks in Le Mans. Demolition in both locations was undertaken by Delair Navarra, a large and well-respected ISO-certified company, working extensively all over France. ISO (International Organization for Standardization) certification ensures the implementation of work practices in strict adherence with legal standards, a vital consideration for the contractor who is ultimately liable.

In Pau, the main objective was to obtain a clean concrete mass to be used on site as fill material to build a new office building. The deconstruction sequence followed essentially the same order as applied throughout the study, but the actual demolition was executed according to the "folding" process, in order to recover as much aluminium as possible. Large quantities of aluminium were thus collected from the exterior profiles after demolition, amounting to two-thirds of the total aluminium recovered. The fact that clean concrete rubble was required for the new on-site construction meant that the concrete had to be stripped completely bare of all foreign materials, which served to boost aluminium collection rates.

Elf Tower in Pau

A significant share of the aluminium in the building (13%) was contained in the interior sun blinds, destined for recycling. According to the head of the demolition unit of the CEBTP, an organization which defends environmental interests in the building sector, the aluminium recovered from these blinds was recycled in its entirety. A number of heavily corroded windows from the original construction had also been replaced with aluminium windows or repaired with aluminium strips, as aluminium is corrosion resistant and therefore ideal for this purpose. As much as possible was recovered and sorted to a special container where hand-cleaned aluminium was readied for shipment. Indeed, all the materials were collected in special bins placed around the building to ensure maximum recovery.

Highly accurate stripping and sorting of aluminium thus yielded a collection rate of 92% from an overall aluminium share totalling 0.064% of the building mass (640g per tonne).

Exterior aluminium profiles in Pau

In Le Mans, the deconstruction and demolition of 2 identical apartment buildings dating from 1971 revealed a very low aluminium content. This was consistent with the global study observations that the northern European residential market uses considerably less aluminium than the southern European residential market and the pan-European commercial building sector.

The aluminium share actually constituted only 0.0018% of the total building mass (18g per tonne). This low concentration, consisting typically of a variety of small objects, was furthermore disseminated over a large area, making aluminium collection somewhat akin to looking for a needle in a haystack.

Since the principal objective of the demolition was to obtain a clean and reusable concrete fraction, a significant percentage of aluminium was lost to recovery, as most of the aluminium components were attached to other materials. For example, door handles, accounting for more than 50% of the total aluminium content, were not separately collected but grouped together with waste wood which was incinerated or dumped and buried. Therefore, due to the complete lack of large aluminium structures, like windows, profiles and exterior cladding, and the extensive dissemination of small objects, which were not the primary focus of the demolition contractor, the collection rate in this instance was only 31%. This was substantially lower than in all the other buildings investigated but did not impact on the mean overall collection rate identified in the study.

Apartment buildings in Le Mans prior to demolition

Small aluminium components mixed with waste wood in Le Mans

Germany

In Germany, the deconstruction of 2 commercial buildings was monitored but only one of the buildings was actually demolished, the courthouse in Wuppertal. The other building, a department store in a busy shopping street in Frankfurt, was stripped down to its base structure to be immediately reconstructed for another purpose.

The courthouse in Wuppertal, built in the early 1960s, was a 17-storey tower block housing numerous offices. It was investigated, section by section, prior to deconstruction in order to determine its overall aluminium inventory, which was found to be in the region of 76 tonnes, a comparatively high 0.75% of the total building mass. This in fact represented the largest aluminium share identified in the study.

The main feature of this property was its extensive exterior aluminium cladding, forming an envelope around the building, which accounted for almost half of all the aluminium found. This was closely followed by the windows, which also made up well over a third of the aluminium content. These exterior cladding panels and aluminium windows were not part of the original construction but had been added 10 years earlier. A vast number of small aluminium objects were also identified, including door handles, name and information plates, ventilation grids, door sensors, and ashtrays affixed to walls, some of which had been installed many years after the construction of the building.

Because deconstruction was so meticulously accomplished by a reputable ISO-certified demolition firm, ECO-Soil, virtually all the materials found their intended destinations. All the aluminium components, large and small, were collected and sorted for resale, melting or shredding. The windows were not dismantled but sold as they were (aluminium and glass) to a buyer in Romania. Hence, an exceptionally high collection rate of 98% was obtained.

