ReThink

COMPANION PAPER

To the Stage 2 Concept Feasibility Report

Development Options

The solutions explored during Stage 2, gathered as options for the Sobha concept.

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Purpose

This paper is a companion to the Stage 2 Concept Feasibility Report for the Sobha lightweight modular system. It gathers the solutions explored during Stage 2 in one place and organises them around a single theme: reaching greater height with fewer compromises. The route to twenty storeys itself is set out in the feasibility report; this paper develops the options that make that route more comfortable.

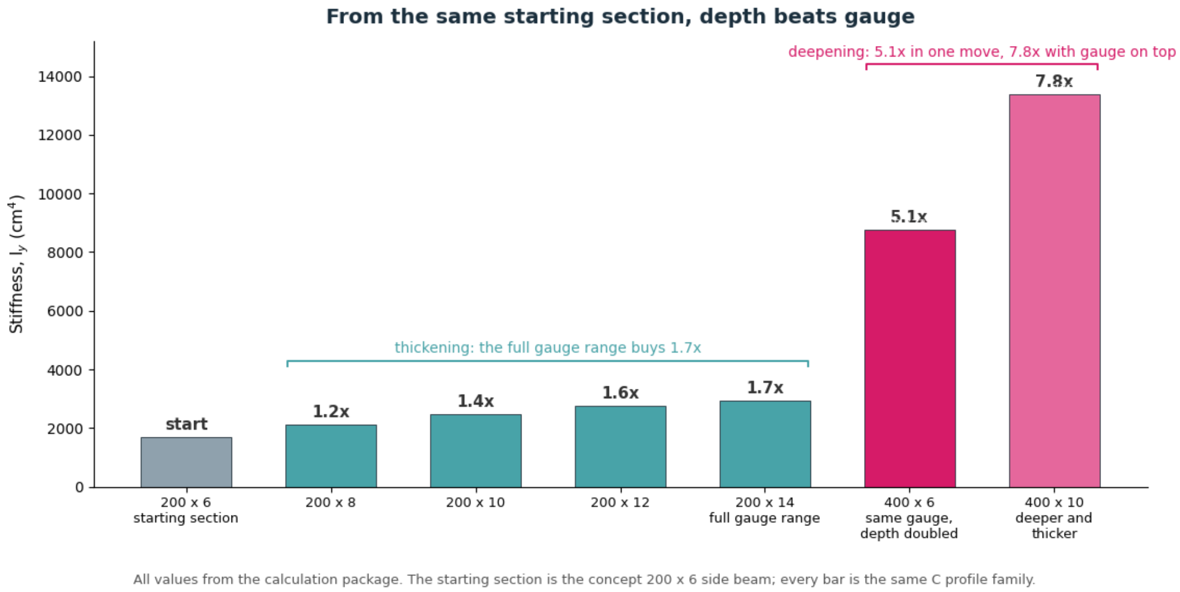
The feasibility report established that the Sobha concept, on Sobha's own sections and gauges, is structurally viable to thirteen storeys, and it identified the issues that shape the design. Those issues each point to options worth developing. This paper takes them in turn. For every option it is clear which issue it resolves, and whether it stays true to the Sobha concept or moves beyond it. The material is offered as food for thought for the next stage, not as instruction.

The starting point is the concept as it stands. It stacks to thirteen storeys conservatively, using one post section for both the corner and intermediate positions, a shallow 200mm side beam that holds the building height down, and the corner block connection. The concept is sound, and the options below build from it rather than replace it.

