TAYLOR'S UNIVERSITY

Wisdom • Integrity • Excellence

BUILDING TECHNOLOGY 1 [ARC3512]
Prerequisite: Building Structures

Project 2 – Advanced Roof & Industrialised Building System

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INTRODUCTION

OBJECTIVES OF PROJECT

- To develop students' understanding in the advanced roof and different types of IBS construction method.
- To apply appropriate roof system and IBS construction method in their own design.
- To demonstrate a comprehensive understanding of advanced roof and IBS construction process.
- To develop students' understanding in matters related to energy efficiency and ecological impact.
- To foster good communication skills among group members through proper delegation of works and also a proper academic report.

This project predominantly relates to the topics of advanced roof construction, Industrialised Building System (IBS) as well as the embodied energy calculation. Prior to work on this project, we are exposed with different types of advanced roof construction, IBS system and the calculation of embodied energy of different building materials.

This project consists of two parts. The first part is a group component where each group is required to conduct a case study of a building which was constructed using an advanced roof construction and IBS system, to understand the systems better. The second part is an individual component where each student has to apply the construction systems that have been studied to their own building design.

1.0 INTRODUCTION TO ADVANCED ROOF SYSTEM

TENSILE STRUCTURE

A tensile structure is a construction of elements carrying only tension and no compression or bending. Most tensile structures are supported by some form of compression or bending elements, such as masts, compression rings or beams.

The tensile structure is in anti clastic (bi-axial) form where membrane and cables are work in tension. Tensile roof structure can be used to form permanent or temporary structure and is often used in large open spaces as they can economically and attractively span large distances.

OPEN SYSTEM

An open system has a fabric perimeter supported by an integral cable. The loads can be substantial on open systems therefore they require larger foundations than a closed system. Open systems are considered the most sculptural form of tensile structure. The open system support structure can be edge masts, corner tri-pods masts or central masts with 'push-ups'.

CLOSE SYSTEM

A closed system structure consists of rigid members around the edge and closed systems require smaller foundations. In a closed system the fabric edge will be supported continuously by a 'keder' fed into an extruded section, normally fabricated from aluminium.

FABRIC CHARACTERISTIC

	PVC	PTFE	ETFE
Durability	Low	High	Medium
Structural Capability	Medium	High	Medium
Initial Cost	Low	High	Low
Performance	Medium	High	Medium
Translucency	Medium	High	High
Flexibility	High	High	High
Potability	High	Low	High
Color Availability	Yes	No	No
Potential "Creep"	Yes	No	High
Fire Performance	NFPA 701	NFPA 701	DIN 4102
		ASTM E84	CLASS B1
		E108,E136	

ADVANTAGES

i. Simple and efficient structural form
- Can be erected easily

ii. Ability to create long span structures
- Fabric and textile are in light weight

iii. Ability to accommodate flexible cladding materials or membranes

iv. Discrete supports lead to concentrated foundation forces

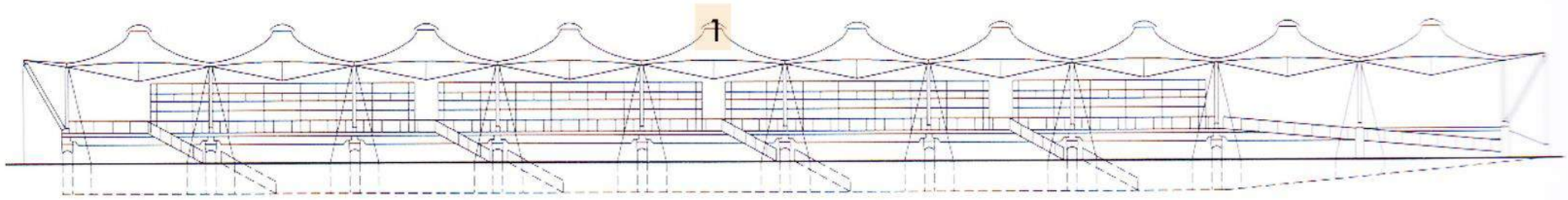
DISADVANTAGES

i. Heavy foundation forces both in compression (under the masts) and in tension (at the tie holding down points)

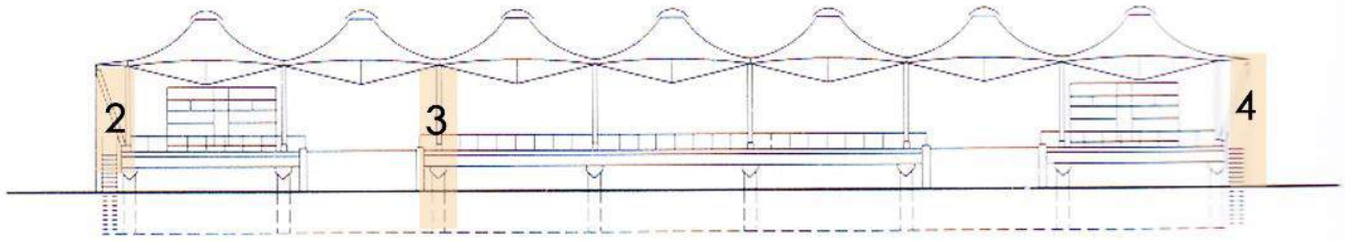
ii. Additional space is required around the structure for the holding down arrangement

iii. Structural elemets or ties often perforate the enclosure

1.3 STRUCTURAL DETAILS



NORTH ELEVATION 1:400

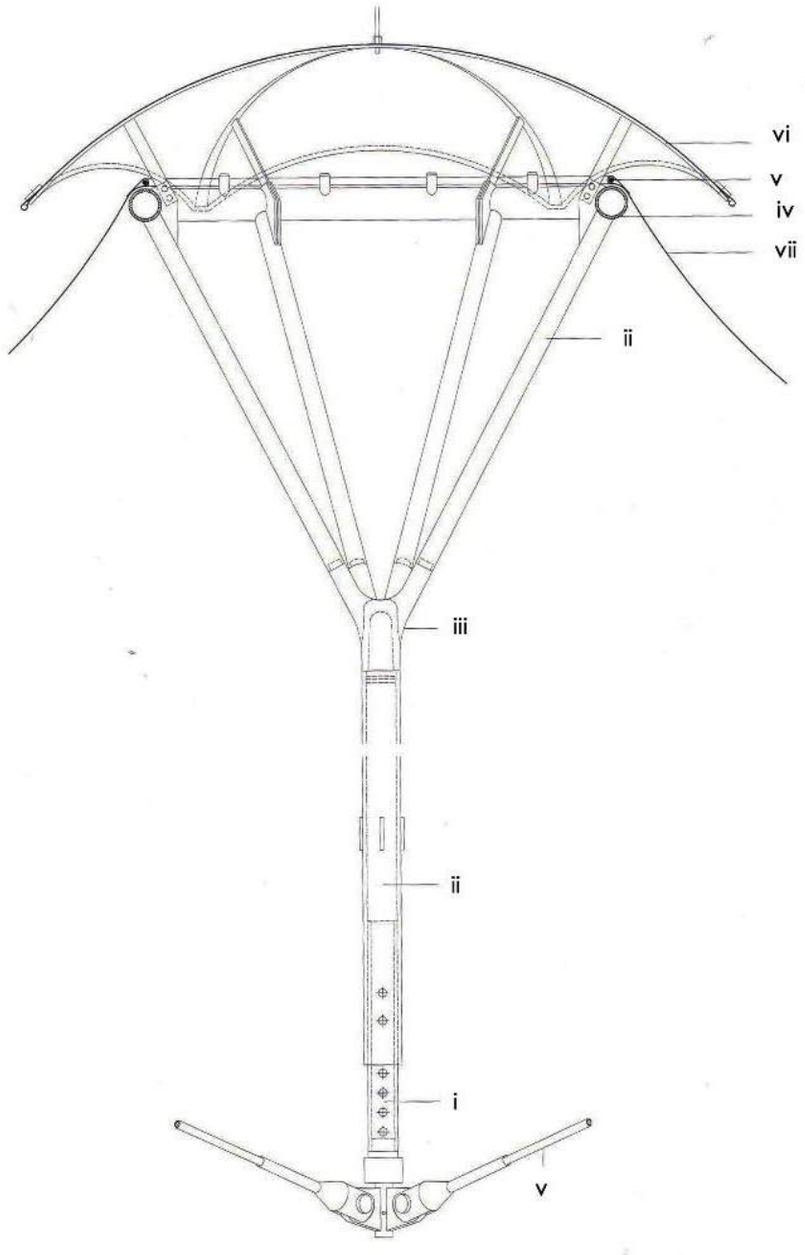


WEST ELEVATION 1:400

1.3 STRUCTURAL DETAILS

DETAIL 1

HIGH POINT 1:20



LEGEND

i. 108mm dia. x 7.1mm tubular steel tensioning element
ii. Suspended support,127.7mm dia.x7.1mm steel tube
iii. Cast steel node
iv. 101.6mm dia.x5mm tubular steel compression ring
v. Steel cable,aluminium zinc coated in membrane pockets:21mm dia. stainless steel cable
vi. 40x90mm flat steel section
vii. Glassfibre textile membrane,1mm PTFE-coated,tear strength 130kN/m

1.3 STRUCTURAL DETAILS

LEGEND

i. 40x6mm flat steel clamping ring,
80x4mm flat steel ring

ii. 193.7mm dia. x 20mm tubular steel edge column
177.8mm dia. x 5mm tubular steel hinged column
60mm dia. x7.1mm tubular steel suspended support

iii. Steel pivot

iv. Aluminium zinc (Al5%) coated steel cable,
Horizontal tensioning: 22mm dia. open spiral strands;
Vertical tensioning: 40mm dia. fully locked strands
In membrane pocket: 21mm dia. stainless steel cable

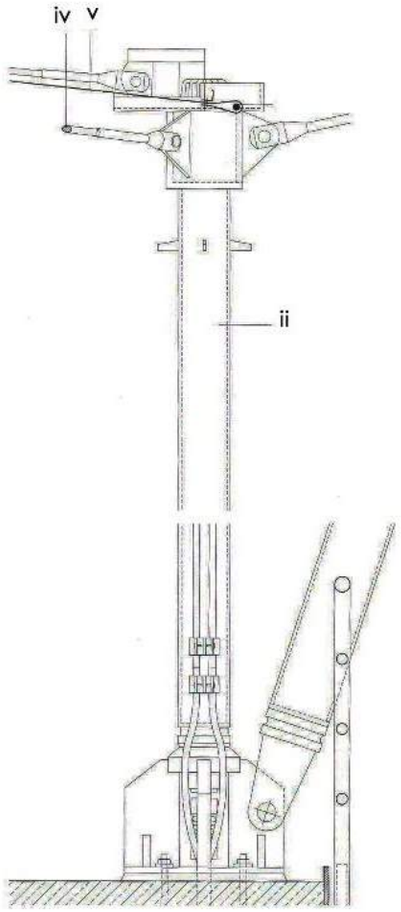
v. Glassfibre textile membrane, 1mm PTFE coated, tear strength 130kN/m

vi. Insulated and heated 50mm downpipe

vii. Electrical cabling for heating

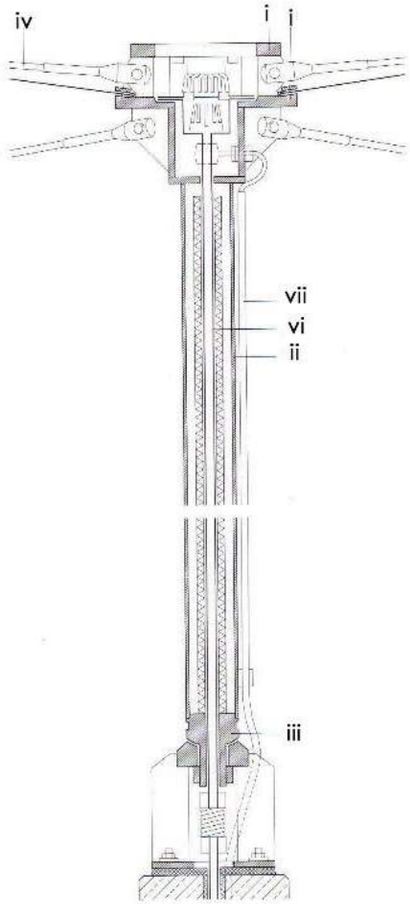
DETAIL 2

EDGE COLUMN 1:20



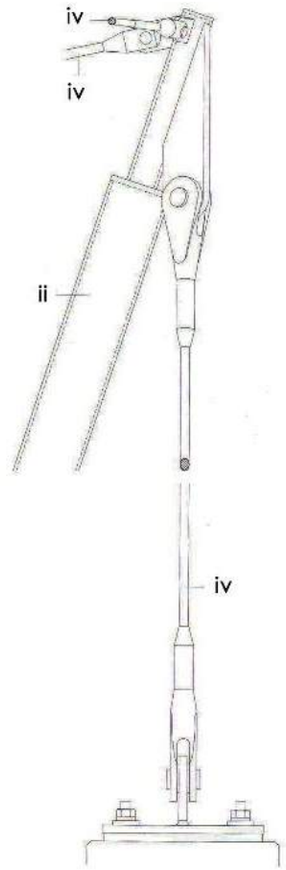
DETAIL 3

INSIDE COLUMN 1:20



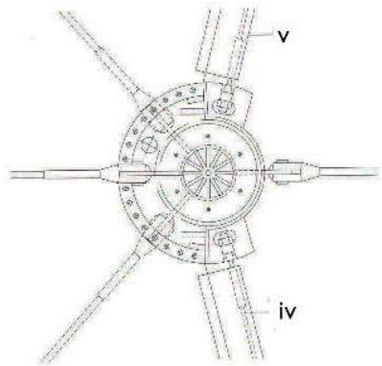
DETAIL 4

TENSION SYSTEM 1:20

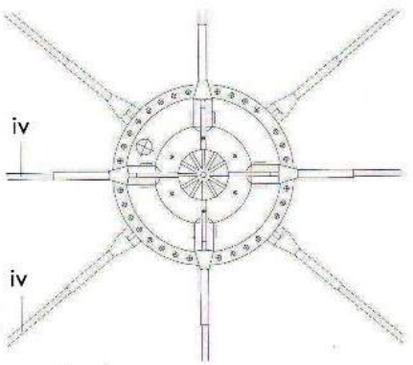


JOINT DETAILS 1:20

DETAIL 2A



DETAIL 3A



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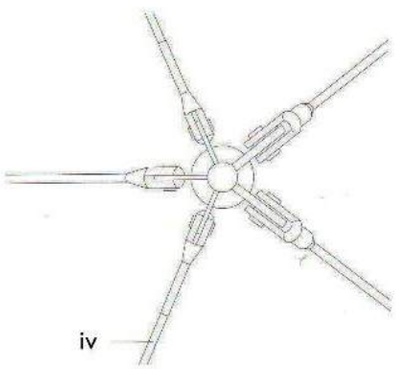


INTRODUCTION TO INDUSTRIALISED BUILDING SYSTEM (IBS)

IBS IN MALAYSIA

IBS in Malaysia has begun in early 1960's when Ministry of Housing and Local Government of Malaysia visited several Europe-an countries and evaluate their housing development program (Thanoon et. al., 2003). After their successful visit in 1964, the government had started first project on IBS aims to speed up the delivery time and built affordable and quality houses.

