A

Euston Tower

Appendices

Appendices

List of Appendices

- A Pre-demolition Audit
- B Material Recovery Strategy
- C GLA Circular Economy Statement Template
- D BREEAM Wst 06
- E BREEAM Wst 05

reusefully

Report From:

Katherine Adams and Gilli Hobbs
Circular Economy and Waste Specialists
Reusefully Ltd

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

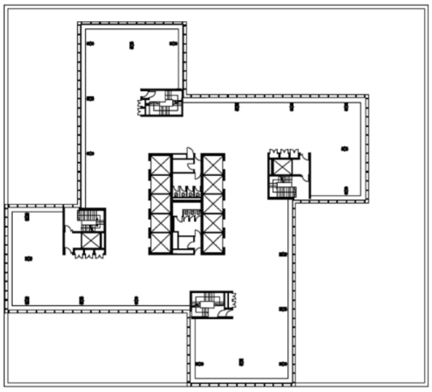
Euston Tower is located on Euston Road in the London Borough of Camden. It was built in 1970 and has been mainly used for offices. It has a storey height of 36 floors; the overall height of the building is 124 metres. There is a wraparound building on the ground and 1st floor which is used for retail/café 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:

<u>Demolition</u>

- 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.

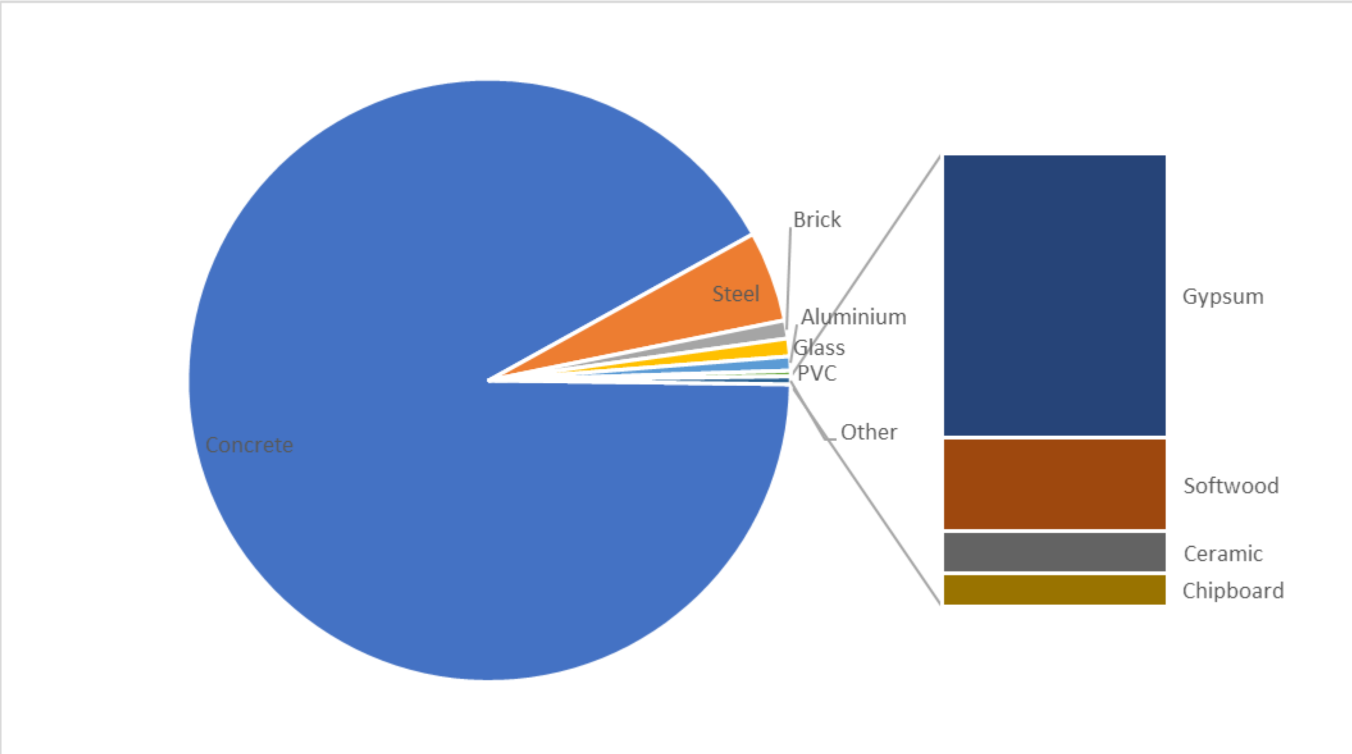


Figure 1: Demolition Results - KDPs by weight (tonnes)

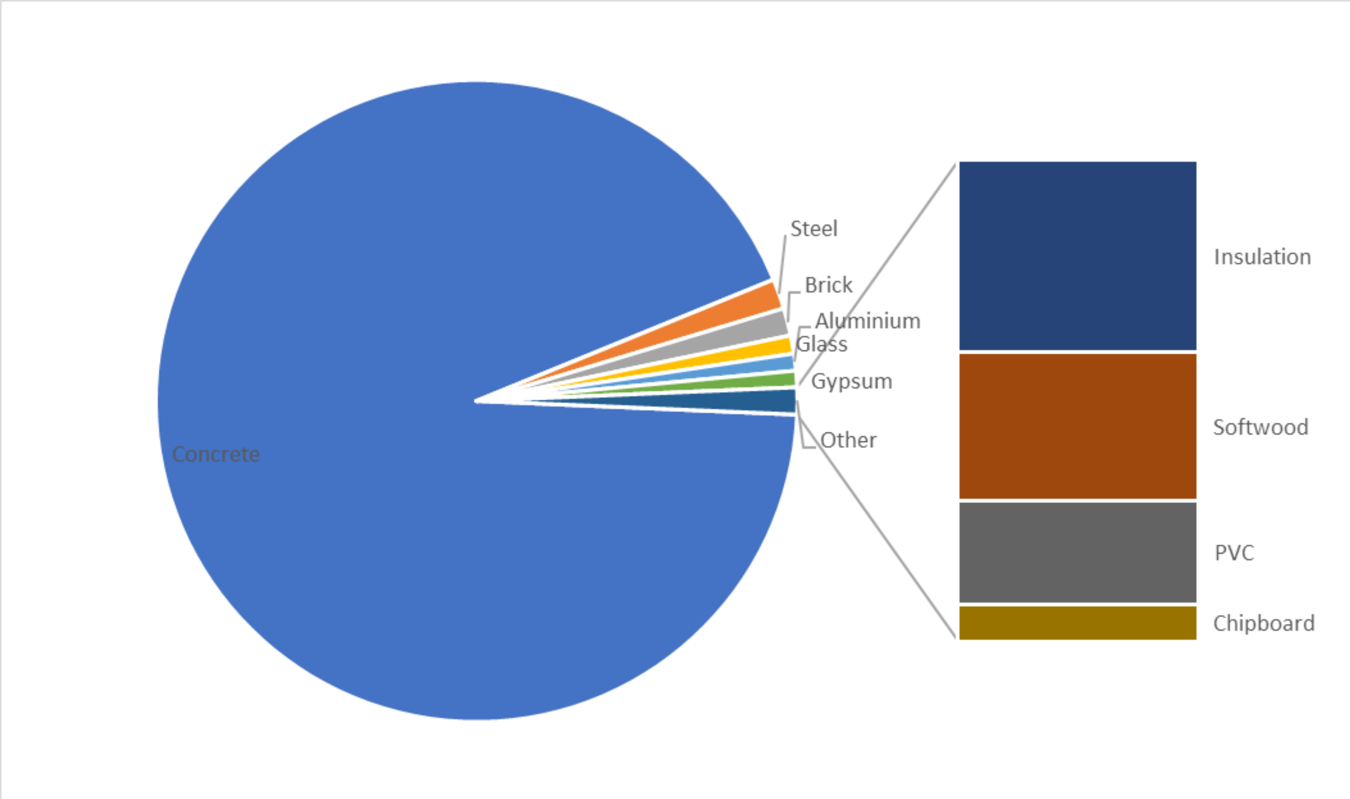


Figure 2: Demolition Results - KDPs by volume (m^3)

