

21-2135

North Manchester General Hospital

Generator Extension Building

for

**Manchester University NHS Foundation
Trust**



**Stage 3 Design Commentary /
Report (Option H)**

Suite 2, 1st Floor, XYZ Building
2 Hardman Boulevard, Spinningfields
Manchester
M3 3AQ

(Tel): 0161 832 2274

(E-mail): info@ccs-consulting.co.uk

(Web): www.ccs-consulting.co.uk

Prepared by Yannis Angelidis

Authorised by Lee Coverley

Issued by Lee Coverley

Rev A

Date 28/10/22

Rev:	Revised for:	Issue date:	Prepared by:	Authorised by:
-	Original Issue	18/10/22	YA	LDC
A	Revised to Include 3 rd Party Information in Appendices & Update External Slab Specification	28/10/22	YA	LDC

Prepared by,



Yannis Angelidis
Senior Engineer – Structural / Civil Engineering
Yannis.Angelidis@ccs-consulting.co.uk
(t) 0113 532 6988

For and on behalf of CCS Consulting Limited

Approved by,



Lee Coverley
Director - Structural/Civil Engineering
B.Eng (Hons), C.Eng, MStructE
Lee.Coverley@ccs-consulting.co.uk
(t) 0161 832 2274
(m) 07970 978 317

List of Contents

1	Executive Summary	4	5.1	Introduction	11
1.1	Structural Engineering	4	5.2	Design Standards and Guidance	11
1.2	Geotechnical Engineering	4	5.3	Approvals and Agreements	11
1.3	Civil Engineering.....	4	5.4	Underground Pipework.....	11
2	Introduction.....	5	5.5	Manholes, Covers and Inspection Chambers	11
3	General Site Information.....	5	5.6	Design Life.....	11
3.1	Site Location	5	5.7	Drainage Strategy	11
3.2	Site constraints	6	Appendix A – CCS Consulting Stage 3 Proposed Steelwork Information	12	
4	Structural Engineering.....	7	Appendix B – CCS Consulting Stage 3 General Arrangements.....	22	
4.1	Structural solution	7	Appendix C – Supporting Information	24	
4.2	Steel Frame	7			
4.3	Slab Construction	7			
4.4	Foundations	8			
4.5	Robustness and Disproportionate Collapse	8			
4.6	Fire resistance	9			
4.7	Fuel Tank Considerations	9			
4.8	Stairs	9			
4.9	Design life	9			
4.10	Design Assumptions.....	9			
4.11	Codes of practice.....	10			
4.12	Displacements.....	10			
5	Civil Engineering	11			

List of Photographs / Reference Images

Image 1: Ground Floor Plan: DAY Architectural 5

Image 2: Site Location; source: Google Earth 5

Image 3: Proposed Building Outline on GPR Survey Extract 6

Image 4: Typical MD146 construction in-situ slab 7

Image 5: Proposed Ground Floor/Foundation Plan 8

Image 6: Extract of Table 11 from the Building Regulations Approved Document A 2013 8

Image 7: Design Standards and Codes of Practice. 10

1 Executive Summary

1.1 Structural Engineering

The following report is based on the agreed “Option H” proposals from DAY Architectural. The proposals are for a single storey scheme with a flat roof and associated upstand parapet. The building is to be used to house a range of plant and ancillary elements, and as such the structure is to be designed for general plant loadings accordingly. The design accounts for a future lightweight rooftop extension. This is considered in the design of superstructure and substructure (foundations).

It is suggested that the structure will be a braced steel frame. This allows for large areas of open spans and clear headroom as required from the services Engineers’ proposals, whilst also offering robust support to large span floors and heavier walls which are generally commonplace in schemes of this nature.

The superstructure is to be a braced steel frame, with composite steel beams and a 215mm overall depth profiled metal deck (Kingspan MD146) composite concrete floor slab with a power floated finish.

The stability of the frame will be achieved by utilising vertical bracing bays and one number portalised bay, which will be strategically located around the building; coordinated with the architectural and services layouts and requirements.

It is anticipated that all walls (internal and external) will be traditional masonry construction (combination of block and brick), with the architectural cladding at first floor level off a bespoke secondary framework (tbc for the future phase if required).

The construction and layout of the roof is to cater for future plant space, and as so will comprise a composite concrete slab. The roof is to be waterproofed by means of liquid applied waterproof membrane.

1.2 Geotechnical Engineering

A detailed Phase II geotechnical site investigation has been undertaken by *Ground Consult* to determine the underlying strata and ground bearing capacity. The report concludes the geotechnical testing results; foundation and ground floor slab recommendations; contaminant results; and the ground gas monitoring results. Refer to Appendix B for the complete Phase II SI report by *Ground Consult*.

Trial pits found made ground to be maximum depth of 2.0m below ground level with two main natural stratifications below: medium dense slightly gravelly silty sand deposits and stiff grey slightly gravelly silty clay. Groundwater strike was encountered at 3.0m bgl.

Due to the proposed loads and the geo-technical results, a mini-piled foundation solution is required to ensure satisfactory structural integrity of the building. Reinforced Concrete ground beams are proposed between piles to support the infill masonry cavity walls.

1.3 Civil Engineering

It has not been advised whether the Planning Application requires a Surface Water Management Plan and outline SuDS drainage design. As such, it is proposed that CCS provide an effective traditional (i.e. not SuDS) drainage strategy for both surface and foul water systems to tie into the nearest existing drainage runs.

A CCTV Survey by Drain Doctor has been completed to determine the suitability of the existing on-site drainage network. All existing networks were deemed in good condition and in line with the arrangement from the GPR arrangement. Primary runs are not affected by the proposed layouts, therefore tributary drain runs from the new building will seek to interface with the existing manhole primary positions.

The current proposal requires surface water drainage only, as there are no foul provision of soil vent pipes (SVP) within the building.

2 Introduction

CCS Consulting Ltd has been appointed by Manchester University NHS Foundation Trust to undertake the structural design of the proposed Generator Extension building at North Manchester General Hospital (latest Option H proposals from DAY Architectural)

The proposed new building consists of one storey to be used to house the relevant M&E plant as identified in SI Sealy's design information. The proposed building is circa 12.0m by 12.5m (max) with a clear internal height requirement of 6m. The fuel tank is to be located externally, on a raised concrete plinth - with a canopy over to provide shelter. The fuel tank is to incorporate in-built bunding and as such no external bund / associated drainage protection measures are required.

The internal ground floor and external slab below the fuel tank are to be designed for 25 kN/m² imposed loading. To allow for a future rooftop extension to the building, the roof is designed to accommodate general plant loadings (7.5kN/m²) as per Eurocode requirements. Architectural Planning drawings have been provided by DAY Architectural which detail the proposal.

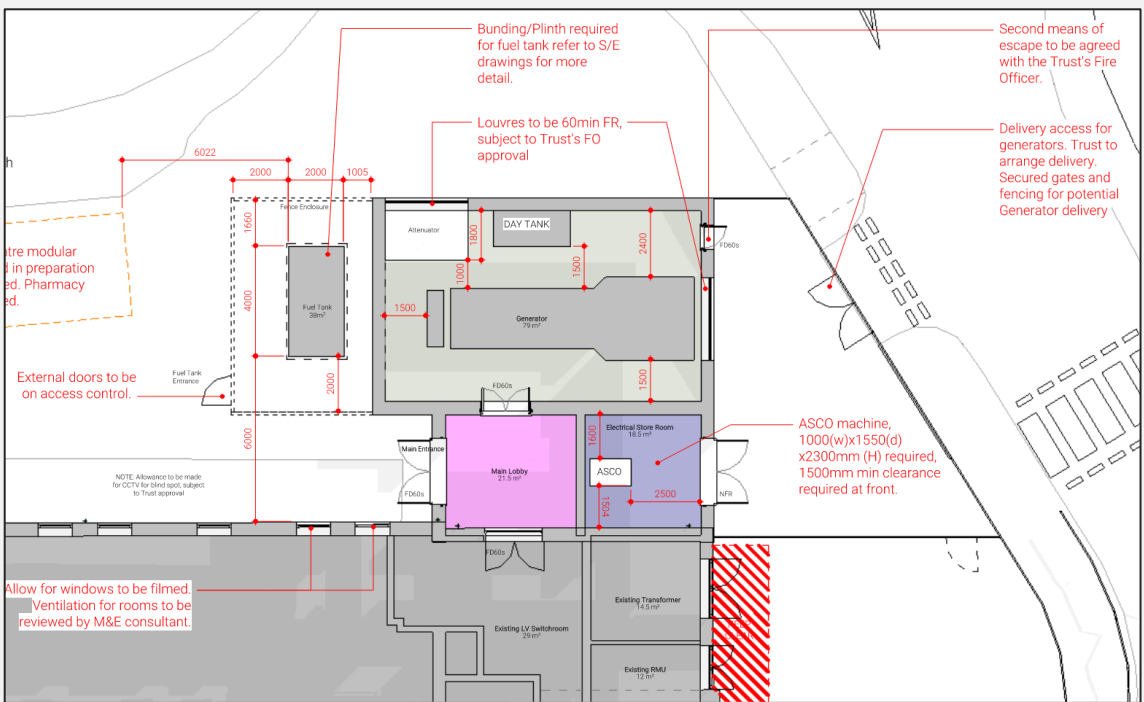


Image 1: Ground Floor Plan: DAY Architectural

CCS Consulting Ltd are requested to identify appropriate construction methods for the building, to develop the cost model and architectural coordination during the Planning phase. DAY Architect plans (Option H) have been received which indicate the general layout of the proposed building and proximity to the adjacent hospital building.

3 General Site Information

3.1 Site Location

The site is located at the entrance to North Manchester General Hospital, which is located Crumpsall, M8 5RB (Greater Manchester). The surrounding area is noted as predominantly residential use.

The access to the site is currently from the Delaunays Rd onto Central Drive and the new scheme will retain this access, with a few minor architectural changes local to the proposed building.

The levels around the site currently range between 66.30m AOD at the entrance of the site and 66.84m AOD at the interface of the existing buildings. Although the proposed levels will not vary significantly from the existing, the site entrance, removal of trees and potential drain diversions, will require greater degrees of remodelling / spoil removal from site.

