

**BETTER BARNSLEY
NEW PUBLIC LIBRARY
STAGE 3 REPORT - STRUCTURES**



1. INTRODUCTION

1.1. Project

It is proposed to construct a new central library within Barnsley Town centre located on May Day Green between Eldon Street and Cheapside. The building will share a party wall with the rear walls of properties on Burlington Arcade. The main library portion of the building will rise in part to four storeys with adjacent café and retail areas to two storey height.

The main library entrance has a feature double storey height void. The building has glazed facades to three sides and the rooftop entertainment area is set back from the front facades on three sides to create a terrace area.

1.2. Project Brief

Our brief at this stage of design is to develop the proposals agreed with the client following the initial feasibility report and as outlined in the stage 2 design proposals prepared by Robson and Liddle. This report is intended to form the structural aspects of the client's requirements which will inform the technical design work to be undertaken.

1.3. Report Limitation

This Report is provided solely for the purposes and use of Barnsley Metropolitan Council and should be regarded as confidential to this party, their professional advisors. NPS Humber Ltd accepts responsibility to this party alone that the Report has been prepared with the skill, care and diligence reasonably expected of a competent Structural Engineer. No responsibility whatsoever is accepted to any third party in respect of the whole or any part of its contents and any such parties rely upon the Report at their own risk and without prejudice.

Neither the whole nor any part of this Report, nor any reference thereto, may be included in any published document, circular or statement, nor published in any way, nor disclosed to any third party without our prior written consent.

2. SITE AND EXISTING BUILDING CONSTRAINTS

2.1. Site Location

The site is located in central Barnsley in the markets area off Eldon/Kendray Streets on the edge of the proposed regeneration area. Mayday Green and Queen Street are pedestrianised areas. On the site are existing two storey, reinforced concrete structures, commercial buildings constructed circa 1960s, which will be demolished as part of a separate contract. A concrete and asphalt ramp structure to a first floor exposed parking deck on the site at the centre and towards the Northern boundary of the site is also to be demolished to make way for the new building. Adjoining the ramp at the West edge of the site is a row of Victorian terraced houses on Burlington Arcade with a three storey framed building to the South. To most of the remainder of the site there are no adjoining or nearby structures. It is envisaged that part of Mayday Green will be available to the site for contractor facilities and be landscaped in a separate contract, to be planned according to the phasing of nearby redevelopment works.

2.2. Site Geology

The 1:50,000 scale British Geological Survey (BGS) geological map (Sheet 87 Barnsley) indicates that the site is underlain by the Pennine Middle Coal Measures. To the north west of the site the Kent's Rock, a sandstone flag within the Pennine Middle Coal Measures outcrops. There are no superficial deposits underlying the site. There are three coal outcrops indicated to be present within the site.

The Pennine Middle Coal Measures Formation is described by the BGS as "Interbedded grey mudstone, siltstone, pale grey sandstone and commonly coal seams".

The site investigation undertaken by Wardell Armstrong for the redevelopment of the Markets in 2007 and 2008 proved Made Ground over the majority of the site overlying a thin layer of Glacial Till over weathered Pennine Coal Measures.

The Made Ground typically comprised gravel, sand and clay with brick, sandstone and concrete and some coal, ash and clinker. The depth of Made Ground was typically found to be 2 to 3m deep with a maximum depth of 6m recorded. However it was absent in the western section of the Market Basement.

Although no superficial deposits are recorded on the BGS mapping the Wardell Armstrong report recorded a layer of firm to stiff sandy gravelly clays which were identified as characteristic of Glacial Till deposits. Occasional plant remains were recorded within this stratum.

The Glacial Till was underlain by the solid geology of the Pennine Middle Coal Measures. This material was weathered to stiff gravelly clay near the surface, with intact bedrock being encountered at depths of 0.3m and 8.6m bgl (86 and 91m OD). The Kent's Rock, a sandstone flag within the Pennine Coal

Measures, was recorded at depths between 15.75m bgl and 35.5m bgl. The thickness of the Kent's Rock was proven in five locations to be between 6.11m and 12.85m.

Three coal seams were recorded in the strata above the Kent's Rock and they were interpreted as comprising the Winter/Abdy, Top Beanshaw and Low Beamshaw coals.

The Winter/Abdy seam was encountered during the Wardell Armstrong investigation at between 2.5m bgl and 10.28m bgl. The Winter/Abdy coal was recorded as ranging from 0.58m thickness split over three leaves of coal to 1.17m.

The Top Beamshaw coal was present in boreholes across the majority of the site investigated by Wardell Armstrong ranging from depths of between 0.3m bgl (within the market basement) in the west of the Site to 23.95m bgl in the south-east of the Site. The Top Beamshaw coal varies widely in thickness and quality across the Site and is often recorded as a shaley coal or a mudstone and coal. The coal is generally subdivided into two leaves separated by a dark grey mudstone, however, it is often recorded as being a single coal and is also recorded as three coals at one location. The Top Beamshaw ranges in thickness from 0.25m to 1.23m split over two leaves of coal.

The Low Beamshaw coal is present in boreholes beneath the Top Beamshaw coal at depths ranging from 5.16m bgl to 31.23m bgl. The Low Beamshaw is present generally as a single coal ranging widely in recorded thickness across the Site from 0.35m (BH104) to 1.14m including a mudstone parting.

A number of 30m deep boreholes, shallow window samples and soil tests were completed by Wardell Armstrong in 2007 to the areas around the perimeter of the site which showed made ground up to approx. 5m depth made ground overlaying Pennine coal measures and mudstone. A Desktop Study and interpretive report for the Mayday Green area by Robson Liddle in 2014 is available and this was based on chemical analyses and testing done by Wardell Armstrong in 2008. Copies of all these reports will be made available separately.

