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Cost model: Residential timber

6 June 2017 | By Alex Hyams, Steve Watts, Catherine Harvatt

p>A familiar building material now has many innovative and scientifically developed forms, of which cross-laminated timber is perhaps the most compelling. Alex Hyams, Steve Watts and Catherine Harvatt of Alinea detail the costs of building with CLT

Source: Daniel Shearing

01 / Introduction

Timber has been used in construction for thousands of years, and timber framing is one of the oldest known methods of building. In Britain, archaeologists uncovered traces of timber-framed homes from more than 10,000 years ago and, comparatively recently, the building method saw a surge in popularity in Roman times and the Georgian period, encouraged by the sturdy, resilient qualities of the material and relative ease of construction.

Glued laminated timber, known as glulam, has also been used in construction since the mid-1800s, but the latest innovation in timber construction began in the 1990s with the creation of cross-laminated timber (CLT).

CLT is a multi-layered solid timber panel product used for the wall, floor and roof elements of a building's superstructure.

In 1996, an industry / academic joint research programme was undertaken in Austria, which resulted in the development of what we know as CLT today. The large format, solid engineered, cross-laminated timber panel production was pioneered by companies such as KLH Massivholz, who in 1999 were one of the first companies to open a CLT manufacturing facility in Europe.

Although wood has been used in buildings for centuries, CLT panels offered – for the first time – a wood product to match the structural and technical requirements of more traditional building materials such as concrete. It took several years and extensive product testing for CLT to become recognised and accepted within the European market.

02 / Types of timber products

CLT

This cost model uses a CLT design for a residential building as its basis, but it is not the only way of using timber as a structural solution. Below is an outline of the main options.

CLT – also referred to as XLam, solid timber, engineered timber or massive wood – is a manufactured multi-layered solid timber panel product used for wall, floor and roof elements of a building's superstructure. Made from kiln-dried finger jointed spruce or fir planks, the board layers (lamella) are laid out, stacked at right angles and glued together in perpendicular layers using high-pressure bonding.

The majority of CLT panels currently manufactured use polyurethane adhesive to glue the sheets together. The polyurethane adhesive is a solvent and formaldehyde-free adhesive "0" emission class), which has no risk of toxic emissions at any stage in the product's lifecycle.

CLT panels can be manufactured in three, five, seven or more lamella, with typical thickness ranging from 80mm to 300mm, in various widths from 1.25m to 3.00m and lengths of up to 18m. In the UK it is recommended that the panels are no longer than 13.5m for transportation purposes (standard panel sizes vary depending on the CLT manufacturer).

CLT panels can be supplied with three different finishes to the outer layer of the panel: non-visual, industrial visual, and visual.

The number of board layers and panel widths will depend on the purpose and structural requirements of the element of the building for which they are designed. CLT panels are manufactured at full size as "master panels" and then cut to the size and shape of the individual elements required for the building – minimising the waste from master panels is called panel optimisation and clever panel optimisation can reduce CLT panel wastage and therefore cost.

The benefits CLT offers to structural applications include:

- **Flexibility** The computer numerically controlled (CNC) cutting process used in the manufacture of CLT panels allows the panels to be cut or routed to almost any shape.
- **Strength** CLT is stronger than solid timber as it has a wider distribution of natural defects due to the cross lamination process and high standard of board strength grading.
- **Capability** CLT is typically used for floor, roof and wall elements of building structures with spanning capabilities of up to 8m or up to 12m when used compositely with concrete or as a fabricated cassette section. CLT has high in-plane strength and stiffness, which also allow it to also be used effectively as shear walls, diaphragm plates and deep beams.
- **Quality** CLT is manufactured to strict QA requirements from stress graded timber of known structural capacity.
- **Stability** CLT is manufactured from kiln-dried timber (12% moisture content) and the cross lamination process makes it less prone to movement caused by changes in moisture content.

Glulam

Glue laminated timber (glulam) is an engineered solid timber product manufactured for load bearing purposes, predominantly used for columns, beams and truss components. Typically made of spruce, glulam is also made by gluing together lamella. Glulam is available in a range of both softwood and hardwood species including spruce, pine, birch, oak and iroko.