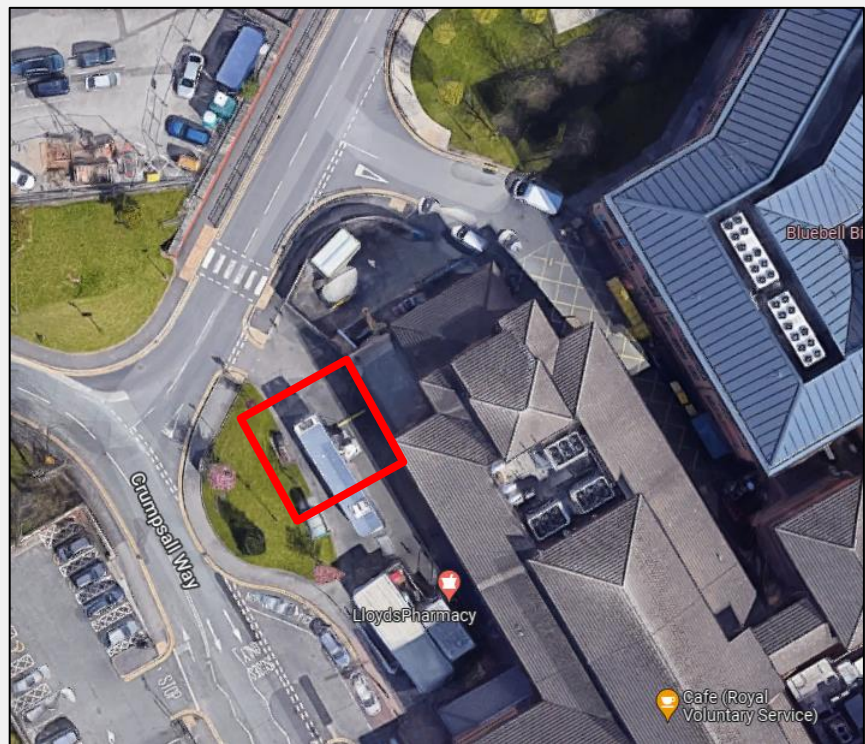


Image 2: Site Location; source: Google Earth

3.2 Site constraints

Attention should be paid during the foundation excavations to ensure the surrounding building will not be adversely affected, due to ground & foundation settlement that could create structural problems. Pre-commencement surveys (photograph records) are therefore advised. The ground works contractor should provide the design team and the client with a suitable method statement detailing the temporary works strategy for the site. Any new foundations are to be located away from the immediate building edge, with cantilever ground beams accordingly to interface with the adjacent structure.

The site is currently occupied with general circulation areas, and a bus drop-off. All services in the area should be fully investigated to ensure that residual live services (gas, electricity, water, drainage, telecoms) which may be passing through the site are redundant. A GPR survey has been undertaken which has identified services on site. On the below GPR survey extract the approximate extent of the proposed structure (including the potential canopy) is outlined.

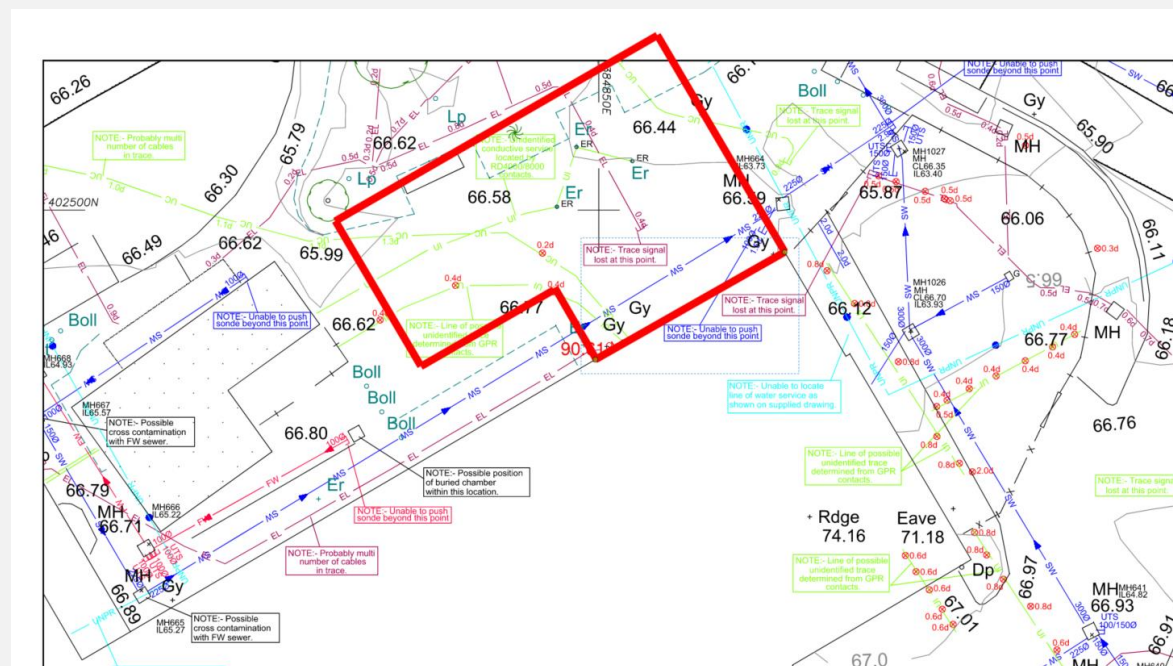


Image 3: Proposed Building Outline on GPR Survey Extract

Several services are likely to be affected by the proposed works, these are as follows:

- Unidentified cables,
- Electric cable,
- Surface water sewer.

Further investigation is required to confirm which of the above are live. Subject to findings diversions may be required to enable construction of proposed structure.

A method statement from all the contractors incorporating any CAT scan / final confirmatory surveys should be included for, and will be required to protect them from the site operations during the construction of the new building.

A Phase 2 Geotechnical site investigation has been undertaken for the area, so that the most appropriate foundation solution can be established and designed. Ground water is identified at 3m below ground level, with no reports of ground gas. No influence of tree roots are noted within the report.

4 Structural Engineering

CCS Consulting have suggested the construction method for the building as a steel frame with beams / composite decking. Areas of either (flat bars) bracing, together with portalised bays (for access) will be incorporated to achieve building stability.

4.1 Structural solution

The architectural and services Engineers' requirements / design parameters for the scheme have been considered, and it is suggested that the proposal will allow the construction to be robust, whilst allowing for the required "plant loading" to be achieved to all floor / roof areas in the future. The consistency of a steel frame, across the entire building, will minimize the risk of differential deflections and cracking.

It is anticipated that the ground floor will be detailed and constructed using reinforced concrete ground bearing slabs on compacted MOT Type-1 sub-base, with the made ground removed and replaced with compacted fill materials (6F2 / MOT-1 upper layers). The roof slab will be formed using deep-troughed composite profiled metal decking (Kingspan MD 146 or similar); supported off composite steel beams. This minimises the requirement for internal supports and enables the M&E access zones to be achieved, and allows for the potential future vertical extension of the building.

This will satisfy the architectural criteria of the building whilst still maximizing the available space for the servicing zones around the proposed plant areas.

4.2 Steel Frame

The proposed steel frame design considers full area plant loading (7.50 kN/m²) at roof level). The roof edge beams are also designed to support 4.6m of 140mm blockwork. To satisfy plant height requirements and clearance at ground floor level, the minimum clear height from GF FFL to underside of roof structure is assumed to be 6m.

Proposed steel beams span a maximum distance of 7.2m achieve the required open plan arrangement. Due to the large span and considerable plant loading, composite steel construction is adopted to reduce steel weight and deflection. The edge beams and framing steelwork are to be grade S355 UB beams sections. All columns are to be grade S355 UB column sections. No allowance has been made for trimmers around risers, access rooflights and air inlet voids.

Lateral stability of the steel frame is to be achieved by utilisation of numerous vertical bracing bays and moment/portal sway frames. The location and detailing is subject to the architectural requirements, openings, and layouts. Stability bays are to be cross-braced bays fabricated from grade S275 flat bars. Due to access / maintenance restraints, bracing cannot be installed along the east elevation, therefore, a portalised bay is required to laterally restrain this elevation. To keep sway within the acceptable limits on this plane an additional vertical bracing bay has been introduced; this is to be located in the cavity of the division wall between the main lobby and the electrical store room.

Refer to Appendix A for Tekla Structural Designer Extracts. 3D views along with plans and sections indicating steelwork details have been included.

4.3 Slab Construction

Ground Floor construction is to be a 175mm deep ground bearing slab designed for 25 kN/m² imposed load. A power float finish is recommended to provide a more durable and crack resistant slab, suitable for high plant loads. Movement joints are to be installed at circa 6m centres to mitigate cracking.

Subject to geotechnical findings, the ground bearing slab is to be constructed onto minimum 300mm thick MOT Type 01 to be laid in maximum 150mm thick well compacted layers over 6F2 material (to suitable depth).

The proposed slab construction for the roof is to be a 215mm deep heavy-duty composite metal profile deck (Kingspan MD-146) coupled with top reinforcement and C28/35 grade concrete. The above metal deck type has been specified to mitigate the requirement for propping during construction and therefore to be reduce risk of bowing. Shear studs are required to ensure robust fixity between slab and steel beams



Image 4: Typical MD146 construction in-situ slab

4.4 Foundations

Based on the limited information at this stage (and from geotechnical phase 2 report / BGS Data), the preferred structural solution for the foundations of the building will be a combination of piles with suspended ground beams and ground bearing slabs.

