

CONSTRUCTION COST COMPARISON REPORT - AFFORDABLE HOUSING

TIMBER VS. MASONRY

PRELIMINARY FINDINGS FOR
PRESENTATION AT ECOBUILD 2018



Timber frame vs. masonry. An independent study to compare the cost of the two build methods in order to determine which is more economical for affordable housing.

The purpose of this report is to gain an appreciation of the comparative costs and establish the basis for a more detailed study. The report's conclusion of this preliminary investigation is that timber is marginally more cost effective than masonry. However, to unequivocally prove the case a more extensive investigation and detailed analysis will be undertaken.

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PREFACE

Rider Levett Bucknall (RLB) has delivered many residential projects over the years.

The selection process over the form of construction considers a number of factors including availability, practicality and technical performance. Importantly this process also involves commercial considerations and sometimes the debate over whether masonry or timber is the most economical solution.

This deliberation is continuing throughout the industry and will be intensified by structural offsite timber solutions becoming increasingly used to fulfil the growing demand for new homes across the UK. Equally there is increasing demand for cross laminated timber (CLT) which is now competing economically with steel and concrete frames.

We are pleased to have been able to complete this independent study comparing timber frame to masonry for a conventional housing project and we gratefully appreciate the time taken by the four contractors who priced the model project, the consultant architects and engineers who provided their expertise, as well as the other parties involved.

We hope the research will be of interest to many members of the construction industry and has provided an answer to a question that has been debated for many years, and probably will continue to be in the future.

Andrew Reynolds
UK and Global Board Director
Rider Levett Bucknall UK Ltd

EXECUTIVE SUMMARY

The research study has been managed independently by Rider Levett Bucknall (RLB) with the support of the parties named.

The affordable house type designs were provided by independent architect and engineering companies.

From the fully designed project RLB prepared Bills of Quantities for the contractors to price.

Four contractors were approached to submit their pricing and all four responded.

Contractor information was received regarding the anticipated construction programmes.

RLB has used the pricing to formulate this independent report and the costs summaries therein.

COST SUMMARY

	TIMBER	MASONRY
Construction cost per m ²	£1,055.90	£1,067.24
Overall cost per m ²	£1,148.38	£1,180.34
Programme (weeks)	41	49
Construction cost saving	1.1%	
Overall cost saving	2.8%	
Programme saving	19.5%	

The independent result of this study has resulted in timber frame being the most economic structural solution.

We are aware the market could change the result in the future.

RLB would like to undertake a future study of a speculative development of houses and apartments.

As with many structural solutions throughout the construction industry this debate will continue and RLB hopes to be part of the future discussions.

1 INTRODUCTION

Which is the more economical way to build housing: timber frame or masonry?

This question has been posed by many people and organisations within the construction industry for years. As both construction techniques are widely used throughout the UK industry, albeit masonry is more prevalent in England and Wales, we assume that there is not much between the two. If one was more expensive than the other, it simply would not be used.

One would assume it is a simple question to answer, but the more in depth you look the more multifaceted the answer becomes. We have discussed with contractors in the past about their build preferences, some saying timber, some saying masonry. Indeed tenders returned over the years have had similar differences, some timber some masonry, for the same project but with the overall tender price being very comparable.

Comparing the two build methods is difficult as the structures, procurement models and site operations are different. Masonry construction, in general terms, constitutes separate supply members and then site assembly of the constituent parts (walls, floors, roof trusses) whereas with timber frame the offsite manufacturer usually designs, manufactures, delivers and erects the whole structural shell of the home, including the roof structure. This presupposes the timber frame company supplies and erects the whole frame (walls, floor and roof).

We are aware the national house builders, and residential contractors, have prepared their own internal studies and comparisons, however, these are private internal analyses with commercial aspects included and as such are not suitable for wider publication.

Rider Levett Bucknall (RLB) has also been asked this question in the past and it is difficult to give a precise answer without looking in detail at the specific design and nature of the buildings and the associated build programme for the individual projects. Indeed comparing a structural steel frame with a concrete frame has been debated for decades with no definitive answer resulting as to which is more economical to build.

RLB in undertaking this independent study required the input from other organisations and these are listed throughout. We stress that it is an impartial study by RLB with the analysis prepared using the mean results from the independent prices received.

In our experience the costs related to all forms of housing construction, at any one time, depend on:

- Experience
- Availability of resources
- Organisations commercial position
- Market situation - national and local
- Site specific constraints and risks

What RLB has tried to do with this study is to provide an independent market tested model to arrive at an answer. The model used in this report is a typical affordable housing design and we plan to publish a further assessment in the future of a speculative private housing model for detached, semi-detached and medium rise apartment accommodation.

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2 SCOPE OF STUDY

The model is a typical affordable two storey housing design using 2 bed four person dwellings to create a single terrace. Each block was assumed to have the following mix:

- 2nr mid terrace
- 2nr end terrace

Creating 4nr houses per block and to give a degree of scale, 8nr blocks, resulting in a total scheme delivery of 32 new dwellings.

The house type designs were prepared by HTA Architects with structural engineering input by Milner Associates. It is assumed that the foundation design is similar for both build methods.

The designs create the same layouts, sizes and arrangements and are designed to the current edition of the Buildings Regulations in England.

RLB prepared an NRM Bills of Quantities (BQ) document with an overall pricing summary for issue to the contractors as follows:

- Timber frame - mid terrace
- Timber frame - end terrace
- Masonry - mid terrace
- Masonry - end terrace

The study compared the buildings only, with the external works and utility services discounted at this stage as these will be very much site specific in their content, works and any abnormal or risk areas, and assumed to be the same cost regardless of superstructure construction method. It also assumes a continuous build on site from commencement to completion.

