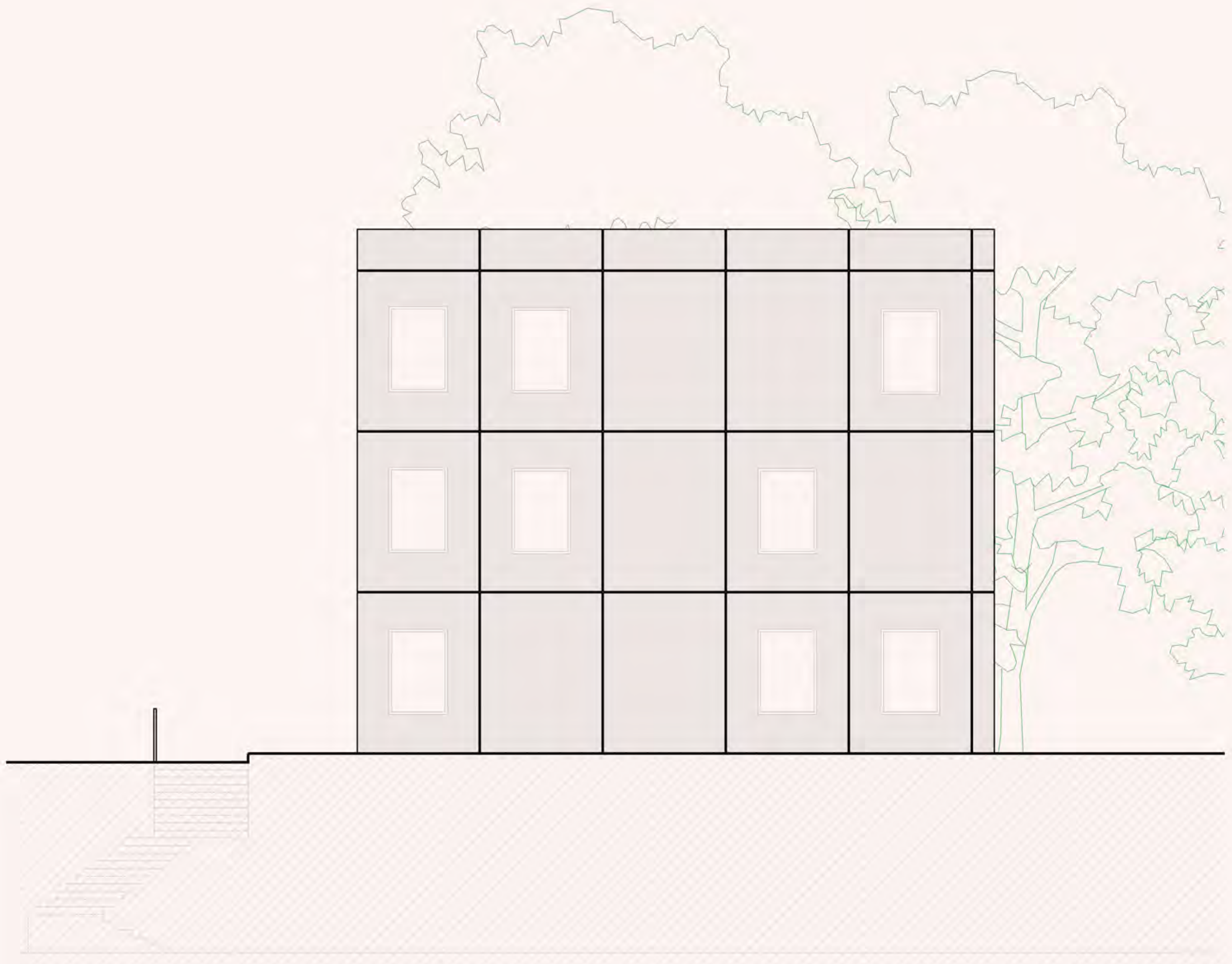
