AIMCH

TRANSFORMING HOW WE BUILD HOMES

Work package 5:

Affordable Homes Pattern Book

January 2022

mtc Manufacturing Technology Centre

L&Q

Construction Scotland Innovation Centre

Forster Group

Stewart Milne Group

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EXECUTIVE SUMMARY

This work package was delivered by the AIMCH developer partners, Stewart Milne Group (SMG) & London, and Quadrant Housing (L&Q). By working collaboratively and sharing information on affordable housing requirements, market knowledge, housing concepts, design principles, DFMA, standardisation, technical compliance, construction optimisation and brand attributes, a means to create housing collections for each developer was derived.

The outcome being a Pattern Book of Affordable Homes, tailored to each partners requirement, for future commercial exploitation beyond the AIMCH project.

The partners focus was on affordable homes, where each developer had a requirement to create a range of homes, and where government policy is driving change towards Standardisation, DFMA, MMC and future NZC housing, which aligns well with AIMCH deliverables and exploitation outlook.

The developers ranges have been fully developed leveraging the learnings from Design for Manufacture and Assembly (DFMA), Design Standardisation and Product Families (Kit of Parts) and BIM (3D modelling) outputs previously developed within this work package. In additional each developer's market, design, technical, construction and commercial knowledge was brought to the fore, to optimise house designs, leading to standard house type pattern books, that can be exploited by each developer on sites they own, or through strategic partnerships with other developer/clients, or as a MMC supply chain offering, under a license agreement to 3rd party developers, benefiting the wider housing industry.

This work package undertook a structured development approach over 18 months. The work entailed the following development stages:

1. Design Brief
2. Market Research
3. Competitor Analysis
4. Range Scoping - Accommodation Schedule
5. Concept Designs
6. Space and Accessibility Standards Compliance Checks
7. DFMA & MMC Optimisation
8. Standardisation and Product Families
9. Final Designs
10. 3D BIM Modelling & Technical Information
11. Pattern Book & Exploitation

The work concludes by providing a full suite of technical information for SMG and L&Q Affordable House Ranges of the future. This information will be used by the AIMCH developers on future affordable housing developments. In total SMG developed 18 homes, including bungalows and cottage flats. L&Q developed 6 core 2 and 3 bed homes, providing a basis to develop additional homes in the future.

A novel approach from the supply side, is that Stewart Milne Timber Systems will offer the use of these homes to affordable homes providers, via a free to use license agreement, in return for utilising their timber based panelised MMC systems.

The exploitation of future Industrialised Housing Pattern Books, that embrace design standardisation, BIM and MMC, will fuel a path to delivering more, appealing, and functional homes, that deliver high quality at an affordable cost, using panelised MMC timber building systems.

BACKGROUND & OVERVIEW

Pattern book housing designs are not new and have been successfully used within the private housing sector for many years. However, within the affordable homes sector there is limited use. This is generally because affordable homes providers procure through development or building contracts, and do not have in-house technical teams, that govern the use of standardised house types.

There is the opportunity to develop an affordable homes pattern book that could be used by affordable homes providers, keen to procure timber panelised MMC systems, with the benefit of a preconfigured off-the-shelf range of homes that can be used in any location. Where affordable housing providers are becoming developers/ constructors, there is opportunity to develop in-house standard house types, as is the case for L&Q. This is increasingly the strategy for many larger HAs, LAs and RSLs where they seek to compete with the private sector for land.

Pattern Books would be of benefit to smaller developers, SMEs and new entrants who do not have in-house technical teams to develop house type designs and associated information collateral, which can take many years to evolve and refine. Homes England affordable housing funding is already encouraging a more diverse mix of affordable homes providers, and keen to support local authority, SMEs, and new entrant developers.

Therefore, these new developers are likely to be receptive to pre-configured and pre-approved housing designs, they can use with confidence and deploy at pace, to accelerate and increase overall housing output.

In the earlier stages of this work stream the AIMCH partners undertook detailed studies and prepared new guidance on design standardisation principles. This information was used in the detailed development of the affordable housing pattern books. These studies included:

1. **DFMA** – Design for Manufacture and Assembly
2. **BIM** – 3D Design Modelling
3. **Standardisation and Product Families** – Kit of Parts Commodities and Design Principles

The outputs from these studies have been brought to life and used within the final Housing Pattern Books created.

Figure 1:

AIMCH DFMA, BIM & Standardisation Guides Developed for use within Affordable Homes Pattern Books

JOURNEY

A key early-stage strategy was to develop a clear brief for the design of each developer's house range. By doing this, it prevented drift, scope creep and dilution of objectives, improving outcomes and bringing confidence in exploitation.

AIMCH took advantage of the projects collaborative ethos and working relationship, to share information and knowledge, by jointly creating one design brief that satisfied each developer's requirements. By working together, it became evident, that knowledge gaps exist within each developer's thinking, and no single developer has all the answers. By working together, a better, integrated, and robust design brief was developed.

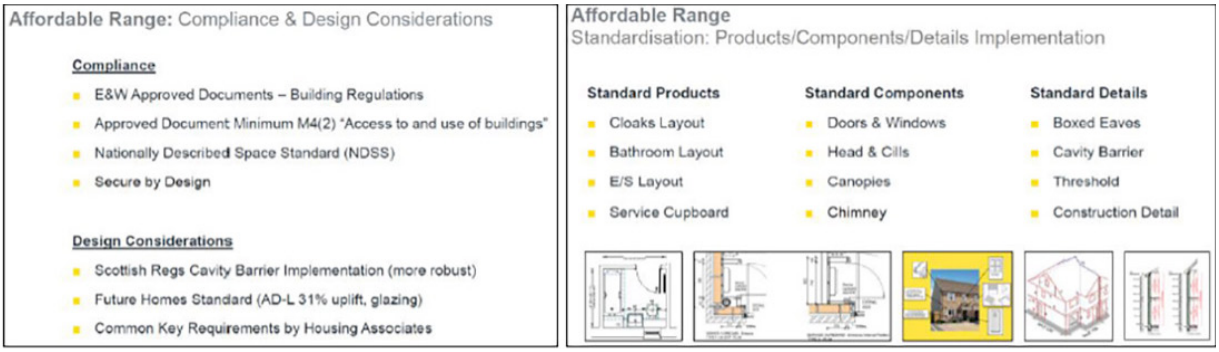


Figure 2: Extract from Design Principles: AIMCH Affordable Homes Pattern Book

The design brief set out the principles to develop a house range. This included the following core elements:

Part 1: Design Brief

1. Background
2. Aims & Objectives
3. Purpose
4. IP & Scope Governance
5. Number, Type & Mix of Homes – Market Coverage
6. Budget, Timeframe and Work Plan
7. Exploitation Outlook

Part 2: Design Guidance

1. Compliance Requirements – Building Regulations, SAP & Overheating, Space & Accessibility Standards
2. Technical Scoping – DFMA, Standardisation, BIM
3. Design Boundaries – External Fenestrations and Internal Options
4. Future Proofing – NZC Homes, Fabric First, Heat Pump Ready
5. Information Required
6. Assumptions

The final document crystallised the partners thinking and provided a robust internal justification and approval basis and acts as a future reference document, to refer to, as designs and work developed.

MARKET RESEARCH

As with any new product introduction process, it is crucial that the developers understood the affordable market requirements and how best to respond to these before housing design commences. The project had the benefit of having one of the UKs largest affordable homes provider as an active partner. L&Q provided great insight to the needs of the affordable housing marketplace, they shared the experiences of the differing nuisances and regional/client based needs, impacting on housing design, specification, and construction.