The site assumed for the study was in the Midlands, on the outskirts of Birmingham, and within relatively easy access from a main A-road.

The detailed specification was included on the drawings issued to each contractor. In regard to the masonry and timber frame aspects, relating to the structural elements, the summary table on Page 12 lists the key specification items that are included.

Each contractor received the following drawing information with the specification included:

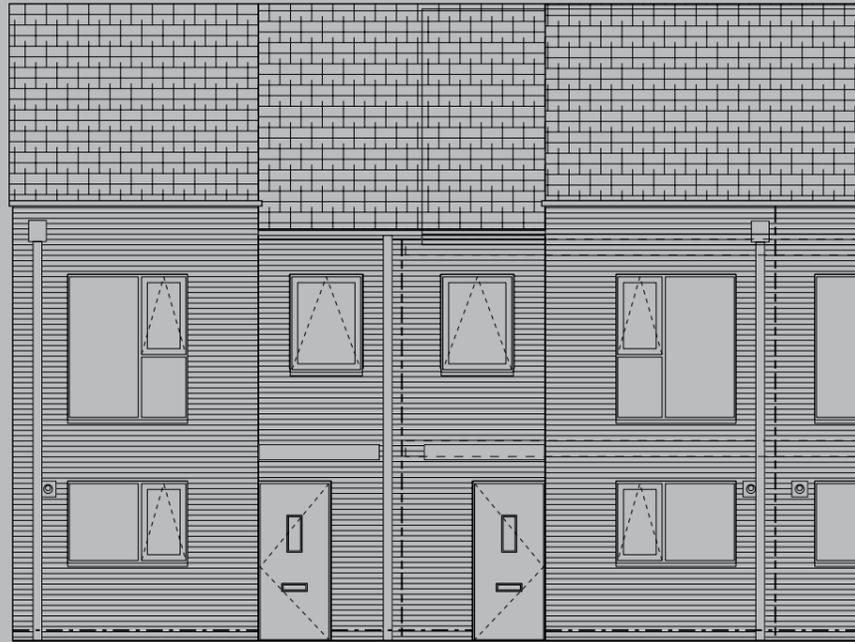
- Mid terrace floor plan
- End terrace floor plan
- General arrangement plans (dimensions)
- Sections
- Elevations
- Wall types
- Floor and roof types
- Substructure details 1 - threshold and ventilation details
- Substructure details 2 - foundation sections
- Substructure details 3 - threshold and internal wall foundation details
- Ground floor penetrations
- Superstructure details 1 - floor / wall edge and external wall opening details
- Superstructure details 2 - eaves, gable wall and verge details
- Superstructure details 3 - parapet roof and ridge details
- Superstructure details 4 - external canopy and floor/wall junction details
- Internal stair details

The design, manufacture and delivery of the timber frame, including plant and site labour to off-load and erect, with internal safety decking / working platforms / fall arrest systems was included within the timber frame price issued to all contractors.

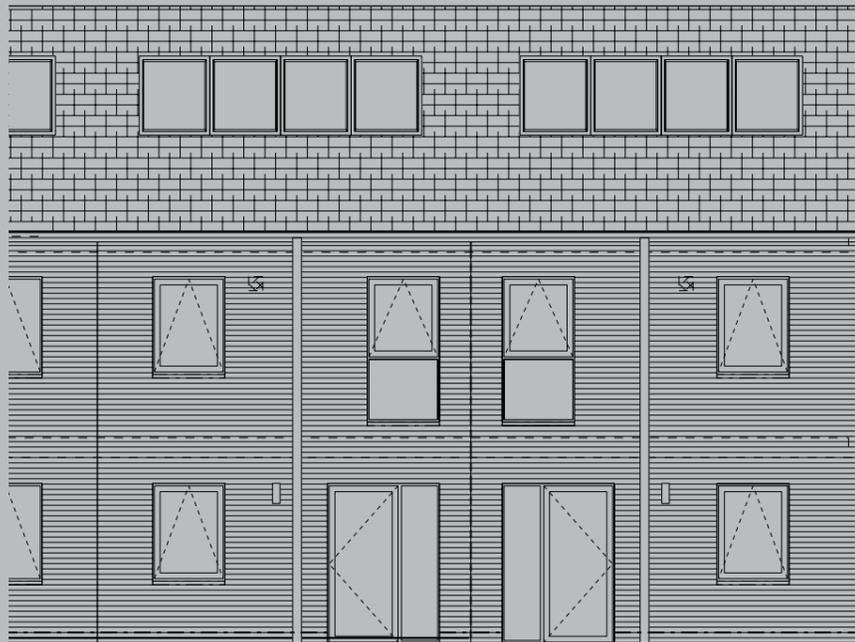
We also advised the contractors regarding the specific durations per block for delivery and erection of the timber frame as follows:

- Three crane days per terrace for the erection of the timber frame
- Three deliveries per terrace for the timber frame (excluding trusses direct to site).