Wuppertal courthouse prior to demolition

Extensive exterior aluminium cladding

Removal of hazardous waste from the roof of the courthouse

The department store in Frankfurt was a very old building, dating back to just after the Second World War, which had been renovated, or at least revamped, 25 times in its existence. Due to financial considerations, the building had been sold and the new owner planned to use it for an entirely different purpose, for which it needed to be completely stripped clean of all materials in order to be rebuilt. Thus, the building was to be completely deconstructed but not actually demolished. Furthermore, disassembly was to be completed within a period of just four weeks because of the exorbitant real estate prices in downtown Frankfurt. Due to the speed of the project, assessment of the aluminium inventory had to be made promptly, before an extremely accurate deconstruction scheme was applied by another highly proficient ISO-certified demolition operator, Hochtief.

Aluminium window frames in the Wuppertal courthouse

The interior of the building was found to contain a diversity of decorative and practical aluminium components, typical of a retail outlet. A significant proportion of aluminium was also utilized for exterior elements. Up to 99% of aluminium parts encountered were wrought alloys with a broad range of application.

Aluminium was detected in bus bars installed in the ceilings for lighting, in air conditioning tubes, in casing for cables and in windows, doors and outside panelling. More than a quarter of the total aluminium inventoried was used for an immense variety of smaller pieces. It was found to make up 0.175% of the total building mass, amounting to an overall aluminium content of 21 tonnes.

Aluminium windows to be reused intact

During disassembly, all the aluminium components were clearly identified and, for the most part, separately collected in designated boxes. Those which could not be individually retrieved were, in all likelihood, separated during the subsequent rubble processing but, for the purposes of the study, this tiny percentage was considered lost. Nevertheless, the deconstruction process yielded a remarkably high collection rate of 98%.

Italy

Pirelli building prior to demolition

In Italy, the deconstruction and demolition of one immense commercial building, the Pirelli building situated in the north of Milan, was closely and scrupulously followed. Data were also gathered on aluminium content in a number of residential buildings, in various locations, to obtain some indication of expected collection rates in the absence of demolition.

The Pirelli building had formerly housed a factory producing insulated copper cables as well as office premises. Though only a two-storey building, it occupied a vast surface area of 45 000 m^2, totalling some 90 000m^2 over the two levels, the ground floor being devoted to factory operations and the first floor primarily to office space. Thus, deconstruction needed to be extremely methodical and precise and the contractor, General Smontaggi, an ISO-certified company based in Turin, showed a high level of competence in their approach to the entire demolition process.

In particular, tight procedures had to be maintained for the removal of hazardous and environmentally unfriendly materials such as asbestos, mineral wool, fluorescent tubes, PVC and roofing tars, of which there were significant amounts. Boreholes were also drilled to obtain soil samples prior to demolition, to check for soil contamination.

Aluminium pipes and office windows in the Pirelli building

The largest share of aluminium, amounting to 25 tonnes out of an overall inventory of 61.4 tonnes, was found in the office windows of the building, the majority of which was successfully recovered. A substantial proportion (almost a quarter of the total aluminium content) had been used as insulation cover for the 16 000 metres of insulated pipes running through the factory on the ground floor. Because these pipes contained both asbestos and mineral wool, they required extremely thorough specialized stripping, which in turn boosted aluminium collection. The same was true of the square ceiling plates and strips which accounted for approximately one-sixth of the aluminium inventory: mineral wool had to be separated from the aluminium, so the recovery of one material aided collection of the other. Considerable amounts of aluminium were also retrieved from partition wall profiles and door frames.

Square aluminium ceiling plates stacked and ready for transportation

The building contained a wide variety of small aluminium components like warning and information signs, name and light switch plates, frames around plates, door handles and thresholds, adding up to about 6 000 individual items but actually making up less than 1% of the total aluminium content. These pieces, widely disseminated over the whole area of the building, were not recovered from the debris because no mechanical processing was available. They were simply stripped together with waste materials such as wood and subsequently transported to a disposal site. Furthermore, due to restricted access to the site by a limited number of operators, many small items that would otherwise have been recovered manually by on-site workers were lost to recovery.