Timber lamellas used in the production of glulam are typically finger-jointed into continuous lengths. The thickness of the lamella will depend on the application and species used, typically 40mm with homogeneous and composite build-ups available. Once glued, the members are planed and cut to exact size and shape. The length and shape of glulam sections are only limited by the manufacturing and transport capabilities of the manufacturer, and it can be used in almost any type of building from simple dwellings to major public buildings and bridges.

Compared with CLT, glulam offers opportunity for use in a variety of situations requiring strength and spanning capabilities, because:

- It is ideal as a structural beam and can be manufactured curved or straight
- It is possible to manufacture glulam beams with higher strength lamella in areas of high stress – such as in the top or bottom lamella of beams – and lower strength lamella in areas of low stress. Steel screw and plywood panel reinforcement can also be incorporated in areas of high tensile stress
- Glulam beams may be able to carry equivalent loads to those of steel or concrete beams, but provide a lighter, more sustainable material due to their high strength-to-weight ratio.

LVL

Laminated veneer lumber (LVL) is a high-strength engineered wood product used primarily for structural applications. It is comparable in strength to concrete and steel and is manufactured by bonding together rotary peeled or sliced thin wood veneers under heat and pressure.

LVL is used for structural elements including beams, lintels, purlins, truss chords and formwork. LVL can also be manufactured to almost any length, restricted only by transportation to site.

In LVL, the grain of each layer of veneer runs in the same (long) direction, so it is strong when edge loaded as a beam or face loaded as a plank. This kind of lamination is called parallel-lamination.

The veneering and gluing process of LVL enables large members to be made from relatively small trees, thereby providing for efficient utilization of wood fibre. LVL is used primarily as structural framing (posts and beams) for residential and commercial construction.

Roof cassettes

Roof cassettes can be specifically adapted to meet various physical and loadbearing requirements. The structure consists of loadbearing timber ribs, clad top and bottom and filled with glass wool or mineral wool thermal insulation. The moisture-adaptive vapour barrier, applied seamlessly across the full width of the cassette, ensures the desired performance of the building can be met.

The standard version of the roofing cassette is used for a maximum single span of 7.5m and is 160-280mm thick – depending on the load specification, but cassettes can be produced up to 22m in length, double or even triple spanning across the structure.

The design of the roofing elements allows for a wide range of coverings to optimally fulfil the specific requirements of the project team. In the construction of flat roofs and flat inclined roofs, it is possible to use PVC, FPO, EPDM membranes (rubber) and bitumen waterproofing (two layers) as well as more traditional corrugated steel or aluminium profile roofing systems.

Wall cassettes

Due to well-established prefabrication techniques, timber wall cassettes offer countless possibilities for interior and exterior wall surface finishes. With various types of panelling available for walls and facades, timber cassettes can be customised to meet each project’s design and performance specifications.

Using wall elements of single-storey height, buildings are erected one floor at a time, known as platform construction, starting with the internal and external walls, followed by the roof. This is a distinctive construction technique, as no supporting frame is required. Each element has a maximum width of approximately 4.5m and a maximum length of 22m. The wall elements retain load transfer and racking resistance capabilities.

Timber concrete composite

Timber concrete composite is a ribbed floor system built from prefabricated concrete slabs on glulam ribs, which can provide thermal mass through the exposed concrete soffit and inherently has good acoustics.

The flat slab concrete system, in combination with CLT, allows for a smooth timber ceiling and a shallow construction depth.

Timber concrete composites can be used:

- In spans from 6m to 12m
- As a dry, prefabricated system
- In heavy-duty floors
- As acoustic floors

- For offices, residential and other commercial buildings

ZÜBLIN has developed a timber-concrete composite as a prefabricated system, combining the beneficial properties of concrete, as a damper for vibration and as a sound absorbing mass in the compression zone, with dry, fast and precise timber construction.

03 / Benefits of CLT

All the above fundamental approaches to timber buildings share a number of inherent advantages, but given that this cost model is based on a CLT solution, the following is a summary of that product's benefits:

Airtightness CLT structures typically offer higher levels of airtightness (2-3m3/m2/hr) than traditional construction.

Quality Surface grade finish of boards can be specified for an exposed finish.

Services installation CLT forms an easy surface to fix to and services installation is likely to be quicker.