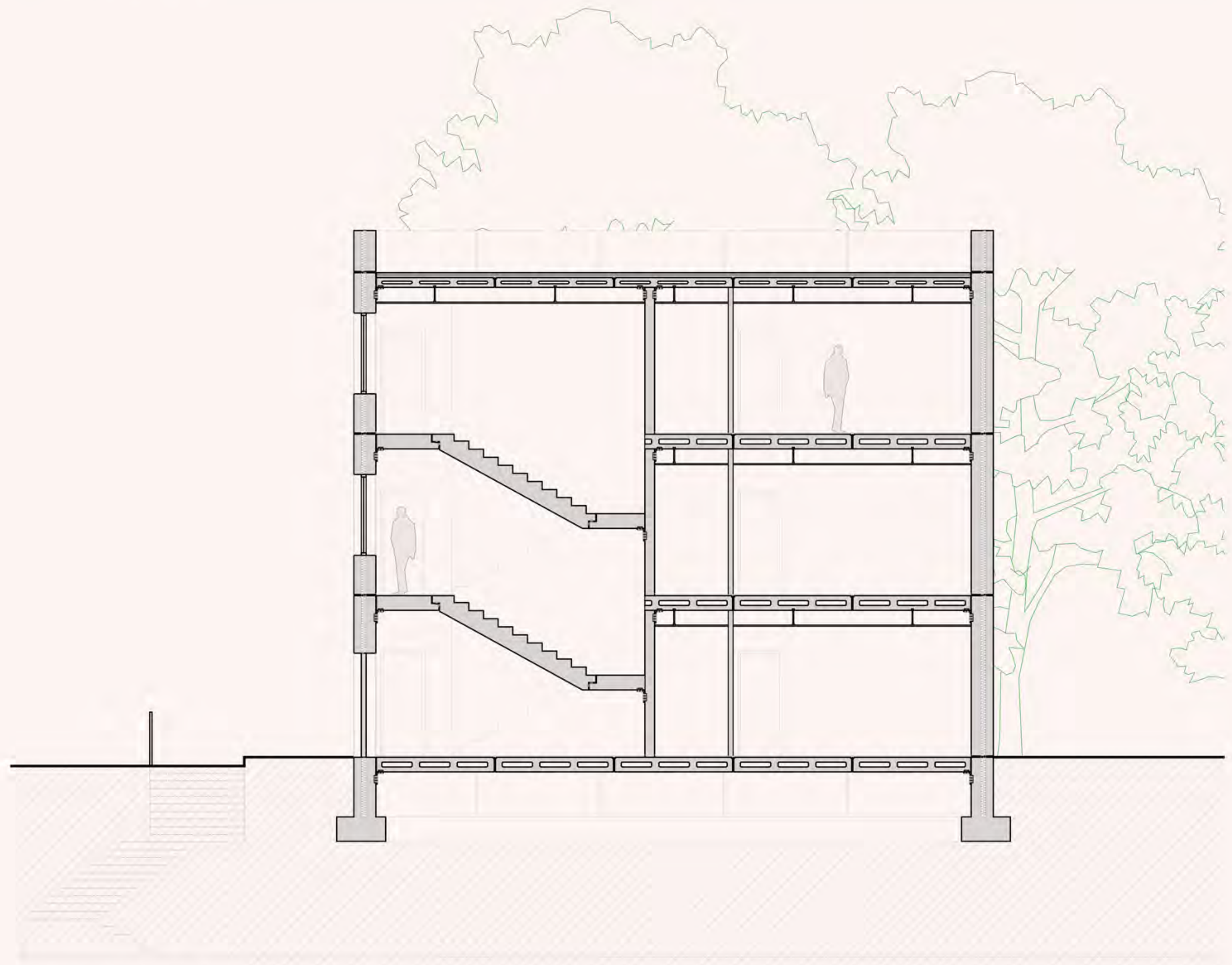


