Gloucester Courts Block A
BU 2373-001 EQ2

Detailed Engineering Evaluation

Quantitative Report

Version FINAL

250 Gloucester Street, Christchurch

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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250 Gloucester Street, Christchurch

Christchurch City Council

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Gloucester Courts Block A

BU 2373-001 EQ2

Detailed Engineering Evaluation

Quantitative Report - SUMMARY

Version FINAL

250 Gloucester Street, Christchurch Central

Background

The 3 storey apartment building at 250 Gloucester Street, Christchurch Central has been assessed for its safety during an earthquake. We have assessed the structure of the building to determine the current level of safety it affords during an earthquake, and have compared that level to the legal requirements.

This is a summary of the Quantitative report for the building structure, and is based in part on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, visual inspections on 06th March 2012 and Qualitative report version draft issued on 12th April 2012.

Building Description

Gloucester Courts Block A is located at 250 Gloucester Street, Christchurch Central. The building was constructed in 1998 and 1999. The building contains residential units, storage to the rear and residents parking. No alterations have been made to the building since its construction.

The building is of mixed construction. The roof is constructed of lightweight metal cladding on timber purlins and roof trusses. Perimeter walls from ground to 2nd floor level consist of concrete filled masonry block and from 2nd floor to roof level are timber framed walls. The building is divided into 3 parts by 2 transverse concrete filled masonry block walls extending from ground to 2nd floor level with timber framing above up to roof level. The rest of the interior transverse framing comprises of cast-in-situ reinforced concrete columns and beams. Foundations consist of reinforced concrete strip footings. The suspended floor slabs are 150 mm thick Unispan precast concrete flooring. They comprise 75 mm precast reinforced concrete slab units with 75 mm in-situ reinforced concrete topping.

All balconies protruding out from the building are cantilevered from the internal floor slabs. Steel reinforcement connects the cantilevered balconies into the in-situ concrete topping of the precast floor slab. The stairs are composed of precast concrete units which are supported at top and bottom by cast in-situ concrete landings connected to the masonry walls.

The building is approximately 40 m in length, 11 m wide and 9.5 m in height. The nearest building is Gloucester Courts Block B.

Key Damage Observed

Key damage observed includes:

- Minor cracks in plasterboard wall linings
- Cracks in the ground floor slab
- Cracks in the first floor concrete slab above the south entrance

Building Capacity Assessment

GHD finds that the structure of the building achieves overall 34% New Building Standard (NBS) with a Seismic Grade of C and therefore falls within the “Earthquake Risk” category. A building with a % NBS score in this order range 34% to 67% NBS is between 5 to 10 times more likely than a similar building constructed to current loading standards to cause loss of life or serious injury during a seismic event.

Recommendations

It is recommended that:

- A strengthening scheme is developed to increase the seismic capacity of the building to at least 67% NBS.
- The current placard status of the building of green to remain as is.
- The building can remain occupied as per CCC’s policy to occupy “Earthquake Risk” buildings.

1. Background

GHD has been engaged by the Christchurch City Council (CCC) to undertake a detailed engineering evaluation of a three storey apartment block known as Gloucester Courts Block A.

This is a Quantitative Assessment Report of the building structure; Quantitative Assessment involves full seismic review of the existing structure, which is discussed in this report. The structural investigation has been carried out in accordance with the requirements of the relevant New Zealand Standards and the New Zealand Society for Earthquake Engineering (NZSEE) Guidelines for the Assessment and Improvement of the Structural Performance of Buildings in Earthquakes.

2. Compliance

This section contains a brief summary of the requirements of the various statutes and authorities that control activities in relation to buildings in Christchurch at present.

2.1 Canterbury Earthquake Recovery Authority (CERA)

CERA was established on 28 March 2011 to take control of the recovery of Christchurch using powers established by the Canterbury Earthquake Recovery Act enacted on 18 April 2011. This act gives the Chief Executive Officer of CERA wide powers in relation to building safety, demolition and repair. Two relevant sections are:

Section 38 – Works

This section outlines a process in which the chief executive can give notice that a building is to be demolished and if the owner does not carry out the demolition, the chief executive can commission the demolition and recover the costs from the owner or by placing a charge on the owners' land.

Section 51 – Requiring Structural Survey

This section enables the chief executive to require a building owner, insurer or mortgagee carry out a full structural survey before the building is re-occupied.

CERA now requires a detailed engineering evaluation to be carried out for all buildings (other than those exempt from the Earthquake Prone Building definition in the Building Act). The Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011 has been adopted by CERA for evaluations. This document sets out a methodology for both qualitative and quantitative assessments.

The qualitative assessment is a desk-top and site inspection assessment. It is based on a thorough visual inspection of the building coupled with a review of available documentation such as drawings and specifications. The quantitative assessment involves analytical calculation of the buildings strength and may require non-destructive or destructive material testing, geotechnical testing and intrusive investigation.

Factors determining the extent of evaluation and strengthening level required include:

- The importance level and occupancy of the building
- The placard status and amount of damage
- The age and structural type of the building
- Consideration of any critical structural weaknesses
- The extent of any earthquake damage

2.2 Building Act

Several sections of the Building Act 2004 are relevant when considering structural requirements:

Section 112 – Alterations

This section requires that an existing building complies with the relevant sections of the Building Code to at least the extent that it did prior to any alteration. This effectively means that a building cannot be weakened as a result of an alteration (including partial demolition).

Section 115 – Change of Use

This section requires that the territorial authority (in this case Christchurch City Council (CCC)) be satisfied that the building with a new use complies with the relevant sections of the Building Code 'as near as is reasonably practicable'.

Regarding seismic capacity 'as near as reasonably practicable' has previously been interpreted by CCC as achieving a minimum of 67% NBS, however where practical achieving 100% NBS is desirable. The New Zealand Society for Earthquake Engineering (NZSEE) recommend a minimum of 67% NBS.

2.2.1 Section 121 – Dangerous Buildings

The definition of dangerous building in the Act was extended by the Canterbury Earthquake (Building Act) Order 2010, and it now defines a building as dangerous if:

- In the ordinary course of events (excluding the occurrence of an earthquake), the building is likely to cause injury or death or damage to other property; or
- In the event of fire, injury or death to any persons in the building or on other property is likely because of fire hazard or the occupancy of the building; or
- There is a risk that the building could collapse or otherwise cause injury or death as a result of earthquake shaking that is less than a 'moderate earthquake' (refer to Section 122 below); or
- There is a risk that that other property could collapse or otherwise cause injury or death; or
- A territorial authority has not been able to undertake an inspection to determine whether the building is dangerous.

Section 122 – Earthquake Prone Buildings

This section defines a building as earthquake prone if its ultimate capacity would be exceeded in a 'moderate earthquake' and it would be likely to collapse causing injury or death, or damage to other property. A moderate earthquake is defined by the building regulations as one that would generate ground shaking 33% of the shaking used to design an equivalent new building.

Section 124 – Powers of Territorial Authorities

This section gives the territorial authority the power to require strengthening work within specified timeframes or to close and prevent occupancy to any building defined as dangerous or earthquake prone.

Section 131 – Earthquake Prone Building Policy

This section requires the territorial authority to adopt a specific policy for earthquake prone, dangerous and insanitary buildings.

2.3 Christchurch City Council Policy

Christchurch City Council adopted their Earthquake Prone, Dangerous and Insanitary Building Policy in 2006. This policy was amended immediately following the Darfield Earthquake of the 4th September 2010.

The 2010 amendment includes the following:

- A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;
- A strengthening target level of 67% of a new building for buildings that are Earthquake Prone;
- A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
- Repair works for buildings damaged by earthquakes will be required to comply with the above.

The council has stated their willingness to consider retrofit proposals on a case by case basis, considering the economic impact of such a retrofit.

We anticipate that any building with a capacity of less than 33% NBS (including consideration of critical structural weaknesses) will need to be strengthened to a target of 67% NBS of new building standard as recommended by the Policy.

If strengthening works are undertaken, a building consent will be required. A requirement of the consent will require upgrade of the building to comply 'as near as is reasonably practicable' with:

- The accessibility requirements of the Building Code.
- The fire requirements of the Building Code. This is likely to require a fire report to be submitted with the building consent application.

2.4 Building Code

The building code outlines performance standards for buildings and the Building Act requires that all new buildings comply with this code. Compliance Documents published by The Department of Building and Housing can be used to demonstrate compliance with the Building Code.

After the February Earthquake, on 19 May 2011, Compliance Document B1: Structure was amended to include increased seismic design requirements for Canterbury as follows:

- Hazard Factor increased from 0.22 to 0.3 (36% increase in the basic seismic design load)
- Serviceability Return Period Factor increased from 0.25 to 0.33 (80% increase in the serviceability design loads when combined with the Hazard Factor increase)

The increase in the above factors has resulted in a reduction in the level of compliance of an existing building relative to a new building despite the capacity of the existing building not changing.

3. Earthquake Resistance Standards

For this assessment, the building's earthquake resistance is compared with the current New Zealand Building Code requirements for a new building constructed on the site. This is expressed as a percentage of new building standard (%NBS). The new building standard load requirements have been determined in accordance with the current earthquake loading standard (NZS 1170.5:2004 Structural design actions - Earthquake actions - New Zealand).

The likely capacity of this building has been derived in accordance with the New Zealand Society for Earthquake Engineering (NZSEE) guidelines 'Assessment and Improvement of the Structural Performance of Buildings in Earthquakes' (AISPBE), 2006. These guidelines provide an Initial Evaluation Procedure that assesses a buildings capacity based on a comparison of loading codes from when the building was designed and currently. It is a quick high-level procedure that can be used when undertaking a Qualitative analysis of a building. The guidelines also provide guidance on calculating a modified Ultimate Limit State capacity of the building which is much more accurate and can be used when undertaking a Quantitative analysis.

The New Zealand Society for Earthquake Engineering has proposed a way for classifying earthquake risk for existing buildings in terms of %NBS and this is shown in Figure 1 below.

Description	Grade	Risk	% NBS	Existing Building Structural Performance
Low Risk Building	A or B	Low	Above 67	Acceptable (Improvement may be desirable)
Moderate Risk Building	B or C	Moderate	34 to 66	Acceptable legally, Improvement recommended
High Risk Building	D or E	High	33 or lower	Unacceptable (Improvement Required)

Improvement of Structural Performance	
Legal Requirement	NZSEE Recommendation
The Building Act sets no required level of structural improvement (unless change in use) This is for each TA to decide. Improvement is not limited to 34% NBS.	100% NBS desirable. Improvement should achieve at least 67% NBS
	Not recommended. Acceptable only in exceptional circumtances
Unacceptable	Unacceptable

Figure 1 NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE

Table 1 compares the percentage NBS to the relative risk of the building failing in a seismic event with a 10% risk of exceedance in 50 years (i.e. 0.2% in the next year). It is noted that the current seismic risk in Christchurch results in a 6% risk of exceedance in the next year.

Percentage of New Building Standard (%NBS)	Relative Risk (Approximate)
>100	<1 time
80-100	1-2 times
67-80	2-5 times
33-67	5-10 times
20-33	10-25 times
<20	>25 times

Table 1: % NBS compared to relative risk of failure

4. Building Description

4.1 General

Gloucester Courts Block A is located at 250 Gloucester Street, Christchurch Central. The building was constructed in 1998 and 1999. It is a 3 storey apartment building containing residential units, storage areas and residents' parking garages. It appears that no alterations have been made to the building since its construction.

The nearest building is Gloucester Courts Block B. The nearest waterway is the Avon River approximately 400 m to the north-west. The building is situated on a flat site.

Summary of Building key structural features:

- The building is approximately 40 m in length, 11 m wide and 9.50 m in height.
- The roof is constructed of lightweight metal cladding on timber purlins and roof trusses.
- Perimeter walls from ground to 2nd floor level consist of concrete filled masonry block and from 2nd floor to roof level are timber framed walls.
- The building is divided into 3 parts by 2 transverse concrete filled, masonry block walls extending from ground to 2nd floor level with timber framing above up to roof level.
- The rest of the interior transverse framing comprises of cast-in-situ reinforced concrete columns and beams.
- The foundations consist of reinforced concrete strip footings.
- The suspended floor slabs are 150 mm thick Unispan precast concrete flooring. They comprise 75 mm precast reinforced concrete slab units with 75 mm in-situ reinforced concrete topping.
- All balconies protruding out from the building are cantilevered from the internal floor slabs. Steel reinforcement connects the cantilevered balconies into the in-situ concrete topping of the precast floor slab.
- The stairs are composed of precast concrete units which are supported at top and bottom by cast in-situ concrete landings connected to the masonry walls.

Figure 2 on the next page below shows structural floor plans for the building.

A set of drawings are included in Appendix C.

4.2 Gravity Load Resisting System

Gravity loads from the lightweight metal roof cladding are supported by the timber purlins spanning on to the timber roof trusses. The roof trusses are supported by the timber framed walls.

The gravity loads on the first and second floors are carried by the concrete floor slabs spanning to the reinforced concrete masonry walls and reinforced concrete frames.

Loads are transferred through the walls and the frames down to the foundations.

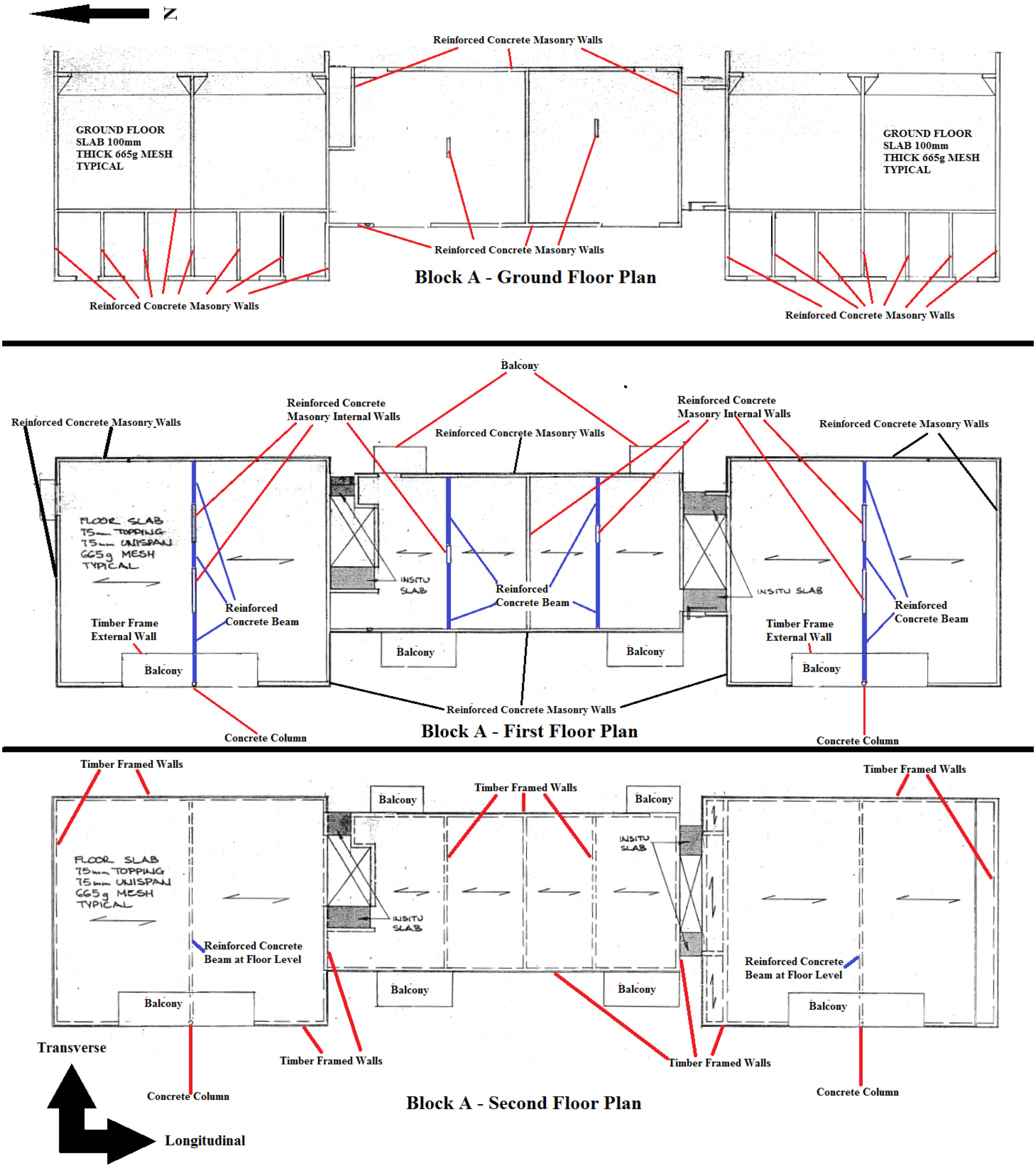

Figure 2 Sketch Plans of the Ground, First and Second Floors Showing Key Structural Elements

4.3 Lateral Load Resisting System

At the second floor level of the apartment building, the seismic load resisting structural elements are the plasterboard lined timber framed walls in both the longitudinal and transverse directions. Plasterboard ceiling linings attached to the underside of the roof trusses together with the timber purlins and trusses will provide the diaphragm distribution of lateral loads, transferring them to the lined walls. These timber walls then transfer the upper loads to the second floor concrete slab and down through the reinforced concrete masonry block walls below which resist the lateral loads of the structure from ground to 2nd floor levels in both transverse and longitudinal directions, With the help of concrete frames in the transverse direction, lateral loads on the 1st and 2nd levels are distributed to the reinforced masonry block walls and concrete frames through the diaphragm action of the concrete floor slabs.

5. Assessment

5.1 Site Inspection

An inspection of the building was undertaken on the 6th March 2012. Both the interior and exterior of the building were inspected. The main structural components of the roof of the building were able to be viewed through the roof space access panel. The roof space survey from the access panel was limited due to the location of the panel.

The inspection consisted of observing the building to determine the structural systems and likely behaviour of the building during an earthquake. The site was assessed for damage, including examination of the ground conditions, checking for damage in areas where damage would be expected for the type of structure and noting general damage observed throughout the building in both structural and non-structural elements.