The Floor Beam

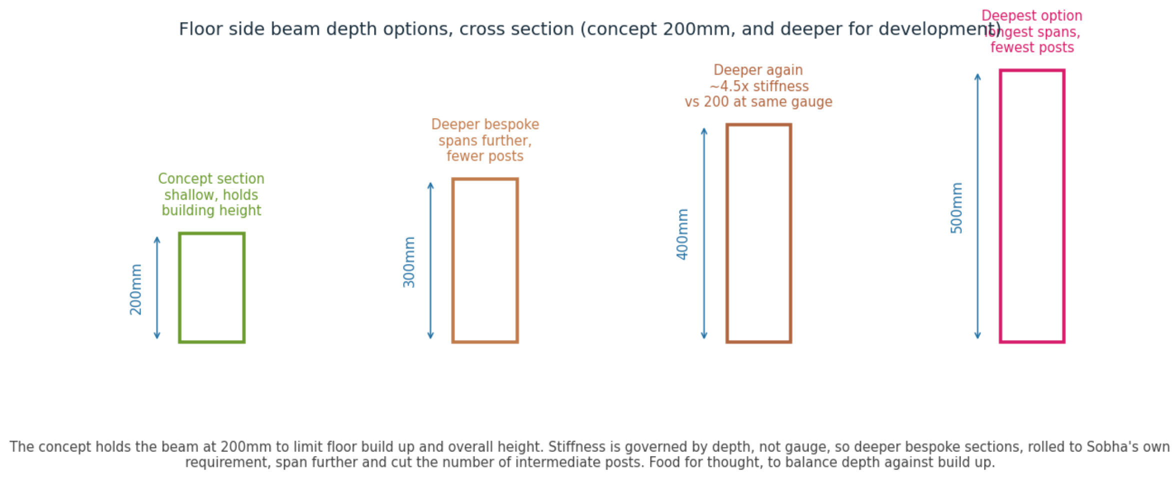
The concept holds the side beam at 200mm deep. This is a deliberate and well judged choice: a shallow beam keeps the floor and ceiling build up down, which holds the floor to floor dimension and the overall height of the building. That driver is respected here.

The engineering point to work with is that the stiffness of a beam is governed by its depth, not its thickness. Increasing the depth of the section from 200mm to 400mm increases stiffness by about five times at the same gauge, whereas taking the 200mm section through its full range of gauge adds only about seventy percent. Thickening the beam therefore reaches its useful limit quickly; depth is the effective lever.



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 idea to play with is a deeper side beam, rolled by Sobha to their own requirement. A deeper beam spans further, which reduces the number of intermediate posts and, with them, the number of posts standing in the room. It is a direct answer to both the span limitation and the room intrusion. The trade to balance is depth against build up: a deeper beam recovers span and posts, at the cost of floor to floor height, and the two can be tuned against each other.

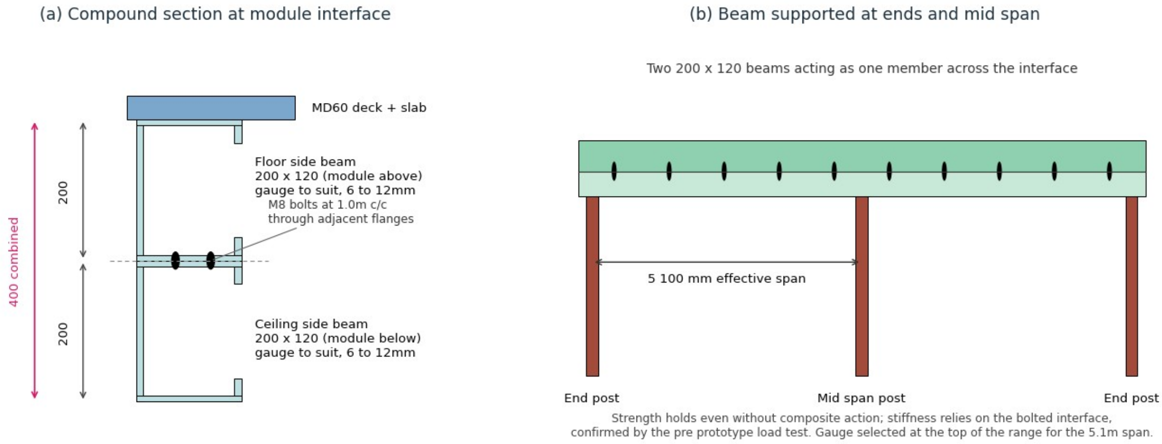


Floor side beam depth options in cross section. The concept 200mm section, and deeper sections for development, which span further and reduce the post count.

This stays true to the concept in material and method, cold formed sections rolled by Sobha, and simply extends the depth. A worked deeper section from earlier development is included above as a starting point for discussion rather than a fixed proposal.

The deeper beam is not a sketch; it has been engineered. A 500mm x 100mm x 5mm C section in 450 N/mm² steel was checked as the floor side beam, carried on a single mid span post with no fixing across the module interface: the 200mm ceiling beam of the module below is retained unchanged, so each module keeps its own floor and ceiling members. At the 5.1m span it passed with margin: moment 71.35 kNm against a capacity of 184.93 kNm, deflection 11.77mm against 14.17mm allowable, a governing utilisation of 0.83, at a self weight of 28 kg/m. The same calculation set also confirmed the other direction: keeping the 200mm beam exactly as drawn and adding intermediate posts so it spans 2.55m passed at a governing utilisation of 0.55, with substantial margin. The two results bracket the choice: hold the beam and add posts, or deepen the beam and remove them.