The site is classed as Brownfield and samples for contamination to the surrounding area of the subject site were taken. The site is described as at low risk of ground gases (see below) with possible radon protection measures required. A hot spot was recorded for this site due to petrochemical pollutants and spoil removed may be assumed to be assumed to be non-inert. Estimates of the volumes of contaminated material to be removed from site are given in the Wardell Armstrong report, basement Area A encompassing the site.

Water ingress was recorded in two window samples within 2m of the ground level but this was inconclusive and shallow groundwater may not be an issue.

For costing, grouting may be assumed to be required although the nearest boreholes did not hit coal, some iron ore extraction is noted in the Desktop Study (by Robson Liddle). For costing, ground gas protection with under slab venting would be advised.

As no site specific boreholes were possible on the site, further boreholes, contamination testing and probing for existing foundation concrete etc. will be required to ensure that further risk in the ground is reduced to sensible proportions and a detailed interpretive report based on the factual results will be

required. During this stage of the design development a site scoping visit was undertaken by ourselves and Robson Liddle's Geo Environmental Engineer to assess these works. Further intrusive investigation is planned to suit the decant of tenants and subsequent demolition of the existing buildings.

Cellars are envisaged for much of the boundary with Burlington Arcade the extent and projection of these will be determined by trial pit excavation. Archive searches have located existing foundation positions which can be confirmed during demolition. Ground gas monitoring is advised and should be scheduled to be completed 3 months in advance of the works commencing on site to enable appropriate remediation measures.

2.3. Hydrogeology

The Environment Agency classifies the bedrock geology at the site to be Secondary A Aquifer. The site does not lie within a Source Protection Zone. The nearest groundwater abstraction lies circa 900m west as is licence for the abstraction of groundwater for bottling i.e. potable water. The Wardell Armstrong report recorded groundwater as typically encountered at or around the bedrock at between 86 and 92m AOD; typically between 5m and 8m bgl. A shallow perched groundwater circa 3m bgl was also encountered in the Made Ground in the Market Basement area. The site lies over a Secondary A Aquifer, however the only groundwater abstraction lies up gradient of the site. The above would suggest that groundwater would be of low sensitivity to any potential sources of contamination.

2.4. Hydrology

There is a surface water culvert, Slough Dyke which runs along the northern boundary of the site and partly under the footprint of the existing building and proposed development. The exact position and condition of the culvert is currently being determined.

The proximity of Slough Dyke to the site would suggest that surface water is considered to be of high sensitivity to any potential sources of contamination. The Wardell Armstrong's report recommended that further modelling was required to quantify the potential risk to this receptor.

The closest designated watercourse is the River Dearne which lies c.850m north east of the site at its closest point. The Environment Agency classifies the River Dearne as having an ecological quality of Moderate Potential and a chemical quality of Good.

2.5. Topography

The site is sloping with elevations falling to the east and south, external levels ranging from 98m A.O.D. to 96m A.O.D.

2.6. Existing Building Condition

We have not had sight of a condition survey for any of the existing buildings which are to be demolished or retained, these should be sought where possible. The contractor should review and update as necessary by undertaking any required surveys. There is concern around the junction of the existing building to be demolished and those retained on Burlington Arcade. As part of the demolition design works it should be established, if possible, whether any lateral support is offered by the building to be removed to those remaining. Should this be the case temporary and permanent works will need to be put in place which may affect the design of the new structure.

The new extension will, ideally, be structurally independent from the existing. It is recommended that a dilapidations survey be undertaken prior to construction.

2.7. Site Access

Site access is reasonable with an established road network though, as with any city centre site, will require careful consideration to enable supply of materials and public safety. This should be addressed early in the next design phase with the contractor, considering the overarching better Barnsley project, as this may have an impact on detailed design proposals.

3. CURRENT DESIGN PROPOSAL

3.1. Sub Structure Design

3.1.1. Foundations

Initial guidance can be given based on the desktop study and intrusive investigations adjacent to the site. Actual bearing capacities & required foundation depths need to be obtained from an intrusive ground investigation however we believe it is unlikely that shallow foundations will be feasible.

From the high level geotechnical information available and discussions with specialist piling contractors at the previous design phase piles should be assumed to be 450mm diameter continuous flight augered 16m rock socketed. Piles will be arranged in groups at column positions which they will support via a reinforced concrete cap. At shear wall positions the piles will be arranged in line with the walls or the ground floor slab designed to transfer the forces to the piled foundations. At the junction with the existing buildings piles will be set back to suit the existing foundation positions.

Concrete ground beams will span between the pile caps and support the ground floor. At the junctions with existing buildings the beams will cantilever a short distance over the setback piles, supporting the columns above. It is hoped that this approach will avoid any clash with existing building foundations and also prevent them being undermined. We anticipate basements to the Burlington arcade properties, the proposed foundation solution will avoid any additional surcharge to their retaining walls, though careful consideration will need to be given to construction loading including the installation of piles.

To accommodate the site slope a retaining wall will be provided, where external levels exceed those inside the building. This will be supported from the piled foundations, formed in reinforced concrete and require tanking to prevent water ingress.

Schematic drawings are provided in Appendix A, Figures 1 & 2 to illustrate the current foundation proposals. These proposals will be developed further at the next design stage once further intrusive site investigation has been undertaken.

3.1.2. Sough Dyke

At the site boundary to Eldon St exists a culverted watercourse 'Sough Dyke'. The size, position and condition of this culvert is currently being established. From information we have to date the dyke appears to run either immediately adjacent to the existing / new building line, perhaps partially under the existing building. To either side of the dyke there is 6m easement to allow for any future maintenance. During initial discussions with the Environment Agency; construction within the easement area was not explicitly precluded, however we were advised that any maintenance work required to the dyke during the life of the building was not restricted. We currently have two design proposals to be further developed once we have accurate survey information, these are shown in Appendix A, Figures 1 & 2.