5.2 Investigation and Opening Up Work

No Opening up work was undertaken

5.2.1 Available Drawings

Copies of the following construction drawings were provided by CCC:

Item	Title	Sheet No.	Date
1	Site Plan	1	19/06/98
2	Ground Floor Plans	2	18/08/98
3	First Floor Plans	3	18/08/98
4	First Floor Plans - Amendments	3	09/10/98
5	Second Floor Plans	4	18/08/98
6	Second Floor Plans - Amendments	4	09/10/98
7	Elevations – Block A, B and C	5	18/08/98
8	Sections	7	18/08/98
9	Section 03	8	19/06/98
10	Drainage Plan	D1	19/06/98
11	Ground Floor Plans	67-5/1	07/98
12	First Floor Plans	67-5/2	07/98
13	Second Floor Plans	67-5/3	07/98

14	Block A & C – Block Wall Elevations	67-5/4	07/98
15	Block B – Block Wall Elevations	67-5/5	07/98
16	Block A and C – Block Wall Elevations	67-5/6	07/98
17	Block B – Block Wall Elevations	67-5/7	07/98
18	Block A and C – Block Wall Elevations	67-5/8	07/98
19	Block B – Block Wall Elevations	67-5/9	07/98
20	Block B – Block Wall Elevations	67-5/10	07/98
21	Block B – Block Wall Elevations	67-5/11	07/98
22	Block C – Block Wall Elevations	67-5/12	07/98
23	Blocks A to E – Details	67-5/24	07/98
24	Blocks A to E – Details	67-5/25	07/98
25	Blocks A to E – Details	67-5/26	07/98
26	Blocks A, B and C – Details	67-5/27	07/98

The drawings have been used to confirm the structural systems, investigate potential critical structural weaknesses (CSW) and identify details which required particular attention.

Some specification information was also supplied but no structural calculations for the building are available.

Drawings are included in Appendix C of this report.

5.3 Analysis and Modelling Methodology

The seismic assessment procedure determines the capacity of the structure to withstand seismic loading (as defined in the current New Zealand Standard 1170.5:2004) through structural analysis. The seismic capacity of the structure is measured as a proportion of New Building Standard (% NBS), the standard to which a new building must perform in terms of current design codes and standards. The weakest structural element of the structure is the element which governs the seismic capacity of the overall structure.

The methodology and approach adopted for the analysis and assessment is presented in the following sections.

5.3.1 Building Modelling

There were two separate model analyses carried out for the buildings. The timber wall structure was modelled to determine the loads to be transferred to masonry wall structure. Each structure was modelled as a three-dimensional space frame, using finite elements, with joints and nodes selected to model the stiffness and inertia effects of the structure. The structural software ETABS v.9.7.2 was used for the general modelling and analysis of the structures. The stairs and roof were not included in the model but the weights were loaded onto supporting members. The foundations were assumed to be pinned in the 3D model. Figures 3 and 4 show overall views of the two parts of the model.

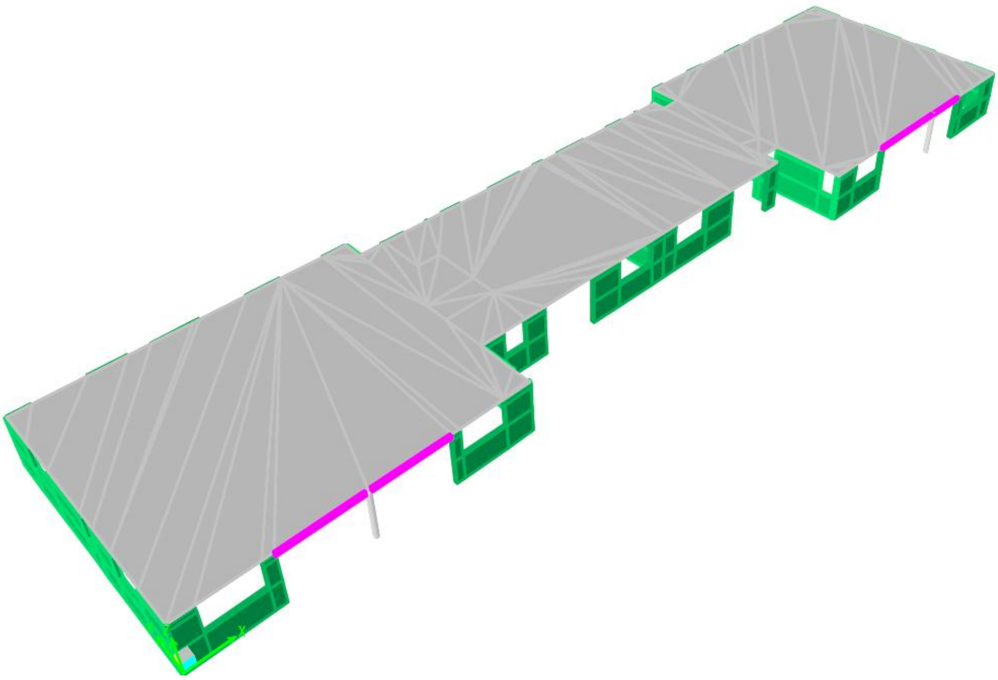

Figure 3: Model of building developed in Etabs - Timber Wall Structure (Upper Storey)

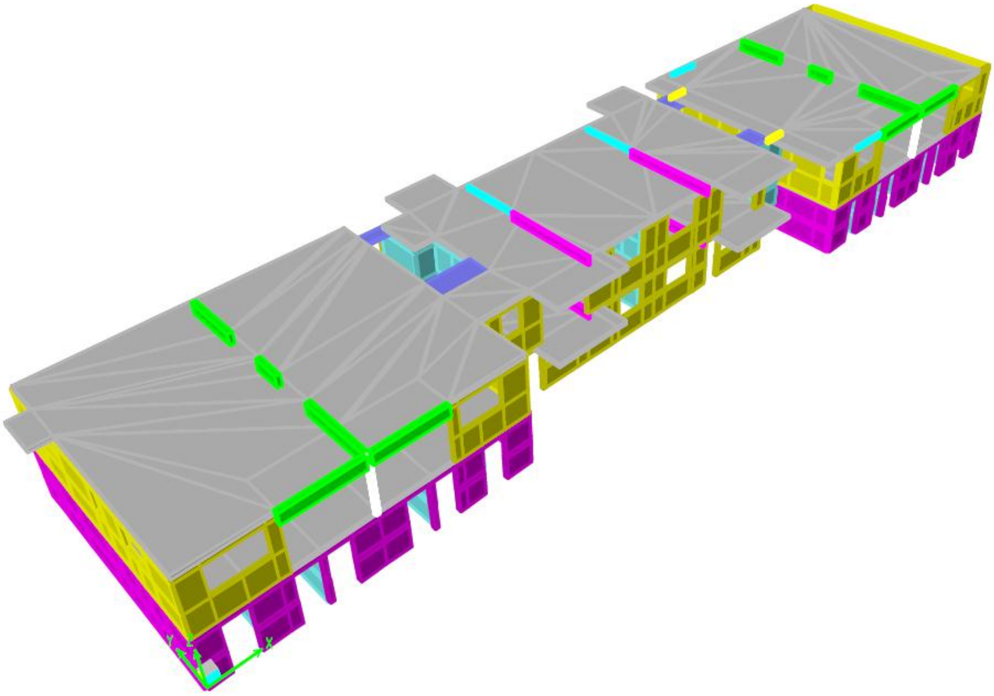

Figure 4: Model of building developed in Etabs - Masonry Wall Structure (Lower 2 Storeys)

5.3.2 Structural Calculations

The seismic assessment was undertaken using the equivalent static method as described in Clause 6.2 of the NZS 1170.5 and the 3D model created in Etabs.

The capacity of the existing structure and its components under ultimate loading conditions (earthquake) were obtained based on determined critical load combinations. The capacity to demand ratio of each member was computed and the capacity expressed as a percentage of New Building Standard (% NBS).

For the Masonry Assessment, GHD used the Design of Reinforced Concrete Masonry for Specific Design (NZS 4230:2004) instead of the Non-Specific Design (NZS 4229:1999) because the building was greater than 2 storeys and it is constructed on a Class D Soil (Soft Soil) which is outside the limitation in NZS 4229:1999.

Complete set of structural calculations are shown in Appendix E.

6. Damage Assessment

6.1 Surrounding Buildings

Gloucester Courts Block A is surrounded by Gloucester Courts Block B to the east and other residential apartments to the south. The Latimer Hotel and apartments that were situated to the west have been demolished following the 22nd of February seismic events. The Block B buildings appear to have suffered only minor damage and pose no structurally detrimental influence to Block A.

6.2 Residual Displacements and General Observations

There were no residual displacements of the building noted during the inspection.

Minor cracking was observed to plasterboard linings in several areas of the building.

Cracks were noted to the ground floor slab in several locations.

A concrete canopy over the door to the southern apartments has significant cracking as shown in Photographs 10, 11 and 12. This cast in-situ reinforced concrete slab has cracked as a result of differential movement of the two supporting walls.

It is believed that the cracks mentioned above are due to localised stresses in floors and walls during earthquake shaking.

6.3 Ground Damage

There was no evidence of ground damage on the property.

7. Seismic Analysis

7.1 Seismic Parameters

Seismic loads were applied based on criteria specified by the New Zealand Code (NZS 1170.5:2004) and New Zealand Society of Earthquake Engineering (NZSEE).

The seismic assessment parameters are as tabulated below:

Site Classification	D
Importance Level	2
Hazard factor, (Z) (Table 3.3, NZS 1170.5:2004)	0.30 (Christchurch)
Annual Probability of Exceedance (Table 3.3, NZS 1170.0:2002)	1/500 (ULS)
Annual Probability of Exceedance (Table 3.3, NZS 1170.0:2002)	1/25 (SLS)
Return Period Factor (R_u), (Table 3.5, NZS 1170.5:2004)	1.0 (ULS)
Return Period Factor (R_s), (Table 3.5, NZS 1170.5:2004)	0.33 (SLS)
Ductility Factor (μ) (Section 4.3.1.1, NZS 1170.5: 2004)	1.50
Performance Factor (S_p) (NZS 3101 Section 2.6.2.2.1)	0.871
Liquefaction Potential	minor to moderate

An increased Z factor of 0.3 for Christchurch has been used in line with requirements from the Department of Building and Housing resulting in a reduced % NBS score.

8. Geotechnical Investigation

The subject site is located within the Christchurch Central Business District, at approximately 5 m above mean sea level. It is surrounded by commercial and medium-density residential properties. The site is situated approximately 400 m southeast of the Avon River, and 8 km west of the coast (Pegasus Bay).

8.1 Published Information on Ground Conditions

8.1.1 Published Geology

The geological map of the area indicates that the site is underlain by Holocene alluvial soils of the Yaldhurst Member, sub-group of the Springston Formation, comprising alluvial sand and silt overbank deposits.

8.1.2 Environment Canterbury Logs

Information from Environment Canterbury (ECan) indicates that there are eight boreholes are located within a 200m radius of the site. Of these boreholes, four contain a lithographic log.

The conditions described within the logs indicate the geology to be layers of sand and clay/silt to ~9m bgl, underlain by layers of gravel, sand and clay. Layers containing peat and organic matter are indicated to be present between 24m and 65m bgl.

Table 2 ECan Borehole Summary

Bore Reference	Log Depth	Groundwater	Distance & Direction from Site
M35/1931	128 m	'artesian'	120 m W
M35/12095	3.05 m	-	120 m E
M35/12811	3.66 m	-	200 m W
M35/17504	4 m	-	150 m SW

It should be noted that the boreholes were sunk for groundwater extraction and not for geotechnical purposes. Therefore, the amount of material recovered and available for interpretation and recording will have been variable at best and may not be representative. The logs have been written by the well driller and not a geotechnical professional or to a geotechnical standard. In addition strength data is not recorded.

8.1.3 EQC Geotechnical Investigations

The Earthquake Commission has not undertaken geotechnical testing in the area of the site.

8.1.4 CERA Land Zoning

Canterbury Earthquake Recovery Authority (CERA) has published areas showing the Green Zone Technical Category in relation to the risk of future liquefaction and how these areas are expected to perform in future earthquakes.

The site is classified as Green Zone Technical Category 2; yellow (TC2, yellow). This means that minor to moderate land damage from liquefaction is possible in future significant land damage.

Land is generally suitable to be repaired and rebuilt on; land damage may be present but this can be repaired on an individual basis as part of the normal insurance process. Specific engineering foundation design is required.

8.1.5 Post-Earthquake Aerial Photography

Aerial photography taken following the 22 February 2011 earthquake shows signs of liquefaction in adjacent properties, particularly those to the northwest across Gloucester Street (see Figure 5). However, little to no effect can be observed on the site itself.

Figure 5 Post February 2011 Earthquake Aerial Photography

8.1.6 Summary of Ground Conditions

From the information presented above, it is anticipated that the site is underlain by stratified alluvial deposits, consisting of layers of gravel, sand, silt and clay, typical of the Springston formation.

8.2 Seismicity

8.2.1 Nearby Faults

There are many faults in the Canterbury region, however only those considered most likely to have an adverse effect on the site are detailed below.

Table 3 Summary of Known Active Faults[1,2]

Known Active Fault	Distance from Site	Direction from Site	Max Likely Magnitude	Avg Recurrence Interval
Alpine Fault	120 km	NW	~8.3	~300 years
Greendale (2010) Fault	30 km	W	7.1	~15,000 years
Hope Fault	107 km	N	7.2~7.5	120~200 years
Kelly Fault	115 km	NW	7.2	150 years
Porters Pass Fault	54 km	NW	7.0	1100 years

Recent earthquakes since 22 February 2011 have identified the presence of a previously unmapped active fault system underneath Christchurch City and the Port Hills. Research and published information on this system is in development and not generally available. Average recurrence intervals are yet to be estimated.

This seismic activity has produced earthquakes of Magnitude 6.3 with peak ground accelerations (PGA) up to twice the acceleration due to gravity (2g) in some parts of the city. This has resulted in widespread liquefaction throughout Christchurch.

8.2.2 Ground Shaking Hazard

New Zealand Standard NZS 1170.5:2004 quantifies the Seismic Hazard factor for Christchurch as 0.30, being in a moderate to high earthquake zone. This value has been provisionally upgraded recently (from 0.22) to reflect the seismicity hazard observed in the earthquakes since 4 September 2010.

The recent seismic activity has produced earthquakes of Magnitude-6.3 with peak ground accelerations (PGA) up to twice the acceleration due to gravity (2g) in some parts of the city. This has resulted in widespread liquefaction throughout Christchurch.

[1] Stirling, M.W, McVerry, G.H, and Berryman K.R. (2002) A New Seismic Hazard Model for New Zealand, Bulletin of the Seismological Society of America, Vol. 92 No. 5, pp 1878-1903, June 2002.

[2] GNS Active Faults Database

8.3 Slope Failure and/or Rockfall Potential

The site is located on flat land within Central Christchurch. Global slope instability is considered negligible. However, any localised retaining structures and/or embankments should be further investigated to determine the site-specific slope instability potential.

8.4 Field Investigations

In order to further understand the ground conditions at the site, intrusive testing comprising two piezocone CPT investigations was conducted at the site on 25 June 2012.

The locations of the tests are tabulated in Table 4 and illustrated in Figure 6.

Table 4 Coordinates of Investigation Locations

Investigation	Depth (m bgl)	Easting (NZMG)	Northing (NZMG)
CPT 001	15.29	2481302	5741852
CTP 002	16.32	2481300	5741869

The CPT investigations were undertaken by McMillans Drilling Ltd, typically to a target depth of 20m below ground level. However, refusal was reached at depths of 15.3 m and 16.3 m due to the presence of dense sands.

Figure 6: Intrusive Investigation Location

8.5 Ground Conditions Encountered

Interpretation of output graphs[3] from the investigation showing Cone Tip Resistance (qc), Friction Ratio (Fr) and Inferred Lithology are presented in Table 5 .

[3] McMillans Drilling CPT data plots, Appendix A.

Summary of CPT-Inferred Lithology

Table 5 Summary of CPT-Inferred Lithology

Depth (m)	Lithology [1]	Cone Tip Resistance q_c (MPa)	Friction Ratio Fr (%)	Relative Density Dr (%)
0 – 6.0	SILT Mixtures	0.5 – 5	1 – 8	(Su ≥ 40 kPa)
6.0 – 11.0	SAND	3 – 22	0.5 - 3	60 – 80
11.0 – 12.0	SILT Mixtures	1 – 5	2 - 3	(Su ≥ 80 kPa)
12.0 – 15.0	SAND	5 – 34	0.5 – 1	40 – 100

Groundwater was inferred to be at levels of 1m below ground level.

8.6 Liquefaction Assessment

Due to the anticipated presence of loose/soft alluvial soils a more comprehensive liquefaction analysis has been undertaken.

8.6.1 Parameters used in Analysis

Assumptions made for the analysis process are as follows:

- D50 particle sizes for the site soil (sands) from CPT soil analysis;
- Importance Category 2, post seismic event (50-year design life);
- PGA 0.35g

The following equation has been used to approximate soil unit weight from the CPT investigation data: [4]

$$\gamma = \frac{\gamma_w Gs}{2.65}\left(0.27 \log Fr + 0.36 \log\left(\frac{qc}{p_{atm}}\right) + 1.236\right)$$

This typically gave values ranging between 16 and 21 kN/m3 (saturated).

The liquefaction analysis process has been conducted using the methodology from Robertson & Wride5, and from the NZGS Guidelines6. Settlements have been estimated using the procedure described in Zhang et al7, as recommended by Appendix C of the DBH guidelines (April 2012).

[4] Robertson P.K., & Cabal K.L. 2010: *Estimating soil unit weight from CPT*. Gregg Drilling & Testing Inc.: Signal Hill, California, USA.

[5] Robertson P.K. & Wride C.E. (1998): *Evaluating cyclic liquefaction potential using the cone penetration test.* Canadian Geotechnical Journal, 35: pp. 442–459.

[6] Cubrinovski M., McManus K.J., Pender M.J., McVerry G., Sinclair T., Matuschka T., Simpson K., Clayton P., Jury R. (2010): Geotechnical earthquake engineering practice: *Module 1 – Guideline for the identification, assessment and mitigation of liquefaction hazards*. NZ Geotechnical Society

[7] Zhang G., Robertson P.K., & Brachman R.W.I. (2002): *Estimating liquefaction-induced ground settlements from CPT for level ground*. Canadian Geotechnical Journal, Vol 39, pp. 1168-1180

8.6.2 Results of Liquefaction Analysis

The results of the liquefaction analysis, as outlined in Table 6, indicate that several layers are considered highly liquefiable. Specifically this includes three pockets between 0.6 to 6 m, Sand from 6 to 7.2 m and 9.8 to 10 m, and Sand/Silt Mixtures from 11 to 16 m.

Please refer to Appendix A for further detail.