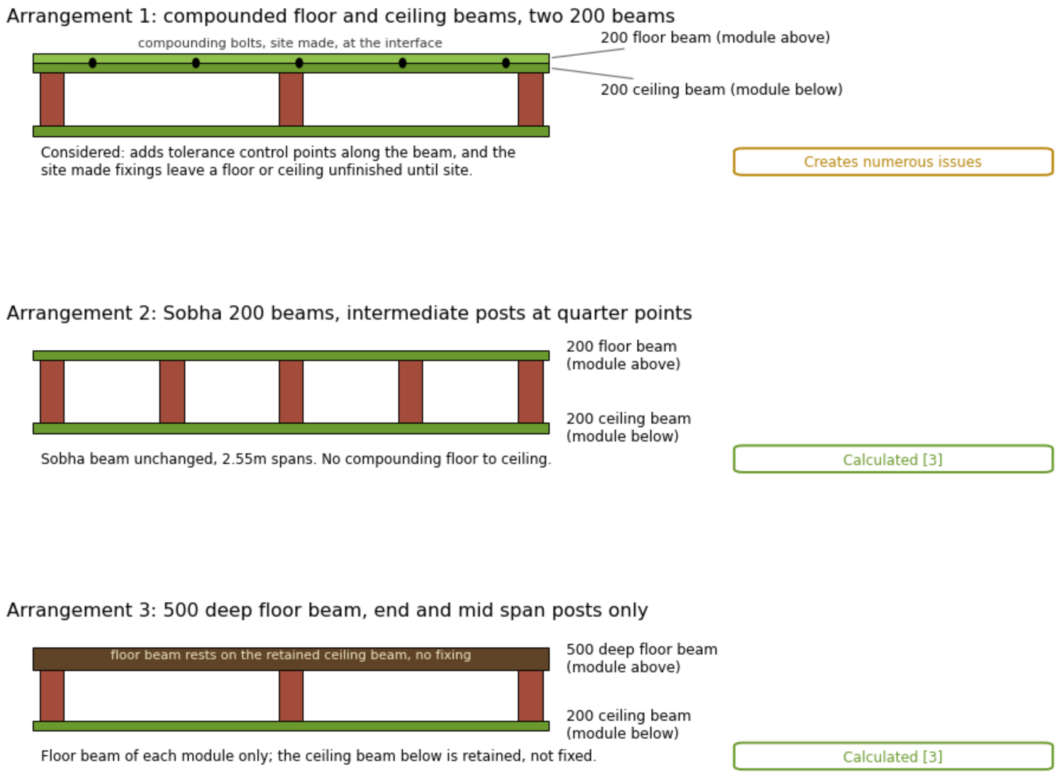
There is a second answer, revisited here because it may deserve a fresh look: the compound beam, using only sections the concept already has. In the assembled building the floor beam of each module sits directly on the ceiling beam of the module below. Bolting the two through at the interface, M8 at 1.0m centres, makes them act as one member: 400mm deep overall, with the wide flanges of the 200 x 120 section top and bottom. Inference from the calculated section properties puts the fully compounded pair at least the equal of a single 400mm deep section at every matched gauge, so wherever a 400 deep beam answers the span, the compounded pair of 200s answers it too, with no new section to roll. The strength case is comfortable even before any composite action is counted, since two 200mm beams sharing the bending resist well above the calculated demand; it is stiffness that depends on the bolts carrying the longitudinal shear between the two, and that composite action is precisely what the pre prototype load test of the bolted pair measures.



The compound side beam at the module interface: two 200 x 120 beams, the floor beam of the module above bolted to the ceiling beam of the module below, acting as one member with mid span support.

