reusefully

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Report Prepared For:

GXN

Pre-demolition audit of Euston Tower

24th August 2022

Executive Summary

The pre- demolition audit was undertaken on the 6th of January 2022 and 10th February 2022 by Katherine Adams and Gilli Hobbs of Reusefully Ltd. A visual survey of the building, combined with analysis of the plans provided, was used to calculate the Key Demolition Products (KDP). The audit has investigated the key materials which are likely to rise from the full demolition to aid with the decision making for the proposed development at RIBA Stage 1. The embodied carbon of these materials has also been estimated. The quantities are as follows:

Materials	**Tonnes**	**Volume (m^3)**
Concrete	36,981	15,548
Steel	1,942	250
Brick	389	229
Glass	378	151
Aluminium	305	140
PVC	120	48
Gypsum	105	137
Softwood	34	69
Ceramic	16	7
Chipboard	12	17
Fibreboard	7	10
Aggregate	6	4
Insulation	4	89
Vinyl	1	1
Grand total	**40,303**	**16,701**

Concrete is by far the most prominent material, estimated to be 36,981 tonnes from a full demolition (92% of all demolition arisings. This does not include waste that has already been generated as part of the strip out process, which is estimated to be 1,848 tonnes (as provided by the demolition contractor). The embodied carbon of the materials present within the building is estimated to be 10,937 tonnes of CO_2e.

Parameters and points of interest have been provided for key products to assist with reuse in this development and externally and to assist with BREEAM requirements. A presentation has also been issued which has the key parameters for products and images (titled *ET Pre-Dem Results 20.4.22*).

Contents

1. The Requirement

GXN have engaged Reusefully Ltd to carry out a pre-demolition audit of Euston Tower in London. The aim of the audit is:

- To provide an understanding of the types and amounts of products and materials arising during the demolition.
- Provide key parameters for products and elements to identify opportunities for reuse.
- To optimise the management of products and materials from the demolition and provide recommendations to the design team and demolition contractor in line with the waste hierarchy i.e. maximise reuse and recycling and minimise waste to landfill
- To provide details of the embodied carbon of the materials resulting from demolition
- To provide technical advice on the reuse of products and recycling of material on site
- To provide data to help with populating the Resource Management Plan and in support of the BREEAM assessment and the Greater London Authority Circular Economy Statement
- To advise on targets for reuse and recycling for products and materials arising during the demolition

2. Site details

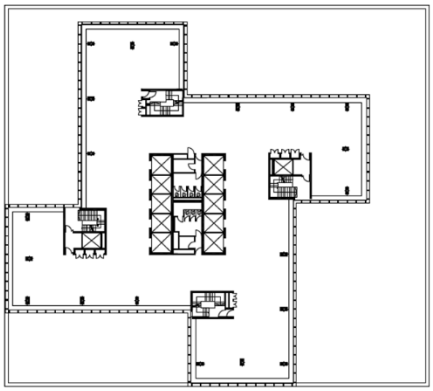
Euston Tower is located on Euston Road in the London Borough of Camden. It was built in 1970 and has been mainly used for offices. It has a storey height of 36 floors; the overall height of the building is 124 metres. There is a wraparound building on the ground and 1st floor which is used for retail/café space (on the ground floor) and offices (on the 1st floor). At the time of the visit, strip out works had occurred on most of the floors, with some plant equipment still being removed. The floor plate is the same for each floor of the tower with 4 core areas of stairs, a central core of bathrooms and lifts (one set to Floor 19 and the other set to Floor 35). There are a number of floors which have plant equipment (Floors 1, 12, 24, 34 and 25). The building comprises the following:

- Glass façade with aluminium mullions and aluminium sheet cladding on the tower
- Secondary glazing throughout the Tower (except Floor 36)
- Glass façade with louvres on the ground and first floor
- A double height glass atrium
- Reinforced concrete floors and columns – beam, ribbed and standard sections
- A mix of precast concrete, concrete block, brick and stud walling.
- A steel deck poured with concrete used for the lower floor building

The floor plate of the Tower is shown below(taken from Euston Tower Design Scheme Presentation 11.1.22).

Demolition

Existing



3. The Pre-Demolition Audit

The pre-demolition audit was undertaken on the 6th of January and the 10th of February 2022, consisting of a non-invasive visual survey of the buildings. Certain areas were inaccessible, such as the ground floor units and not all floors were visited. Hence, construction details and materials have been inferred based on typical practice. Survey notes and photographs were taken, and plans of the buildings were supplied (though not detailed floor layouts). Also provided was access to Matterport files, demolition and orginal architectural and engineers drawings. There is also a BIM model of the core areas and some floors.

On the basis of information gathered and provided, an analysis of materials arising from a full demolition has been undertaken, with results reported in both weight and volume. The weight has been calculated using standard density figures for the materials identified. Embodied carbon figures have also been used (See Appendix A for source and assumptions).

A presentation has also been issued which has the key parameters for products and images (titled '*ET Pre-Dem Results 20.4.22*).

The following assumptions have been applied:

Demolition

- Removal of the entire building down to floor slab

Please note, a number of areas have not been included in this audit, due to lack of access/information – however the amount of materials is thought to be relatively insignificant compared to the amount of materials already identified. This includes the internal areas of the commercial and retail units, the fixtures and fittings on the ground floor and first floor (which have

not as yet been removed), any waste electronic and electrical equipment including lifts and plant equipment. As the basement is communal with other buildings, this has been excluded. Any equipment on the roof has not been included.

4. Demolition Results

Overall, there is an estimated 40,303 tonnes (16,701m^3) arising from the demolition. Concrete is the largest KDP (36,891 tonnes) followed by Steel (1942 tonnes), Brick (389 tonnes), Glass (378 tonnes), Aluminium (305 tonnes), PVC (120 tonnes), Gypsum (105 tonnes) and Softwood (34 tonnes) as shown in Figure 1 and 2 and Table 1. In volume, the largest KDP is Concrete (15,547m^3), followed by Steel (250m^3), Brick (229m^3), Glass (151m^3), Aluminium (150m^3), Gypsum (137m^3) and Insulation (89m^3). Each of these KDPs is described later in the report detailing their arising, likely management options and next steps (where applicable) to support reuse and/or higher value recycling.