Table 6 Summary of Liquefaction Susceptibility

Depth (m)	Lithology	Triggering Factor F_L	Liquefaction Susceptibility [8]
0 – 6	SILT Mixtures	0.4 – 0.8	Isolated pockets susceptible
6 – 7.2	SAND	0.5	High
7.2 – 9.8	SAND	>1.2	Low
9.8 – 10	SAND	0.5	High
10 – 11	SAND	>1.2	Low
11 – 12	SILT Mixtures	0.4	Severe
12 - 16	SAND	0.5 - 2	High

Settlement estimates for the CPT points are between 107 mm and 126 mm for ULS conditions.

Please refer to Appendix D for further details.

8.7 Interpretation of Ground Conditions

8.7.1 Liquefaction Assessment

Overall, the site is considered to be moderately susceptible to liquefaction. This is based on:

- Evidence of liquefaction at the surface in the post-earthquake aerial photography;
- Estimated settlements from the CPT results (107 mm to 126 mm) are in excess of the 100 mm limit for TC2 classification, indicating the site should be considered in line with TC3 guidelines; and,
- The layers of 6 m to 7.2 m and 9.8 m to 10 m and 11 m to 12 m are indicated to be highly susceptible, as outlined in Table 6**.**

8.7.2 Slope Failure and/or Rockfall Potential

The site is located on flat land within Central Christchurch. Global slope instability is considered negligible. However, any localised retaining structures and/or embankments should be further investigated to determine the site-specific slope instability potential.

8.7.3 Foundation Recommendations

Based on the information presented above, we recommend the following for the subject site:

[8] Table 6.1, NZGS Guidelines Module 1 (2010)

- The soil class of D (in accordance with NZS 1170.5:2004) recommended in Section 8 of the Qualitative DEE is still believed to be appropriate; and,
- Any remedial works to foundations (or proposed new structures) be undertaken in accordance with DBH's guidelines for TC3 land, due to the high levels of estimated settlement; and,
- All significant repairs to and proposed new foundations be specifically-designed by a suitably qualified and experienced geotechnical engineer.

9. Results of Analysis

9.1 Summary of Results

The outcome of the three-dimensional model analysis and demand/capacity assessment is summarised below in Table 7. Note that the values given represent the critical elements in the building, as these effectively define the building's capacity. Other elements within the building will have significantly greater capacity when compared with the governing elements.

A diagrammatic plan is shown in Figure 7.

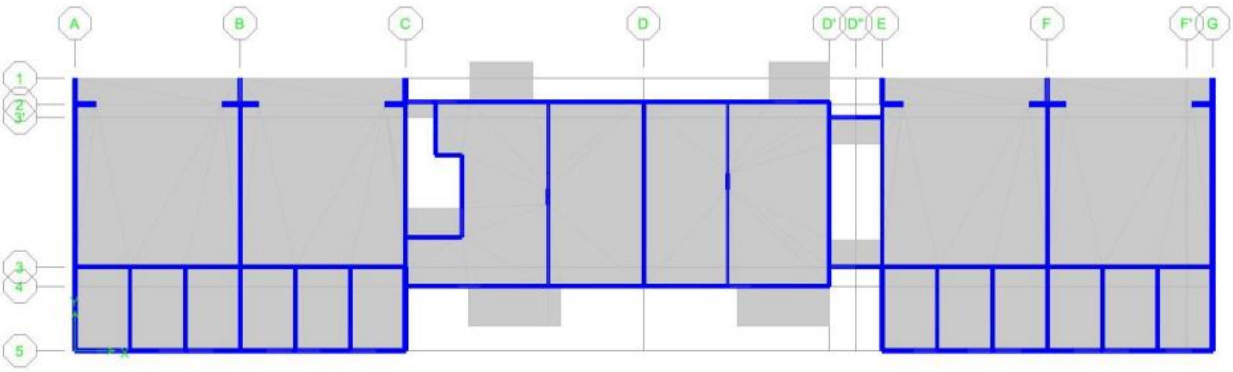

Figure 7: Plan Showing Gridlines

Table 7: Existing Building Element to % NBS

Level	Direction	Element	(% NBS)
Second – Roof Level	Transverse	Timber Wall	61%
		RC Beam (Second Floor)	83%
	Longitudinal	Timber Wall	43%
		RC Beam (Second Floor)	83%
		RC Column	>100%
First – Second Floor	Transverse	Masonry Wall	70%
		RC Beam (First Floor)	99%
		RC Column	> 100%
	Longitudinal	Masonry Wall	34%
		RC Beam (First Floor)	> 100%
Ground – First Floor	Transverse	Masonry Wall	> 100%
	Longitudinal	Masonry Wall	52%

9.1.1 Columns and Beams

All columns achieved over 100% NBS. All beams achieved at least 83% NBS.

Further results can be found in Appendix E.

9.1.2 Masonry Walls

Based on the analysis, the RC Masonry Block Walls in the longitudinal direction were assessed to be the critical structural weakness of the building having the lowest NBS score of 34% on Gridline 2' and Gridline 1 at First to Second Floor Level. In the transverse direction, the masonry walls achieve ratings greater than 67% NBS. Hence only the masonry walls in the longitudinal direction fall within the "Earthquake Risk" category.

Further results can be found in Appendix E.

9.1.3 Timber Walls

Calculations showed that the overall bracing capacity of the timber walls achieved a rating of 43% NBS in the longitudinal direction. However, overall bracing capacity of the timber walls in the transverse direction achieved a rating of 81% NBS. Because of the weakness in the longitudinal direction the wall bracing system falls in the "Earthquake Risk" category.

Further results can be found in Appendix E.

9.1.4 Beam – Column Joints

Based on the results obtained from the beam – column joint analysis, all joints achieved an NBS score over 100%, indicating that they have sufficient steel reinforcement content to resist the forces required under the seismic loading condition.

Further results can be found in Appendix E.

9.1.5 Inter-Storey Drift

The maximum calculated inter-storey drift occurs at roof level in transverse direction. The inter-storey drift rating for all levels is more than 100% NBS. A full summary table of deflections and drifts for each storey is included in Table 8.

Table 8: Inter-Storey Drift

Floor Level	Max Displacement m	Drift Modification Factor	Direction	Load	Modified Drift/floor mm	Storey height m	Allowable (2.5% limit) mm
ROOF	0.037	1.20	Transverse	EQY	24.9	2.16	54.0
STOREY 2	0.012	1.20	Longitudinal	EQX	12.0	2.56	64.0
STOREY 1	0.0002	1.20	Transverse	EQX	0.2	2.36	59.0

9.1.6 Stairs

Two precast concrete staircases are present providing access to the upper levels. These stairs are supported by top and bottom in-situ cast concrete landings at the floor floor levels, and at mid height. It is unlikely that the stairs will contribute a significant detrimental stiffness concentration in this part of the complex.

Based on the displacement result from Etabs, the maximum ultimate movement of the structure is 0.40 mm in the transverse direction at second floor. Given the detailing of the connection between stairs and landings, the stairs appear to be adequately anchored to the supporting reinforced concrete slabs. It is not expected that the stairs would become dislodged during a seismic event. The calculated % NBS of Stairs is over 67 % NBS.

Details of the calculation are presented in Appendix E.

9.1.7 Flooring

The building slab is typically "Unispan" concrete precast slab with an overall thickness of 150 mm – this thickness is composed of 75 mm precast concrete slab with 75 mm concrete topping. These slabs are supported by concrete masonry block walls at first floor level and a combination of masonry walls and reinforced concrete frames at second floor level.

This precast slab has a typical wire mesh reinforcement of HRC 665 mesh. The precast floor system is connected to the supporting walls and beams by HRC 665 wire mesh reinforcement and D12 reinforcement with a typical spacing of 600 mm.

All slabs perform satisfactorily under seismic loading having an NBS over 100%.

9.1.8 Foundations

The existing structure is supported on reinforced strip footings. Due to the nature of the ground floor structure, relatively stiff concrete masonry walls and no signs of significant land damage or settlement around the building, it is not believed that the foundations are an "Earthquake Risk".

10. Conclusions

Our detailed seismic assessment shows that the overall building achieves 34% NBS. The building is therefore classified as an “Earthquake Risk”. A building with % NBS score in the range 34% to 67% NBS is between 5 to 10 times more likely than a similar building constructed to current loading standards to cause loss of life or serious injury during a seismic event.

The client may choose to consider strengthening the building to 67% NBS, i.e. beyond Earthquake Risk. The scope of work would likely include strengthening of a few timber and masonry walls or possibly by the addition of extra bracing walls.

11. Recommendations

Based from the results acquired in the quantitative analysis performed, the following recommendations can be endorsed:

- It is recommended that the current placard status of the building of green remain.
- The building can remain occupied as per CCC's policy to occupy "Earthquake Risk" buildings.
- A strengthening scheme is developed to increase the seismic capacity of the building to at least 67% NBS should be prepared.

12. Limitations

12.1 General

This report has been prepared subject to the following limitations:

- Visual inspections of the roof space were limited to the vicinity of the access hatch and due to its non-central location; the entirety of the roof space could not be inspected visually.
- No level or verticality surveys have been undertaken.
- No material testing has been undertaken.
- This report is prepared for CCC to assist with assessing the remedial works required for council buildings and facilities. It is not intended for any other party or purpose.

12.2 Scope and Limitations of Geotechnical Investigation

The data and advice provided herein relate only to the project and structures described herein and must be reviewed by a competent geotechnical engineer before being used for any other purpose. GHD Limited (GHD) accepts no responsibility for other use of the data by third parties.

Where drill hole or test pit logs, cone tests, laboratory tests, geophysical tests and similar work have been performed and recorded by others under a separate commission, the data is included and used in the form provided by others. The responsibility for the accuracy of such data remains with the issuing authority, not with GHD.

The advice tendered in this report is based on information obtained from the desk study investigation location test points and sample points. It is not warranted in respect to the conditions that may be encountered across the site other than at these locations. It is emphasised that the actual characteristics of the subsurface materials may vary significantly between adjacent test points, sample intervals and at locations other than where observations, explorations and investigations have been made. Subsurface conditions, including groundwater levels and contaminant concentrations can change in a limited time. This should be borne in mind when assessing the data.

It should be noted that because of the inherent uncertainties in subsurface evaluations, changed or unanticipated subsurface conditions may occur that could affect total project cost and/or execution. GHD does not accept responsibility for the consequences of significant variances in the conditions and the requirements for execution of the work.

The subsurface and surface earthworks, excavations and foundations should be examined by a suitably qualified and experienced Engineer who shall judge whether the revealed conditions accord with both the assumptions in this report and/or the design of the works. If they do not accord, the Engineer shall modify advice in this report and/or design of the works to accord with the circumstances that are revealed.

An understanding of the geotechnical site conditions depends on the integration of many pieces of information, some regional, some site specific, some structure specific and some experienced based. Hence this report should not be altered, amended or abbreviated, issued in part and issued incomplete in any way without prior checking and approval by GHD. GHD accepts no responsibility for any circumstances which arise from the issue of the report which have been modified in any way as outlined above.

13. References

- Drawings and Specifications for Residential Units Inner City preferred by Bryndwr Builders Ltd.
- Gloucester Courts Block A, BU 2373-001 EQ2, Detailed Engineering Evaluation, Qualitative Report, Version Draft; April 12, 2012, GHD Pty Ltd. - Christchurch

New Zealand Standard

- NZS 1170.0:2002 Structural Design Actions Part 0: General Principles
- NZS 1170.1:2002 Structural Design Actions Part 1: Permanent, Imposed and Other Actions
- NZS 1170.1:Supplement 1:2002 Structural Design Actions: Permanent, Imposed and Other Actions-Commentary
- NZS 1170.5:2004 Structural Design Actions Part 5: Earthquake Actions – New Zealand
- NZS 3101: Part 1: 1995 Concrete Structures Standard
- NZS 4230: 2004 Design of Reinforced Concrete Masonry Structures
- NZS 3604:2011 Timber Framed Buildings
- New Zealand Society of Earthquake Engineering Guidelines for Assessment and Improvement of the Structural Performance of Buildings in Earthquakes
- Department of Building and Housing (DBH) Practice Advisory 13 – for staircase assessment.

Appendix A

Geotechnical Investigation Results and Analysis

Borelog for well M35/12811

Gridref: M35:81126-41894 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 7.75 +MSD
Well name : CCC BorelogID 986
Drill Method : Not Recorded
Drill Depth : -3.66m Drill Date :

Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
		-0.30m	topsoil	
		-2.13m	silty sand	
		-3.05m	clay	
		-3.35m	wet silty sand	
		-3.66m	saturated sandy silt and clay	

Unknown No:	M35/17504
Well Name:	CCC BorelogID 7539
Owner:	CCC borelog

Street of Well:		**File No:**	
Locality:		**Allocation Zone:**	Christchurch/West Melton
NZGM Grid Reference:	M35:81229-41737 QAR 3		
NZGM X-Y:	2481229 - 5741737		
Location Description:		**Uses:**	Foundation/Investigation Bore
ECan Monitoring:			
Well Status:	Filled in		

Drill Date:	19 Dec 1997	**Water Level Count:**	0
Well Depth:	4.00m -GL	**Strata Layers:**	6
Initial Water Depth:	-2.50m -MP	**Aquifer Tests:**	0
Diameter:		**Isotope Data:**	0
		Yield/Drawdown Tests:	0
Measuring Point Ait:	7.67m MSD QAR 4	**Highest GW Level:**	
GL Around Well:	0.00m -MP	**Lowest GW Level:**	
MP Description:		**First Reading:**	
		Last Reading:	
Driller:		**Calc. Min. GWL:**	
Drilling Method:		**Last Updated:**	27 Mar 2008
Casing Material:		**Last Field Check:**	
Pump Type:			
Yield:		**Screens:**	
Drawdown:		**Screen Type:**	
Specific Capacity:		**Top GL:**	
		Bottom GL:	
Aquifer Type:			
Aquifer Name:			

Borelog for well M35/17504

Gridref: M35:81229-41737 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 7.67 +MSD
Well name : CCC BorelogID 7539
Drill Method : Not Recorded
Drill Depth : -4m Drill Date : 19/12/1997

Environment Canterbury Regional Council

Depth(m)	Full Drillers Description	Formation Code
-0.20m	brown topsoil	
-0.60m	brown silt	
-0.90m	brown / orange mottled moist silt	
-1.80m	brown sand	
-1.95m	brown / mottled orange and grey silt	
-4.00m	blue / grey silt	

Scale(m): -0.2, -0.4, -0.6, -0.8, -1, -1.2, -1.4, -1.6, -1.8, -2, -2.2, -2.4, -2.6, -2.8, -3, -3.2, -3.4, -3.6, -3.8

Water Level

Borelog for well M35/1931

Gridref: M35:812-418 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 6 +MSD
Driller : not known
Drill Method : Unknown
Drill Depth : -128m Drill Date :

Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	-1.50m	Clay	sp?
	-9.10m	Clay	sp?
	- 13.7m	Gravel	sp?
	- 26.5m	Sand (Peat at 24.3m)	ch
	- 44.8m	Gravel	ri
	- 53.6m	Sand & gravel	br
	- 59.4m	Clay (Peat at 54.5m)	br
	- 62.1m	Gravel	li-1
	- 67.9m	Clay (Peat at 65.5m)	li-2
	- 75.2m	Gravel	li-2
	- 78.3m	Clay	li-2
	- 84.4m	Gravel	li-3
	- 86.8m	Sand	he
	- 89.9m	Gravel	he
	- 97.5m	Sand & gravel	he
	- 97.6m	Clay	
	- 105.7m	Gravel	bu
	- 123.4m	Sandy clay	sh
	- 128.0m	Gravel	wa

Borelog for well M35/12095

Gridref: M35:81415-41896 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 7.62 +MSD
Well name : CCC BorelogID 87
Drill Method : Not Recorded
Drill Depth : -3.05m Drill Date : 1/01/1972

Depth(m)	Full Drillers Description	Formation Code
-0.30m	road metal	
-0.61m	black silt	
-1.22m	grey silt	
-1.52m	sandy silt	
-2.89m	running sand	
-3.05m	sandy silt	

CPT ANALYSIS NOTES

Soil Type

Interpretation using chart of Robertson & Campanella (1983). This is a simple but well proven interpretation using cone tip resistance (q_C) and friction ratio (f_R) only. No normalisation for overburden stress is applied. Cone tip resistance measured with the piezocone is corrected with measured pore pressure (u_C).

- sand (and gravel)
- silt-sand
- silt
- clay-silt
- clay
- peat

Liquefaction Screening

The purpose of the screening is to highlight susceptible soils, that is sand and silt-sand in a relatively loose condition. This is not a full liquefaction risk assessment which requires knowledge of the particular earthquake risk at a site and additional analysis. The screening is based on the chart of Shibata and Teparaksa (1988).

- high susceptibility
- medium susceptibility
- low susceptibility

High susceptibility is here defined as requiring a shear stress ratio of 0.2 to cause liquefaction with D_{50} for sands assumed to be 0.25 mm and for silty sands to be 0.05 mm.

Medium susceptibility is here defined as requiring a shear stress ratio of 0.4 to cause liquefaction with D_{50} for sands assumed to be 0.25 mm and for silty sands to be 0.05 mm.

Low susceptibility is all other cases.

Relative Density (D_R)

Based on the method of Baldi et. al. (1986) from data on normally consolidated sand.

Undrained Shear Strength (S_U)

Derived from the bearing capacity equation using $S_U = (q_C - \sigma_{VO})/15$.