Option one consists of cantilevered ground beams supporting the Eldon St elevation in turn supported by a contiguous piled retaining wall running adjacent to the culverted dyke, with returns coming as far back as to the edge of the easement area. Whilst construction is undertaken within the easement the retaining wall will allow for safe excavation to be undertaken to replace or repair the culvert in the future.

Option two consists of spanning ground beams bridging the dyke and supporting the Eldon St elevation. Again the beams can be supported from a contiguous piled wall to facilitate future works. This option requires construction outside the building line and will require consultation with various land owners, authorities and service providers, though may be necessary if the dyke is found to run a significant distance under the building.

Once the dyke position is established and the appropriate option developed, detailed discussions can be undertaken with the environment agency and Barnsley council and formal approval obtained.

3.1.3. Ground Floor

A 300mm cast in situ concrete slab is proposed to the ground floor. Assuming made ground is encountered this will be suspended and span between the ground beams. A floor screed may be adopted to take out construction tolerances, house services and protect insulation. Alternatively a high tolerance power floated floor may be adopted with any insulation located below the slab.

A schematic drawing is provided, Appendix, A Figures 3 to illustrate the floor proposals.

3.2. Superstructure Design

3.2.1. Upper level Floors

Flat cast in situ reinforced concrete floor slabs, 300mm nominal thickness will be supported from 500mm circular columns, generally on a 6m grid. To the rear of the library area, where smaller room spaces exist, the support will be provided from concrete walls. Typically the floor construction will be devoid of downstand beams, with some exceptions to the rear area.

Consideration was given to the use of a ribbed slab in an attempt to reduce acoustic reverberation, this has now been dropped in favour of panels suspended from the floors also used to house lighting and services. A raised access floor is anticipated in most areas above the structural floor facilitating service runs.

Drawings, Figures 4 to 6 are provided in appendix A showing the upper floor construction proposals.

3.2.2. Roof

For the majority of the building the concrete floor form will be repeated at roof level, with insulation and waterproofing over. This robust construction will be used in certain areas to provide an external terrace.

At 3rd floor level the events space area will be contained in a light weight steel framed structure supported off an upstand concrete beam.

3.2.3. Walls

The external walls of the building are typically of curtain form, fixed back to the floor construction. Internally, reinforced concrete shear walls will be adopted where structural support is required with smaller internal dividing walls formed from concrete blockwork and plasterboard faced metal stud to suit durability, acoustic and thermal requirements.

The structural walls are highlighted in Figures 3 to 6 in appendix A

3.3. Lateral Force Resisting System

3.3.1. Diaphragm / Horizontal Bracing

The in situ concrete floor slab will provide resistance to horizontal loading imparted by the external cladding acting as a plate diaphragm spanning between concrete shear walls.

3.3.2. Vertical Stability System

Reinforced concrete shear walls will provide resistance to lateral floor loads. The walls themselves cantilever vertically from foundation level, where forces are transferred to ground.

4. STRUCTURAL DESIGN CRITERIA

4.1. Building Design Life

The buildings shall be designed and constructed so as to achieve an indicative design life in accordance with the client's requirements of 50 years.

4.2. Design Codes

The design of structural elements is to be in accordance with all current relevant Legislation, Eurocodes and British Standards. British Standards are only to be used where there is no equivalent Eurocode.

4.3. Deflection and Vibration Limits

4.3.1. Superstructure

Design of the main structural frame and all secondary structural systems shall take account of the specific loading, tolerance, builders work, and deflection and vibration requirements of any specialist equipment to be installed in the building.

The structure will be designed with the following deflection limits for variable actions. In addition the deflection limits of any items supported by the structure, as specified by their manufacturer,

should be adhered to. If limits are not given below for a particular situation then the guidance given in the appropriate design code must be used.

Perimeter frame supporting façade:	span / 360
Cantilevering perimeter frame supporting façade:	span / 180
Internal frame supporting partitions etc.:	span / 360
Cantilevering internal frame supporting partitions etc.:	span / 180
Members supporting roofing elements	span / 250
Cantilevered roof member	span / 125
Floor beams	span / 360
Cantilevered floor beams	span / 180
Tops of columns	storey height / 300

4.3.2. Substructure

Deflection, movement, settlement of the substructure shall be in accordance with and not greater than limits given in the appropriate design codes for the type and material of the substructure. The resultant deflection, movement, settlement of the substructure shall not be detrimental to the superstructure or its function.

4.4. Durability and Fire Resistance

4.4.1. Durability

The building is to be designed to BS7543:2003 in terms of its durability. All main structural components are to have a service life equal to their design life.

4.4.2. Fire Resistance

Fire resistance to the structural frame is to be provided by inherent fire capacities, such as any concrete or precast elements, and where needed specified intumescent paint finishes or fire rated boarding.

Periods of resistance, structural elements and areas requiring protection are to be confirmed by the project Fire Consultant, Building Control inspector or the local Fire Officer.

4.5. Actions

4.5.1. Permanent Actions

These are to be assessed at the next design stage and include:-

- Design permanent actions due to the building fabric
- Permanent and variable actions from installed equipment and plant.

4.5.2. Variable Actions

The table below gives vertical imposed loading for different category areas within the proposed building.