3 TIMBER FRAME ELEVATIONS AND PLANS

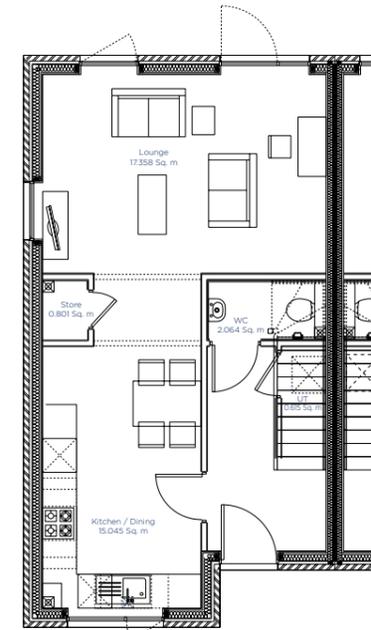


FRONT ELEVATION

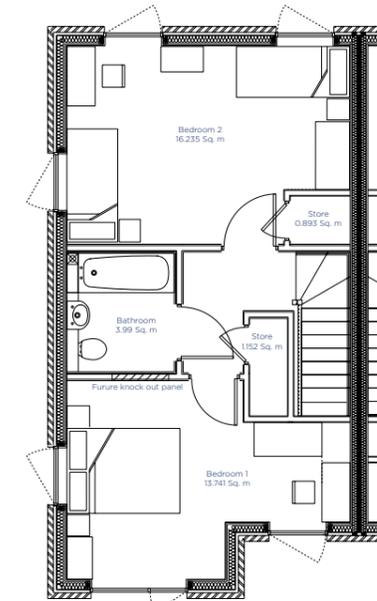


REAR ELEVATION

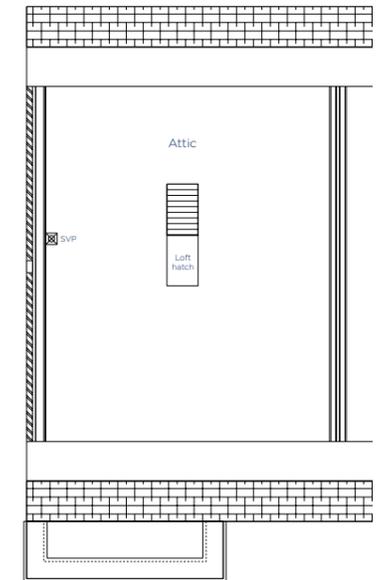
END TERRACE



2B4P House
Ground floor plan

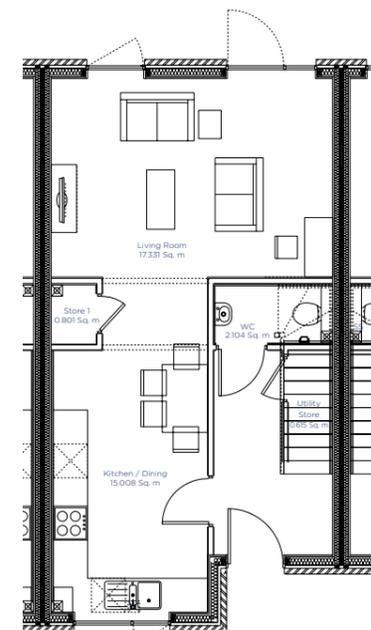


2B4P House
First floor plan

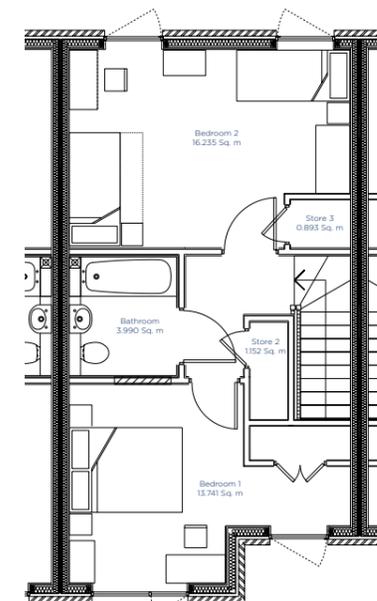


2B4P House
Second floor plan

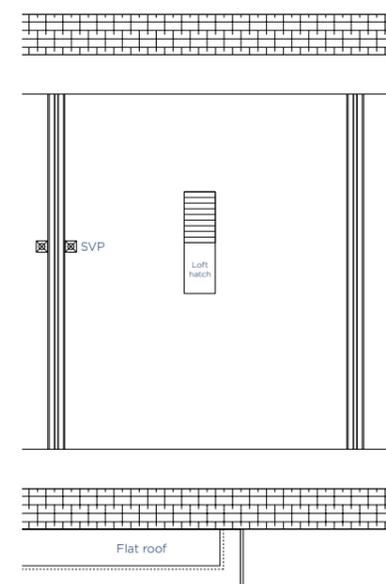
MID TERRACE



2B4P House
Ground floor plan

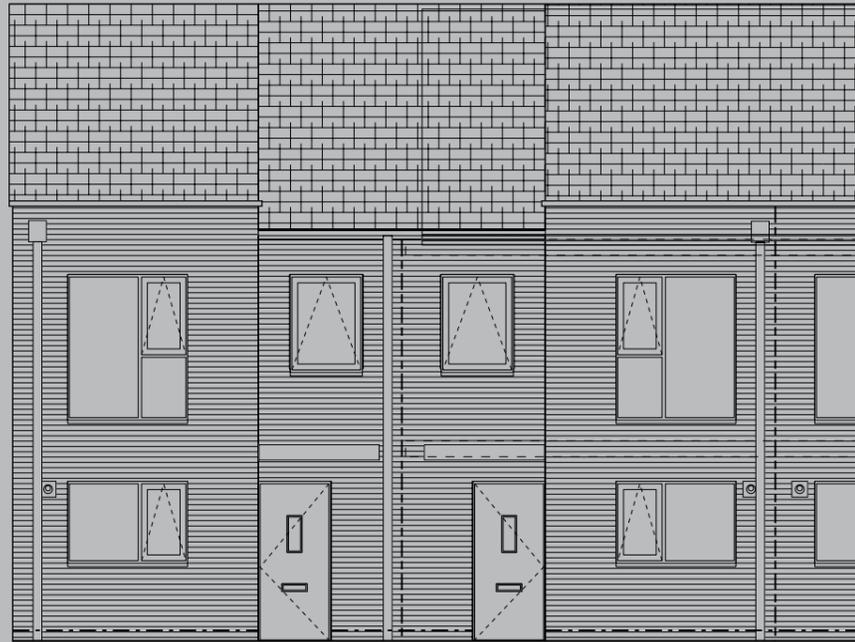


2B4P House
First floor plan

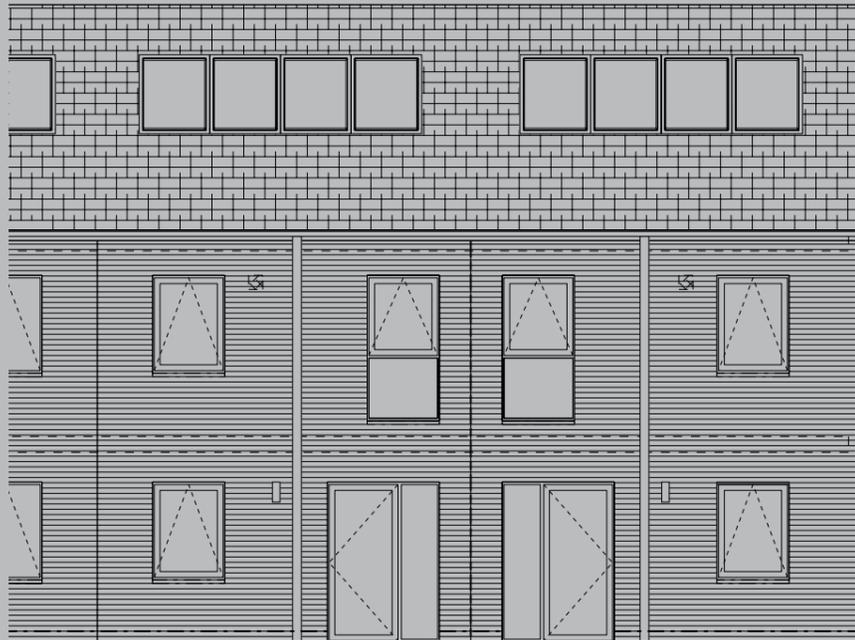


2B4P House
Second floor plan

4 MASONRY ELEVATIONS AND PLANS

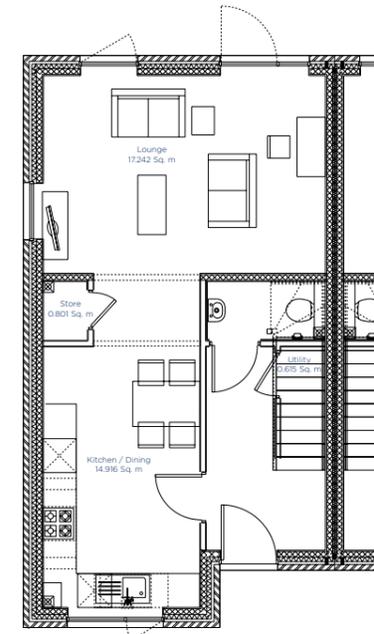


FRONT ELEVATION

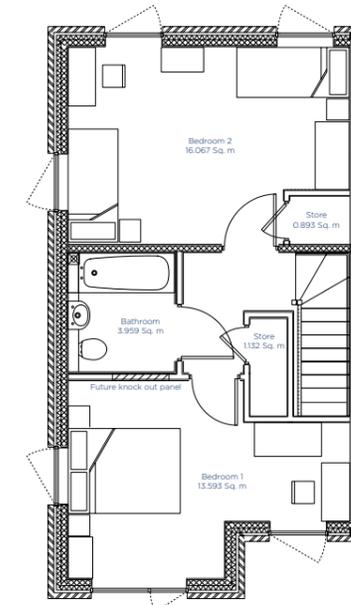


REAR ELEVATION

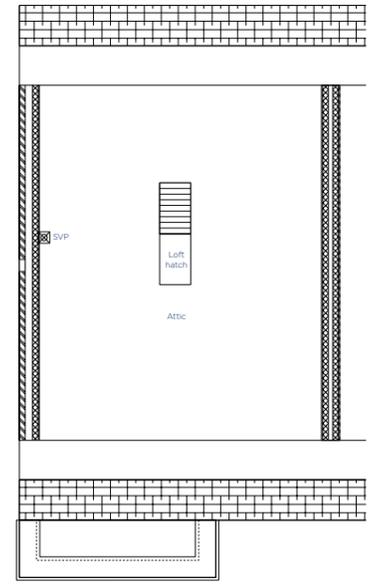
END TERRACE



2B4P House
Ground floor plan

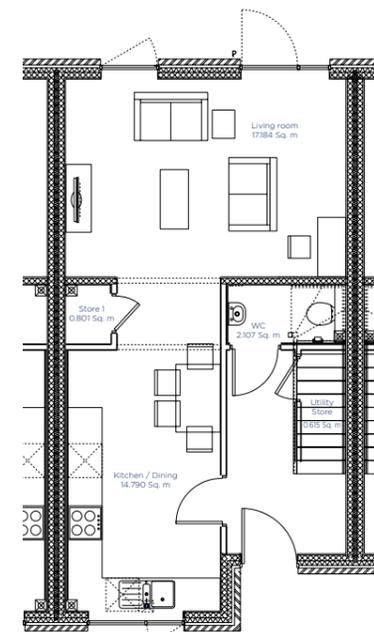


2B4P House
First floor plan

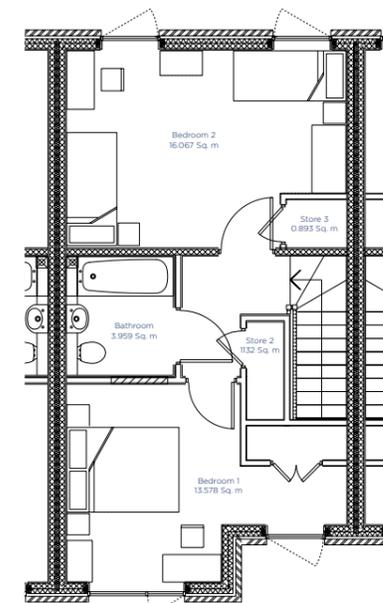


2B4P House
Second floor plan

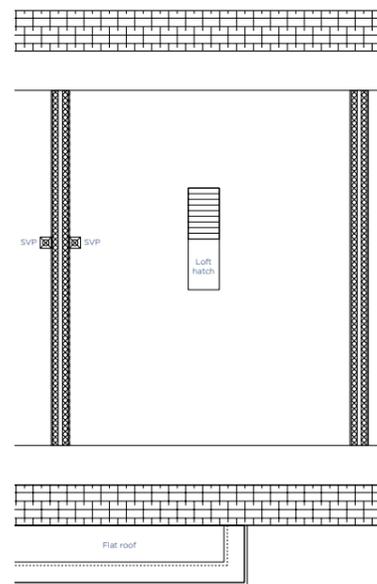
MID TERRACE



2B4P House
Ground floor plan



2B4P House
First floor plan



2B4P House
Second floor plan

5 DETAILED SPECIFICATION

TIMBER FRAME

EXTERNAL WALLS TO HOUSES

102.5mm facing brickwork

- Timber frame wall-ties to suit 50mm cavity
- Cavity barriers to suit 50mm cavity