The research focused on the following main market research areas:

1. Engagement with G10 Group of large Affordable Homes providers
2. Engagement with smaller regional HA's
3. Engagement with Affordable Housing Consultants
4. Engagement with Homes England.
5. Engagement with targeted HA's via Online Questionnaire

L&Q are part of a network of HA's and as a member for G10 group of Housing associations, were able to discuss with their G10 partners thoughts around market requirements, as part of the collective market research undertaken. In addition, as a large framework partner to several affordable home's procurement groups, L&Q were able to interview several smaller HA's to gather their thoughts on housing design and market requirements. A key outcome from these discussions was the asset management requirements, which informed the partners approach to specification and construction, and how best to maximise BIM 3D modelling.

SMG typically provide affordable housing as part of a planning agreement for new build private housing in a regional context. This provided a differing perspective on marketplace, seen through the eyes of a supply and purchase contract for affordable homes, via smaller Housing Associations. Interviews were conducted with several HA clients of SMG and with their consultants. In addition, SMG interviewed their own specialist affordable home consultants, who act in an intermediatory role, when delivering affordable homes. These interviews provided much insight and shed light on specific areas of interest to regional and smaller HA's.

A key piece of work undertaken as part of the market research was to engage interviews with Homes England. Through various on-line teams' interviews, Homes England divulged areas of interest, compliance requirements and future thinking, regarding current and future affordable funding policy. This was of particular interest and unearthed the need to offer homes that provide full NDSS space standards compliance and homes that are only 85% of NDSS where development/ regional viability is more commercially challenged.

The Design Brief was updated as the research unearthed key requirements pertinent to the design of the ranges. Some of the key findings from the market research was:

1. Need for homes to comply 100% and up to 85%, with NDSS space requirements
2. Homes needed to include a wide range of tenure and occupancy needs
3. The bulk of housing centres around 2 and 3 bedroom homes
4. Bungalow and cottage flat options were needed, to add more range flexibility
5. The differences in specification preferences between HA's
6. The differences in HFVN & NDSS reginal space standards, between England & Scotland
7. The preference for client options between HA's
8. The grant funding thresholds, to provide cost targets, to design solutions
9. Indications of accessibility, user, and habitation usage requirements for all able and less abled persons
10. Homes need to be appealing, simple, robust, easy to use and maintain

The findings from the market research were invaluable, to inform the next stages of the Pattern Book development process. Several findings emerged that were not envisaged or considered.

Overview

We recognise that across the UK, Registered Providers (RPs) have historically developed their own house types, all meeting similar regulatory requirements. This localised approach misses out on a golden opportunity for RP's & their wider Alliance network to benefit from the Commercial & wider Business benefits offered by a single range of well-designed homes that can be used in different developments by different RPs.

In response to this, Stewart Milne Timber Systems are developing a new range of Affordable Homes intended for use by RPs across the UK. Developed through years of experience within our organisation in the delivery of both Affordable & Private Homes & the AIMCH Project (www.aimch.co.uk), these Homes will be designed to meet Homes England & The Scottish Government's requirements for Modern Methods of Construction (MMC) & off-site manufacture within Affordable Housing.

The range will be designed with flexibility in mind & will come with a selection of elevational styles to reflect local character & Planning requirements. It will also provide a mix of homes that meet M4(1), M4(2) & M4(3) standards. Many homes will also comply with NDSS requirements.

AIMCH

STEWART Milne TIMBER SYSTEMS

Housing Association:

Point of Contact:

Date:

To ensure the new range complies in the broadest of terms & we deliver a single range of home designs that can be used by a wide range of RPs, we are keen to understand your views in relation to the following points.

House Range:

Would the housing mix proposed cover your requirements in the majority of developments?

Are there any additional homes that you use commonly that you would like to see?

What are your preferred & most commonly used housing sizes/arrangements/occupancy levels?

Do you require compliance with any of the 'Good Practice Standards' criteria in the Housing Federation, Housing Design Guide?

Do you have any specific design or specification requirements out with NDSS & M4(1)/M4(2)/M4(3) requirements, specific to your HA approach or local area need?

Do you think that you would utilise a standardised home design across your developments (the elevations have pre-determined variations to allow for Planning Approvals)?

Figure 3: Extract of AIMCH Affordable Homes Pattern Book: Market Research Questionnaire

COMPETITOR ANALYSIS

In parallel with undertaking the market research, the developer partners, each undertook their own competitor analysis research. The purpose of this work was to establish good/bad practise and to better understand where competitors housing designs meets, exceeds, or falls short of meeting the affordable housing market needs.

The work included identifying affordable housing competition and then gathering publicly available data from websites, developers' sales centres, planning and building control approval portals.

Once drawing information had been sourced and gathered into a repository, the drawing information for each home was analysed in great depth.

1. L&Q Assessed – 52 house types across 9 developers
2. SMG Assessed – 64 House types across 13 developers

The findings from this research and detailed technical studies, provided the following hi level findings:

1. Large variability in space standards, with many compliant and non-compliant house designs evident
2. Commonality of terraced design typologies, using 2 and 3 bedroom typologies
3. A split in internal habitation spaces & layouts, between front and rear facing homes
4. Lack of product variability, disabled friendly homes, bungalows, and cottage flat typologies
5. Large variety of room layouts, internal storage, and furniture configurations
6. Good and bad design principles and house typologies
7. Lack of preconfigured options, DFMA, future proofing and standardisation
8. Lack of plotting efficiency and considered terracing interfaces, impacting land and construction efficiency

Figure 4 – Summary of AIMCH L&Q Competitor Analysis

HOUSING RANGE - SCOPING & ACCOMMODATION SCHEDULE

The learning and data derived from the market research was critical in ascertaining the product mix required by each of the AIMCH developer partners. The scoping of the range from 1 – 4 bed options was a vital part to determine and agree, before developing concept house designs.

The developers worked together to share thoughts on market needs, gaps, business preferences and the extent of the range to be created and managed by each developer. It was evident that to maintain commercial competitiveness, a range of homes was needed that catered for compliant and non-compliant homes, with a minimum 85% compliance with NDSS/HVFN standards, to meet the minimum affordable grant funding, provided by Homes England and Scottish Government.

This approach did vary between the AIMCH developer partners. For L&Q, as a Registered Social Landlord, who maintain, manage, and own the housing asset, over the lifetime of the home, they had a preference towards 100% NDSS compliance. This fits with their corporate strategy of future proof there housing stock and taking a holistic whole life cost perspective. For SMG, flexibility was needed to ensure where delivering affordable housing, under a section agreement or in a competitive tendering situation, value for money lower capital cost solution is needed, offering choice to HAs and LAs housing partners, that they deal with.