Secondary structure Secondary framing or brackets are virtually eliminated.

Embodied carbon For every 1,000m2 of building built in CLT instead of steel or concrete, up to 350t of CO2 is saved or stored (representing up to 10 years of operational CO2 emissions).

Sustainability All the timber for CLT panels should be PEFC certified, with the raw material used coming from sustainably managed forests.

Programme Construction programme speeds can be optimised through maximum repetition and rectilinear forms. Early weathertight date allows "vertically stacked" programme.

Loadbearing facade Can be used as a loadbearing CLT facade structure, preferably with a punched window approach. Windows are pre-ordered as CLT tolerances are high.

Roof A simple CLT roof profile also aids an early watertight date.

Foundations Shallow strip foundations are more likely possible if a load bearing CLT wall structure is adopted.

Waste Construction waste associated with the structure is virtually zero.

04 / Technical issues

To ensure the most effective and efficient design, a number of particular technical considerations must be addressed in the design. These include:

Design responsibility Engineers should design CLT with knowledge and understanding of the CLT supply chain and each company's standard sizes.

Grids and spans should be planned with a 2.35m grid where possible with spans limited to 7.5m where possible. Greater spans will require thicker panels.

Building services Early and detailed design co-ordination is required (before panel fabrication), board layouts should be planned to suit opening where possible

Acoustics Specialist advice should be sought at early design stage.

Floor vibration Design limits must be determined for intended use.

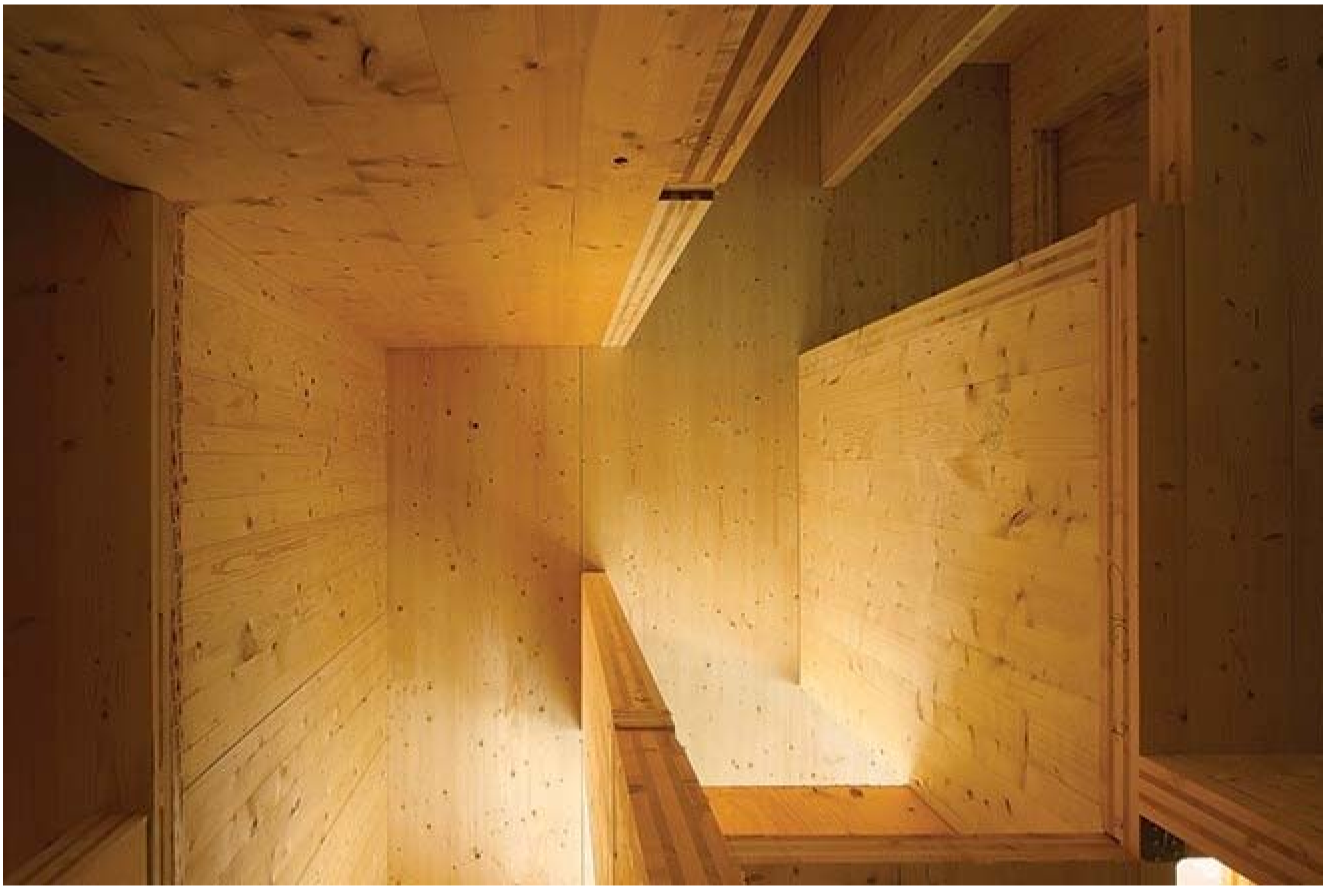
Thermal mass CLT has a significant thermal mass but less than exposed concrete soffits.