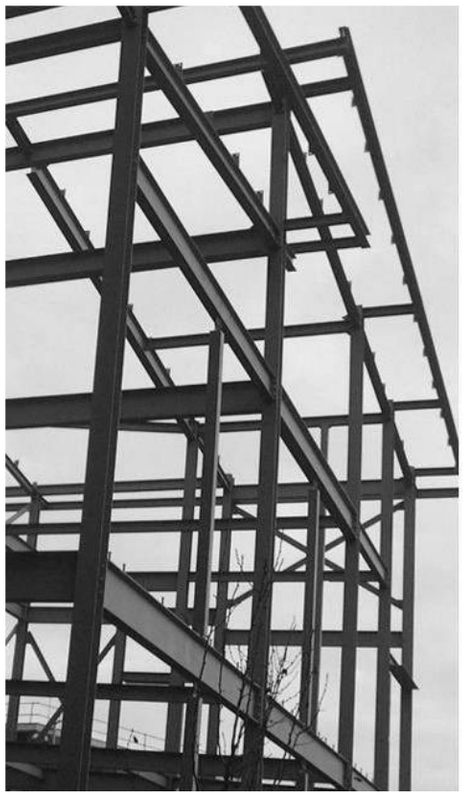
In line with the development of more efficient building technologies, the Malaysian construction industry is moving towards the adoption of IBS to shorten the construction period, lower costs and ensure better construction quality.

Current systems in Malaysia which supports the usage of Industrialised Building Systems (IBS) are mainly a close system, where there are five main IBS groups identified as following:

PRECAST SYSTEM

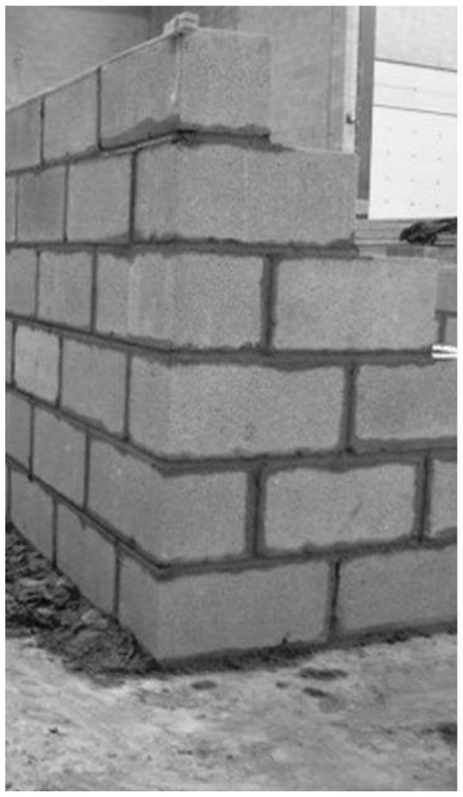
FORMWORK SYSTEMS

STEEL FRAMING SYSTEMS



PREFABRICATED TIMBER FRAMING

BLOCK WORK SYSTEMS



INTRODUCTION TO INDUSTRIALISED BUILDING SYSTEM (IBS)

IBS is a system of construction which uses industrial production techniques either in the production of components or assembly of buildings, or both. One of these techniques is the utilisation of standardised forms of pre-cast concrete and prefabricated steel structures in construction works. The system also involves offsite, and to a lesser extent, on-site, mass production of building components. This system of construction allows for a more efficient and cost effective construction cycle because the pre-cast concrete and prefabricated steel structures for each individual project are customised and standardized. In addition, there will be improvements to the quality of these pre-cast concrete and prefabricated steel structures as there will be greater consistency in the fabrication of these structures. Such pre-cast concrete and prefabricated steel structures are particularly useful for high rise buildings or mass housing estates where a similar structure can be replicated numerous times.

The system can be divided into open building system and close building system.

OPEN BUILDING SYSTEM

A system which allows the production of building components by various factories and to be compatible with each other to be used in any building project.

CLOSE BUILDING SYSTEM

A system where all elements of industrial production of components are used for specific projects. The system does not allow for the interchangeability of components from different factories.

INTRODUCTION TO INDUSTRIALISED BUILDING SYSTEM (IBS)

According to CIDB (2003), compares to conventional construction method, the industrialised building system has the following advantages:

i. Less construction time
Casting of precast element at factory and foundation work at site can occur simultaneously and the work at site is only the erection of IBS components.

ii. Cost savings
The formwork of IBS components allow for repetitive use and this leads to considerable cost savings.

iii. Saving in labour
Higher degree of utilisation of machine is permitted and the use of labour will be reduced and lead to saving in labour cost.

iv. Less labour at site
The use of IBS will reduce the construction process at site and consequently reduce the number of labour required at site.

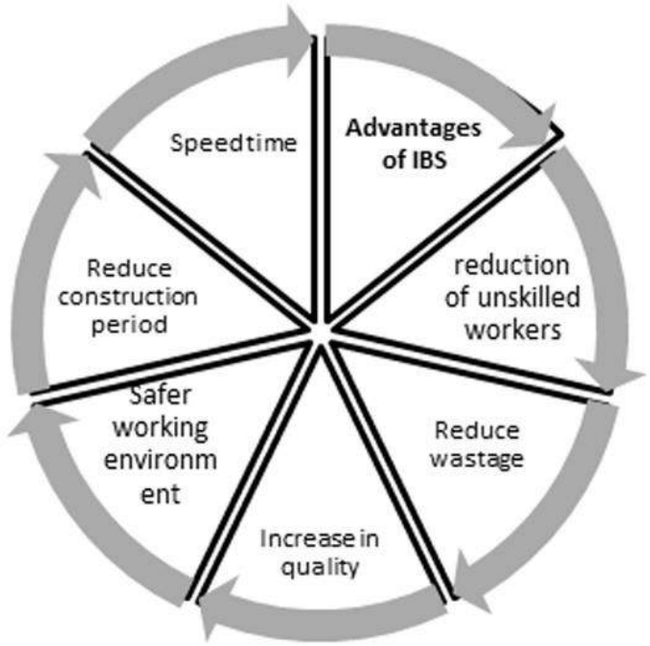
v. Optimised use of material
The utilisation of machine during the production of IBS components lead to higher degree of precision and accuracy in the production.

vi. Higher quality and better finishes
Due to the careful selection of materials, use of advanced technology, better and strict quality assurance control since production in factory is under sheltered environment.

vii. Construction operation less affected by weather
The effects of weather on construction operation are less due to the fabrication of IBS components is done in factory while at site is only erection of the components.

viii. Flexibility
Different systems may produce their own unique prefabrication construction methods. ix. Increase site safety and neatness.

ADVANTAGES



INTRODUCTION TO INDUSTRIALISED BUILDING SYSTEM (IBS)

IBS often misinterpreted with negative image due to its unattractive architecture, Rahman & Omar (2006). Aside from that, IBS are not familiar or make a deep impact in the industry due to other factors,

i. IBS is not favourable and popular among designers

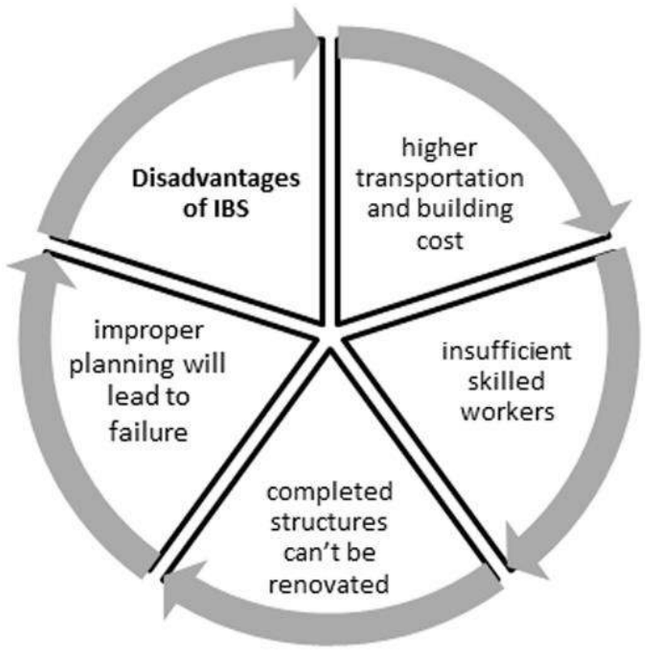
ii. Lack of understanding of among designers, client and contractors

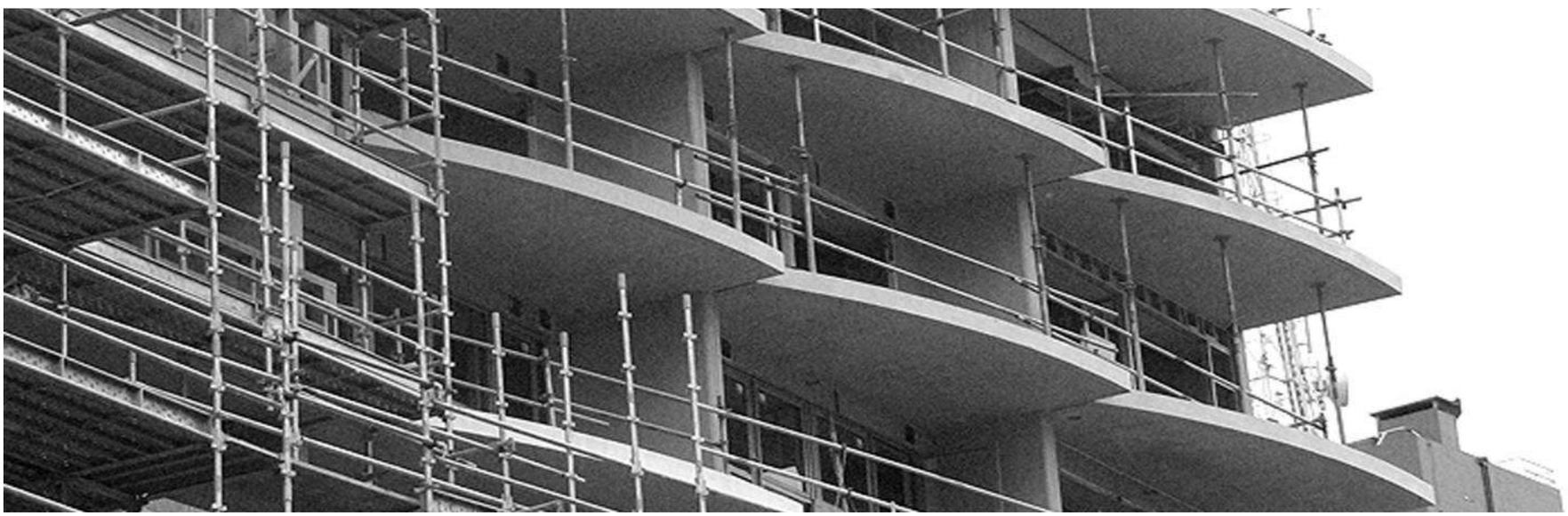
iii. Slow adoption among contractors with the available systems and high degree of skills, mechanism, coordination and logistic for transportation and erection of the system.

iv. The lest standardized and non-concurrent for joints, design, adaptation, chemistry of the components produced coupled with the poor quality and bad aesthetic outlook have make it much harder to promote it within the build communities especially contractors.

v. The chances of securing a continuous project from government worries the contractor in term of cash flow where the break event point after investing on IBS system

DISADVANTAGES





INTRODUCTION TO CASE STUDY 1

APPLICATION OF PRECAST IN RESIDENTIAL BUILDING

INDAH HEIGHTS
THREE STOREY CLUSTER HOUSE

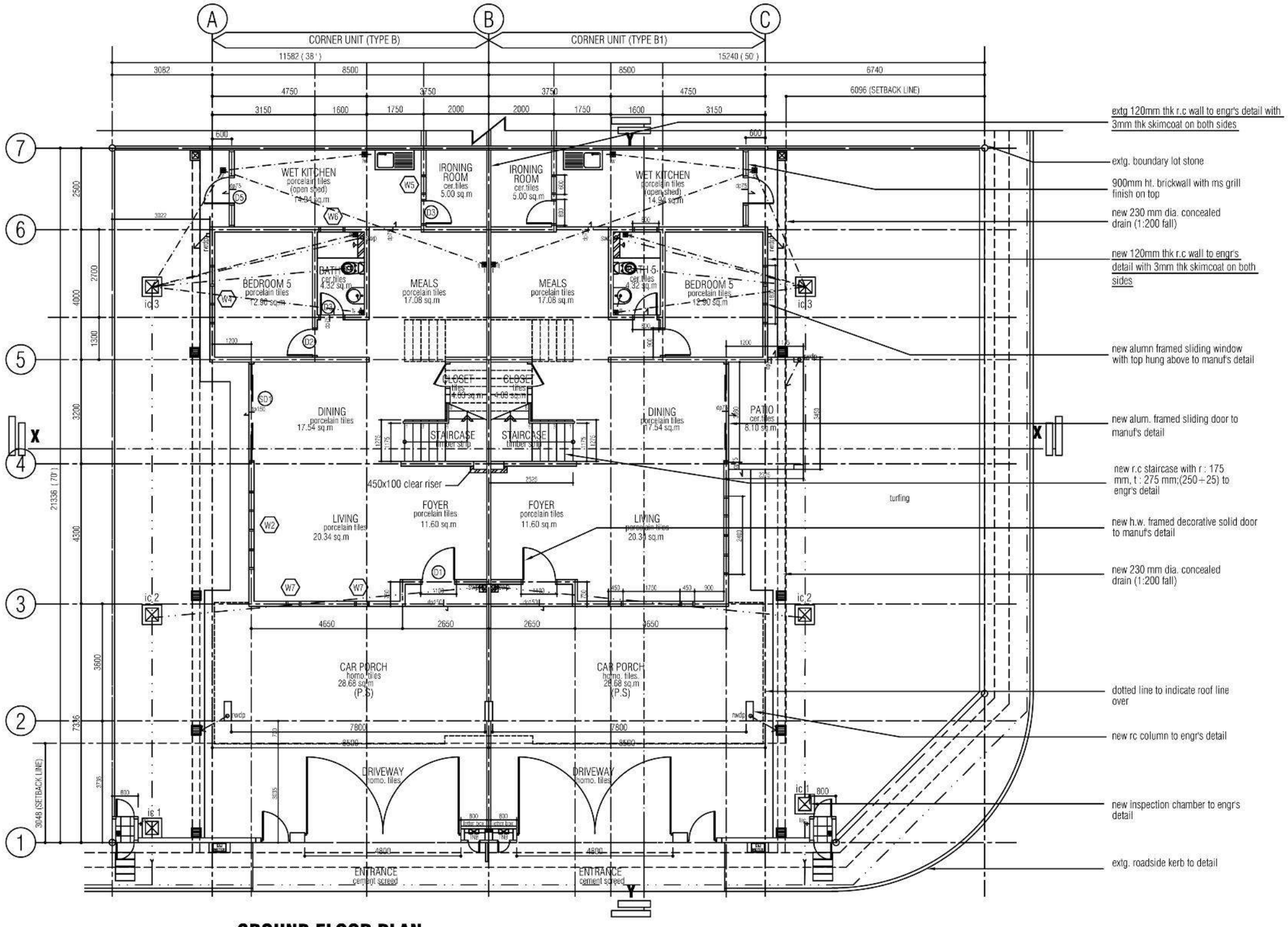
Build Up Size : 3280 sq ft
Contractor : KIMLUN Sdn Bhd
Owner : Scudai Development Sdn Bhd
Town Ship : Taman Skudai Indah 2, Johor, Malaysia
Architect : DC Akitek (M) & Rakan-rakan

LOCATION MAP

Scudai Development Sdn Bhd, whose business activities range from construction, precast concrete manufacturing and quarry, specialises in the development of high-quality residential property development including single and double storey terrace houses , semi-detached houses and high-rise apartments.