The compound beam has been considered rather than recommended, and the concerns are worth stating plainly. The first is tolerance: the compounding bolts add a run of connection points along every beam, each one a position to be controlled, on top of the post and corner positions the system already works hard to hold, so the arrangement multiplies the tolerance control points at the module interface. The second is access: the bolts join two modules, so they can only be made on site after the modules are stacked, which means either the floor of the upper module or the ceiling of the lower module must remain unfinished until it reaches site, conceding part of the fully finished factory principle. These are production and installation concerns rather than structural ones, and Sobha may weigh them differently; if the site operation is acceptable, or can be confined to an access strip at the module edge that closes quickly, the compound beam reaches the depth the span asks for using members that are present anyway.

To those concerns is added the cost of steel weight. Two 200mm beams at the top of the gauge range run to roughly 85 kilograms per metre combined, where a single 400mm deep section of the same stiffness carries about two thirds of that. So the weight reduction option is the mirror of the tooling one: a 400mm deep section, rolled at the gauge the specific building actually needs, matches the compounded pair for stiffness at a fraction of the weight, at the price of one new profile in the family. The compound of two 200s spends steel to save tooling; the 400 spends tooling to save steel. Which is the better bargain depends on volumes, and it is exactly the kind of decision the manufacturing note later in this paper informs.



Principle only, after the design sketches of 28 July 2026 [1]. Nothing is fixed across the module interface in arrangements 2 and 3; in arrangement 1 the two 200 beams are bolted through at the interface to act as one member, inferred equivalent to a single 400 deep section from the calculated section properties. In arrangement 3 the 500 deep floor beam of the module above rests on the retained 200 ceiling beam of the module below.

The three side beam arrangements, shown as module frames with the floor beam above and the ceiling beam below: the compound beam, considered but creating numerous issues; the 200mm beam with added posts; and the deep beam with a single post.

Each arrangement is grounded in the calculation package: the 200mm beam with added posts and the 500mm beam directly, and the compounded pair through the section properties of the 200 and 400 sections. The choice between them belongs with Sobha, taken together with the floor build up and the apartment layouts. Roof modules follow whichever arrangement is selected, using the existing 200mm beam as the roof side beam.

The Floor Build Up

Every beam and post argument above is eased by carrying less floor. The validated basis of the calculations is the MD60 composite deck, 130mm overall at 1.2mm gauge, spanning the 3.8m module width directly between the side beams with no joists at all. That remains the reference design.

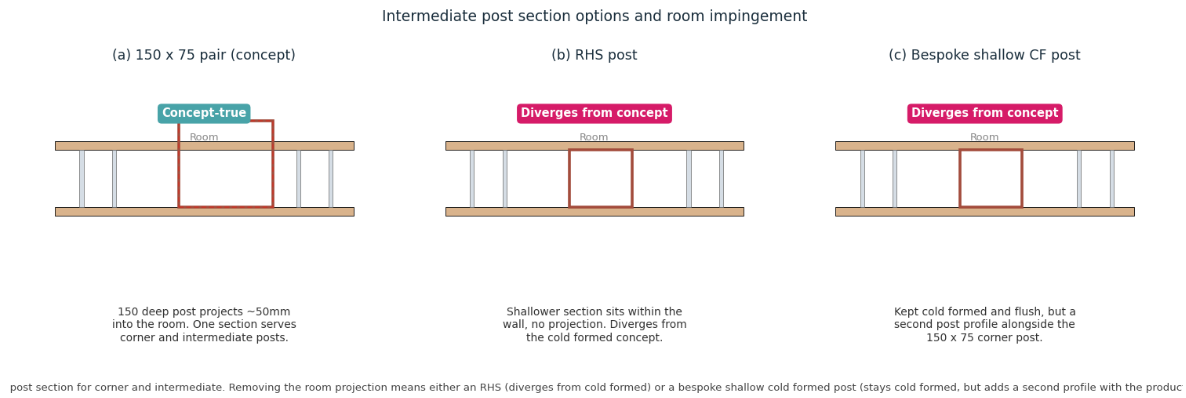
The lever worth holding alongside it is the Cellecta ScreedBoard 28 dry build up: a 28mm high density composite acoustic overlay board, 20mm high density gypsum over an 8mm resilient layer at 26 kg per square metre, laid on a steel joisted floor to the Cellecta FFT4 detail. With this build up the floor dead load falls to 1.075 kN per square metre and the dead load on each side beam falls from 5.70 to 2.04 kN per metre, roughly a two thirds reduction. The saving accumulates through every post down to the foundations, and it removes concrete curing from the factory takt entirely, which is a production gain as much as a structural one. The board also typically performs around 5dB better than the legislative acoustic requirement.