Exposed finishes Early attention to details is required and an early decision made on the visual surface grade (with a cost allowance for the upgrade). Possible issues to address are: staining (rain and UV) and drying shrinkage cracking (gradual commissioning of the building heating system can avoid this).

Moisture CLT needs to breathe and specific types of insulation and vapour barrier must be used to prevent moisture condensation against the CLT surface.

Fire requires a fire engineered approach (see box, right). Exposed CLT panels can be engineered for 1-2hr fire resistance, but exposed CLT will require a spread of flame treatment in the UK.

Cost comparison should not be limited to the cost of the frame: consideration must be given to programme, foundations, facades, secondary structures, etc.



Source: Will Price

05 / Reinforced concrete frame vs CLT

If the cost of a CLT frame is comparable to a reinforced concrete frame (see cost model), and appears to have more advantages than disadvantages, why do we not see more CLT frames being built?

When evaluating structural frame options at concept design stage there will be certain design criteria that will make one structural form more attractive than the other.

If one is looking to utilise thermal mass in a building to control the internal environment then exposed concrete soffits and walls have a distinct advantage over CLT planks. There are also times when more weight is needed in a building structure, most often when there is a basement with two levels or more. The additional weight of a concrete frame will be beneficial in controlling uplift forces.

From a structural engineering perspective there is little difference between the frame types in terms of flexibility on site and the opportunity to makes changes or corrections. In terms of design approach the industry wide adoption of BIM Level 2 means that buildings are more co-ordinated between design disciplines and this is especially true of window and wall openings and MEP builders' work penetrations. Again, given the changes in design technology, there is no particular advantage of one frame type over the other in terms of the design process.

When it comes to the "crunch time" of decision making there is more collective industry experience in building traditional reinforced concrete frames and therefore more comfort of knowing what can go wrong and how to solve problems once construction has started. Notwithstanding the suitability of the scheme's dimensions, this "safety net" sentiment can have a bearing on the decision.

06 / Supply chain

There are a little over 20 manufacturers of structural timber products in Europe. The most prominent, and their product ranges, are shown in the table below.

Timber products

Manufacturers	CLT	Glulam	LVL	Cassettes	Hybrid
KLH	♦				
Stora Enso	♦		♦		
Binderholz	♦	♦		♦	
Mayr Meinhof-Holz	♦	♦			
ZÜBLIN Timber	♦	♦			♦
Hasslacher	♦	♦			
Egoin	♦			♦	
Schilliger	♦			♦	
Wiehag	♦	♦		♦	
Rubner Holzbau	♦	♦			
Hess Timber	♦	♦			

This list is likely to grow because there are already other companies looking to start manufacturing CLT in the future.

Designing timber for fire

Reasonable questions often arise regarding a timber structure's performance in fire. Such concerns are shaped by history and are typically rebutted on the basis that timber elements, such as those formed of CLT, can achieve comparable fire resistance ratings as those formed of concrete and protected steel. However, such a comparison can be overly simplistic.