- 140mm wide timber stud panels with 9mm OSB and low emissivity reflective breather paper
- 140mm wide timber soleplates, head-binders and rails
- 90mm TW55 insulation Factory-fitted to external wall panels

Internally lined with low emissivity vapor control layer, 25mm service zone battens and 1 layer of 12.5mm plasterboard with taped & filled joints

Overall thickness of external wall = 340mm
To achieve 0.19 W/m²K U-value

EXTERNAL WALLS TO ROOF PARAPET

102.5mm facing brickwork

- Timber frame wall-ties to suit 50mm cavity
- Cavity barriers to suit 50mm cavity
- 140mm wide timber stud panels with 9mm OSB and low emissivity reflective breather paper
- 90mm TW55 insulation Factory-fitted to external wall panels, filled with 50mm Rockwool R3 to internal side
- 18mm plywood to internal face of parapet fitted on site
- 18mm plywood capping piece to top of parapet wall

50mm rigid insulation board to upstand
Waterproofing membrane lapped up and under copping

INTERNAL WALLS: LOADBEARING

15mm Gyproc wall board with taped & jointed finish

- 89mm wide timber stud panels with one row mid-height noggins with the walls to the cloakroom and bathroom pre-fitted with 18mm ply to one side
- 89mm wide timber soleplates (with 450mm DPC), head-binders and rails

15mm Gyproc wall board with taped & jointed finish