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

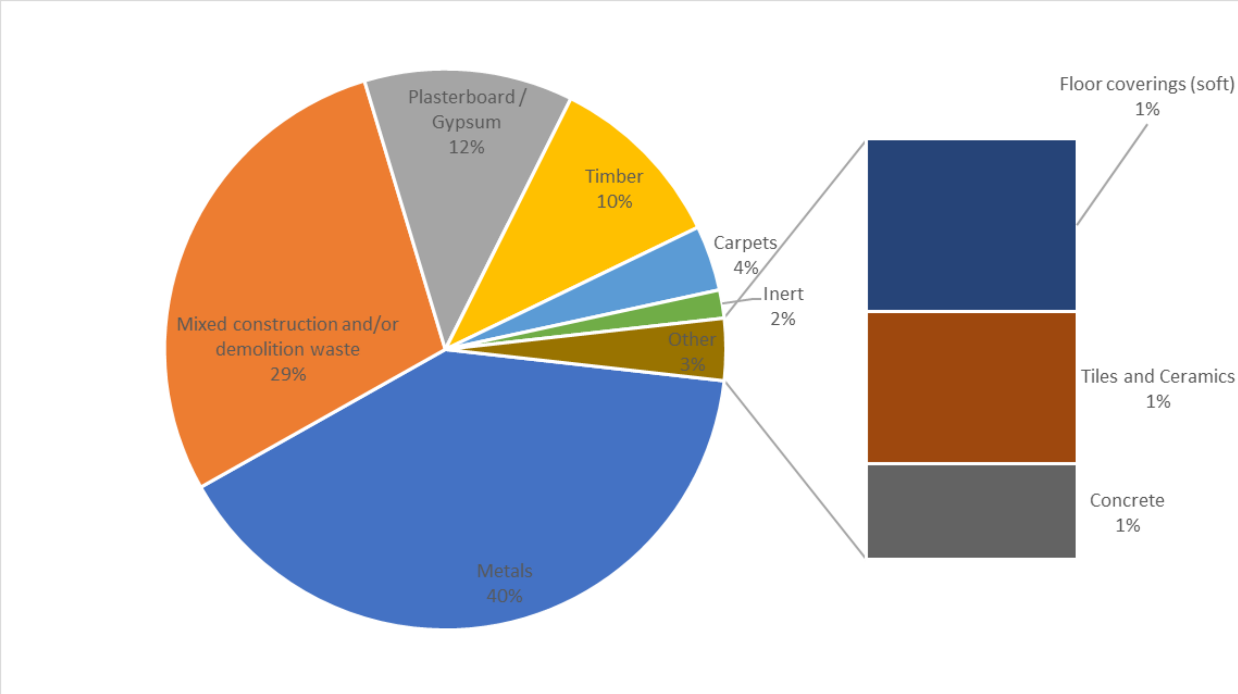


Figure 3: Strip Out Waste Results – waste by tonnage

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.

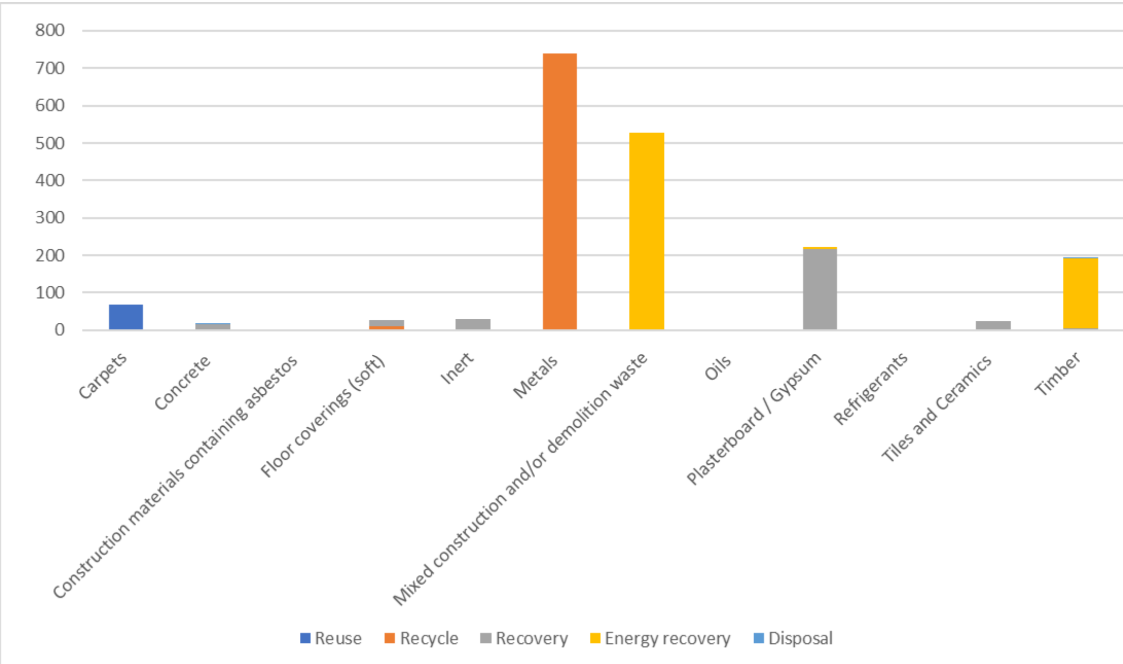


Figure 4: Strip Out Waste Results – waste management routes

	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 (Cambridgeshire 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 m²	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 m²	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 800$m^{2,}$ 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).

GREATER LONDON AUTHORITY

Detailed Application Stage - Circular Economy Statement

Project details	
Project name	Euston Tower
Planning application reference number (if applicable)	British Land Property Management Limited
Applicant	
London Borough	London Borough of Camden (LBC)
Brief description of the project	Redevelopment of Euston Tower, including the partial retention (retention of existing core, foundations and basement), disassembly, reuse and extension of the existing building, to provide a 32-storey building for use as offices and research and development floorspace (Class E(g)) and office, retail, café and restaurant space (Class E) and learning and community space (Class F) at ground, first and second floors, and associated external terraces. Provision of public realm enhancements, including new landscaping, and provision of new publicly accessible steps and ramp. Provision of short and long stay cycle storage, servicing, refuse storage, plant and other ancillary and associated works
Author/s	GXN
Date of assessment	Nov-23
Number of Use Types	3
Use Class / Type	**Floor Area by use type (m2)**
Office (Class E(g(i)))	*74791*
Retail (Class E)	*748*
Retail/Community Space (Class E/F)	*2003*
Overall GIA (m2)	77542.00

Circular Economy Design Approaches

Circular Economy Design Approaches for Existing Structures / Buildings		Applicant Response
Is there an existing building on the site?		Yes
Is it technically feasible to retain the building(s) in whole or in part?		Yes
Is the existing building, or parts of the building, suited to the requirements for the site?		Yes, in part
The preferred strategy is:		**PARTIAL RETENTION and REFURBISHMENT**
Circular Economy Design Approach	**Phase/Building/Area/Layer**	**Strategic Response**
Refurbish	N/A	An extensive three-part feasibility study has been carried out, to evaluate the technical feasibility and viability of retaining the existing building on site, and to which degree the existing building can be retained and still suit modern requirements for the proposed development. This has been independently reviewed by a third-party. Feasibility Study Volume One, supported by a number of both intrusive and non-intrusive surveys, concludes that the existing services and facade system are no longer fit for purpose in line with current guidelines. It furthermore establishes that, despite the superstructure being in good condition, the extent of the upgrades that are required to bring the existing tower up to current building regulations and standards are extensive. The extent of upgrades required, and the quality and quantum of compromised space delivered, would make the resulting product challenging in the leasing market. Feasibility Study Volume Two concludes that in order for the existing tower to support alternative uses (those other than office use) substantial structural alterations are required to deliver the necessary upgrades to accommodate modern services and lift requirements. Considering the technical challenges in providing the necessary upgrades, as well as the resulting compromised space, low quality units, and policy non-conformance, the existing tower was shown not be appropriate for alternative uses. From the two studies it is concluded that a full retention and retrofit is not considered feasible either for continued office use or alternative uses, but that the existing substructure and parts of the superstructure could be retained.
Repurpose	Substructure, Superstructure	The existing tower foundation, basement and central core are retained as part of the proposed development. A range of options for re-purposing and retaining the existing tower has been considered in Feasibility Study Volume Three. It has been shown that an option that retains the existing foundation and basement, as well as the central core, provides the best balance of structural retention and quality, flexibility, adaptability and buildability, and whole life-cycle carbon emissions.
Disassemble / Deconstruct and Reuse	Superstructure, Space	A material strategy has been developed to ensure that the deconstructed materials and products are retained at the highest possible value. This includes identifying materials that could be suited for direct reuse or upcycling. The proposed development has a pioneering approach to material recovery through prototyping innovative approaches for reuse/recycling of difficult-to-handle materials like concrete and glass from the deconstruction. Early tests are being conducted to test innovative approaches to cutting out and reusing parts of the existing ribbed slabs. Refer to the Strategy for Material Recovery for more information. The existing fit out and finishes have already been stripped out and sent for either reuse or recycling. Refer to the Pre-demolition Audit for more detail.
Demolish / Deconstruct and Recycle	Services, Superstructure, Facade, Space	The development is committed to a 98% diversion from landfill of all demolition waste related to the scheme. Furthermore, a material strategy has been developed to ensure that the deconstructed materials and products are retained at the highest possible value. This includes ensuring that the materials that cannot be directly reused or remanufactured are carefully separated and recycled at the highest value possible. Refer to the Strategy for Material Recovery. The services and interior finishes from the existing building have already been stripped and the elements that were unfit for direct reuse have been treated for recycling. Refer to the Pre-demolition Audit for more detail.
Circular Economy Design Approaches for New Buildings, Infrastructure and		**Applicant Response**
Is the whole building designed to have a short life on its current site? (e.g. less		No
Is it foreseeable that the building will need to change use/function within its design life?		No
All developments should apply the 6 Circular Economy principles, including:		**Designing for DISASSEMBLY and ADAPTABILITY, MATERIAL REUSE ON-SITE and/or RECYCLING should be maximised**
Circular Economy Design Approach	**Phase/Building/Area/Layer**	**Strategic Response**
Building relocation	N/A	Not applicable according to decision tree (CE statement guidance figure 5) because the proposed development is expected to have a long life.
Component or material reuse	N/A	Not applicable according to decision tree (CE statement guidance figure 5) because the proposed development is expected to have a long life.
Adaptability	Superstructure, Shell/skin, Services	Adaptability is considered in the design of the superstructure, facade, and services. The structural system aims to allow for future adaptability, both regarding short term changes such as vertical connectivity, as well as medium-long term changes such as changes in building geometry or functionality. This is achieved with a soft core, regular structural grid, and an adaptable floorplate system. The facade enables this adaptability through a component-based construction with mechanical fasteners that can be non-destructively decoupled from the structure.
Flexibility	Superstructure, Space, Services	[illegible]
Replaceability	Services, Facade, Space	[illegible]
Disassembly	Superstructure, Shell/skin, Services, Space	[illegible]
Longevity	Substructure, Superstructure, Shell/skin	[illegible]

Circular Economy Design Principles by Building Layer

The Circular Economy Commitments table should consider where the Applicant seeks to go beyond standard practice. If there are multiple phases / buildings / areas with different measures / strategies, please specify those separately within the table below.