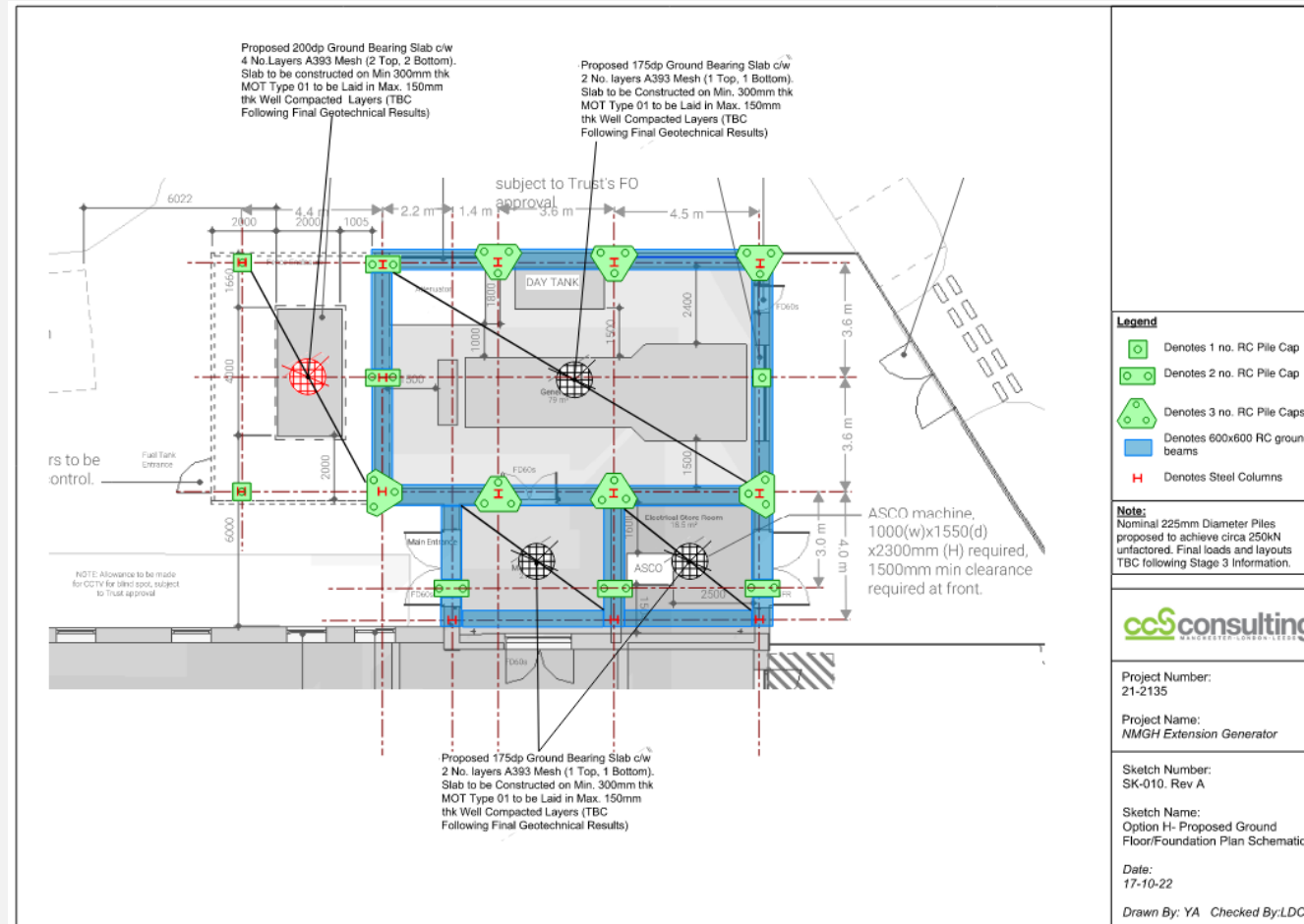


Image 5: Proposed Ground Floor/Foundation Plan

Piles are located at all column positions and at mid-span between columns with long spanning ground beams. Two-pile & three-pile caps are proposed in the current arrangement, dictated by proposed loads and the assumed pile capacity. Piles are indicated as 225mm diameter pile with a maximum capacity of circa 250kN (unfactored).

The finalised pile designs are to be completed by a specialist piling sub-contractor.

Reinforced Concrete ground beams are designed to support the proposed masonry cavity wall around the perimeter of the building and internal blockwork walls. Ground beams support the external brickwork leaf to full height (circa 12.5m) and all blockwork (internal leaf and internal walls) to u/s first floor level only (circa 6.5m).

All other internal blockwork walls without ground beam below are to be built onto/supported by the ground bearing/suspended slab.

For costing purposes, estimated typical reinforcement quantities for RC pile caps and ground beams are 115kg/m³ and 230kg/m³, respectively.

4.5 Robustness and Disproportionate Collapse

In order to prevent brittle failure or sudden collapse of any part of the building, the structure will be designed to comply with the robustness requirements of Eurocode BS EN 1991-1-7.

In accordance with the Table 11 of the code, the proposed structure is considered to fall under the Building Consequence Class 1.

Table 11 Building consequence classes	
Consequence Classes	Building type and occupancy
1	Houses not exceeding 4 storeys Agricultural buildings Buildings into which people rarely go, provided no part of the building is closer to another building, or area where people do go, than a distance of 1.5 times the building height
2a Lower Risk Group	5 storey single occupancy houses Hotels not exceeding 4 storeys Flats, apartments and other residential buildings not exceeding 4 storeys Offices not exceeding 4 storeys Industrial buildings not exceeding 3 storeys Retailing premises not exceeding 3 storeys of less than 2000m ² floor area in each storey Single-storey educational buildings All buildings not exceeding 2 storeys to which members of the public are admitted and which contain floor areas not exceeding 2000m ² at each storey
2b Upper Risk Group	Hotels, blocks of flats, apartments and other residential buildings greater than 4 storeys but not exceeding 15 storeys Educational buildings greater than 1 storey but not exceeding 15 storeys Retailing premises greater than 3 storeys but not exceeding 15 storeys Hospitals not exceeding 3 storeys Offices greater than 4 storeys but not exceeding 15 storeys All buildings to which members of the public are admitted which contain floor areas exceeding 2000m ² but less than 5000m ² at each storey Car parking not exceeding 6 storeys
3	All buildings defined above as Consequence Class 2a and 2b that exceed the limits on area and/or number of storeys Grandstands accommodating more than 5000 spectators Buildings containing hazardous substances and/or processes
Notes: - For buildings intended for more than one type of use the Consequence Class should be that pertaining to the most onerous type. - In determining the number of storeys in a building, basement storeys may be excluded provided such basement storeys fulfil the robustness requirements of Consequence Class 2b buildings. - BS EN 1991-1-7:2006 with its UK National Annex also provides guidance that is comparable to Table 11.	

Image 6: Extract of Table 11 from the Building Regulations Approved Document A 2013

4.6 Fire resistance

It is anticipated that the Fire resistance criteria for this building would be R60 (60 mins) – to be confirmed.

Across the building the fire resistance will be achieved in many ways.

- Steelwork – An appropriate fire protection system, such as intumescent coatings, may be applied to any steelwork element that require fire protection. Alternatively, all steel columns and beams are to be wrapped/boxed in an appropriate fire boarding system.
- Roof / (future First floor) slabs – The slabs will be designed with sufficient reinforcement and with appropriate consideration for “concrete cover”, to enhance the inherent fire resistance of the element.

4.7 Fuel Tank Considerations

An external fuel tank is specified, and it is understood that this will contain an integral inner bunded arrangement. As such, no external bunds are required, and the tank is supported off a designed concrete slab.

A steel framed canopy roof is proposed to provide at least 2m edge protection around the tank.

Finalised information on the fuel tank / associated loadings are to be provided by specialists.

4.8 Stairs

At this stage there is no provision for stairs for any future upper storey. It is anticipated that these would be added as part of any future extension proposals along with the associated steel trimmers around the future opening to be formed through the first floor slab.

4.9 Design life

According to the latest Codes of Practice, the new structures are to have a nominal structural design life of 50 years.

4.10 Design Assumptions

Due to the lack of detailed information at the time of undertaking the design several assumptions had to be made, these are as follows:

- Proposed future second floor roof to be of lightweight construction capable of accommodating light services,

- Overall height of columns,
- Level of proposed floor / roof levels (including those for future structure and canopy),
- Level of roller shutter doors head beams,
- 0.5m high parapet to be built off the composite slab forming the low-level roof,
- First floor steelwork has been designed to support a single leaf of 140mm wide blockwork only. Proposed beams cannot accommodate outer leaf of potential cavity wall. It is assumed that this leaf will be able to run from foundation all the way up to top floor. This is subject to confirmation of final heights.

4.11 Codes of practice

All structural designs will be undertaken in accordance with the relevant British Standards, Eurocodes and UK National Annexes, and Building Regulations. These include the following:

Document Reference	Document Title
BS EN 1991-1-1	Eurocode 1: Actions on structures – Part 1-1: General actions – Densities, self-weights and imposed loads
BS EN 1991-1-3	Eurocode 1: Actions on structures – Part 1-3: General actions – Snow loads
BS EN 1991-1-4	Eurocode 1: Actions on structures – Part 1-4: General actions – Wind actions
BS EN 1992-1-1	Eurocode 2: Design of concrete structures – Part 1-1: General – Common rules for building and civil engineering structures
BS EN 1993-1-1	Eurocode 3: Design of steel structures – Part 1-1: General rules and rules for buildings
BS EN 1994-1-1	Eurocode 4: Design of composite steel and concrete structures – Part 1-1: General – Common rules and rules for buildings
BS EN 1996-1-1	Eurocode 6: Design of masonry structures – Part 1-1: General – Rules for reinforced and unreinforced masonry, including lateral loading
BS EN 1997-1	Eurocode 7: Geotechnical design – Part 1: General rules
BS5606:1990	Guide to Accuracy in Building
	Building Regulations Approved Document A 2013

Image 7: Design Standards and Codes of Practice.

4.12 Displacements

All structural elements will be designed to limit vertical and lateral displacements in accordance with the relevant Eurocodes.

Deflection limits for the proposed solution would be as follows:

- Horizontal column/storey drift: $H/300$
- Vertical mid-span deflection for beams under full load that do not support brittle materials: $L/250$
- Vertical mid-span deflection for beams under full load that support brittle materials: $L/360$
- Vertical edge deflection for cantilever beams: $L/180$

5 Civil Engineering

5.1 Introduction

Trial pits found made ground to be maximum depth of 2.0m below ground level with two main natural stratifications below: medium dense slightly gravelly silty sand deposits and stiff grey slightly gravelly silty clay. Groundwater strike was encountered at 3.0m bgl.

Suitable bearing strata is below 2.0m depth due to made ground levels.

The site is currently occupied by a loading bay and grassed area and adjacent to an existing 2-storey traditional style building. Therefore, it is assumed that existing foul and surface water drainage systems for the adjacent building are present on the site, which are then connected to the main off-site network.

A CCTV survey has been completed to establish the drainage networks run and where they connect to, whilst also establishing their condition. No significant issues have been noted.

A Phase II ground investigation has been completed by Ground Consult on 01 March 2022. 4 no window sample boreholes were drilled to circa 5.5m depth and 3 no. trial pits were excavated to determine ground conditions. Initial findings found a combination of gravelly silty sand and gravelly clay to 2m depth; gravelly silty sand deposits from 2.0m to 5m depth and gravelly silty clay to borehole base at circa 5.5m depth.