Ref:	Type of Activity / Occupancy for Part of the Building Structure	Uniformly Distributed Load kN/m ²	Concentrated Load kN
B1	Office areas upper floors	2.5	2.7
B2	Office areas at ground floor	3.0	2.7
C11	Cafes and restaurants	2.0	3.0
C21	Assembly areas with fixed seating	4.0	3.6
C34	Corridors	5.0	4.5
C35	Stairs and Landings	4.0	4.0
C51	Assembly areas without fixed seating	5.0	3.6
D1	Areas in general retail shops (T.B.C)	5.0	3.6
E2	Plant rooms.	7.5	4.5
E12	Reading rooms with book storage, e.g. libraries	4.0	4.5
E13	General Storage	2.4 per metre of storage height	7.0
H	Roofs not accessible except for normal maintenance and repair. Slope <30°	0.6	0.9
I	Roof areas with maintenance access.	1.5	1.0
I	Roof terrace areas	5.0	3.6

The table below gives loads on parapets and partition walls acting as barriers.

Type of Activity / Occupancy for Part of the Building Structure	Horizontal Uniformly Distributed Line Load kN/m

Restaurants and cafes	1.5
Stairs, Landings, Balustrades, Corridors & Ramps	0.74
External Balconies & Edges of Roofs	0.74
Auditoria, assembly areas, studios.	3.0
Horizontal loads imposed by vehicles	See BS EN 1991-1-1:2002, Annex B

4.5.3. Wind and Snow Loads

Wind loads are to be determined in accordance with BS EN 1991-1-4:2005 and its National Annex

- Basic Wind Speed, V_b , map 22.30 m/s
- Site Altitude, S_a +98.0 m A.O.D.

Snow loads are to be determined in accordance with BS EN 1991-1-3:2003 and its National Annex

- Zone number, Fig NA.1 4
- Characteristic Ground Snow Load, s_k 0.6kN/m²

4.5.4. Notional Horizontal Load

Notional horizontal loads are to be used as given in the Eurocode for the relevant material and its National Annex.

4.5.5. Geotechnical Actions and Actions Caused by Water

For Geotechnical actions see BS EN 1997 and for water see BS EN 1991-3.

4.5.6. Load Combinations

Appropriate load combinations are to be used as given in the Eurocode for the relevant Material and its National Annex.

4.5.7. Dynamic Loads

For dynamic loads caused by machinery see EN 1991-3

4.5.8. Actions during Execution

Refer to BS EN 1991-1-6 and the UK National Annex for construction loads.

4.6. Movement Joint

A full structural movement joint is not anticipated on a building of this size and construction type, though the new and existing constructions will be separated. The spacing of joints within elements of the building will be determined in accordance the Eurocode for the relevant material and its National Annex.

4.7. Robustness

The design is to follow BS EN 1991-1-7:2006 + A1:2014 and the Building regulations part A in terms of accidental actions and disproportionate collapse. The building is to be designed to class 2B for disproportionate collapse as per table 11 of the building regulations, section A3. The building class being; "All buildings to which members of the public are admitted which contain floor areas exceeding 2000m² but less than 5000m² at each storey."

The design of a building to this classification and consequence class, will require the provision of internal and peripheral ties or for areas of collapse to be limited to specific areas or elements which should be designed as key elements and withstand an equivalent blast load as set out in the codes of practice. Compliance of an in situ concrete framed building such as this can be achieved without significant difficulty.

4.8. Interface with Existing Buildings

4.8.1. Foundation Interface

The existing foundations are as yet unknown and are to be determined by intrusive investigation. New foundations will be constructed independently from those existing and care taken to avoid them being undermined or compromised.

4.8.2. Floor, Roof and Wall Interface

The new superstructure is to be designed independently from the existing buildings it adjoins, the possible exception being if it is found that the buildings to Burlington Arcade need support. Adjoining floors, where suspended will cantilever past the last line of support up to the junction with the existing. The same principal will be adopted generally with the roof construction, junction details will be developed with the architect for gutters and flashing. The walls of the new structure should butt up to the existing where they adjoin and not take lateral or vertical support.

At all junctions between new and existing buildings appropriate jointing details should allow for any differential movement between the two structures.

