ReThink

MODULAR CONSTRUCTION

Stage 2 Concept Feasibility Report

Sobha Lightweight Modular System

A feasibility review of the Sobha modular concept using Sobha's own sections and gauges, the limitations identified through calculation, and the route to greater height.

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This report is the Stage 2 deliverable under the engagement agreed in August 2025 [15]. The structural conclusions in Section 5 are supported by the MMCEngineer Ltd calculation package 26025 with appendices [1], issued separately. The structural content has been developed iteratively with MMCEngineer Ltd through calculation, independent checking and engineering review; the record of that development is held in the project file. All structural work is at concept and feasibility level as defined in the commissioning scope; application to a specific building design should follow, to further validate the concepts presented in this report.

Contents

Executive Summary

Rethink Construction was commissioned by Sobha Reality to carry out Stage 2 of a two stage technical review of Sobha's proprietary lightweight modular building system. Stage 1 (April 2026) validated the concept as a medium gauge steel volumetric system and set out the engineering programme needed to reach prototype and deployment. This report presents the work undertaken in Stage 2. Structural engineering was carried out by MMCEngineer Ltd, with member checks to EN 1993-1-3 issued as calculation package 26025 [1].

Stage 2 examined the concept using Sobha's own proposed sections and gauges, without substitution: the 150 x 75 toe-to-toe posts at gauges of 6 to 12mm, the 200mm side beams, and the male and female corner block. The purpose of the review was to establish what the concept achieves as provided, where it is limited, and how it can be extended.

The concept is structurally viable to thirteen storeys using Sobha's own sections and gauges, calculated on a conservative post arrangement. This is the starting point, not the limit.

Two limitations were identified, both inherent to the concept as drawn, and both with clear routes to improvement:

- The 200mm side beam is limited by its depth, not its gauge. Increasing the depth of a beam is far more effective than thickening it: doubling the depth increases stiffness roughly five times at the same gauge, whereas the full range of gauge increase adds only about seventy percent. The 200mm beam therefore cannot span the full module length, and intermediate posts are required. The number of posts, and so the number of columns appearing in the apartment, is set by how far the beam can span.
- The 150mm posts are deeper than the roughly 100mm wall and project into the room by around 50mm. The calculated arrangement also concentrates the posts as a doubled pair at mid span. Distributing single posts at maximum pitch is the practical refinement, reducing the load on each support line and removing the central concentration of steel.

Height is achieved by layering the post gauge, heaviest at the base and lightest at the top, across Sobha's 6, 8, 10 and 12mm range. On this basis the concept reaches thirteen storeys on the conservative mid span arrangement, with useful margin in every gauge band.

The corner block is reviewed in its own right. The governing issue is tolerance control across the meeting of four modules, for which factory jigging with an adjustable jig is recommended. A design for manufacture review examines the manufacturing routes, notes that casting and machining are both costly for a separate block, and points development toward building the connection features into the corner posts themselves, with a fabricated plate block as the nearer term alternative.

The route to greater height is set out at the end of the structural review. Doubling the intermediate posts takes the concept to twenty storeys on its own sections, with the 200mm beam spanning the shorter distances comfortably and concrete cores carrying the lateral demand at building scale. A deeper bespoke beam, rolled by Sobha to their own requirement, is not needed for the height itself; its value is in reducing the number of intermediate posts standing in the rooms. The report also provides concept level guidance on fire, acoustics, durability, manufacture and logistics, an indicative testing plan, and a recommended route to prototype and authority approval.

1. Introduction

Stage 1 of this engagement [14] established that the Sobha lightweight modular system has a credible structural form, compares well against international benchmarks including the Vision Modular system used at Ten Degrees Croydon, and justifies further development. Stage 2 was commissioned in August 2025 [15]. The Stage 2 scope is restated below, with cross references to where each item is addressed:

- Review the supplied chassis and advise the maximum feasible height (G+X), with changes to achieve G+20 if required (Section 5.9)
- Commentary on the structural design philosophy and load path strategy (Section 5.2)
- Concept level structural calculations and checks to justify the recommended design envelope (Section 5 and calculation package 26025)
- Connection strategies, bolted vs welded vs Huck fasteners, with recommendations and rationale (Section 6)
- Sizing guidance for bolted connections and welded joint specifications at concept level (Section 6)
- High level guidance on fire, acoustics and durability, with an indicative testing plan (Sections 7, 8, 9 and 13)
- Manufacture, logistics and assembly review covering lifting, transportability, tolerance and sequencing (Section 10)
- DfMA improvement opportunities: simplification, part count reduction and takt alignment (Section 11)
- Guidance towards typical detail development for key interfaces and joints (Section 12)
- Recommended next steps including prototype path and approvals strategy (Section 14)

The structural analysis in this report is based on the 10.2m x 3.8m module, the largest and therefore governing module in the proposed range. Where a smaller module is used the results here are conservative. Throughout this report, “Stage 3” means the application of the validated system to the full design of a specific building: the work here is a system level feasibility study, and building specific calculation, testing and approval sit in Stage 3.

2. Stage 1 Summary and Baseline

The Stage 1 Concept Validation report (April 2026) established the following baseline:

- Medium gauge steel PPVC using cold formed C sections (1 to 2mm) for secondary structure and medium gauge sections (3 to 8mm) for primary members
- Corner posts formed by doubling two C sections toe to toe, a defining feature of the system
- Composite floor construction: profiled steel decking topped with an in situ concrete slab
- Male and female corner block connection system (S355 body, S460 pin and base) developed with PNC Architects
- Target height G+20, with lateral stability at building scale via concrete cores
- A 16 criterion requirements matrix from five QFD workshops, against which the Sobha concept scored well, with expected advantages in module weight and layout flexibility

3. Supplied Information and Inputs

The following information was supplied and reviewed as part of Stage 2:

- Steel Modular System Details: module sizes, floor build up, facade strategy, fire requirements summary and MEP strategy note
- Module Structure Concept Details (PNC Architects, April 2026): long beam, short beam and double C column drawings for the G+1 mockup
- Module Connection Block Concept Details: corner block male and female type 1 and type 2 assemblies, materials and dimensions
- Expected Loadings: structural schematic report for Sobha Global Square (conventional tower, Hartland 2), from which the design load schedule in Section 4.2 is drawn
- Facade sections, corridor assembly sections, roof cassette sections and wall sections in DWG format
- G+1 mockup details, concept plans and pilot project drawings
- Steel Modular Concept Introduction presentation (May 2026)

Additional items produced during Stage 2:

- Calculation package 26025 with full appendices [1], including the weld capacities appendix [2] and the side beam options calculations [3]; Section 5 presents the findings
- Flag plate dimension drawing, the beam and post arrangement options sketch, and the layering elevation sketches of 24 July 2026, issued within the calculation package [1]
- Huck Magna-Lok fixing data sheet [4] and the Huck parts catalogue [5]
- Cellecta ScreedBoard 28 product data [6] and floor detail RD-E-FS-3, FFT4 [7]
- Cavgard modular construction brochure [16]: intumescent cavity protection supplied as a roll, pre fixed to modules in the factory
- ARaymond module to module connector data sheet [17]: clip together module connection for evaluation

4. Design Basis

4.1 Standards and Codes

Design aspect	Standard
Cold formed steel member checks	EN 1993-1-3
Cold formed posts and side beams	EN 1993-1-1:2005
Imposed loads and combinations	EN 1990 and EN 1991-1-1
Wind loading (module stack checks)	EN 1991-1-4:2005+A1:2010
Wind and seismic (UAE building level)	ASCE 7-16, with wind tunnel testing (HFFB method) and ETABS analysis for the deployment project
Erection tolerance and stability philosophy	SCI P402 [8] and the BCSA National Light Gauge Steel Specification Standard [9]
Execution of drawings	EN 1090-4, particularly clause 4.1.3

The calculations were produced in Tedds by Trimble with a peer reviewed light gauge steel add in by Modern Engineered Software Solutions Ltd. The module level checks use EN 1991-1-4 wind loading; building level wind and seismic design for the UAE deployment will use ASCE 7-16 with wind tunnel data, as required by Dubai authorities. This mixed code basis is taken forward for agreement with Dubai Municipality through the design basis submission at Stage 3.