5.2 Design Standards and Guidance

All drainage designs will be undertaken in accordance with the relevant Eurocodes and National Annexes, British Standards, and Building Regulations, including:

- The Building Regulations 2010 Approved Document H 'Drainage and Waste Disposal 2015 Edition
- WRc 'Sewers for Adoption' (8th Edition August 2018)
- BS EN 752:2008 'Drain and Sewer Systems Outside Buildings'
- BS EN 12056 'Gravity Drainage Systems Inside Buildings'
- Ciria SuDS Manual C753 (2015)

5.3 Approvals and Agreements

In the event that new applications will have to be made to the local Water Authorities in order to accommodate the new/revised flow rates, the following will apply:

- All drainage that is to be adopted by the local Water Authority, or new connections to the existing system, will require a Section 104 application to be made.

- All drainage within the site, including drainage below the building, must be approved by the local Building Control.
- Local Council Lead Local Flood Authority (LLFA) to approve the design and drainage principles., with regards to surface water management and the risk of flooding.
- The proposed foul water connection to the existing offsite sewer in South Downs Road will require a Section 106 Agreement with United Utilities.

5.4 Underground Pipework

All new drainage pipework for foul and surface water systems will be designed on the basis of UPVC to BS EN 1401-1. The suitability of these will need to be agreed with the local Building Control. The performance of plastic pipes varies according to the specific supplier, so any plastic pipes will need to be installed in accordance with the supplier's specification and design requirements.

All new pipework will be installed with sufficient gradient to achieve self-cleansing velocities where possible.

5.5 Manholes, Covers and Inspection Chambers

In general, manholes will be constructed in pre-cast concrete or brick. Inspection chambers will be Polypipe PPIC or similar, depending on loading requirements.

Manhole covers will be in accordance with BS EN 124:1994 'Gully Tops and Manhole Tops for Vehicular and Pedestrian Areas'

Ductile iron covers will typically be adopted where situated in trafficked areas such as roads and service yards.

Internal manholes within the building are to be avoided.

5.6 Design Life

All new drainage systems will be designed to achieve a 50-year design life.

5.7 Drainage Strategy

Drainage requirements for the site (designed by others) is to be determined by the Architect.

A GPR survey, undertaken in May 2020, has been provided by S.I Sealy for the site. The survey indicates a surface water (SW) drainage run across the adjacent Hospital access road, connecting to a manhole at the intersection with Crumpsall Way.