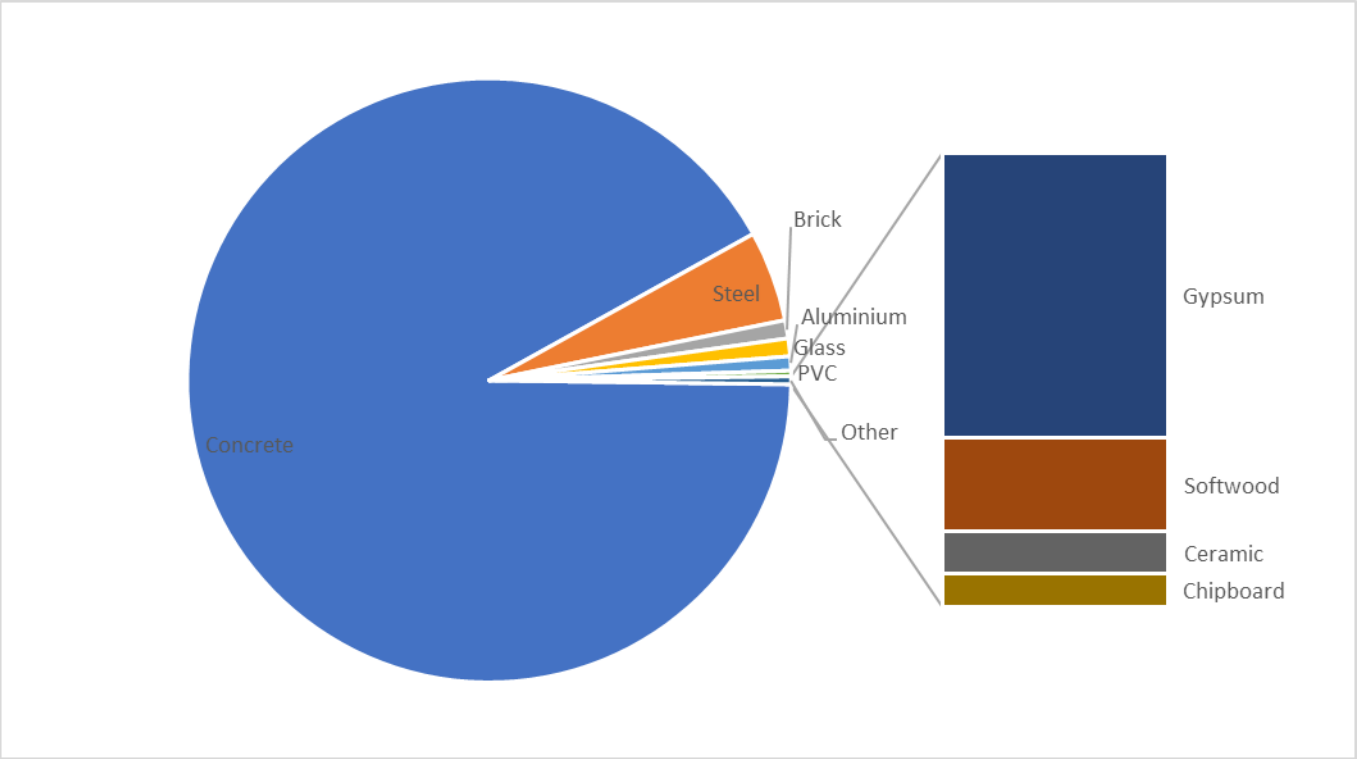


Figure 1: Demolition Results - KDPs by weight (tonnes)

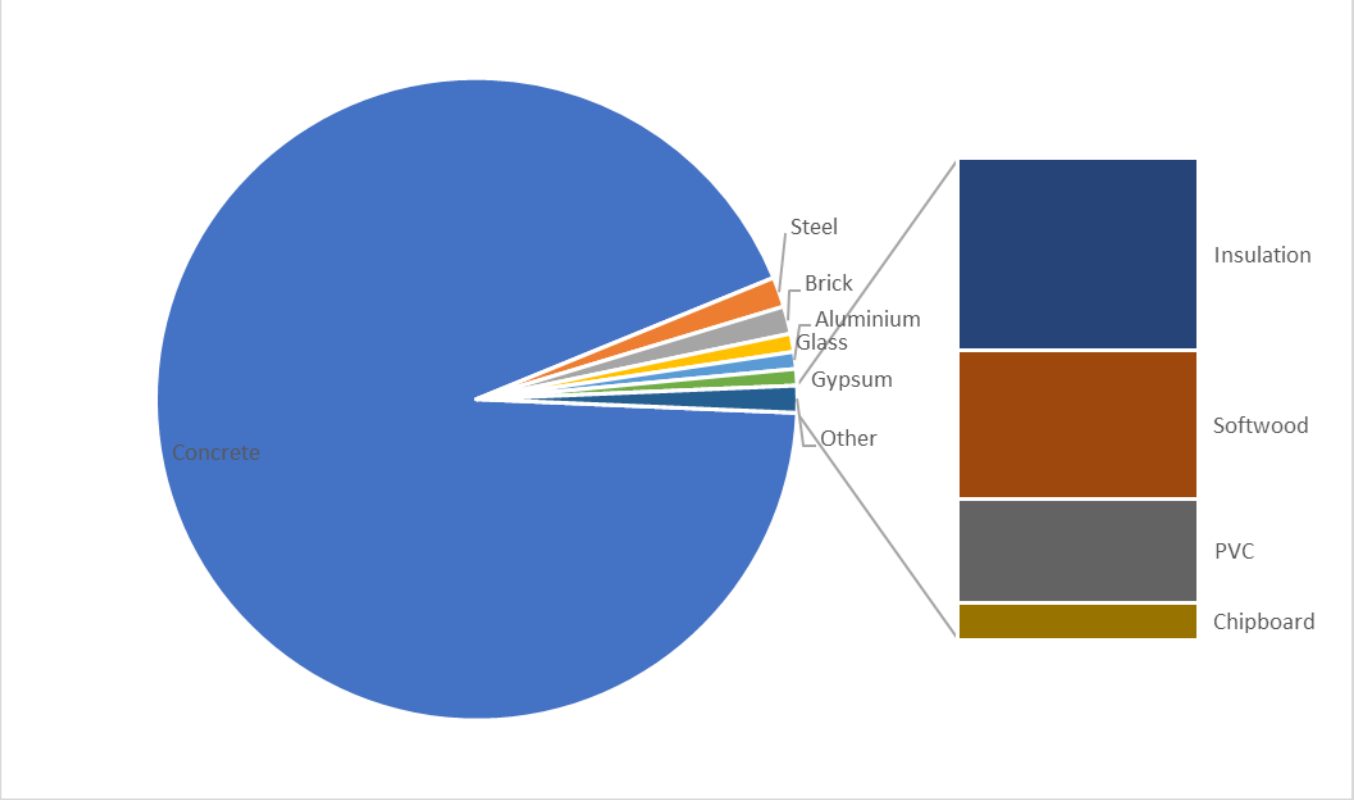


Figure 2: Demolition Results - KDPs by volume (m^3)

Table 1 provides the weight (tonnes), volume (m^3) and European Waste Codes for each KDP.

	Weight (tonnes)	Volume (m^3)	EWC
Concrete	36,981.12	15,547.81	17 01 01
Steel	1942.39	249.78	17 04 05
Brick	388.50	228.53	17 01 01
Glass	378.37	151.35	17 02 02
Aluminium	305.13	140.49	17 04 05
PVC	120.30	48.12	17 02 03
Gypsum	105.38	137.14	17 08 02
Softwood	34.31	68.63	17 02 01
Ceramic	15.84	6.60	17 01 03
Chipboard	12.22	17.46	17 02 01
Fibreboard	7.18	10.26	17 02 01
Aggregate	6.48	4.00	17 01 01
Insulation	4.47	89.36	17 06 04
Vinyl	1.34	0.99	17 02 03
Grand total	**40303.05**	**16700.52**	

Table 1: Demolition Results - KDPs by tonnage and volume (m^3)

Strip out results

Information has been provided by the contractor, JF Hunt, on the amount and type of waste that has been produced from the strip out process to December 2021. This has been logged on to BRE's SmartWaste system. As of the 21st of December 2021, 1,848 tonnes of waste had been produced and of that 100% diverted from landfill. Of this, metals were the greatest, at 740 tonnes (40%); followed by mixed waste at 527 tonnes (29%), plasterboard/gypsum at 222 tonnes (12%), timber at 193 tonnes (10%) and carpet at 70 tonnes (4%). There are smaller amounts (less than 30 tonnes each) of inert waste, floor coverings, tiles and ceramics and concrete. There was also 1.4 tonnes of hazardous materials (oils, refrigerants and asbestos). Due to way the data has been collected it is difficult to infer what materials are in the mixed waste category. The results can be seen in Table 2 and Figure 3. Note, these figures are likely to have increased as more plant has been taken out since these figures were provided.

	Weight (tonnes)	**EWC**
Metals	739.49	17 04 07
Mixed construction and/or demolition waste	526.52	17 09 04
Plasterboard / Gypsum	222.2	17 08 02
Timber	192.86	17 02 01
Carpets	69.5	20 01 11
Inert	30	17 01 07
Floor coverings (soft)	26.92	20 01 11
Tiles and Ceramics	23.82	17 01 03
Concrete	15	17 01 01
Oils	1	13 01 13*
Refrigerants	0.371	14 06 01*
Construction materials containing asbestos	0.03	167 06 05*
Grand Total	**1847.71**	