In conclusion, the AIMCH Affordable Homes Pattern Book, accommodation schedules agreed by the developer partners were:

1. **L&Q House Range** – 6 homes, predominantly 2 and 3 bedroom two storey accommodation, suitable for terracing and all homes 100% compliant with NDSS. Further typologies are planned to be introduced beyond AIMCH.
2. **SMG House Range (Forest Collection)** – 18 Homes, with a wider mix of 1-4 bedroom homes, with a broader range of typologies including bungalows, terraced and semidetached homes and two storey cottage flats, with arrange of 85%/100% NDSS compliant homes

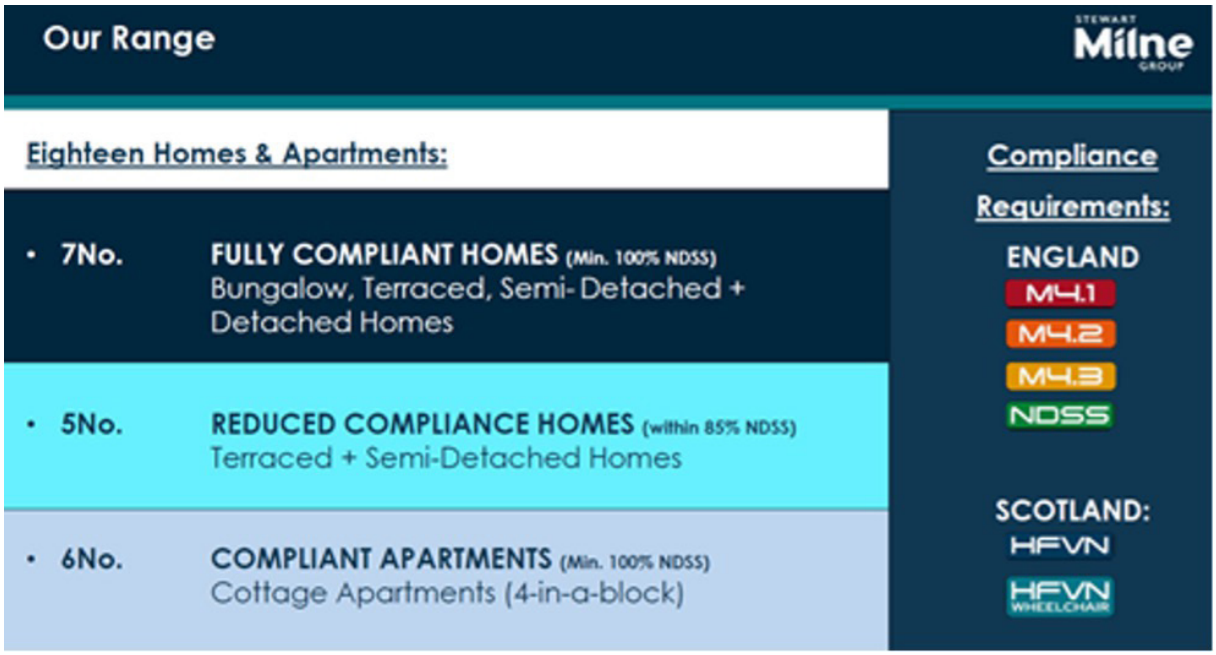


Figure 5 – SMG Affordable Homes Pattern Book House Range – Final Accommodation Schedules

STANDARD AFFORDABLE HOUSING PATTERN BOOK
Counties Timber Range T01

L&Q

REVISION 10.11.2021

House Type				Compliance		Size (mm)			Net Internal Area			Storage Area			Nationally Described Space Standard (NDSS)		Plotting arrangements		
Item	Name	HT Code	Type	M4(1)	M4(2)	Shape	Width	Depth	Area (nett m²)	Diff. (m²)	Diff. (%)	Area (nett m²)	Diff. (m²)	Diff. (%)	Target area (nett m²)	Target storage (nett m²)	Det	End/ Semi	Mid
BUNGALOWS																			
FOG																			
2 STOREY																			
1	Trent	H2490T	2B4P	✓		Narrow	4945 4785 Mid	9665	79.25	0.25	0.3%	2.38	0.38	19.0%	79	2	/	✓	✓
2	Lea	H2491T	2B4P		✓	Narrow	5058 4897 Mid	9665	79	0	0.0%	2.32	0.32	16.0%	79	2	/	✓	✓
3	Medway	H3590T	3B5P	✓		Narrow	5957 5837 Mid	9440	95.5	2.5	2.6%	3.97	1.47	58.8%	93	2.5	/	✓	✓
4	Wharfe	H3591T	3B5P		✓	Narrow	5957 5837 Mid	9440	96.08	3.08	3.3%	3.17	0.67	26.8%	93	2.5	/	✓	✓
5	Clyde	H3592T	3B5P		✓	Wide	8713 Semi 8605	6627	96.58	3.58	3.8%	2.85	0.35	14.0%	93	2.5	/	✓	✓
6	Ettrick	H4690T	4B6P		✓	Narrow	6520 6400 mid	9665	107.62	1.62	1.5%	4.56	1.56	52.0%	106	3	✓	✓	✓
2.5 STOREY (ROOM IN ROOF)																			
3 STOREY																			

Figure 6 – L&Q Affordable Homes Pattern Book House Range – Final Accommodation Schedules

CONCEPT DESIGNS

Having finalised the house range and accommodation schedule, the process of creating concept designs was started. The design process utilised in-house expertise and third-party architects, knowledgeable in affordable housing design to develop layouts, dimensions and templates that can be easily configured as terraces.

This process was intuitive and evolved over many iterations, as designed were challenged, tested, and refined following a process of internal review and assessment. The concept designs centred around the following core design principles:

1. Flexible, with internal and elevational options
2. Standardised & Optimised, for Cat 2 Panelised MMC system
3. Simple & Elegant
4. Functional & Compliant
5. Efficient, to Plot & Construct
6. Fabric First and Future Proofed

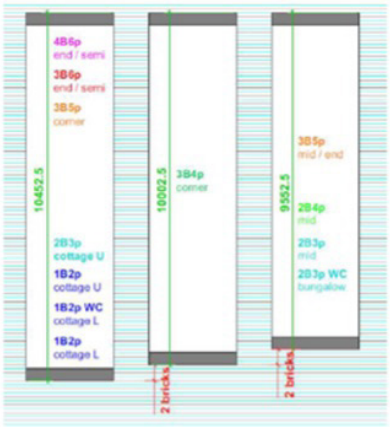
A key design feature used was to minimise plot depth to only a few variants meaning all homes can be simply terraced, avoiding costly and complex steps and staggers junctions. In additional rooflines were simplified, to ensure good inter-connection and end turning roof lines were designed to favour good placemaking and planning requirements.

All homes were designed using closed panel MMC timber technology, optimised to meet 55% PMV (Premanufactured Value), a requirement of Homes England grant funding and with a 0.20 U-Value to provide a fit and forget, fabric first approach to energy efficient building fabric. A feature within the concept design was to build in, the ability to have either gas or ASHP heating. The layout and fabric efficiency of the building envelope, ensures that homes are heat pump ready.

The designs were reviewed several times, by an array of disciplines with differing perspectives including land, technical, sales & marketing, construction, commercial and procurement. The conclusion was a suite of concept homes for each AIMCH developer that met the design brief and provided a sound basis to develop the detailed production and technical information, using 3D BIM modelling techniques.