Appendix A – CCS Consulting Stage 3 Proposed Steelwork Information

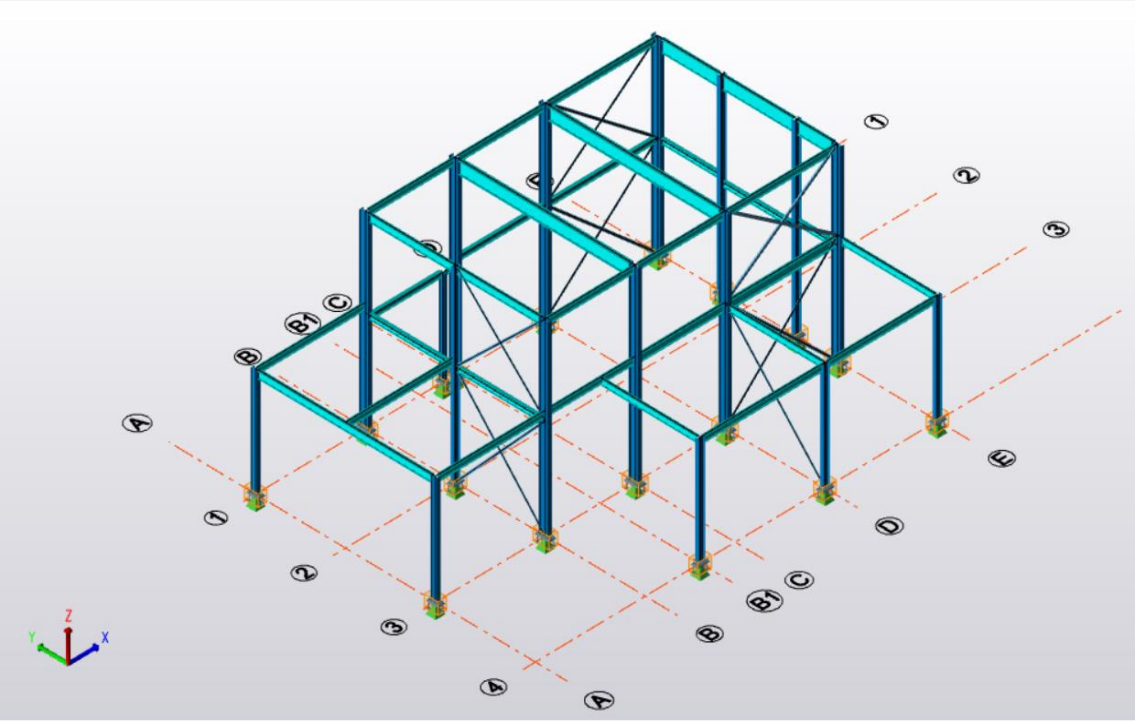


Figure 1: 3D View 1

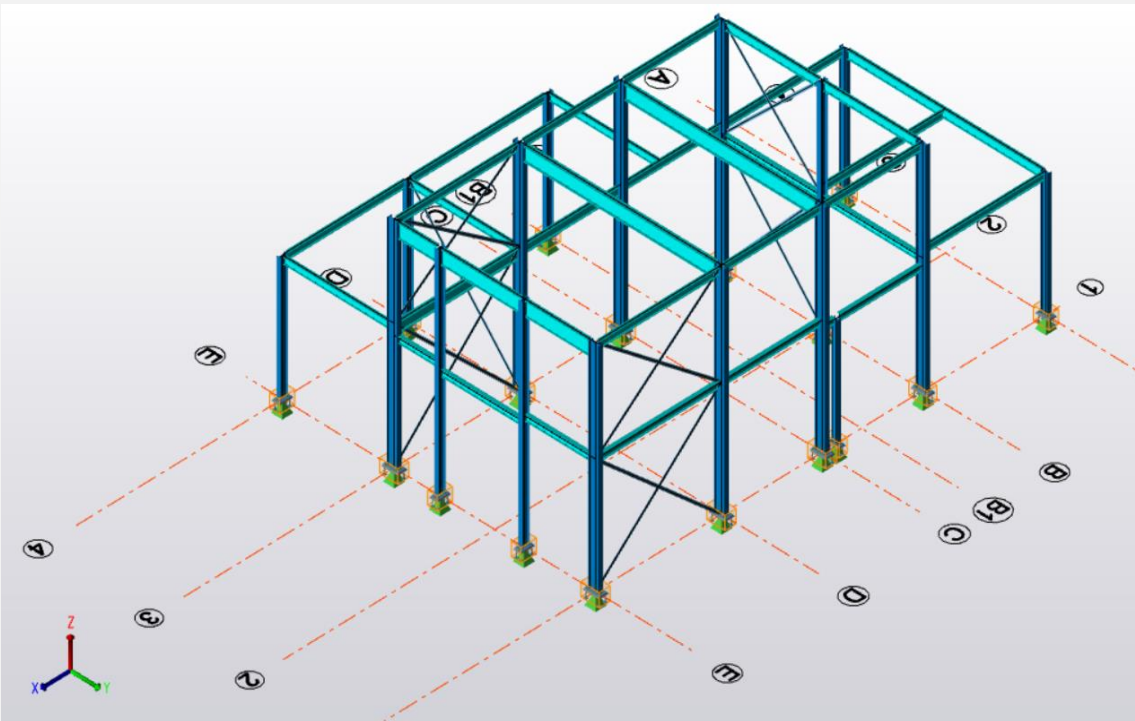


Figure 3: 3D View 3

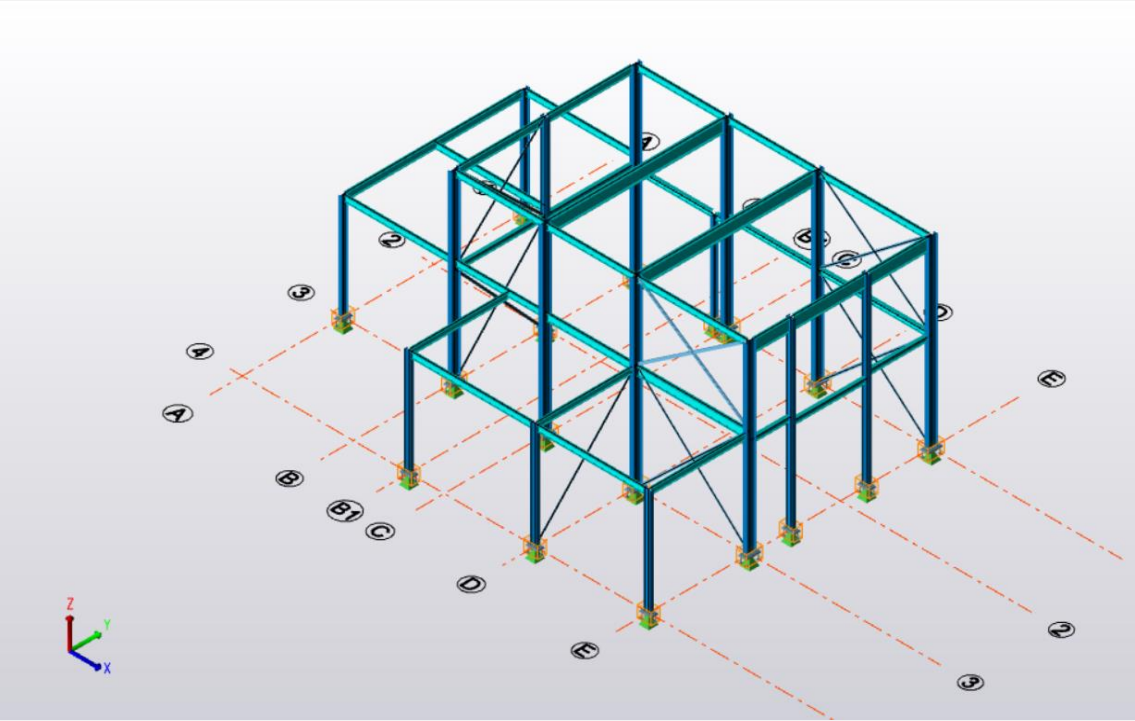


Figure 2: 3D View 2

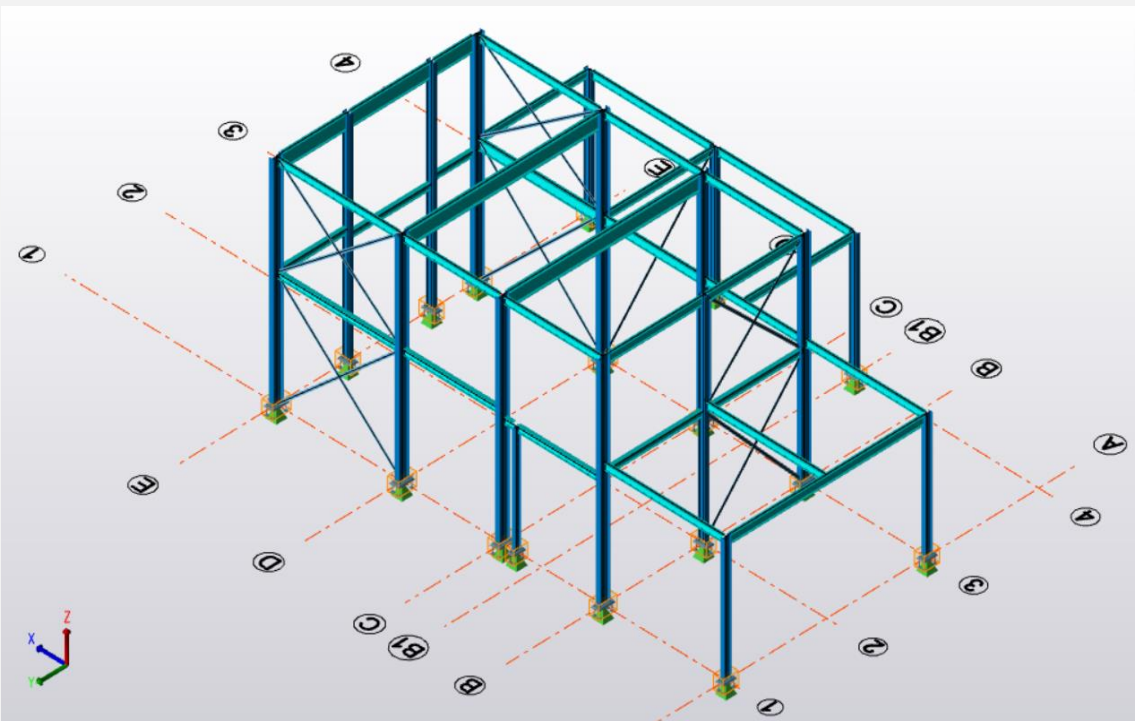


Figure 4: 3D View 4

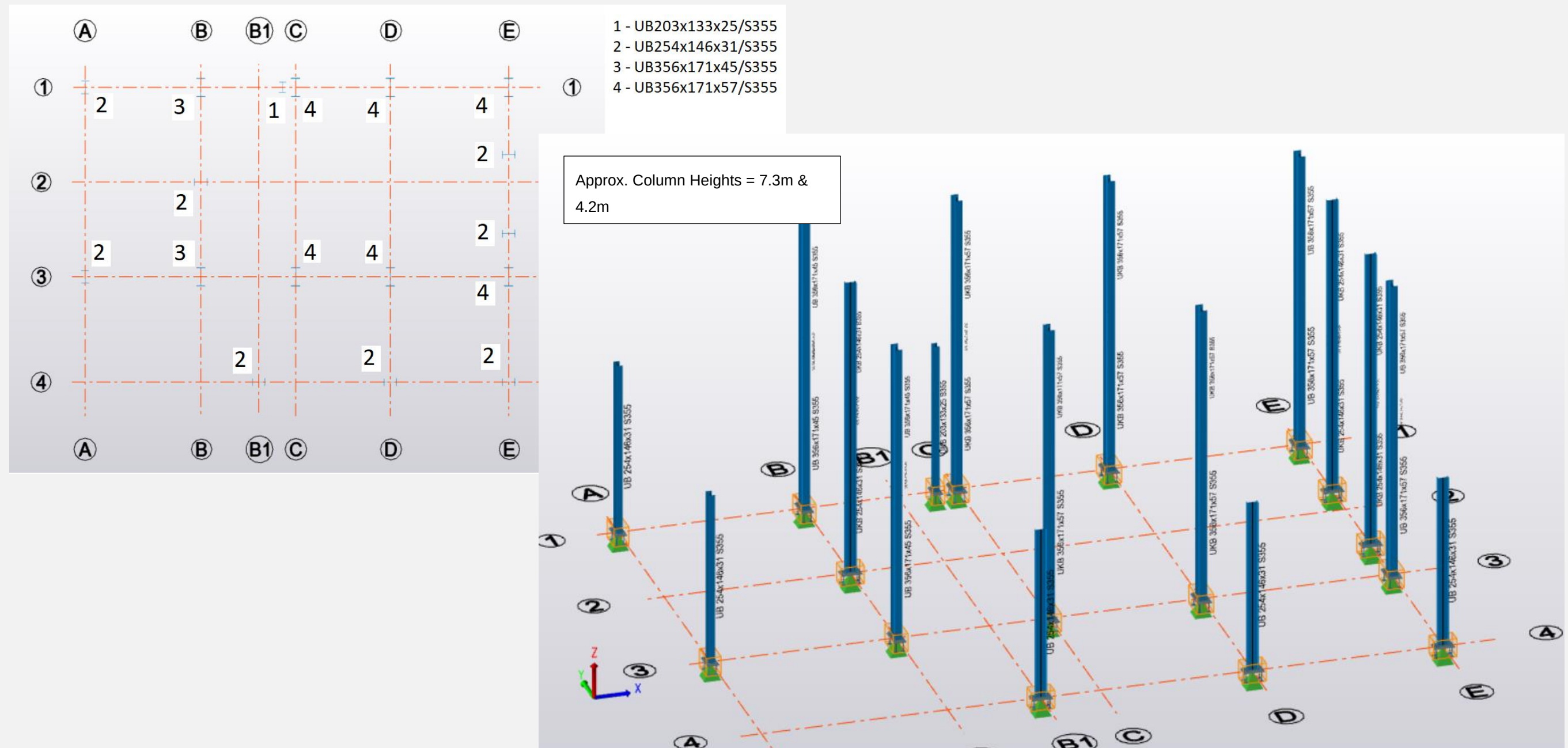


Figure 5: Proposed Column Plan & 3D

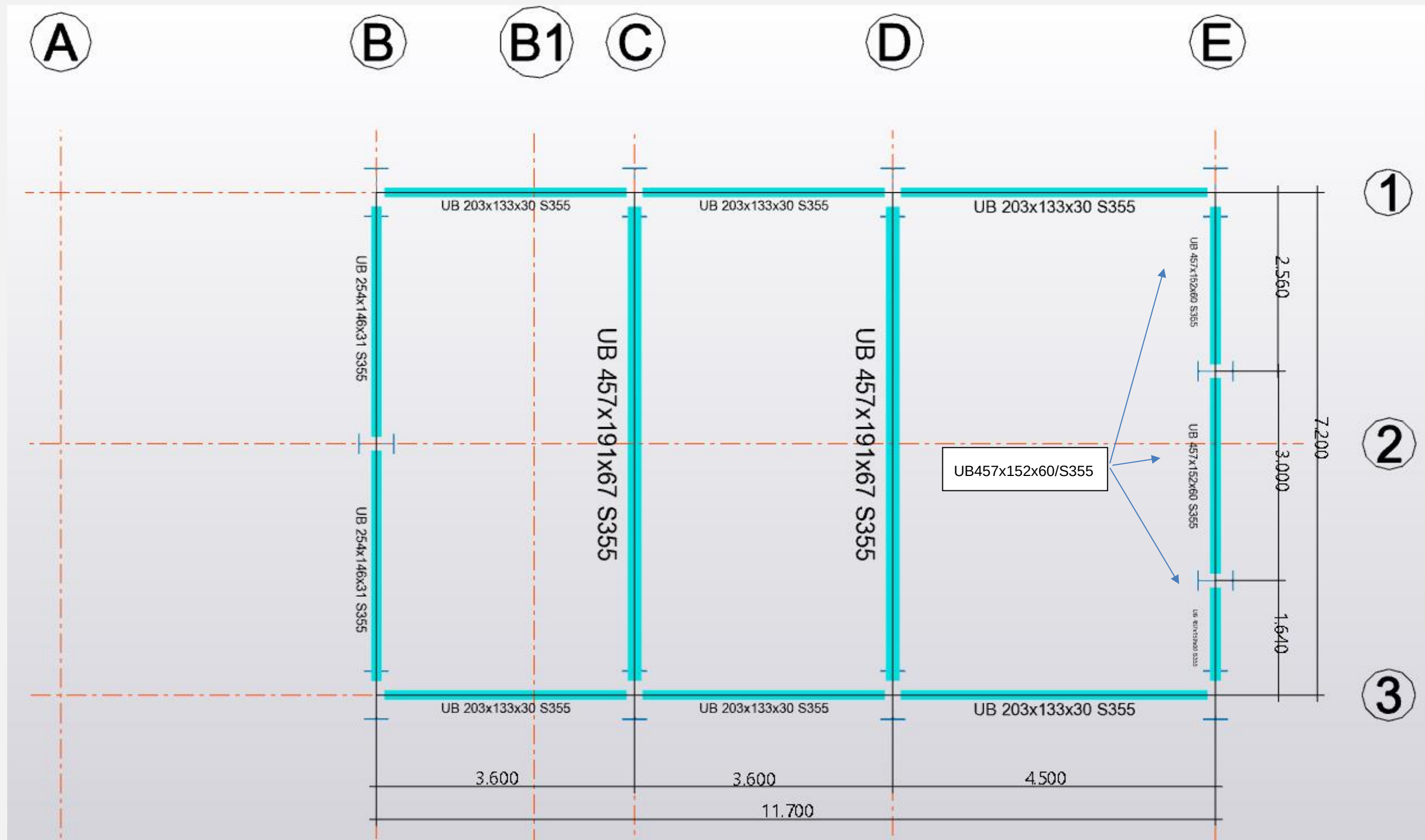


Figure 6: High Level Roof (Future First Floor)