Table 2: Strip Out Results – Waste by tonnage

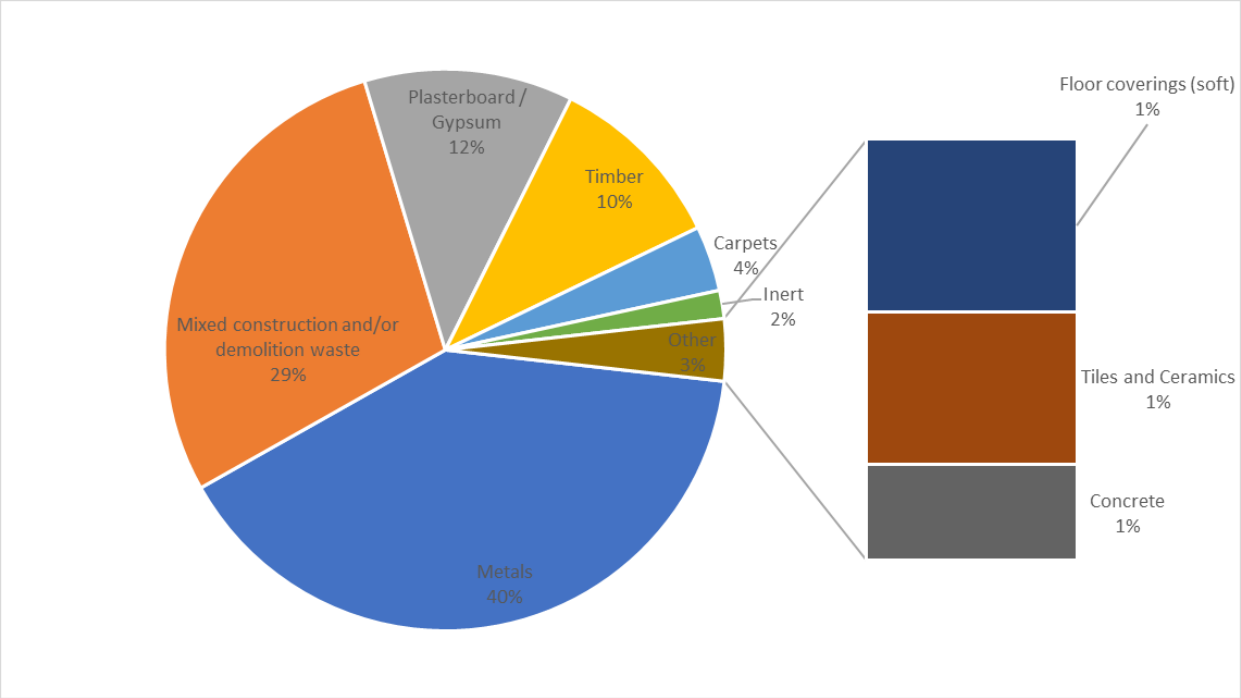


Figure 3: Strip Out Waste Results – waste by tonnage

The destination of the waste materials has also been recorded. This shows overall that 4% of materials was reused (all of the carpet at 60.5 tonnes); 41% of the materials were sent for direct recycling (largely the metals) and 37% for recovery (further reprocessing) which accounted for the plasterboard and gypsum. The majority of the timber was sent for energy recovery as well as the mixed construction and demolition waste at 39% (these figures seem high, so there could be some inaccuracy in their reporting). Table 3 and Figure 4 provide more information.

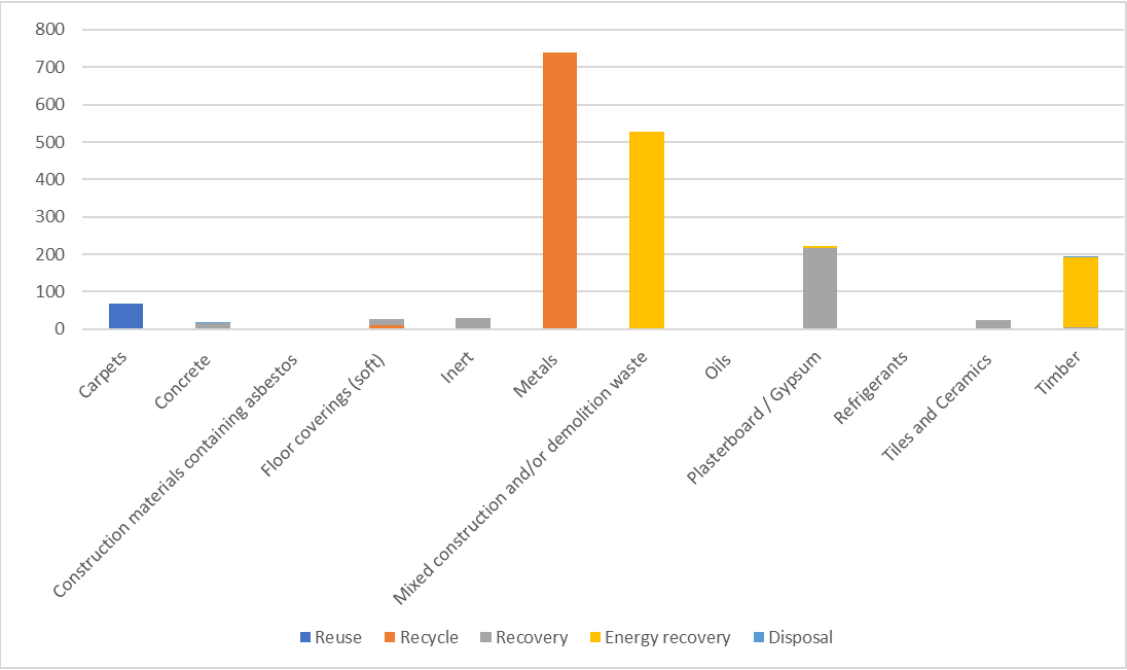


Figure 4: Strip Out Waste Results – waste management routes

	Reuse	Recycle	Recovery	Energy recovery	Disposal
Carpets	69.5				
Concrete			15		0.03
Construction materials containing asbestos					
Floor coverings (soft)		9.84	17.08		
Inert			30		
Metals		739.49			
Mixed construction and/or demolition waste				526.52	
Oils			1		
Plasterboard / Gypsum			216.64	5.56	
Refrigerants			0.371		
Tiles and Ceramics			23.82		
Timber			4.32	188.54	0.03
Grand Total	**69.5**	**749.33**	**308.23**	**720.62**	**0**

Table 3: Strip Out Results – Waste management routes (by tonnes)

Table 4 provides details of the waste destinations. Carpet was reused by community organisations (one abroad) via Globechain. Most of the waste was sent to waste transfer stations such as Westminster Waste, Suez and Powerday for either further sorting or recycling. Metals were sent directly to metal recycling sites. Concrete was also sent directly for recycling.

Waste type	Destinations
Carpets	CCORRN (Cambridgshire Community Reuse and Recycling Network) via Globechain Hawa Trust via Globechain
Concrete	Recycled Material Supplies Ltd - Sunshine Wharf
Construction materials containing asbestos	Cohart Asbestos Disposal Ltd
Floor coverings (soft)	European Metal Recycling – Willesdon Worcester Recycling Croydon Ltd
Inert	Recycled Material Supplies Ltd - Sunshine Wharf
Metals	European Metal Recycling – Wandsworth European Metal Recycling – Willesdon Southwark Metals Ltd Suez Recycling & Recovery South East Ltd Westminster Waste
Mixed construction and/or demolition waste	Powerday Plc Suez Recycling & Recovery South East Ltd Westminster Waste
Oils	MAG Properties Services Ltd
Plasterboard / Gypsum	Powerday Plc Suez Recycling & Recovery South East Ltd

	Westminster Waste
Refrigerants	MAG Properties Services Ltd
Tiles and Ceramics	MSK Waste Management & Recycling Ltd
Timber	Powerday Plc Suez Recycling & Recovery South East Ltd Westminster Waste

Table 4: Strip Out Results – Waste management destinations

5. Concrete

Concrete is the largest KDP identified, estimated to be approximately 36,981 tonnes from the full demolition as shown by Table 5 (equivalent to 3,865 tonnes of CO_2e). This is from a number of sources, the most from the concrete floor slabs (17,613 tonnes), the columns (4,355 tonnes), precast walls (9,488 tonnes) and beams (4,043 tonnes). Most of the concrete is unsuitable for reuse, as it is not in precast sections, though some of the walls are precast. There is also fire retardant spray (similar to grout) on the underside of around half of the floor slabs; this maybe difficult to remove.

Concrete is in theory 100% recyclable. It can be segregated and crushed for reuse as hard core, fill or in landscaping or used as recycled aggregate in new concrete. Although recycled and secondary aggregates can be used in some concrete applications, other lower grade end uses (e.g. in unbound materials as fill and hardcore) may sometimes be more resource efficient due to reduced processing demands and transportation. Often such waste does not even leave the demolition site, being used for the site's redevelopment, as shown by the NFDC figures with nearly half of inert waste (over 9 million tonnes) treated this way. Otherwise, it is used on other sites as fill to offset the need for primary raw materials. Very little concrete waste therefore tends to go to landfill.