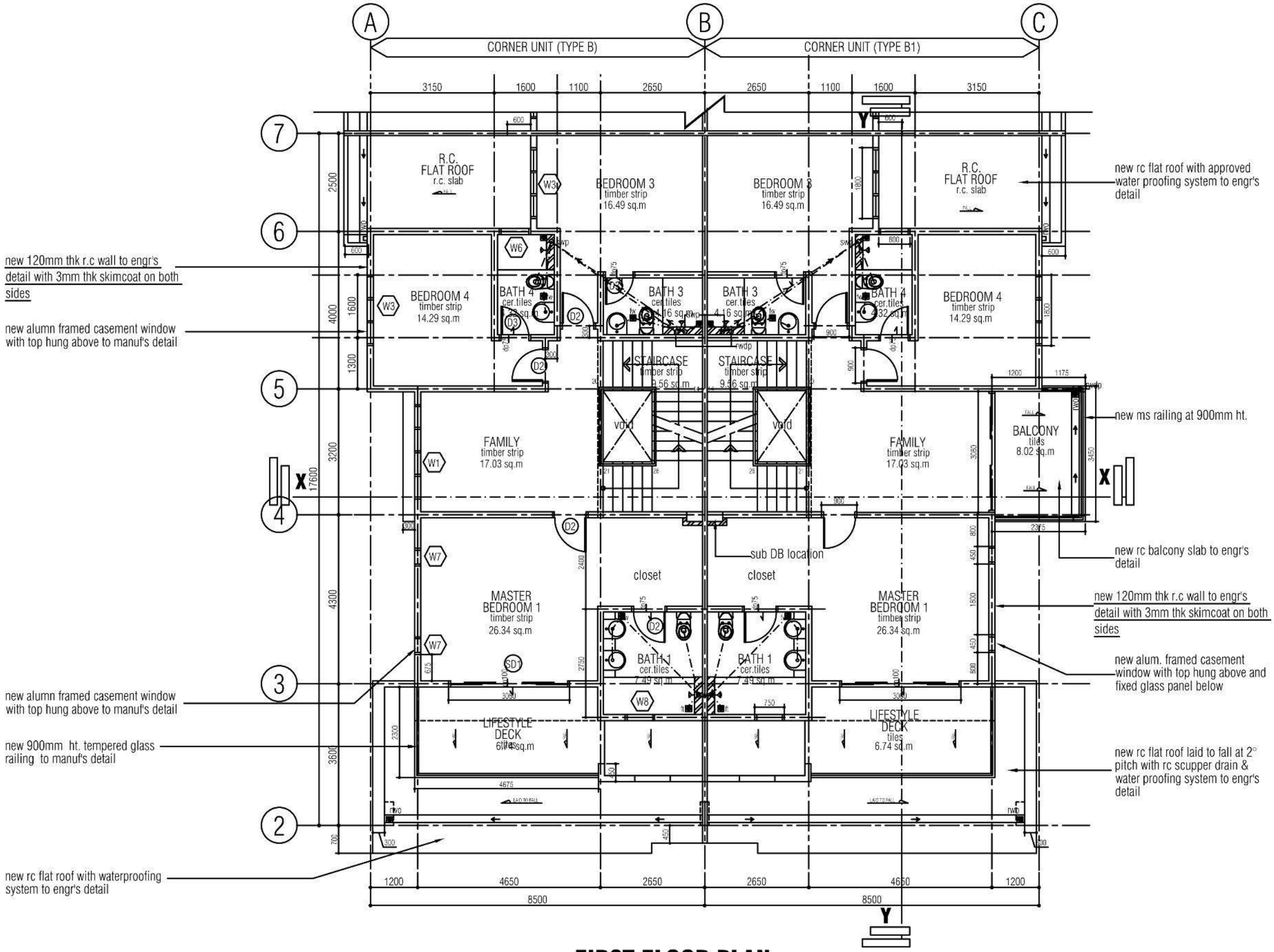
Considering precast concrete products offer design flexibility, excellent quality assurance and many other benefits that make it a wise choice, so it seems its widespread use into the residential market should be a natural fit.

The Three Storey Cluster House is constructed partially using IBS with the use of precast concrete components throughout the building.