The challenge for timber buildings (particularly those exposed in the design) is not to demonstrate how comparable fire resistance ratings can be achieved, but how adequate performance in real fire events can be demonstrated.

This has been the focus of the research community and is yielding new tools and methods that are allowing the boundaries to be pushed. More importantly, advances are allowing structural fire engineers to design on the basis of sound scientific principles.

Fire resistance periods (and, thus, the fire resistance required of elements) are a proxy for what level of performance in a standard test is required to ensure that elements would survive the burnout (full duration) of a real fire event. These periods are predicated on inert enclosures, for example, where structural elements / enclosure are not a source of fuel.

In "real performance terms" challenges exist with regards demonstrating how a timber structure can resist burnout. It is necessary to characterise: (a) how the combustible elements affect a fire's development, and (b) how, once involved, structural elements (such as CLT) might self-extinguish.

Specific to CLT, behaviours can also be observed in fire, like delamination, that influence both fire development and load -bearing capacity.

Such has been the rate of emergence and development of engineered timber, such as CLT, the production of design guidance has struggled to keep pace. Interim fire design guidance has been published by European research institutions (SP) and further work is underway within the EN 1995-1-2 committee and aligned research projects (such as COST FP 1404). Irrespective, as boundaries continue to be pushed, engaging timber structural fire specialists will be essential.

Danny Hopkin, associate – structural fire engineering, Olsson Fire & Risk

07 / Cost model

We have prepared two detailed cost models, one each for a CLT and concrete design for a seven-storey private residential building. The scheme has been designed with both a timber and concrete solution in mind at the outset, with a structural layout to suit both. The cost model included here is the CLT version, with the summary table below showing how the affected elements differ in cost between the two.

The cost model shown is based on:

- A building in London (Zones 3 – 6)
- 307,912ft² gross internal floor area / 223,286ft² net internal (residential) area
- A small retail shell at ground level
- 294 residential apartments (all for private sale)
- CLT frame, upper floors, roof, core, stairs, external walls (all first floor and above)
- Reinforced concrete ground and transfer slab
- CLT all non-visual grade
- Piled foundations due to poor ground conditions
- All rates are base dated at Q2 2017 and reflect a two stage competitive design and build tender.
- Exclusions from the cost model include demolitions, fees (professional and pre-construction), external works, incoming utilities, section 106/278 agreements and VAT.

The CLT costs are based upon subcontractor costs received on a design completed by Engenuiti whereby a reinforced concrete frame alternative was also priced for comparative purposes. We have assumed that the internal CLT walls and soffits are boarded in order to provide an accurate comparison to the RC version in respect of acoustic, fire and visual requirements.

Estimates were obtained from two independent specialist CLT contractors, and analysed by Alinea, based upon tender-quality pricing schedules. Concrete costs are based on recent tendered information and are commensurate to a mid-market frame contractor pricing level. These were reconciled and compared with a similarly detailed estimate of costs prepared by Alinea for the concrete frame option. The correlation of the CLT “tenders”, together with their alignment with Alinea’s expectations, provide a relatively high degree of certainty in the numbers.

The summary below shows that the construction cost variance between timber and concrete for this hypothetical scheme is minimal. The higher CLT superstructure costs are offset by the ability to reduce pile quantities because of a lighter frame, hence a saving on substructure. The CLT programme for the frame and upper floors is around 10–15% shorter than the concrete option, resulting in a lower preliminaries cost.

	Total (£)	**Total (£)**	**Total (£)**
Element / Description	CLT	Concrete	Variance
Substructure	5,248,535	6,011,035	(762,500)
Above-ground shell, works & fit out	57,070,618	55,882,224	1,188,394
Main contractor items (preliminaries, OH&P, fixed price risk)	14,751,225	15,084,934	(333,709)
Total (£)	77,070,378	76,978,193	92,185

With the quicker frame programme and virtual parity in construction costs the overall appraisal figure with CLT should glean a greater return, with units coming to market quicker than the equivalent RC scheme. Further potential savings could arise from the ability to reduce floor-to-floor heights (CLT floors are thinner than the concrete equivalent), which brings savings not only in frame costs but more significantly in external walls.