The figures quoted are derived from the product data; supporting calculations would be produced if the option is taken forward. The issue this resolves is the demand side of the beam and post design: a lighter floor lets the 200mm beam span further, reduces the load on every post, and eases the route to height before any section is changed. It combines naturally with any of the beam arrangements, and most powerfully with the compound beam, since the joisted dry floor and the compound fixing both live at the module interface.

The Intermediate Posts and the Room

The concept uses a single section, the 150 x 75, for both the corner posts and the intermediate posts, varied only by gauge. This is an elegant feature: one profile serves two roles, which is a real advantage in production, fewer profiles, fewer tool changes and a simpler section family.

The issue is that the 150mm post is deeper than the roughly 100mm wall, so it projects into the room by around 50mm. There are three ways to address this, and each carries a cost that should be weighed openly.



Intermediate post options in the wall. The concept 150 x 75 projects into the room; an RHS or a bespoke shallow section removes the projection, each with a consequence.

- An RHS post can be made shallower through the wall, so it sits flush and removes the projection entirely. It resolves the impingement outright. It diverges from the cold formed concept, introducing a hot rolled item into a cold formed system, which is why the concept has set it aside; it is recorded here as the cleanest geometric answer.
- A bespoke shallow cold formed post keeps the system cold formed and also sits flush. It stays true to the material of the concept. Its cost is that it is a second post profile: the corner posts remain the 150 x 75, and the intermediate posts become a different section, so the single section elegance is lost and a further profile, with its tool changes, enters production.
- Spreading the posts along the beam, as set out in the feasibility report, does not change their number but reduces the load arriving at each support line, with the gauge matched to position; it is the deeper beam and the alternative sections that reduce the count. The approaches are complementary.

There is no free answer here, and the paper does not pretend there is one. The choice is between accepting the projection to keep one section, changing the section to remove it, or reducing the number of posts. The right balance is a matter for the next stage, weighed against the apartment layouts.

Huck Fixings

The Huck Magna-Lok fixing is a blind structural fastener installed from one side. The pin is drawn, the collar swages permanently into the pin grooves, and the pintail breaks off at a set preload, so a correct installation is confirmed by eye and does not depend on torque discipline. The preload is mechanical and permanent, and it does not relax under transport vibration.

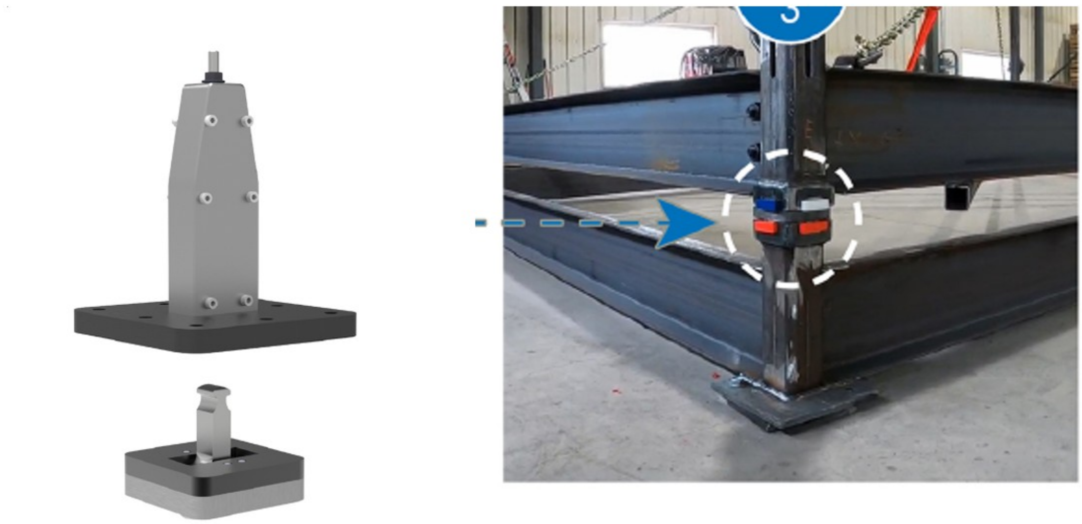
In this system the Huck fixing pairs naturally with the fabricated corner block developed in the feasibility report: a block folded or fabricated from plate accepts blind fixings through its faces, where a monolithic casting does not. In the factory it removes hot works and the post weld zinc repair that welding brings, with a fast cycle time; at the module to module interface it needs one sided access only and gives visual confirmation of a correct connection under site conditions.