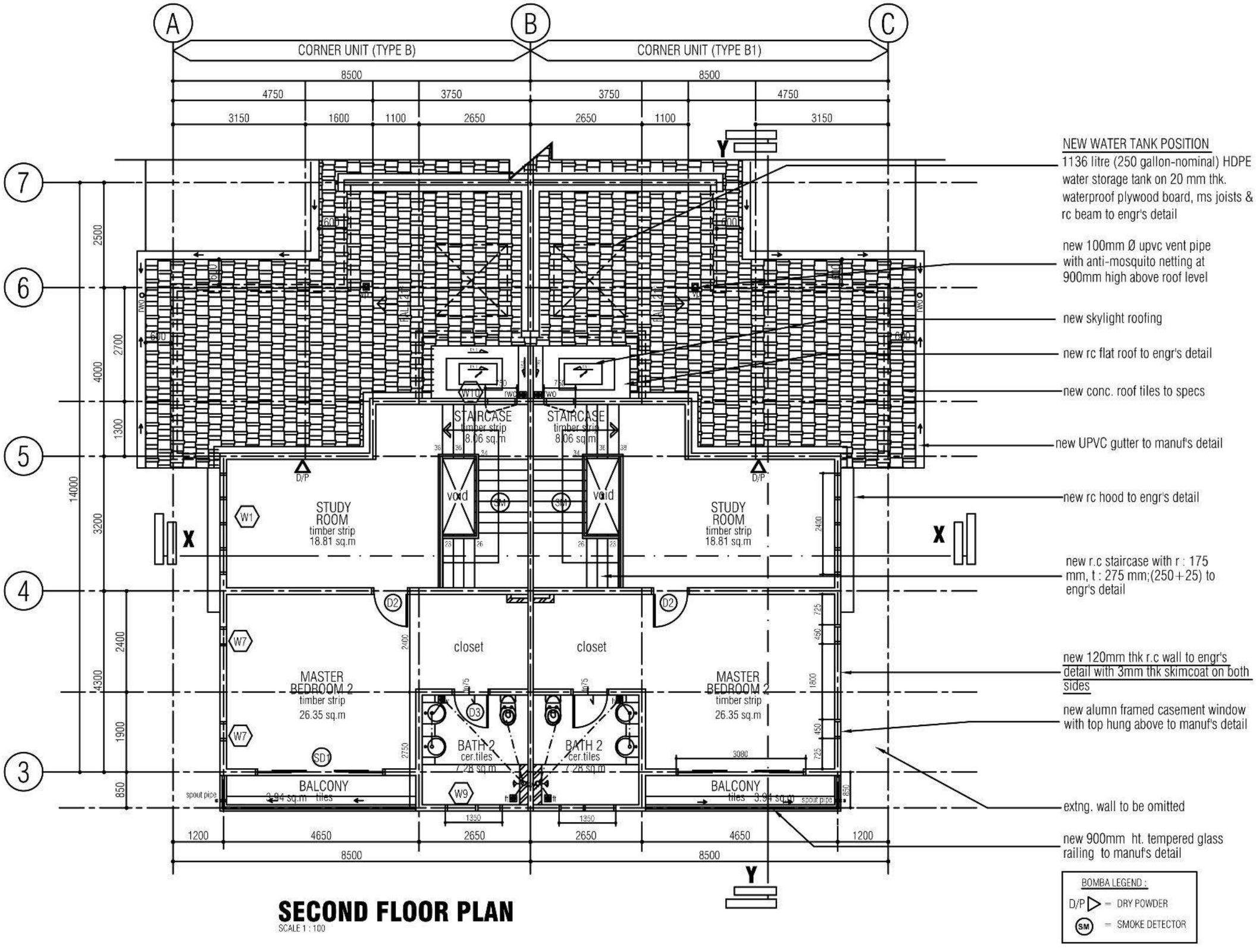
GROUND FLOOR PLAN

SCALE 1 : 125



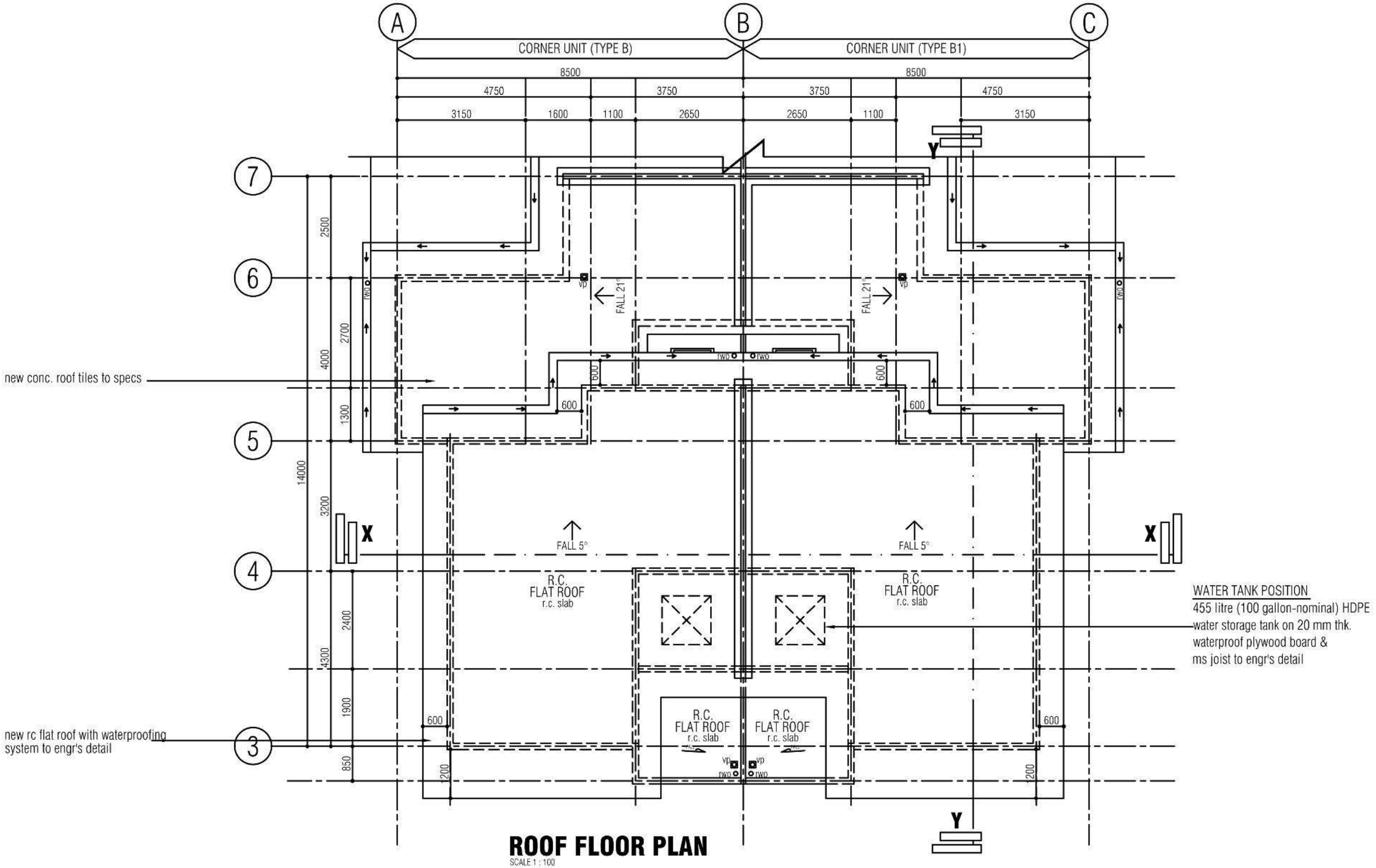
FIRST FLOOR PLAN

SCALE 1 : 100



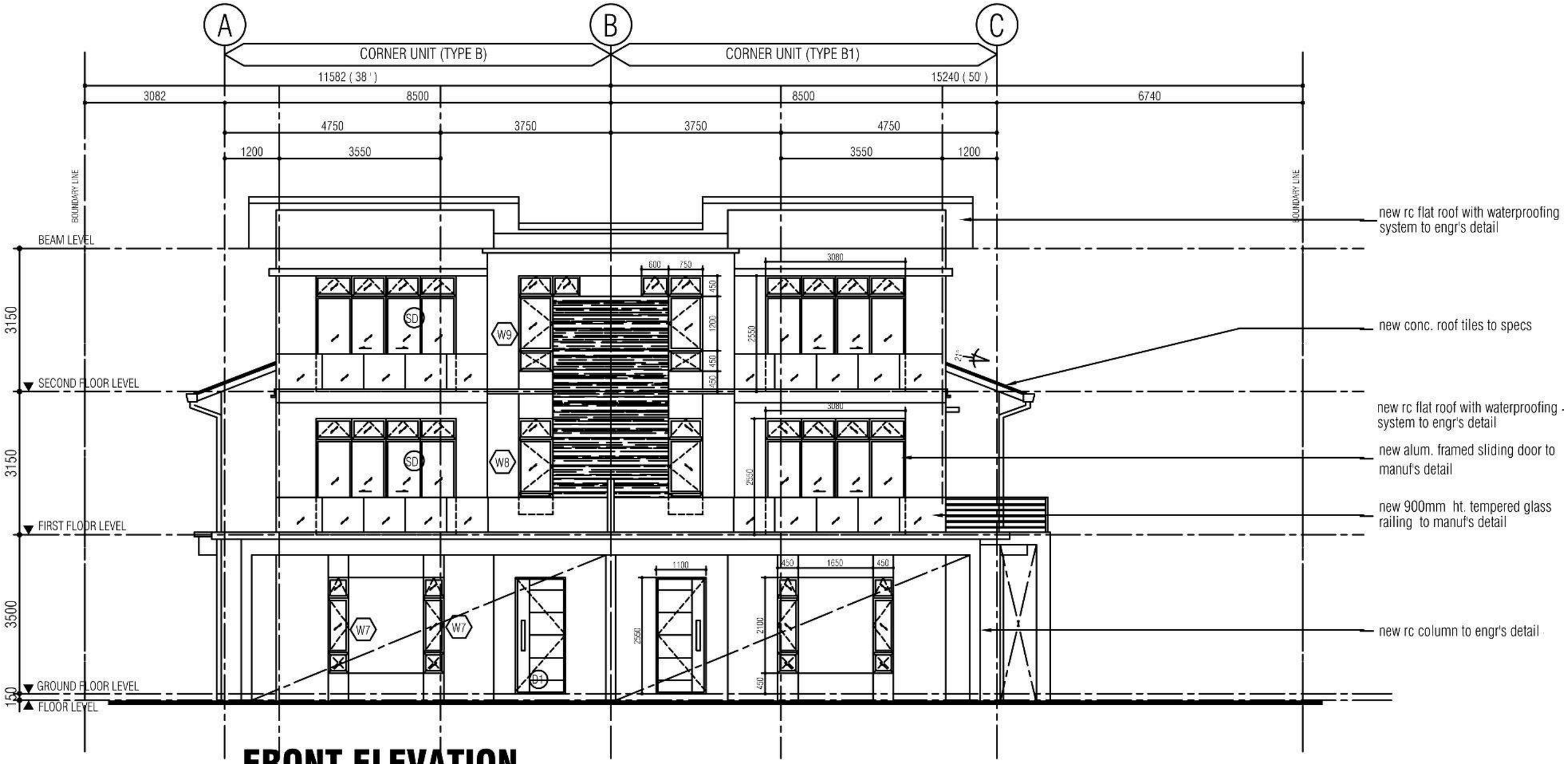
SECOND FLOOR PLAN

SCALE 1 : 100



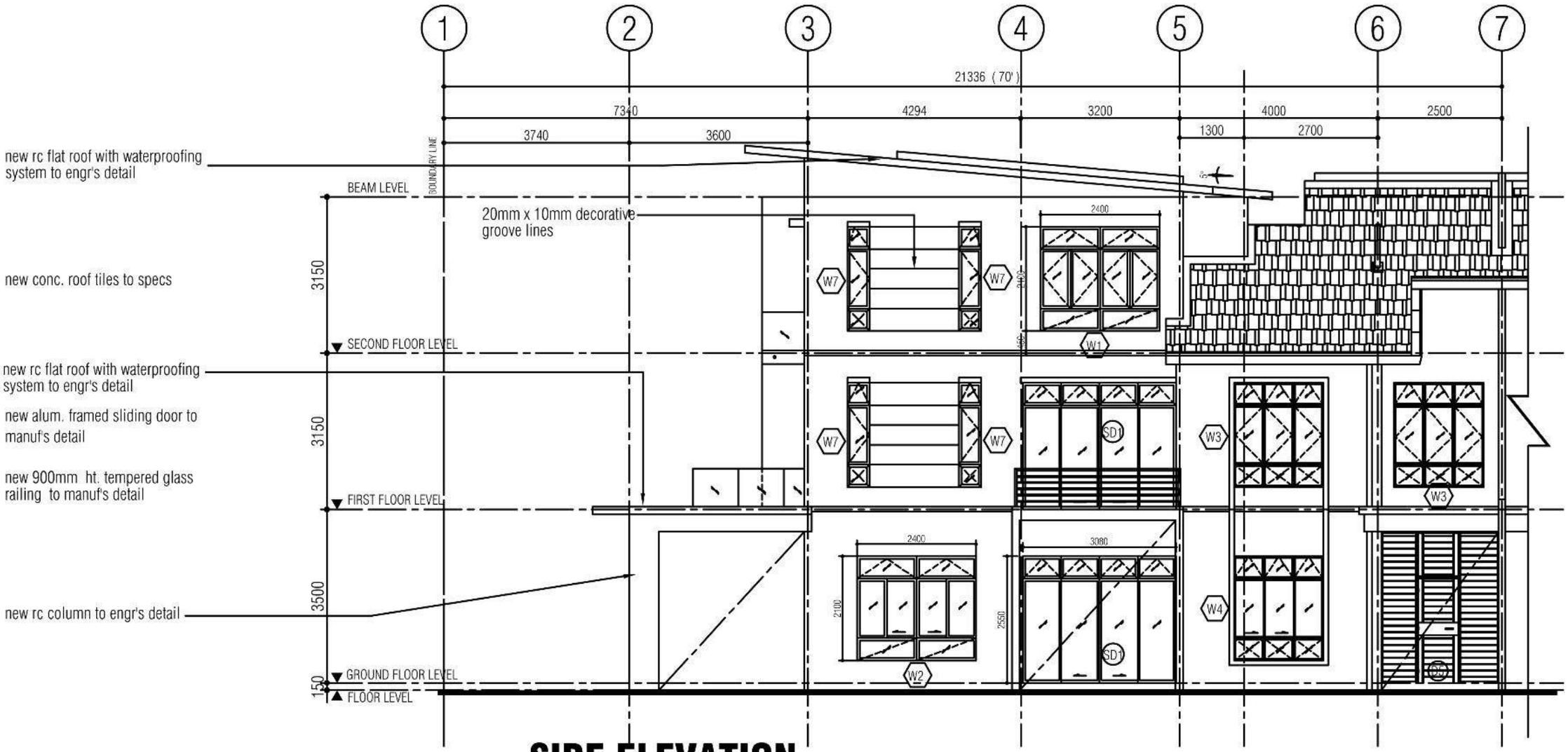
ROOF FLOOR PLAN

SCALE 1 : 100



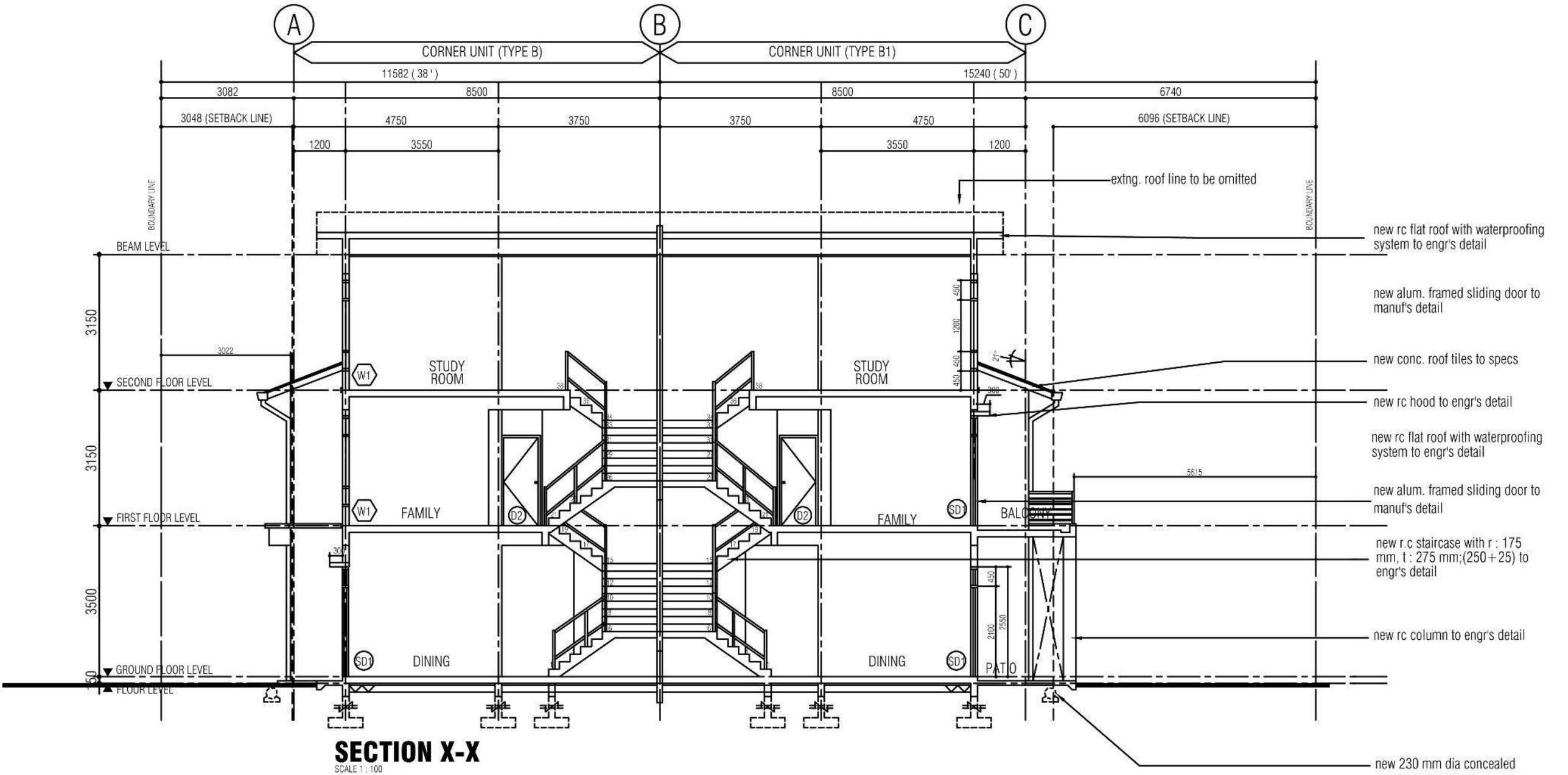
FRONT ELEVATION

SCALE 1 : 100



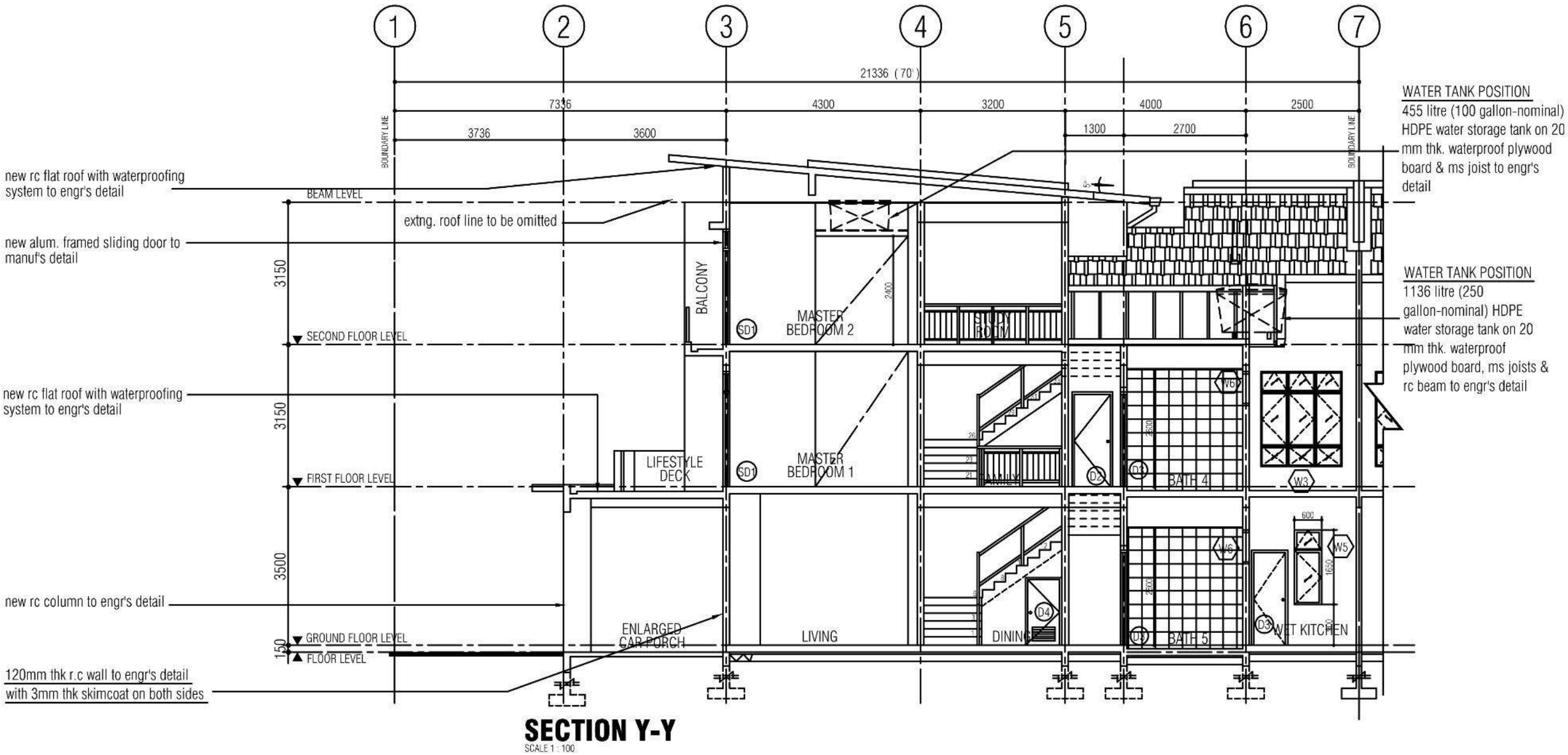
SIDE ELEVATION

SCALE 1 : 100



SECTION X-X

SCALE 1 : 100



SECTION Y-Y

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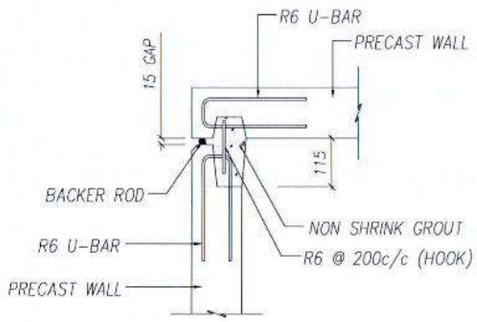
JOINT DETAILS *BETWENN PRECAST WALL & SLAB*