[illegible]

Bill of Materials

[illegible]

Recycling and Waste Reporting table

	Type of Waste	Source of Information	Overall Waste (tonnes)	Overall Waste (tonnes/m²)	Performance Indicator (LPG Appendix 1)	Reuse Onsite (%)	Reuse Offsite (%)	Recycle Onsite (%)
	PRODUCT AND CONSTRUCTION STAGE (MODULE A)							
1	Demolition Waste	Pre-demolition Audit	37420	0.483	3rd Quartile	0%	0%	0%
2	Excavation Waste	Site Waste Management Plan (SWMP)	30408	0.392	2nd Quartile	0%	0%	0%
3	Construction Waste	Site Waste Management Plan (SWMP)	5,185	0.067	2nd Quartile	0%	0%	0%
	USE STAGE (MODULE B)							
3	Demolition / Strip-out Waste		0	0.000	-			
4	Construction Waste		0	0.000	-			
			Overall Waste (tonnes/annum)	Overall Waste (tonnes/annum /m²)	Performance Indicator (LPG Appendix 1)	Reuse Onsite (%)	Reuse Offsite (%)	Recycle Offsite
5	Municipal Waste	Operational Waste Management Strategy (OWMS)	2927	0.038	3rd Quartile	0%	0%	0%
6	Industrial Waste (if applicable)			-	-			
	MODULE A - MODULE C							
			Overall Materials (tonnes)	Overall Materials (Modules A-C) (tonnes /m²)	-	Reuse Onsite (%)	Reuse Offsite (%)	Recycle Offsite
7	Total Materials		0	0.000	-			

[illegible]

Circular Economy Targets

Circular economy targets for existing and new development	Policy Requirement	Target Aiming For (%)	Policy Met?	Explanation (How will performance against this metric be secured through design, implementation and monitoring?)
Demolition waste materials (non-hazardous)	Minimum of 95% diverted from landfill for reuse, recycling or recovery.	98%	Exceeds Policy	The various demolition protocols and waste hierarchy will be followed. If feasible, a strategy of re-use on site will be pursued. Where materials cannot be recycled or re-used on site, the Principal Contractor will identify opportunities for potential re-use of materials off-site. The applicant will refer to the London Waste Map to consider opportunities for using local sites to manage materials and waste. A Site Waste Management Plan (SWMP) has been produced. The Principal Contractor will include information on the pre-demolition audit in the final SWMP. The demolition contractor will put procedures in place for segregating and storing demolition waste prior to collection by a licenced waste contractor.
Excavation waste materials	Minimum of 95% diverted from landfill for beneficial reuse.	95%	Yes	There will be some excavation works associated with the construction of foundations and basement. Where feasible (in accordance with specific physical and chemical composition) this material will be reused off site for beneficial reuse, including quarry restoration or as material fill. A Site Waste Management Plan (SWMP) documenting measures to reduce construction, demolition and excavation waste has been produced. The contractor for below grounds work will put procedures in place for segregating and storing excavation waste prior to collection by a licenced waste contractor.
Construction waste materials	Minimum of 95% diverted from landfill for reuse, recycling or recovery.	96%	Exceeds Policy	A Site Waste Management Plan (SWMP) has been prepared for the proposed development. Construction waste will be separated into recyclable waste streams before removal from site for reuse or disposal. A range of measures will be investigated to facilitate the minimisation of waste generation. The volume/tonnage of waste generated (or sent off site) as well as the percentage or volume/tonnage reused, recycled or disposed will be recorded throughout the construction phase. The Principal Contractor will provide a monthly report to the applicant on the progress of the Waste Management Strategy. Monthly reporting of all construction waste data throughout the project checked against what would be expected based on the stage of the project, invoices, etc., to validate completeness of waste reporting data.
Municipal waste	Minimum 65% recycling rate by 2030.	65%	Yes	A dedicated bin store accommodating recycling and refuse bins will be provided for the proposed development. The development will be designed with adequate, flexible, and easily accessible storage space and will support the separate collection of dry recyclables. Space will also be provided to allow for storage of food waste and glass waste prior to collection. This will demonstrate how the development has taken into account sustainable methods for waste and recycling management during its operation in order to meet requirements from the London Plan and London Borough of Camden policies and all applicable legal requirements. Tenanted areas will be provided with suitable segregated waste receptacles which will support the separate collection of residual waste, dry mixed recyclables (e.g. plastics, metals, glass etc.), mixed paper, card and cartons, glass waste and food waste. On site FM or staff will be required to transport the waste from tenanted areas to the commercial waste store, located at basement level and segregate the waste into the appropriately labelled bins. The commercial waste store will accommodate sufficient storage for residual waste, dry mixed recyclables, mixed paper, card and cartons, glass waste and food waste. Residual waste and recycling will be stored in 1,100L Eurobins, with food waste and glass waste will be stored in 240 L wheeled bins. The municipal waste recycling rate has been calculated using the estimated weekly waste generation which is based on metrics extracted from BS5906:2005 per class use. It is anticipated that the proposed development will generate significantly less waste than estimated due to lower occupancy rates associated with life sciences and recent trends towards paperless offices and hybrid working practices. The developer will be contractually responsible for all operational waste reporting for the Proposed Development. This reporting will be based either on number of container lifts per waste stream, or collection weight data if available. Data requirements and reporting methods will be agreed with the relevant authorities once all elements are occupied. Refer to Operational Waste Management Strategy (OWMS) for further details.
Recycled content	Minimum 20% of the building material elements to be comprised of recycled or reused content.	25%	Exceeds Policy	New materials to be tracked as part of BREEAM sustainable procurement process.
Additional requirements	**Policy Requirement**	**Please acknowledge acceptance for a planning condition**		**Please set out an indicative timescale and responsible party for the provision of this information**
Post-Construction Report	A CE Statement is required at post-construction (i.e. upon commencement of RIBA Stage 6 and prior to the building being handed over, if applicable. Generally, it would be expected that the assessment would be received no more than three months post-construction)	It is accepted that the Post Construction Reporting will be conditioned		The post construction report will be completed within 3 months of practical completion of the project. This will be included in the Principal Contractor's prelims.

SWECO

Adaptation & Disassembly Guide - BREEAM

Euston Tower – Stage 2

Contents

1 Introduction

This document is intended to summarise the strategy and proposed actions at RIBA Stage 2 to promote the functional adaptability and design for disassembly of the Euston Tower development, in line with the requirements set out in the BREEAM 2018 Wst06 section and ISO 20887:2020. Included in the following pages are recommendations and design measures that facilitate the potential for future change of use of the development. The report is required to be reviewed and updated at RIBA Stage 4 with supporting evidence and information to confirm that the measures have been implemented in the final design.

This document is populated by a number of different consultants (primarily architects and MEP consultants), and therefore, to ensure that this document is robust and can be used as BREEAM submission evidence to meet the BRE QA quality control requirements, the email from each contributing consultant that contains the return of this report will be included as evidence to demonstrate chain of custody. The BREEAM assessor will compile the responses into a single master report which will be submitted as evidence to the BRE.

There is clear value in undertaking such an exercise for new developments, and it is important that this exercise is undertaken during the early concept. design stage to ensure that best-practice thinking on the relevant subjects is considered from the earliest stage.

ISO 20887: 2020 provides a framework for disassembly and adaptablity principles and key issues that should be considered, particularly by the designers.

The following has been established to help direct the subsequent design and service life planning process:

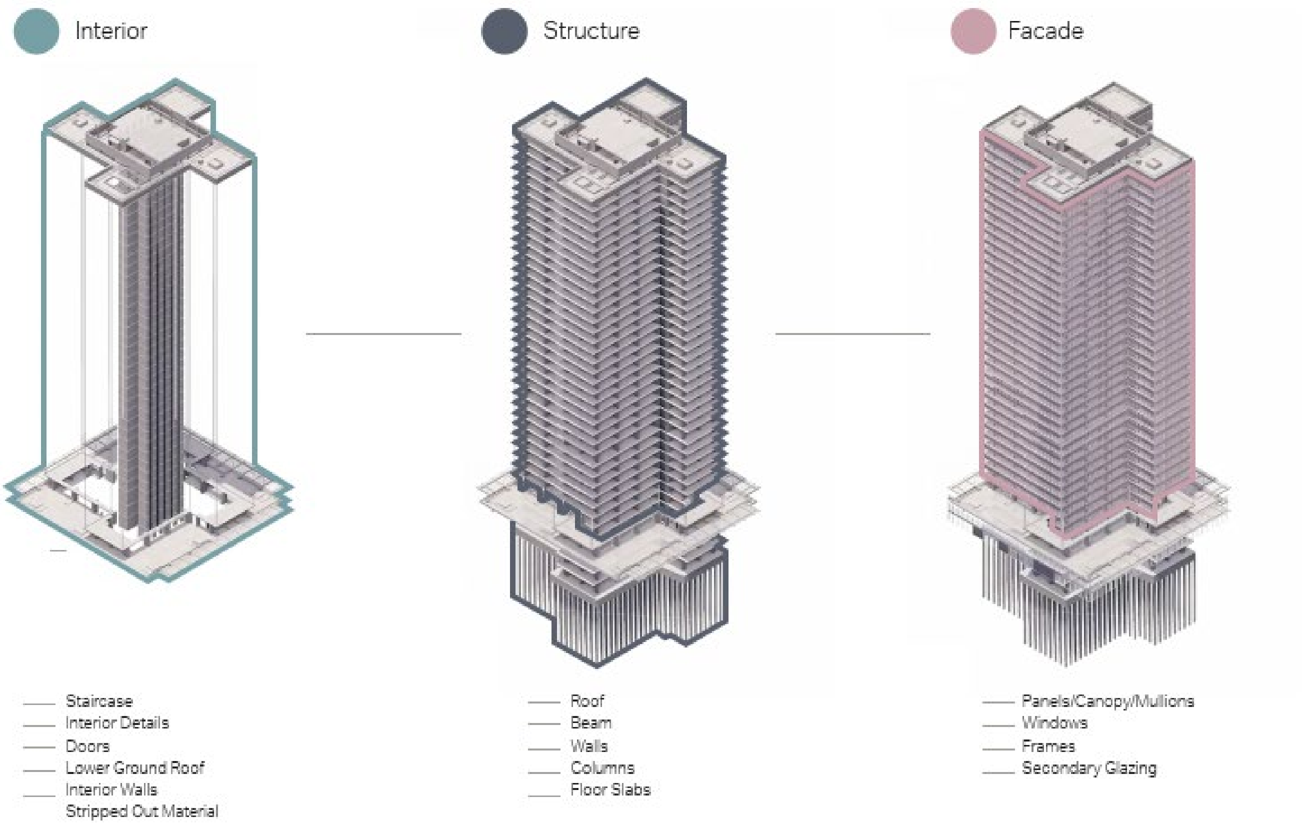
- required service life of the construction works — this can be highly variable from a temporary structure to infrastructure with several-hundred-year service life requirements;
- expected use(s) of the construction works over its required service life — is it going to be a single use type, such as a dwelling; or is there likely to be multiple use types, such as commercial, retail and leisure;
- consideration of staged development to meet the changing demand or alternative uses;
- ownership of the asset — for example, a public sector long-term infrastructure asset versus a speculative commercial building with multiple tenants; this could also be relevant if leasing of products or systems form part of the business model;
- operation of the asset — who will maintain the asset and be responsible for documentation storage and transfer of information;
- any specific options, targets, benchmarks and objectives relating to adaptability, disassembly or outcomes depending on these, such as re-use potential or reduction of life cycle impacts;
- review of the regulatory and policy environment, including compliance requirements and incentive programs;
- review of foreseeable economic and market risks; — likelihood of obsolescence;
- length of supply contracts.

Please note this document is in DRAFT format. The final document will be completed before handover and the relevant supporting documentation will be included.

2 The Development

Office with Research and Development

BREEAM ‘Outstanding’



Project description Project description

3 Functional Adaptation

3.1 Feasibility

Feasibility is necessary to accommodate changes in use type, demographics, or user needs. The initial cost may be balanced against the future cost of adaptation. The needs of users might also change with respect to limitation of physical abilities during the course of time. Also, adaptations can be sequential, occurring over time, or parallel, able to perform various functions, typically repeatable over a period of time. Specific adaptations in both parallel and sequential modes are less abstract and more clearly defined in functional requirements and typically take precedence over general adaptations. If the principles of universal design are taken into account at the outset (e.g. by respecting the space needed for manoeuvring a walking frame or wheelchair, the door width, the absence of thresholds or the installation of ramps and lifts), it can avoid the need for costly conversion at a later date.

Content Requirement

The likelihood to contain multiple or alternative building uses, area functions and different tenancies over the expected life cycle, e.g. related to the structural design of the building.

Design Strategy

Euston Tower has been designed as a best-in-class office with provision for both traditional office and laboratory-enabled spaces to leverage its position in the Knowledge Quarter. The tower is located at the South-east corner of the Regent's Place Campus. The current scheme provides approximately 30,000 m2 NIA of office space and 14,000 m2 NIA of lab-enabled space supported at ground by a multi-level podium comprising a mixture of programmable spaces for both the local community and building occupiers.

In the current scheme, approximately 30% of the floors are designed to support future use as potential laboratory space. This is enabled through additional allowance in terms of MEP design and a structural design that can meet the higher vibration criteria. A baseline lab-enabled specification is proposed, with possibility for operators to retroactively increase specification should they require (e.g. additional structural hangers to improve vibration performance).

The core and floor layouts have been designed to accommodate various tenant scenarios with a range of single tenants over several floors, to multiple tenants sharing a single floor. In the lower stack (lab-enabled), up to two tenants can be accommodated. In the mid and upper stacks, up to three separate tenants can be accommodated on a single floor all with direct access into the core.

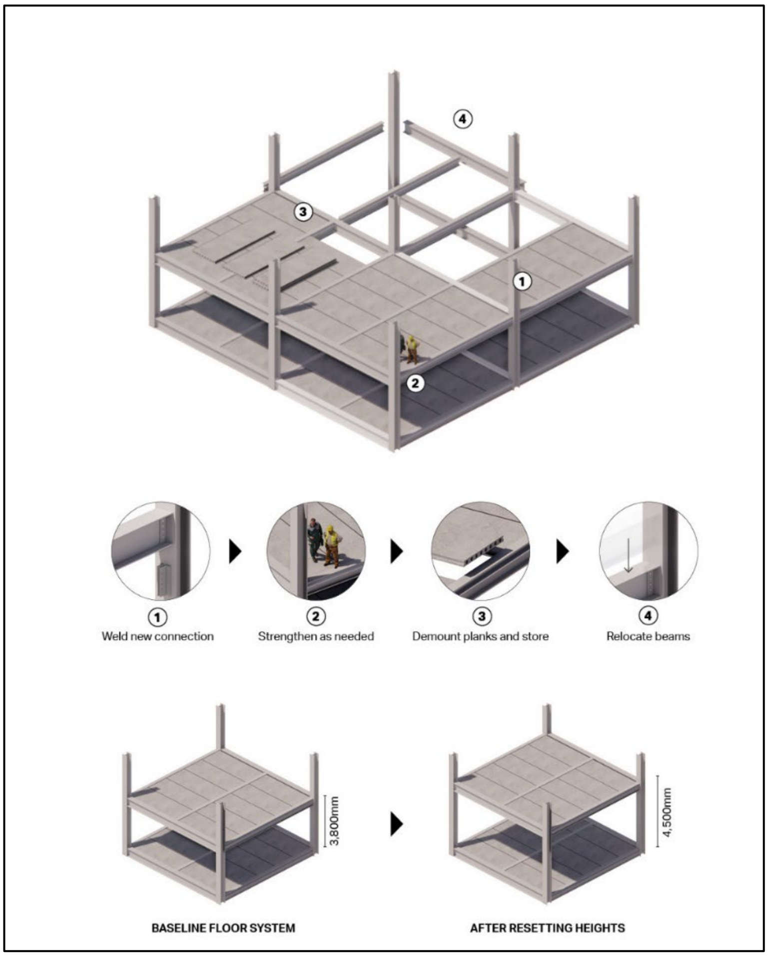
The design team has carried out a detailed study on the feasibility of the existing tower to support alternative uses, including residential, hotel and student accommodation. This study sets out the potential of how the site could be suited for alternative uses and interventions required for the existing tower to support this. The feasibility study highlights the challenges of adapting the existing tower with alternative uses. In the proposed design, considerations have been made to ensure that these challenges are not inherited in the new design. The following structural measures have been taken:

- Regular structural grid that allows for future flexibility that would require changing of the floor layout
- Soft core that is not part of the global stability system that enables low-intervention future changes to the functionality of the core
- Adaptable floor plates through a disassemble floor system.

The ability to reset floor to floor heights in a non-destructive way would be of great benefit in designing a new structure for longevity, helping to ensure that it does not become obsolete prematurely.

The proposed structural system would, in theory, allow the floor levels to be reset, in a way that cannot practically be achieved in in-situ concrete systems that rely on continuity.

The diagram below illustrates indicatively the steps that would be required. Here it is assumed that the facade and vertical transportation and circulation would be replaced at the same time.



Drawings & Reports

- Programming stack
- Multi-tenant layout diagram.

3.2 Accessibility

Ease of access in design allows for a material, component, or connector of an assembly, especially those with the shortest anticipated life cycle, to be easily approached, with minimal damage to and impact on it and adjacent assemblies. Ease of access reduces replacement time and the generation of unnecessary waste during the replacement or maintenance of materials or components. Ease of access is closely related to independence and is often related to uncoupling "layers" of a building or components of construction works that have significantly different lifespans. Ease of access to parts and components of the building or civil engineering works should be provided for ease of disassembly and adaptability. If possible, recovery of components without the use of specialized equipment should be allowed for.

Exposed connections are left accessible for disassembly or modification of components, assemblies, or systems within a constructed asset. By making the connections more visible, it will be more apparent where steps have been taken to promote ease of disassembly. Where such connections are not visible, there is an increased risk that disassembly techniques which optimise material and product re-use will not be planned or subsequently adopted in deconstruction or strip out of the construction works.