Aluminium ceiling strips in the Pirelli building

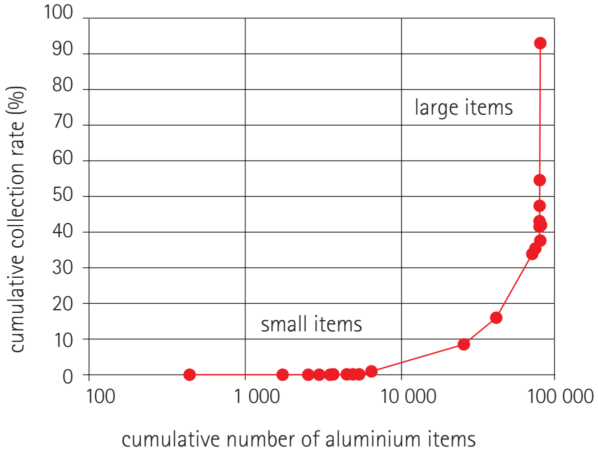
However, as these small components accounted for such a tiny proportion of the overall aluminium inventory of the building, the fact that they were not retrieved did not have any impact on the final collection rate. As was observed throughout the study, the best collection rates were systematically achieved from the recovery of larger pieces. Thus, from an aluminium share of 0.043% of the total building mass, a highly satisfactory collection rate of 94% was demonstrated.

Additional data were also obtained on the aluminium content of residential housing in two different regions: Rome and the Milan/Brescia area. In Rome, former houses that had been transformed into offices were investigated in the old city centre, as well as apartments in a busy shopping street and a middle income residential quarter. In the Milan/Brescia area, three separate sites accommodating different types of apartment buildings were studied.

Aluminium window frame and shutters in a Milan apartment building

The aluminium inventory identified in all these instances, consisting principally of large components like windows, doors and sun blinds which lend themselves to simple deconstruction and separation, strongly indicates that collection rates nearing 100% are entirely feasible. In view of aluminium's high scrap value compared to other demolition debris, such prime rates are fully anticipated.

COLLECTION RATES OF PIRELLI BUILDING REPRESENTATIVE OF GLOBAL STUDY OBSERVATIONS



The Netherlands

In the Netherlands, only residential housing was investigated, as no commercial demolition sites were available for investigation at the time. Thus, a complex of apartment buildings in Ridderkerk, close to Rotterdam, and a large series of over 200 virtually identical terraced houses in Eindhoven were selected for study.

Terraced houses in Eindhoven

In Ridderkerk, 7 apartment blocks constructed in the 1970s were readied for demolition by an experienced contractor, Van Eck, operating with full ISO-certification. As in all cases, a comprehensive aluminium inventory was made and was found to include items such as door and window grips, door thresholds, draught prevention strips and strips around windows. The aluminium content of a single apartment was calculated at just 3.8 kg which, when extrapolated to include all 7 apartment buildings containing 272 apartments, gives a total figure of just over one tonne for the entire complex. This constitutes a very low aluminium inventory in these 7 buildings, amounting to only 0.0032% of the overall mass, completely in line with the global study findings on residential housing in northern Europe.

Meticulous stripping was carried out in order to obtain the cleanest possible fractions of the various materials contained in the buildings. Waste wood was processed, with foreign materials being individually retrieved, to secure a pure wood fraction for the production of wood chips or combustion. Such processing is of great benefit to aluminium recovery as each category of material is separated: ferrous metals, non-ferrous metals, rubble, plastics, etc. Similar treatment was applied to stone rubble, concrete rubble and polymers, from which metals were recovered with magnets and eddy current separation, or by manual picking.

Aluminium contained in parts destined for export, incineration or disposal was lost to recovery but this did not significantly affect the final collection figure as the quantities were very small. Indeed, the percentages involved are generally insubstantial since export is banned for most materials, incineration incurs excessive costs, though aluminium can often be recovered from bottom ashes, and dumping is not widely practised in the Netherlands. Optimal aluminium recovery rates are thus assured as a result of rigorously applied procedures, in this case yielding an excellent collection rate of 95%.