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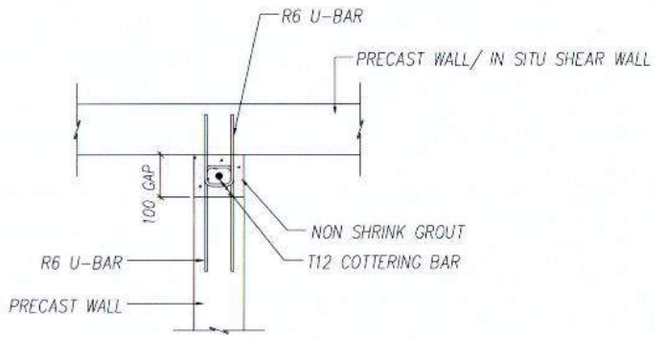

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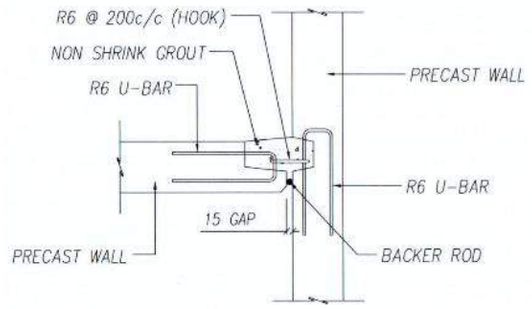

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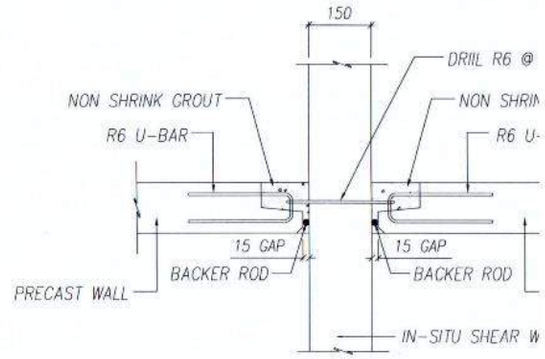

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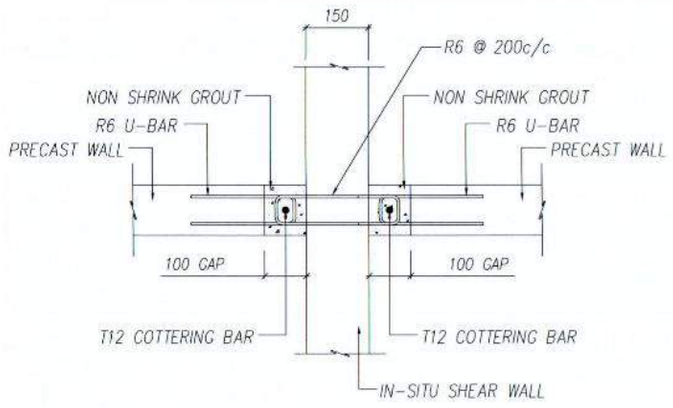

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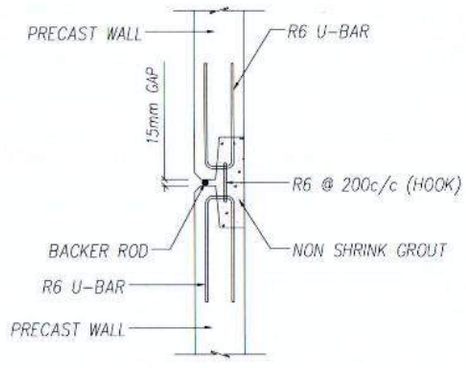

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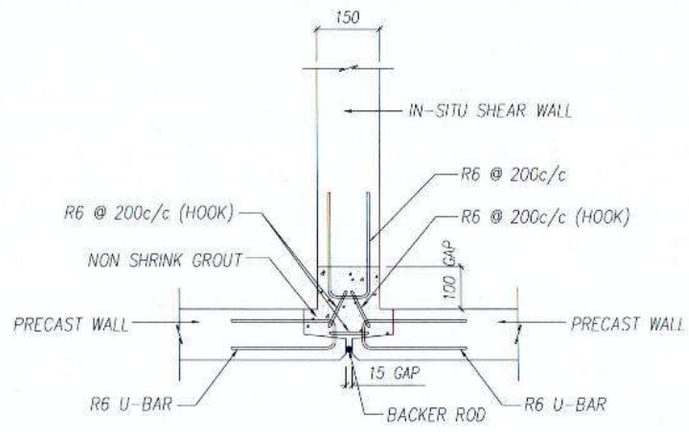

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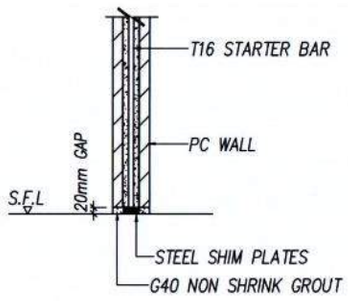

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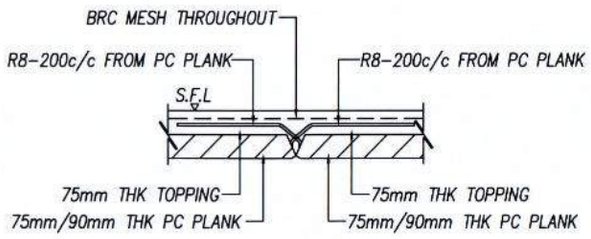

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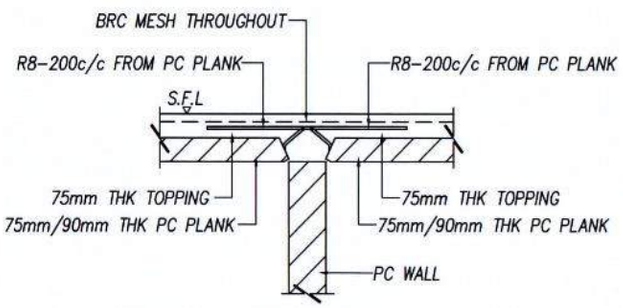
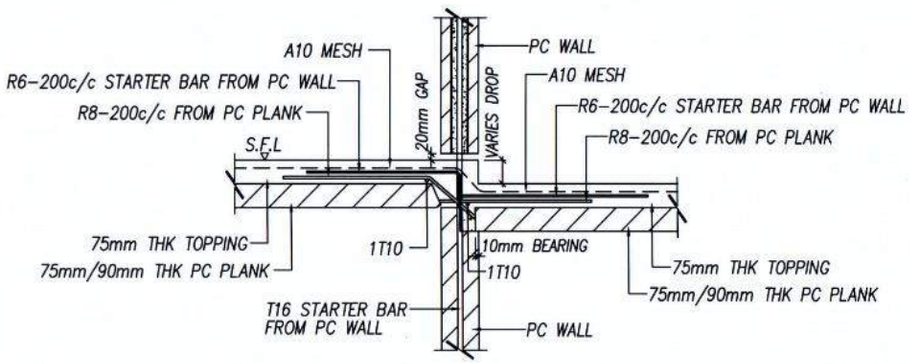


DETAIL 10

JOINT DETAILS *BETWENN PRECAST WALL & SLAB*



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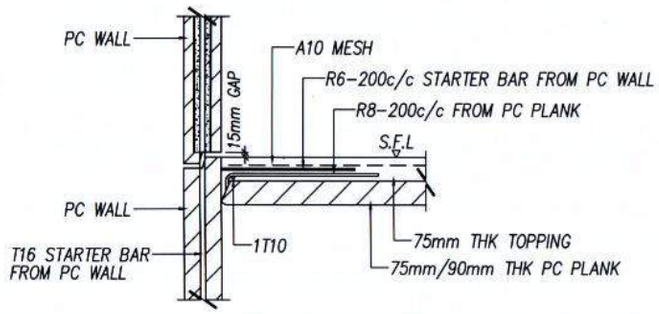

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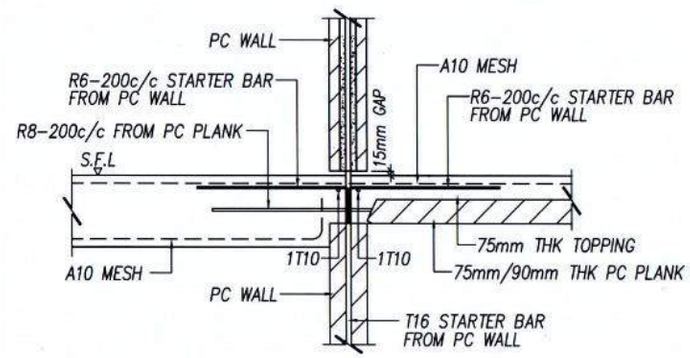

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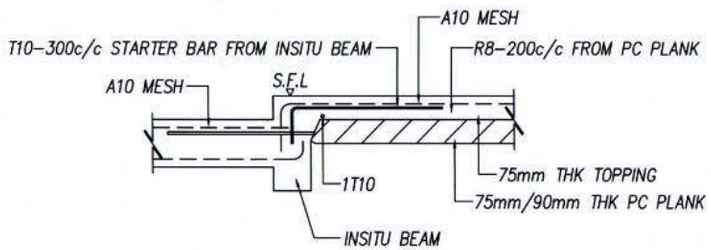

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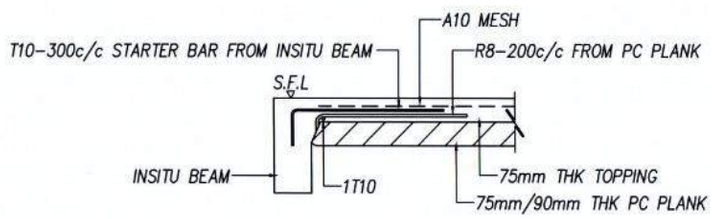

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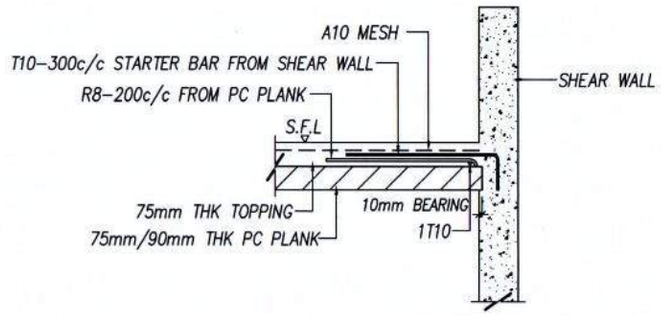

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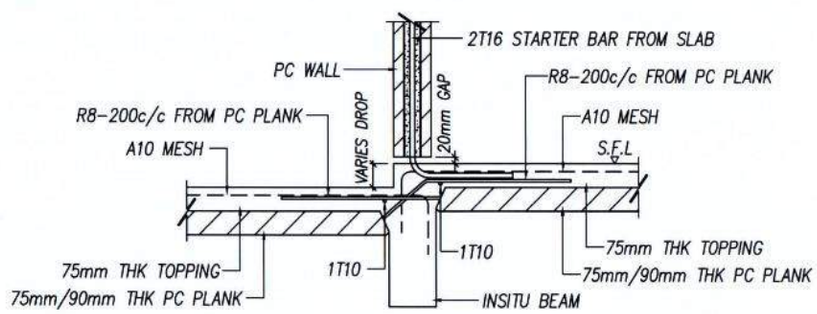

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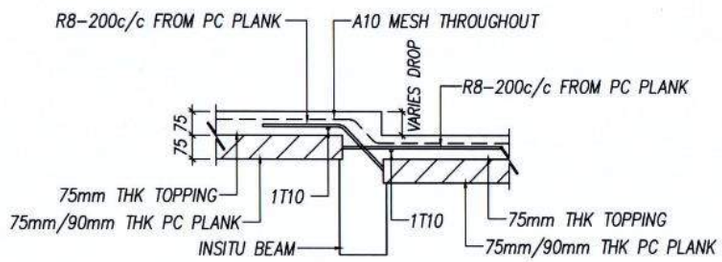