4.2 Loading Criteria

Sobha's design load schedule, drawn from the Expected Loadings report and repeated in calculation package 26025:

No	Area	SDL (kN/m2)	Live (kN/m2)
1	Corridor (first floor)	4.0	4.8
2	Corridor (typical)	4.0	3.83
3	Stair	2.0	4.8
4	MEP areas at mech level and roof	5.0	7.5
5	Roof, general area and terrace	3.5	2.0
6	Water tanks at mech level	7.5	25.0
7	Canal (1.5m deep)	3.0	10 x water height
8	Ground floor entrance, lobby, event hall, mockup units	3.0	5.0
9	Fire water tank	2.0	15.0
10	ETS room	7.5	10.0

Module design values used in the 26025 checks: roof SDL of 3.5 kN/m2 with 2.0 kN/m2 imposed, and a floor imposed load of 5.0 kN/m2, which envelopes the residential, corridor and lobby cases in the schedule above. The as built self weight of the composite deck and concrete is 2.36 kN/m2, inside the 3.0 kN/m2 allowance in the specification. Heavier localised cases (water tanks, MEP plant) sit on dedicated structure outside the standard module design envelope and are addressed at building design stage.

4.3 Wind and Seismic Parameters

Module stack wind checks use EN 1991-1-4 with a 30 m/s basic wind speed, town terrain, and a total stack height of 34.2m. Peak velocity pressures range from 0.68 kN/m2 low on the sheltered face to 1.54 kN/m2 at the top of the stack. For the UAE deployment, ASCE 7-16 applies with a basic wind speed of 47 m/s (700 year) and 30 m/s (10 year serviceability), and seismic parameters SS of 0.51g and SDS of 0.4406g under the Dubai Building Code, Seismic Design Category C. Site specific wind tunnel data will supersede these values for the deployment project.

4.4 Module Geometry

Primary module analysed: 10.2m long x 3.8m wide in plan, 3.42m floor to floor, 2.85m clear internal height. Sobha intends to standardise on three to four module types within the ranges: length 6 to 12m, width 3 to 4.5m, floor to floor 3.40 to 3.60m. The analysed module is the governing case.

5. Feasibility Review of the Sobha Concept

This section reviews the structural feasibility of the Sobha modular concept using Sobha's own proposed sections and gauges. It records what the concept achieves as provided, the limitations identified through calculation, and the options available to extend performance. All member checks were carried out by MMCEngineer Ltd and are issued separately as calculation package 26025 [1].

5.1 The Concept as Provided

The review was carried out on the sections and connection concept supplied by Sobha, without substitution. The primary members are:

Member	Section	Basis
End and intermediate posts	150 x 75 toe-to-toe compounded C section, gauge 6, 8, 10 or 12mm, 390 N/mm²	Sobha section, gauge layered by height
Floor and ceiling side beams	200 x 120 C section, gauge selected and held constant	Sobha section, single gauge per building
Module to module connection	Male and female corner block	Sobha proprietary concept
Floor	MD60 composite deck, 130mm overall, or dry alternative on joists	Deck may sit within the beam depth

The floor deck does not have to sit on top of the side beams. It can be carried within the beam depth, which controls the floor to floor build up and the overall building height. The gauge of the 200mm side beam is increased as required and held at one gauge throughout a building, with only the posts varying by height.

5.2 Design Philosophy and Load Path

The load path is direct. The floor deck carries floor load across the 3.8m module width to the two side beams. The side beams deliver these reactions to posts at the module ends and at intermediate positions along the length. The posts carry the accumulated load from every floor above and pass it down, post to post, through the stacked corner blocks to the foundation. There are no transfer structures.

Each module is structurally complete and independent, which supports factory completion, transport without a temporary bracing regime, and future adaptability. Lateral load within the stack is resisted by diaphragm action through the deck and ceiling boards fixed to the horizontal members, and by moment frames formed by the flag plate connections between the posts and the side beams. Where a stiffer or more redundant solution is preferred, K braced bays in the light gauge walls carry the racking load.

5.3 Floor

The floor is the MD60 composite deck as the primary option, at 130mm overall depth spanning the 3.8m module width. Carrying the deck within the beam depth rather than on top of the beams reduces the floor to floor dimension. Two dry alternatives were identified for evaluation: the Lewis metal deck, which is lighter but requires joists to span, and the Cellecta ScreedBoard 28 acoustic overlay, which also requires joists. Neither spans without joists, so the joist family returns if a dry deck is selected. The floor build up should be minimised in either case.

5.4 Floor Beam: Depth Governs Span, Not Gauge

The first limitation of the concept as provided concerns the side beam. The Sobha concept fixes the beam at 200mm deep and increases capacity by thickening the gauge. This gives diminishing returns, because the stiffness of a beam is governed principally by its depth, not its thickness.

The calculated section properties make the point directly. Increasing the depth of the section from 200mm to 400mm increases stiffness by a factor of about five at the same gauge. Increasing the thickness of the 200mm section from 6mm to 14mm increases stiffness by only about 1.7. A 400mm deep section at 10mm has 5.4 times the stiffness of the 200mm section at 10mm, for a 31 percent increase in weight. Depth is therefore far more efficient than gauge.

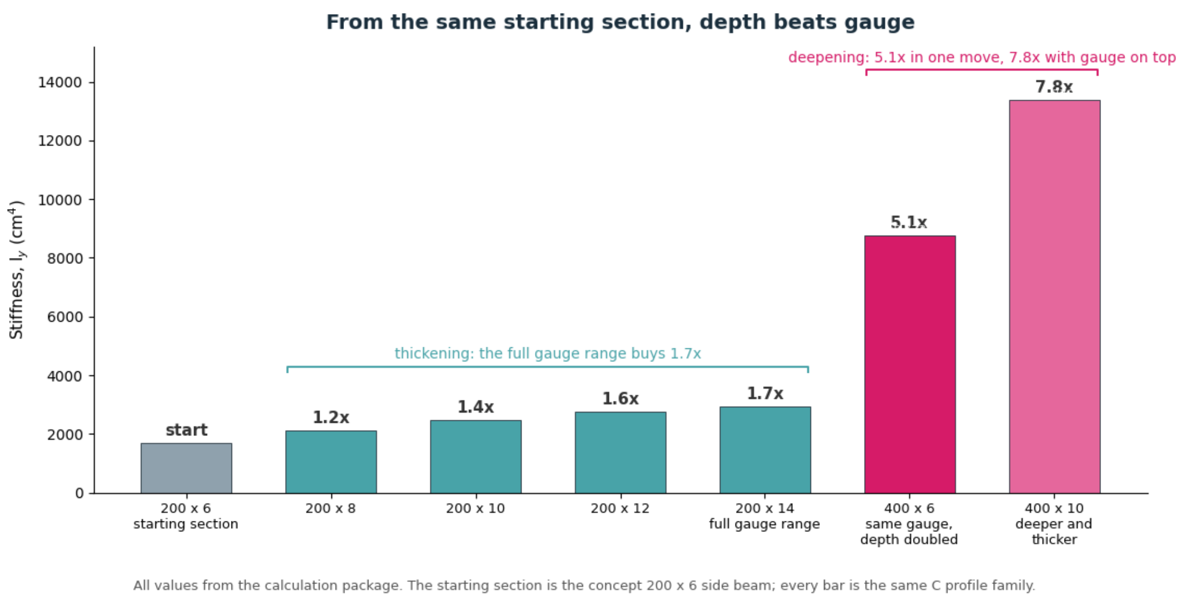

Figure 5.1: Beam stiffness from the same starting section, the 200 x 6 side beam. The full gauge range buys 1.7x; doubling the depth at the same gauge buys about five times.

The consequence is that the 200mm beam, however thick, cannot span the full 10.2m module length under floor loading. Intermediate posts are required to break the span.

The number of intermediate posts is set by how far the beam can span, and that in turn drives the number of columns appearing within the apartment. It also follows that beam depth is a function of span and load per floor only; it is not affected by the number of storeys. Storey count drives the size and number of the posts, not the beam.

5.5 Intermediate Posts: Impingement and Arrangement

The second limitation concerns the intermediate posts. Sobha's post is a 150 x 75 section compounded toe to toe, which is 150mm deep. The module wall is of the order of 100mm, so the post is deeper than the wall and projects into the room, by around 50mm. This is an unavoidable consequence of using the 150mm section within a 100mm wall and is illustrated in Figure 5.2.