APPENDIX A – SCHEMATIC DRAWINGS

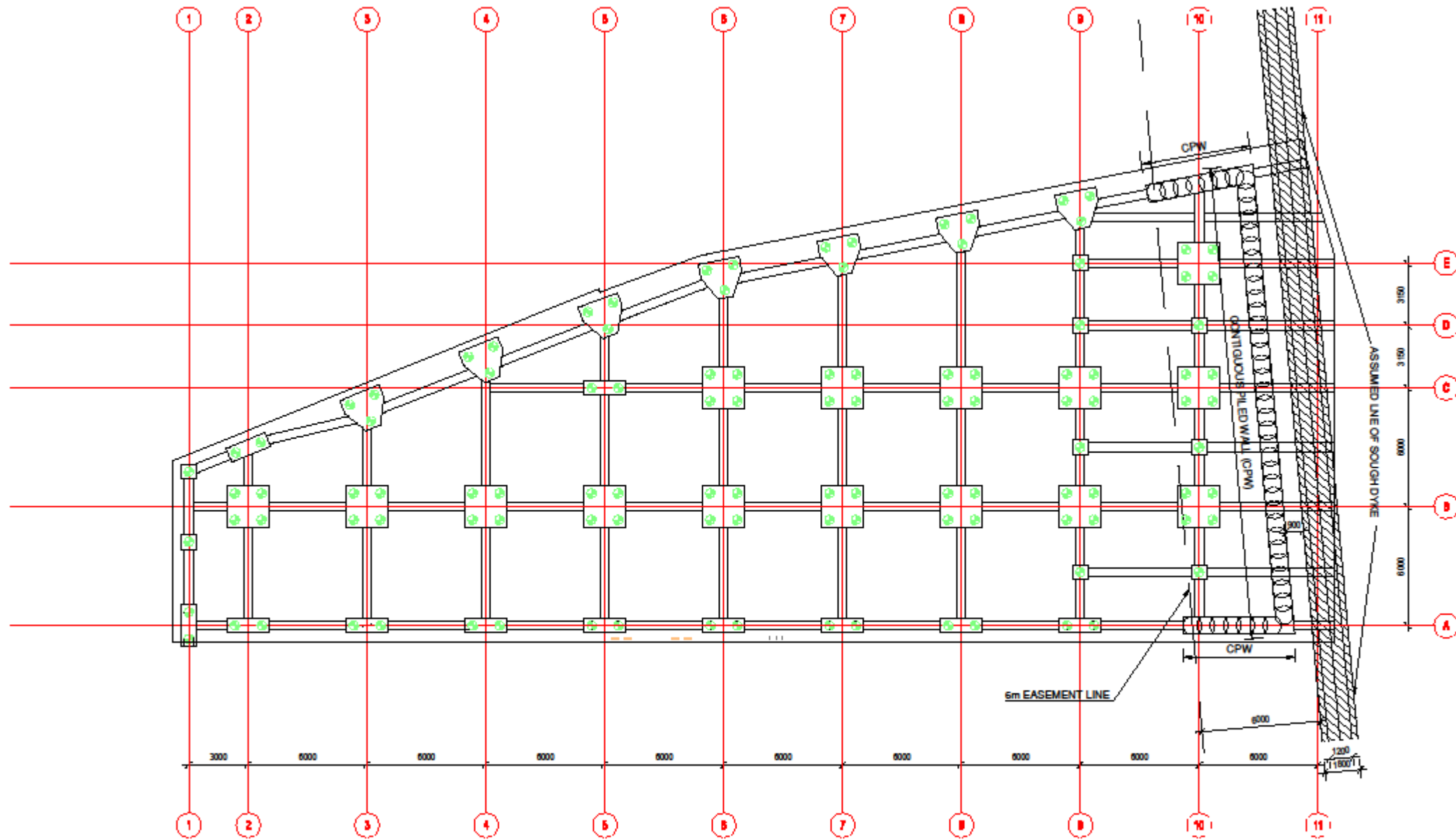


FIGURE 1
FOUNDATION PLAN - OPTION 1
(CANTILEVER OVER)

ASSUMED 450mm DIA. CFA PILES 16M LONG
 ROCK SOCKETED
 ASSUMED GROUND BEAMS 450mm WIDE X
 750mm DEEP
 ALL PILE CAPS ASSUMED 1000 DEEP
 ASSUMED 900mm DIA. CONTIGUOUS PILES

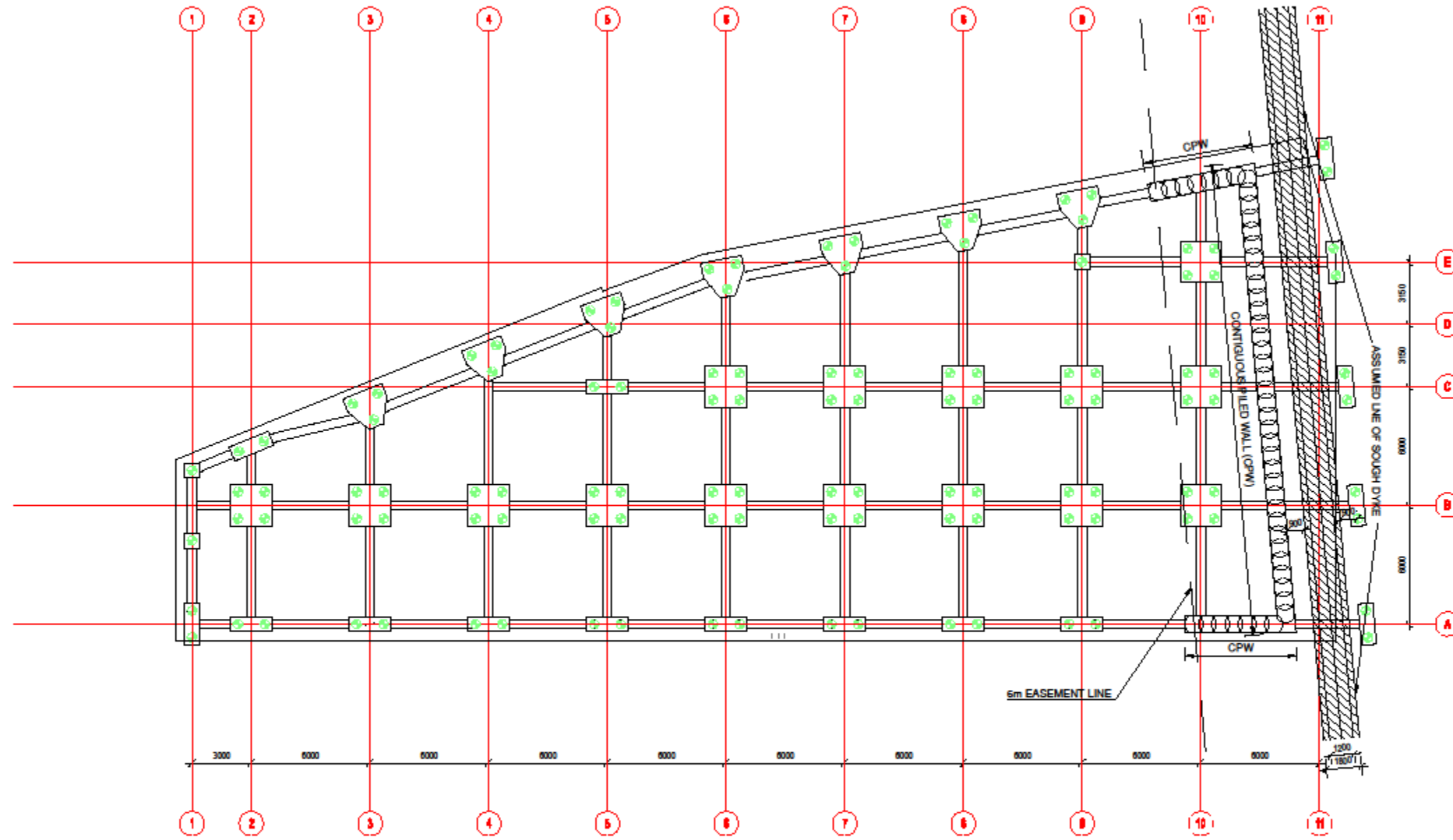


FIGURE 2
FOUNDATION PLAN - OPTION 2
(BRIDGE OVER)