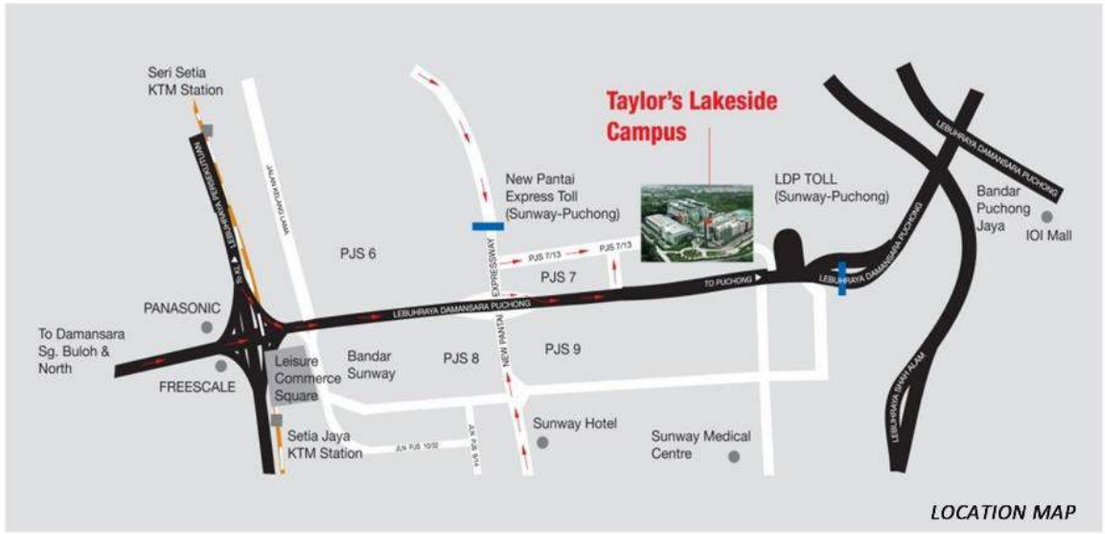
DETAIL 18

INTRODUCTION TO CASE STUDY 2

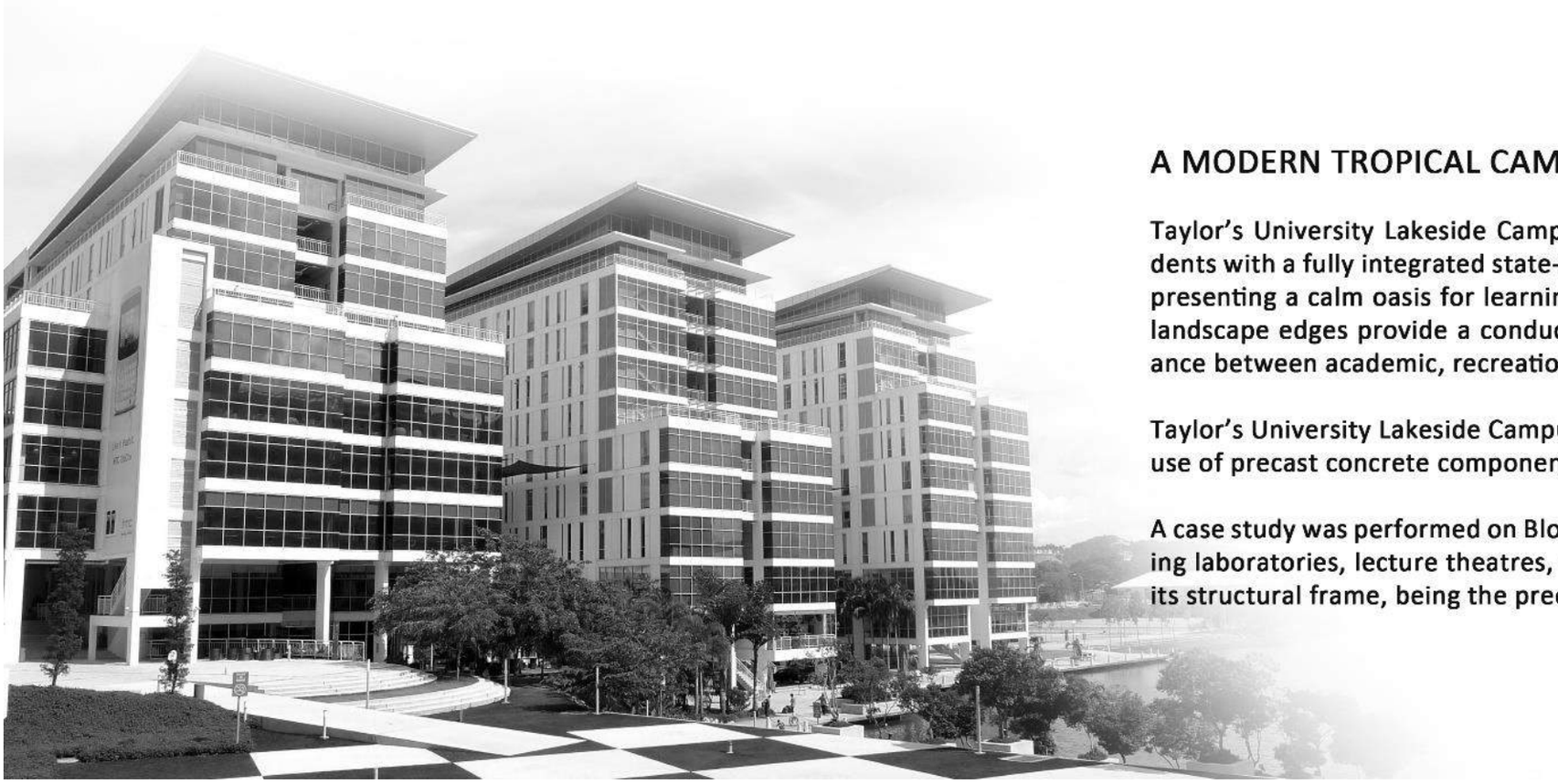
APPLICATION OF PRECAST IN COMMERCIAL BUILDING

TAYLOR'S UNIVERSITY, LAKESIDE CAMPUS

Gross Floor Area : 76,551 m2
Building Height : 40m
Owner : Taylor's College Sdn Bhd
Address : No. 1, Jalan Taylor's, 47500 Subang Jaya, Selangor Darul Ehsan.
Architect : NWKA Chartered Architect
Principal Architect: Ar. Ng Wai Keong



LOCATION MAP

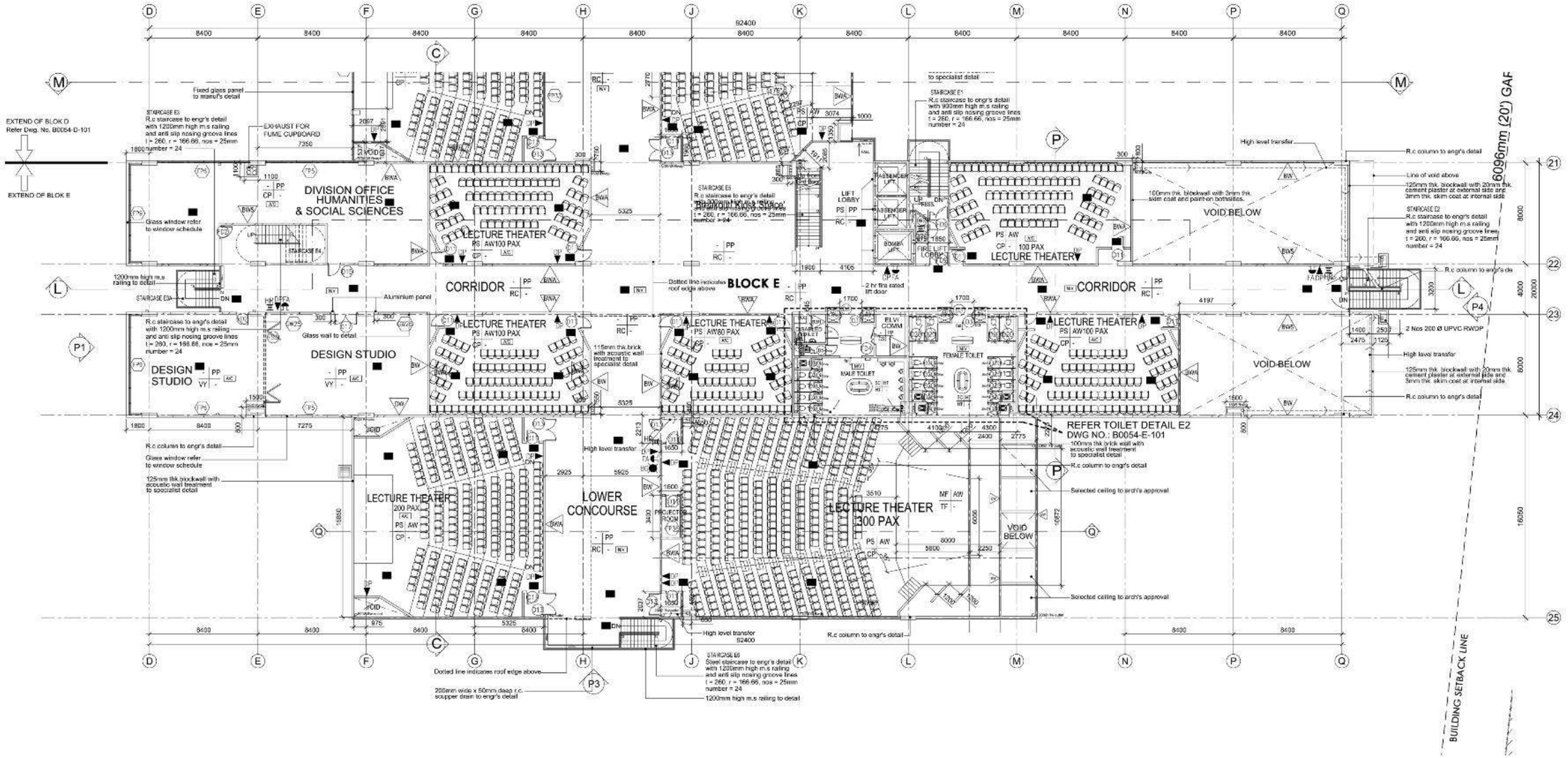


A MODERN TROPICAL CAMPUS

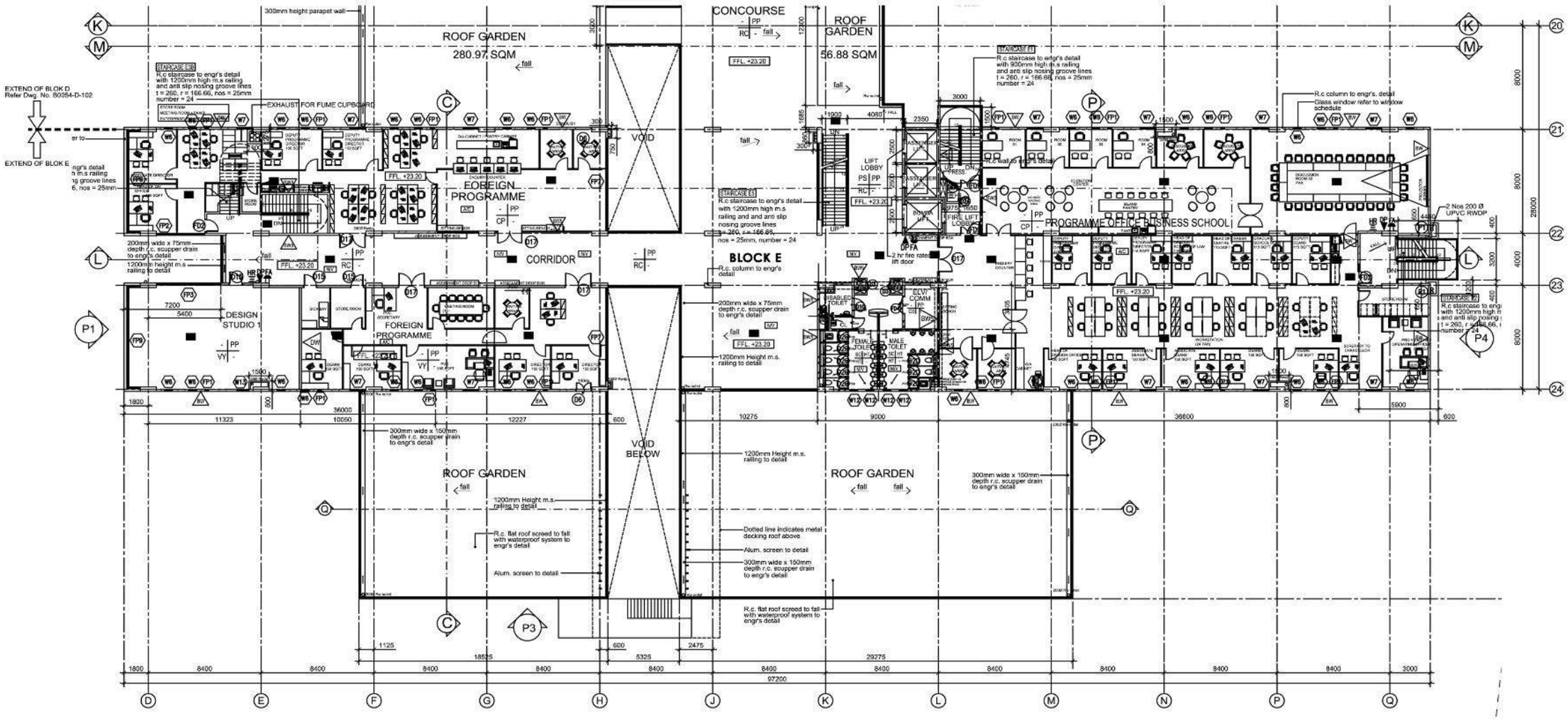
Taylor's University Lakeside Campus aims to provide up to 12,000 local and foreign students with a fully integrated state-of-the-art facility expressed in a modern tropical design, presenting a calm oasis for learning. Centred around a 5.5-hectare rehabilitated lake, the landscape edges provide a conducive setting for interaction and exchange, striking a balance between academic, recreation, social and leisure activities.

Taylor's University Lakeside Campus was constructed partially using IBS with the extensive use of precast concrete components throughout the buildings.

A case study was performed on Block E, which accommodates gallery, carpentary, enginerring laboratories, lecture theatres, design studios as well as offices, specifically to study on its structural frame, being the precast columns and beams.