Proposed North Elevation
Scale 1:100



Proposed Section B-B
Scale 1:100

Design for Disassembly / Reuse

ID Code | AC724

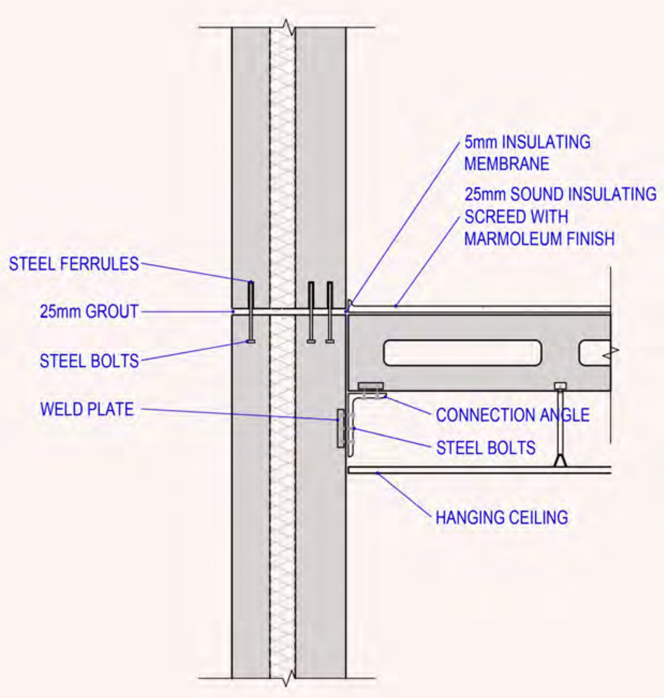
Introduction

This project sets out to investigate the design of a 3 storey, concrete office block which can be disassembled and re-used, after its proposed lifespan. The objective of my design is to create a building which can be reused for multiple different purposes during its lifespan and then be disassembled so that it's parts can be reused for a new building. This presentation shows how my design is flexible in use, how it is assembled / disassembled, and catalogues it's reusable parts.

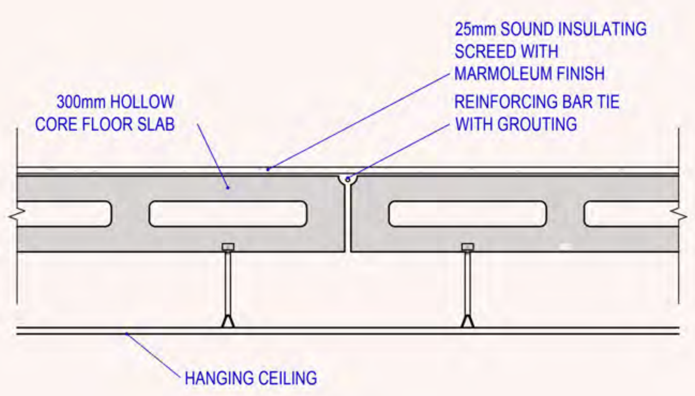
It is well known that concrete is not an environmentally friendly material to use in construction, given the CO_2 emissions released during manufacturing. However, it is less known that concrete absorbs CO_2 and embodies it. When structures are dismantled and broken up, the embodied CO_2 is released back into the atmosphere. A solution to this is Design for Disassembly (DfD) and Design for Reuse (DfR). Elements of DfD and DfR buildings can be disassembled and reused for future buildings, in an environmentally friendly way. DfD and DfR are not only environmentally friendly, but are more cost and time efficient too. 'Reusing concrete panels from buildings for buildings: Potential in Finnish 1970s mass housing' by J.H. Hakanen, S. Huuhka, T. Kaasalainen & J. Lahdensivu, 2015) investigates the scope for reuse of precast concrete panels, in Finland. The report aims to identify what parts of existing housing blocks were prefabricated, and to what extent, whether there were recurring panels, and whether existing panels were suitable to be used in new construction projects. The report's main conclusion was that although there were recurring panels which could be reused, the dimensions no longer met regulation dimensions and therefore weren't appropriate to be reused for apartment buildings. They could however be reused for different building types, such as detached houses. The research found that panels from one typical block of flats could provide precast panels to make 9 detached houses. It was also found that the building stock that was erected in the 1970s, in Finland, could provide for almost 108,000 detached houses.
Design for Disassembly (DfD) and Design for Reuse (DfR) are techniques used in building design, which aim to reduce the environmental impact on the world. DfD and DfR minimizes the amount of waste material that a building produces at the end of it's life span. As well as cutting down on material waste, DfD andDfR reduces labor time and is overall more cost effective. DfD and DfR seem to be the way to go for a cleaner, more environmentally friendly future in construction.
The potential of DfD and DfR is clear from the research paper discussed previously. It would reduce the demand for new concrete to be manufactured, dramatically decreasing CO_2 emissions within the construction industry.