It is recommended that the concrete should be segregated either onsite (space is limited on site) or at a waste facility and crushed to produce recycled concrete aggregate (RCA)[1] in accordance with the WRAP Quality Protocol for aggregates[2] from inert waste. Ideally, this should be used back in concrete, possibly into precast elements to be used in the further development. It can also be used for lower value applications such as for piling mats and temporary/ permanent fill (infilling). If reprocessed, stored and/or used onsite then appropriate permits[3] or exemptions will be required for these operations. RCA is of a higher quality than recycled aggregate (RA) due to the limit of masonry in the aggregate (maximum of 5%). The performance characteristics of RCA are better than RA and therefore there are fewer restrictions on the use of RCA in concrete. The use of RCA in concrete is given in BS 8500-2[4].

Various options are available to utilise RCA as listed below.

Recycled concrete aggregates can be used in:

[1] Recycled concrete aggregate is aggregate resulting from the processing of inorganic material previously used in construction and principally comprising crushed concrete [BS 8500-1: 2002].

[2] https://www.gov.uk/government/publications/quality-protocol-production-of-aggregates-from-inert-waste

[3] https://www.gov.uk/guidance/waste-environmental-permits

[4] https://shop.bsigroup.com/products/concrete-complementary-british-standard-to-bs-en-206-specification-for-constituent-materials-and-concrete/standard

1. Bitumen bound materials – Recycled concrete aggregate can be used may be used in a variety of base course and binder course mixtures.

2. Concrete – Recycled concrete aggregate is permitted for use in certain grades of concrete. It is generally acknowledged that RCA can be used to replace 20% of the coarse aggregate in concrete up to Grade 50.

3. Pipe bedding – suitably graded recycled concrete aggregate is used in pipe bedding.

4. Hydraulically bound mixtures (HBM) for subbase and base – recycled concrete aggregate can be suitable for use in HBMs. These can be used in the construction of car parks, estate/minor roads and hard standing.

5. Unbound mixtures for subbase – suitably graded recycled concrete aggregate is used as subbase.

6. Capping – Recycled concrete aggregate is suitable for capping applications.

Best practice

There is an opportunity to reuse the concrete paving stones used on the lower ground roof with the majority (at least 75%) which appear to be of good quality. There is an example of reuse of precast panels through a new EU Project: Recreate and the SuperLocal project Superlocal . There are also examples of higher value recycling technology where the constituents of concrete are separated, also producing a cementitious product that can reduce the need for new cement Smartcrusher (note not in the UK as yet).

Inert waste can also be used for making bricks e.g. the K-Briq (in Scotland) https://kenoteq.com/ and StoneCycle https://www.stonecycling.com/ .

Examples of structural concrete that have been used as RCA include the London Olympics 2012 London 2012 sustainable aggregates and Building B16 at BRE; BRE's Environmental Building

Otherwise, concrete waste can also be used for blocks and paving. For example, Blocks (Aircrete) can be up to 70%; other blocks average 24%; Aggregates in concrete blocks; but can vary considerably e.g. 74%; Sheehan Concrete blocks.

Further testing and investigation

It is recommended that further sampling and testing is carried out to enable high quality recycling of all the concrete removed. This includes:

- Testing of the 'groutlike' substance on the underside of numerous concrete floor slabs to determine the composition and likely impact as a contaminant in the recycling applications listed above.
- Testing of the concrete (removal of small samples) in each of the key areas – floor slab, columns and walls to determine composition of the concrete and possible contaminants, such as elevated levels of chlorides and sulphates.
- Further testing of the concrete, as required, to meet the specifications of potential high value end uses, such as precast concrete elements, concrete blocks etc
- Discussions with the providers of the SmartCrusher equipment on the viability of using this system in the UK.

Local waste management companies

Local waste management companies that could manage the concrete waste include:

- Powerday, https://www.powerday.co.uk/ T: 020 3858 0504
- Norris Skips, https://norriskips.co.uk/skip-hire/ T: 020 8698 8000
- RTS Waste, www.rtswaste.co.uk T: 020 7232 1711
- Days Group, http://www.daygroup.co.uk/. T: 0845 065 4655

Alternatively, licensed waste management contractors or demolition contractors should be able to reprocess concrete waste into aggregates.

Item	Area m^2	Volume (m^3)	Tonnes	Tonnes of CO_2e
Concrete floor slab	20,391.37	5,063.69	12,152.85	1,251.74
Columns	3,148.52	1,814.66	4,355.18	448.58
Concrete beams	5,691.15	1,680.88	4,034.12	415.51
Precast walls - 300mm	5,391.76	1,596.03	3,830.48	394.54
Ribbed slab - ribs	7,466.00	1,445.42	3,469.00	357.31
Precast walls - 200mm	7,110.34	1,407.89	3,378.94	348.03
Precast walls - 380mm	2,045.28	773.13	1,855.51	191.12
Ribbed slab - intermediate areas	11,172.17	541.85	1,300.44	133.95
Precast concrete staircase	34.80	477.46	1,145.89	118.03
Lower ground roof deck	2,304.00	345.60	691.20	71.19
Precast walls - 100mm	1,780.59	176.28	423.07	43.58
Block: Concrete: Lightweight	1,808.66	168.93	236.50	61.49
Mortar	4214.870843	52.90	100.51	20.10
Paving slabs lower roof	62.00	3.10	7.44	0.77
Total	**72,621.52**	**15,547.81**	**36,981.12**	**3,855.94**

Table 5: Estimated concrete arisings from demolition

6. Steel

Steel accounts for 1,942 tonnes (250m^3) of materials arising from the demolition as shown by Table 6 (equivalent to 3,938 tonnes of CO_2e). This comes from a variety of sources, but the majority is as reinforcement in the structure at 1,871 tonnes from the demolition. There is likely to be limited opportunity to reuse this steel as the majority is embedded within the structure. Smaller items such as the joists on the internal staircase, handrails and balustrades could potentially be reused, as could the steel supports on the secondary glazing structure.

Where structural steel is available and suitable for reuse, then the SCI has produced a protocol for its reuse[5] including how to test for recertification. This describes the following process:

- A building is offered for salvage of the steelwork for reuse. Considerations include the acceptability of the source material, the demountability of the structure, the increased cost of careful demolition, etc.

[5] https://steel-sci.com/assets/downloads/steel-reuse-protocol-v06.pdf

- A business case is established between the holder of stock and the company responsible for demolition.
- Important details of the anticipated salvaged steel are recorded as described in the document
- Salvaged steelwork is received by the stockholder, grouped and listed as described in the document. The necessary grouping has an important impact on the extent of testing required.
- Members are inspected and tested in accordance with the guidance with the information appended to the stock data. The testing regime involves a combination of non-destructive and optional destructive testing, with the opportunity to make conservative assumptions about certain material characteristics. Testing may be completed at any convenient time, but the seller of the stock is responsible for declaring the necessary characteristics as the material is sold.
- Material is sold, with an accompanying declaration of the material characteristics by the holder of salvaged stock.
- Structural design and member verification is completed with certain modifications, as described in the document.

For recycling, steel should be segregated on site. It is common practice for demolition contractors to reduce their contract value by allowing for the income from the recycling of metals during demolition. Standard skip hire companies are likely to charge for haulage costs only and may give back a small rebate on the metals. Once segregated, it is usually sent to a metal scrap merchants (recyclers). At these, the metals will be sorted, sheared (cutting large pieces), shredded, graded, and baled. The steel will be then sent to smelters to be re-melted as ingots (which are usually downcycles material), and then sent to steel furnaces. Much of this maybe abroad - depending on the price per tonnes the scrap merchant can obtain (currently it is around £350/tonne). The UK does not use all the scrap metal it produces with around 80% exported to countries such as China and Turkey.

Best practice

Best practice for steel is for it to be reused; recycling is the business as usual model. Cesla Steel (are introducing a scheme where steel can be bought by them and recycled in their furnace and a voucher provided for new high recycled content steel (around 98%) (mainly rebar). They are looking for companies to pilot this with.

Further testing and investigation

As indicated, there is limited reuse options for steel, with only a small quantity of structural steelwork available (as part of the internal staircase on level 34/35). Should this be suitable for reuse than further testing may be required to determine chemical composition, Charpy impact test (fracturing) and yield/tensile strength. This could also be useful if considering reuse opportunities for the secondary glazing support struts.