Aluminium sink unit, door handles and window strips

In Eindhoven, the study focused on the demolition of 213 terraced houses from a series of 311 in total that had been constructed in the early 1920s and later renovated in 1970. The remaining 98, constituting one entire section built around an inner courtyard, were preserved as a site of historical interest. Due to a shortage of wood in the 1920s, asbestos had been used for many elements and needed to be removed by a specialized contractor, before further demolition could be expertly carried out by the ISO-certified Gebroeders van Zundert.


Aluminium identified in roof strips and chimneys

The aluminium found in these houses had actually been added several decades after the original construction. It had been utilized essentially for items like doors, kitchen sinks, strips and pipes, accounting for 0.0049% of the overall mass of a single house or a total weight of 8.7 kg per house. Since the houses were practically identical and the aluminium had always been used for similar applications, the final calculations could be based upon the mean figure obtained for just several houses.

During deconstruction, separation procedures were extensively implemented, the metal components being initially collected in one mixed metal container, before being sent to a local scrap dealer for separation into individual fractions. Waste wood was also sent to a processing facility where all foreign materials, including aluminium, were retrieved to obtain clean wood for recycling. This type of processing is widespread in the Netherlands where waste wood recycling plants are routinely equipped with metal recovery machinery. Rubble was also similarly treated.

As in Ridderkerk, the low percentage of aluminium lost to recovery was in the small fractions destined for dumping, export or incineration which, for reasons previously outlined, did not significantly affect final recovery rates. Thus, the aluminium collection rate from this large series of houses was also found to be in the region of 95%.


Mixed metal scrap

Spain

In Spain, the stripping and deconstruction of a building housing the BNP Paribas bank, situated right in the centre of Madrid, was carefully monitored. Additional data were also collected on the aluminium inventories of various commercial and residential properties in different parts of the country, in order to refute some existing statistics apparently indicating low aluminium content in Spanish buildings.

The BNP Paribas building was to be stripped down to its bare concrete shell in order to be subsequently rebuilt. Deconstruction was consummately performed by an ISO-certified demolition company, Detecsa, according to the standard sequence, beginning with the retrieval of hazardous and semi-hazardous materials. This was followed by the systematic removal of all other materials, starting from the top floor, working down to the ground, floor by floor. Only the roof was left intact to protect the site from adverse weather conditions.

The building was essentially a 7-storey construction with 2 further levels containing service equipment like elevator hoisting and air conditioning elements, as well as the electricity and

Inclined exterior aluminium panels and windows of the Madrid BNP Paribas bank

water supply. It had a rather striking appearance due to the rows of inclined exterior aluminium panels positioned above the windows on each floor, which easily accounted for the largest share of aluminium in the building. Each individual panel weighed between 60 and 80 kg so these panels alone made up more than half of the overall aluminium content, while over a quarter could be attributed to the windows and doors. The total aluminium inventory was calculated to be 92 tonnes, a very respectable 0.40% of the total building mass.

Aluminium cladding, windows and ducts

Demolition in progress

Some aluminium structures were rather imaginatively used by the demolition contractor for various practical purposes during demolition, before being recovered from the site. For example, partition wall profiles were utilized to cover open holes in the floors to assist with deconstruction and retrieval procedures. Aluminium components were also found serving very specific functions. Raised floors, specially designed to allow for the passage of a diversity of cables underneath, were supported by metal constructions held in place with highly resistant cast aluminium studs.

Clean rubble after meticulous stripping of aluminium and other materials

The ground floor, fairly typical of a bank lobby with high ceilings and luxurious brass and marble fittings, was effectively transformed from an opulent entrance hall to a logistics area and depot during demolition. Heaps of separate materials were collected on each floor and the elevator shafts were used to transfer the different materials, including rubble, to waiting containers below.


Separation of metals


Demolition in progress

Aluminium was recovered competently and accurately, with effective collection of all the large components. As is generally the case, aluminium contained in small parts, weighing less than 250g, was lost to recovery as these pieces were often attached to other materials which were not selectively disassembled.