Construction Type

The building is a tilt-up structure at ground floor level. The tilt-up construction process involves the precast concrete walls, whichare laid flat on the ground, being tilted up vertically into position. Once in position, the walls are temporarily braced to the ground until they are tied together.This construction method is extremely efficient in terms of time, cost, and energy. The walls of the upper floors slot onto the wall panels below, connected with steel ferrules; one on the exterior leaf and two on the interior leaf.
The load bearing walls are fastened together with steel plates, which are attached with steel bolts. The floor plates are bolted to the load bearing walls using a steel connection angle. The connection angles are hidden by a hanging ceiling which is attached to the concrete floor slab above. The hanging ceiling allows the concrete on the underside of the floor slab to be left exposed to the air, which allows the concrete to absorb more CO_2.
The simple construction allows for easy disassembly after the life span of the building.

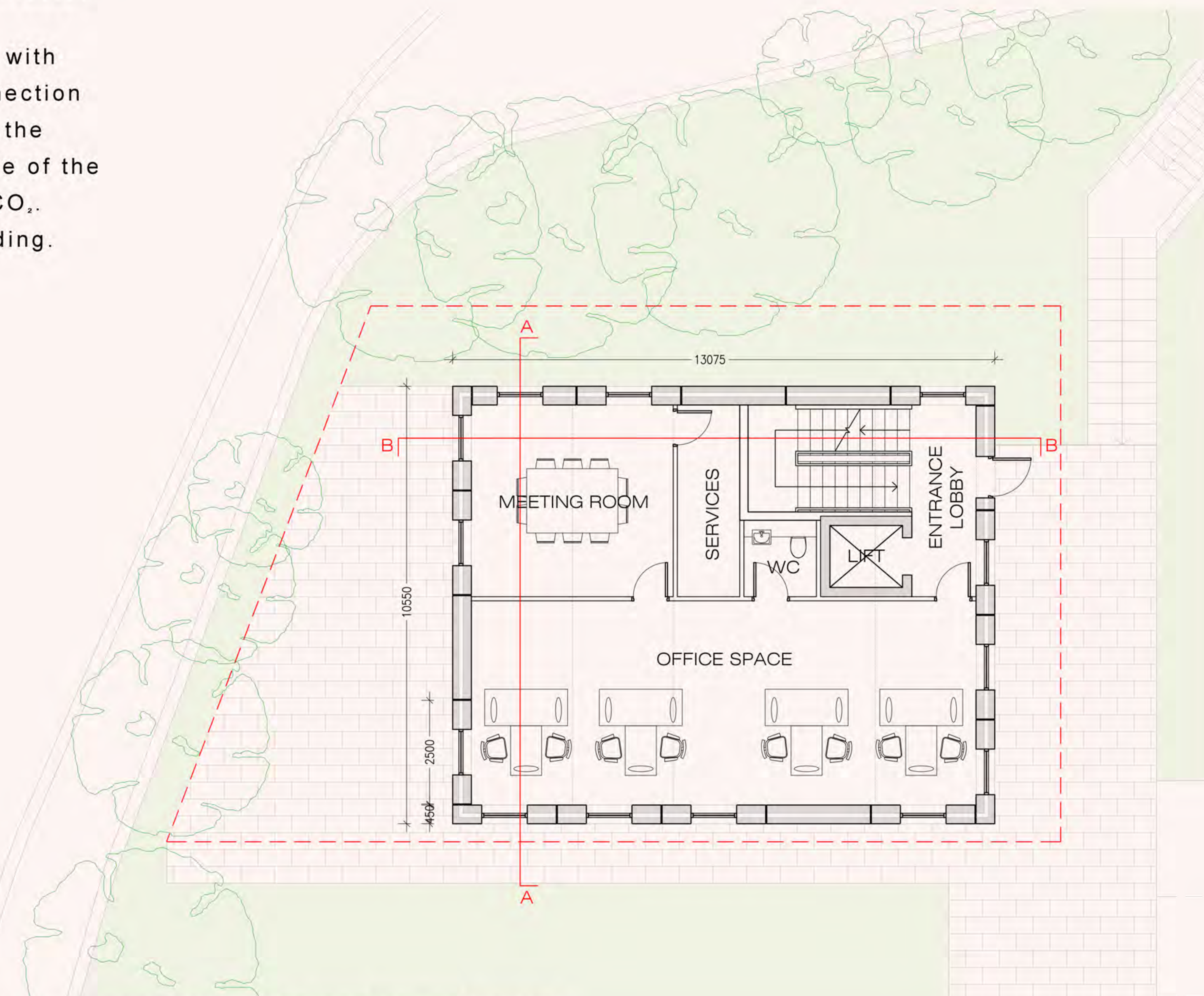


Precast Hollowcore Floor - Wall Section



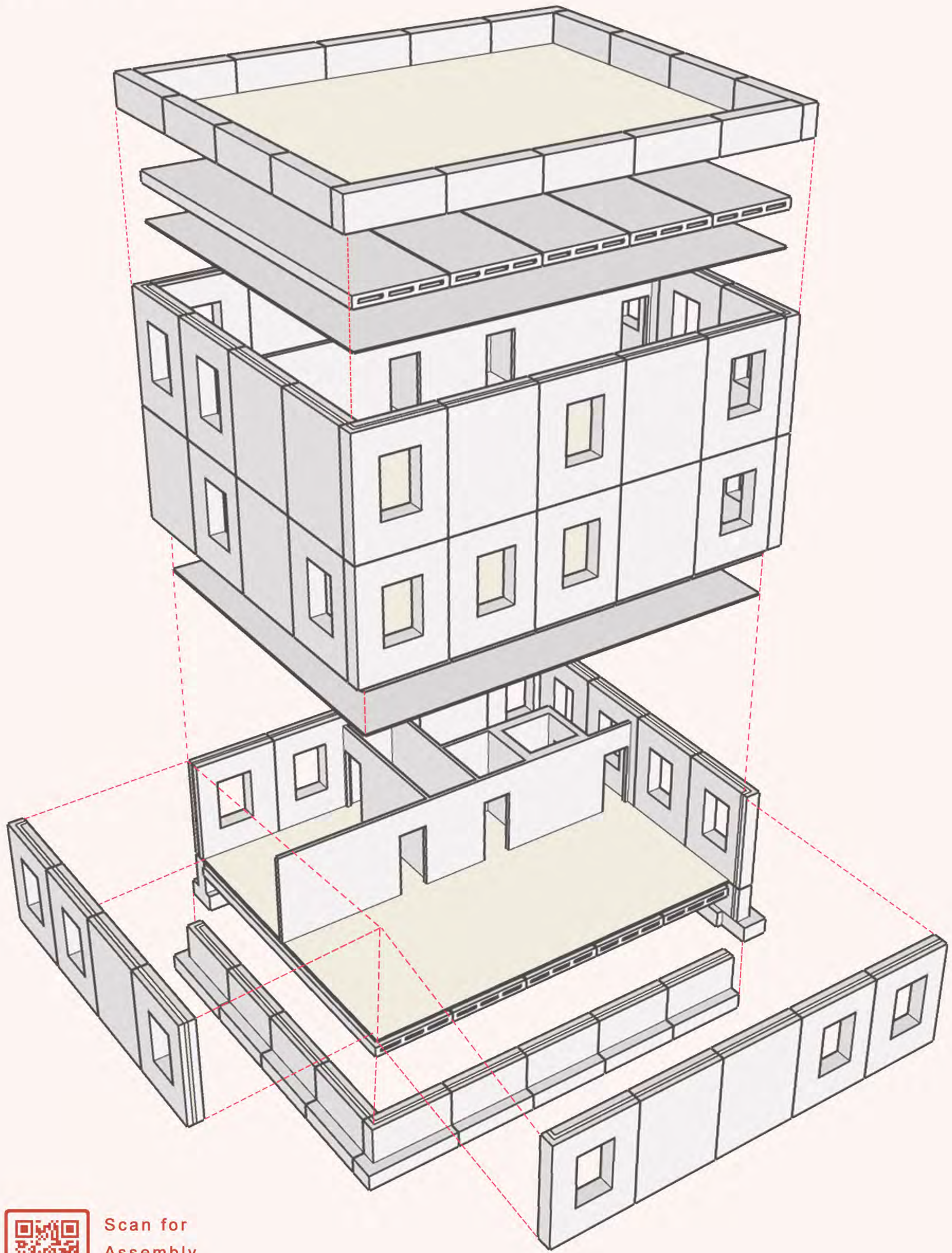
Precast Hollowcore Floor - Floor Section