- **FLEXIBLE:**
  - Our standard chassis will be able to offer variety of elevational styles to our customers
  - Internal options to be considered
  - Homes to be able to be pieced together in a very simple way to give wide range of mix & streetscapes
- **STANDARDISED for MMC:**
  - Our homes will be designed with standardisation at its heart
  - Future proofed for pod wet areas
- **SIMPLE:**
  - Our homes will ensure simplicity in construction enabling high quality build & more predictable programmes
- **ELEGANT:**
  - Our designs will be well proportioned & well designed in Plan & Elevation
  - Consider the end users in every aspect

- **Fully compliant NDSS & HfVN Homes:** *Typically for SMTS RP Mid-Market Rent*
  - Work as close to NDSS SQFT Areas as possible whilst meeting Detailed UK Space Standards
- **Non-NDSS/HfVN homes:** *Typically for SMH Delivery & Discount Market Sale for RP's*
  - to be within 85% of NDSS Floor Areas to ensure Homes England funding & to be designed to M4.1 English Building Regs & Silver Standard (Energy-Aspect 2) Scottish Building Regs
- **Some homes to be Wheelchair accessible to ensure we can meet min 10% of all homes on a development being wheelchair accessible**
- **Standard plot depths to allow:**
  - Simpler Build
  - Standardise Timber Kit/Chassis
- **Land Efficiency & Infra Costs:**
  - Plot width to be kept to a minimum to ensure market leading plot efficiency
- **Variety of elevational styles:**
  - Tenure Blind
  - Standard widths of openings, perhaps with 2 different window depths
  - End Terraced homes to have roof truss designs for side-to-side roofs & front-to-back trusses
- **Designed for the Homes Divisions & SMTS**
- **2022 Building Regulations:**
  - External walls designed to 350mm thickness & party walls to 313mm
- **Standardised Components:**
  - Designed to Brick sizes, Bathrooms, Stairs, Windows to utilise a very limited standard range of designs to allow for off-site manufacture & principles of pod wet areas



- **Standard Plot Depths ensures efficient use of land, ease of build & greater standardisation**

Figure 7: Concept Design: Core Principles, Early stage Studies, Technical Requirements & Plot Depth Standardisation Studies

SUMMARY:

- **Grnd Floor 70.9sqm (101% of NDSS)**
- **1st Floor 84.2sqm (120% of NDSS)**
- **Designed to work as End Terrace/Semi**
- **Standard Depth to match other fully compliant homes in Stewart Milne Affordable range**
- **High plot efficiency over competition**
- **Narrowest fronted fully compliant home**
- **Straight Stair**
- **Simpler form with no ground floor projections reduces Build Costs**

Figure 8: Concept Design: Example Early Stage Floor Plate Studies and Design Iterations: Cottage Flats

Figure 9: Concept Design: L&Q Affordable House: Early Stage Design Principles

SPACE AND ACCESSIBILITY STANDARDS – COMPLIANCE CHECKS

An important consideration within the detailed design stages, is to ensure the homes comply with the requirements of NDSS (National Design Space Standards) in England and Wales, and the equivalent but different HFVN (Housing for Varying Needs) space standards in Scotland.

This is critical compliance requirement to secure affordable homes grant funding and building regulations compliance. These are technically complex requirements and cover a wide range of internal spatial design requirements, as well as a few external considerations.

Key special and accessibility requirements include:

1. Gross internal floor area – relevant to bedroom and occupancy levels
2. Hall widths, door positioning and sizing, to allow free movement for a range of abled and less abled persons
3. Access requirements around fixtures such as beds, desks, and seating
4. Minimum sizing of furniture and fixtures within homes, to ensure adequate fit out and operation
5. Access ad space within wet room areas and head/foot of stairs
6. Provision for future disabled fixtures and fittings
7. Minimum storage provision, for cupboards and fitted kitchen units

This analysis evolved as detailed designs were worked up in depth, often requiring fine tuning, modification, and review. Significant effort was invested to reach floor plans that were compliant. This included drafting two compliance layouts, for furniture, accessibility, and storage, showing NDSS compliance for E&W and HFVN compliance in Scotland, from the same floor plan.

Once the design team were confident, compliance had been reached the next detailed design considerations could begin.

Table 1 - Minimum gross internal floor areas and storage (m^2)

Number of bedrooms(b)	Number of bed spaces (persons)	1 storey dwellings	2 storey dwellings	3 storey dwellings	Built-in storage
1b	1p	39 (37) *			1.0
	2p	50	58		1.5
2b	3p	61	70		2.0
	4p	70	79		
3b	4p	74	84	90	2.5
	5p	86	93	99	
	6p	95	102	108	
4b	5p	90	97	103	3.0
	6p	99	106	112	
	7p	108	115	121	
	8p	117	124	130	
5b	6p	103	110	116	3.5
	7p	112	119	125	
	8p	121	128	134	
6b	7p	116	123	129	4.0
	8p	125	132	138	

Figure 10: Concept Design: NDSS Minimum Gross Internal Floor Area Requirements

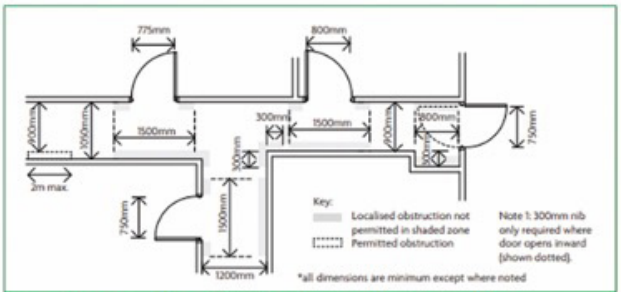


Diagram 2.3 Minimum door and hall widths and restrictions on localised obstructions

Table 2.1 Minimum widths of corridors and passageways for a range of doorway widths

Doorway clear opening width (mm)	Corridor clear passageway width
750 or wider	900 (when approached head on)
750	1200 (when approach is not head-on)
775	1050 (when approach is not head-on)
800	900 (when approach is not head-on)

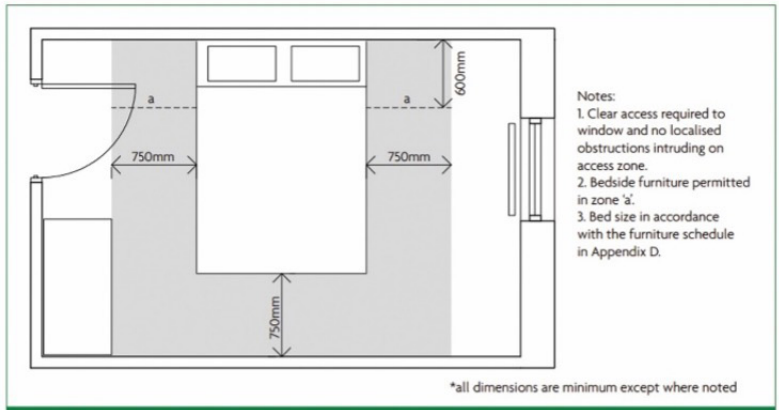


Diagram 2.4 Clear access zones to principal bedroom

Figure 11: Concept Design: Extract of NDSS Minimum Spatial Standards Requirements

DFMA & MMC OPTIMISATION

A core principle of the Affordable Homes Pattern Books was to embrace Design of Manufacture and Assembly (DFMA), ensuring all homes are designed, for ease of manufacture and assemble on the building site.

This work leveraged the DFMA Guide developed by the AIMCH partners in the earlier stages of this workstream. The guide (available for download www.aimch.co.uk) provides guidance, advice, and solutions on the best way, to optimise the use of panelised timber MMC systems.

An important consideration was a common approach to building heights between developer partners. All homes have been designed to the same storey heights, meaning the wall panels are identical in height between two separate ranges, bringing efficiencies in the supply of MMC systems to both developers.

The teams also worked to standardise window openings and ensure opening locations were bricked coursed, reducing cutting time and improving aesthetics, whilst also allowing sufficient depth, to allow optimum timber lintel design over openings.