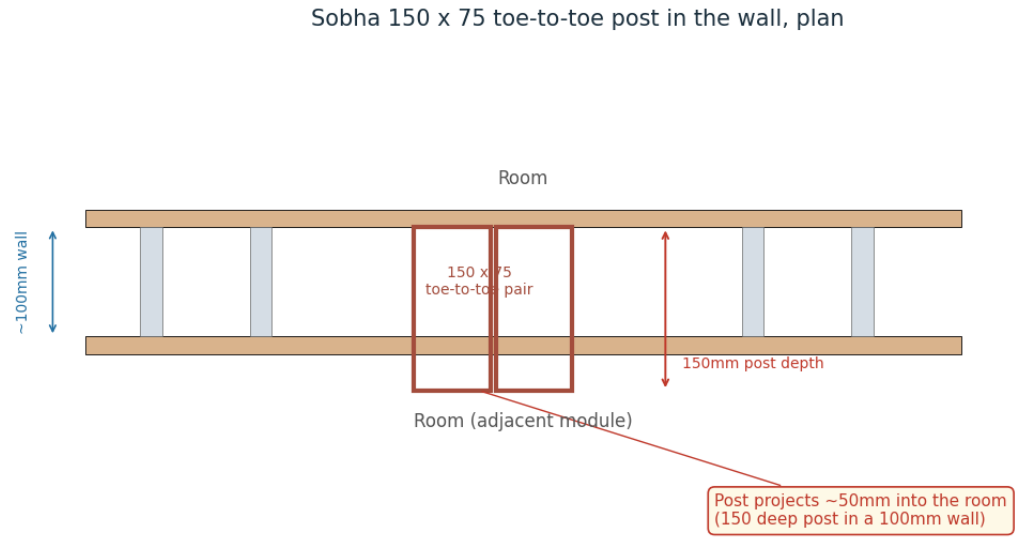

Figure 5.2: The Sobha 150 x 75 toe-to-toe post in a 100mm wall, in plan. The post is deeper than the wall and projects into the room.

The arrangement of the intermediate posts also matters. The calculation package supports the posts as two compounded pairs at mid span, a single support point at the centre of the module. This is the conservative baseline: a single support carries the largest beam reaction, so the posts at that point are doubled to carry the load. It concentrates the steel at the centre of the module.

In practice the posts would be distributed along the beam at maximum pitch, each a single toe-to-toe pair rather than a doubled cluster. Distributing the supports shortens the beam spans, reduces the load arriving at each support line, and removes the concentration of steel at the centre; the gauge at each position is then selected to suit, using the range the concept already provides. The distributed arrangement spreads the demand more evenly and is confirmed position by position at building design; the mid span arrangement is retained here as the calculated case that bounds it. Both are shown in Figure 5.3.

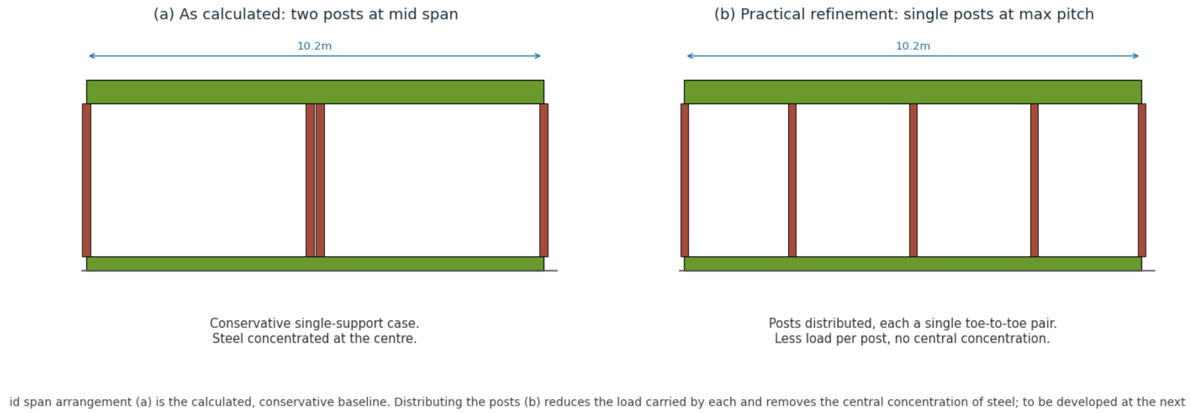

Figure 5.3: Intermediate post arrangements. (a) Two posts at mid span, the calculated conservative baseline. (b) Single posts distributed at maximum pitch, the practical refinement for development.

5.6 Height Capacity on Sobha's Sections

Using Sobha's 150 x 75 post as a compounded toe-to-toe pair at mid span, the calculated capacity increases with gauge. The heavier the gauge, the more floors a post can carry. Layering the gauge by height, heaviest at the base where the accumulated load is greatest and lightest at the top, a thirteen storey building is achievable on Sobha's own sections.

The calculated post capacities are as follows, each for the 150 x 75 toe-to-toe pair at mid span:

Post gauge	Floors carried	Governing utilisation
6mm	8	0.49
8mm	10	0.48
10mm	11 to 12	within the Sobha range
12mm	13	0.48

The 10mm gauge sits within Sobha's preferred 6, 8, 10, 12mm range and is layered between the 8mm and 12mm bands. Layered over a thirteen storey building the gauges fall as shown in Figure 5.4: 12mm at the base, stepping up through 10mm and 8mm to 6mm at the top, where each post carries only a few floors.

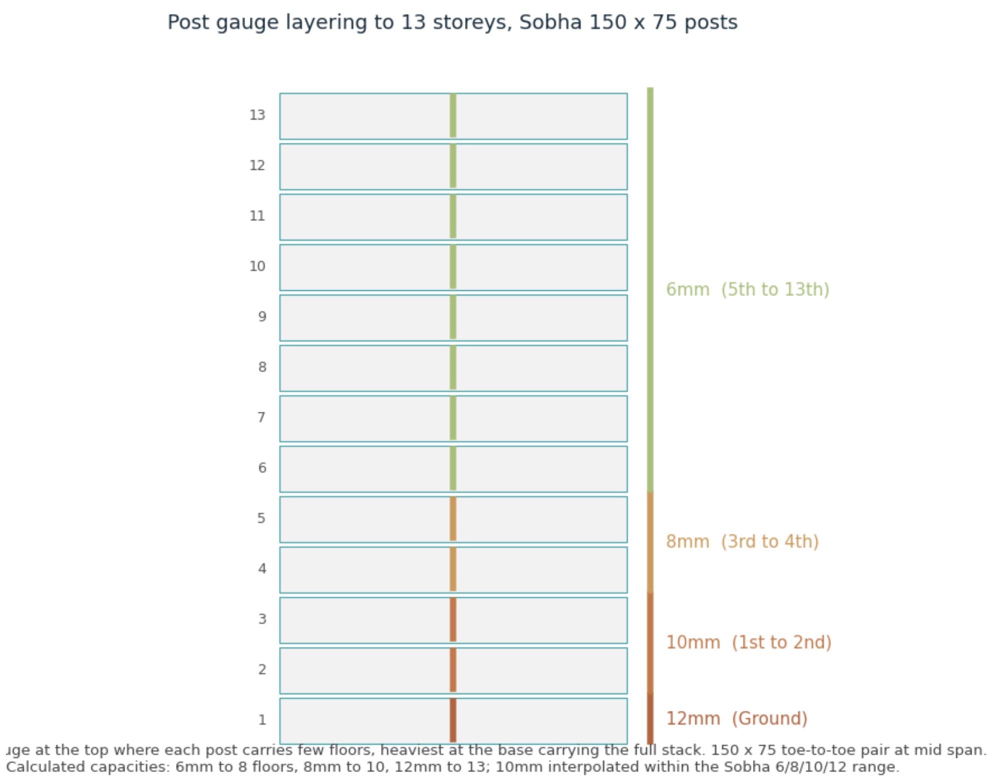

Figure 5.4: Post gauge layering to thirteen storeys on Sobha's 150 x 75 posts.

Thirteen storeys is therefore the height achievable on the concept exactly as provided, calculated on the conservative mid span post arrangement. It is a floor, not a ceiling: no support line in any other arrangement carries more than the checked mid span case, and doubling the provision extends the concept to twenty storeys, as set out in Section 5.10. The utilisations of around 0.48 to 0.49 across the gauge bands show useful margin in every band.

5.7 Lateral Stability and the Flag Plate Connection

Lateral stability within the stack is provided by the flag plate moment connection between the posts and the side beams, working with diaphragm action through the deck and ceiling boards. The flag plate connects to the corner block, and the connection has been developed to a 22mm diameter bolt group acting in tension. Diaphragm continuity between modules and between the modules and the concrete cores is achieved through the screwed and mechanical fixings connecting the deck and boards to the horizontal members, which is established practice. Where a stiffer racking solution is preferred, K braced bays in the light gauge walls carry the load as an alternative to the moment frame.

5.8 The Corner Block: Concept, Tolerance and Manufacture

The corner block is the male and female connection at the meeting of four modules and is central to the Sobha concept. It carries the vertical load path post to post, locates the modules, and provides the fixing point for the flag plate lateral connection. Two aspects govern its feasibility: tolerance control and manufacture.