Scale 1:25



Proposed Ground Floor Plan in Context
Office Layout
Scale 1:100

Exploded Axonometric



Scan for Assembly Animation

Design for Disassembly / Reuse

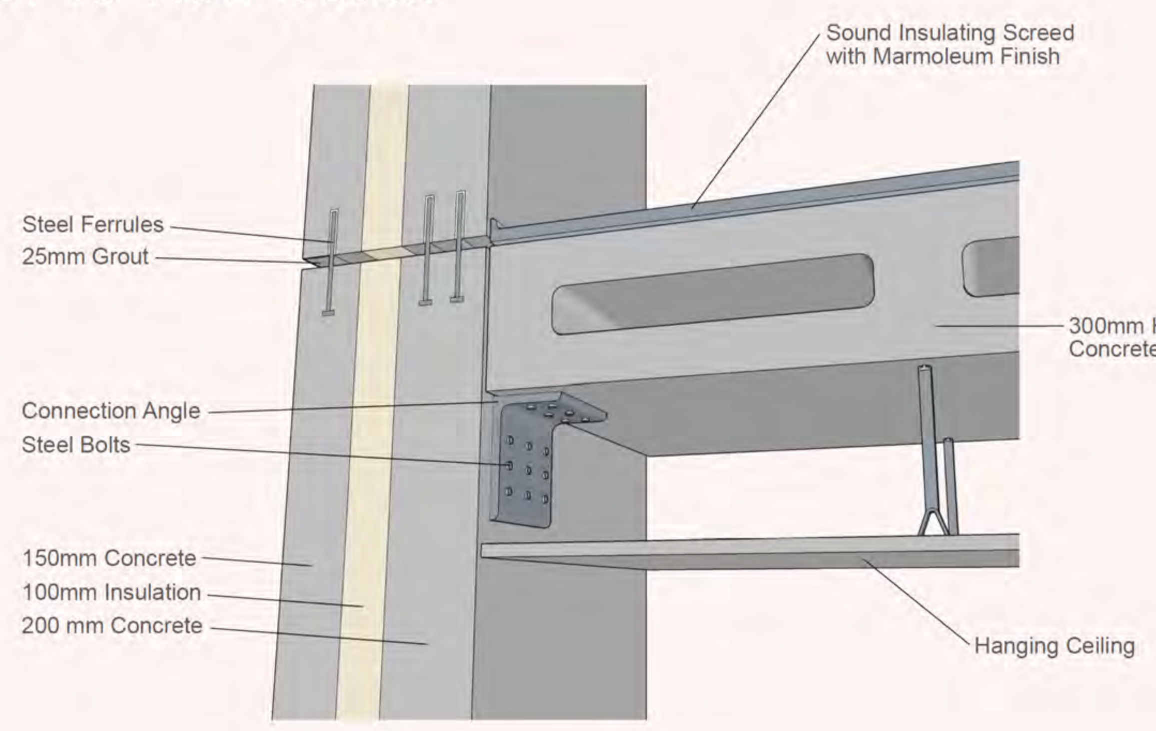
ID Code | AC724

Assembly Plan

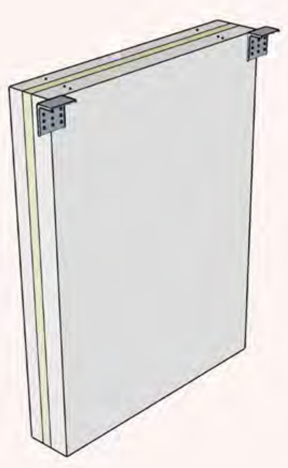
1. Foundation blocks are laid
2. Blocks are fastened together with connection angles
3. Precast hollow-core concrete floor slabs are laid on top
4. Tilt-up walls are lifted into position and braced in sequence
5. Wall panels are fastened together with connection angles
6. Bracing is removed
7. Internal walls are built
8. Upper hollow-core concrete floor slabs are bolted to connection angles
9. Hanging ceiling is bolted to underside of floor slabs
10. Upper pre-cast concrete sandwich wall panels and lifted into place, connected to lower panels with steel ferrules
11. The process is repeated for upper floors
12. Concrete parapets are attached to the walls below with the same ferrule method as the walls
13. An external epoxy roof finish is used on the roof
14. All internal floors are finished with a soundproof insulator and marmoleum flooring