Building services, stairwell designs and joist spans were also reviewed. This ensured that vertical and horizontal service runs such as SVP ducts, toilet waste runs and ventilation ducts were fully considered, to avoid clashes with structural elements by designing away clashes, or where not feasible accommodating trimming to service efficient routing. Stairwell designs were fully considered and wherever possible straight flight stairs were used, as the most efficient and cost-effective option.

In summary key DFMA considerations built into the house ranges during the detailed design process:

1. Regular build form, no projections, and straight stairs
2. Joist and services to span front to back on narrow terrace designs
3. Loadbearing floor support point within middle third of homes – LB wall or down stand beam
4. All beams to be down standing to allow continuous oversale of floor cassettes
5. All brickwork fully supported down to slab level
6. No services, beams of stair trimming clashes
7. Principle horizontal and vertical services accommodated
8. Optimised panel heights to avoid cutting of sheathing and plaster boarding
9. Brick co-ordinated dimensions and openings
10. Standardised openings and full depth lintels to avoid beams in floors

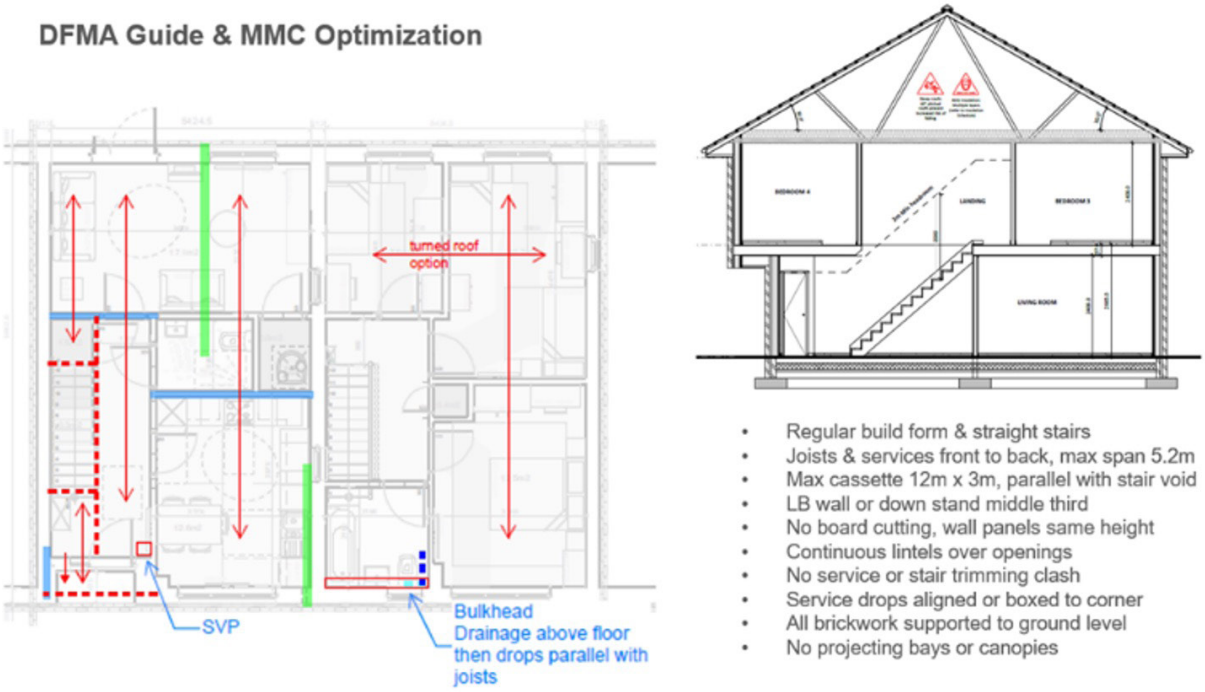


Figure 12: Example of DFMA overmarks showing optimised Category 2 Panelised timber MMC building solution

STANDARDISATION AND PRODUCT FAMILIES

A key design principle was to embrace standardisation within the final affordable homes pattern books being created. This built on the extensive standardisation studies and product family recommendations, derived in earlier stages of this workstream.

The findings from this work can be downloaded from www.aimch.co.uk.

The key areas of standardisation were:

1. External Apertures – windows and doors
2. Stairs
3. Wet rooms – bathrooms and GF cloaks
4. Plot depth and brick coursing
5. Building heights
6. Roof lines
7. Optional gable window – preconfigured locations

An important aspect was external openings and the ability to standardise opening sizes to suit brickwork dimensions and simplify the MMC system for manufacturing. By standardising aperture dimensions and detailing, feature sills, cavity trays and firestopping specification, procurement, and construction was greatly simplified. In doing so the by produce of each home's designs, brings about a high degree of commonality and familiarisation, increasing productivity, reducing waste, and lowering costs.

Another consideration was in the standardisation of wet room areas, in particular bathrooms. This is of particular benefit to affordable homes providers, in the maintenance and upkeep of their assets, and simplifies replacements and refit of homes in the future. The simplicity and repetition of the bathrooms and cloaks, increases site productivity and familiarisation, reducing time to construct, defects and costs.

The final standardisation focus was on the plot depth of homes. By standardising the depth of plots, land efficiency can be increased, and awkward step, staggers and roof junction details avoided. Within the SMG affordable range, eighteen homes were developed across 3 plot depths. Each home can be plotted as terraced blocks and rooflines fully considered, to ensure alignment and interconnectivity, minimising site disruption, reducing costs and improving productivity.

A feature built into the Pattern Book collections, has been to consider pre-configured client or design options. The market research highlighted preferences for HAs to have internal layout options, for example bedroom wardrobes and future ASHP storage cupboards. In addition, optional gable windows and rooflines, including gable fronted and hipped options, are needed for good placemaking principles and planning permissions. By standardising options, flexibility has been built in in a manageable way and integrated with the MMC building systems for ease of manufacturing and construction.

The AIMCH developers' partners have seen significant benefit in embracing standardisation and there is increasing opportunity for further collaboration across developers, as has been the case in the car industry, where common product families can be used across a broad church of housing developers, improving productivity at a sector level.

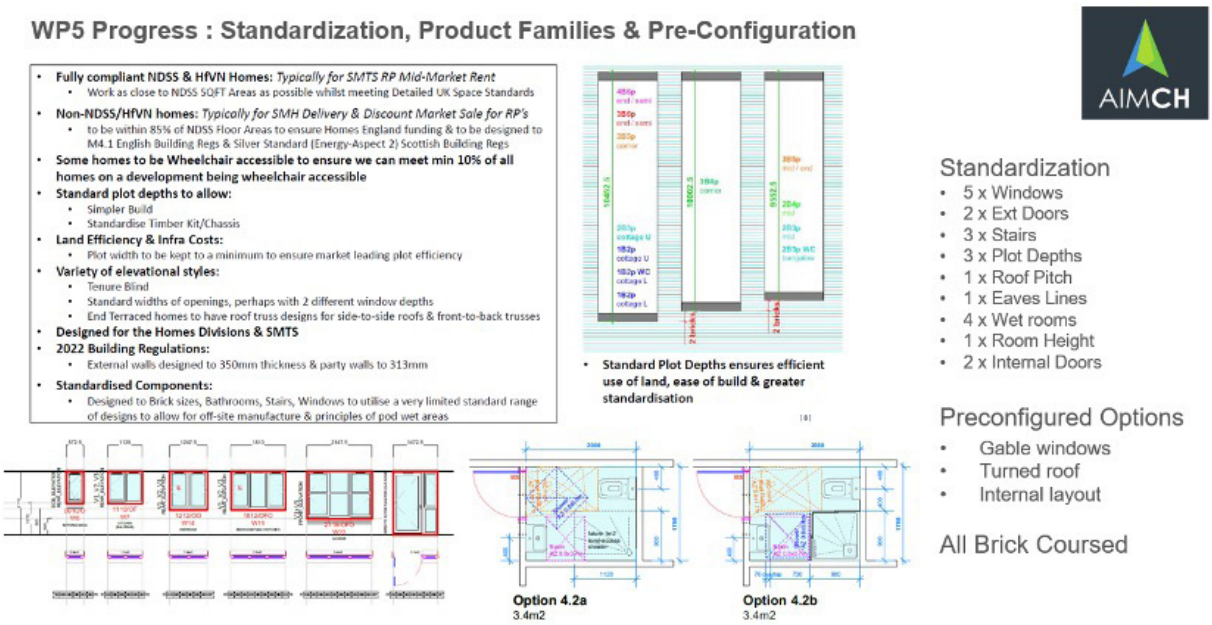


Figure 13: Examples of Standardisation Principles and Product Families built into Pattern Books.