The principal risk is tolerance. Four modules meet at each block, so any dimensional error in the position of a post or a connection point accumulates across the corner. Tight control of the module node and connection block positions is therefore essential, and it is a factory discipline rather than a site one. The recommended approach is to set out the post and connector locations on a factory jig, so that the dimensional control lives in the jig and not in the operator. An adjustable jig is shown in principle in Figure 5.5. One edge of the bed is the datum rail, which never moves and carries the master datum towers; the opposite rail rides on cross slides to set the module width; and the carriages travel the rails to set the node positions along the length. One bed therefore serves the module range in both directions, and every module leaves the bed referenced to the same master datum. In a detailed design the cross slides would be recessed, or the datum side packed, so the locating pins share one level plane.

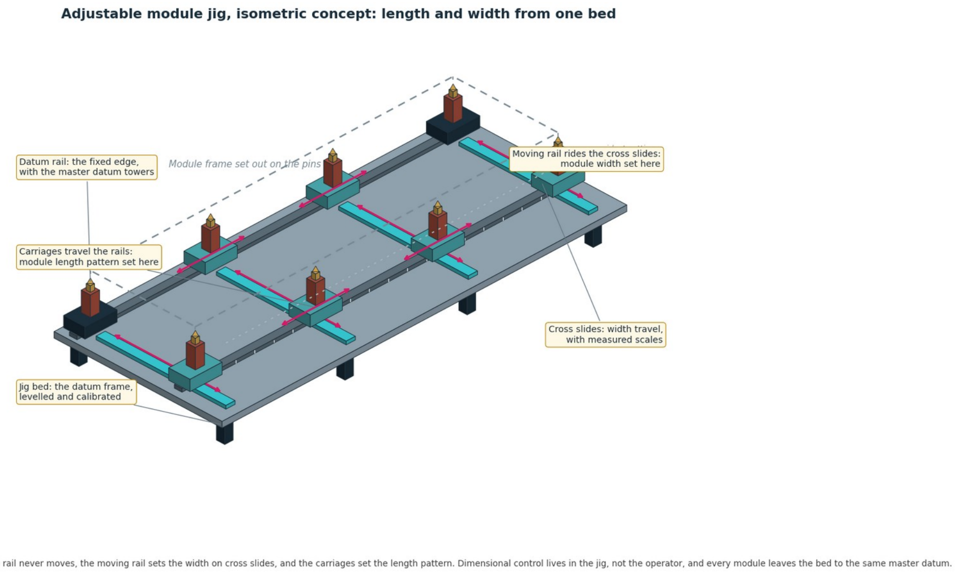

Figure 5.5: Adjustable module jig, isometric concept. The datum rail is fixed, the moving rail sets the width on cross slides, and the carriages set the length pattern.

On manufacture, following the concept as proposed, the corner block is a cast or a machined component. Either route is costly: casting carries tooling cost, lead time and a post cast galvanising step, and machining from solid is slow and wasteful of material. Experience across modular systems is consistent on this point: a separate corner connector block is very often the first target for value engineering once production begins, because its cost sits visibly on every module. That pressure is better anticipated in design than discovered in production. The direction worth developing is to build the locating and fixing functions into the corner posts themselves, so the connection arrives as a feature of the post fabrication rather than as a separate component; this also opens further design for manufacture opportunity in the fabrication of the posts. A block folded and welded from plate remains a nearer term alternative: it removes the casting tooling, can be tuned to the gauge of the members it connects, accepts blind or Huck mechanical fixings which a monolithic casting does not, and can be adjusted where a casting is fixed. There is a direct precedent for this route: the UK Seismic platform, developed through a thirty million pound public innovation programme, adopted a folded and welded corner connector for exactly this reason, proving the design before committing to significant tooling investment [18]. Figure 5.6 shows the Seismic connector as an example of a folded and welded prototype component; these options should be weighed at the next stage.

Figure 5.6: A folded and welded prototype corner connector on the UK Seismic platform, adopted prior to significant tooling investment. Image: Seismic Group [18].

A proprietary module to module connector, the ARaymond connector, was also reviewed. It clips modules together on landing without operative access or tooling, and can be disconnected for module relocation. It requires at least the same standard of tolerance control as the corner block, since it too depends on accurate node positions. Its natural development in this system would be integration into the corner post fabrication rather than addition as a separate component, so that the engagement features arrive with the post. Several points require study before it could be adopted: it is a patented product, so its use would create a dependency; access would be needed to disconnect it; the horizontal locking of adjacent modules, the connection to the concrete core or slab, and its possible use as a lifting point all need development; and the connector introduces a gap between beams that would affect beam bearing and building height. It is carried forward as an option for evaluation, not a recommendation; its chief value is in showing where the richest design for manufacture opportunities in this concept lie, around the corner block approach and the fabrication of the posts.

5.9 Robustness and Progressive Collapse

Under the UK Building Regulations Part A classification the building falls into the higher consequence class, requiring provision against progressive collapse. This UK basis is used as a recognised proxy at concept stage; the applicable UAE classification under the Dubai Building Code and ASCE 7-16 is to be confirmed at building design. The system's tying is largely inherent: the deck is tied to the side beams, the side beams to the posts through the flag plates, and module to module through the corner blocks.

5.10 Issues Identified and Alternative Solutions

The feasibility review establishes that the Sobha concept, using Sobha's own sections and gauges, is structurally viable to thirteen storeys as calculated on the conservative arrangement. Each issue identified through the review has one or more solutions, set out below and developed at the next design stage. The issues are inherent to the concept as drawn; none is a barrier, and each has a route to improvement.

Issue identified	Alternative solutions (for development at the next stage)
1. The 200mm side beam is limited by its depth, so it cannot span far and intermediate posts are required	• A deeper bespoke side beam rolled by Sobha to their own requirement, for example 220mm or greater, which spans further and reduces the number of posts • A compound floor and ceiling beam, the ceiling beam of the module below bolted to the floor beam above to act as one member using the concept's own sections: considered, with concerns over added tolerance control points and the site access needed to make the fixings (companion paper) • Carry the floor deck within the beam depth so a deeper beam adds no floor to floor height • Reduce the floor dead load with a dry deck build up to ease the beam demand • Accept additional intermediate posts where a deeper beam is not adopted
2. The 150mm intermediate posts are deeper than the wall and project into the room	• Separate the mid span pair into single posts spread along the beam, reducing the concentration of steel and the load on each support line, with the gauge matched to position • Adopt a deeper side beam to reduce the number of posts, and so the number of projections • Locate posts on partition or party wall lines where the plan allows • Architectural boxing or feature treatment where a post must fall within a room
3. Height is limited to thirteen storeys on the concept as calculated	• Double the post provision, as pairs bounded by the calculated case or spread with the gauge matched to position, extending the concept to twenty storeys per Figures 5.7 and 5.8 • Layer the post gauge fully across the 6, 8, 10 and 12mm range, heaviest at the base • Adopt a deeper bespoke beam, reducing the load per post • Carry lateral demand on concrete cores at building scale as height increases • A revised cold formed section, or a hot rolled section such as an

	RHS, as an intermediate post for greater height; this sits outside the cold formed concept and is a design development option Sobha have chosen to avoid
4. Tolerance control across the meeting of four modules at the corner block	• An adjustable factory jig that sets the post and connector positions for each module type, in both length and width • A fabricated or folded plate corner block that can be adjusted, rather than a fixed casting • A self locating module connector such as the ARaymond connector, for evaluation • Fixing and locating features integrated into the cold formed bespoke posts, removing the separate block
5. Corner block manufacture: casting or machining a separate block is costly, and a separate connector block is a likely value engineering target in production	• Connection and locating features built into the corner posts themselves, removing the separate block • A block fabricated or folded from plate, tuned to the gauge of the members, accepting blind or Huck fixings which a casting does not • Cast or machined blocks retained as the concept baseline, with cost and material waste watched closely
6. Factory fixing between face to face studs	• Complete the connections in the factory rather than on site • One sided blind rivet or Huck fixings where access is restricted
7. Site access to the connections between modules	• The connector plate overlaying the module nodal points in the concept is feasible, though it may require access to fix down • A self locating connector, or engagement features integrated into the posts, removing the access need • Design node access into the module so inner connections can be reached
8. Setting up roll forming for thick bespoke sections is a significant capital and process development in its own right	• Prove the product and the module manufacture on available sections before committing to bespoke thick gauge roll forming • Procure or partner for proven roll forming capability rather than developing it in parallel with the product • Treat manufacturing process development, product development and module production as sequential gates rather than simultaneous risks • Pilot and prototype the rolled sections before capital commitment

The route to twenty storeys follows directly from the way the load is carried. The calculations show the module standing to thirteen storeys with two intermediate posts, toe to toe at mid span, carrying the full tributary load on one line. That is the hardest condition any support line can face, so it bounds every arrangement that keeps the posts as pairs: twenty storeys is reached by doubling the provision to a toe to toe pair at each of two positions, with each pair carrying well below what the mid span pair was checked for. Spreading single posts along the beam is the further refinement. The calculation package includes the spread support case, with the 200mm beam spanning 2.55m between supports at a governing utilisation of 0.55;

each support line then carries a smaller, defined share of the load, and matching the post gauge to the position is the same mechanism the concept already uses through the height, with the position by position schedule set at building design in the ordinary way. In every arrangement the 150 x 75 posts across their gauge range provide the capacity and concrete cores carry the lateral demand at building scale. Figure 5.7 sets out the arrangements, and Figure 5.8 shows the resulting twenty storey stack with the gauge layering carried through.