MASONRY

EXTERNAL WALLS TO HOUSES

102.5mm facing brickwork

Masonry wall ties to suit 130mm cavity
50mm clear cavity
80mm Kooltherm K108 installed in the cavity
100mm medium density blockwork
6mm Gyprock Sound Coat Plus to seal hidden air paths
12.5mm Gyproc wall board on 10mm adhesive dabs
Overall thickness of external wall = 361mm
To achieve 0.19 W/m²K U-value

EXTERNAL WALLS TO ROOF PARAPET

102.5mm facing brickwork

Masonry wall ties to suit 130mm cavity
50mm clear cavity
80mm Kooltherm K108 installed in the cavity
100mm medium density blockwork
50mm rigid insulation board to upstand
Waterproofing membrane lapped up and under copping

INTERNAL WALLS: LOADBEARING

12.5mm Gyproc wall board with taped & jointed finish
10mm adhesive dabs
100mm lightweight concrete blocks
10mm adhesive dabs

12.5mm Gyproc wall board with taped & jointed finish

OR

12.5mm Gyproc wall board with taped & jointed finish

- 89mm wide timber stud panels with one row mid-height noggins with the walls to the cloakroom and bathroom pre-fitted with 18mm ply to one side
- 89mm wide timber soleplates head-binders and rails

12.5mm Gyproc wall board with taped & jointed finish

TIMBER FRAME

PARTY WALLS

12.5mm Gyproc wall board with taped & jointed finish (with joints staggered vertically and horizontally)