Exposing walls and soffits of slabs could also benefit costs and programme, but this would depend particularly upon input from fire and acoustic specialists to ensure a fair comparison.

Concrete is the most prevalent frame material both historically and currently for new-build residential developments. Aside from its inherent design qualities, the costs associated with low/mid-rise residential are in the main more competitive than alternative materials. The scale of competition in the concrete market helps to keep costs competitive, meaning that pricing levels are subject to a high degree of variation. Concrete generally remains the most cost effective residential frame solution; however, the gap has narrowed and as the CLT supply chain grows, this gap will continue to close. CLT will therefore become a more viable alternative to concrete as long as it is considered early and schemes are designed to match the specific dimensional requirements. A building requiring longer spans or a more complex configuration will likely increase costs above concrete and therefore nullify the advantages of CLT.

	Total (£)	**£/m2**	**%**
Substructure	5,248,535	183	11%

	Total (£)	£/m2	%
Excavation; including disposal off site and 10% EO allowance for treatment of non-hazardous material (5,078m³ @ £60)			
Pilling mat; including disposal (7,357m² @ £50)			
Bored piles; 600mm diameter, 25m deep, including setting up rig, disposal of pile arisings off site, trimming tops of piles, pile / integrity testing (450nr @ £3,750) Reinforced concrete to pile caps; including reinforcement, formwork and blinding layer (2,002m³ @ £520)			
Reinforced concrete to ground slab; 350mm thick, including insulation, reinforcement and formwork (7,357m² @ £200)			
Allowance for lift pits (6nr @ £7,500)			
Below ground drainage (7,357m² @ £45)			
Frame	7,447,140	260	15%
Reinforced concrete frame; comprising columns, upstands, core walls and transfer beams, including reinforcement and formwork; to ground floor (6,812m² @ £95) CLT frame; Level 1 and upwards comprising of: * 120mm external walls			
* 120mm party walls (ground to third floor) * 100mm party walls (third floor to roof)			
* 120mm internal walls (ground to fifth floor) * 100mm internal walls (fifth floor to roof)			
* 140mm upper floors			
Upper floors	982,938	34	2%
Reinforced concrete to transfer slab; 400mm thick, including reinforcement, formwork and movement joints; Level 01 (4,510m² @ £210)			
Note: The upper floors (Level 01 and above) form part of the CLT package Edge protection for CLT upper floor slabs (3,584m @ £10)			
Roof	2,551,815	89	5%
Note: The main roof structure forms part of the CLT package Roof finish; paving on supports, including waterproofing and insulation (2,318m² @ £415)			
Roof finish; green roof, including waterproofing and insulation (3,645m² @ £200) Roof finish; planted area, including topsoil, waterproofing and insulation (717m² @ £235)			
Roof finish; decking area, including supports, waterproofing and insulation (340m² @ £315)			
Allowance for mansafe system (669m @ £200)			
Metal balustrading to terrace; 1.8m high (70m @ £875)			
Allowance for plant screening (1 item @ £30,000) Allowance for lift overuns (2 item @ £25,000)			
Allowance for plant supports, sundry roof steelwork, stepovers, gantrys, etc (1 item @ £100,000)			
Allowance for FF&E to courtyard; including planters, fencing, courtyard lighting (1 item @ £200,000)			
Stairs	213,000	7	0%
Reinforced concrete internal stair; dog leg, half landing, total rise per floor 3.125m, including reinforcement and formwork – to ground floor (8nr @ £6,000) CLT internal stair; dog leg, half landing, total rise per floor 3.125m; level 1 and upwards (33nr @ £5,000)			
External walls, windows, doors and balconies	10,427,900	365	21%
Note: The main external walls panels are part of the CLT package. They require a waterproof layer installed prior to final rainscreen/brickwork installation Facing brickwork (PC sum £700/1000); including VCL insulation and all associated Ancon brick angles and ties, including 1m parapet (8,871m² @ £300) Galvanised steel louvres (216m² @ £450)			
Curtain walling with louvres (196m² @ £975)			
Shopfront support steelwork (204m @ £250)			