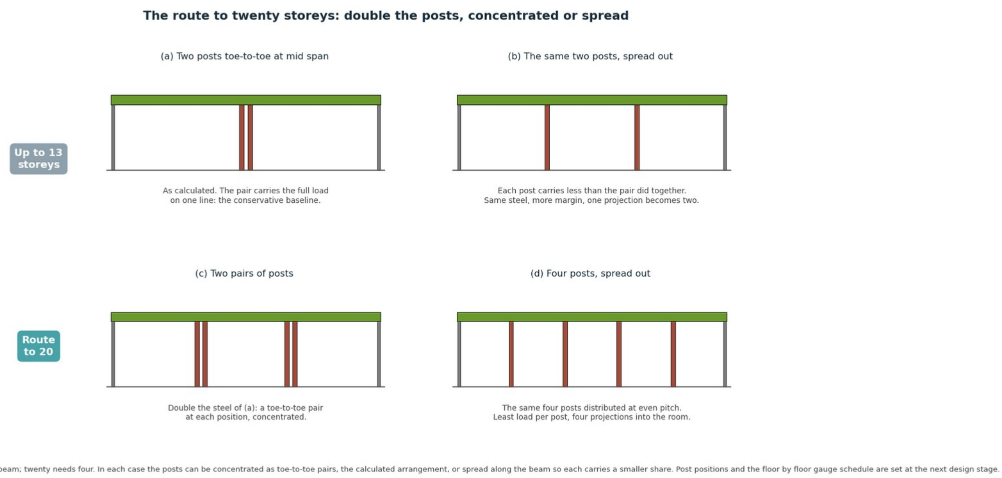

Figure 5.7: The route to twenty storeys. Thirteen storeys needs two intermediate posts per module beam, twenty needs four; concentrated as toe-to-toe pairs, the arrangement the calculation bounds, or spread along the beam with the gauge matched to each position.

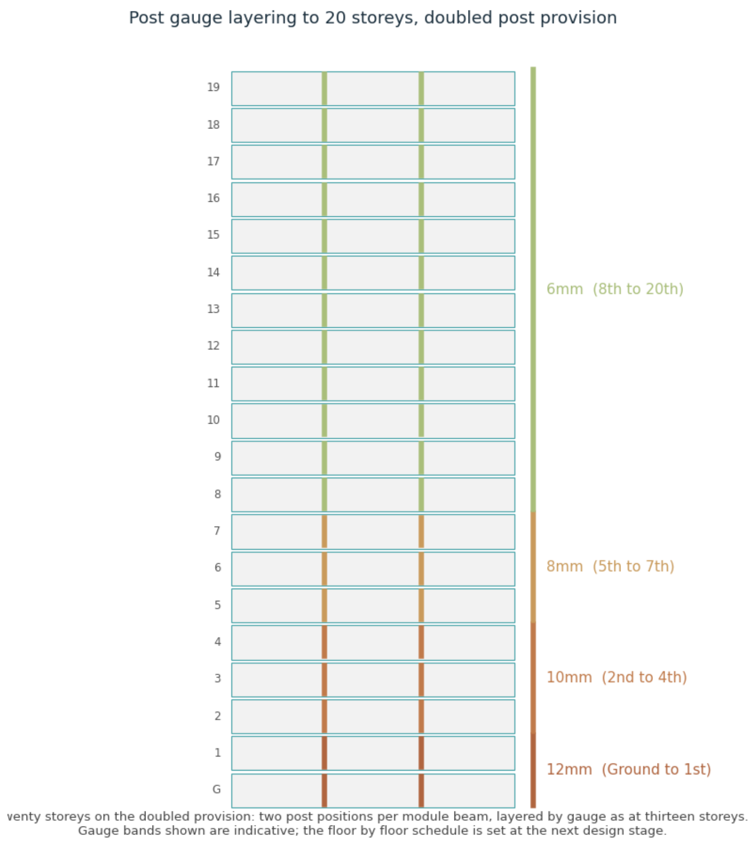

Figure 5.8: Post gauge layering to twenty storeys on the doubled provision, two post positions per module beam. Gauge bands indicative; the floor by floor schedule is set at the next design stage.

The cost of this route is a greater number of intermediate posts, and so more of the 150mm projections into the room. This is where the alternative solutions earn their place: a deeper side beam, or a shallower post section, reach twenty storeys with fewer posts and less intrusion. These options are developed in the companion paper, Development Options, RC/SOBHA/S2/003. The member schedule for a specific twenty storey building is developed at the next design stage, when the implications of the issues raised in this report are balanced against the solutions provided in the companion report.

A word on the manufacturing route. Sobha have both the capability to invest and a clear intention to develop their own sections and intellectual property, which is a genuine strength of the concept. It carries a delivery risk that is worth stating plainly. Standing up roll forming for the thicker bespoke sections is a substantial capital and process development in its own right, and doing it at the same time as developing the product and standing up module manufacture means running three demanding programmes in parallel. Modular ventures in the United Kingdom have aimed high on exactly this basis and fallen short, and the failures have left a lasting mark on the reputation of modular construction. The recommendation is not to avoid the ambition but to sequence it: prove the product and the module build on sections that can be obtained now, and bring the bespoke rolling on stream as a controlled, later step once the product is settled.

6. Connection Strategy

The connection strategy uses each fastening method where it is strongest, with a consistent preference for mechanical fixings made in the factory and no site welding. Three methods carry the system: pop rivets, which are the original Sobha baseline, mechanical Huck fixings, and welding where a jig based weld is the better production answer. Sobha's stated preference is to avoid welding where possible, and where welding is used a robotic laser weld is preferred for automation conformity.

6.1 Recommendation

- Post and stud compounding: mechanical fixing between the profile lips, pop rivet as the Sobha baseline or Huck where higher capacity is required. Welding avoided; robotic laser weld only where a welded tie is unavoidable.
- Flag plate to corner block: bolted connection, 22mm diameter bolts as calculated. Holes can be provided for blind riveting, which removes welding and the associated galvanising damage.
- Module to module at the corner block: retain the Sobha corner block as the primary locator and compression path, secured mechanically. The ARaymond connector is an alternative for evaluation (Section 5.8).
- Deck and joist fixings: self drilling screws to the schedules in the calculation package. Ceiling fixing capacity to be confirmed against MEP loads fixed to the ceiling.

7. Fire Strategy

7.1 Regulatory Context

The governing document for UAE deployment is the UAE Fire and Life Safety Code of Practice, administered in Dubai by Dubai Civil Defence (DCD). Structural fire resistance requirements step with building height: buildings up to 23m carry lower ratings (2 hour and 2 hour class), from 23m to 128m the requirement rises through 3/3/2 above floor 12, and above 128m higher again. A thirteen storey stack at around 45m with podium sits in the middle band; the working target for design is 2 hour fire resistance for floors, loadbearing walls and the structural frame, established with DCD at the concept engagement. UAE facade requirements are strict on combustibility: cladding and insulation of A1 or A2 classification. Figure 15(a) shows where the validated stack sits in the height bands.