Certainly, a small quantity of aluminium was disposed of together with the mixed rubble and waste wood fractions destined for landfill sites. In Spain, the abundance of quarries means building materials are readily available and used rubble is rarely needed for new constructions. Open quarries are therefore routinely filled with mixed rubble from demolition sites, though this practice is set to be curbed by EU legislation. Nevertheless, a very favourable aluminium collection rate of approximately 95% was achieved.

Further data were gathered on the aluminium content of several commercial and residential properties in different areas of Spain. In central Madrid, a large office and laboratory building belonging to a public electricity company was investigated and aluminium was widely detected, principally in the windows and partition walls, but also in a variety of small objects in the laboratory.

Residential housing in Barcelona and Alicante was also studied and found to contain significant volumes of aluminium in applications such as windows, roller shutters, sliding doors and fences. The apartments investigated in Alicante are brand new constructions which, although strictly classed as residential, could more accurately be described as semi-commercial, since many of them are used exclusively as holiday homes. Thus, these premises are very luxurious, incorporating a whole host of large aluminium fittings, which can be easily dismantled and retrieved. Excellent collection rates are therefore indicated in case of future demolition.


Extensive use of aluminium in residential housing in Spain


Aluminium identified in windows and balcony fences in Alicante

The United Kingdom

In the United Kingdom, the demolition of an enormous sports stadium, the world famous Wembley Stadium, was investigated for the purposes of the study. This arena, measuring some 200 metres wide and 300 metres long, was to be razed to make way for a brand new sports complex on the same site. Revered by many as the spiritual home of football, but actually used for a diversity of other sporting events as well as pop and rock concerts, Wembley Stadium had achieved iconic status in the UK. It had, however, stood empty for several years prior to demolition, not having seen any match play since 1995.

It had originally been conceived as the centrepiece of the British Empire Exhibition in 1924. It took one year to build and was completed in 1923, well in time for its intended purpose. The main feature of this construction was the inclined concrete stair-like seating sections that had the capacity to hold up to 90 000 spectators. Tucked away beneath these seating sections, a huge range of facilities was housed, including restaurants, bars, sanitation areas, reception halls, meeting rooms, offices, media installations and VIP suites. The legendary twin towers at the main entrance to the stadium became the enduring symbol of this arena, even after its demolition. A devastated Wembley devotee described the demolition scene as reminiscent of an execution, with the towers holding their own until the bitter end, an image that remains deeply etched into the hearts and minds of many a football fan in the UK.

Demolition was undertaken by a well-established ISO-certified contractor, Griffiths McGee, implementing deconstruction practices conforming entirely to legal standards, with a strong focus on environment, health and safety. Selective disassembly of materials was applied following the prescribed order, starting with all hazardous and toxic materials, before the collection of metals. Particular care was taken to protect the original clay and concrete from contamination as the rubble was intended for reuse in the construction of the new stadium. A mobile crusher with magnetic separation equipment was utilized to this end, in order to obtain clean concrete fractions to level the site in readiness for the new construction.

The famed Wembley twin towers prior to demolition

The stands after removal of all the seats

Removal of turf from Wembley Stadium

Substantial quantities of aluminium, amounting to 185 tonnes out of an overall inventory of 213 tonnes, were identified on the roof of the stadium, which was constructed of a steel cantilever covered with aluminium plates. This vast amount accounted for the principal share of aluminium found in this arena, though a significant volume was also detected in the windows and doors. Such distribution is quite typical of that encountered in most sizable commercial premises where one or two larger categories of components account for the lion's share of collectable aluminium, while smaller objects are frequently lost to recovery.