Local waste management companies

Local waste management contractors include:

- Capital Metal Recycling, http://capitalmetalrecycling.co.uk/ T: 0208 964 2120
- London Scrap Metal Recycling, http://www.londonscrapmetalrecycling.com T: 0208 809 1019
- EMR Group http://www.emrgroup.com/

Item	Area m^2	Volume (m^3)	Tonnes	Tonnes of CO_2e
Columns	3,148.52	80.62	624.74	1,270.75
Ribbed slab - steel rebar	17,875.48	55.24	429.45	854.61
Concrete floor slab - steel rebar	20,391.37	34.16	265.56	528.46
Concrete beams - steel rebar	5,691.15	26.46	205.76	409.46
Precast walls - 300mm - steel rebar	6,111.76	24.37	189.46	377.02
Precast walls - 200mm - steel rebar	7,110.34	14.18	110.23	219.37
Precast walls - 380mm - steel rebar	2,045.28	4.08	31.69	63.07
Steel deck	2,304.00	3.46	26.87	66.10
Secondary glazing support	146.00	2.13	16.55	45.69
Precast walls - 100mm - steel rebar	1,780.59	1.78	13.84	27.55
Metal ballustrade	1,319.50	1.32	10.26	28.01
Metal handrail	204.75	1.02	7.96	21.73
Metal studwork - joists	387.21	0.77	5.42	14.96
Metal studwork - top/base channels	69.52	0.28	1.95	5.37
Steel Staircase (internal)	6.32	1.14	1.17	3.23
Precast concrete staircase - steel rebar	34.80	0.14	1.08	2.15
Total	**68,626.58**	**251.14**	**1,942.00**	**3,937.53**

Table 6: Estimated steel arisings from demolition

7. Brick

Brick is estimated at 388 tonnes from the internal walls from the demolition, with an assumption of 4" thick. This is equivalent to 229m^3 and 138 tonnes of embodied carbon. They are thought to be a mix of brick types. However due to the age of the buildings it is likely that cement mortar has been used, making it much harder to reuse the bricks. Bricks can potentially be recovered and reused, but most often they are crushed and recycled into fill materials or recycled aggregate. Although there is a market for recovered clay bricks, it is not always done, commonly due to the inability to remove mortar from the bricks. Traditional lime-based mortars are generally weaker than cement-based mortars and hence easier to remove. The more recent use of strong mortars with a high cement content can increase the time and effort required to remove the mortar and/ or lead to subsequent damage to the bricks. These mortars may be chosen to improve longevity in use and reduce maintenance requirements from repointing for instance.

It is recommended that bricks that are unable to be reused are segregated either onsite or at a waste facility and crushed to produce recycled aggregate (RA). This RA can be used as fill materials or added (up to 20%) to a crush mix with concrete for end use applications such as Type 1 aggregates for road sub-base. Considering the size of the site, it is likely that this will be offsite. Finished recycled aggregates should not contain more than 1% by weight of clay, soil, metals, wood, plastic, rubber and gypsum plaster, in line with the limits set within the aggregates standards. It is

recommended that they are processed where possible into recycled aggregates (RA) following the Quality Protocol for inert materials (Quality Protocol for Aggregates from Inert Waste)

Best practice

There could be possibility of using the recycled aggregate to make new bricks and blocks, for example the K- Brick is a new product made from construction and demolition waste (https://kenoteq.com/).

In terms of reuse techniques not tried out in a commercial setting in the UK, there are a couple of areas to consider.

Firstly, is the brick panel cutting process, as deployed in the Resource Rows project in Copenhagen. Here, 1 metre square brick panels from a Carlsberg brewery demolition were incorporated vertically and horizontally in the façade of new housing (Resource Rows).

Secondly, recent R&D into the potential to laser cut brickwork adhered with cement mortar could be of interest for separating the bricks for further use. This was carried out as part of the REBUILD project (Rebuild).

Further testing and investigation

Sometimes, the cement mortar used in brickwork can be relatively weak and easy to separate. Therefore, it would be useful to test a sample of brickwork (taking down a section of wall) to determine the strength of the mortar bond to the brick. Should it be viable to clean the brick quickly and without damage then these bricks should be suitable for reuse. Typically, it is possible to gauge the condition of the bricks visually and use again in a brick as façade application. For use in further structural applications, it may be necessary to test for compressive strength and frost resistance.

If the mortar bond is very strong, the reuse options outlined above (create brick panels and/or laser cut walls to reclaim bricks) could be investigated in more depth for viability on this project.

Waste management companies

Local waste management companies that could manage the brick waste include:

- Brewsters Waste, https://brewsterswaste.co.uk/, T: 020 7474 3535
- Ohara Bros, http://oharabros.co.uk/services/aggregates-recycling, 020 8424 2220
- RTS Waste, www.rtswaste.co.uk T: 020 7232 1711
- Days Group, http://www.daygroup.co.uk/. T: 0845 065 4655

Alternatively, licensed waste management contractors/demolition contractors should be able to reprocess the brick waste into aggregates.

If any of the bricks are suitable for reclamation, then local reclamation companies that can be contacted with regard to reclaiming the bricks and the value in doing so include:

- London Reclaimed Brick Merchants, www.lrbm.com, T: 020 8452 1111
- Premier Reclaimed Bricks, http://www.premierreclaimedbricks.co.uk/, T: 020 8684 3537
- Contact Salvo, https://www.salvoweb.com/

8. Glass

Glass is estimated to be 378 tonnes (equivalent to 592 tonnes of CO_2e), the majority arising from the windows (façade) (169 tonnes) in the tower and the associated secondary glazing (161 tonnes) as shown by Table 7. For glass to be reused it needs to be collected on specialist steel A frame stillages, handled and stored carefully. There is potential for the newer facades on the lower floors to be reused and also some internal partitions, as these are relatively new and of good quality.

Glass can be collected in skips and containers for recycling. The quality of the glass in the skips will be dependent upon the awareness and training of those working on site and appropriate site management is required along with clear signage. They also need to be close to the workplace due health and safety risks from transporting glass.

A few glass manufacturers run their own cullet recycling scheme when they will collect cullet from processors or of older glass where they will be returned to the float line. The UK has three flat glass manufacturers, all operating float lines: Guardian Glass UK, Pilkington UK Ltd and Saint-Gobain Building Glass which are all based in the North of England. One of the limiting factors in the use of post-consumer flat glass as cullet back into the float glass manufacturing process is the availability of it in the right quality and chemical compatibility as the manufacturing process is sensitive to low levels of contamination. Most of post-consumer flat glass waste produced does not go back into glass and is will be used as aggregate or landfilled. For demolition, it is more likely to be crushed into aggregate with other inert waste.

There is a health and safety consideration for the workforce if it is to be segregated onsite. According to the NFDC, glass from facades may be available for recycling back into glass, as they are likely to be deconstructed and the glass less contaminated. As the cost of logistics is high, large volumes of waste are preferred when collecting. The quality of the glass waste is important with minimal contamination requiring the effective separation and segregation on site, which in turn requires education and training for those working on site. UKGBC have an example of glass being turned into new glass (UKGBC case study). Other markets include the use of glass in glass wool insulation, container glass and ballotini products (glass beads).

The glass recycling industry has developed grades of glass cullet:

- Class C – which is contaminated and not suitable for re-melting back into glass. Contamination can include ceramic frit, putty, lead beading and space bars. This will be used as aggregate and road paint.
- Class B – this is called ‘mixed cullet’ and may have some contamination such as laminated glass, which is suitable for glass wool insulation and container glass.
- Class A – clean clear glass cullet with no contamination which can be used back in the floating by re-melting. This is currently mostly from pre-consumer glass. Demand for this outstrips supply.

If glass waste is sent to landfill and not mixed with other types of non-inert waste, it will attract the lower rate of tax, currently at £3.10/tonne. There are economic opportunities with a market price of £50/tonne for recycled glass compared to €90/tonne for virgin material. For flat glass, one tonne of recycled material results in savings of 1200 kg of virgin material and 300kg of CO_2 emissions directly linked to the melting process[6].

[6] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52014DC0445&from=EN

Further testing and investigation

In the event that there's a possibility to reuse the glass panels on the ground - 2nd floor, further investigation into the ease of removal without causing damage should be undertaken by a competent contractor, such as JF Hunt who are currently on site. This limited panel removal could also provide an opportunity to develop prototype elements for the subsequent development, should this be considered as an end use option.