19mm Gypsum plank

- 89mm wide timber stud panels with 9mm OSB to cavity face
- 89mm wide timber soleplates (with 150mm DPC), head-binders and rails
- TF Party wall cavity insulation, with polythene sleeved cavity barriers to seal edges of party wall cavity.
- 89mm wide timber soleplates (with 150mm DPC), head-binders and rails
- 89mm wide timber stud panels with 9mm OSB to cavity face

19mm Gypsum plank

12.5mm Gyproc wall board with taped & jointed finish (with joints staggered vertically and horizontally)

- Achieving Robust Detail EWT2

Overall thickness of party wall = 313mm

INTERNAL WALLS: NON-LOAD BEARING

12.5mm Gyproc wall board with taped & jointed finish

- 89mm wide timber stud panels with one row mid-height noggins with the walls to the cloakroom and bathroom pre-fitted with 18mm ply to one side
 - 89mm wide timber soleplates head-binders and rails
- 12.5mm Gyproc wall board with taped & jointed finish

INTERMEDIATE FLOOR (LOOSE JOISTS)

- 22mm T+G plywood flooring
- Nominal 250mm deep metal-web timber joists, including trimmers and beams to form upper floor
- FCM750 air-tight membrane to external and party wall perimeter of upper floor
- Joist hangers and all other associated ironmongery to form the structural floor

15mm Gyproc wall board with taped & jointed finish

ROOF

Roof trusses, beams and stability bracing
89mm wide timber spandrel panels with 9mm OSB and standard breather paper
63mm timber gable ladders
Truss shoes and all other associated ironmongery
Nominal 38x140mm flat roof joists, timber beam to support trusses and 38x50mm firings
Party wall spandrel panels, pre-clad with 2 layers 12.5mm plasterboard and polythene protection

MASONRY

PARTY WALLS

15mm Gyproc wall board with taped & jointed finish (with joints staggered vertically and horizontally)

10mm adhesive dabs

100mm medium density blockwork

Acoustic wall ties

75mm mineral wool

100mm medium density blockwork

10mm adhesive dabs

15mm Gyproc wall board with taped & jointed finish (with joints staggered vertically and horizontally)

- Achieving Robust Detail EWM27

Overall thickness of party wall = 325mm

INTERNAL WALLS: NON-LOAD BEARING

12.5mm Gyproc wall board with taped & jointed finish

- 89mm wide timber stud panels with one row mid-height noggins with the walls to the cloakroom and bathroom pre-fitted with 18mm ply to one side
 - 89mm wide timber soleplates head-binders and rails
- 12.5mm Gyproc wall board with taped & jointed finish

INTERMEDIATE FLOOR (LOOSE JOISTS)

- 22mm T+G plywood flooring
- Nominal 250mm deep metal-web timber joists, including trimmers and beams to form upper floor
- Joists supported off internal leaf on joist hangers to SE specification
- Joist hangers and all other associated ironmongery to form the structural floor

15mm Gyproc wall board with taped & jointed finish

ROOF

Roof trusses, beams and stability bracing
Masonry external walls continued up to underside of roof covering, with cavity insulation terminated in line with top of the ceiling insulation.
63mm timber gable ladders
Truss shoes and all other associated ironmongery
Nominal 38x140mm flat roof joists, timber beam to support trusses and 38x50mm firings
Masonry party walls continued up to underside of roof covering, with cavity insulation terminated in line with top of the ceiling insulation.

6 COST COMPARISON

The results and comparison within this section are based on prices received by RLB during the 1Q 2018. The resulting tables and charts have been prepared by the author, Ian Dacre of Rider Levett Bucknall, and are the “mean” prices of those received.

The prices are based on three timber frame quotations and four main contractor quotations for the housing model and were received during January / February 2018.

You will see there are some unusual cost differences for one or two elements but we have chosen to leave the base data as submitted by the four contractors to arrive at the mean costs per element.

As with any tender exercise there are vagaries of pricing and if you look at one individual tender this could be an issue. We have received four and between the prices we have been able to normalise the vagaries whilst also leaving the base pricing level data un-touched.

The results were interesting. One contractor of the four priced the construction elements resulting in the masonry option being more economical than timber frame, whereas the other three had the timber frame more economical.

Also, within the pricing it was evident that the external cavity walls by all four contractors resulted in masonry being more economical than a timber frame solution for this particular element. However, as can be seen from the tables below, the overall situation, when factoring in the other building elements and site preliminaries, results in the timber frame solution being more economical to construct.

The preliminaries pricing by the contractors was based on their own interpretation of the construction programme for each build method. The tables below have been based on the mean programme (in weeks) and the costs associated. All four contractors suggested constructing in timber is between 6 and 13 weeks quicker than in masonry. The mean of the four is 8 weeks quicker.

The tables below give the overall average elemental analysis plus cost and programme summaries.