	Total (£)	£/m2	%
Pilaster column treatment (30nr @ £1500)			
Glazed shopfronts; including manual entrance doors (613m² @ £1,000) Shopfront fascia panels (430m² @ £350)			
Glazing to residential entrances (120m² @ £850) Aluminium composite window; double glazing, including all ironmongery, infill panels, aluminium cill, brick support to heads of windows (4,456m² @ £650)			
Bolt-on balcony with metal railing; including sliding door to balcony, membrane and decking (294nr @ £8,000)			
Residential entrance doors (3nr @ £15,000)			
Bin store doors; double, including ironmongery (2nr @ £5,000) General access scaffold to all areas (11,634m² @ £100) Allowance for mock-ups and testing (1 item @ £50,000)			
Internal walls and partitions	2,875,825	101	6%
Note: The party walls and corridor walls are part of the CLT frame package Partitions to ground floor areas retail and BOH; 215mm blockwork (3,062m² @ £120) Wall lining to CLT apartment demise walls, 70mm battens, 50mm mineral wool, 2 layers of 25mm gypsum fibre board, measured both sides; level 01 and above (10,488m² @ £75)			
Wall lining to CLT apartment corridor walls, 70mm battens, 50mm mineral wool, 2 layers of 25mm gypsum fibre board, measured both sides; level 1 and above (19,242m² @ £75)			
Wall lining to CLT external wall; two layers of 15mm gypsum fibre board on dabs; level 1 and above (7,961m² @ £35)			
Internal doors	533,100	19	1%
Apartment internal entrance door; single, including frame, ironmongery (294nr @ £1,500)			
Internal staircase access door; single, including frame and ironmongery (56nr @ £1,000)			
Internal plant room door; double, including frame and ironmongery (8nr @ £1,200) Internal BOH doors to retail; double, including frame and ironmongery (4nr @ £1,750)			
Internal refuse chute doors; double, including frame and ironmongery (13nr @ £1,500)			
Internal finishes	2,009,900	70	4%
Dust sealant to retail walls and columns (2,346 m² @ £10)			
Paint wall finish to core walls/refuse/plant rooms (2,685m² @ £15) Acoustic floor build up, 60mm rigid insulation, sound absorption layer, dry screed board; level 1 and upwards (27,116m² @ £65)			
Floor paint to plant rooms, refuse, storage, cleaners (695m² @ £15) Dust sealer to retail, plant room, refuse, storage and cleaner's soffit (2,535m² @ £10) Sundry BOH finishes (say £50,000)			
Allowance for spread of flame treatments to the CLT core wall; level 1 and above (3,914m² @ £25)			
Fittings, furnishing and equipment	0	0	0%
Included in residential fit-out works – communal areas			
MEP	8,163,839	285	16%
Sanitary installations; included in residential fit-out works – apartment fit-out Disposal installations (28,606m² @ £24)			
Water installations (28,606m² @ £15)			
Heat source (28,606m² @ £45)			
Space heating and air treatment (28,606m² @ £28)			
Ventilation systems (28,606m² @ £16)			
Electrical installations (28,606m² @ £78)			
Gas installations (28,606m² @ £0)			
Protective installations (28,606m² @ £11)			
Communication installations (28,606m² @ £49)			
Special installations (28,606m² @ £0)			
Lift installations (28,606m² @ £12)			

	Total (£)	£/m2	%
Builders' work (28,606m² @ £7)			
Preliminaries, OH&P and contingencies	9,422,139	329	19%
Preliminaries @ 14%			
OH&P @ 5%			
Contractor's fixed price risk @ 3%			
Total shell works	49,876,131	1,744	100%
Residential fit out works – communal areas			
Stairs	123,000	4	7%
Stair finishes, paint to walls, floor and soffit, nosings and mild steel handrails			
Internal walls and partitions	0	0	0%
Included in shell works			
Internal Doors	163,150	6	10%
Internal doors; single, including frame and ironmongery			
Internal doors; double, including frame and ironmongery			
Internal doors; single including frame and ironmongery to risers and stores Internal doors; double including frame and ironmongery to risers and stores			
Wall Finishes	287,235	10	17%
Finish to walls and columns to communal areas; paint			
Finish to entrance; Feature wall			
Skirting to partitions and linings: MDF skirting and painted			
Floor finishes	205,325	7	12%
Finish to communal corridors and apartment lobbies; carpet Finish to entrance lobby			
Finish to management areas			
Finish to BOH circulation			
Finish to bicycle store; epoxy "anti slip" floor paint			
Ceiling finishes	250,440	9	15%
Finish to common corridors; plasterboard with acoustic backing Finish to entrance lobby; suspended plasterboard ceiling, including edge detailing, primed, sealed and decorated			
Finish to management areas; suspended plasterboard ceiling, taped and jointed, primed, sealed and decorated			
Finish to bicycle store and BOH circulation; dust sealant			
Fittings, furnishing and equipment	300,734	11	18%
Reception desk to main entrance			
Post boxes in main entrance			
Allowance for fittings to lettings office, post room and management			
Statutory signage			
Cleaners cupboard with sink and services			