The issue this resolves is the quality assurance and access side of the corner connection, and it supports the fabricated route to the corner block. It stays entirely within the concept: nothing about the sections or the block geometry changes, only the method of fixing.

The ARaymond Module Connector

The ARaymond module to module connector is a clip together device developed for industrialised construction, applicable to both hot rolled and cold formed structures. Modules engage vertically on landing: the connection is made by the act of placement, with no operative access and no tooling. The connector is concealed within the joint and can be disconnected for module relocation and connector reuse.

The L size connector suits columns from 68 x 68mm, with ultimate tensile resistance of 80 to 100 kN and ultimate shear resistance of 100 kN, quoted without safety factor, at a placement tolerance of plus or minus 3mm. An XL variant reaches 180 kN tensile and 150 kN shear.



(a) Connector pair: upper and lower units

(b) Installed at a module corner

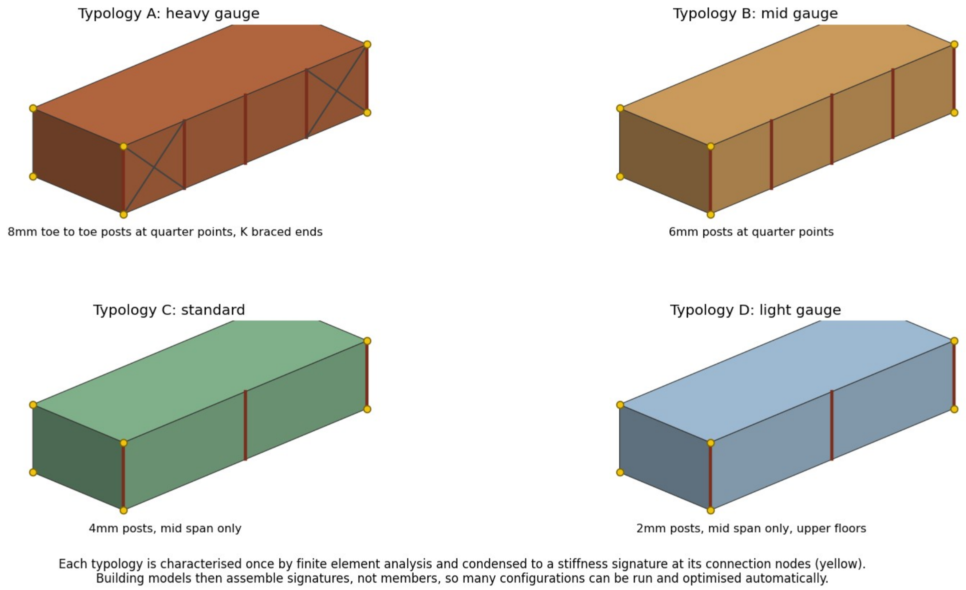
The ARaymond module to module connector. The connection is made by the act of placement, with no operative access.

The issue this resolves is site connection access at the corner: with the corner block, an operative must reach the joint, and with this device no access is needed at all. 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. It is a proprietary component rather than part of the concept, so it sits on the divergent side of the ledger, and the recommendation is to evaluate it at the next stage alongside the corner block approach and the fabrication of the posts, where the richest design for manufacture opportunities lie.