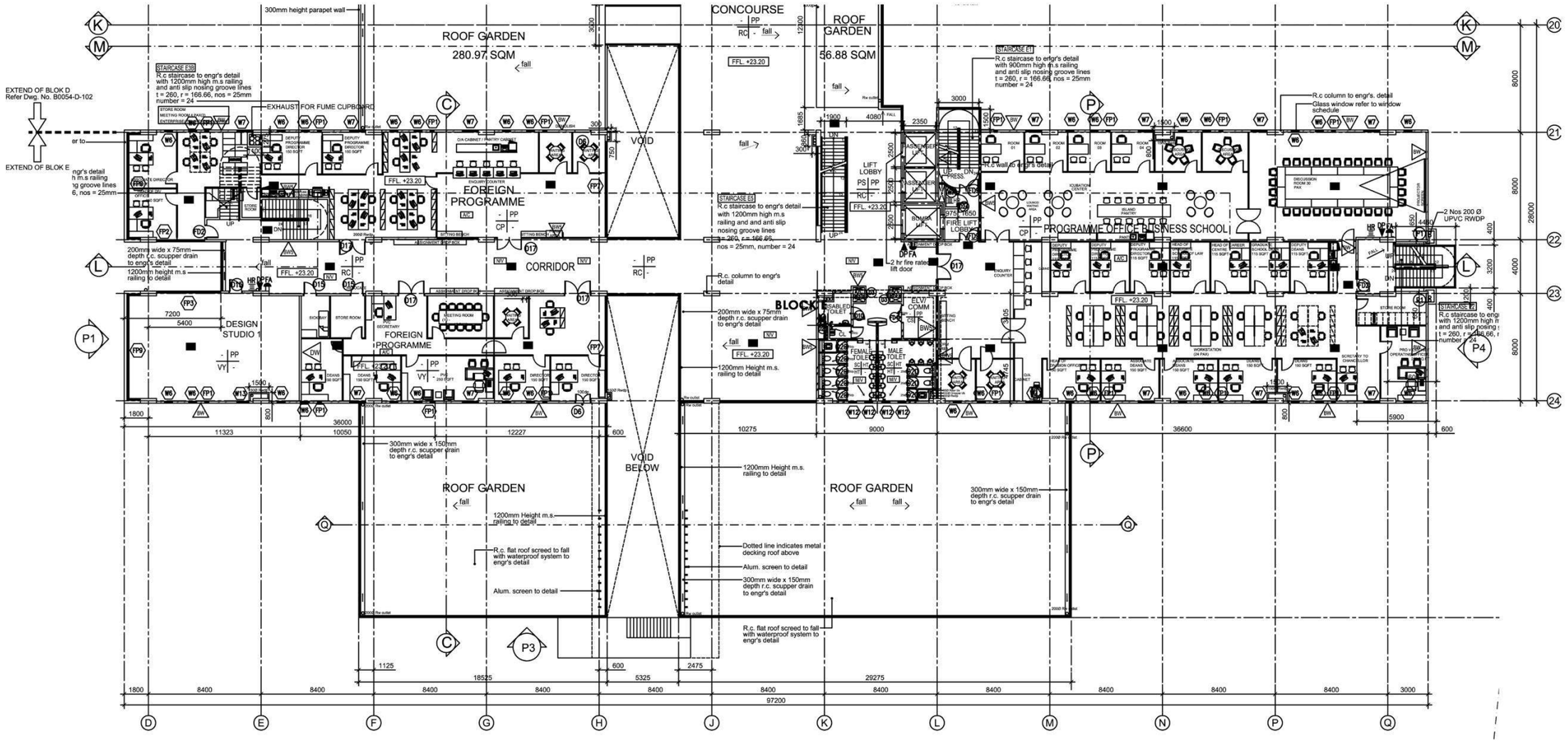


FIRST FLOOR PLAN
SCALE 1:350

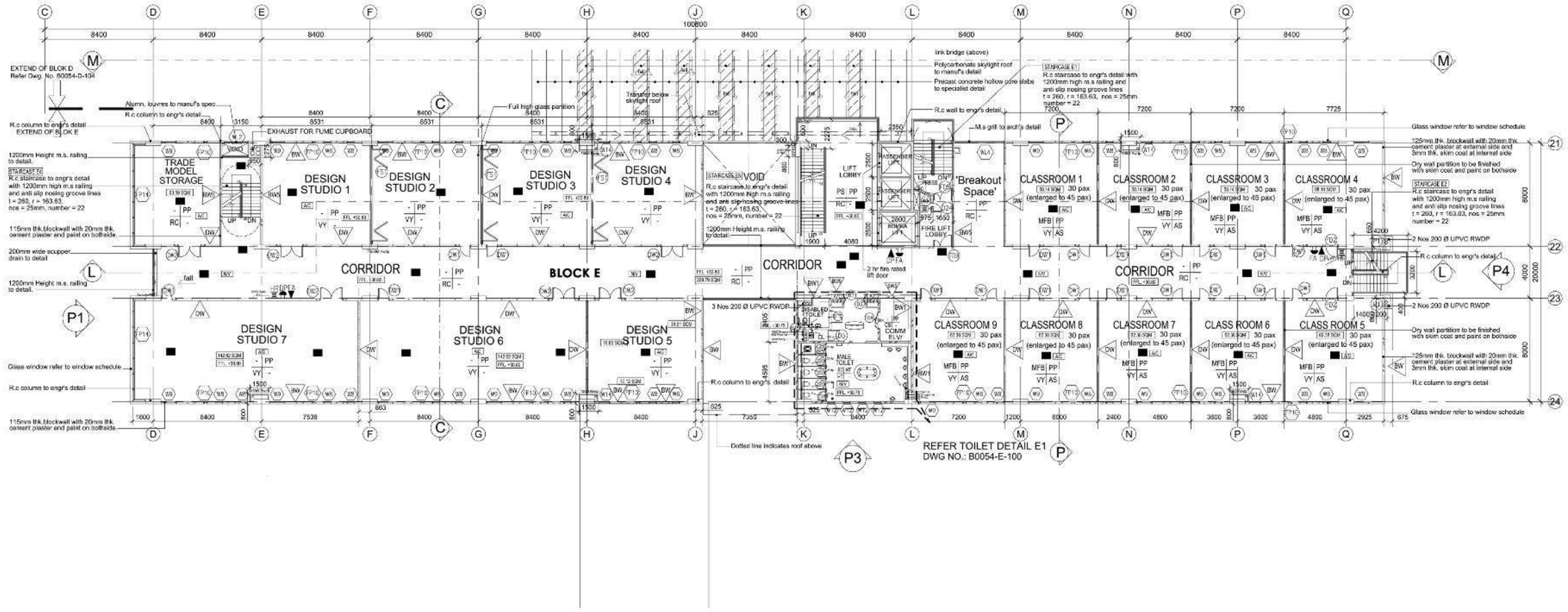


PELAN LANTAI TINGKAT 2 (BLOK E)
SKALA 1 : 200

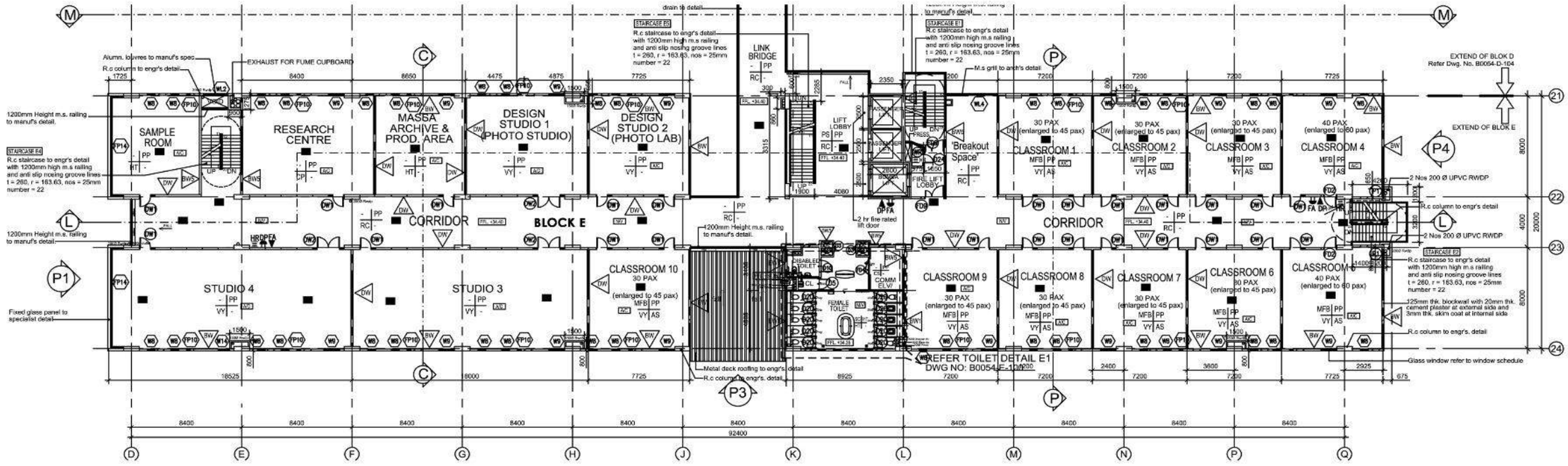
SECOND FLOOR PLAN
SCALE 1:350



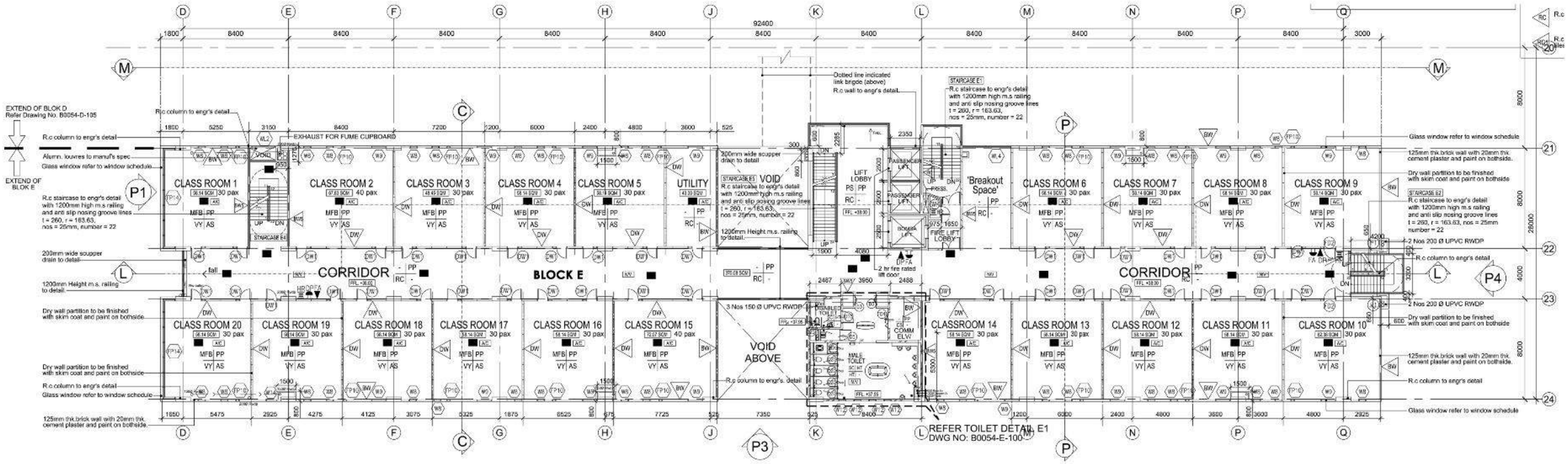
THIRD FLOOR PLAN
SCALE 1:350



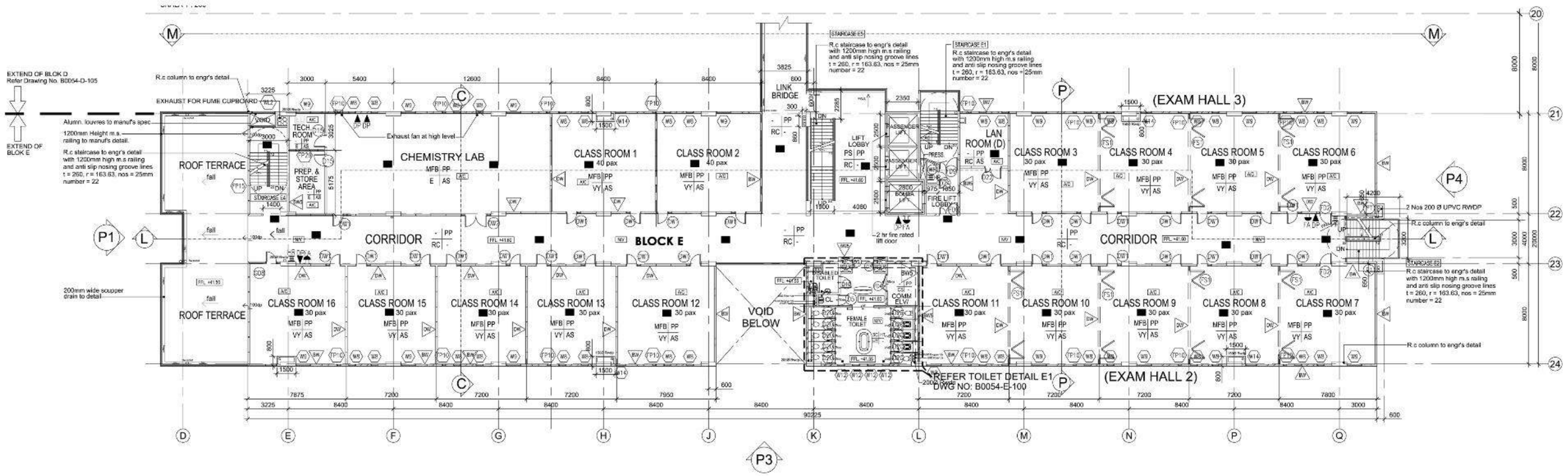
FOURTH FLOOR PLAN
SCALE 1:350



FIFTH FLOOR PLAN
SCALE 1:350

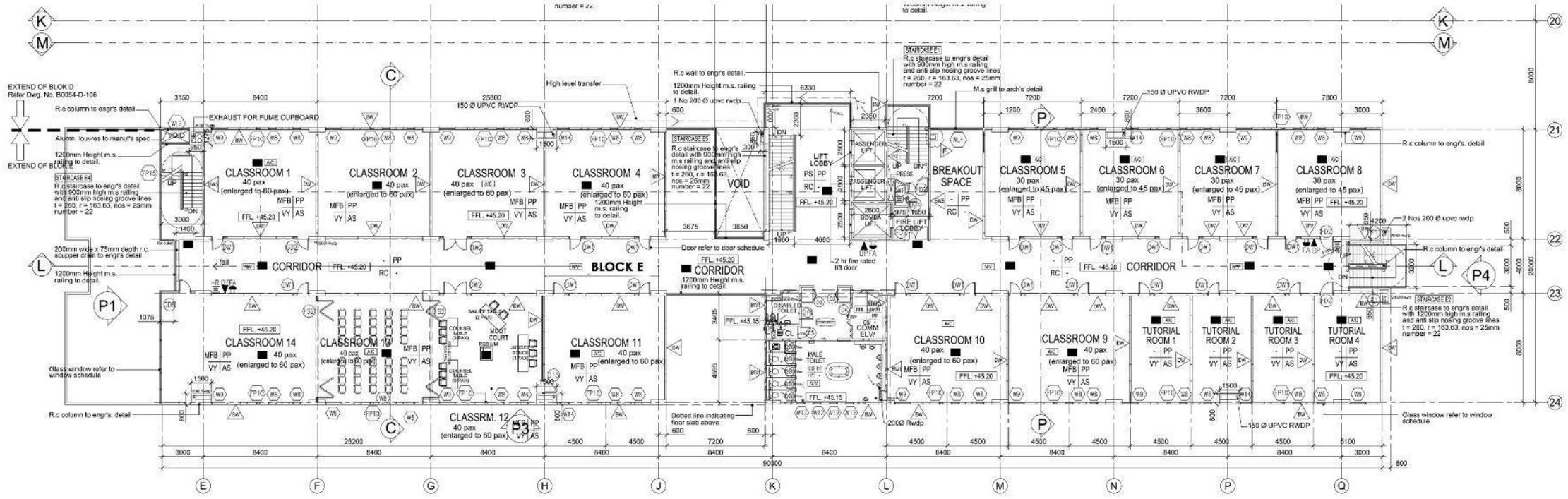


SIXTH FLOOR PLAN
SCALE 1:350

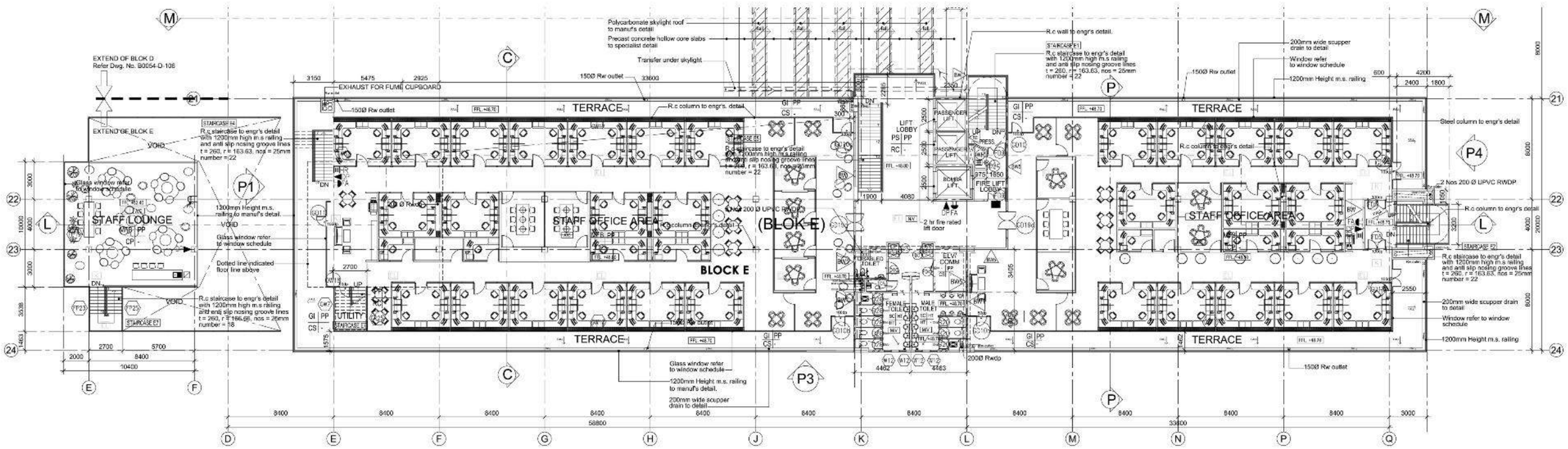


SEVENTH FLOOR PLAN

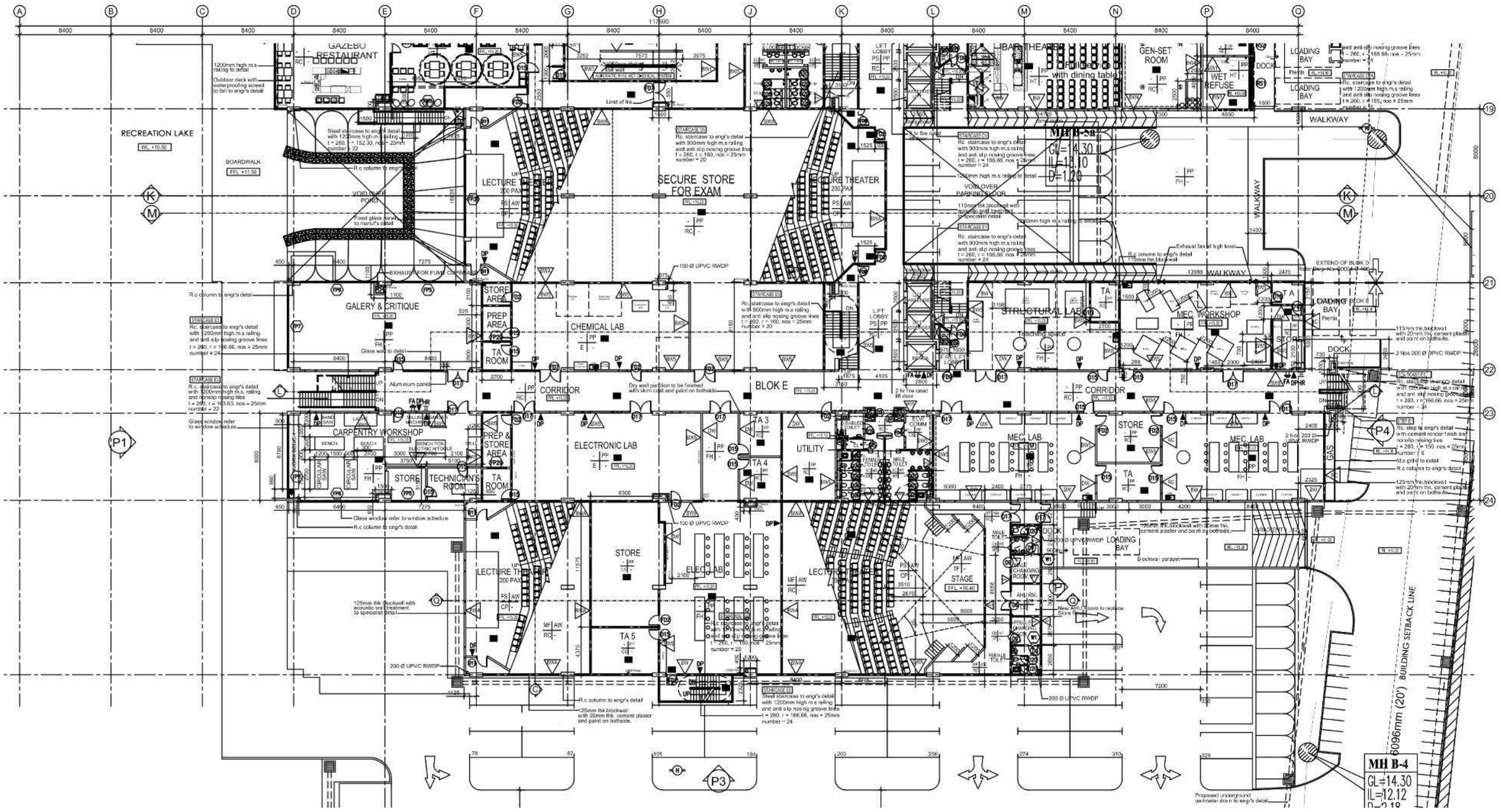
SCALE 1:350



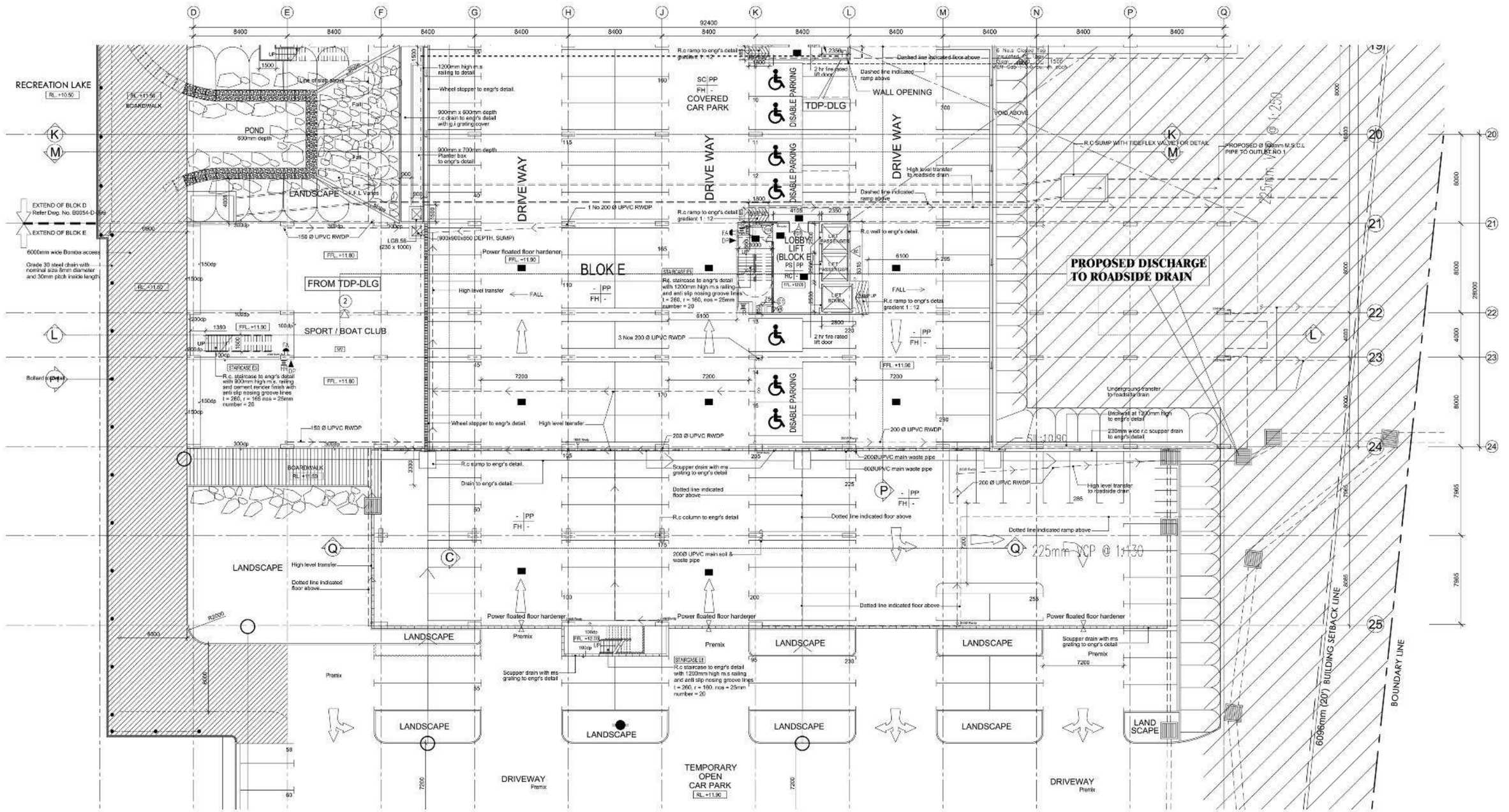
EIGHTH FLOOR PLAN
SCALE 1:350



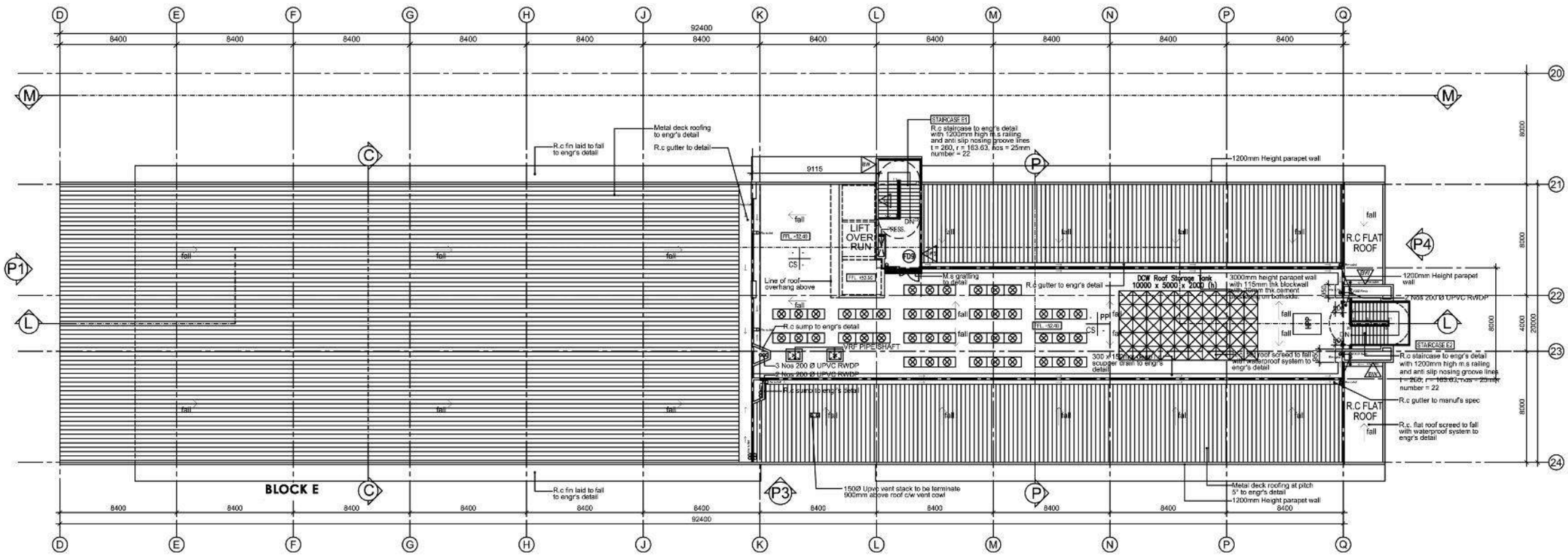
NINETH FLOOR PLAN
SCALE 1:350



GROUND FLOOR PLAN
SCALE 1:350