7.2 Compartmentation Strategy

Each module is a fire compartment. This is the natural strategy for stacked volumetric construction and it is inherently strong here because every dwelling boundary is doubled: two independent stud walls between adjacent modules, and a concrete floor above an independent protected ceiling between stacked modules. Figure 15(b) shows the strategy. Specific provisions:

- Floors: the 130mm composite concrete deck provides the primary horizontal separation. Concrete floors of this depth comfortably achieve 2 hour integrity and insulation in tested composite assemblies; the ceiling below adds a second protected layer.
- Ceilings: fire rated board layers on the 100 x 80 x 4 joists protect the ceiling void and the side beams of the module below. Board type and layers to be selected from tested LGS systems.
- Walls: double stud party walls with fire rated boards each side of each leaf. Loadbearing posts encapsulated within the board build up.
- Structural protection: cold formed members lose strength at elevated temperature and rely on encapsulation. Every primary member (posts and side beams) must sit inside a tested board or encasement system rated to the target FRR. Because the 150mm intermediate posts are deeper than the wall and project into the room (Section 5.5), the encapsulation is carried around the projecting post, and the corner block is boxed out where it enters the room corner.
- Module interfaces: the joints between modules are the critical detail. Cavity barriers and fire stopping at every module to module joint, at each floor line and at vertical compartment lines, detailed to accommodate the tolerance and movement at the corner block interfaces. Factory fitted intumescent strips are the recommended technology at the module gaps: applied to the module side

in the factory, they partly close the gap while leaving installation tolerance, and expand to seal it in fire. This is more reliable than site fitted fire socks, which need fixing from both sides of each joint and are routinely damaged or badly installed. Example products are the Tenmat FF102/50 cavity fire barrier, rated up to 120 minutes [10], and the Cavgard intumescent roll, supplied for pre fixing to modules in the factory [16].

- Penetrations: MEP penetrations through module walls and floors sealed with tested fire stopping systems; service routes to be rationalised so penetrations occur at repeatable, pre engineered positions.

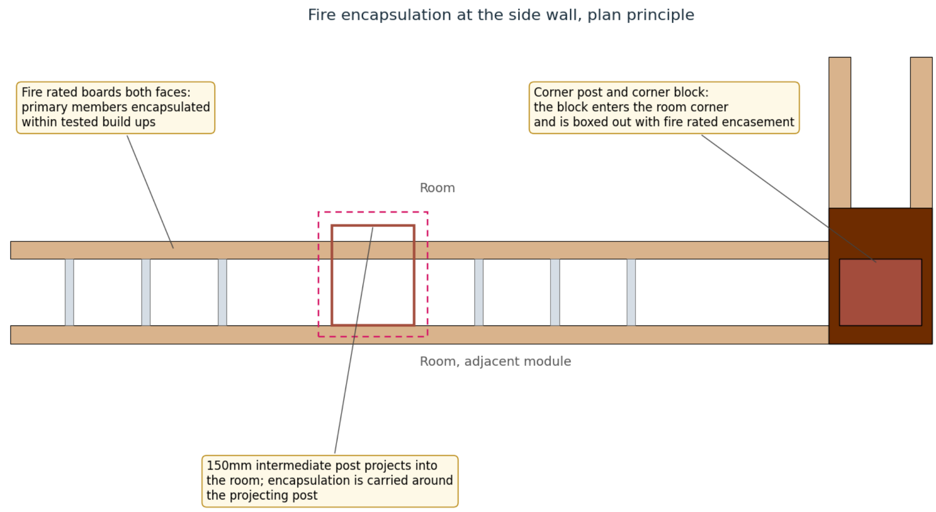

Figure 14: Fire encapsulation at the side wall, plan principle

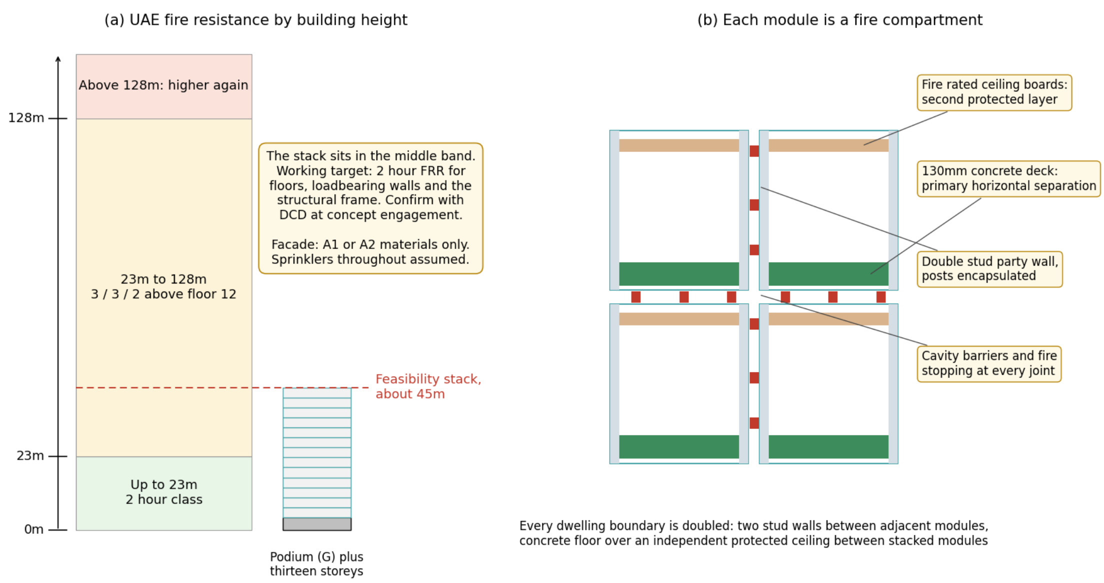

Figure 15: UAE fire resistance height bands and the module compartmentation strategy

7.3 Approach to Demonstration

The demonstration route is tested assemblies rather than calculation: select floor, ceiling, wall and junction build ups from systems with existing test evidence where possible, and close the gaps with the indicative fire tests in Section 13 (floor and ceiling assembly, party wall, and module interface fire stopping under thermal movement). Engage DCD at concept stage with the compartmentation strategy and the test plan; early engagement was identified as a low cost and effective de risking measure. Sprinkler provision throughout residential areas is expected under the UAE code and should be assumed in MEP coordination from the start.

8. Acoustics

Dubai residential projects are typically specified to international benchmarks: airborne sound insulation between dwellings of DnT,w around 50 dB or better and impact sound of L'nT,w not exceeding around 62 dB, with project specifications sometimes tighter for premium product. Sobha's market position indicates that design to the premium end of the range is appropriate. Exact contractual targets should be fixed with an acoustic consultant at deployment project stage.

The system starts from an unusually strong position for lightweight construction because every separating element is doubled and the floor provides substantial mass:

- Separating floors: 130mm concrete slab (upper module) over an air gap and an independent boarded ceiling (lower module). The combination of mass and isolation is the established arrangement for both airborne and impact performance; with resilient flooring or a thin screed isolation layer it should exceed the targets with margin.
- Separating walls: two fully independent stud walls with a cavity between modules, each boarded. Independence of the two leaves is the principal acoustic benefit; mineral wool in both stud zones and the inter module cavity completes the build up.
- Within module partitions: standard LGS partition build ups to suit room to room requirements.

The principal acoustic risk lay in flanking transmission rather than in the separating elements themselves. Figure 16 shows both: the doubled build ups and the paths that bypass them. Structure borne sound can bypass the doubled build ups through the posts, side beams and corner blocks, which are necessarily rigid and continuous.

The mitigations are all detailing disciplines: keep board linings isolated from primary steel (resilient bars or independent lining frames), do not bridge the inter module cavity with rigid packers or debris, seal all joints airtight, noting that airtightness and acoustic performance are achieved by the same detailing, and treat the corner block zones with local mass and sealant detailing.

The ScreedBoard 28 floor option strengthens the acoustic position further: it is an acoustic overlay product with its own resilient layer [6], adding isolation at source on top of the doubled build ups.

The acoustic tests in Section 13 (airborne and impact, on a two module assembly) are designed to measure the as built system including these flanking paths, rather than the separating element in isolation.