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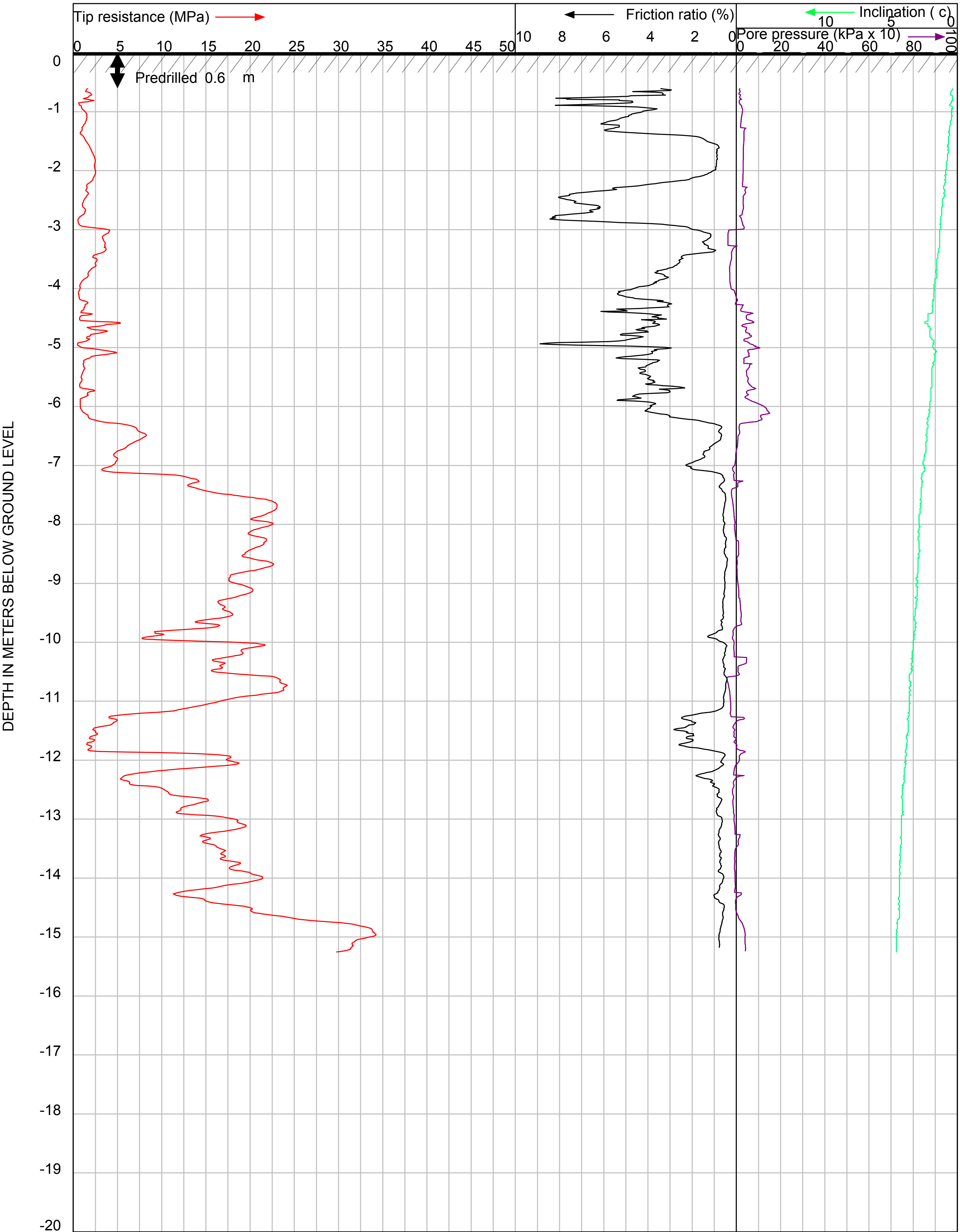

CLIENT : GHD NZ Ltd
LOCATION : 250 Gloucester Street, Christchurch
DATE : 25-6-2012
OPERATOR : S.Cardona
REMARK 1 : CPTu001
REMARK 2 : Effective Refusal

JOB # : 10680
TEST # : 1
CONE TYPE/SERIAL #: I-CFXYP20-10/ 071017T

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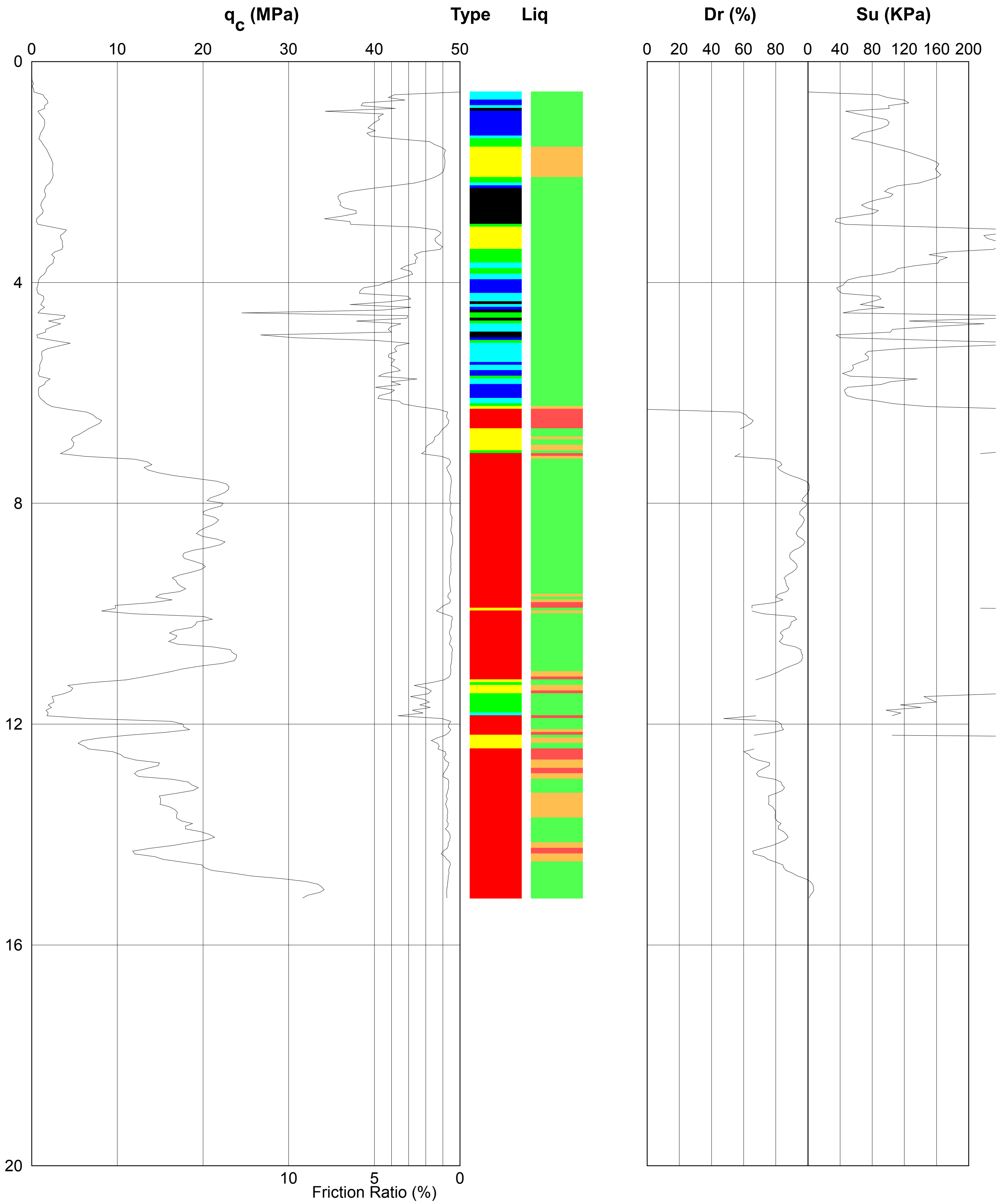
www.drilling.co.nz

PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



Job No:	10680	Date:	25-6-2012
CPT No:	CPTu001	Operator:	S.Cardona
Project:	GHD NZ Ltd	Remark:	Effective Refusal
Location:	250 Gloucester Street, Christchurch		

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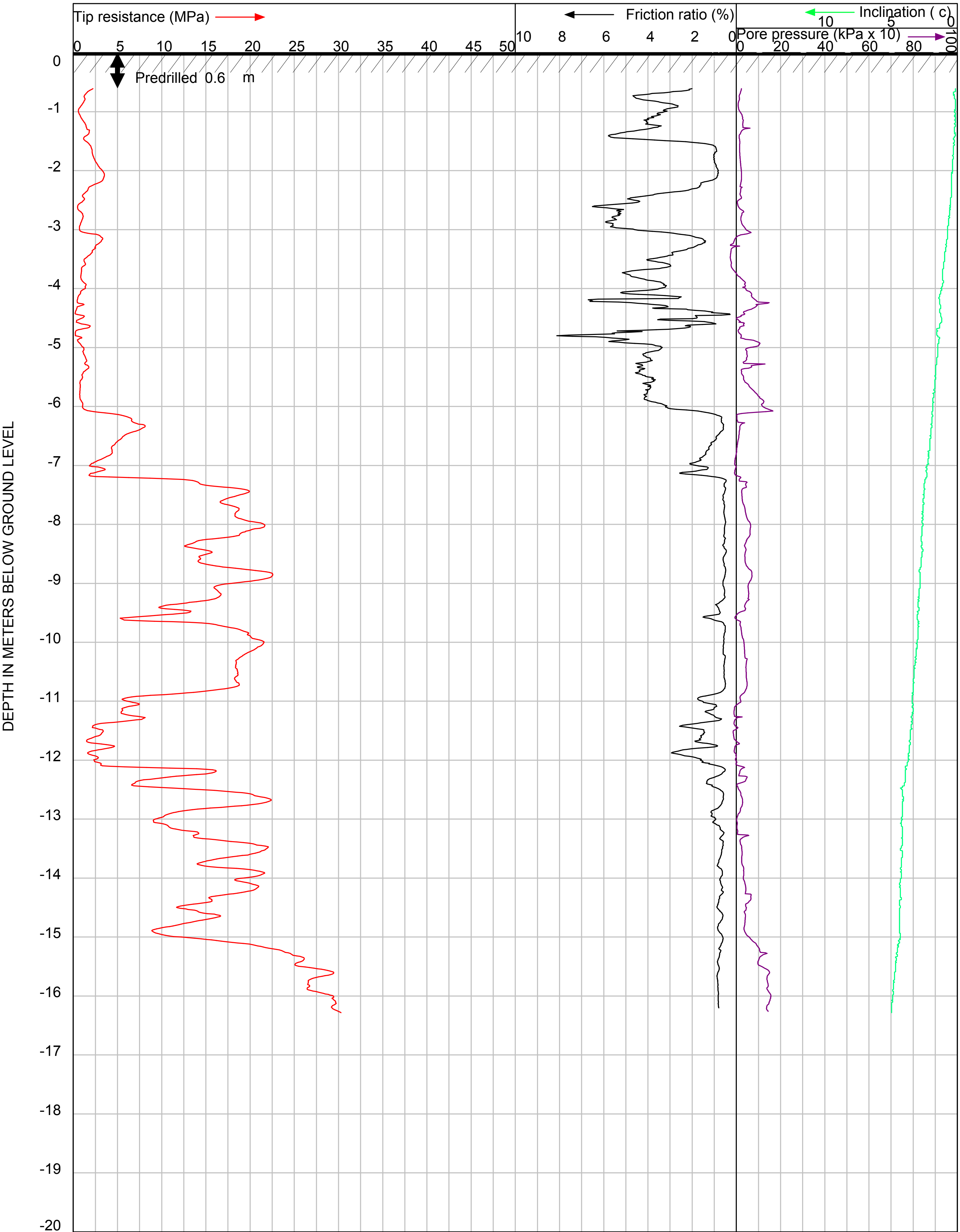

CLIENT : GHD NZ Ltd
LOCATION : 250 Gloucester Street, Christchurch
DATE : 26-6-2012
OPERATOR : S.Cardona
REMARK 1 : CPTu002
REMARK 2 : Effective Refusal

JOB # : 10680
TEST # : 2
CONE TYPE/SERIAL #: I-CFXYP20-10/ 071017T

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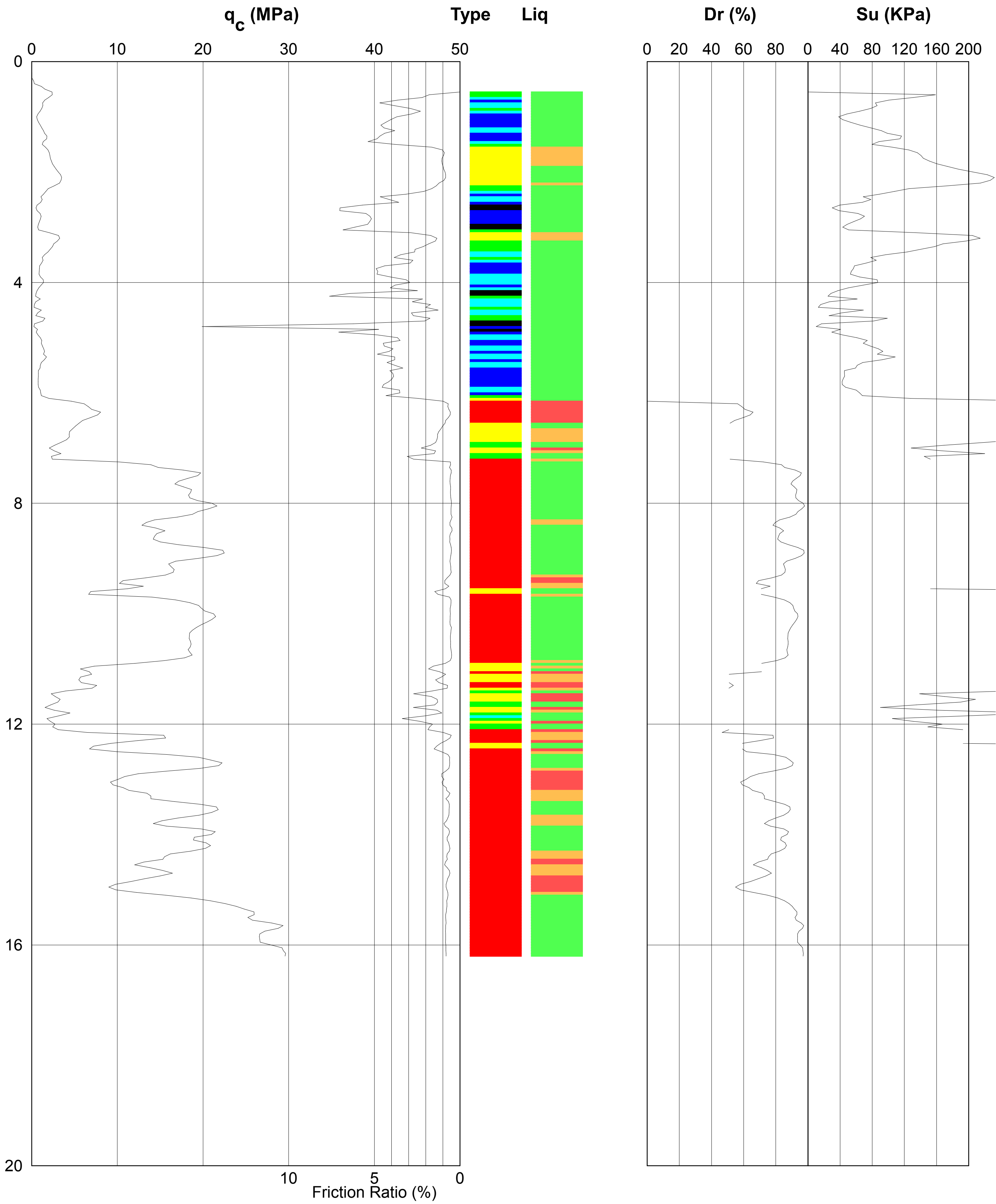
PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



Job No:	10680	Date:	26-6-2012
CPT No:	CPTu002	Operator:	S.Cardona
Project:	GHD NZ Ltd	Remark:	Effective Refusal
Location:	250 Gloucester Street, Christchurch		

McMILLAN DRILLING SERVICES

CIVIL CONSTRUCTION OVERVIEW

- 5 x Piling Rigs (20 to 80 tonne);
- 4 x Tieback/Micro-Piling Rigs (0.5 to 20 tonne);
- Sheet Piling & Injection Grouting;
- Dewatering;
- 26 x Drilling Rigs Company wide.

A NEW ZEALAND FIRST METHOD – INTRODUCED TO THE MARKET BY MCMILLAN'S:

Provisionally Patented Vibration Free Stone Column Method:

- Can be used next to sensitive buildings;
- No mess (dry);
- Cost effective (minimal setup times);
- Further savings possible for building construction – i.e. ground beams, deep rafts, pile starters, boxing to piles;
- No corrosion issues, all natural materials;
- Reliance on individual piles, and the risk of differential settlement is reduced.

Fully Instrumented Continuous Flight Auger / Displacement Auger Piling:

- Cost effective;
- Sizes 350mm to 900mm and 19m depth;
- Fast (150m of 600mm diameter reinforced concrete pile can be installed per day);
- Lateral load capacity of RC piles exceed some other piling methods;
- Quiet & vibration free;
- Fully reinforced concrete piles, with no corrosion issues.

McMILLAN'S ALSO OFFER THE FOLLOWING SERVICES:

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- Conventional Bored Concrete Piles;
- Mini & Micro Piles;
- Retaining Walls;
- Sheet Piling;
- Anchors & Tiebacks.