As described above, there are closed loop recycling opportunities with the façade/window glass. However, the level of contamination will need to be kept to a minimum and the method of extracting the glass will be critical to achieving this. The façade glass is referred to as 'Armour clad colour 3.039' in the original drawings so is likely to have coatings that could be detrimental to the new glassmaking process. Therefore, it would be useful to obtain clear specifications from the glass manufacturers in terms of glass composition and acceptable quality/ segregation to match against the glazing available and the likely demolition method. This could require laboratory testing for unacceptable coatings and chemicals. Alternatively, if it is too difficult to reach these specifications, for example it impacts negatively on safety, programme or cost, the next option should be to supply into the glass wool manufacturers. Again, this should be matched against their specifications for quality of feedstock.

Glass recyclers

- RTS Waste (www.rtswaste.co.u k T: 020 7232 1711). Note they may require the glass to be removed and stacked as panels.
- Berryman Glass Recycling (www.berrymanglassrecycling.com E: info@berryman-uk.co.uk
- May Glass Recycling (http://www.mayglassrecycling.co.uk/) ; may only take new glass
- Viridor https://www.viridor.co.uk/siteassets/document-repository/brochures/glass-recycling-ukviridor-low-res.pdf.

Item	Area m^2	Volume (m^3)	Tonnes	Tonnes of CO_2e
Façade (tower)	10,639.00	67.78	169.46	244.02
Secondary glazing	8,890.00	64.28	160.69	267.23
Glass façade (lower floor)	466.56	7.00	17.50	29.22
Windows (ground and first floor)	598.91	5.99	14.97	25.00
Windows (second floor)	286.05	2.86	7.15	11.94
Atrium	175.20	1.75	4.38	7.31
Doors (second floor)	84.60	0.85	2.12	3.53
Blue panels (int. ground floor)	42.12	0.42	1.05	1.76
Crazy glass feature (int.ground floor)	19.60	0.20	0.49	0.82
Staircase (internal)	13.30	0.13	0.33	0.56
Clear panel (int. ground floor)	6.71	0.07	0.17	0.28
Clear panel door (int. ground floor)	1.60	0.02	0.04	0.07

Total	**21,223.65**	**151.34**	**378.34**	**591.73**

Table 7: Estimated glass arisings from demolition

9. Aluminium

There is an estimated 305 tonnes of aluminium, equivalent to 2,035 tonnes of CO_2e from the demolition as shown by Table 8. Most of the items are panellised and as such may be suitable for reuse though may need to be cut and cleaned. This includes the cladding and the canopy.

Aluminium is usually treated in a similar manner to steel, in that it will be sent to a scrap merchant, where it will be sorted, sheared (cutting large pieces), shredded, graded, and baled. There are 14 aluminium recyclers in the UK and the total recycled is 800,000 tonnes per year. The UK exported nearly 437,500 tonnes of scrap aluminium in 2020[7]. As it is non-ferrous it needs to be separated from the ferrous (steel) material) either on or offsite. Aluminium will be sent for smelting (only one plant in the UK), the actual furnace type will depend on the level of contamination of the aluminium. Secondary aluminium refiners will either convert most of the materials into foundry ingot to produce aluminium castings. Some secondary refiners produce deoxidiser for the steel industry, this material being in a variety of forms such as notched bars and granules. Some secondary refiners also produce hardeners or master alloys such as aluminium-manganese alloys for use by other sectors of the aluminium industry. These hardeners are used to adjust the composition of molten aluminium so that specified alloy compositions can be produced. The wrought remelters take good quality old and new scrap and convert this into extrusion billet or rolling slab, usually of the same alloy. Secondary aluminium refiners may be integrated into major aluminium companies or they may be independent companies. The UK is unusual in that the arising of aluminium scrap more than meets the needs of the UK foundry industry, as such much gets exported, particularly to China. The remelters are usually within the control of the integrated, global aluminium companies and most of the production of rolling slab and extrusion billet is used within their own supply chain. The current scrap price is around £1000/tonne.

Aluminium has high recycling rates, which can be between 92% and 98% for architectural aluminium and there is a highly established aluminium recycling market. Around 75% of all aluminium ever produced is still in productive use. Recycling uses only 5% of the original energy used to produce primary Aluminium and water. Some aluminium can be up to 75% recycled content (postconsumer); about half of the aluminium produced in Europe originates from recycled materials.

Best practice

Reuse of panels is best practice. The original drawings indicate the aluminium cladding and mullions are a form of anodised aluminium sheeting. This material is highly durable whilst being lightweight and easy to handle.

The Council for Aluminium in Building has recently launched a closed loop recycling scheme for its members CAB recycling .

Further testing and investigation

There is a large surface area of anodised aluminium sheeting that could be used again in applications requiring, or benefitting from a form of lightweight cladding/covering. It is not clear, as yet, whether

[7] https://www.statista.com/statistics/518633/uk-volume-of-exports-of-aluminum-waste-and-scrap/

the new development designs will provide such as opportunity. If so, the performance requirements of the potential application should be matched against the ability of the sheeting, which could involve a range of tests and prototyping to be undertaken.
In the event of this not being possible and for residual scrap, there could be advantages of using the CAB closed loop recycling scheme as opposed to normal recycling routes. Alternatively, the aluminium will typically be recycled back into new aluminium even in the 'business as usual' management route.

Local waste management companies

Local waste management contractors include (same as steel):

- Capital Metal Recycling, http://capitalmetalrecycling.co.uk/ T: 0208 964 2120
- London Scrap Metal Recycling, http://www.londonscrapmetalrecycling.com T: 0208 809 1019
- EMR Group http://www.emrgroup.com/

Item	Area m^2	Volume (m^3)	Tonnes	Tonnes of CO_2e
Anodised aluminium curtain walling	784.78	36.13	90.33	602.51
Aluminium panels (Ground and first floor)	219.53	32.93	86.94	579.90
Aluminium/ secondary glazing window frame		51.93	77.90	519.58
Mullions (Aluminium)	196.80	9.19	22.99	153.32
Canopy	585.60	5.86	15.81	105.46
Frames	372.15	4.45	11.17	74.47
Total	**2158.86**	**140.49**	**305.13**	**2035.23**

Table 8: Estimated aluminium arisings

10. PVC

There is an estimated 120 tonnes (16m^3) of plastic arising, from the uPVC windows used for secondary glazing on the tower floors, with an estimated 372 tonnes of CO_2e. The uPVC may be collected through the Recovinyl scheme for recycling: Axion recycling . It should be noted that there is likely to be more plastic arising than estimated from hidden components such as cabling. The management of the PVC should be done in conjunction with the glass recycling to maximise the amount and quality of recycled feedstock of both materials.

11. Gypsum

There is an estimated 105 tonnes (137m^3) of plaster and plasterboard arising from full demolition. See Table 9. Plaster skim is assumed to be used on the internal brick walls.

Plasterboard should be possible be segregated on site, or if room does not permit then well sorted and segregated at a waste transfer station. The plaster maybe difficult to remove from the brickwork/blockwork, and as such it can be treated with the bricks as Recycled Aggregates, if it is in low quantities. There are a number of companies within the London area that offer recycling services, as long as the plasterboard is relatively free from contamination. Some of the recycling routes can include being used in the plasterboard manufacturing process (although this tends to be mainly for new plasterboard offcuts rather than older plasterboard from demolition). The legal minimum, if sent to disposal, is to landfill in a monocell (landfilled separately from any degradable waste) to avoid the production of hydrogen sulphide gas.

A recovery use previously existed in animal bedding but the risk to animals, humans or the environment from hydrogen sulphide generation through the mixing with biodegradable waste means that this is not an acceptable route currently. Paper from the plasterboard can also be recycled, for example, for wallpaper manufacture.

Further testing and investigation

For demolition plasterboard, the options for closed loop recycling back into new plasterboard are very limited, if at all. Therefore, recovery is principally as a soil conditioner as land treatment.

It is technically possible to recycle back into gypsum for plasterboard manufacture through demonstrating compliance with BSI PAS 109 Specification for the production of recycled gypsum from waste plasterboard (2008). This standard includes meeting certain threshold levels for particle size distribution, residual paper, purity levels and presence of soluble chloride, magnesium oxide and sodium oxide. However, the current position is that demolition waste is not accepted. It may be worthwhile making further enquiries to each of the three UK manufacturers to see if they can make exceptions where the composition has been tested and meets the quality criteria.