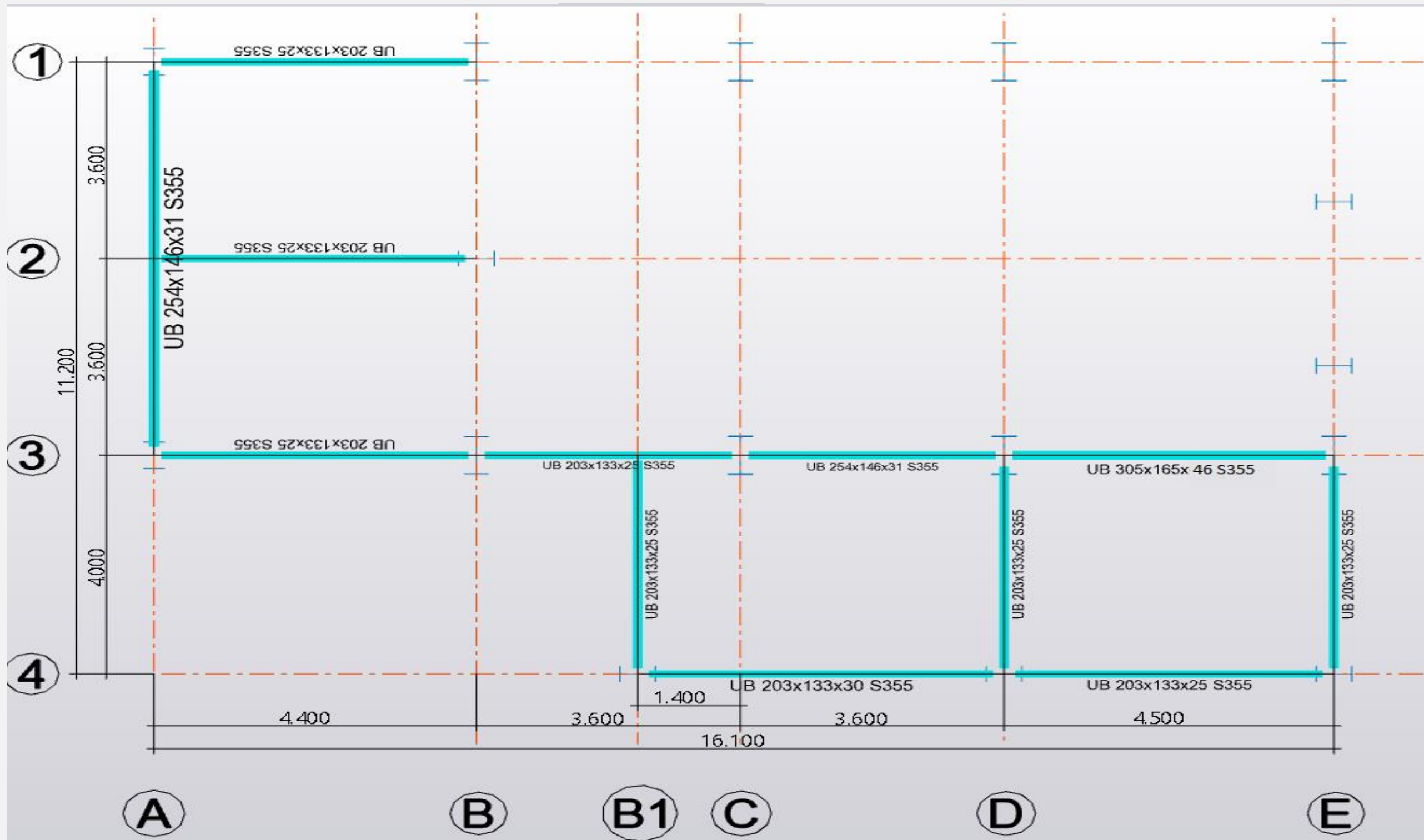


Figure 7: Low Level Roof / Canopy

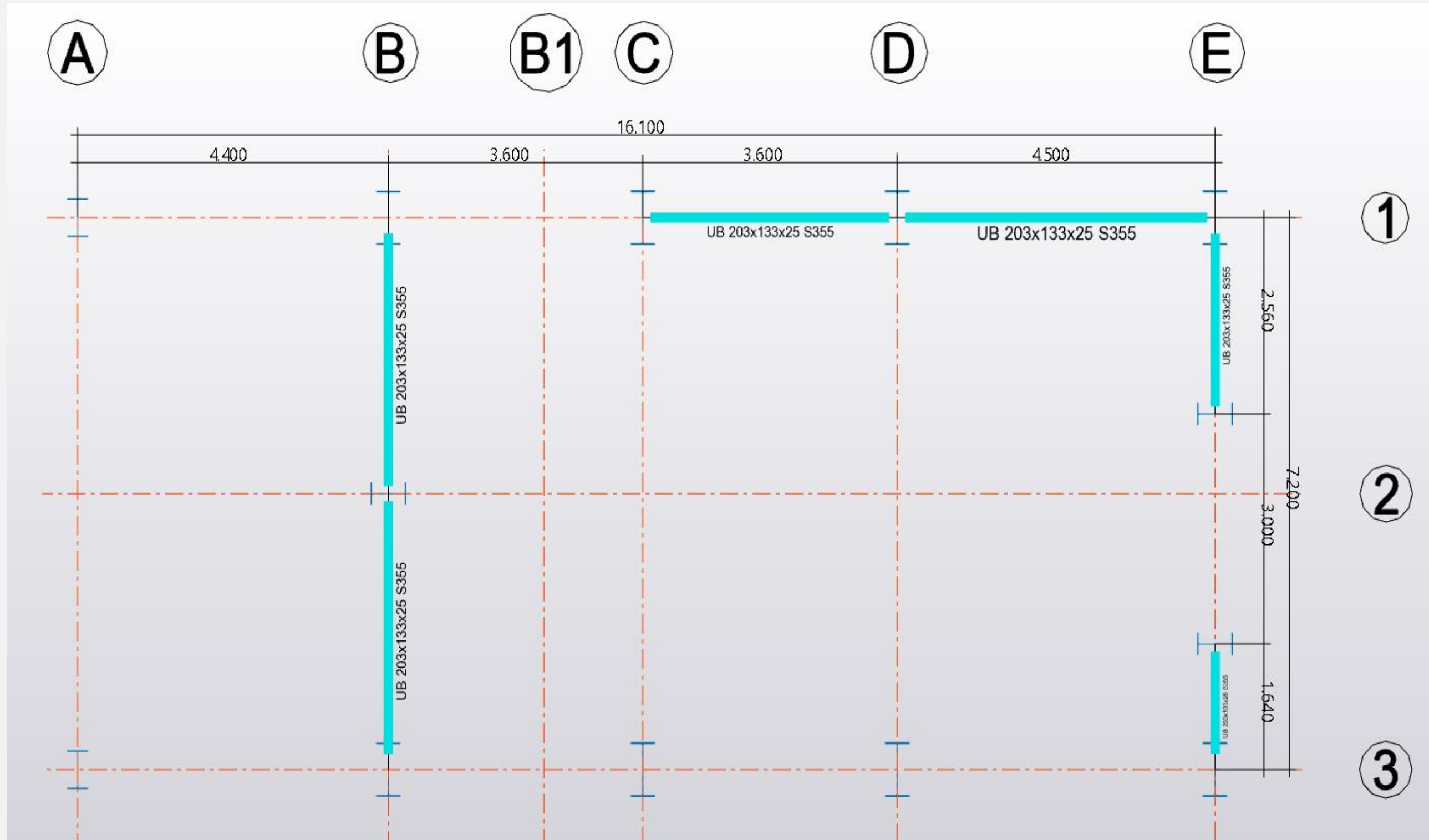


Figure 8: Proposed Mid-Height Column Restraint Plan

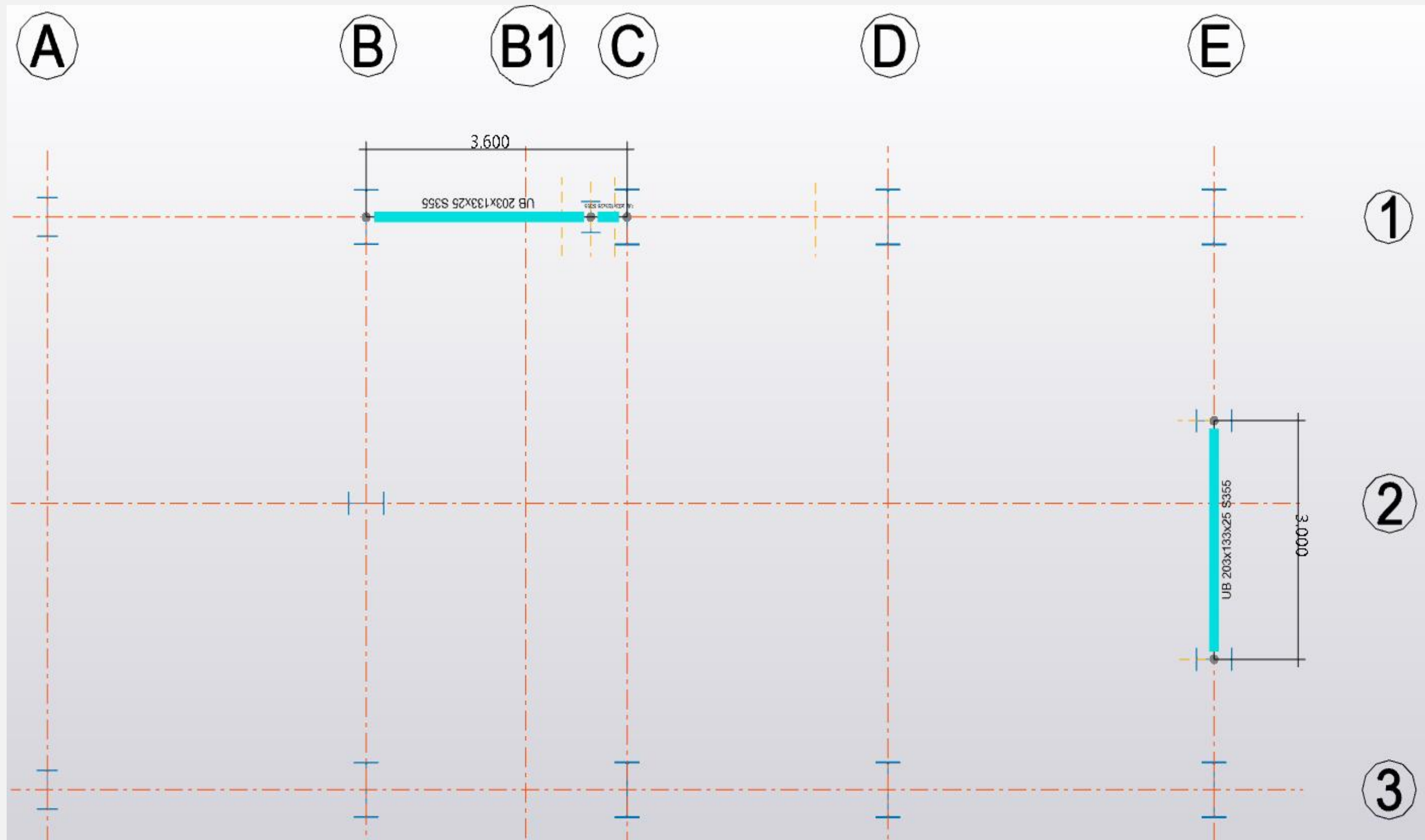


Figure 9: Proposed Louvre Door Head Beams Plan

All Proposed Bracing to Comprise
100X10/S275 Cross Flat Bars.