FINAL DESIGNS

Final design agreement and sign-off is an important stage. This process requires the presentation of the design principles, market assessment, technical and build cost information to inform decision making and design rationale, to inform senior executive sign-off. In advance of presenting this information, other business and functional stakeholders were engaged, such as sales & marketing, design & technical, construction, procurement, after care and commercial.

This collaborative approach is a lengthy time-consuming exercise but important to secure input and buy-in from stakeholders who will be involved in the future exploitation and commercialisation of the pattern books, beyond AIMCH.

The final house ranges are summarised below:

1. **L&Q House Range** – 6 homes
   a. Predominantly 2 and 3 bedrooms
   b. Two storey accommodation, suitable for terracing
   c. All homes 100% compliant with NDSS.
   d. Further L&Q typologies are planned to be introduced beyond AIMCH.

2. **SMG House Range (Forest Collection)** – 18 Homes
   a. Wider mix of 1 to 4 bedroom homes
   b. Two storey accommodation, suitable for terracing
   c. Broader range of typologies including bungalows and cottage flats
   d. Homes offer 85% and 100% NDSS compliance
   e. The range is designed to meet 100% of SMG affordable homes requirements

Figure 14: SMG Forest Range of Affordable Homes

FULLY COMPLIANT HOMES M4.2 M4.3 NDSS HFVN HFVN WHEELCHAIR Stewart Milne Group

House Type	Name	Size	Area	NDSS	Compliance
Bungalow Terrace (Mid + End) + Semi-Detached + Detached	Hatfield	2 Bed 3 Person	76.3sqm/821sqft	125%	English M4.3 + Scottish HfVN (wheelchair)
Terrace (Mid + End)	Epping	2 Bed 3 Person	74.1sqm/797sqft	106%	English M4.2 + Scottish HfVN
Terrace (Mid + End)	Keilder	2 Bed 4 Person	80.1sqm/862sqft	101%	English M4.2 + Scottish HfVN
Terrace (End/Corner)	Moors	3 Bed 4 Person	84.6sqm/911sqft	101%	English M4.2 + Scottish HfVN
Terrace (Mid + End) + Semi-Detached	Tentsmuir	3 Bed 5 Person	94.6sqm/1018sqft	101%	English M4.2 + Scottish HfVN
Terrace (End) + Semi-Detached	Tollymore	3 Bed 6 Person	106.3sqm/1144sqft	104%	English M4.2 + Scottish HfVN
Terrace (End) + Semi-Detached + Detached	Wyre	4 Bed 6 Person	110.9sqm/1194sqft	104%	English M4.2 + Scottish HfVN

Figure 15: SMG Fully NDSS Compliant Homes

REDUCED STANDARD HOMES M4.1 HFVN NDSS Stewart Milne Group

Three ENGLISH Homes with a variety of terraced + semi-detached options

House Type	Name	Size	Area	Within NDSS	Compliance
Terrace (Mid + End)	Cannock	2 Bed 3 Person	60sqm/646sqft	86%	English M4.1
Terrace (Mid + End)	Haldon	2 Bed 4 Person	72sqm/775sqft	89%	English M4.1
Terrace (End + End) + Semi-Detached	Kinver	3 Bed 5 Person	79.5sqm/856sqft	85%	English M4.1

Two SCOTTISH Homes with a variety of terraced + semi-detached options

House Type	Name	Size	Area	Compliance
Terrace (Mid + End)	Galloway	2 Bed 4 Person	70.3sqm/757sqft	Reduced HfVN
Terrace (Mid + End) + Semi-Detached	Strathyre	3 Bed 5 Person	87.3sqm/940sqft	Reduced HfVN

Figure 16: SMG 85% NDSS Compliant Homes

COMPLIANT APARTMENTS M4.1 M4.2 M4.3 NDSS HFVN HFVN WHEELCHAIR Stewart Milne Group

Six UK Cottage Apartments with a variety of end-terraced + semi-detached options

House Type	Name	Size	Area	Within NDSS	Compliance
Ground Floor Cottage Apartment	Ashdown	1 Bed 2 Person	50.47sqm/543sqft	101%	English M4.2 + Scottish HfVN
First Floor Cottage Apartment	Dalby	1 Bed 2 Person	66.2sqm/713sqft	132%	English M4.1 + Scottish HfVN
Ground Floor Cottage Flat	Burnham	1 Bed 2 Person	58.7sqm/543sqft	117%	English M4.3 + Scottish HfVN (wheelchair)
First Floor Cottage Apartment	Dallington	2 Bed 3 Person	74.5sqm/802sqft	122%	English M4.1 + Scottish HfVN
Ground Floor Cottage Apartment	Delamere	2 Bed 4 Person	70.2sqm/756sqft	100%	English M4.2 + Scottish HfVN
First Floor Cottage Apartment	Marston	2 Bed 4 Person	86.0sqm/926sqft	123%	English M4.1 + Scottish HfVN

Figure 17: SMG Fully NDSS Compliant Cottage Apartments

L&Q

STANDARD AFFORDABLE HOUSING PATTERN BOOK
Counties Timber Range T01

REVISION
10.11.2021

House Type				Compliance		Size (mm)			Net Internal Area			Storage Area			Nationally Described Space Standard (NDSS)		Plotting arrangements		
Item	Name	HT Code	Type	M4(1)	M4(2)	Shape	Width	Depth	Area (nett m²)	Diff. (m²)	Diff. (%)	Area (nett m²)	Diff. (m²)	Diff. (%)	Target area (nett m²)	Target storage (nett m²)	Det	End/ Semi	Mid
BUNGALOWS																			
FOG																			
2 STOREY																			
1	**Trent**	H2490T	2B4P	✓		Narrow	4945 4785 Mid	9665	79.25	0.25	0.3%	2.38	0.38	19.0%	79	2	/	✓	✓
2	**Lea**	H2491T	2B4P		✓	Narrow	5058 4897 Mid	9665	79	0	0.0%	2.32	0.32	16.0%	79	2	/	✓	✓
3	**Medway**	H3590T	3B5P	✓		Narrow	5957 5837 Mid	9440	95.5	2.5	2.6%	3.97	1.47	58.8%	93	2.5	/	✓	✓
4	**Wharfe**	H3591T	3B5P		✓	Narrow	5957 5837 Mid	9440	96.08	3.08	3.3%	3.17	0.67	26.8%	93	2.5	/	✓	✓
5	**Clyde**	H3592T	3B5P		✓	Wide	8713 Semi 8605	6627	96.58	3.58	3.8%	2.85	0.35	14.0%	93	2.5	/	✓	✓
6	**Ettrick**	H4690T	4B6P		✓	Narrow	6520 6400 mid	9665	107.62	1.62	1.5%	4.56	1.56	52.0%	106	3	✓	✓	✓
2.5 STOREY (ROOM IN ROOF)																			
3 STOREY																			

Figure 18: L&Q Range of Affordable Homes

PLACEMAKING AND STREET SCENES

An important aspect of the final designs developed was to ensure there efficient use to help create great places and visually appealing streetscenes. All homes developed are designed with this requirement in mind as it is critical to ensure we create sustainable communities, with a strong sense of long lasting legacy appeal.