Local waste management companies

Local waste management options include:

- Powerday, https://www.powerday.co.uk/ T: 020 3858 0504
- Plasterboard Recycling Solutions http://www.plasterboardrecyclingsolutions.co.uk/ T: 0780 118 6380
- Hintons Waste, https://www.hintonswaste.co.uk/recycling-facilities/plasterboard-recycling/ T:020 3322 3476
- Hippo Waste (collect in bags), https://www.hippowaste.co.uk/blog/plasterboard-recycling-removal/ T: 0333 9990 999
- RTS Waste Management, https://www.rtswaste.co.uk/plasterboard-mobile-compaction-service/ T: 020 7232 1711

Item	Area m^2	Volume (m^3)	Tonnes	Tonnes of CO_2e
Plasterboard - walls	1,844.76	27.67	20.75	8.09
Plaster skim (modern) walls	1,363.52	4.09	3.48	0.45
Plasterboard (secondary glazing)	6,137.00	58.30	43.73	17.05
Plaster skim (modern) walls	7,044.67	21.13	17.96	2.34
Plasterboard - walls	1,729.46	25.94	19.46	7.59
Total	**18,119.40**	**137.14**	**105.38**	**35.52**

Table 9: Estimated plaster and plasterboard arisings

12. Softwood

As shown by Table 10, there is an estimated 34 tonnes (68m^3) of timber arising from the demolition, equivalent to the storage of 44 tonnes of CO_2e. The largest source is from the framing system used in the secondary glazing system – as these are largely uniform they could be suitable for reuse/remanufacture. Other sources include the doors and riser cupboards.

It is recommended that a local wood recycling organization is contacted (Community Wood Recycling, www.communitywoodrecycling.org.uk) to see what timber items are suitable for reclamation and reuse. The nearest enterprise is Shaw Trust Wood Recycling (Croydon); T: 020 8300 9744, and Solo Wood Recycling; www.solowoodrecycling.co.uk There are also examples of the reuse of doors (FCRBE door reuse). If reuse is not viable, most of the solid timber can be recycled, usually into chipboard. Due to the age of the building, some of the timber maybe hazardous due to the coatings and preservatives used. Guidance has been issued for this[8]. Timber should be segregated on site if space permits, to improve level of reuse or recycling. If sent offsite to a licensed waste management contractor, this will typically result in recycling for chipboard (if well segregated) or as an energy feedstock (especially where mixed with other materials).

Further testing and investigation

For any significant amounts of timber that seem to be coated or treated prior to 2007 it is recommended to test for preservatives containing hazardous substances. In the event these occur over certain threshold limits the waste wood is classed as a hazardous waste.

Most of the visible timber (supporting the secondary glazing) seems to be of the type of timber used to construct stud walls and hence less likely to have been treated. This timber also seem to be highly reusable in any similar applications, such as partitioning, other internal joinery etc.. Depending on the application, further testing linked to performance requirements may be required.

Item	Area m^2	Volume (m^3)	Tonnes	Tonnes of CO_2e

[8] https://condemwaste.org/wp-content/uploads/2021/07/CIWM-CD-Waste-Wood-Guide-v1.0.pdf

Timber struts (secondary glazing)	480.88	52.18	26.09	-33.65
Fire Doors and Frames	211.20	8.45	4.22	-5.45
Riser Cupboards (full)	451.44	5.42	2.71	-3.49
Riser Cupboards (half)	158.40	1.90	0.95	-1.23
Riser Cupboards (frame)	68.64	0.69	0.34	-0.44
Total	**1370.56**	**68.68**	**34.34**	**-44.27**

Table 10: Estimated softwood arisings

13. Other materials

Ceramics

There is an estimated 16 tonnes (6.6m^3) of ceramic materials arisings covering 1320m^2; with an embodied energy of 12 tonnes CO_2e. This is estimated to be from the WCs on Floor 2 to 35, on the walls and the floor. It will be difficult to remove these tiles intact for reuse without damage and their monetary value is relatively low. There is a factsheet produced by the FCRBE project which discusses the requirements for reuse; see FCRBE ceramic reuse. However, for this project, it is recommended that these are either crushed with the inert waste on site or sent off site to produce recycled aggregate.

Chipboard

There is an estimated 12 tonnes of chipboard (17.5m^3) arising from the demolition; with 11 tonnes from the toilet cubicles and 1.6 tonnes from the sink carcasses. This equates to -14 tonnes of CO_2e if carbon sequestration is factored in. It is unlikely that this will be suitable for reuse as it is of low monetary value and of average quality. However, the panel sizes are consistent and could potentially be repurposed. It is also difficult to recycle due to the length of the fibres and the glues, so the most appropriate route is likely to be energy from waste.

Further testing and investigation

In the event that recycling is considered to be an important option to pursue, there has been R&D in the past to separate MDF back to particle form (and then used to make more timber based board products). This is now a commercial process, run by MDF Recovery. Other R&D revolved around composting with high organic matter substances for soil replacement. Either of these options could be investigated in more detail if of interest.

Fibreboard

Fibreboard in the form of a wool wood board (assumed) is apparent on Floor 34, above the internal windows, covering an area of 95m^2, estimated to be 7 tonnes (10m^3) and 7 tonnes of CO_2e. The board is of low quality and low monetary value, making reuse difficult. It is unlikely to be recycled due to its composite nature. The most likely recovery route is energy from waste.

Aggregate

There is loose aggregate on the lower floor roof, covering around 800m^2, with a volume of 4m^3 and a tonnage of 6.5. The embodied carbon of this material is estimated to be 0.05 tonnes. The aggregate

is loose and not fixed to the substrate and of reasonable condition. As such it should be suitable for reuse on another similar project, donated or used for landscaping elements.

Insulation

There is an estimated 4.5 tonnes (89m^3) of insulation arisings from the demolition, covering an area of 1789 m^2; this equates to 5.7 tonnes CO_2e. This insulation is assumed to be mineral wool and present in the internal stud walls that are to be removed. From a visual inspection it is difficult to ascertain the type of insulation used and the extent of it. There may be more present within the external walls. No insulation has been included which has been used for pipes. Recovery of insulation material is unlikely to be possible if it is bonded to the substrate. Insulation is usually disposed of to landfill via a licensed waste management contractor or could be sent for energy recovery if foam-based insulants can be successfully segregated. There is a pilot project looking at the recycling of insulation including from Knauf: (Knauf recycling) and Rockwool offer a recycling scheme: Rockwool recycling. Care should be taken to ensure that insulation that may contain ozone-depleting substances are removed and handled carefully.

Further testing and investigation

It could be useful to test samples of the insulation to determine the composition and check for problematic substances or fibres.

Vinyl

There is an estimated 1.3 tonnes (0.99m^3) of vinyl covering approximately 495m^2 of the toilet areas from Floors 2 to 35. This is equivalent to 9 tonnes of CO_2e. The condition is thought to be average (note, not all floors were observed). The best route for this vinyl is either recycling or energy recovery. Schemes exist to recycle old vinyl flooring, depending on the quality and amount of screed attached. This can either be dropped off at specific locations or collected. See Recofloor and Recofloor specifications for more details. Tarkett also has a program, called ReStart program, where old vinyl flooring can be reused in new flooring: Tarkett flooring. If the product does not meet the specification for recycling, then it is likely to be sent for energy recovery.

Further testing and investigation

As described above, there are recycling schemes that could be relevant to this waste stream. However, conditions in terms of quantities and flooring type are attached so it would be necessary to investigate further with each option, and carry out any tests (if needed) to determine polymer type, presence of unwanted substances etc..

14. Maximising Reuse and Best Practice

It is advised that a long lead-in time as possible and maximum exposure are required to enable the reuse of products and components. The best chances for reuse, with the associated environmental and economic benefits, are as near to site as possible:

- Used by the same client locally
- Sold or given away locally

Table 11 shows the items that maybe suitable for reuse. The following recommendations may assist in maximising the reclamation potential of the items identified:

- Consult the client on the findings of this report and consider any options for closed-loop re-use in a similar project (or within the further development)
- Consider setting aside storage on site for segregation of salvaged items.