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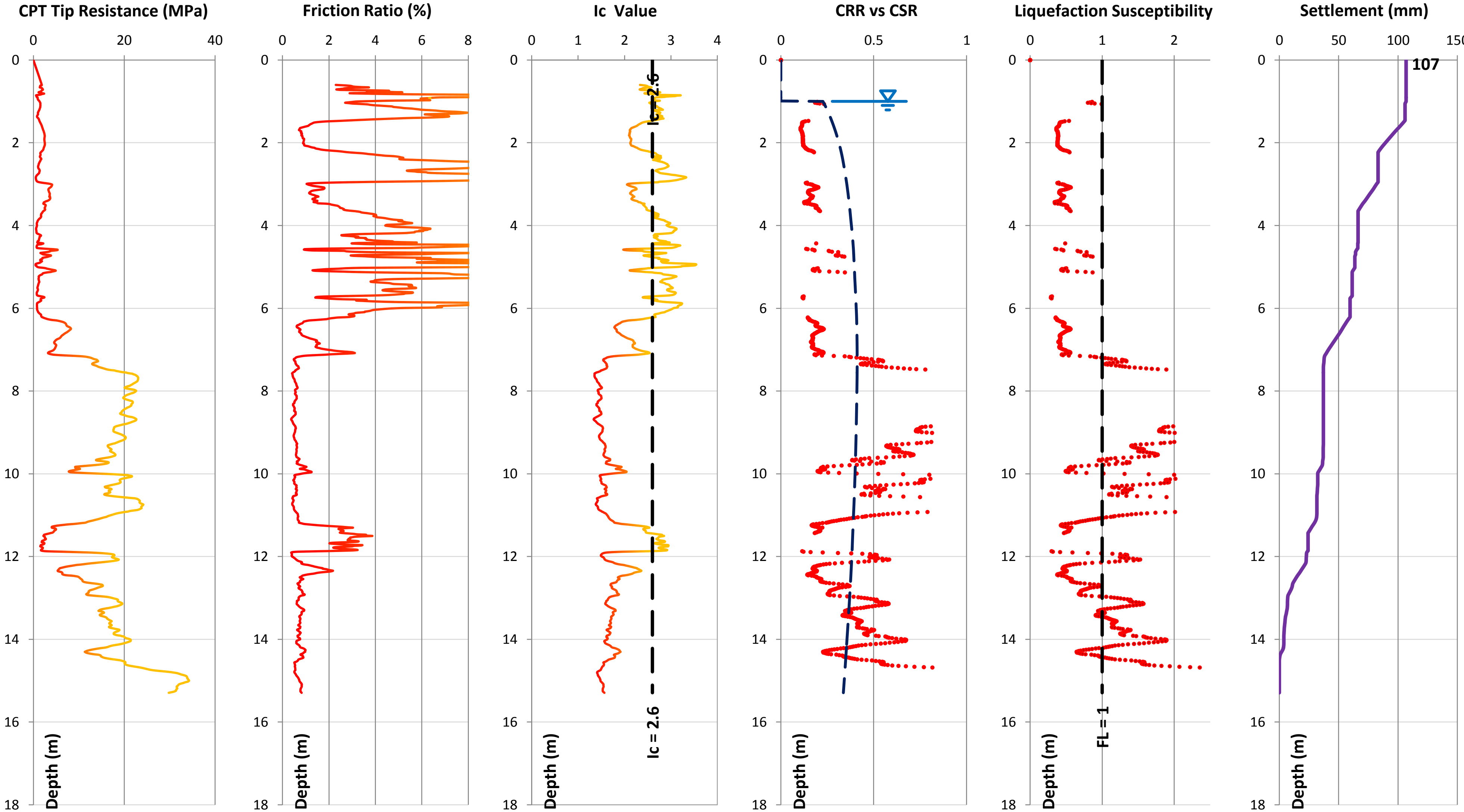
SOIL LIQUEFACTION SUSCEPTIBILITY ASSESSMENT

LOCATION :	CPT 01	SHEET :	1 (ULS)
PROJECT :	Gloucester Courts	CALCULATED :	HNN/DW
JOB NO :	51 30596 36	CHECKED BY :	JR
TEST DATE :	25 Jun 2012	DATE :	22 Aug 2012

PGA (a_{max}):	0.35 g	Groundwater Level (m bgl):	1.0	Bore depth (m):	15.29
EQ Magnitude:	7.5	Atmospheric Pressure (kPa):	101	Test data step (m):	0.01

Total Estimated Settlement (mm)

107



N:\NZ\Wellington\Projects\51\30596\36 Gloucester Courts Block A\Investigation\Geotech Investigation\Liquefaction Analyses\Liquefaction and Settlement Analysis CPT 01

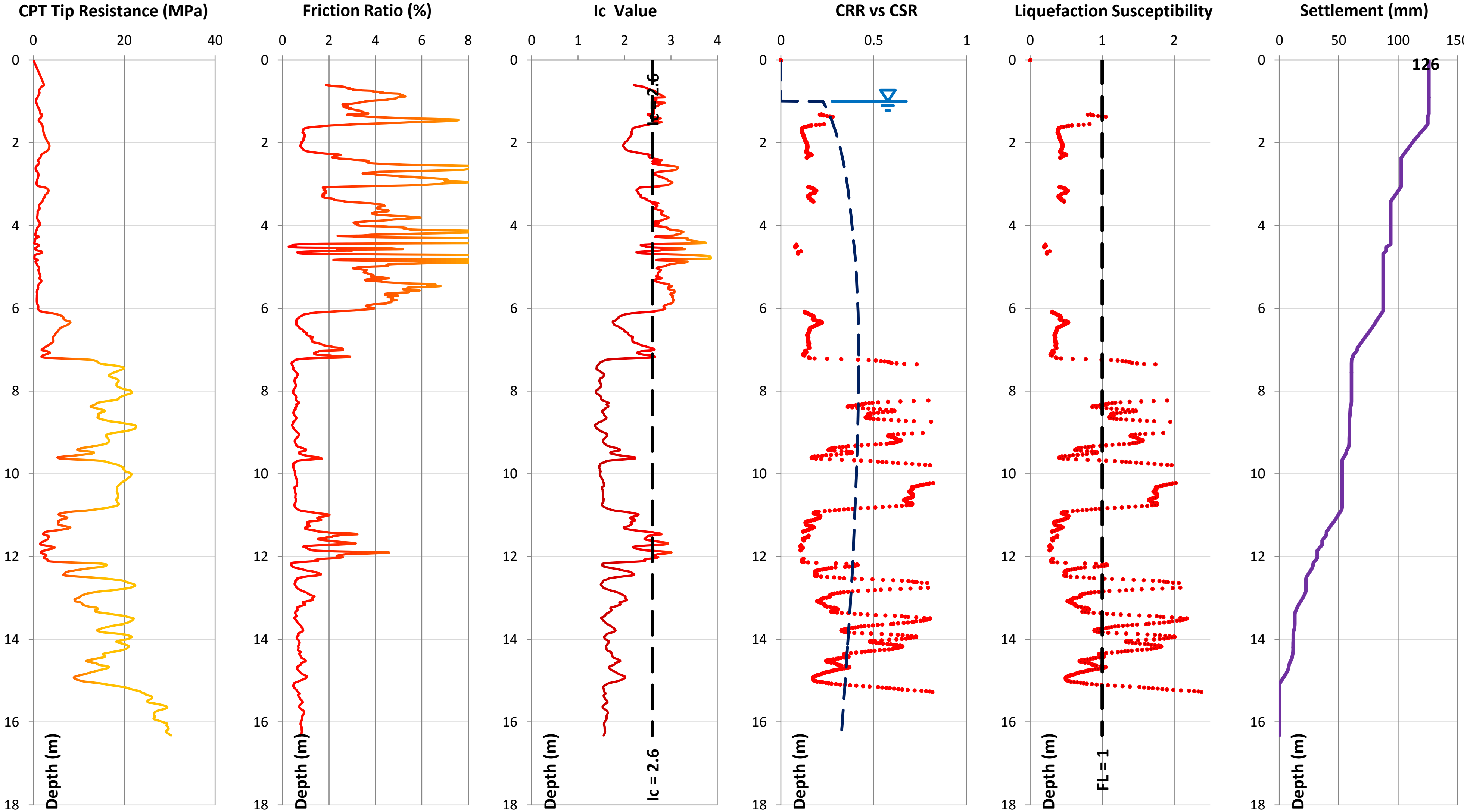
SOIL LIQUEFACTION SUSCEPTIBILITY ASSESSMENT

LOCATION :	CPT 02	SHEET :	1 (ULS)
PROJECT :	Gloucester Courts	CALCULATED :	HNN/DW
JOB NO :	51 30596 36	CHECKED BY :	JR
TEST DATE :	25 Jun 2012	DATE :	22 Aug 2012

PGA (a_{max}):	0.35 g	Groundwater Level (m bgl):	1.0	Bore depth (m):	16.32
EQ Magnitude:	7.5	Atmospheric Pressure (kPa):	101	Test data step (m):	0.01

Total Estimated Settlement (mm)

126



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Appendix B

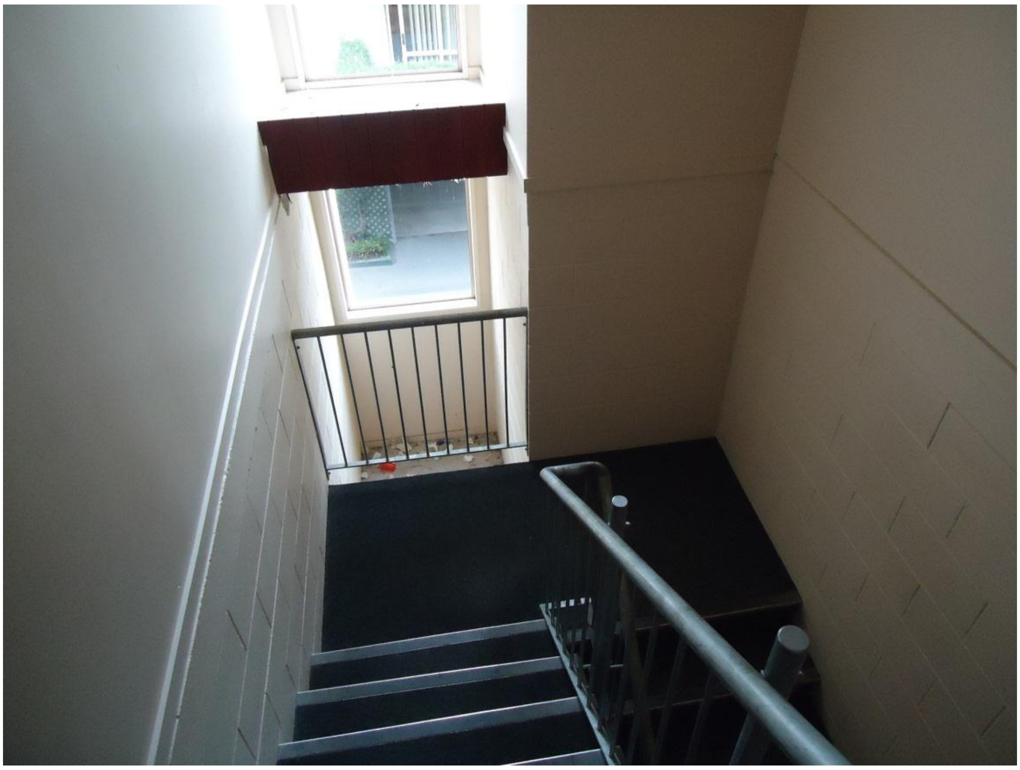
Photographs

Photograph 1 Eastern façade of the building looking north.

Photograph 2 Eastern façade of the building looking south.

Photograph 3 Timber roof trusses. No roof cross bracing visible.

Photograph 4 Lightweight metal roof cladding.



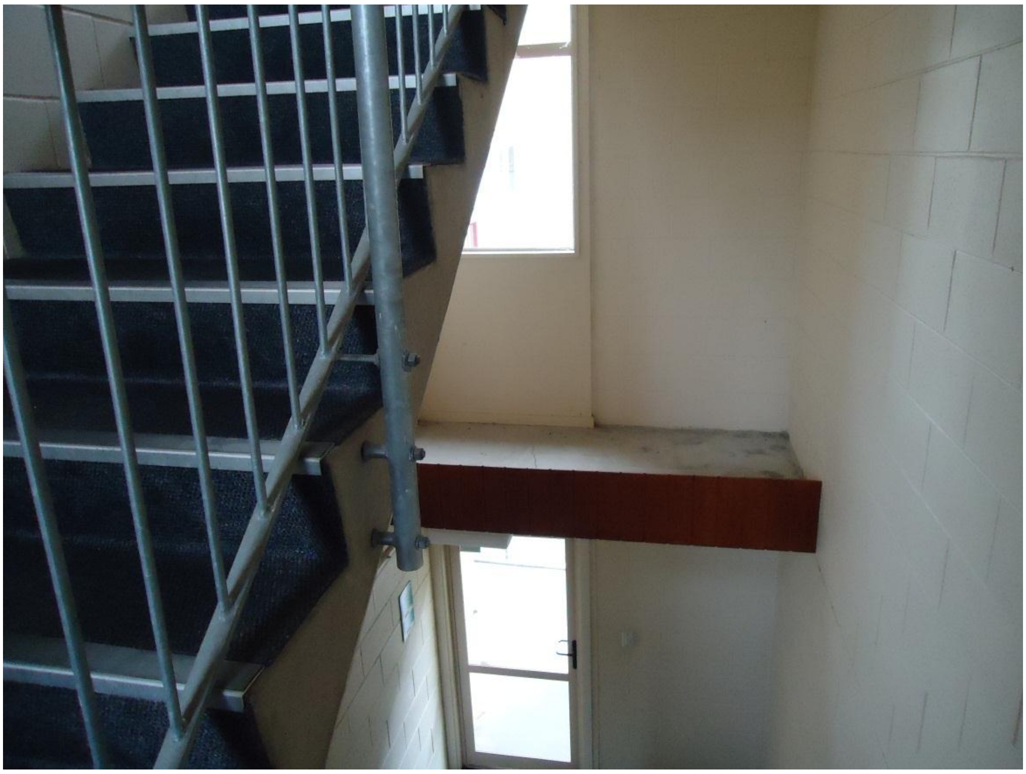
Photograph 5 Change from concrete masonry walls to timber framed walls visible at 2nd floor level in the stairwell.

Photograph 6 Cracking to plasterboard lining noticeable throughout the building.

Photograph 7 Connection of precast stairs unit to the precase concrete floor slabs.

Photograph 8 Reinforced concrete column and beam frame system.

Photograph 9 Plasterboard lining around reinforced concrete beam.

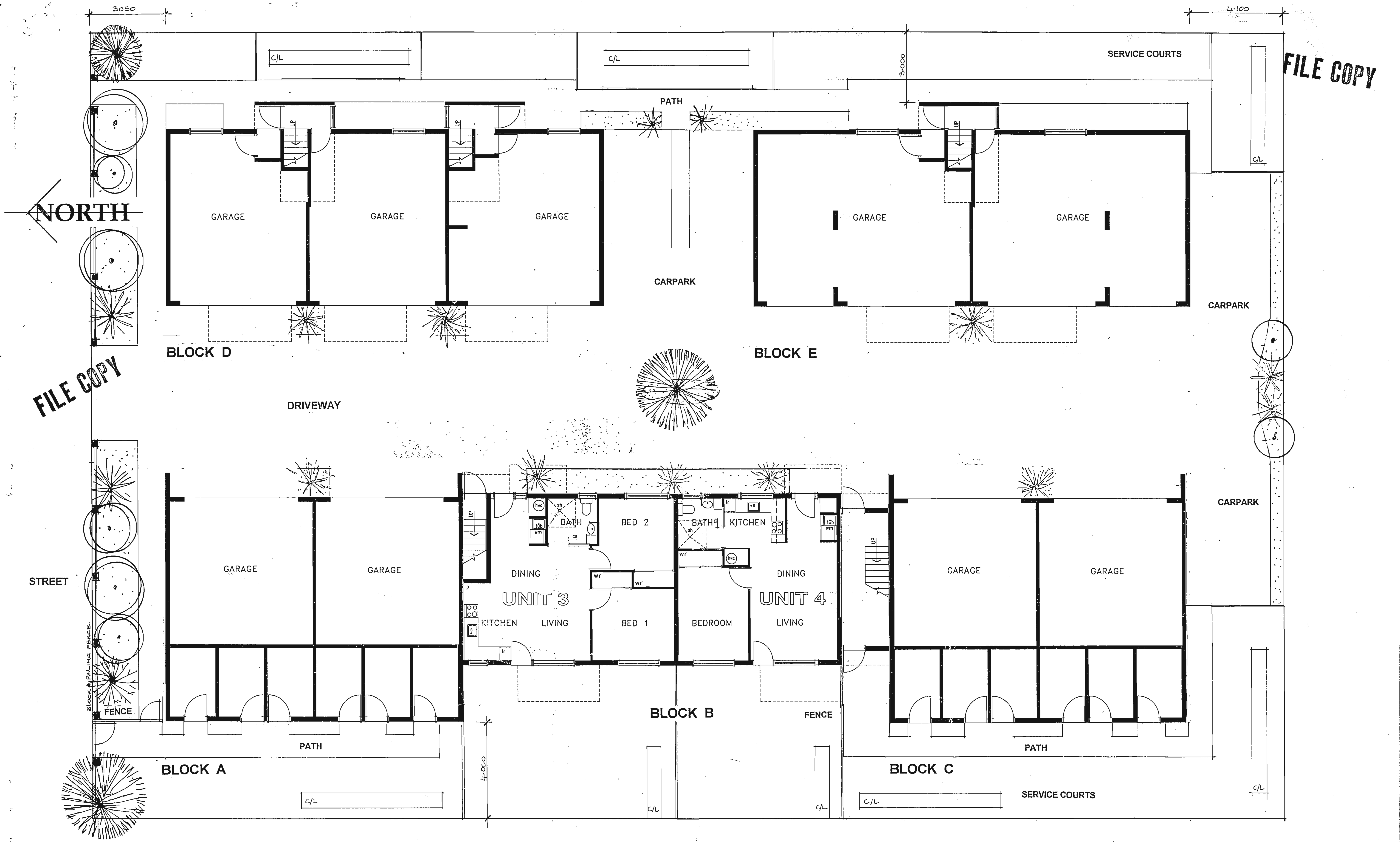


Photograph 10 Cracking to concrete slab above southern entrance.

Photograph 11 Cracking to underside of concrete slab above southern entrance.

Photograph 12 Cracking to concrete slab above southern entrance.

Appendix C
Original Drawings



SITE PLAN

SCALE 1:100

...CHURCH CITY COUNCIL
P.I.M. APPLICATION
Rec'd 23 JUL 1998
Civic Offices
PROJECT No. 9800~~2440~~

BCP

98002450

PROPOSED RESIDENTIAL DEVELOPMENT BY BRYNDWR BUILDERS LTD.