Content Requirement

Design aspects that facilitate the replacement of all major plant within the life of the building, e.g. panels in floors and walls that can be removed without affecting the structure, providing lifting beams and hoists. Accessibility also involves access to local services, such as local power, data infrastructure etc.

Design Strategy

The design strategy at this stage facilitates the replacement of major plant within the life of the building through a number of strategies:

- Goods lifts from Ground serve the L30 plant room and are appropriately sized to accommodate the largest sections of plant when broken down, for end of life replacement.

- A platform lift allows transfer of equipment and plant sections between the L30 plant room and L31 roof.

- Basement access routes have considered for main plant and equipment, primarily using the existing loading dock. However large elements of plant shall be replaced via access hatches to lift out the basement using temporary lifting equipment e.g. generators and transformers.

Drawings & Reports

- Stage 2 Report and associated deliverables include Access & Maintenance Strategy Drawings

3.3 Versatility

Versatility is the ability to accommodate different functions with minor system changes. Versatile structures and spaces facilitate alternative uses over the course of a day or week with minor system changes. In designing for versatility for specific adaptation, it is important to consider the needs of the targeted users. For example, having one space that accommodates many uses can reduce the overall building footprint, required floor area, costs, and resources. For general adaptations, leading to potential future adaptations, it is possible to look beyond the boundaries of the current user/owner immediately occupying the space to seek potential partnerships with outside interests that could use it at times when it would otherwise go unused, potentially cutting costs and reducing the need to construct more single-use structures and assets. This type of versatility can result in measurable benefits by increasing building utilization. One of the aims of versatility is to reduce strip-out and fitout over the life cycle.

Content Requirement

The degree of adaptability of the internal environment to accommodate changes in working practices.

Design Strategy

The large, open floorplates and core layout provided in the scheme are designed to allow for various tenant scenarios with a range of single tenants over several floors, to multiple tenants sharing a single floor.

The design furthermore includes potential for a wide range of current and future workplace fitouts from traditional cellular layouts to a large open plan space. This versatility is further strengthened by a logical and uniform structural grid and a core layout.

The double height amenity spaces distributed across the perimeter of the tower are designed to provide and promote a versatile working environment with areas of different interior and potentially exterior environments and furniture.

Versatility is also delivered in the scheme through the lab-enabled areas that are designed to allow lab users to fit out and occupy the space with both write up space and laboratory equipment.

The MEP systems have been developed against a basis of design that is thinking about flexibility for the future, with fresh air rates that are exceed current Building Regulations, and a decentralised ventilation system that enables total separation between tenancies.

Drawings & Reports

- Base Build Definition Rev06 (BBD)
- Multi-tenant layout diagram.

3.4 Adaptability

Adaptability is necessary to accommodate changes in use type, demographics, user needs or due to the need for adaptation to external factors, such as climate change, for resilience or future proofing. The initial cost may be balanced against the future cost of adaptation. The needs of users might also change with respect to limitation of physical abilities during the course of time. In case of residences, an adaptable building can enable users to live an independent life in their familiar surroundings for as long as possible. Also, adaptations can be sequential, occurring over time (often non reversible), or parallel, able to perform various functions, typically repeatable over a period of time. Specific adaptations in both parallel and sequential modes are less abstract and more clearly defined in functional requirements and typically take precedence over general adaptations. If the principles of universal design are taken into account at the outset (e.g. by respecting the space needed for manoeuvring a walking frame or wheelchair, the door width, the absence of thresholds or the installation of ramps and lifts), it can avoid the need for costly conversion at a later date.

Content Requirement

The potential of the building ventilation strategy to adapt to future building occupant needs and climatic scenarios.

Design Strategy

The proposed ventilation strategy employs on-floor Air Handling Units supplying fresh air at a rate of 16 l/s/person. The on-floor strategy increases flexibility for tenants to adapt the provision to their requirements and is also a lower embodied and operational carbon approach.

There is scope for a tenant to increase this if required, through the installation of a larger AHU with their demise, additional louvre space has been designed in to accommodate this.

The additional louvre space could also be used by a tenant to install their own auxiliary ventilation equipment if required. For example, a small extract fan to provided dedicated extract of a kitchenette or printing area.

A mixed mode strategy is also proposed, with openable façade panels, to allow increased levels of fresh air in the perimeter zone if desired by a tenant. This will be further developed in later design stages.

Drawings & Reports

- Stage 2 Report and associated mechanical strategy drawings.

3.5 Convertibility

Convertibility is the ability to accommodate substantial changes in user needs by making modifications. In regard to buildings, convertibility is related to versatility, in that both principles involve using single spaces for multiple uses. However, convertibility is achieved by designing the space or fit-up to facilitate minor, non-structural modifications to interior spaces (e.g., partitions, ceiling, and finishes) or furnishings to suit changing needs, either on an infrequent or irregular basis or at a future point in time. Convertibility for multiple uses can improve the profitability of a space, as well as reducing the need for other facilities, thereby reducing resource and energy use. Convertibility can be related to versatility in civil engineering works, however, conversions are more often sequential, and rarely revert back to the original use (e.g., coal fired power plant being converted to natural gas).

Content Requirement

The degree of adaptability of the internal physical space and external shell to accommodate changes of use.

Design Strategy

The scheme is focused on accommodating office use and lab-enabled space. In principle the tower is designed to support a wide range of uses with minimal architectural intervention. The core has been designed to provide all vertical transportation, emergency egress and some of the riser space as a central function of the tower, and has been designed as a “soft core” (see Feasibility). The air handling units are provided on a floor-by-floor basis which supports the convertibility of the MEP system to changes in use across the tower. Converting the office spaces to other uses would require the following considerations:

- Existing lift provisions would be an overprovision for residential or hotel use,
- The depth of the floorplates would make for an inefficient arrangement of residential or hotel use, but a perimeter arrangement could be suitable.
- The installation of lightweight finishes for high end hotel or residential use.

Given the different requirements considered for the alternative use, a higher degree of intervention is required to adapt the façade. The façade is designed to be modular in construction which would support potential changes required for converting the building use.

The structural floor system for the tower comprises a steel frame with precast concrete planks, supported on shelf plates and recessed within the beam depth. Unlike a typical in-situ concrete system which relies on continuity across the slabs, this system does not rely on continuity across the individual planks. This means that, within reason, a proportion of planks could be removed without affecting the structural integrity of the frame.

Consideration should be given to the practicality of removing pre-cast units within an occupied building, due to weight and scale of the elements. This could be achieved through strategic openable façade panels and dedicated lifting equipment.

Together with a system that is designed to be demountable, this enables short-term adaptability in a relatively non-destructive (and reversible) manner:

- It is possible to form new (larger) risers for potential future changes to the MEP servicing strategy by removing planks
- New lifts could be added by removing planks to accommodate potential changes in the vertical transportation strategy
- Double height spaces and/or new inter-storey connections could be created by removing planks.

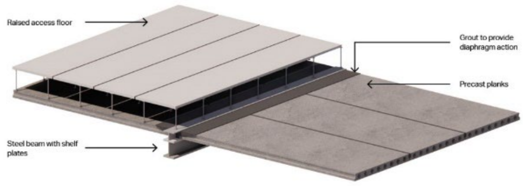


Figure 5.1 Sketch of structural floor system components

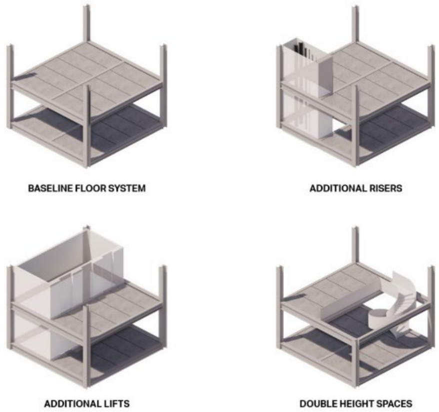


Figure 5.2 The structural system is adaptable to a variety short-term changes

Drawings & Reports

- Residential test fit

3.6 Expandability

Expandability is the ability of a design or the characteristic of a system to accommodate a substantial change that supports or facilitates the addition of new space, features, capabilities and capacities. In regard to buildings, expandability involves designing to allow for either vertical or horizontal additions in floor space. Expanding vertically can require consideration of structural allowances in the foundation and superstructure to bear larger loads or allow for the ability to easily increase the load bearing capacity of the structure without major disruptions to the occupants. For expanding horizontally, the design shall facilitate the disassembly of existing walls, envelope, or partitions so that space can be expanded without significant damage and materials can be re-used, either on the existing project or another. Designing in this way will also facilitate the reduction of space, as necessary, as well as evaluating the potential for increased space requirements in the future. Designing for expansion can require redundancy, e.g., foundation allowances for vertical and horizontal expansions (additional loads and footprint size, respectively).

Content Requirement

The potential for the building to be extended, horizontally or vertically.

Design Strategy

The site layout puts restriction on future potential for expandability.

The building height is constrained by the historic viewing corridors (LVMF 19A), so any possibility of future vertical expansion is unlikely. Therefore, the building structure has not been designed to be expanded vertically. Similarly, expansion to the West is limited by protection of the view from Parliament Hill to the Palace of Westminster (LVMF 2A.2).

On the South and East, the site is bounded by Euston Road and Hampstead Road respectively, both of which are TfL red routes meaning significant expansion is unlikely on these major throughfares. To the North of the site, the proximity to the buildings on Brock Street limit potential expandability in this direction.