SUMMARY PRICING BY ELEMENT

AVERAGE CONTRACTOR PRICING ELEMENTAL BREAKDOWN	TIMBER FRAME		MASONRY	
	MID TERRACE	END TERRACE	MID TERRACE	END TERRACE
Substructures	£13,694.52	£16,386.15	£14,544.76	£17,139.28
Upper floors	£2,950.04	£2,800.04	£2,786.21	£2,789.48
Stairs	£1,182.09	£1,182.09	£1,182.09	£1,182.09
Roof	£10,850.29	£11,244.88	£10,756.46	£11,526.97
External walls	£8,916.31	£17,985.09	£7,426.50	£17,373.37
Windows and external doors	£6,495.67	£8,084.09	£6,801.00	£8,411.45
Internal walls	£10,723.04	£8,991.96	£10,539.91	£9,578.60
Internal doors	£4,341.71	£3,952.95	£4,403.68	£4,012.82
Wall finishes	£4,314.09	£4,285.71	£5,068.67	£4,314.98
Floor finishes	£1,829.76	£1,827.04	£1,853.73	£1,827.04
Ceiling finishes	£1,831.95	£1,836.41	£1,831.95	£1,836.41
Fixtures and fittings	£8,700.47	£8,700.47	£8,700.47	£8,700.47
Sanitary appliances	£3,205.94	£3,205.94	£3,238.64	£3,238.64
Mechanical services	£7,883.38	£7,883.38	£7,923.50	£7,923.50
Electrical services	£2,972.40	£2,972.40	£2,989.45	£2,989.45
Builders works	£471.75	£471.75	£673.26	£673.26
SUB TOTAL	£90,363.41	£101,810.32	£90,720.28	£103,517.82
Number of units - 16nr each	£1,445,814.53	£1,628,965.20	£1,451,524.52	£1,656,285.07
Total construction works		£3,074,779.73		£3,107,809.59
Preliminaries		£269,303.36		£329,349.52
TOTALS		£3,344,083.09		£3,437,159.12

SUMMARY BY BUILD TYPE

TIMBER	NR UNITS	£ / UNIT	TOTAL	£ / m ²
Mid terrace unit	16	£90,363.41	£1,445,814.53	
End terrace unit	16	£101,810.32	£1,628,965.20	
SUB TOTAL			£3,074,779.73	£1,055.90
Preliminaries (41 weeks)			£269,303.36	£92.48
TOTAL			£3,344,083.09	£1,148.38
MASONRY	NR UNITS	£ / UNIT	TOTAL	£ / m ²
Mid terrace unit	16	£90,720.28	£1,451,524.52	
End terrace unit	16	£103,517.82	£1,656,285.07	
SUB TOTAL			£3,107,809.59	£1,067.24
Preliminaries (49 weeks)			£329,349.52	£113.10
TOTAL			£3,437,159.12	£1,180.34

7 PROCUREMENT GUIDANCE

The procurement process for a timber frame solution is different to that of a more traditional masonry build, and the following items should be considered in the pre-planning stage of a project to ensure the overall success.

- Lead in time for the timber frame design and manufacture
- Engage timber frame suppliers early to maximise value engineering opportunities
- Manage the design process to achieve final design to allow early off-site manufacture
- Ensure level and dimensional tolerance for foundations are understood and achieved
- Minimise change once manufactured
- Engage with follow on trades and materials suppliers earlier to ensure understanding of programme and timescales of timber frame
- Consider fire risk mitigation at cost plan stage, design stage, and construction stage on site
- Consider the quicker return on investment of capital employed

Some, if not all of the above, issues have been taken in account with the four contractors' pricing levels we have seen. All four contractors suggested the procurement and overall delivery using a timber frame solution will be quicker (on average by 8 weeks for our model).

8 COST CONSIDERATIONS

To provide a commentary, we have identified areas which have been raised by the industry as factors to consider:

- Duration of scaffold hire / temporary works
- Number of deliveries to site to be ordered, coordinated, checked, signed-off and paid
- Forklift movement of materials on site
- Number of suppliers to manage and coordinate on site
- Requirement for on site storage
- Requirement of setting-out on site for bricklayers
- Requirement for window and door formers
- Requirement for lintels
- The impact of inclement weather on the delivery programme
- Speed of installation of mechanical and electrical services
- Foundation design to suit imposed load from superstructure build method
- Provision of warranties and product guarantees
- Site waste and disposal costs
- Commencement within the build programme of internal works
- Requirement for wet trades and drying out
- Requirement for design input by the client's design and site teams
- Use of Building Information Modelling (BIM)
- Preliminary works and impact on the overall build programme and costs
- Risk of market conditions including:
 - capacity
 - availability of materials
 - availability of skills
- Speed of build and the impact on:
 - cash-flow
 - return on investment
 - interest costs

9 OTHER CONSIDERATIONS

What to consider:

- Early design team integration (and use of BIM) required
- Preparation and completeness of designs (design freeze) to benefit from early off-site manufacture
- Understanding how the choice of build method impacts the remaining supply chain
- A full understanding of the programming opportunities for the follow-on trades
- Fire risk mitigation considered at cost plan, design and stage and construction (on site)
- The need for accurate and level foundation / slab setting out
- Other materials to provide weather proof external envelope and internal finishes.

10 SUMMARY

The debate will continue, we know, but RLB has undertaken an independent pricing exercise to establish which solution is more economical: masonry or timber frame, as a structural building solution.

The results from the four contractors show to us, that overall, timber, in this scenario, is the most economical solution.

We have seen, however, that individual pricing vagaries can slightly affect results and the average prices and programme times from the four contractors have been used to arrive at the summaries in this paper.

One contractor stated that masonry was the most efficient solution but taking in account the programme and preliminaries aspects, timber became more efficient for them.

All four contractors suggested in their pricing that the timber frame external wall element, in isolation, was more expensive than masonry. Again, however, factoring in preliminaries associated with the programme, timber was more efficient overall.

Overall the contractors suggest there are some elements that are more economical to build in a timber frame solution.

The percentage savings are:

- Construction elemental costs
1.1%
- Overall costs (including preliminaries)
2.8%

The summary below highlights the key findings of this study.

We are mindful this study is taken at a point in time and we are aware that the market conditions, commercial matters of companies and the overall economic climate can affect the pricing levels. The prices in this study are taken at the 1Q 2018 with all prices received during this period.