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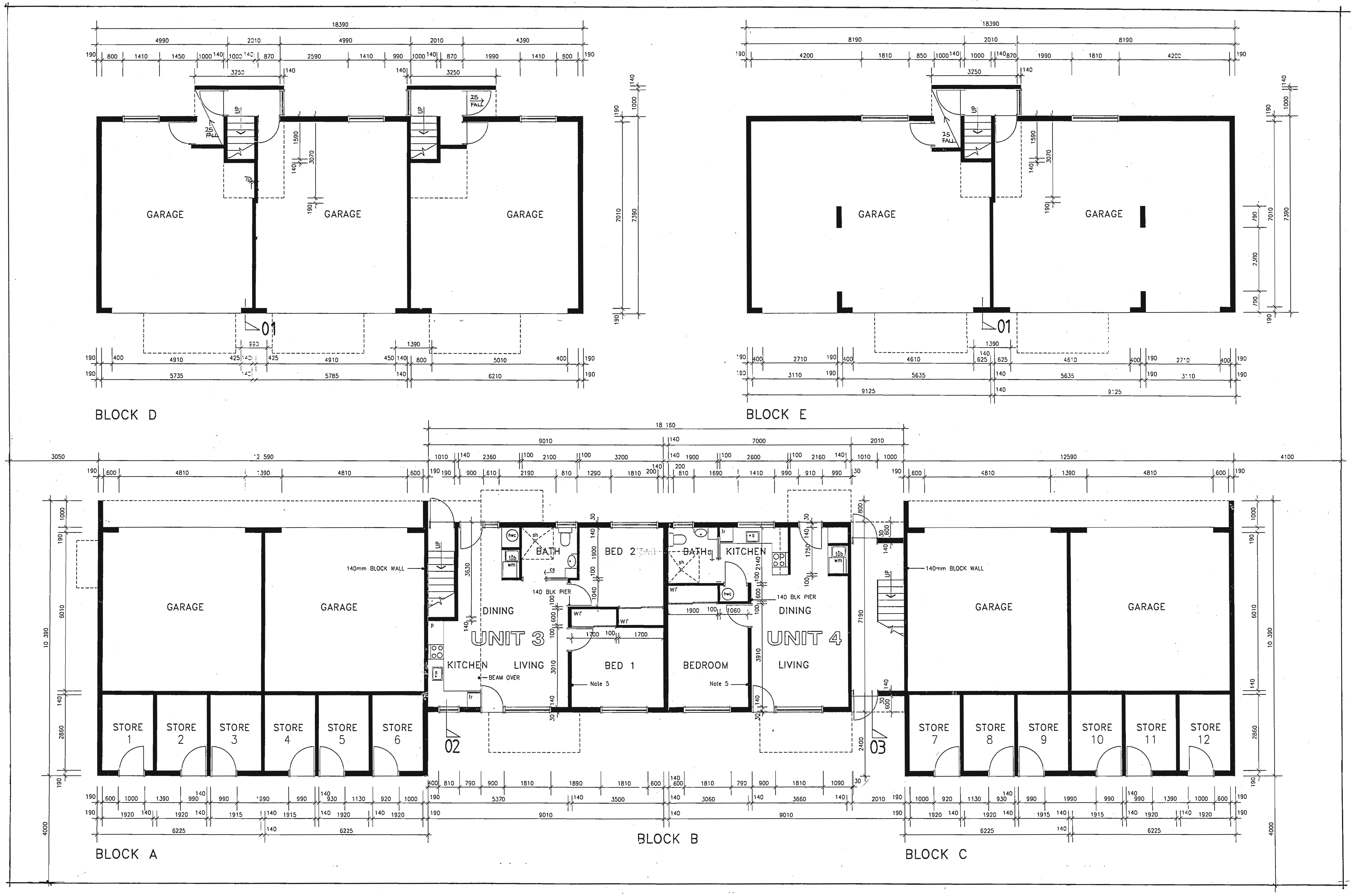
SHEET 01
DATE 19/06/98
ISSUE A



GROUND FLOOR PLANS

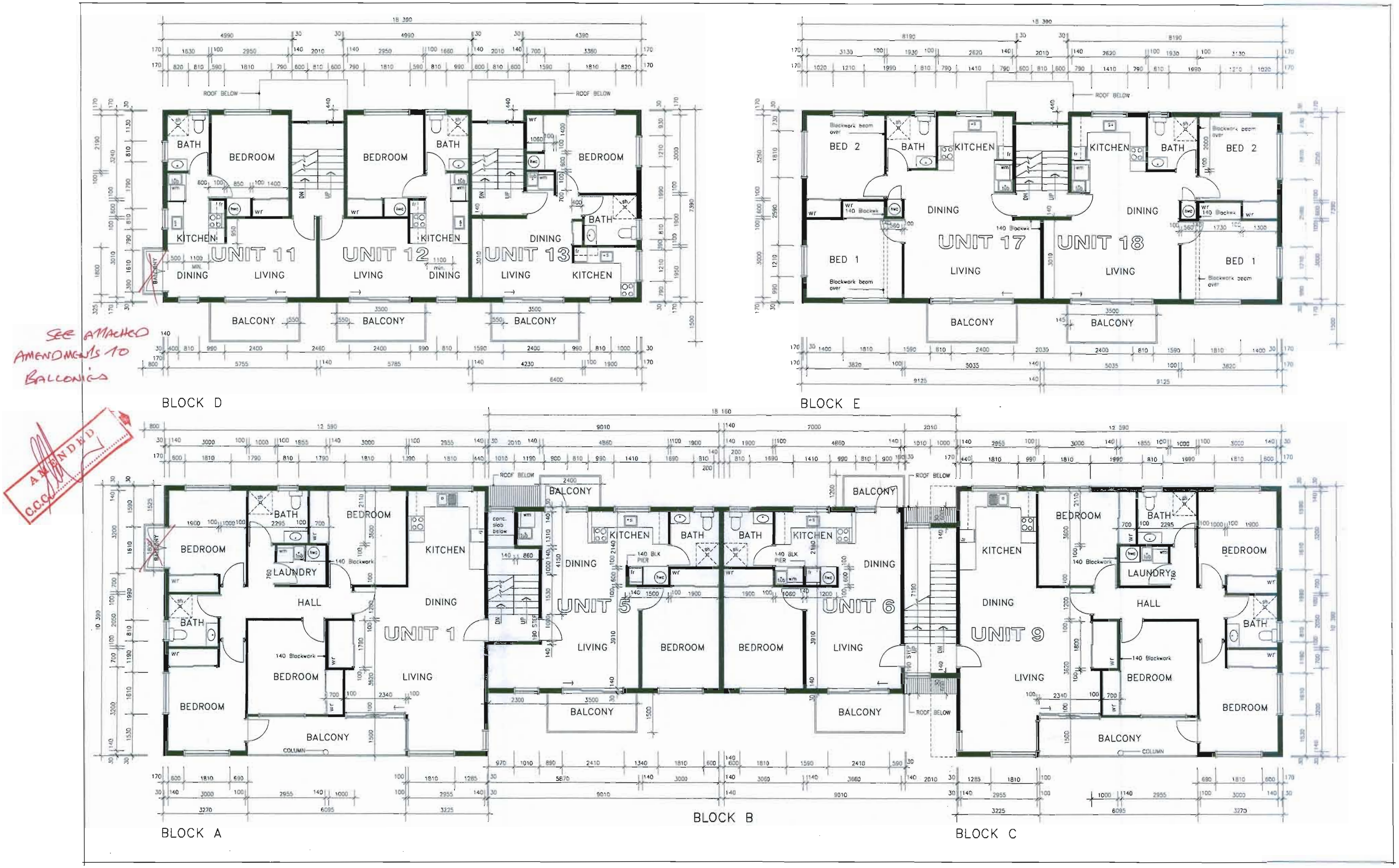
SCALE 1:100

1. Contractor shall verify all dimensions before starting work.
2. Refer to Engineer's drawings for blockwork and foundation details.
3. External walls dimensioned as 170mm are constructed of 140mm blockwork and 30mm polystyrene.
4. Most units are similar but handed as shown. Unit features are typical to each unit and shall be repeated to each unit.
5. 140mm blockwork beam above 140mm timber frame wall - refer Eng. Drawings.

PROPOSED RESIDENTIAL DEVELOPMENT BY BRYNDWR BUILDERS LTD.

SHEET 02

DATE 18/08/98



FIRST FLOOR PLANS

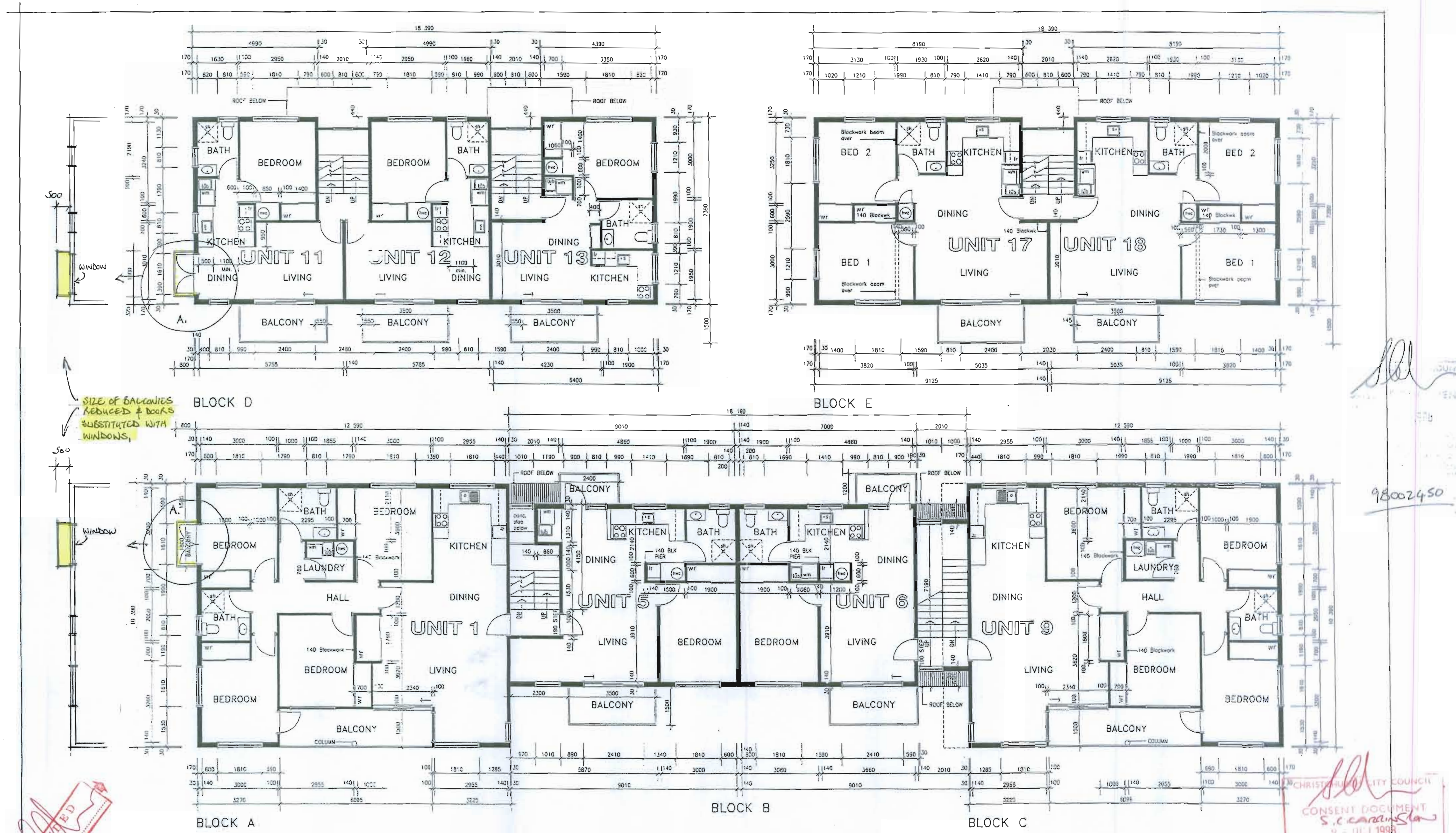
SCALE 1:100

1. Contractor shall verify all dimensions before starting work.
2. Refer to Engineer's drawings for blockwork and foundation details.
3. External walls dimensioned as 170mm are constructed of 140mm blockwork and 30mm polystyrene.
4. Extract fan to Block A and C laundries shall be ducted at top of wardrobe to exterior wall.

PROPOSED RESIDENTIAL DEVELOPMENT BY BRYNDWR BUILDERS LTD.

SHEET 03

DATE 18/08/98



FIRST FLOOR PLANS

SCALE 1:100

1. Contractor shall verify all dimensions before starting work.
2. Refer to Engineer's drawings for blockwork and foundation details.
3. External walls dimensioned as 170mm are constructed of 140mm blockwork and 30mm polystyrene.
4. Extract fan to Block A and C laundries shall be ducted at top of wardrobe to exterior wall.

AMENDMENTS

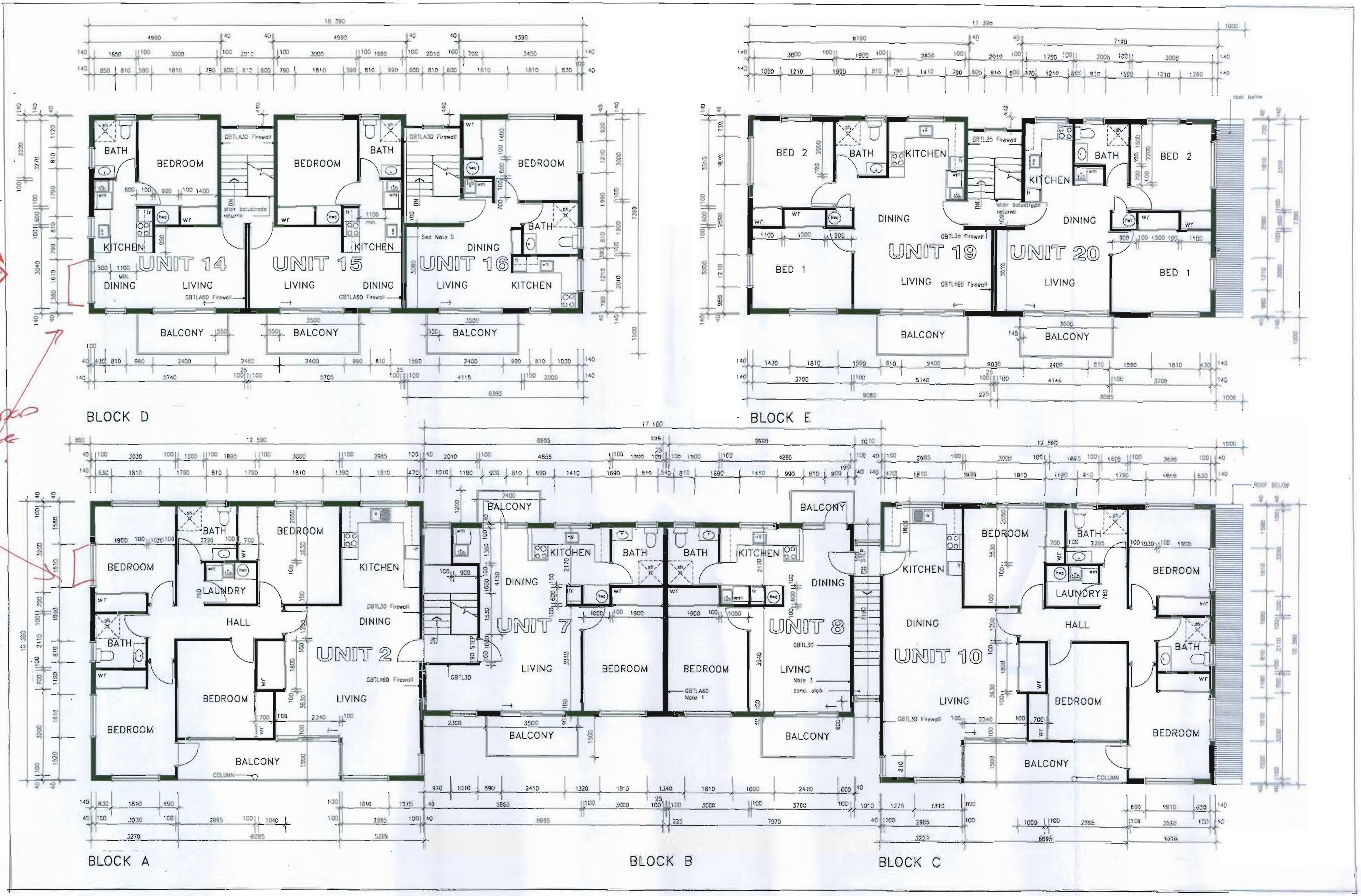
A. BALCONY SIZE REDUCED & DOORS SUBSTITUTED WITH WINDOWS. 9.10.98.

PROPOSED RESIDENTIAL DEVELOPMENT BY BRYNDWR BUILDERS LTD.

SHEET 03
DATE 18/08/98

AMENDED C.C.C.

BALCONIES ADDED IN HERE SEE ATTACHED



SECOND FLOOR PLANS

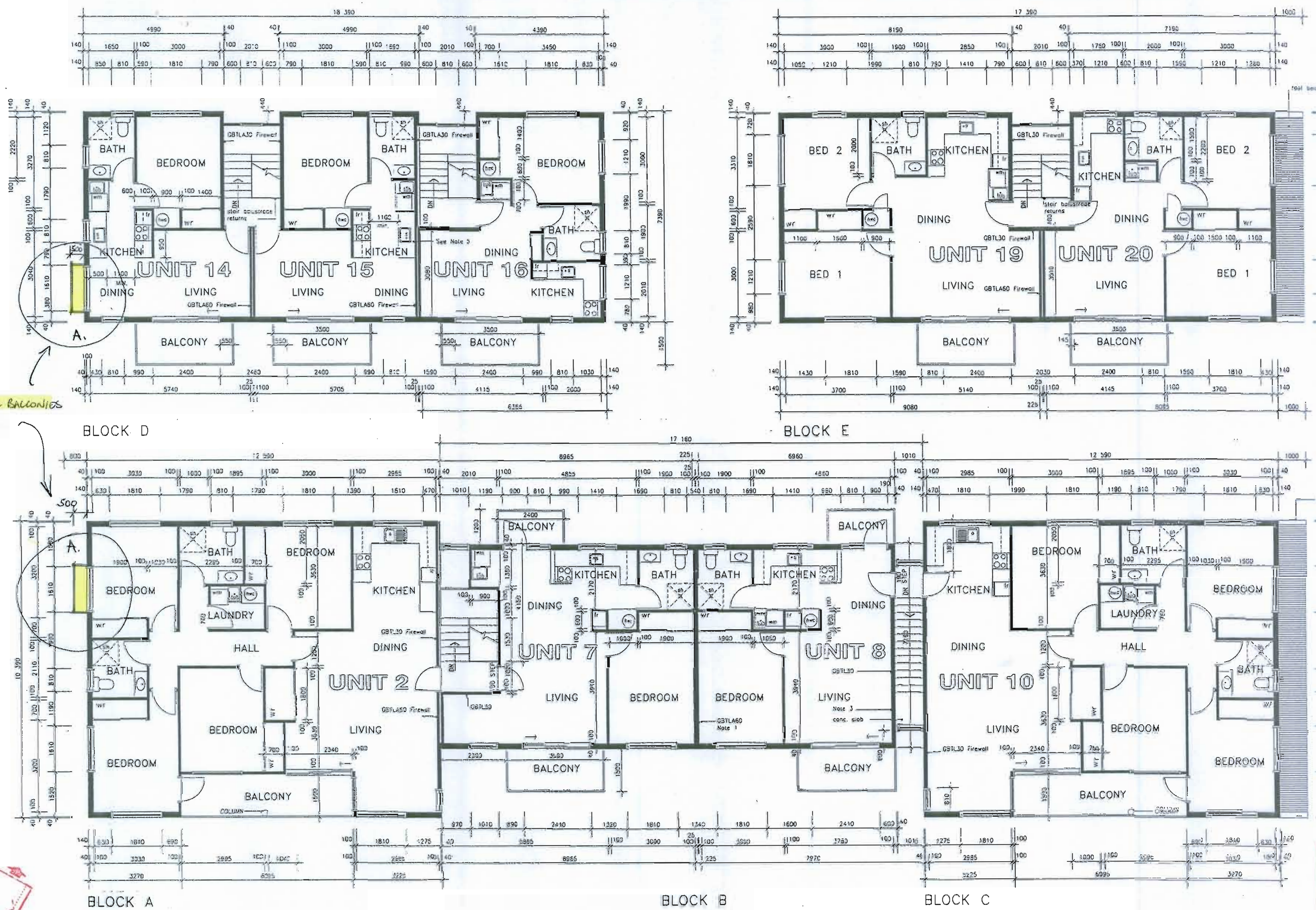
SCALE 1:100

1. GBTLA60 Firewalls between units. GBTL30 Firewalls to stairs.
2. External walls dimensioned as 140mm are constructed of 100mm timber framing and 40mm polystyrene.
3. 40mm packing to stair walls Block A and C
4. Extract fan to Block A and C laundries shall be ducted at top of wardrobe to exterior wall.
5. Unit 15 sink piping not to be installed in sound rated wall to Unit 16.