	Total (£)	£/m2	%
Cycle racks			
Storage bins; 1,100 litre Eurobins			
MEP	0	0	0%
Included in shell works			
Preliminaries, OH&P and contingencies	324,126	11	20%
Preliminaries @ 15%			
OH&P @ 5%			
Contractor's fixed price risk @ 3%			
Total residential fit-out works – communal areas	1,654,010	58	100%
Residential fit-out works – private apartments			
Stairs	0	0	0%
Not applicable			
Internal walls and partitions	1,984,180	69	8%
Note: A proportion of the apartment division walls form part of the CLT frame package. Wall lining to internal partitions, two layers of 15mm gypsum fire board to both sides; 50mm gypframe metal C stud to one side, taped and jointed (17,605m² @ £100) Internal partitions to bathrooms in apartments; metal stud partition system, moisture resistant wallboard, tile backer, insulation, taped and jointed (1,864m² @ £120)			
Internal doors	1,058,120	37	4%
Internal doors to apartments; single, including painted softwood frame, hardwood painted and ironmongery (932nr @ £700)			
Sliding doors to wardrobe and storage areas, painted and ironmongery (294nr @ £730) Utility cupboard door, painted and ironmongery (294nr @ £650)			
Wall finishes	2,273,435	79	9%
Finish to bathrooms and en suites (50%); ceramic tile; finish to kitchen splashbacks; ceramic tile; finish to partitions and linings; emulsion paint			
Skirting to partitions and linings; MDF skirting and painted			
Floor finishes	1,575,645	55	6%
Finish to bathrooms; ceramic tiles, laid on screed; finish to all bedrooms; carpet; finish to all other areas; engineered timber board			
Ceiling finishes	995,115	35	4%
Finish to apartments; suspended plasterboard ceiling, taped and jointed, primed, sealed and decorated			
Access hatches; cut into plasterboard			
Fittings, furnishing and equipment	4,724,920	165	18%
Kitchen to private apartments; including kitchen units, 22mm quartz worktop, undermount 1 1/2 sink, chrome mixer taps, oven, hob, fridge / freezer, microwave, dishwasher, washer and dryer to studio, 1-bed, 2-bed and 3-bed apartments Sanitaryware to bathrooms and en-suites to private apartments; shower tray, close coupled WC pan and			

	Total (£)	£/m2	%
seat, wash hand basin, chrome plated mixed taps, recessed thermostatic shower mixer with chrome head, shower cubicle and screen, enamelled white steel bath, bath panel and mixer taps			
Fittings to bedrooms of private apartments; wardrobe doors and fittings Fittings to bathrooms and en suites of private apartments; including vanity shelf, heated towel rail, wall-mounted mirror cabinet, toilet roll holder			
MEP	7,923,862	277	31%
Sanitary installations; included above			
Disposal installations (28,606m² @ £18); Water installations (28,606m² @ £25); Heat source (28,606m² @ £30); Space heating and air treatment (28,606m² @ £22); Ventilation systems (28,606m² @ £46); Electrical installations (28,606m² @ £70); Protective installations (28,606m² @ £18); Communication installations (28,606m² @ £42); Builders' work (28,606m² @ £6)			
Preliminaries, OH&P and contingencies	5,004,960	175	20%
Preliminaries @ 15%; OH&P @ 5%; Contractor's fixed price risk @ 3%			
Total residential fit out works – private apartments	25,540,237	89300%	100%
Total cost model	77,070,378	2,694	100%

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