Note : Disassembly of the building is carried out in reverse order, ensuring a soft strip of the building happens prior, and material are recycled / disposed of appropriately. All grouting to be knocked out before connection angles are unbolted

Floor to Wall Detail



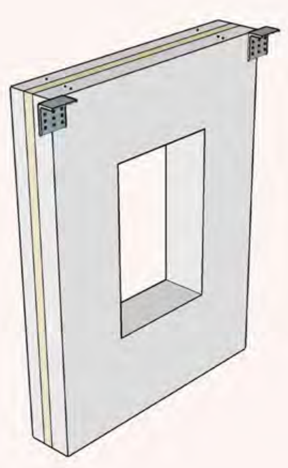
Reusable Parts Inventory



Wall Panel
no opes

3275 x 2500mm

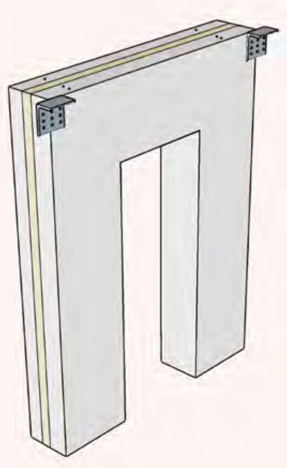
Qty: 17



Wall Panel
w/ window ope

3275 x 2500mm

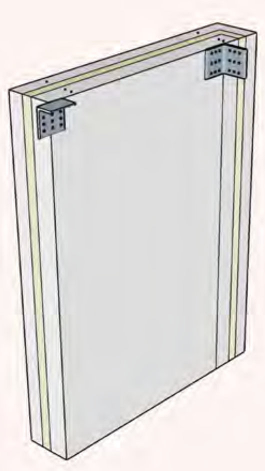
Qty: 17



Wall Panel
w/ door ope

3275 x 2500mm

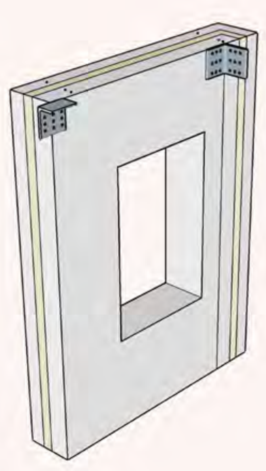
Qty: 1



Wall Panel
corner

3275 x 2500mm

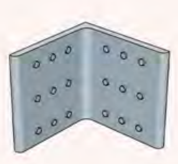
Qty: 1



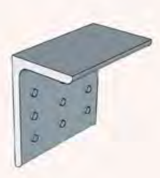
Wall Panel
corner w/ window ope

3275 x 2500mm

Qty: 11

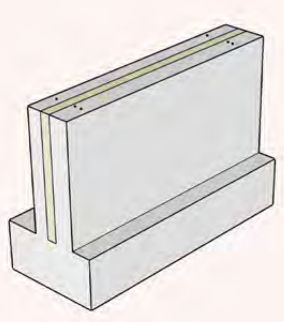


Steel Angle 1
Qty: 16



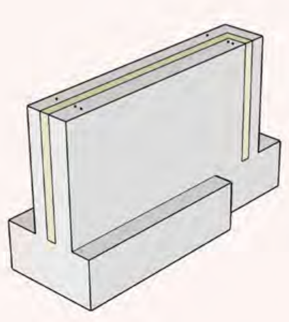
Steel Angle 2
Qty: 60

Steel Bolt
Qty: 1128



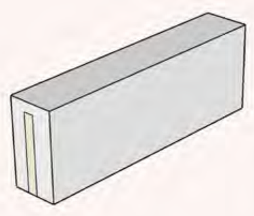
Foundation
side

Qty: 14



Foundation
corner

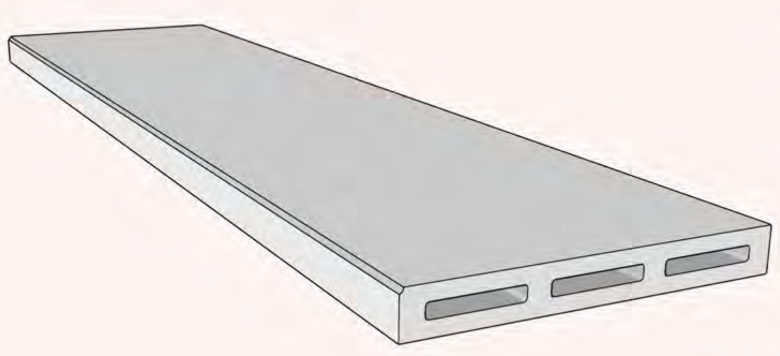
Qty: 4



Parapet

850 x 2500mm

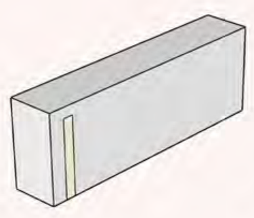
Qty: 14



Floor Slab

12,175 x 9650mm

Qty: 20



Parapet
corner

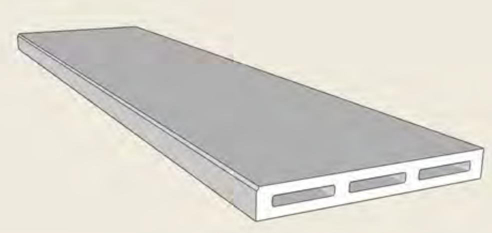
850 x 2500mm

Qty: 4

Material Passport

Element	Precast Concrete Floor Slab
Material	Reinforced Concrete
Product Type	CEM 1 - Ordinary Portland Cement
Strength Class	C25/30
Mass of Cement Clinker per m^3 Concrete	270
Mass Fraction of CaO in Clinker	0.65
Key Dimensions	9.65m x 12.175m x 0.3 m
Connection Type	Floor to Wall
Fastener System	Bolted Connection Angles
Lifespan	50-100 years
Fire Rating	Class A1
Thermal Conductivity	0.4 W/mK

Element Image



Carbonation Calculator