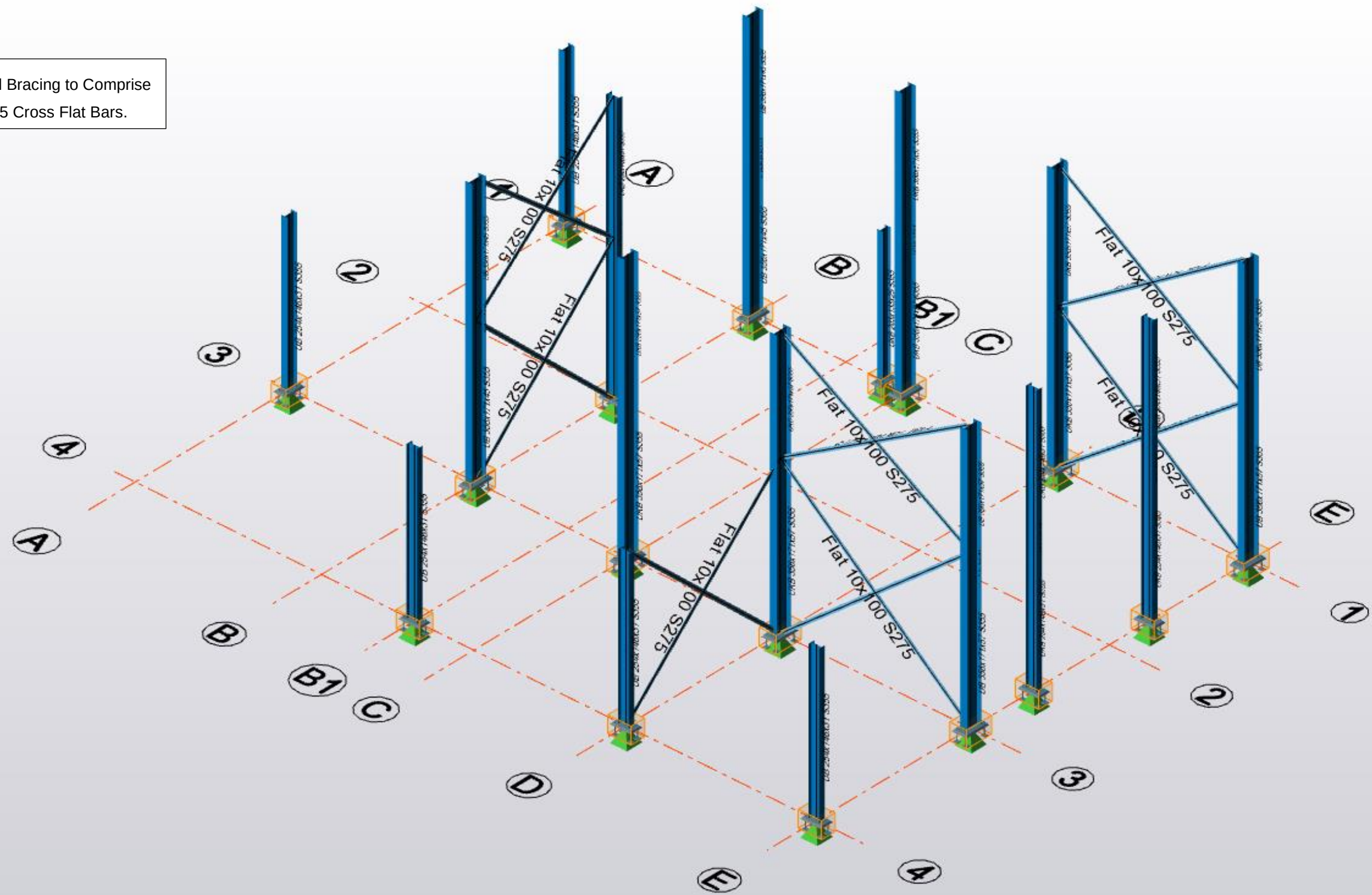


Figure 10: Proposed Bracing 3D Visual

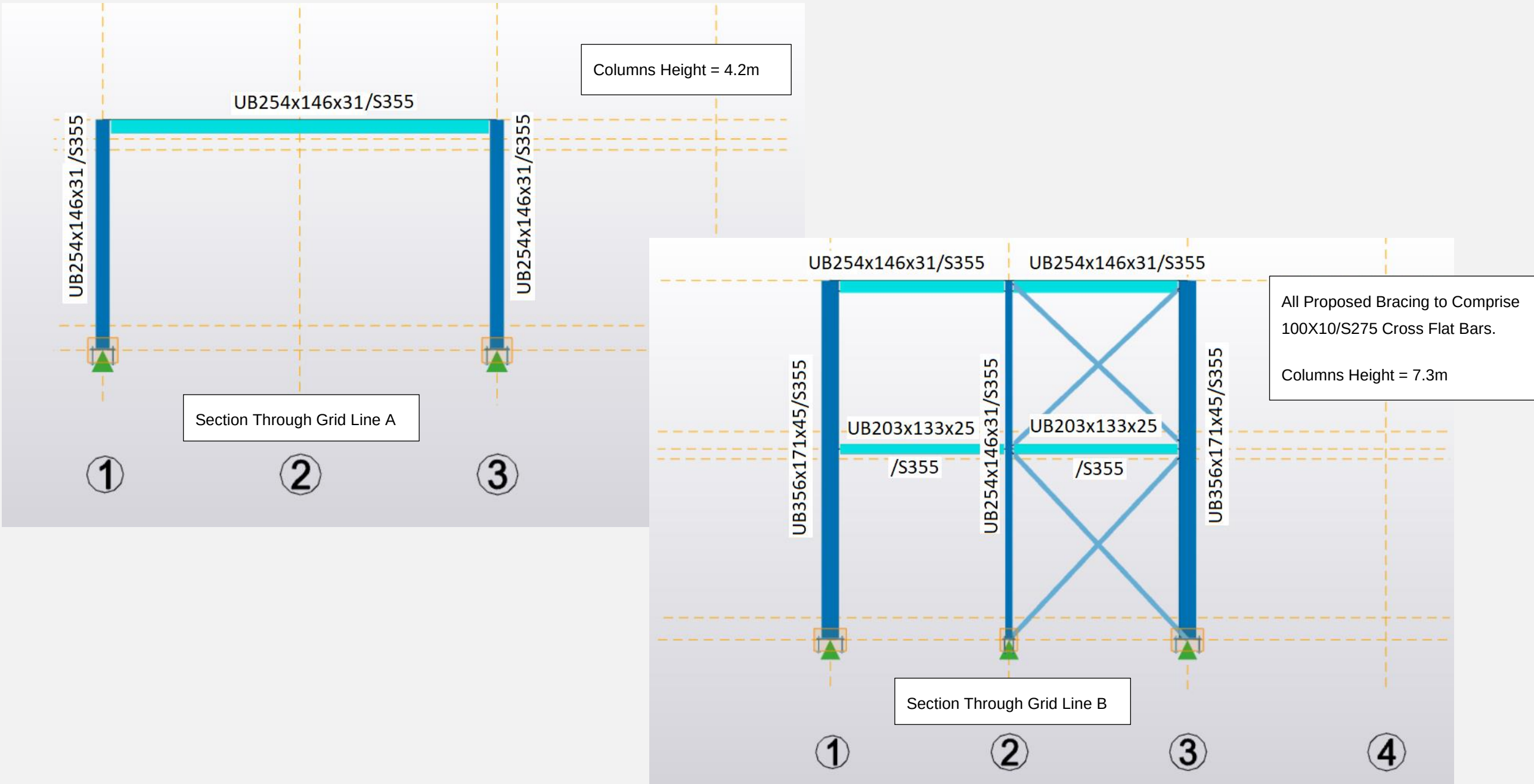


Figure 11: Sections Through Grid Lines A & B

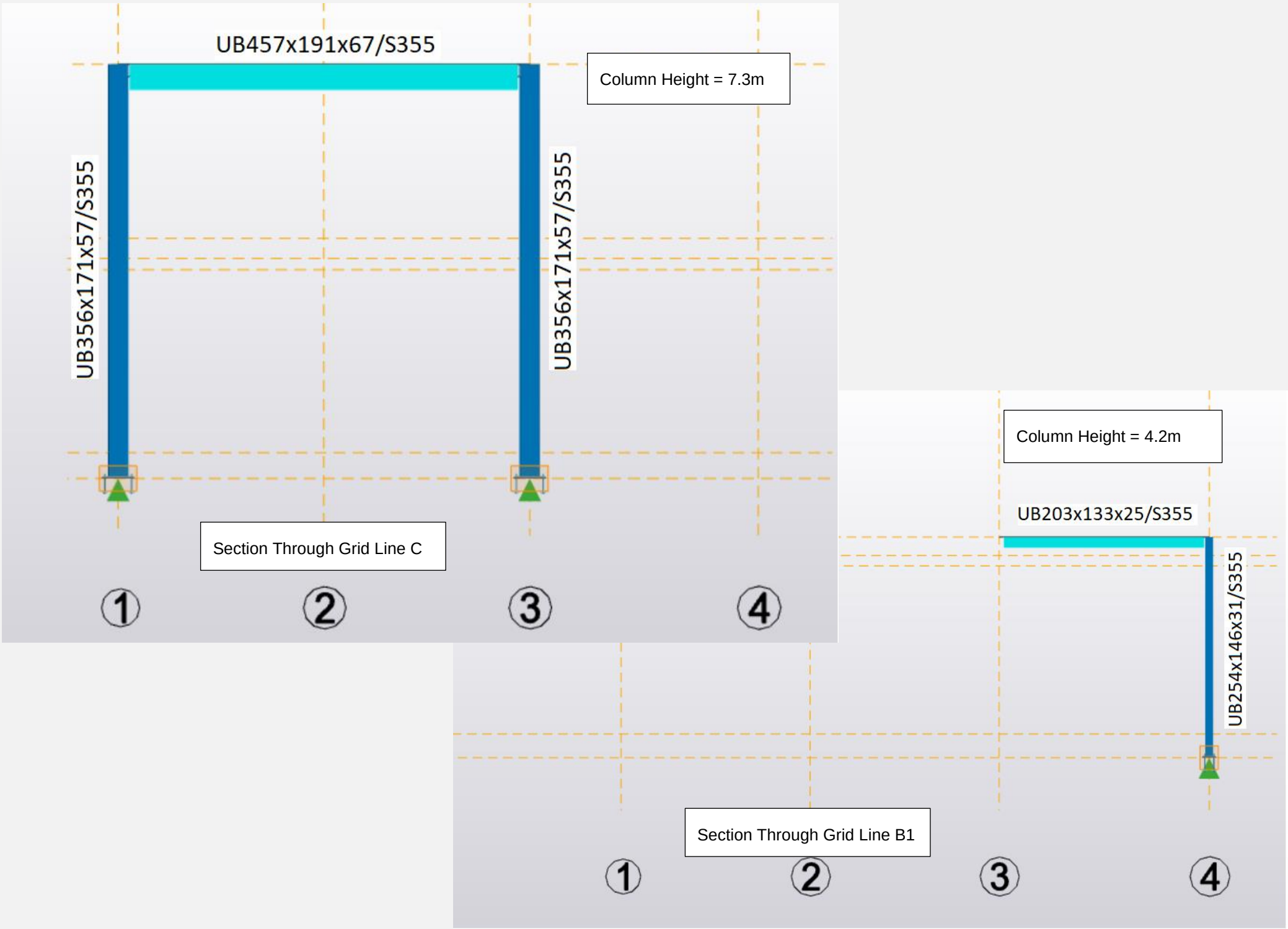


Figure 12: Sections Through Grid Lines B1 & C

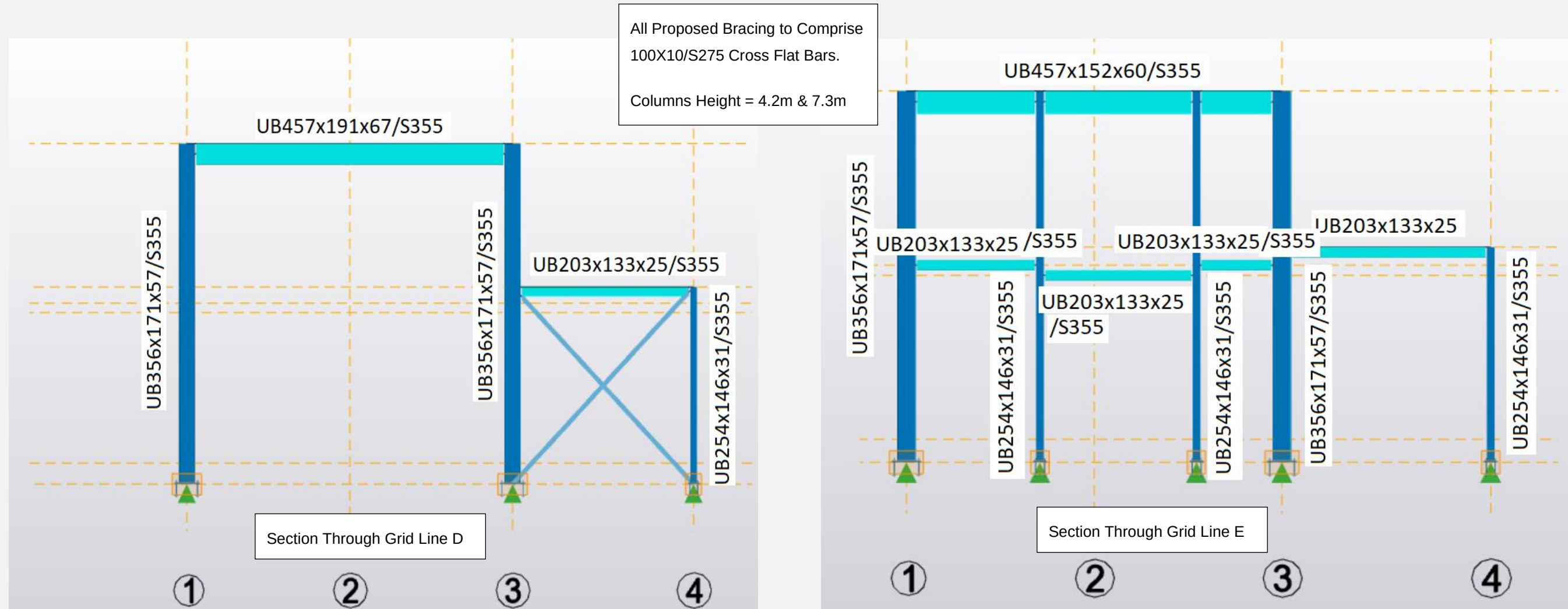
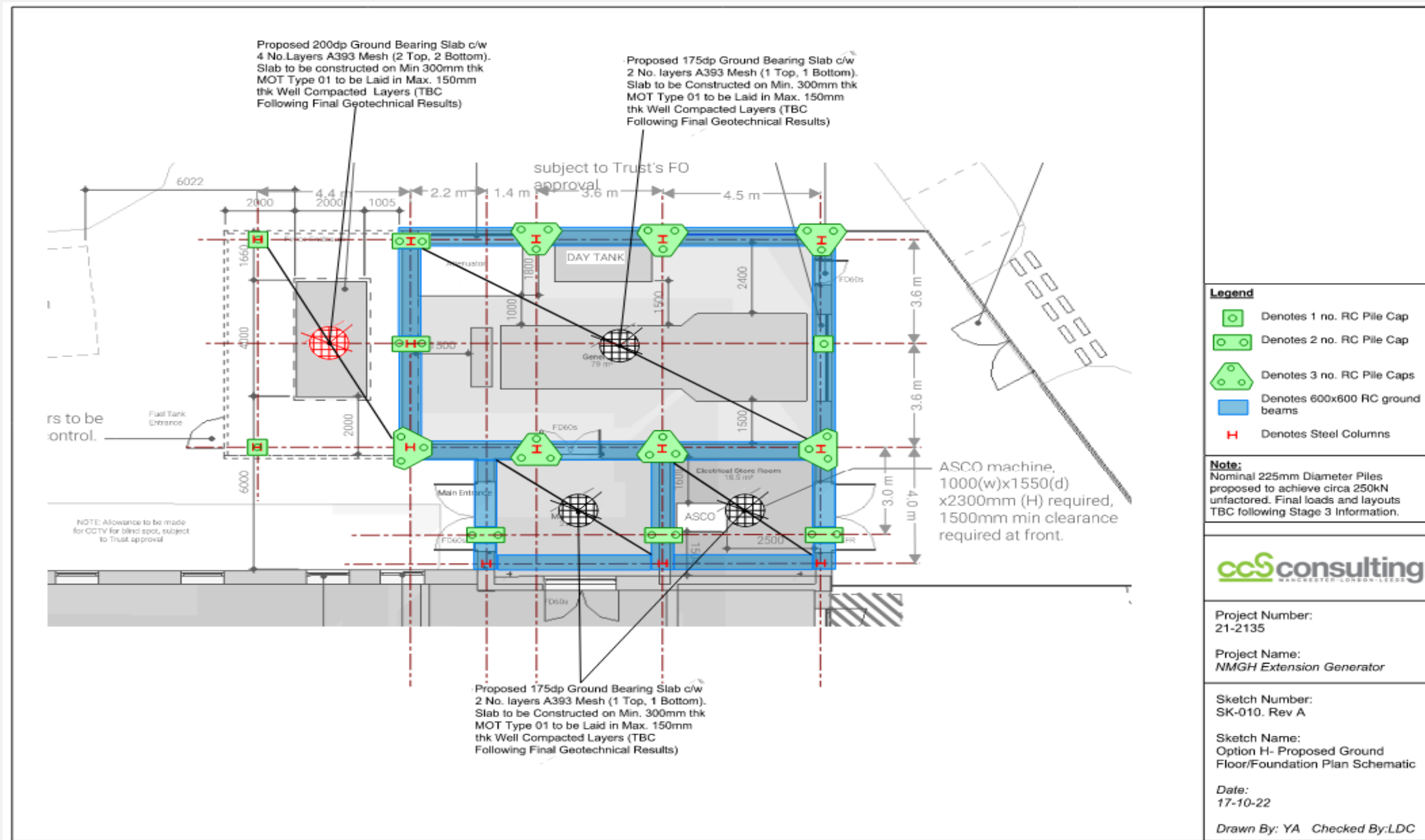


Figure 13: Sections Through Grid Lines D & E

Appendix B – CCS Consulting Stage 3 General Arrangements





Legend

- Denotes Steel Beam
- H Denotes Steel Column
- Denotes Bracing Bay
- ✱ Denotes Moment Connection
- Denotes Span Direction of 215dp Kingspan Composite Metal Deck Slab - MD146 Deck, 1.2mm Gauge c/w A193 Mesh (Top). Power Floated Finished TBC
- ↔ Denotes Cold Form Purlins c/w metal roof decking (mono pitched)

Project Number:
21-2135

Project Name:
NMGH Extension Generator

Sketch Number:
SK-011.REV A

Sketch Name:
Proposed Option H Roof Plan
Schematic

Date:
30-06-22

Drawn By: YA Checked By: LDC

Appendix C – Supporting Information