PROPOSED RESIDENTIAL DEVELOPMENT BY BRYNDWR BUILDERS LTD.

SHEET 04

DATE 18/08/98



SECOND FLOOR PLANS

SCALE 1:100

1. GBTLA60 Firewalls between units. GBTL30 Firewalls to stairs.
2. External walls dimensioned as 140mm are constructed of 100mm timber framing and 40mm polystyrene.
3. 40mm packing to stair walls Block A and C
4. Extract fan to Block A and C laundries shall be ducted at top of wardrobe to exterior wall.
5. Unit 15 sink piping not to be installed in sound rated wall to Unit 16.

AMENDMENTS,

A. 2 DECORATIVE BALCONIES ADDED. 9.10.98.

PROPOSED RESIDENTIAL DEVELOPMENT BY BRYNDWR BUILDERS LTD.

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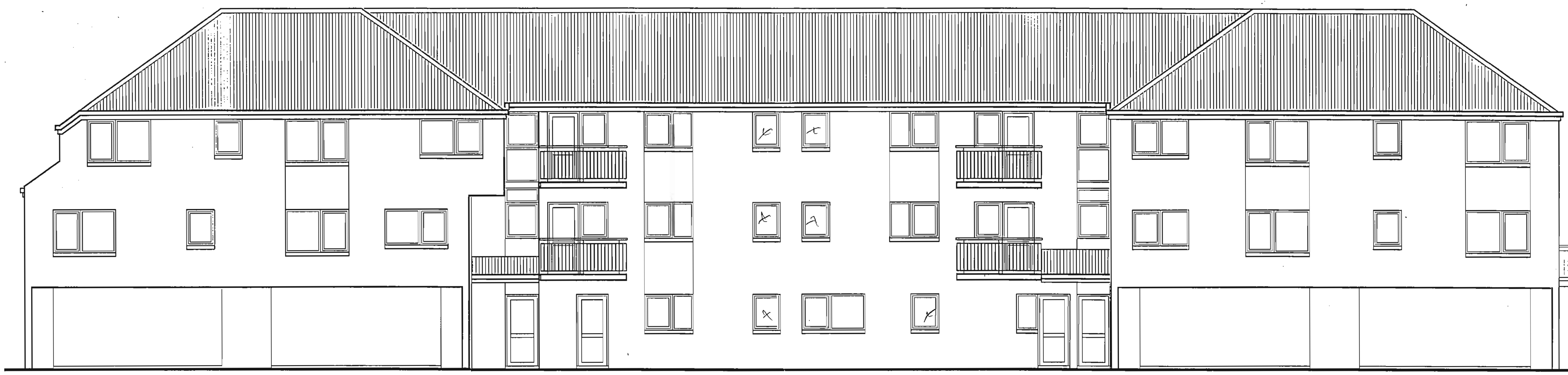
SHEET 04

DATE 18/08/98

AMENDED C.C.C.

CHRISTCHURCH CITY COUNCIL CONSENT DOCUMENT S.C. CARRINGTON 9 - OCT 1998

98002450



EAST

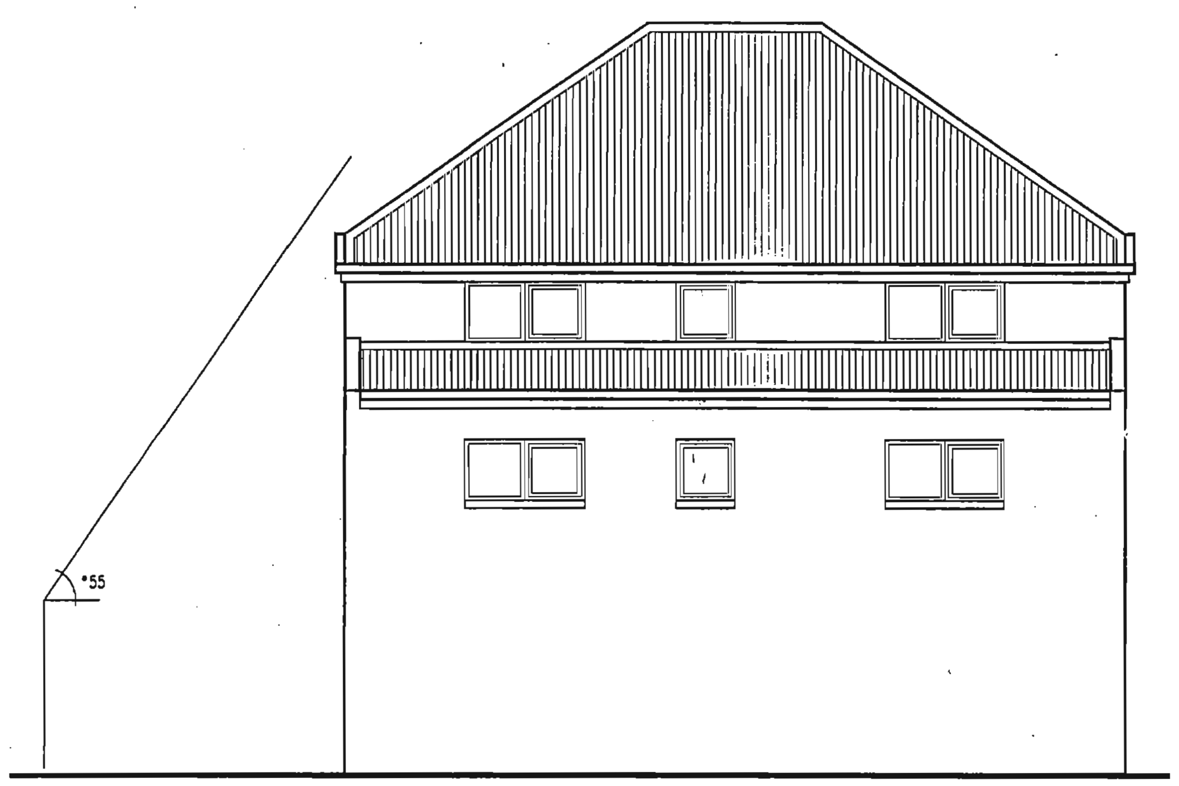
CLADDINGS:
1. Exterior cladding - acrylic plaster system with surface finish on polystyrene insulation where indicated. No polystyrene to ground floor garages.
   On completion the licensed applicator will provide a certificate to the T.A. stating that the cladding has been installed to the manufacturer's specification.
2. Harditex cladding to stairwells and panels under windows as shown.

WINDOWS:
3. Windows to be powder coated aluminium, colour confirmed with Owner.

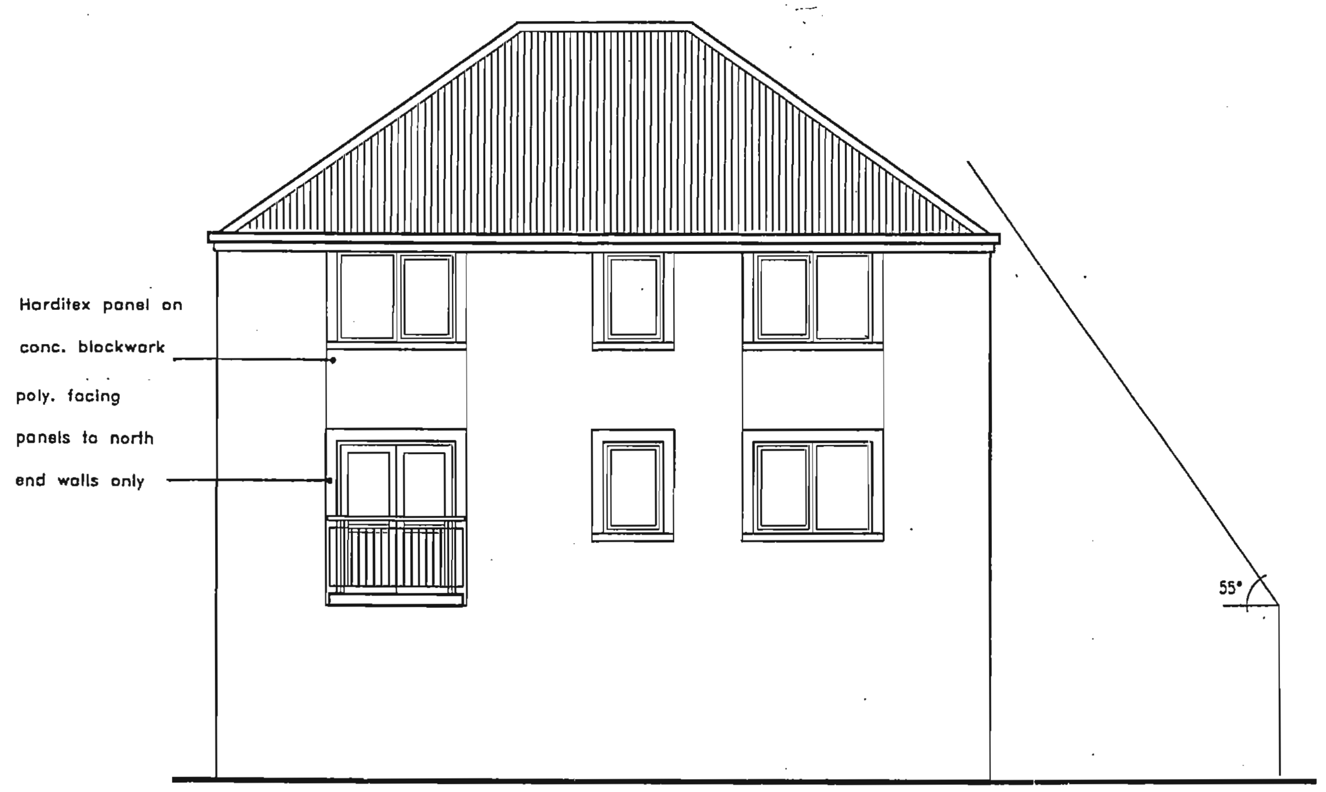
ROOFING:
4. 0.40 B.M.T Corrugated galvanised Colorsteel.

GENERAL:
5. For balcony details refer to cross sections and separate drawing.

WEST



SOUTH



NORTH

Where people could fall one metre or more from floor level, the bottom of **WINDOW OPENINGS** shall be 760 mm above floor and 610 mm above toeholds **or** the openings restricted to 100 mm.

ANTI-SLIP: On all access routes (both external and internal), provide anti-slip surfaces complying with NZBC D1/AS1/Table 2 (except that surfaces inside entry doors of housing may be considered as dry areas).

EXTERIOR CLADDING SYSTEM: Rockcote..........
The manufacturer's approved applicator of the exterior cladding system is to supply a certificate to the Council stating that the cladding has been installed to the manufacturer's specification.

BLOCK A, B AND C

ELEVATIONS

SCALE 1:100

PROPOSED RESIDENTIAL DEVELOPMENT BY BRYNDWR BUILDERS LTD.

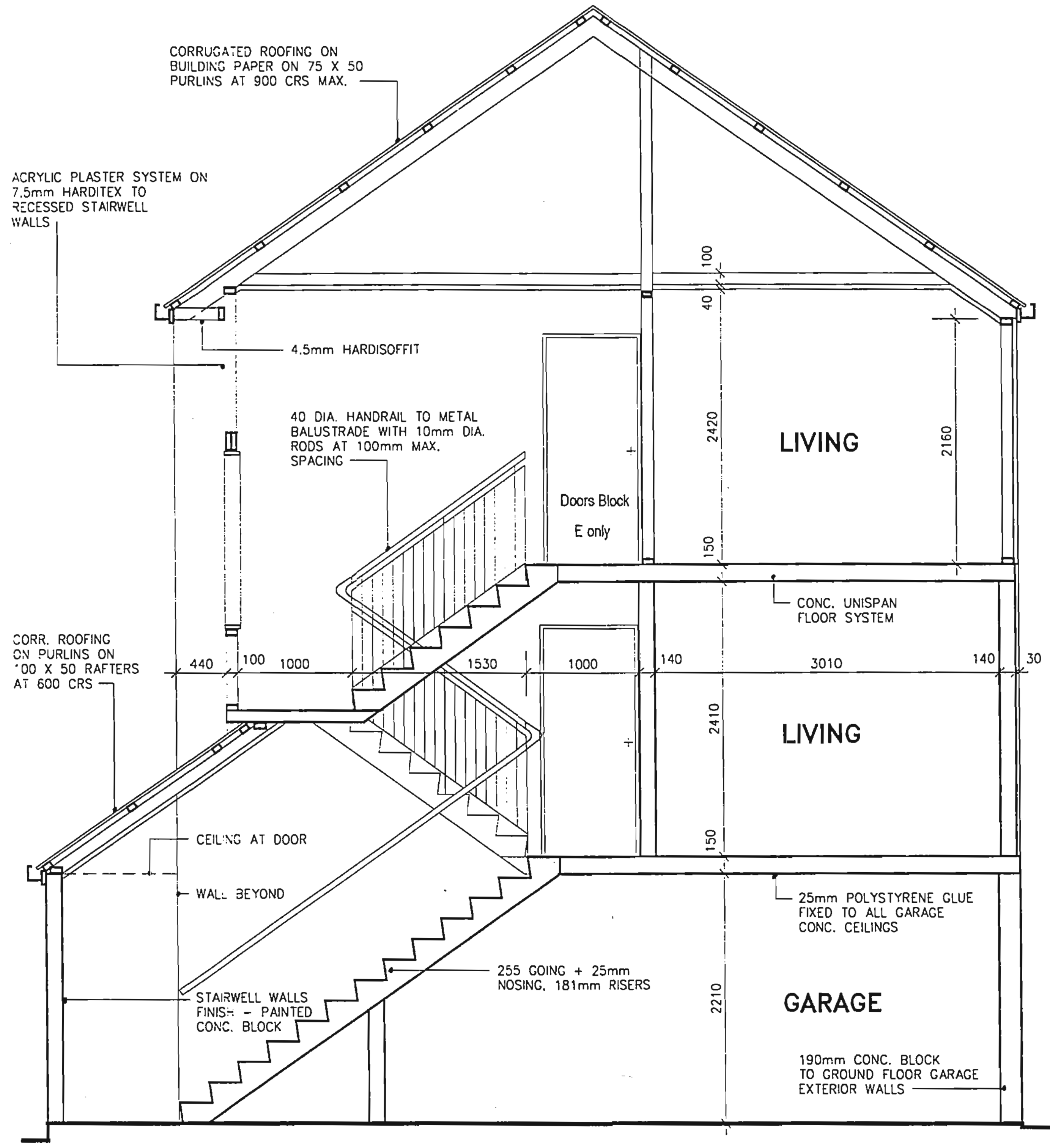
SHEET 05
DATE 18/08/98

ROOFING:

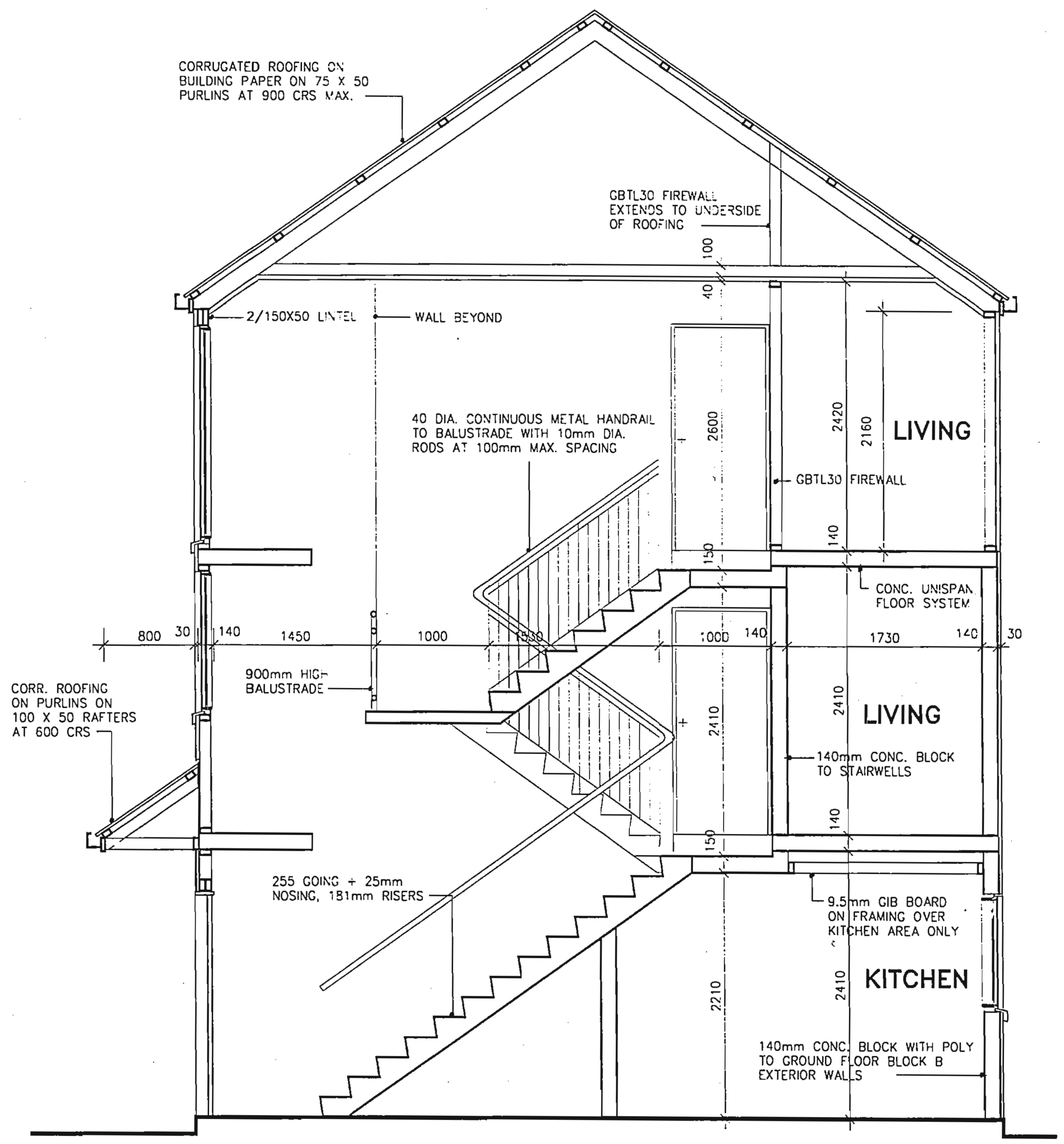
1. 0.40 B.M.T Corrugated galvanised Colorsteel.
2. Colorsteel barge flashing (in long lengths).
3. Colorsteel ridge flashing (in long lengths)
4. Lay selected roofing on building paper.
5. Stratco metal fascia and gutter or similar approved.
6. Prefabricated factory designed and certified roof trusses with suitable chords at 900 crs maximum spacing. Pitch 35 degrees.
7. 75 x 50 purlins at 900 mm crs maximum.
8. 15mm H3 treated plywood under waterproofing membrane to flat roof over Block A and C.
9. 4.5 mm Hardisoffit lining on 75 x 50 eave bearers at 900 crs.