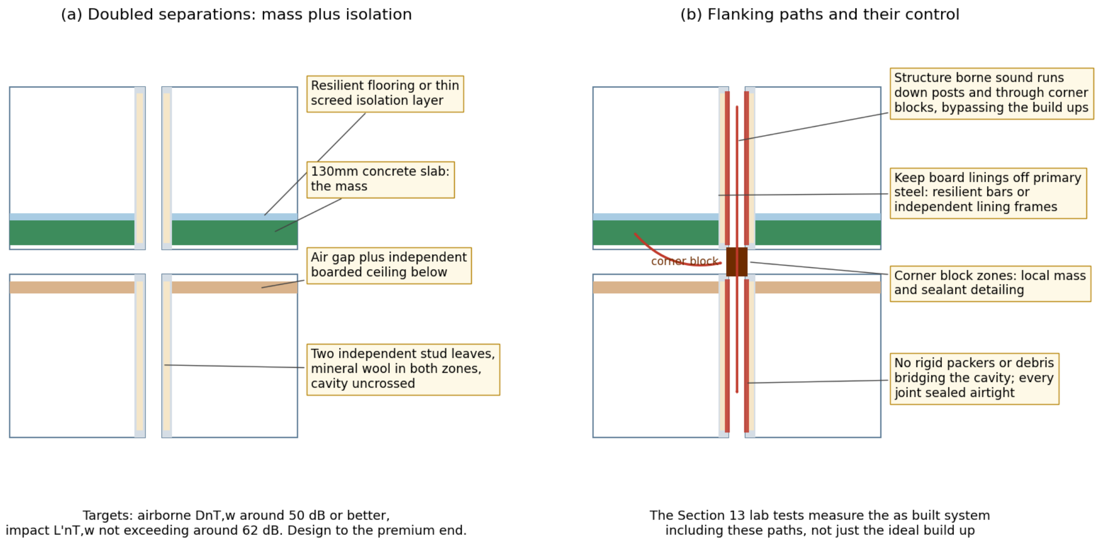

Figure 16: Acoustic separation build ups and flanking control

9. Durability and Corrosion Protection

Dubai's coastal, hot and humid environment places the external envelope in EN ISO 9223 corrosivity category C3 to C4. Sobha targets a 60 year design life, which the following specification supports:

9.1 Cold Formed Steel Members

- Minimum: Z275 hot dip galvanised coating to EN 10346 (the current Sobha specification)
- Recommended upgrade: Z450 for all cold formed steel in perimeter positions or where condensation risk exists
- Site cut ends, drilled holes and site welds: zinc rich paint (minimum 85% zinc dust by dry film weight) applied immediately. Mill and factory cut edges of galvanised sections self heal through sacrificial zinc action and need no treatment

9.2 Medium Gauge and Hot Rolled Steel

- Posts and side beams: factory applied two coat zinc phosphate primer and epoxy system, or hot dip galvanising where geometry allows
- Hot rolled sections, where used for greater height: hot dip galvanised, sealed ends
- Corner block components: hot dip galvanised with a specification that preserves pin and thread fit tolerances

9.3 Module Interfaces and Envelope

- EPDM compression gaskets and low modulus silicone or polyurethane sealants rated for 60 year service at UAE temperatures
- Two stage face seal at facade interfaces: an outer seal sheds the bulk of the water into a drained and ventilated cavity, and an inner seal provides the airtight line, so any water passing the outer stage drains away before it reaches the inner seal
- Each module leaves the factory weathertight, protecting internal steelwork through storage and installation

10. Manufacture, Logistics and Assembly

10.1 Module Weight Model

Indicative lifting weight for the 10.2m x 3.8m module on the Sobha composite deck floor:

Component	Weight
Floor deck and finishes (composite deck)	around 9.3 tonnes
Steel frame (posts, side beams, joists, studs)	3 to 4 tonnes
Walls, boards, finishes and MEP	3 to 4 tonnes
Working lifting figure, fitted out	16 to 18 tonnes

These weights govern crane, transport frame and factory handling selection, and should be tracked as a managed budget for each module type.

10.2 Lifting

- Lift using a certified spreader frame sized to the 10.2m x 3.8m plan [11], keeping slings vertical; the posts and their connections see tension during the lift, the reverse of the in service condition (Figure 17)
- An eight point lift along the module sides has been adopted in place of a four corner lift; pick points and the lifting stiffness check follow with the building design

Module lift: certified spreader frame, eight point lift, slings vertical

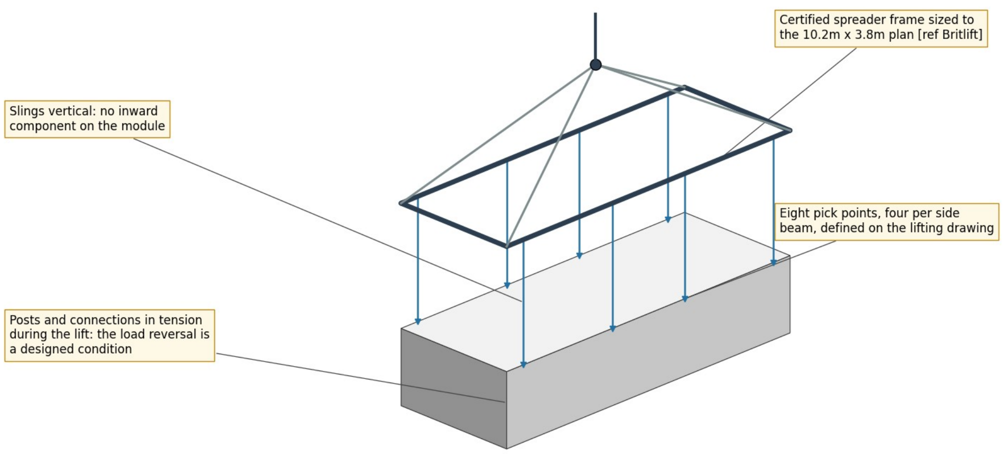

Figure 17: Module lift: certified spreader frame, eight point lift, slings vertical [11]

- The lifting case is a designed condition: the eight point lift is engineered with the module in the air, posts in tension, and pick points defined on the lifting drawing at Stage 3

10.3 Transport

At 3.8m wide and around 3.6m transported height, the module is an abnormal load in the UAE, needing wide load permits, approved routes and possibly escort, with travel height on a low bed trailer around 4.6m against typical clearance limits. UAE authorities process such permits routinely and Sobha's Dubai logistics base makes this workable, but it has cost and programme consequences: route surveys to each site, night movement windows, and a transport frame that restrains the module through road vibration (a further consideration supporting the Huck lockbolts recommended in Section 6, which maintain a permanent mechanical preload under vibration). A 3.5m wide module variant should be retained as an option for long road distances: at that width most routes no longer demand escorts, and transport drops towards standard load cost.

10.4 Tolerances and Sequencing

- Tolerance philosophy to SCI P402 [8]; the male and female corner block provides positive location and a defined shim regime takes up stack tolerance, surveyed at every lift
- Installation sequence: core first, then modules in vertical stacks, tying to the core at each level; corridor modules follow the apartment stacks in each takt zone
- Erectors qualified for light gauge steel modular work (Blue CSCS Card standard or local equivalent), with the corner block joint and shim procedure covered by method statement and inspection records
- Post erection alterations to any structural element are prohibited without system manufacturer sign off; this must carry into Sobha's site quality system

11. Summary of DfMA Improvement Opportunities

The Sobha composite deck spans the module width directly between the side beams, which avoids a separate floor joist family. Further opportunities to simplify the concept, in priority order:

1. Fastener rationalisation: hold the system to three fastener families (5mm self drilling screws, M8 bolts, Huck fixings). Every additional fastener type is a station level cost in tooling, inventory and error opportunity.
2. Intermediate post arrangement: the practical refinement is to distribute single toe-to-toe posts at maximum pitch rather than doubling them at mid span, which reduces the load per support line and the concentration of steel. This is set out in Section 5.5, is subject to Sobha's preference regarding room penetrating features, and should be confirmed by Sobha at the next stage, before jig design.
3. Pre punched holes: fixing holes, including the flag plate bolt patterns in the posts and the vertical compounding fixing positions, should be punched at roll forming, not drilled at assembly.
4. Section rationalisation: the Sobha concept uses a small profile family, the 200mm side beam, the 150 x 75 post, the ceiling joist and the wall stud, with capacity varied by gauge rather than by adding profiles. Holding the family small keeps tooling, stock and changeover cost down; further profiles should be avoided.
5. Takt alignment: target one module per station per shift. On the composite deck the concrete pour and cure is the takt governing operation; a parallel pre cast deck feed should be considered if cycle analysis shows the wet trade holding the line. A dry floor alternative that would remove the wet trade is discussed in Section 5.3 and developed in the companion paper.
6. Jig strategy: set the post and beam frame positions from a factory jig referencing the corner block locations (Section 5.8), so that dimensional control is provided by the jig rather than by the operator. The flag plate bolt group doubles as a squareness datum; that assumes punched hole accuracy, which the roll forming route provides.
7. Supply localisation: Sobha intend to roll their own sections, so the 200mm side beam and the 150 x 75 posts can be produced locally to their own requirement. Local rolling, or import in coil with local forming, keeps freight cost on long structural sections down; localisation is the working assumption for production.