ASSUMED 450mm DIA. CFA PILES 16M LONG
ROCK SOCKETED
ASSUMED GROUND BEAMS 450mm WIDE X
750mm DEEP
ALL PILE CAPS ASSUMED 1000 DEEP
ASSUMED 900mm DIA. CONTIGUOUS PILES

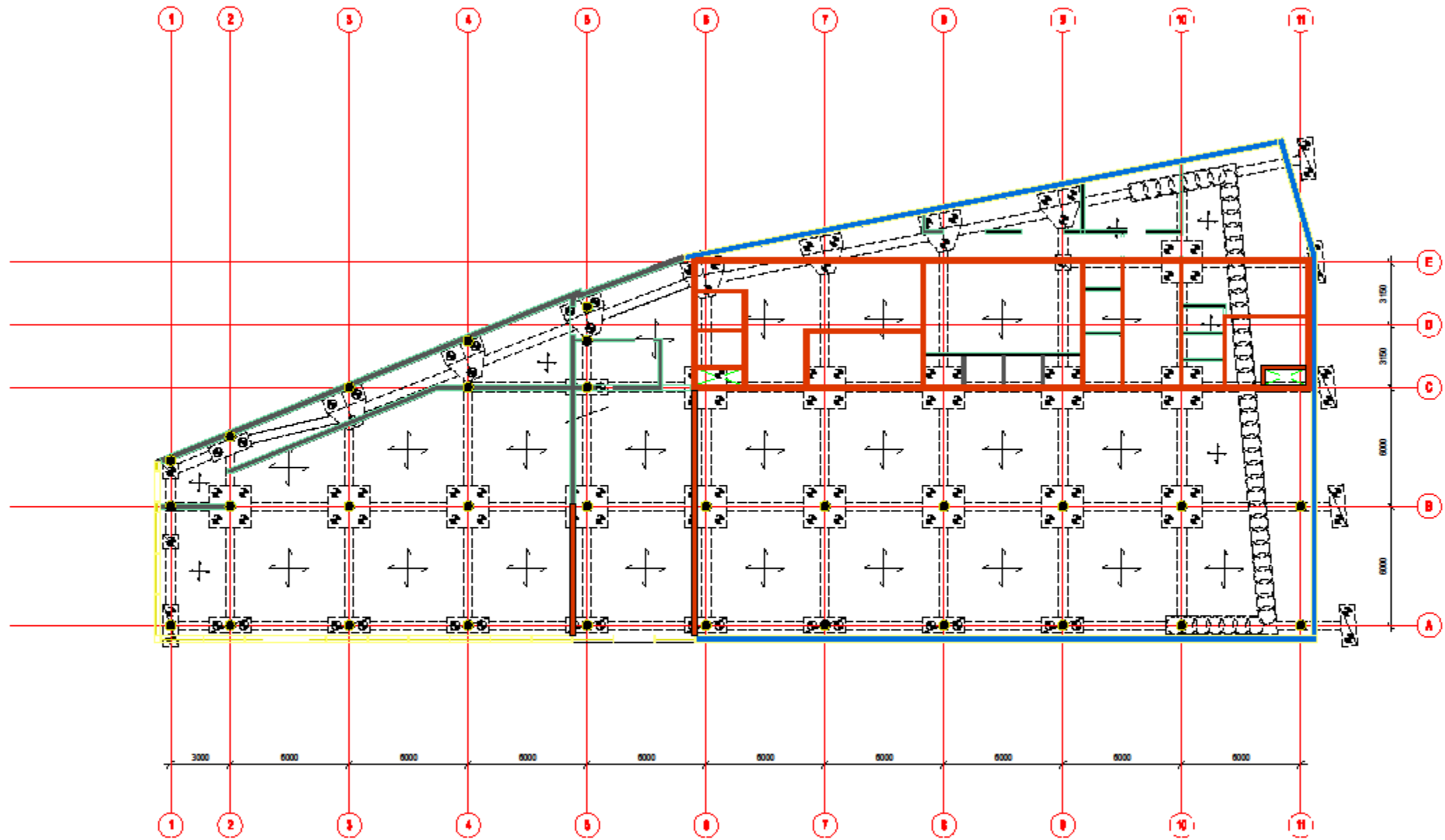