The developers worked togther to develop solutions using approriate materials and preconfigured design options, such as rooflines, gable winodws, entrance canopies, external claddings, fenerstration styles, and material split points, colours and textures, ensures the essence of a single efficient core MMC friendly building fabric is preserved, whilst catering for the local architectural, planning and placemaking principles, pertinent to the site location and neighboring community.

In support of the Pattern book, Placemaking Design Guidance is being developed, that provides good practise guidance and examples, of how each house design can be plotted, elevated and set within a Loacal Authority planning approval and National Development Design Guidance context. In due course the partners, will engage with LA's within there operating areas, to ensure exploitation of there Pattern Book is not impeded, by local authority opinions or policies, that prevent use of standardised housing, but rather conversely, supports the use of this approach and the housing designs created.

Figure 19: SMG Early Stage Elevational and Material Break Studies

Figure 20: Example L&Q Affordable Range – Typical Semi-Detached Arrangement and External Materials Options

3D BUILDING INFORMATION MODELLING

After achieving sign-off of the final designs, the process of creating detailed production information can commence. This built on the previous AIMCH BIM Housing Guide, developed earlier in this workstream, by the AIMCH developer partners. BIM (Building Information Modelling) is a process which digitises information, through using 3D design software and a BIM enabled process.

SMG and L&Q are late BIM and 3D design software adopters, AIMCH presented a real opportunity for both developers to leverage the content previously created and use their affordable homes pattern books, to learn and transition to future BIM adoption within their business.

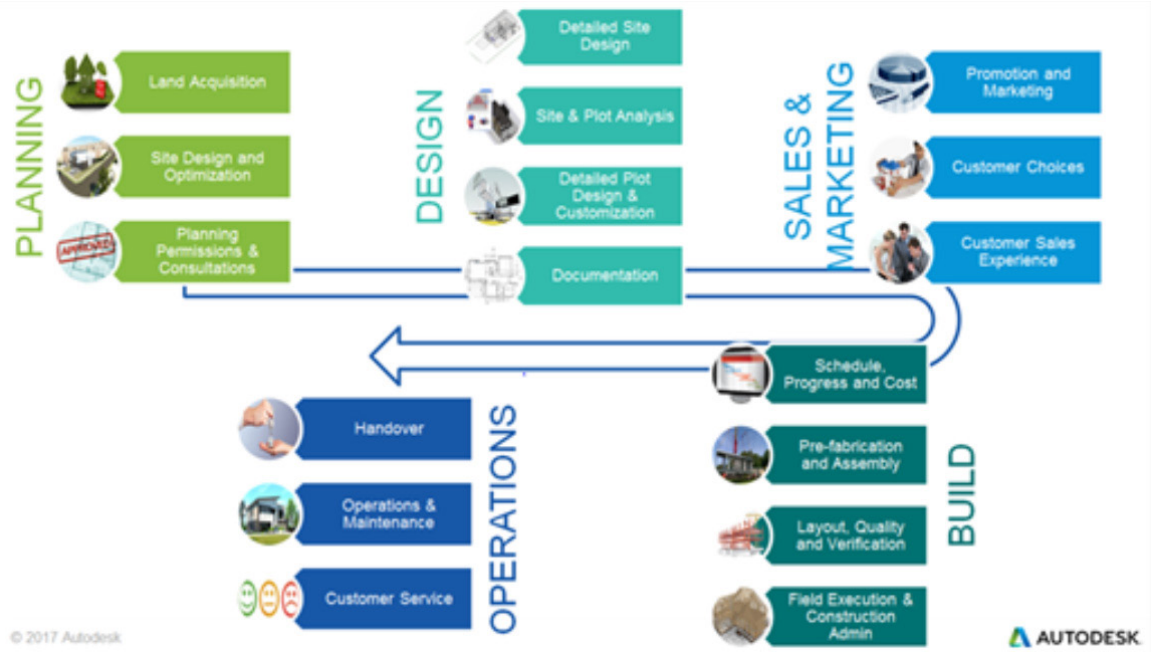


Figure 21: House Building Process Flow Chart

Figure 22: BIM Vision, Principles & Success Factors

To manage this process external 3D modelling resources were brought in, and a detailed delivery plan put in place to process each house design from concept sketch to detailed design outputs, within one fully coordinated and federated BIM architectural model. A key challenge was to set up the scope of the outputs from the modelling and how to configure the models. This was managed more effectively having previously generated the BIM housing guide which provided templates and protocols each developer could use to suit their own business needs.

A key element is to integrate the supply chain components, within the Revit Architectural BIM model. This was achieved by early identification of the key supply chain commodities and systems to be integrated and federated into one common BIM model. As an example, the timber frame MMC systems were designed using the architectural model, bit in a separate standalone 3D software used for manufacturing purposes. These models could then be federated, via IFC file interface, back into the BIM architectural model. This allowed partners to undertake clash detection and generate visualisations of the structural members.

Figure 23: Example: L&Q Affordable Range: Early Stage BIM Architectural Model and 3D visualisations and Clash Detection

DETAILED PRODUCTION INFORMATION

The final stage of the detailed work was to genenate the production information suitable for each business. This is typically 2D PDF drawings automatically generated from one integrated BIM housing model.

The schedule of requirements was agreed earlier, leading a need for each model to generate 25 drawing/scheduling outputs automatically. These can be simply reproduced as the BIM model is updated/changed, requiring very little reworking, which is a significant BIM benefit.

The teams intially spent a lot of time checking the outputs from the models to ensure they met business expectations and the requirements agreed earlier. Each developer approached the output from the persecptive of being the same as what is currently produced using 2D CAD systems. This is easy to achieve in BIM once time is invested to set up and check the content. In this way the end user of the information – site management, suppliers, sub-contractors or in-house functions see no difference and are comfortable to work with with outputs genereated.