Element	Cement Type (influences correction factor depending on cement additives)	Strength Class (based on use - see Tab 2)	Mass of cement clinker per m3 concrete based on strength class (See Tab 2)	Percentage of alternative cementitious material based on cement type (See Tab 1)	Mass of Portland Cement Clinker (assumming CEM I = 95% Portland Cement) Cc = C - (C x (AC/100))	Mass fraction of CaO in clinker	Exposure (see Tab 3)	Carbonation rate (CEM1) based on strength and exposure mm/year (see Tab 3)	Correction Factor to CEM1 rate based on cement additives (see Tab 4)	Corrected carbonation rate	Degree of Carbonation (from Tab 3)	Maximum Theorectical CO2 Uptake [from EN 16757] kgCO2/kg (Portland cement in CEMI is 0.95) Utcc= (0.95 - (AC/100)) x CaO x (Mco2/MCaO)	Time (in years)	Depth of Carbonation mm d = Kc x (√T)	Estimated CO2 uptake kg/m2 during T years CO2/m2 = ((d/1000) x Utcc x C x Dc)	Surface area (m2)	CO2 sequestered CO2kg/element = a x CO2kg/m2
			C	AC	Cc	CaO		k	f	Kc = k[f]	Dc	Utcc	T	d	CO2kg/m2	a	CO2 kg / element
Exterior Exposed	CEM I, Ordinary Portland Cement (OPC)	C25/30	270	0	270	0.65	Outdoor Exposed	1.6	1	1.6	0.85	0.48	1	1.6	0.18	431.4	76.77
Exterior Covered	CEM I, Ordinary Portland Cement (OPC)	C25/30	270	0	270	0.65	Outdoor Sheltered	4.4	1	4.4	0.75	0.48	1	4.4	0.43	117.5	50.74
Interior Exposed	CEM I, Ordinary Portland Cement (OPC)	C25/30	270	0	270	0.65	Inside without cover	6.6	1	6.6	0.4	0.48	1	6.6	0.35	666	230.06
Interior Covered	CEM I, Ordinary Portland Cement (OPC)	C25/30	270	0	270	0.65	Inside with cover***	4.6	1	4.6	0.4	0.48	1	4.6	0.24	352.5	84.87
Buried	CEM I, Ordinary Portland Cement (OPC)	C25/30	270	0	270	0.65	In Ground*	0.8	1	0.8	0.85	0.48	1	0.8	0.09	203.3	18.09
Total																	460.52

Total CO^2 embodied after 1 year = 460.5 kg

Total CO^2 embodied after 50 years = 3256.4 kg