FIGURE 3
GROUND FLOOR PLAN

-  STRUCTURAL SHEAR WALL
-  225mm THICK RC RETAINING WALL
-  SPAN OF 300mm THICK IN-SITU FLOOR SLAB

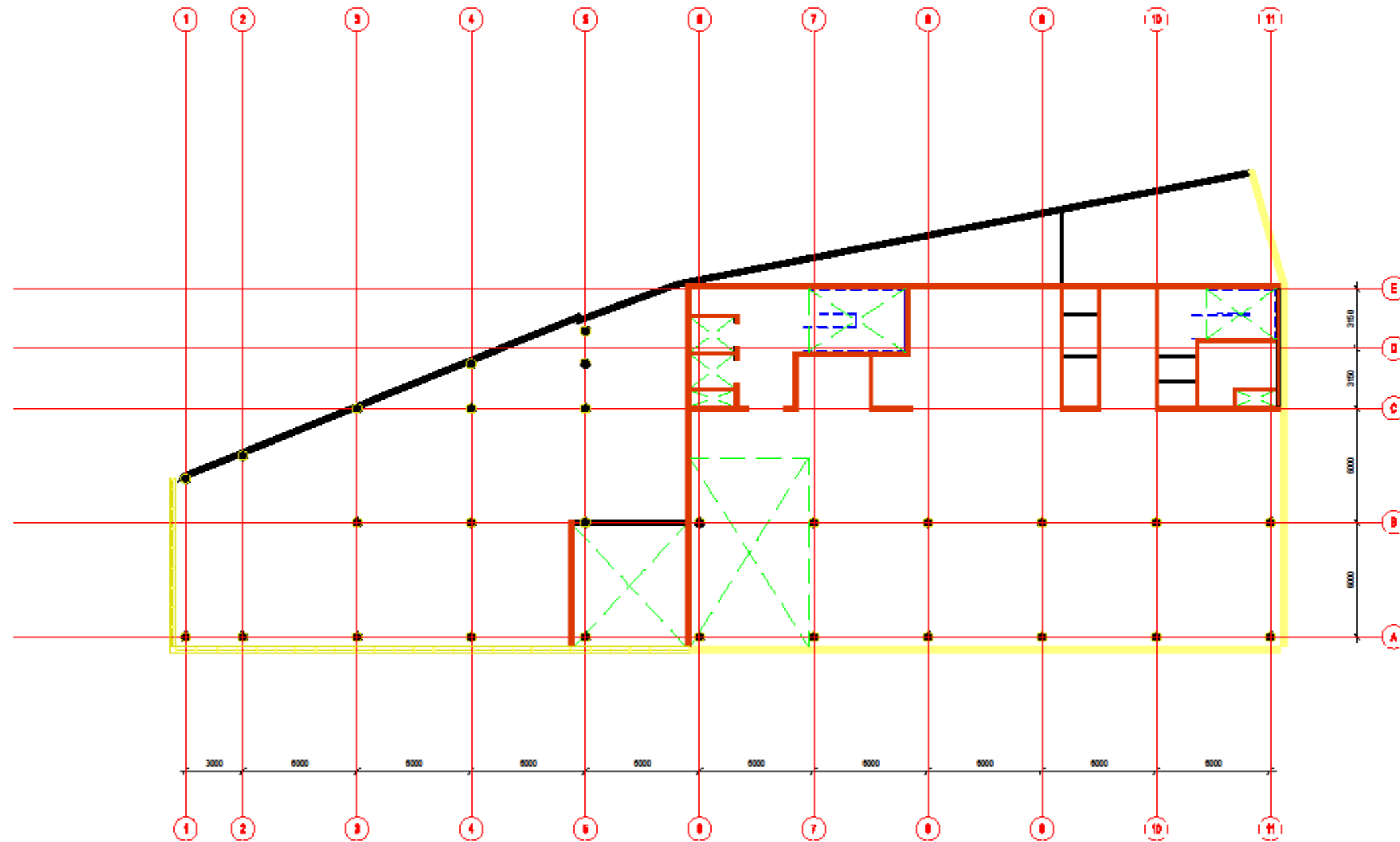


FIGURE 4
FIRST FLOOR PLAN