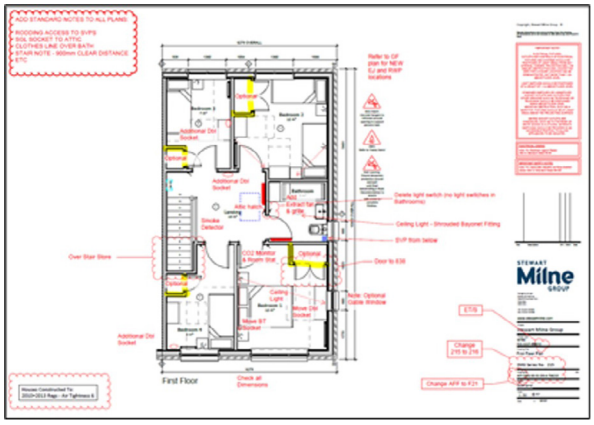


Figure 24: Example BIM Model Design Checks Floor Plans

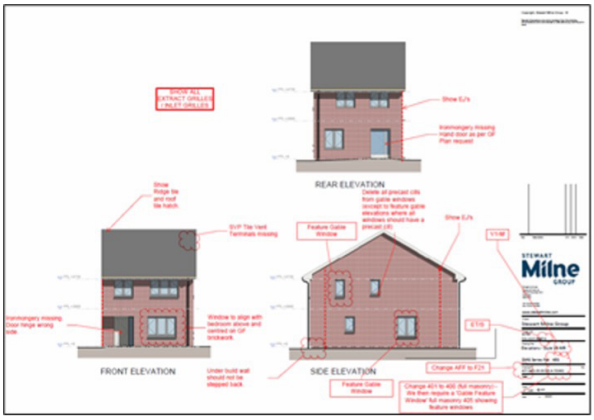


Figure 25: Example BIM 3D Model Design Checks Elevations

By using AIMCH as a learning platform, on live work, each business has been able to showcase and introduce the benefits of BIM, against the backdrop of introducing new Affordable Homes Pattern Books. This has proven to be a very effective way to transition towards 3D design working and adopting BIM processes.

PATTERN BOOK & EXPLOITATION

The final part of the process will be to complete Product Manuals, in the form of a Pattern Book. In the case of SMG, these take the form of a Product Standards of Excellence, Digital Product Manual governed, and controlled by the Group Design and Technical Team.

The format is very user friendly and includes key data on specifications, sizing, layout, design features/benefits and fenestration options. As with any new product introductions, there is a detailed product introduction process, including training and presentations, to inform a wide range of internal and external stakeholders on the product range developed and how to use it.

This content provides a strong exploitable platform for SMG and L&Q, aligned with strong governance, control and use of the range in the future. It also provides a platform for regular updates and the deletion/inclusion of obsolete or new housing products within the governance of the Pattern Book.

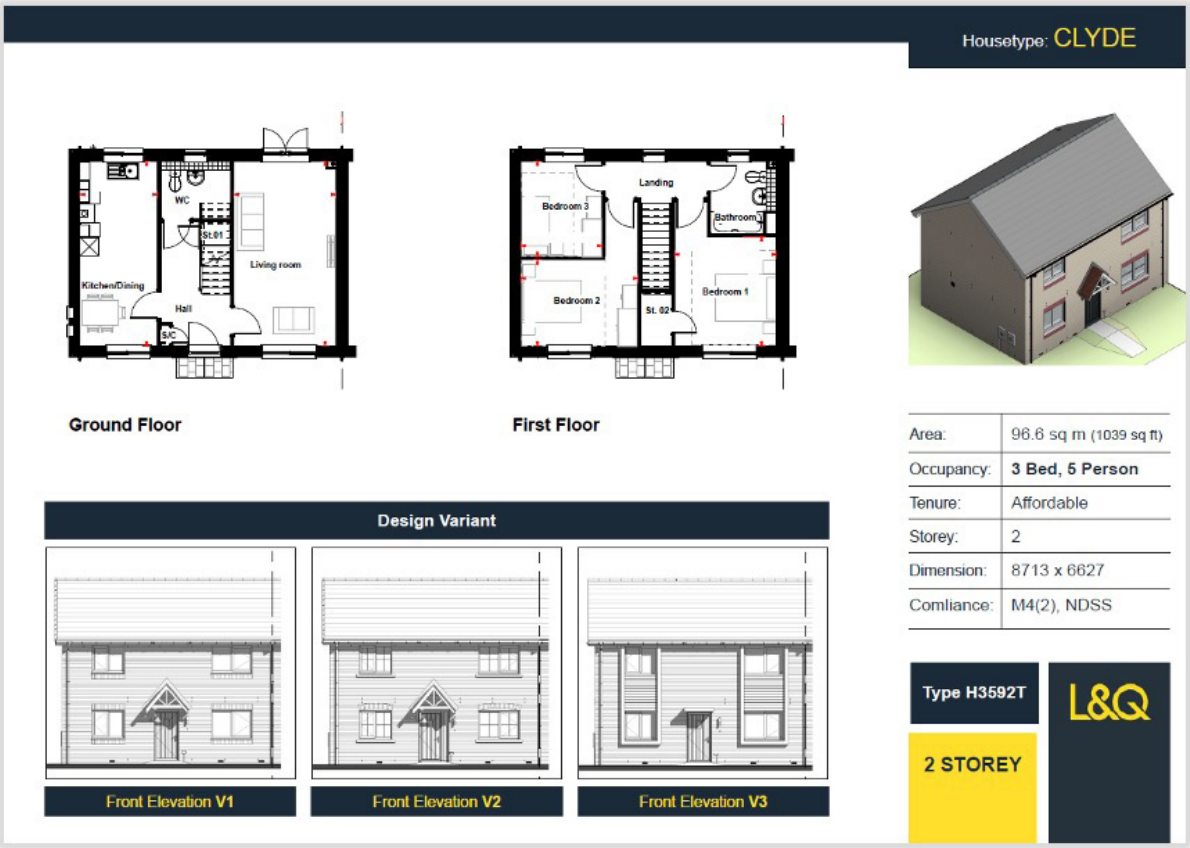


Figure 26: L&Q Affordable House Range: Pattern Book

SUMMARY

The AIMCH Affordable Homes Pattern Books created by SMG and L&Q are significant exploitable outputs, arising from the AIMCH project. This work was accelerated and improved through collaborative innovation, sharing knowledge and learn from each other, to develop two affordable house ranges that can be used by each developer beyond AIMCH.

By showcasing this appraoch and celebrating the pattern books developed, it is hoped that the wider housing sector (in particular the affordable housing sector) will benefit from AIMCH learnings and outputs created.

The key summary outcomes are:

1. A novel collaborataive approach to co-creating differing housing collections
2. Sharing knowledge and learnings to improve and accelerate outputs
3. Collaboartive research to ensure housing designs, meet the needs of the marketplace and targeted developers
4. Collectively progressing technical discussions, compliance assessments and configuration, to reduce risk
5. Embracing DFMA, MMC and Standarisation, ensuring homes are cost effective, efficient and easy to build
6. Preconfigurng options to provide controlled flexiblibty, for clients and local planning authorities
7. Sharing best practise to ensure homes are designed, with a sense of place, appeal and longevity
8. Co-promoting benefits of Housing Pattern Books, for wide market appeal and 3rd party stakeholder endorsement

CONCLUSION

By developing and accelerating the use of pattern books within the affordable housing sector, SMG & L&Q see opportunity where private sector knowledge and skills can be transferred. AIMCH Research and engagement confirms that affordable housing providers large and small, are increasingly receptive to this solution.

Our conclusion, from the work done and outputs created for exploitation, is that the use of Housing Pattern Books within the affordable housing sector, will become common place over time. AIMCH partners have produced outputs, that will accelerate their use. Furthermore, through endorsement from regulators, funders, and insurers, AIMCH believes that Housing Pattern Books will be a key ingredient in unlocking Housing Industrialisation and how we transform how homes are built in the future.

AIMCH

TRANSFORMING
HOW WE BUILD HOMES

mtc Manufacturing Technology Centre

L&Q

Construction Scotland Innovation Centre

Forster Group

Stewart Milne Group

Barratt Developments PLC Building Excellence Since 1958

Industrial Strategy

UK Research and Innovation

@AIMCH2

aimch

aimch@cs-ic.org

www.aimch.co.uk