Drawings & Reports

- Site constraints
- Site location plan.

3.7 Refurbishment Potential

Refurbishability is the ability to restore the aesthetic and functional characteristics of a product, building or other constructed asset to a condition suitable for continued use. The refurbishing of products can reduce the consumption of natural resources. Depending on the intended design life of the construction works, refurbishability can also help reduce operating and maintenance costs. The supplier shall make information available on how a product is refurbishable. The use of construction components that can be refurbished, allowing for an increase in their service life, shall be considered.

Content Requirement

The potential for major refurbishment, including replacing the façade.

Design Strategy

Several measures have been included in the design to simplify potential refurbishment of the tower. Two large goods lifts within the main core and a large loading bay ensure that future refurbishment work can be carried out efficiently, effectively, and non-intrusively.

Following the principle of design in layers, the façade is designed to be modular and divorced from the primary structure. This means that individual elements of the façade can be removed / replaced at end of life, without affecting the primary structure which is expected to have a significantly longer service life.

A maintenance and replacement strategy has been developed to better enable future maintenance and refurbishment of the façade. This strategy will mainly be reliant on the BMUs located on the roof of the tower with sufficient reach and lifting capabilities to reach all elements of the proposed façade.

Through specifications and designs, the materials comprising the structure will be protected against corrosion and deterioration and through regular maintenance, the components of the structure will endure beyond the building's intended design lifespan. The pre-cast plank system furthermore allows for dismantling and refurbishment of individual parts of the structure, should this be required.

Drawings & Reports

- Typical layout showing goods lifts
- Indicative façade sketch showing connection to structure (TT SK 001)
- Façade A&M strategy summary

4 Ease of Disassembly

4.1 Durability

Materials with a high durability rating that require less frequent maintenance, repair, or replacement should be selected. In some cases, however, it might be possible to reduce overall environmental burdens by designing for a shorter life, and for easier disassembly and re-use of components and materials (e.g., with temporary structures). The durability of materials or subsystems within the context of the design life of the constructed asset shall be considered. If the expected design life is short, the importance of durability can be offset by other principles (e.g., accessibility, independence, simplicity, ease of re-use, and recyclability). Assess the service environment to determine the factors that could influence the rate of material or assembly deterioration and determine resilience requirements. Manufacturers' warranties can be used to provide a marginal measure of a product's durability.

Content Requirement

Use materials which require less frequent maintenance, repair or replacement, considering them within the context of the life span of the building.

Design Strategy

The current revision of this report is carried out for the scheme at the end of RIBA Stage 2. Specific material finishes have yet to be confirmed with British Land. The intentions are to consider materials of a high robustness for internal finishes.

In high trafficked areas such as the lobbies, publicly available spaces, amenity spaces, and WCs there will be an enhanced focus on robust and durable materials such as natural/composite stone, ceramics and metals.

From an MEP perspective, emphasis will be placed on the specification of durable equipment and distribution, and the systems designed to minimise the operational maintenance required. BMS monitoring systems will facilitate interaction between FM teams and the systems, ensuring that operational aspects such as plant cycling, duty/standby load transfers and identification of failures are optimised to increase the service life of any equipment to the maximum possible duration.

Drawings & Reports

tbc

4.2 Exposed and Reversible Connections

Ease of access in design allows for a material, component, or connector of an assembly, especially those with the shortest anticipated life cycle, to be easily approached, with minimal damage to and impact on it and adjacent assemblies. Ease of access reduces replacement time and the generation of unnecessary waste during the replacement or maintenance of materials or components. Ease of access is closely related to independence and is often related to uncoupling "layers" of a building or components of construction works that have significantly different lifespans.

Reversible connections can be disconnected and/or disassembled for easy alterations and additions to structures. The use of reversible connections instead of fixed fasteners to connect products or components can allow for easier disassembly. Not only can the material be used again but the connectors (e.g., screws, bolts) can also be re-used. Other methods of disassembly include selecting materials that are fastened by a tongue-and-groove connection rather than by an adhesive compound, which can produce a permanent connection that contaminates the material and affects its re-use and ultimate recyclability. By making products easier to take apart, so that constituent components are not harmed, elements can be re-used directly, so long as they meet performance requirements. Materials can also be readily separated by material type and then serve as inputs for other products through recycling processes. Poured and welded (wet, chemical, or fixed) connections of otherwise demountable elements decrease the potential for disassembly.

Content Requirement

Making the connections more visible provides opportunities to optimise material and product reuse. Welded connections prohibit disassembly and it is preferable to use screws and bolts to allow for disassembly and material reuse.

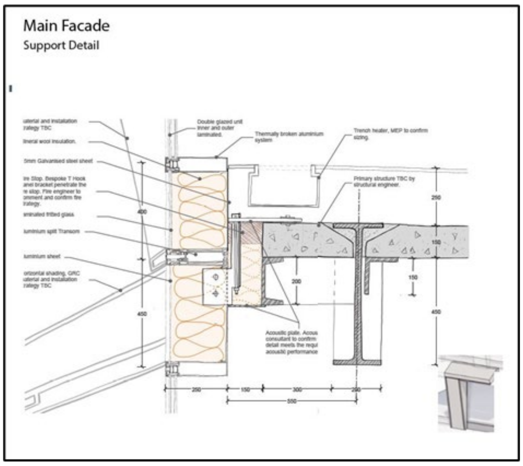
Design Strategy

Finishes

Proposals for finishes and details are still at an early stage and will be further evaluated at a later stage with considerations of exposed and reversible connections.

Façade

Following the principle of design in layers, the façade is designed to be modular and divorced from the primary structure. The façade is connected to the primary structure by a bolted connection to a cast-in channel. This connection is accessible beneath the raised access floor, meaning the façade can be decoupled (and therefore replaced) without impacting the primary structure.



Structure

In the current scheme the structural floor system of the tower comprises a steel frame with precast concrete planks, supported on shelf plates and recessed within the beam depth. Unlike a typical in-situ concrete system, the proposed steel and precast plank structural floor system is constructed using a series of pre-fabricated parts. The intention in the design is to assemble these parts in such a way that facilitates largely non-destructive disassembly. Currently, the planks are designed to be grouted together to act as a rigid diaphragm. Studies are carried out to evaluate the potential of using bolts as a means of connecting the planks to the steel frame, to further aid future disassembly of the structural system.

The diagram in Figure below illustrates indicatively the steps that would be required to disassemble the floor system. It is anticipated that the sequence could happen for a portion of a floor, a full floor, or the entire building.

From an MEP perspective, in later design stages the design team will investigate all possibilities to optimise material reuse and demountability through the specification of non-welded connections, pipe coupling systems and other strategies.

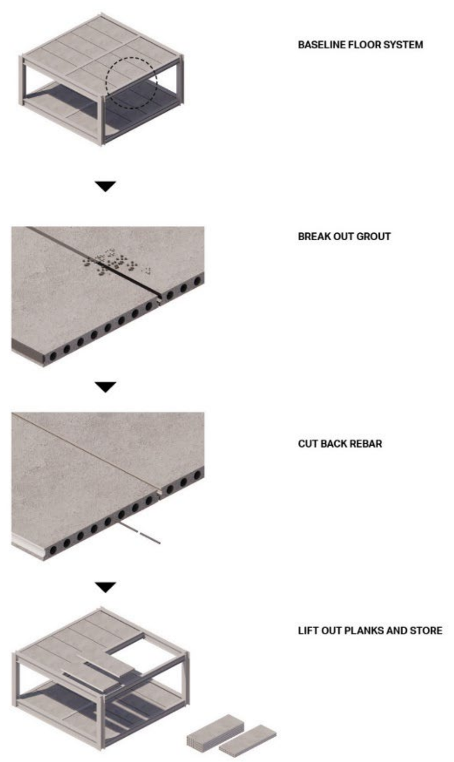


Figure 5.4 The structural system is designed to be demountable in a non-destructive way

Drawings & Reports

- Indicative sketch showing structural disassembly
- Sketch showing façade bolted connection to primary structure (TT SK 001)

4.3 Layer Independence

Independence is the quality that allows parts, components, modules and systems to be removed or upgraded without affecting the performance of connected or adjacent systems. Maximizing independence of the functional requirements of parts, components, modules and systems is key for optimizing disassembly for both re-use and upgrade. Modularization overlaps between adaptability and disassembly when modules achieve functional independence. Independence has to do with designing building systems or “layers” to stand independently, to facilitate the removal, adjustment, replacement, or upgrade of components. It is particularly important to think in terms of “layers” when planning from a temporal perspective for functionality and upgrades. Components of constructed assets have different design lives, and these variations need to be factored into the design. For example, the shell might require a service life that varies from 50 to 100 years, while the services might be expected to last 15 years and the interior fit-out elements perhaps 5 years.

Content Requirement

Designing building systems and components in layers so that removal, adjustment or replacement of some elements is feasible, especially when different components have different life spans and maintenance needs.

Design Strategy

The building structure is designed to be mutually exclusive of the building skin, so that the skin can be removed without compromising the structure. The structure is designed to tolerate the process of removing the facade.

Similarly, the services can be altered / removed without compromising the structure. The building is designed generally to allow for exposed services, or services below a raised access floor, which allows for easy access for maintenance.

The on-floor air handling unit strategy facilitates much simpler upgrade paths and unit replacement when compared to centralised equipment, allowing a tenant to upgrade the equipment to suit their requirements.