We trust this report has given a commentary and understanding of the costs and design implications for pricing a project utilising timber frame.

ELEMENTS	TIMBER FRAME		MASONRY	
	MID TERRACE	END TERRACE	MID TERRACE	END TERRACE
Substructure	£13,694.52	£16,386.15	£14,544.76	£17,139.28
Superstructure	£45,459.16	£54,241.09	£43,895.85	£54,874.79
Finishes	£7,975.80	£7,949.15	£8,754.35	£7,978.43
Fixtures and fittings	£8,700.47	£8,700.47	£8,700.47	£8,700.47
Services	£14,533.46	£14,533.46	£14,824.85	£14,824.85
Sub totals	£90,363.41	£101,810.32	£90,720.28	£103,517.82
Number of units - 16nr each	£1,445,814.53	£1,628,965.20	£1,451,524.52	£1,656,285.07
Total construction works		£3,074,779.73		£3,107,809.59
Preliminaries		£269,303.36		£329,349.52
Totals		£3,344,083.09		£3,437,159.12
Cost per m²		£1,148.38		£1,180.34
Cost per unit		£104,502.60		£107,411.22
Programme		41 weeks		49 weeks

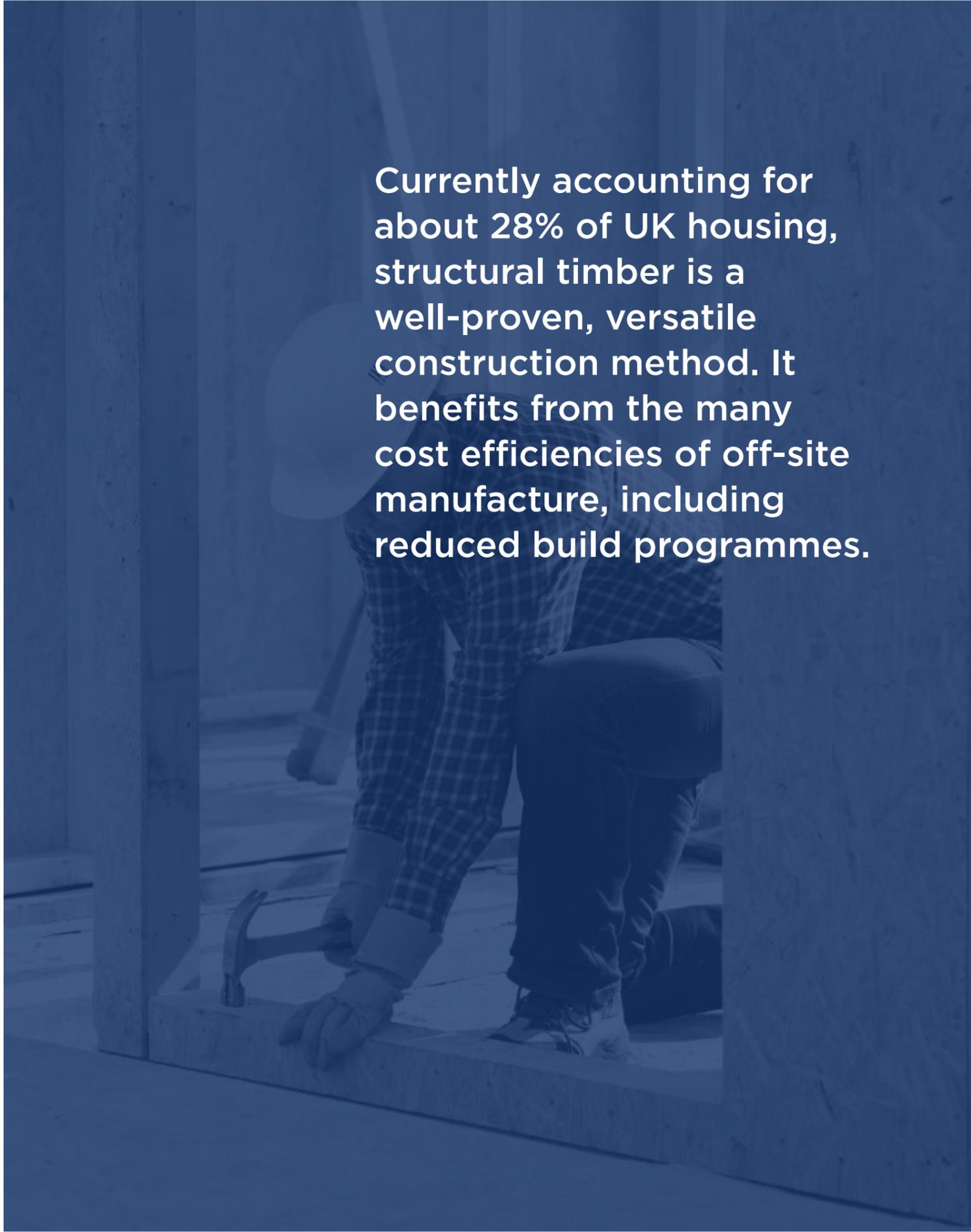
11 ACKNOWLEDGEMENTS

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Currently accounting for about 28% of UK housing, structural timber is a well-proven, versatile construction method. It benefits from the many cost efficiencies of off-site manufacture, including reduced build programmes.

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The majority of UK housing is currently delivered using traditional masonry methods. On site construction using masonry has benefited from recent innovation and remains an efficient and cost effective approach.

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