There are a few organisations that may be able to assist with the reuse of items, which are listed below in London:

- Reyooz: http://www.reyooz.com/about/clients. Offer a service to collect surplus and distribute to charities, schools and small businesses.
- Globechain: https://globechain.com/; a reuse marketplace that donates to charities, schools and small businesses
- Reuse Network: https://reuse-network.org.uk/donate-items/#/
- Collecteco: https://www.collecteco.co.uk/; donation of furniture and equipment to charities, schools and small businesses.
- London Reuse Network - http://lcrn.org.uk/projects-services/london-re-use-network/
- Scrapstores: https://www.workandplayscrapstore.org.uk/ and Reuseful UK https://www.reusefuluk.org/

There is also an interactive map available from the Supply Chain Sustainability School, which shows geographically the different platforms available for material exchange.
https://www.supplychainschool.co.uk/school-launches-new-mep-mapping-tool/

For items that may have some architectural salvage value, specific salvage items can be advertised for free on www.salvo.co.uk or low value materials on www.salvomie.co.uk. Salvo also operate a demolition/refurbishment alert service on their website which serves to bring forthcoming demolition products to the attention of potential buyers or users. Local architectural salvage merchants about specific items can also be contacted. Salvo publishes a directory on their website. Ensure that salvaged items are removed and stored in such a way that all components remain together, e.g. doors in their frames.

Table 11 summarises the products that are likely to be more suitable for reuse. This amounts to 3176 tonnes (174m^3) and 1,516 tonnes of CO_2e.

Item	Area m^2	Volume (m^3)	Tonnes	Tonnes of CO_2e
Anodised aluminium curtain walling	784.78	36.13	90.33	602.51
Aluminium panels (Ground and first floor)	219.53	32.93	86.94	579.90
Timber struts (secondary glazing)	480.88	52.18	26.09	-33.65
Mullions (Aluminium)	196.80	9.19	22.99	153.32
Glass façade (lower floor)	466.56	7.00	17.50	29.22
Secondary glazing support (Steel)	146.00	2.13	16.55	45.69
Canopy	585.60	5.86	15.81	105.46
Paving slabs (lower roof)	62.00	3.10	7.44	0.77
Loose aggregate	800.00	4.00	6.48	0.05
Metal ballustrade	819.00	0.82	6.37	17.38
Metal handrail	120.75	0.60	4.69	12.82
Glass atrium panels	175.20	1.75	4.38	7.31
Fire Doors and Frames	211.20	8.45	4.22	-5.45
Riser Cupboards (full)	451.44	5.42	2.71	-3.49
Steel Staircase (joists)	6.32	1.14	1.17	3.23
Blue panels (int. ground floor)	42.12	0.42	1.05	1.76

Riser Cupboards (half)	158.40	1.90	0.95	-1.23
Crazy glass feature (int.ground floor)	19.60	0.20	0.49	0.82
Riser Cupboards (frame)	68.64	0.69	0.34	-0.44
Clear glass panels (int. ground floor)	6.71	0.07	0.17	0.28
Total	**5821.53**	**173.98**	**316.67**	**1516.25**

Table 11: Products that are potentially suitable for reuse/repurposing/remanufacture

Table 12 summarises the standard and best practice opportunities for each of the KPDs identified on this project.

	Opportunities	
	Standard practice	**Best practice**
Concrete	Crushed as RA for fill on/offsite	Crushed for RCA back into concrete
Steel	Recycled as scrap on the global market	Reuse (structural); closed loop recycling as scrap
Brick	Recycled as RA for fill on/offsite	Reuse; recycle into higher value products
Glass	Crushed and used for RA for fill on/offsite	Reuse; closed loop recycling
Aluminium	Recycled as scrap on the global market	Reuse; closed loop recycling as scrap
PVC	Sent for energy recovery/landfill	Closed loop recycling as scrap
Gypsum	Sent to cement kilns; or spread on land	Closed loop recycling
Softwood	Sent for energy recovery	Reuse; recycled into panelboard and animal bedding
Ceramic	Recycled as RA for fill on/offsite	Higher value recycling e.g into tiles
Chipboard	Sent for energy recovery	Sent for energy recovery (opportunities limited)
Fibreboard	Sent for energy recovery	Sent for energy recovery/landfill (opportunities limited)
Aggregate (loose)	Reuse as RA as fill etc	Reuse as aggregate
Insulation	Sent for energy recovery/ landfill	Closed loop recycling
Vinyl	Sent for energy recovery/ landfill	Closed loop recycling

Table 12: Standard and best practice opportunities for the KPDs

15. Targets

It is highly recommended that to maximise the reuse and recycling of the KDPs that the following materials are segregated on site:

- concrete
- glass
- brick
- steel
- aluminium
- timber (softwood)
- plasterboard
- any hazardous waste

Potential targets for materials are shown in Table 13. Overall, an estimated 98% could be diverted from landfill.

	Reuse	Recycling	Diversion from landfill
Concrete	0%	98%	98%
Steel	1%	99%	100%
Brick	0%	98%	2%
Glass	6%	90%	96%
Aluminium	30%	70%	100%
PVC	0%	50%	75%
Gypsum	0%	50%	75%
Softwood	50%	20%	100%
Ceramic	0%	98%	98%
Chipboard	0%	0%	90%
Fibreboard	0%	0%	90%
Aggregate (loose)	95%	5%	100%
Insulation	0%	25%	50%
Vinyl	0%	50%	75%

Table 13: Recommended targets per material

During the demolition, details of the actual materials arisings and the waste management methods used should be recorded to compare actual with forecast and to assess performance against the targets set. Following completion of the project, any barriers to achieving the targets should be reviewed to ensure that in future projects these barriers can be overcome.

Appendix A

Sources of embodied carbon figures

The embodied carbon figures have been taken from the freely available ICE Inventory of Carbon and Energy V3 -10th November 2019. This can be downloaded at: https://circularecology.com/embodied-carbon-footprint-database.html. It should be noted that as the original material is not known in detail (in terms of its composition, source etc), then the figures used for CO_2e must be treated with some caution).

Material	Kg/CO2e	Assumption
Aggregate	0.007	Aggregates and sand, general UK, mixture of land won, marine, secondary and recycled, bulk, loose
Aluminium	6.670	Aluminium General, European Mix, Inc Imports
Block: Concrete: Lightweight	0.093	Concrete block, medium density solid, average strength, per kg
Bricks	0.354	Clay: all data collected
Ceramic	0.780	General
Chipboard	-1.120	Chipboard - including carbon storage
Concrete	0.103	General
Glass	1.663	Glass glazing (double)
Mineral wool insulation	1.280	Mineral wool
Mortar	0.200	Mortar (1:3 cement:sand mix)
Plaster	0.130	General, gypsum
Plasterboard	0.390	Plasterboard
PVC	3.100	PVC General
Softwood	-1.290	Softwood - including carbon storage
Steel (rebar)	1.990	Steel Rebar
Steel (plate)	2.460	Steel Plate
Steel (hot galavanised)	2.760	Steel hot galvanised)
Steel, finished cold-rolled coil	2.730	Steel, finished cold-rolled coil
Woodwool board	0.980	CO2 Only
Vinyl	3.190	Vinyl

Appendix B

Report Authors

Gilli Hobbs is working with Reusefully Ltd and is based in France & UK and has provided technical & expert input to sustainability related projects in the built environment for over 25 years. Until 2021, this was at BRE, where she was Director in the Strategic Advisory team, working across low carbon buildings and building products, circular & lean construction, renewable energy technologies and sustainable communities, in the UK and overseas. During the last year, Gilli has focussed on working with the World Green Building Council, an expert technical assistance to FCO project in India, and a Rapid Evidence Assessment for Defra. She is also an advisor to London Borough of Enfield on the Meridian Water regeneration project and member of various standards committees including CEN TC 350 SC1 Circular Economy (Chair of UK mirror committee), BS 8895 Material efficiency, B/558 Sustainability of Construction Works and CB/101 Service Life Planning.

Dr Katherine Adams has worked in the area of construction resource efficiency for nearly 20 years, mostly at BRE, where she has been instrumental in shaping the construction industry to achieve high levels of diversion of waste from landfill and reducing waste. She has much experience of Pre-refurbishment and demolition audits, having undertaken and reviewed many for various clients, which has involved the development of a robust methodology. She has been responsible for developing waste reporting, including the online system Smartwaste. She enjoys working closely with many elements of the industry, at both a sector and project level. She has recently finished a PhD at Loughborough University looking how circular economy can be embedded in the building sector. She has recently set up a consultancy, Reusefully Ltd, providing advice on circular economy and waste, to the building sectors. She continues to assist BRE and other organisations such as the Alliance of Sustainable Building Products (ASBP).