Drawings & Reports

- Sketch showing façade bolted connection to primary structure (TT SK 001)

4.4 Avoidance of Unnecessary Toxic Treatments & Finishes

Choice of finishes can limit the options for reusing or recycling the substrate, particularly if potentially hazardous substances are included. To support disassembly, finishes that can prevent the substrate from being re-used or recycled should be avoided. Finishes should serve a specific purpose, e.g. for fire and/or corrosion protection. There might be recyclable or reusable materials that can be used either on the exterior or in the interior of a constructed asset that will have suitable inherent finishes in their “natural state”, so that there is no need to use paint, veneer, or other finishes.

Content Requirement

Some finishes can contaminate the substrate in a way that they are no longer reusable or recyclable. This should be avoided unless finishes serve a specific purpose.

Design Strategy

Proposals for architectural finishes and details are still at an early stage, however it is the ambitions that all material selection will be carried out with high focus on avoidance of unnecessary toxic treatments and finishes.

As part of their Sustainability Strategies, British Land have developed a robust series of policies that identify materials that cannot be used in their developments. This information has been shared with the Design Team and will be reviewed at the outset of RIBA Stage 3. It is the intention to apply the British Land material schedule as a list of criteria for material selection.

The project is also targeting WELL which has strict conditions on material health and toxicity.

Drawings & Reports

- BL Material Schedule

4.5 Standardisation

Standardisation is concerned with the use of common components, products, or processes to satisfy a multitude of requirements. Standardised parts, which make it easier for contractors to disassemble structures while using efficient and repetitive techniques, should be considered. Standardization can support aspects of simplicity, adaptability and further re-use. Standardised parts can also allow for easier transportation, storage, and re-use. Due to the interchangeability of standardised parts and components, standardization facilitates simplicity, adaptability and further re-use in both design and the various phases of constructed assets. Selecting standard-size material can accommodate re-use and upgrading, since materials can be purchased with greater ease (and more cost effectively) when they are of standard dimension. Standard sizes also cut down on the creation of on-site off-cut waste for everything from timber, plywood, masonry, and insulation panels to floor tiles. Using standard dimensions needs to be reconciled with the client's requirements and the sizing requirements imposed by logistics, ergonomics, and functional needs. Design should consider optimisation of materials such as modular construction or prefabrication to reduce materials use. Prefabricated elements or components and a system of mass production should be used to reduce site work and allow greater control over component quality and conformity.

Content Requirement

Standardisation can accommodate reuse and upgrading. It involves aspects such as dimensions, components, connections and modularity. The dimensions of key building elements such as brickwork, blockwork, raised floor systems and doors will be standardised where possible.

Design Strategy

The scheme is based on two fundamental structural grids: 9x9m in the offices and 4,5x9m in the lab-enabled spaces. These structural grids work with a typical planning grid of 1.5m, in all areas. This planning grid is widely adopted in the UK and allows for standard systems to be used in the internal space planning.

The structural system is designed with a steel frame in a uniform grid and modular plank system. It is possible that the structural frame will mainly be from standard rolled steel sections facilitating future reuse.

The façade is designed in modules with focus on standardising the sizes across the individual modules to accommodate manufacturing efficiency and implementation of future upgrades. The façade will be designed to fit within the 1.5m planning grid.

The project's approach to standardisation will be subject to focused review as the design moves into RIBA Stage 3.

In later design stages the design team will assess all opportunities for employing Modular Methods of Construction and Design for Manufacture and Assembly principles to enhance off-site construction potential which is proven to be more efficient in terms of waste generation and material usage.

Drawings & Reports

- Structural grid and planning grid (BBD)

SWECO

SWECO BREEAM 2014 & 2018 Wst05 Data Collection Tool

BREEAM Project Number	BREEAM-0097-4394
Development Name	Euston Tower

RIBA Stage 2 Management & Evidence Log

Key milestones	Date	Email evidence ref. in Wst05 folder
Date Wst05 tool sent to design team	31.10.2022	-
Date tool received from architect	05.05.2023	-
Date tool received from structural	20.06.2023	-
Date tool received from environmental assessor	11.09.2023	-
Date tool received from MEP	20.06.2023	-

SWECO

BREEAM 2014 & 2018 Wst05 Data Collection Tool

Responsibilities Matrix

Consultant	Abbreviation
Architect	A
Structural	ST
Flood Risk Assessor	FRA
Building Services	MEP
Climate Change Consultant	CC

	Structural stability of the development	Structural robustness	Weatherproofing & detailing	Material durability	Health & safety of building occupants	Impacts on contents/business continuity
Changes in temperature & solar radiation	ST	ST	A / MEP	A	A / MEP	CC
Flood risk	ST / FRA	ST / FRA	A / FRA	A / ST	FRA	CC
Precipitation	ST	ST	A	A	A / FRA	CC
Drought	ST	n/a	A / CC	A	A	CC
Air Pollution	n/a	ST	A / MEP	A / MEP	MEP	CC
Wind Speed & Storm Events	ST	ST	A	A	A	CC

	Risks posed by hazard to...					
Hazard	**Structural stability of the development**	**Structural robustness**	**Weatherproofing & detailing**	**Material durability**	**Health & safety of building occupants**	**Impacts on contents/business continuity**
Potential risks posed to the development by changes in temperatures and solar radiation	Increased differential thermal expansion between structural steel elements due to increased temperatures could lead to global building stresses which might compromise structural stability.	Likewise, increased differential expansion between steel components due to increased temperatures could give rise to increased local stresses which might compromise structural robustness	Solar radiation may affect any exposed waterproofing membranes.	Materials changes and degradation due to extreme hot and cold temperatures in the UK.	Overheating risk (through poor façade design and lack of passive design measures employed) - **this is the key item**. Poorly designed building services which are unable to deal with potential future variations in internal conditions.	Loss of staff days for businesses caused by excessive internal temperatures. Uncomfortable internal working conditions can decrease staff productivity. Financial implications of replacing weather-damaged facades. **Note:** very few studies have considered the impacts of higher temperatures on productivity in the UK so there is considerable uncertainty on this subject.
Proposed mitigation measures for this development	Increased differential thermal expansion between structural steel elements due to increased temperatures could lead to global building stresses which might compromise structural stability.	Likewise, increased differential expansion between steel components due to increased temperatures could give rise to increased local stresses which might compromise structural robustness	All waterproofing membranes will be protected from direct sunlight as follows: - Gravel ballast and paviours for Level 31 roof. - Decking for external terraces. - Green roof build up for podium roof. Exposed pipes, ducts and services may be affected by extreme temperatures. All waterproofing membranes will be protected from direct sunlight by employing the following mitigations: - Installation of plant on raised plant deck - Application of paving or gravel - Installation of PV and associated supporting structure - Application of green or blue roof systems where applicable Suitability and location of the above mitigations and strategies will be confirmed in later design stages All exposed services will be clad with suitable materials accounting for the expected weathering and sunlight exposure - to be confirmed in later stages	GRC proposed for 50% of facades. The thermal mass will absorb temperature changes and even out the peak. Remaining 50% is glass combined with external solar shading device. Applied anodizing and/or powder coaating to be approved for outdoor use (UV-resistant). A UV-protecting varnish can be used on interior wood cladding and wood structures.. (Depending on wood type, change of color cannot be totally avoided)	External envelope designed as 50% solid/505 glass. Overal facade design balanced between window wall ratio, glass g-value and reveal depth and external solar shading device to reduce unwanted solar gains. Façade has been carefully designed to limit direct solar gains, with reduced overall glazing percentages, overhanding façade shading elements, low g-value glazing and set backs to amenity space heavily glazed areas. All MEP services are designed accomodate future weather scenarios which may impact on internal design conditions.	
Supporting drawings and documentation	To be included in the BBD. Not yet developed at this stage.	To be included in the BBD. Not yet developed at this stage.			Stage 2 report and associated drawings	

BREEAM Wst05

Flood Risk

Generally refers to the project flood risk assessment

SWECO

	Risks posed by hazard to...					
Hazard	**Structural stability of the development**	**Structural robustness**	**Weatherproofing & detailing**	**Material durability**	**Health & safety of building occupants**	**Impacts on contents/business continuity**
Potential risks posed to the development by flooding	Fluctuation of groundwater levels resulting in decreased stability of the ground. Changes in groundwater levels resulting in the overloading of retaining walls and lowest basement slab. Uneven weight/pressure distribution of the water if it floods basement areas.	Uneven weight/pressure distribution of the water if it floods basement areas. Inadequate drainage design resulting in increased probability of flooding on site. If the development is below the breach flood level AOD there would be a risk of flooding to site.	Lack of adequate waterproofing to basement and ground floor areas to limit the potential impact of flooding. Poor detailing resulting in water ingress in an extreme flooding event.	Degradation and damage to building materials caused by the site flooding under projected climate change conditions. **Note:** the flood risk assessment may well adequately explain how the flood risk is being mitigated and confirm low probability of flooding during the building's life	Loss of life through extreme flooding events Inability for occupants to escape the development in the event of the wider local area flooding (i.e. created an 'island') Hazardous and polluting substances stored in the building (oils etc.) entering the watercourse in a flooding event. Flooding causing damage to dangerous systems i.e. electrical equipment.	Office staff unable to reach the office and not able to work remotely, affecting productivity and causing a reduction in working days. Damage to building contents and fabric resulting in costly replacement and repair. Excessive flooding resulting in breakdown and poor operation of installed drainage systems.
Proposed mitigation measures for this development	Appropriate site specific flood risk assesment produced. Substructure designed to resist appropriate loading. Euston Tower will have deep foundations so damage is very unlikely. Provision of robust stability system.	Appropriate site specific flood risk assesment produced. Structural elements designed to appropriate exposure class. Appropriate products used to mitigate deficient weather resistance in retained elements.		Appropriate site specific flood risk assesment produced. Structural elements designed to appropriate exposure class. Appropriate products used to mitigate deficient weather resistance in retained elements. Final basement grade to be determined. Testing on exsiting elements in progress		
Supporting drawings and documentation	Not yet developed. Final detail to follow the Flood Risk Assessment.	Not yet developed. Final detail to follow the Flood Risk Assessment		Not yet developed. Final detail to follow the Flood Risk Assessment		