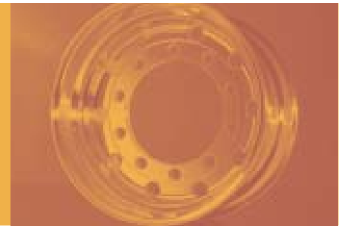
In this case, the aluminium retrieved from the roof was collected in its entirety for subsequent recycling, constituting 87% of the total aluminium identified. A considerable proportion of the remaining 13% was also accurately collected though, as always, a small percentage was not separately recovered but inadvertently grouped with other waste materials like wood and plastics, mainly from interiors. This mixed fraction was then transported to recycling transfer yards, located all over London, where a further, albeit small, quantity of aluminium would have been recovered and the rest inevitably lost. Furthermore, because the site had become a veritable shrine to dedicated football followers far and wide, many of them descended upon the area in the hope of securing their own small piece of Wembley history from the debris. Some undoubtedly succeeded.

In the final count, from a relatively high aluminium share totalling 0.61% of the overall building mass, indeed the second highest identified in the study, an extremely commendable collection rate of 96% was obtained.

Aluminium corrugated roofplates above the inclined concrete stair-like seating sections

Aluminium windows at one of the entrances to Wembley Stadium

Aluminium recovered from the roof of the stadium



CONCLUSION

The present study, executed by recognized authorities from the highly respected Delft University of Technology, has clearly demonstrated the efficiency of aluminium collection during the rigorously controlled demolition process. Indeed, collection rates from a cross-section of residential and commercial buildings investigated in 6 European countries were consistently found to exceed 90%, in some instances reaching 98%, and expected to rise even further. Such prime rates patently affirm the great recycling potential of aluminium, since it is known that recycling does not diminish its inherent value nor alter its unique properties. The recycling of aluminium from buildings is therefore not only economically viable but, above all, environmentally sound, as it makes a significant contribution to the cause of sustainability of resources for generations to come.

The aluminium industry has always placed great emphasis on the importance of recycling, investing widely in comprehensive schemes, such as those linked to the collection and processing of scrap. Long-established and effective recycling strategies all over Europe ensure aluminium's swift and smooth resorption into the economic system, with negligible losses. Although it was revealed that the mean aluminium inventory per building is currently less than 1% of the overall mass, the actual quantities of aluminium recovered from demolition sites are far from insignificant, often yielding a substantial return for the contractor. As observed by Professor Udo Boin, a renowned expert in the field from TU Delft, "this apparently small amount represents a considerable volume for collection and sometimes the only real monetary return from the entire demolition, thanks to the high intrinsic value of the metal".

From a purely practical point of view, it was noted that the recovery of aluminium from buildings is a relatively straightforward operation, since the metal is often affixed to other components from which it can be readily removed. Aluminium is also increasingly utilized for exterior structural elements and design features, like building façades, which are easy to dismantle prior to demolition. Associate Professor Jan van Houwelingen, another leading authority from TU Delft who investigated aluminium collection on site, remarked upon the ease with which the metal can be recovered, "due to its concentration predominantly on the surface of buildings". He also underlined the fact that "the volumes of aluminium retrieved from large parts in buildings far outweigh the quantities of aluminium recovered from small particles", which explains the minute losses incurred. Indeed, it was illustrated, time and time again, that the best collection rates were invariably linked to the recovery of larger pieces of aluminium.

Recycled aluminium poured into ingots for use in new applications

The study strongly indicates that aluminium collection rates will continue to rise with a growing awareness of environmental issues, increased social responsibility and the implementation of enhanced work practices. New Europe-wide regulations have already been introduced relating to the collection and destination of materials retrieved from demolition sites. In the experts' view, such legislation provides an important impetus for the recovery of aluminium. Ongoing cooperation between governments, local communities, businesses, construction companies and demolition contractors is paramount, however, to ensure a harmonious long-term partnership, dedicated to effecting constant improvements. The European aluminium industry is united in its immutable commitment to continued progress.

It has thus been unequivocally proved that aluminium has a fundamental role to play in the preservation of our environment. Vast reserves of this inimitable metal available for recycling effectively constitute a huge energy bank to serve the needs of future generations. The remarkably high aluminium collection rates identified in the study, which implicitly signify similarly high recycling rates, confirm the phenomenal potential of this thriving energy bank and its invaluable contribution to a universal sustainable development strategy.

ADDRESSES OF DEMOLITION COMPANIES BY COUNTRY

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