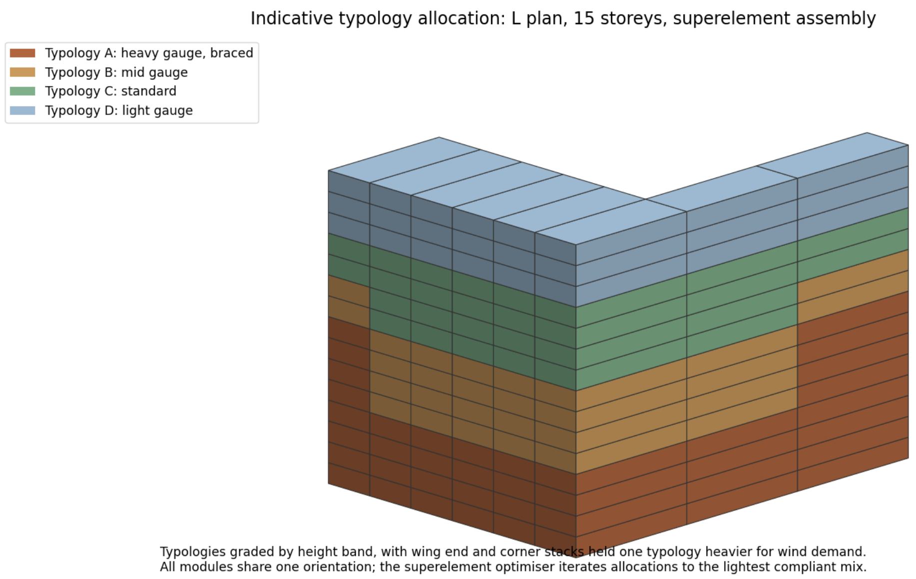
The Super Element Approach

As the building grows taller the variations multiply: post gauge layers through the height, the post count changes with the arrangement, and the racking strategy varies by position in the building. Rather than treating every variation as a one off, each combination is defined once as a typology, a standard module variant with a known structural character.

Each typology is characterised by finite element analysis and condensed to its stiffness signature at the connection nodes, the corner block positions where modules meet. The building model then assembles typology signatures rather than thousands of individual members, so a whole building configuration runs in seconds rather than days, and design automation can iterate typology allocations across a building, check displacements and forces at every node, and converge on the lightest compliant mix.



Module typologies, an indicative set. Each typology is condensed to a stiffness signature at its connection nodes.



Indicative typology allocation for an L plan building: heavier braced typologies at the lower floors and exposed corners, grading to light typologies at the top.

This is the link between a validated module and a repeatable production system: the factory produces a limited family of typologies, and the design system assembles them into any given building, plan or height. The issue it resolves is how the height range becomes designable and repeatable rather than a fresh engineering exercise per project. It is concept true in the fullest sense, since it changes nothing physical; it organises what the concept already provides. The typology library, the finite element condensation and the automation toolchain are next stage work.

A Note on the Manufacturing Route

Several of the options above, the deeper beam and the bespoke post in particular, depend on Sobha rolling their own sections. 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.

The delivery risk is worth stating plainly, as a friend of the project rather than a critic. Standing up roll forming for thicker bespoke sections is a substantial capital and process development in its own right. 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 those failures have left a lasting mark on the reputation of modular construction. The recommendation is not to temper 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. Each new bespoke section is also a new profile in the family, with its own tooling and changeover, so the number of bespoke sections is itself a thing to keep small.

On availability: the 400mm and 500mm deep sections are available today from UK specialist cold formed manufacturers, and both can be produced on Howick roll forming equipment available globally. Local rolling in the UAE or an import arrangement can both be evaluated, which is exactly the sequencing this note argues for: obtain the sections now, prove the product, and bring rolling in house as a controlled later step.

Proving the Options

Each option in this paper carries its own proof, and the pre prototype test programme in the feasibility report was framed with them in mind. The compound beam load test confirms the compound action of the bolted floor and ceiling pair against the calculated stiffness and capacity, and its measured performance may support value engineering of the sections. The module stacking test, two or three modules stacked and loaded with the posts and side beams instrumented, verifies corner block load transfer and stands behind the post arrangement whichever way it is taken. The corner block connection test takes vertical load and shear to characteristic failure and informs the tie force and the Huck fixing sizes. The flag plate racking test confirms the moment connection stiffness that the analysis assumes.

The point of listing them here is sequencing: whichever options Sobha carries forward from this paper, the matching tests move to the front of the programme, and the ones attached to options set aside fall away. The options and the test plan are the same decision seen from two sides.

Bringing It Together

The concept reaches thirteen storeys as it stands, and the feasibility report sets out the route to twenty. The options in this paper are ways of travelling that route more comfortably: a deeper beam, a compound floor and ceiling beam considered with its concerns, and a shallower or hot rolled post reduce the number and the intrusion of the intermediate posts; a lighter dry floor eases every member beneath it; Huck fixings and the ARaymond connector carry the connections; the super element approach turns the height range into a designable, repeatable system; and the manufacturing route is sequenced so the ambition is delivered rather than risked.

None of this is a fixed proposal. It is the set of levers the feasibility work has surfaced, laid out so that the next stage can balance the issues raised in the feasibility report against the solutions gathered here, and settle on the arrangement that best suits a specific building.

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