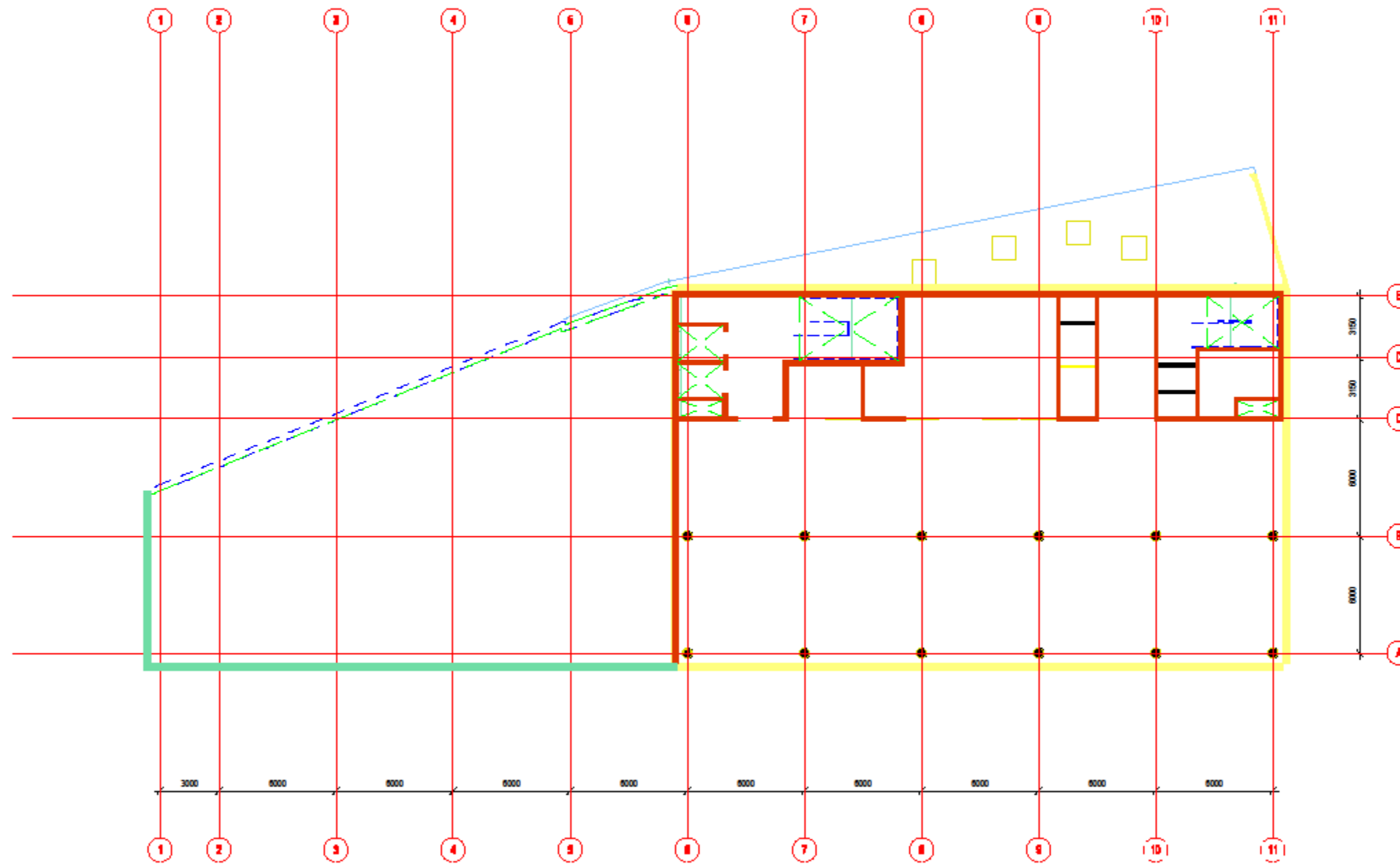


FIGURE 5
SECOND FLOOR PLAN

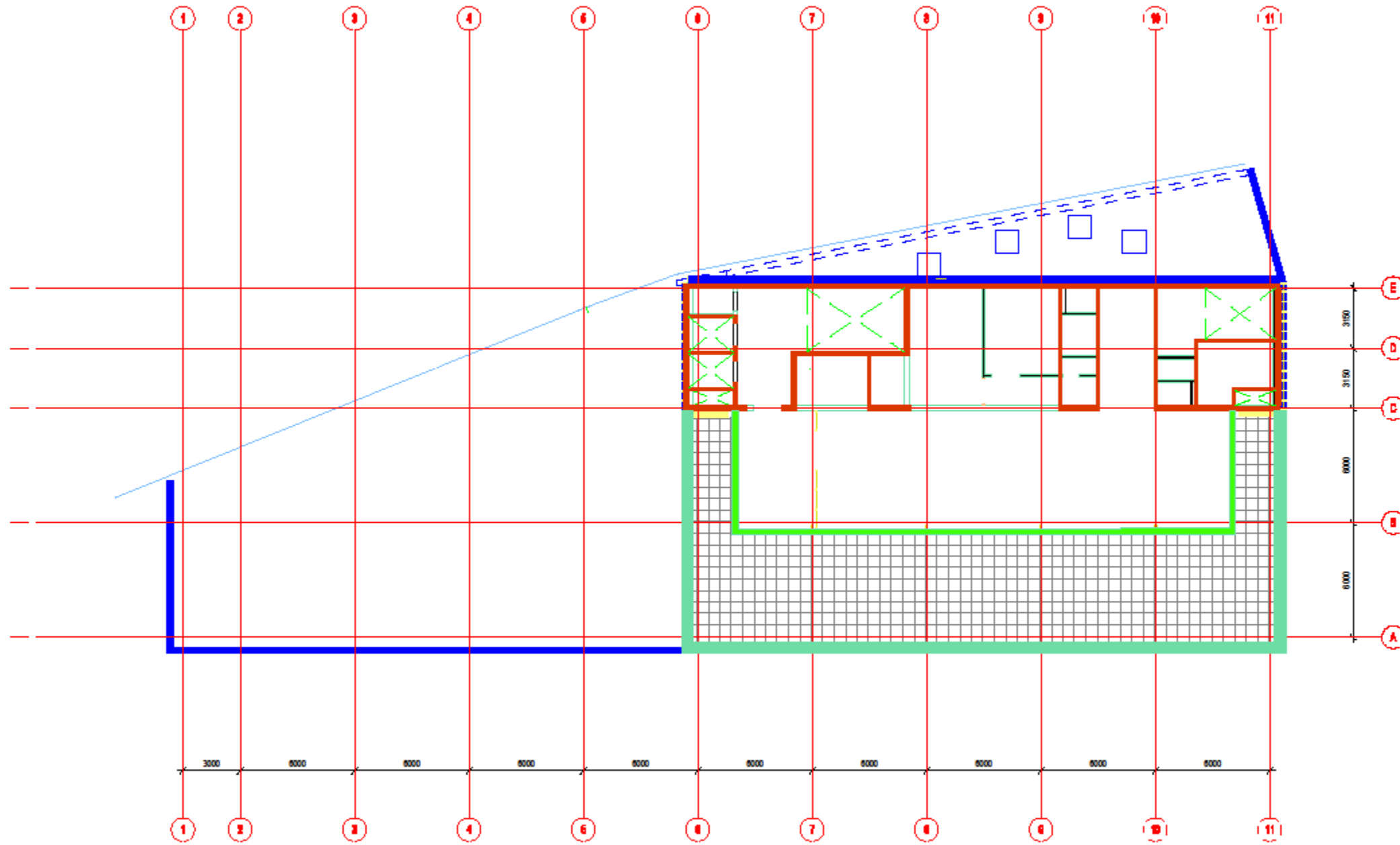


FIGURE 6
THIRD FLOOR PLAN

- STRUCTURAL SHEAR WALL
- RC PARAPET WALL
- LIGHT WEIGHT STEEL FRAMED STRUCTURE