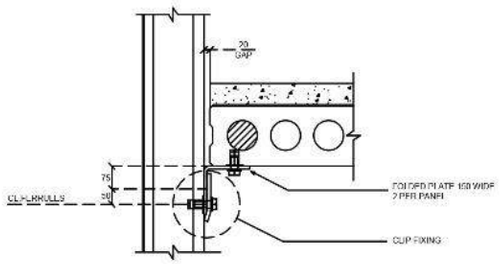


LOWER GROUND FLOOR PLAN
SCALE 1:350

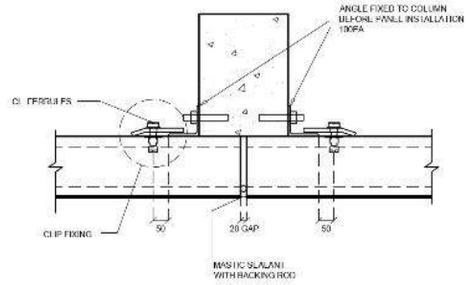


ROOF PLAN
SCALE 1:350

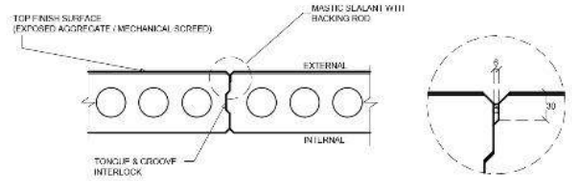
2.3.3 STRUCTURAL DETAILS



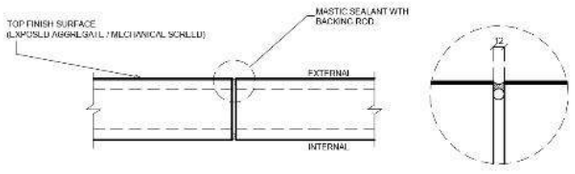
DETAIL 1
WALL TO FLOOR CONNECTION



DETAIL 2
PRECAST COLUMN TO WALL
CONNECTION (PLAN)

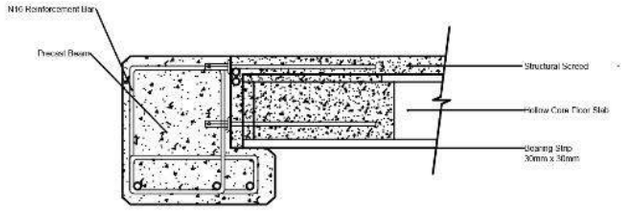


DETAIL 3
WALL TO WALL CONNECTION
(SIDE)



DETAIL 4
WALL TO WALL CONNECTION
(END)

DETAIL 5
INTERMEDIATE COLUMN TO FLOOR
CONNECTION



DETAIL 6
EDGE BEAM TO FLOOR
CONNECTION

2.3.4 SITE PHOTOS- IBS ELEMENTS

PRECAST CONCRETE COLUMNS,BEAMS AND FLOOR SLAB

HOLLOWCORE FLOOR SLAB ON CONCRETE BEAM & COLUMN

CONCRETE BEAM ON CONCRETE COLUMN

TABLE OF CONTENTS

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