BREEAM Wst05
Precipitation

SWECO

	Risks posed by hazard to...					
Hazard	**Structural stability of the development**	**Structural robustness**	**Weatherproofing & detailing**	**Material durability**	**Health & safety of building occupants**	**Impacts on contents/business continuity**
Potential risks posed to the development by excessive precipitation	Risks mainly related to flooding and flash-flooding events caused by intense rainfall events. Changes in ground conditions (ground properties, increased water level) arising from flooding could cause ground movements and overstress the substructure.	Persitent ponding of water on roof elements leading to reduced design life for components such as membranes and seams. Undetected leaks could theoretically compromise local stability strucutre if not maintained.	Poorly designed façade resulting in moisture penetration of building fabric in the event of extreme rainfall events. Building drainage systems not sized appropriately to deal intense rainfall events and potential for flash flooding.	Material degradation in extreme rainfall events. Water stains on materials + rusting of exposed metals. Planted roofs (where applicable) - damage to soils caused by heavy & intense rainfall events Efflorescence of concrete, brick & natural stone materials causing degradation.	Increased risk of flooding (see previous section on flood risk for further details).	Impacts are related to an increased risk of flooding (see previous section on flood risk for further details).
Proposed mitigation measures for this development	Substructure designed to resist appropriate loads.	Design of the finishes to take into accound the deflecition of the strucuture to avoid ponding.	The facade will be designed to achieve British Standards regarding Water tightness. Openable elements form the weakest part in the system and will be selected to meet these standards. All main building entrances will have a canopy to potect the entrance area from rain. All roofs will be designed by the building services engineer to sufficient outlet capacity based on relevant storm events (SWECO to advise further). Attention to general geometries, detailing, vapor barriers, thermal bridges and sufficient insulation are pramount at this early stage.	All metal used in the facade will be either Aluminium, or where steel is required this will be either hot dipped galvanised or stainless steel. The extenal envelope will be designed to British Standards for water tightness to avoid water ingress into the building. Planted roof areas will be designed with adequate drainage layers to allow for water run-off in storm events (Arup to advise further).	All main building entrances will have a canopy or sit under building overhang to offer protection from rain.	
Supporting drawings and documentation	Not yet developed at this stage.	Not yet developed at this stage.	Not yet established at this stage.			

	Risks posed by hazard to...					
Hazard	**Structural stability of the development**	**Structural robustness**	**Weatherproofing & detailing**	**Material durability**	**Health & safety of building occupants**	**Impacts on contents/business continuity**
Potential risks posed to the development by drought / water shortages	Drying out of the subsoil layer resulting in retaining structures becoming unstable.	n/a	n/a	Excessive flow rates of specified water consuming components in the development, increasing the water stress in the local area.	Increased use through poor water efficiency in design may lead to local water shortages and lack of access to water in extreme events for building occupants.	
Proposed mitigation measures for this development	Substructure designed to resist appropriate loads.	n/a	n/a	not yet established. Specification of proposed components to be reviewed at stage 3.	Water consumption will be reviewed at the appropriate design stage. Also refer to water credits targeted under this assessment.	Climate consultant to confirm
Supporting drawings and documentation		n/a		Not yet established	Not yet established	

	Risks posed by hazard to...					
Hazard	**Structural stability of the development**	**Structural robustness**	**Weatherproofing & detailing**	**Material durability**	**Health & safety of building occupants**	**Impacts on contents/business continuity**
Potential risks posed to the development by air pollution	n/a	Chemical particles contained in the air and mixed with the rainwater can deteriorate the concrete and other exposed metal elements.	Chemical particles can deteriorate waterproof membranes and metal details of facades.	Specification of internal finishing materials (paints, varnishes, adhesives etc.) with high VOC content can adversely impact internal air quality. Impact of external air quality on façade materials - degradation & discolouration. Lack of durable materials/robust design used in building services equipment (pipework, ductwork, key equipment) resulting in degradation & leaks.	VOCs from building products & materials impacting on internal air quality. Lack of suitable monitoring and management of building services equipment (i.e. leak detection) resulting in compromised air quality.	Internal air quality influences health of occupants, leading to decrease in student productivity and increased potential for illness. Emissions to external environment may adversely affect the local air quality and health of wider community. Inability to meet local air quality regulations may result in fines or penalisation in the future.
Proposed mitigation measures for this development	n/a	Strucutral elements to be designed to an appropriate exposure class. Appropriate mitigation measures developed for retained elements which might be particulrly vulnerable. Protective paints or coatings to be specified for all steel structural elments of the frame.	A cleaning and maintenace strategy has been developed as part of the stage 2 design. This will be updated with detail added to ensure all exposed materials will be adequately maintained. Specifications of the external envelope will consider requirements for this. Louvres will be designed to prevent ingress of rain The bottom side of the ductwork immediately behind a louvre will slope towards the louvre with facilities for the drainage of any rainwater and will be coated to prevent corrosion All air handling equipment will be specified with appropriate levels of filtration in accordance with relevant statutory regulations, client requirements, industry guidance and best practice. Air pollution can cause poor internal air quality if sufficient filtration is not provided.	Internal finishes will be specified to ensure health and well being of the building users. This will include the use of low VOC paints and adhesives as well as limiting or fully excluding materilas with formaldehyde content. A cleaning and maintenace startegy has been developed as part of the stage 2 design. This will be updated with detail added to ensure all exposed materials will be adequately maintained. Specifications of the external envelope will consider requirements for this. Frames and blades shall be fabricated from galvanized mild steel or from aluminium alloy. All louvres shall be fully protected against corrosion. All materials used in building services shall be selected to be durable and facilitate ease of maintenance. Maintenance routes will be identified and early engagement will facilities managment providers will be encouraged	Bird/vermin screens shall be fitted to all external louvres and shall be removable for cleaning. Intake and exhaust louvre distances will be suitably separated to avoid polluting internal air as a result of re-circulation. Intake louvres will also be located away from other exhausts e.g. standby generators, WC vents. BMS will be used throughout the building to monitor and manage building services. Leak detection will be monitored by use of sub-meters and pressure statuses	Note that a life safety standby generator may be required for the development, although a dual utility power supply is being developed to remove the requirement for a life safety standby generator. Future generator for business contunity for essential lab loads is also being allowed for within the development. All generators to run on HVO fuel instead of diesel to reduce the NOx and particulate matter from emissions.
Supporting drawings and documentation	n/a	n/a	Cleaning and maintenance stragegy as part of the stage 2 report.	Cleaning and maintenance stragegy as part of the stage 2 report.		

	Risks posed by hazard to...					
Hazard	**Structural stability of the development**	**Structural robustness**	**Weatherproofing & detailing**	**Material durability**	**Health & safety of building occupants**	**Impacts on contents/business continuity**
Potential risks posed to the development by high wind and storm events	Increased wind gusts could overstress superstructure with increased lateral loading.	Increased high speed winds could overstress curtain walling, plant screens and rain screen cladding at a local level. Local structural robustness may be insufficient.	Damage to facades via high winds and storms by not providing adequate weatherproofing based on local project climatic conditions.	Excessive replacement of materials that are not durable and not able to withstand the impacts of high wind/storm events.	Risk of falling objects from facades/terraces. Risk of trees being taken down by high winds causing hazard to building occupants. Poor design/orientation of building in appreciation of surrounding buildings, resulting in wind speeds in certain areas of the development being potentially dangerous	Damage to external and internal materials through storm events is well documented - replacement of glass damaged by debris etc. If the development is not adaptable to storm events, it may be closed for long periods therefore impacting staff productivity and attendance levels.
Proposed mitigation measures for this development	Current standards include sufficient allowance for changes in wind patterns. A wind tunnel study could be carried out if deemed necessary which could increase the velocity pressure considered in the design. We will work with the wind consultant to manage this risk.	Current standards include sufficient allowance for changes in wind pattens. A wind tunnel study could be carried out if deemed necessary which could increase the velocity pressure considered in the design. We will work with the wind consultant to manage this risk.	Wind tests have been carried out to better understand general wind conditions of the building and surrounding public realm. Further tests will be carried out during stage 3 to further assess wind conditions to be expected on the facades. Resulting test data will inform the design. Wind loading to be intgrated into envelope requirements. Partial testing of facade will be carried out during construction.	Materials and detailing will be developed based on wind tunnel testing. This will be established during stage 3.	Wind tests have been carried out to better understand general wind conditions of the building and surrounding public realm. Further tests will be carried out during stage 3 to further assess wind conditions to be expected on the facades. Resulting test data will inform the design and detailing to respond accordingly.	
Supporting drawings and documentation	Not yet developed at this stage	Not yet developed at this stage	Wind test data as part of the planning submission by Arup Wind	Not yet established at this stage.	Wind test data as part of the planning submission by Arup Wind	

Euston
Tower

3xn.com