12. Typical Detail Development

The details below are provided as input to Sobha's detail development. Sobha's supplied system details [12] informed the approach throughout this report. The typical details are delivered as guidance here, with the comprehensive detail set developed at Stage 3 through a Sobha and Rethink workgroup (Section 14). Each priority detail below carries specific inputs developed in this report: intumescent fire stopping at the module gaps [10], flanking control at the joints (Section 8), encapsulation build ups (Section 7), the corner block shim and tolerance regime (Section 10.4), and repeatable MEP penetration positions. The priority list, in the order the details de risk the system:

No	Detail	Governing considerations
1	Corner block interface, module to module	Shim regime, Huck fixing access, intumescent fire stopping [10], tolerance take up
2	Side beam bearing and post interface	Fixing counts per the calculation package for the 200mm beam and the 150 x 75 posts, pre punched holes, acoustic and fire continuity at the joint; alternative beam arrangements are gathered in the companion paper
3	Flag plate connection	Two plates per position, 6 No M8 each, plates bolted to the posts per the latest calculation, board encapsulation around the connection
4	Module to core tie	Lateral load transfer, tie force capacity, tolerance to core construction accuracy
5	Party wall junction and inter module cavity	Acoustic independence, cavity barriers, no rigid bridging
6	Floor and ceiling build up at module edge	Deck bearing on side beam, ceiling board fire layer, flanking control
7	Facade anchor to module frame	A1/A2 facade materials, thermal movement, C4 corrosion category
8	Corridor module bearing and connection	Current approach feasible; to be developed further on a building specific design, where multiple interfaces are detailed
9	MEP penetration standard details	Repeatable positions, tested fire stopping, acoustic sealing

13. Testing Strategy

A prototype test programme is essential before production commitment. Detailed specifications should be developed at Stage 3; the indicative matrix:

Test	Purpose and method	When
Module stacking test	Two or three modules stacked and loaded; instrument posts and side beams; verify corner block load transfer. Rigs able to apply high accumulated storey loads are not commercially available; loading regime matched to available rigs	Pre prototype
Compound beam load test	Confirm compound action of the bolted pair of 200 beams against the inferred stiffness and the calculated strength; measured performance may support value engineering of sections	Pre prototype
Corner block connection test	Vertical load and shear to characteristic failure; informs tie force and Huck sizing	Pre prototype
Flag plate racking test	Horizontal load on a two module stack; confirm moment connection stiffness against the alpha crit assumptions	Pre prototype
Floor assembly fire test	EN 1363-1 or UAE equivalent on the deck plus ceiling assembly; 2 hour target	Prototype phase
Party wall fire test	2 hour integrity on the double stud assembly	Prototype phase
Module interface fire stopping	Joint integrity under thermal movement	Prototype phase
Airborne acoustic test	EN ISO 10140-2 on a two module wall assembly, capturing flanking	Prototype phase
Impact acoustic test	EN ISO 10140-3 on the floor build up	Prototype phase
Durability and coating	Coating system verification for C4 exposure	Design finalisation

Following successful testing, pursue third party certification and the Dubai Municipality or Trakhees approval route to obtain a formal statement of system fitness up to a stated building height. Fire test laboratory slots carry 3 to 6 month lead times and should be booked as soon as the build ups are frozen. One qualification applies across the matrix. The load capability of the test rig should be confirmed before any structural test is committed. Rigs able to simulate more than about two storeys of accumulated load do not exist commercially, and a test that cannot reach the required load has no value.

14. Recommendations and Roadmap

14.1 Immediate, 0 to 4 Weeks

- Sobha decisions on the beam arrangement, the floor build up, the vertical post fixing method and the intermediate post arrangement, taken with the options gathered in the companion paper, so that jig design and the twenty storey development start from the right inputs
- Sobha architects to overlay the mid span post positions on the apartment layouts and confirm acceptability
- Complete the corridor module structural review
- Confirm the supply route for any deeper cold formed sections selected for UAE production; Howick roll former route identified
- Begin Dubai Civil Defence concept engagement with the Section 7 fire strategy
- Confirm site specific wind data and building typology for the first deployment project

14.2 Short Term, 1 to 3 Months

- Design development to twenty storeys: doubled post provision, deeper bespoke side beam, and building scale lateral system, developed and calculated for a specific building
- Design basis document to Dubai Municipality covering the EN 1993 plus ASCE 7-16 approach
- Building scale structural model for the G+20 geometry with concrete core, and formal seismic and tie force checks
- Huck fixing review and corner block connection sizing, with evaluation of the ARaymond clip connector as the module to module alternative (Section 6)
- Typical details 1 to 7 from Section 12 produced through a Sobha and Rethink detail development workgroup, established at the start of Stage 3
- Appoint UAE acoustic consultant and freeze fire and acoustic build ups for testing

14.3 Medium Term, 3 to 6 Months

- Prototype specification: G+1 or G+2 build, test objectives and pass criteria, fabrication drawings signed off by the structural engineer before cutting
- Book fire and acoustic laboratory slots (3 to 6 month lead times) and confirm rig load capability first (Section 13)
- Structural test series: stacking, compound beam, corner block and racking tests, with the structural model updated against results

- Certification route confirmed with Dubai Municipality or Trakhees, targeting a formal system approval to a stated height

In conclusion, Stage 1 established that the concept justified development, and Stage 2 delivered that development. The concept was calculated as viable to thirteen storeys on Sobha's own sections and gauges, the route to twenty storeys was set out in Section 5.10, and each issue identified through the review was mapped to solutions for the next stage. On the basis of the work completed in Stage 2, the system was assessed as sufficiently developed to proceed to prototype.

Appendix A: Engineering Calculation Package

MMCEngineer Ltd, calculation package 26025 [1]: feasibility calculations for the 10.2m x 3.8m module and the number of storeys viable, produced in Tedds by Trimble with the Modern Engineered Software Solutions light gauge steel add in, issued as a separate document. The package contains the member checks on Sobha's sections summarised below. Summary of checks:

Check	Key result	Outcome
Post, 150 x 75 pair, 6mm	Carries 8 floors, utilisation 0.49	PASS
Post, 150 x 75 pair, 8mm	Carries 10 floors, utilisation 0.48	PASS
Post, 150 x 75 pair, 12mm	Carries 13 floors, utilisation 0.48	PASS
Deepest 200 side beam	Max span analysis on the deepest Sobha section	Input to post spacing
Flag plate to corner block	22mm diameter bolt group in tension	PASS
Beam stiffness, depth vs gauge	200 to 400 deep 5.1x at matched gauge; 6 to 14mm at 200 1.7x	Design basis

References

[1] MMCEngineer Ltd, Calculation Package 26025: Scheme Design, 10.2 x 3.8 module, with appendices, floor and post options, and design arrangement sketches, reissued 12 August 2026, including the thirteen storey mid span post case. Issued separately to this report.

[2] MMCEngineer Ltd, Weld Capacities appendix, calculation pages 111 to 114, 12 August 2026. Contained within reference 1.

[3] MMCEngineer Ltd, Sobha section post and beam calculations (150 x 75 posts at 6 to 12mm gauge, 200mm side beams), within package 26025.

[4] Huck Magna-Lok MX technical data sheet, part MCHFR-R11-XA.

[5] Huck parts catalogue, February 2026 edition, via Applifast, www.applifast.com.

[6] Cellecta Ltd, ScreedBoard 28 product data, www.cellecta.co.uk/products/screedboard-28.

[7] Cellecta Ltd, floor detail RD-E-FS-3, FFT4 compliant assembly, drawing issued with the report file.

[8] SCI P402, Light Steel Framing: erection tolerances and stability philosophy, Steel Construction Institute.

[9] BCSA, National Light Gauge Steel Specification Standard, British Constructional Steelwork Association.

[10] Tenmat Ltd, FF102/50 Cavity Fire Barrier, rated up to 120 minutes, www.tenmat.com.

[11] Britlift, lifting beams, lifting frames and spreader beams, technical guidance, www.britlift.com.

[12] Sobha Reality, Steel Modular System details package: drawings, data and concept details as listed in Section 3, June 2026.

[13] MetFloor 60 composite deck load span and volume data, as reproduced in reference 1.

[14] Rethink Construction, Sobha Modular, Concept Validation Report V2.0 (Stage 1), April 2026.

[15] Stage 2 commissioning: proposal letter dated 12 August 2025 and PNC Architects LLC Service Purchase Order 1200002466 dated 17 March 2026.

[16] Cavgard, modular construction brochure v1-23-1: pre fixed intumescent cavity protection for modular construction.

[17] ARaymond, Module to Module Connector: innovating industrialised construction, product data sheet, www.araymond-construction.com. [18] Seismic Group, Why Seismic: the Seismic platform and corner connector, www.seismicgroup.co/why-seismic, accessed August 2026.

END OF REPORT

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