WALLS:

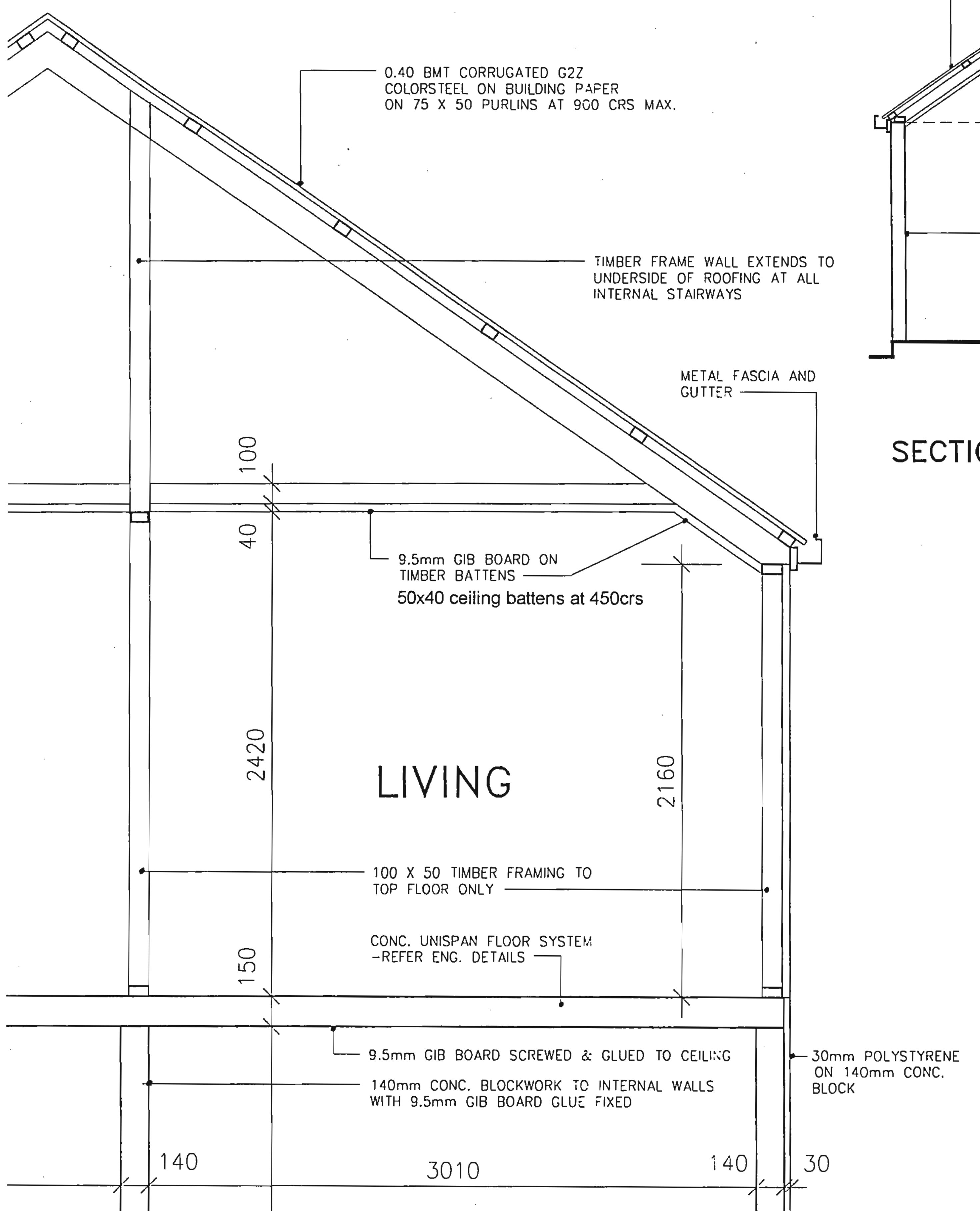
10. Wall Framing - to top floor and internal walls where shown 100 x 50 studs at 600 crs, dwangs -800 crs min.
11. Building paper to walls shall be Heavy duty standard building paper.



SECTION 01 1:50



SECTION 02 1:50



TYPICAL SECTION 1:25

CLADDINGS:

12. Exterior cladding -Rockcote plaster system (with zero ignitability) on polystyrene insulation where indicated. Polystyrene glue fixed to conc block in accordance with Rockcote specifications.

FOUNDATIONS & FLOORS:

13. 100mm thick concrete slab with H.R.C. mesh as shown. Refer to Engineer's drawings for foundations.
14. D.P.C. on Granular hardfill to comply with Appendix E N.Z.S. 3604.

WINDOWS:

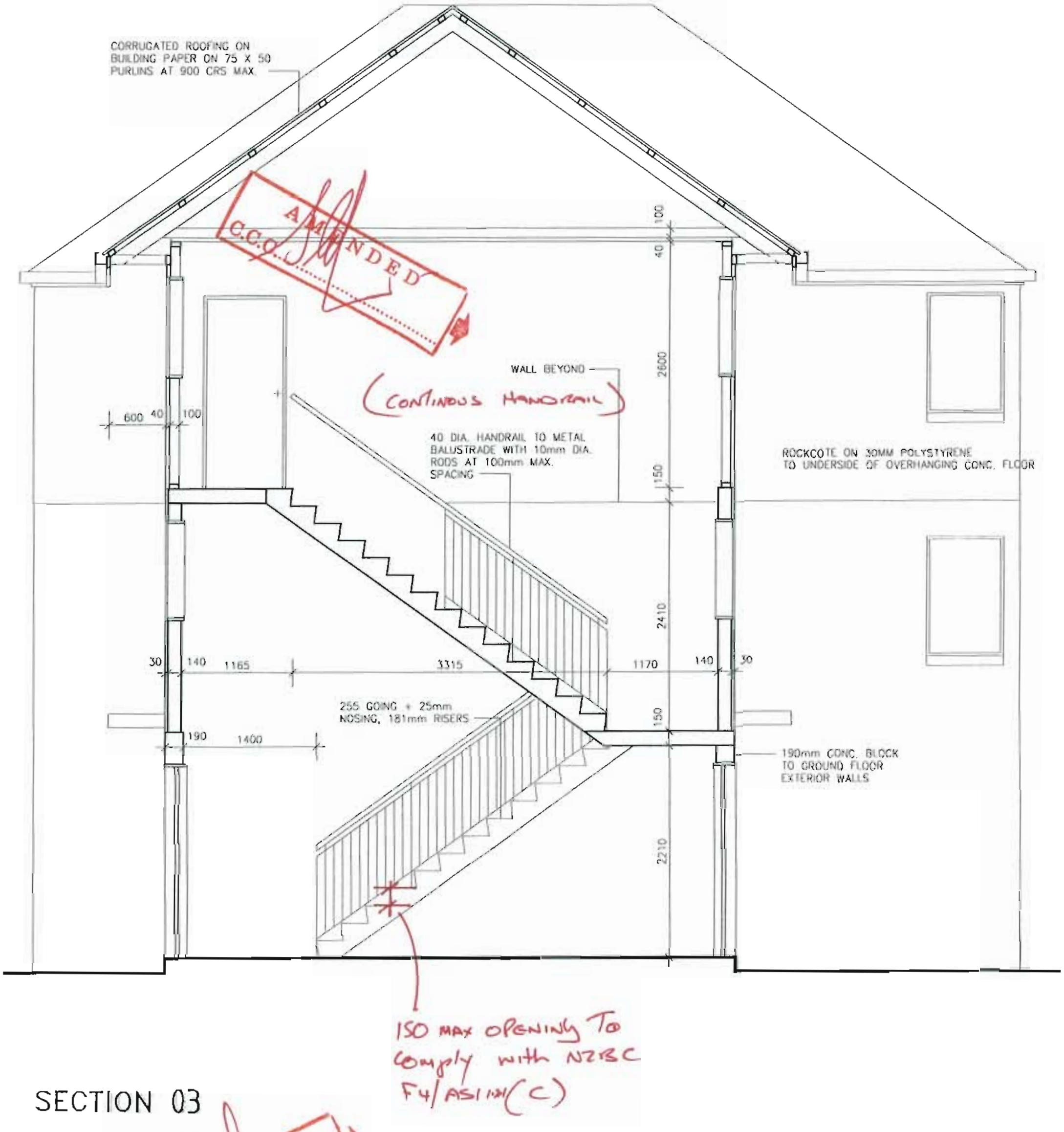
15. Windows to be powder coated aluminium, colour confirmed with Owner.
16. Aluminium windows with condensation channels. Frames to be ex 25mm timber reveals rebated for wall linings.

LININGS:

17. 9.5mm gib board lining glue fixed to external conc. Blockwalls.
18. R1.8 fibreglass insulation to ceilings 2nd floor.
19. 25mm polystyrene insulation glue fixed to underside of first floor concrete slab.
20. Note: Insulation should form a continuous envelope around the building.

21. BALCONY:
Balustrade top rail 40 diam. galv. pipe on 20 diam. verticals at 1.2 m max crs.

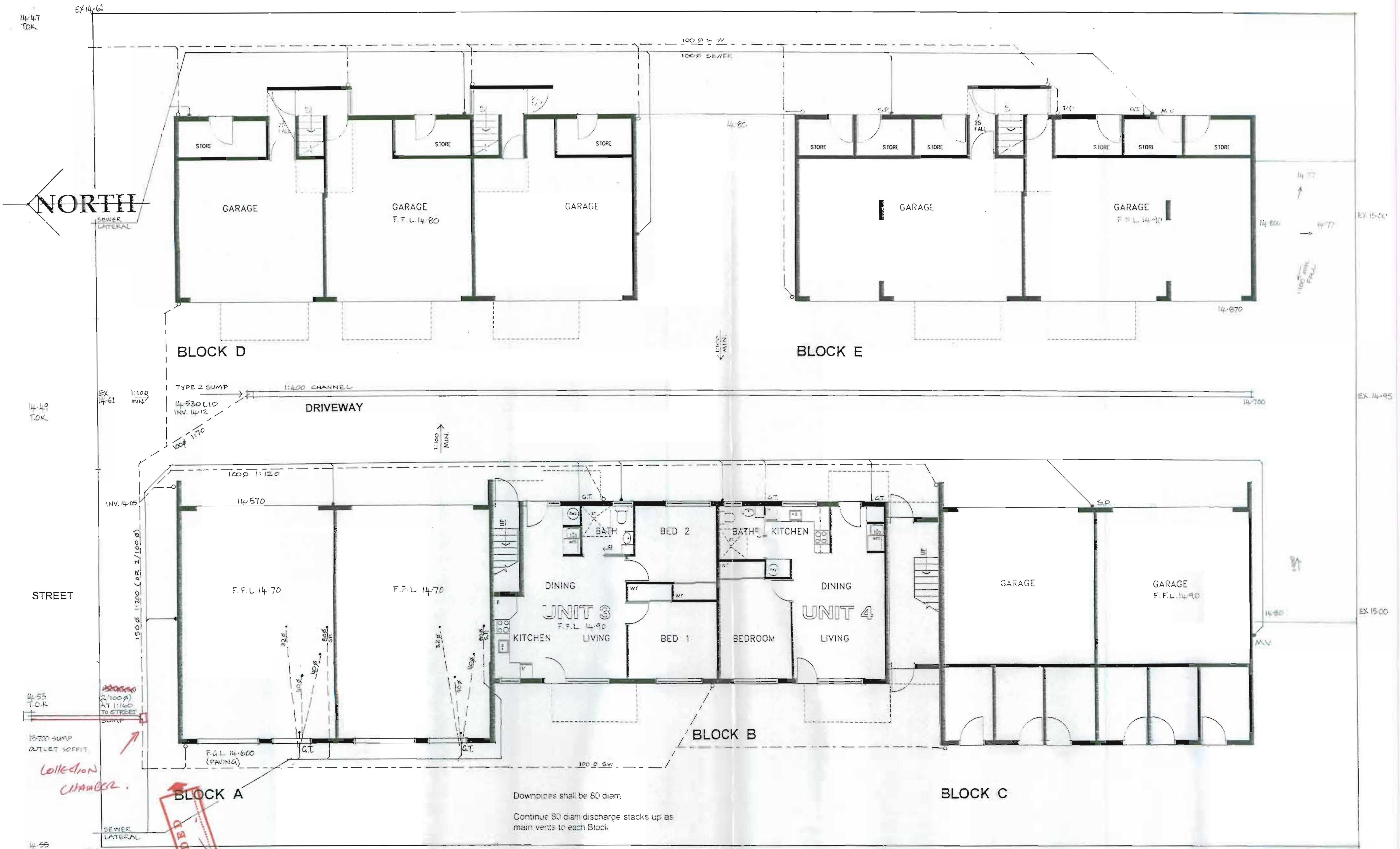
SHEET 07
DATE 18/08/98



SECTION 03

AMENDED C.C.C.

SHEET 08
DATE 19/06/98



DRAINAGE PLAN

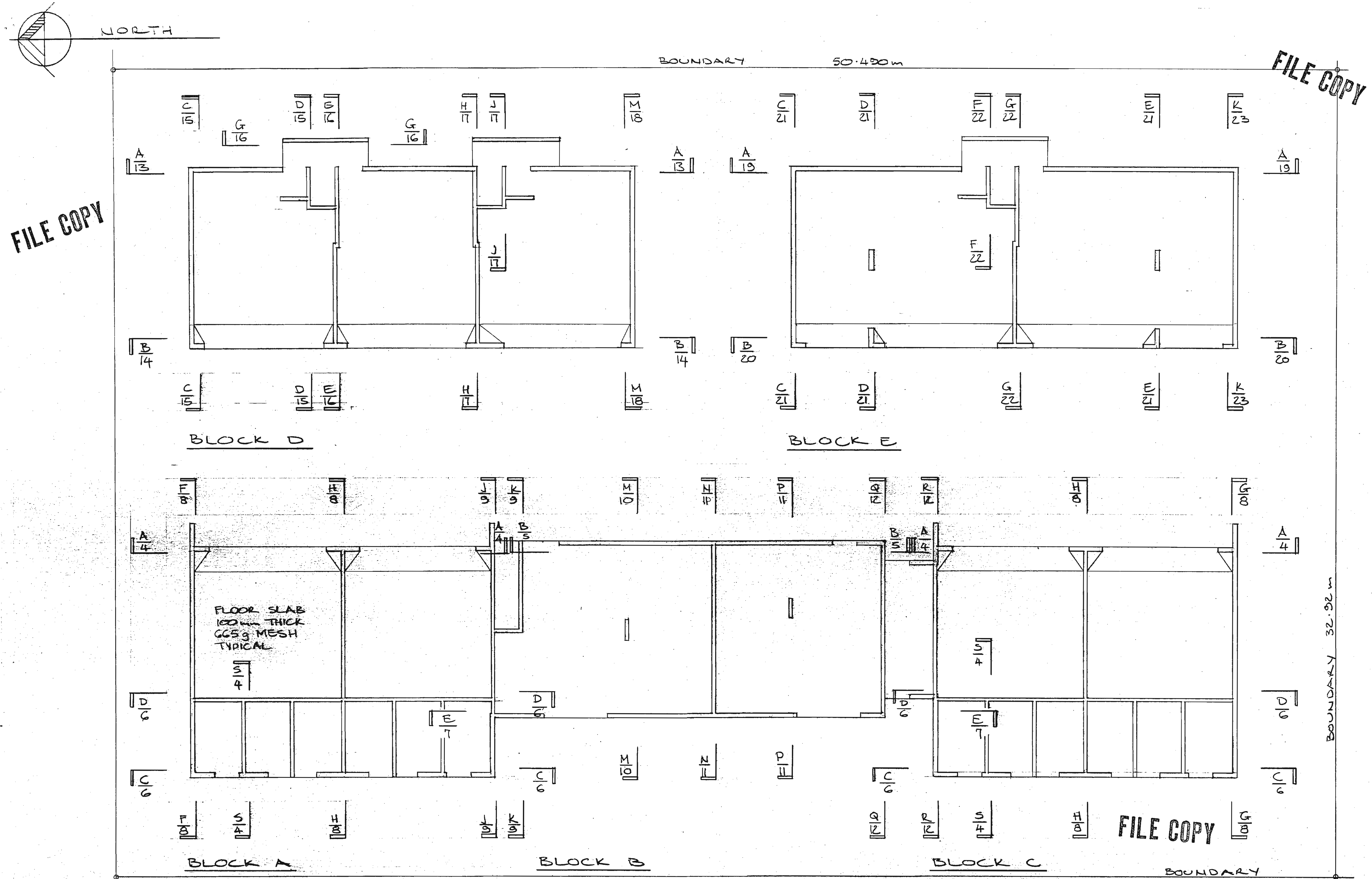
SCALE 1:100

AMENDMENTS -14/09/98

- Block A F.F.L lowered to 14.700
- Driveway sump relocated
- Block A Level 1 soil fixture pipes added
- Block A Store areas relocated to Block D and E

PROPOSED RESIDENTIAL DEVELOPMENT BY BRYNDWR BUILDERS LTD.

SHEET D1
DATE 19/06/98

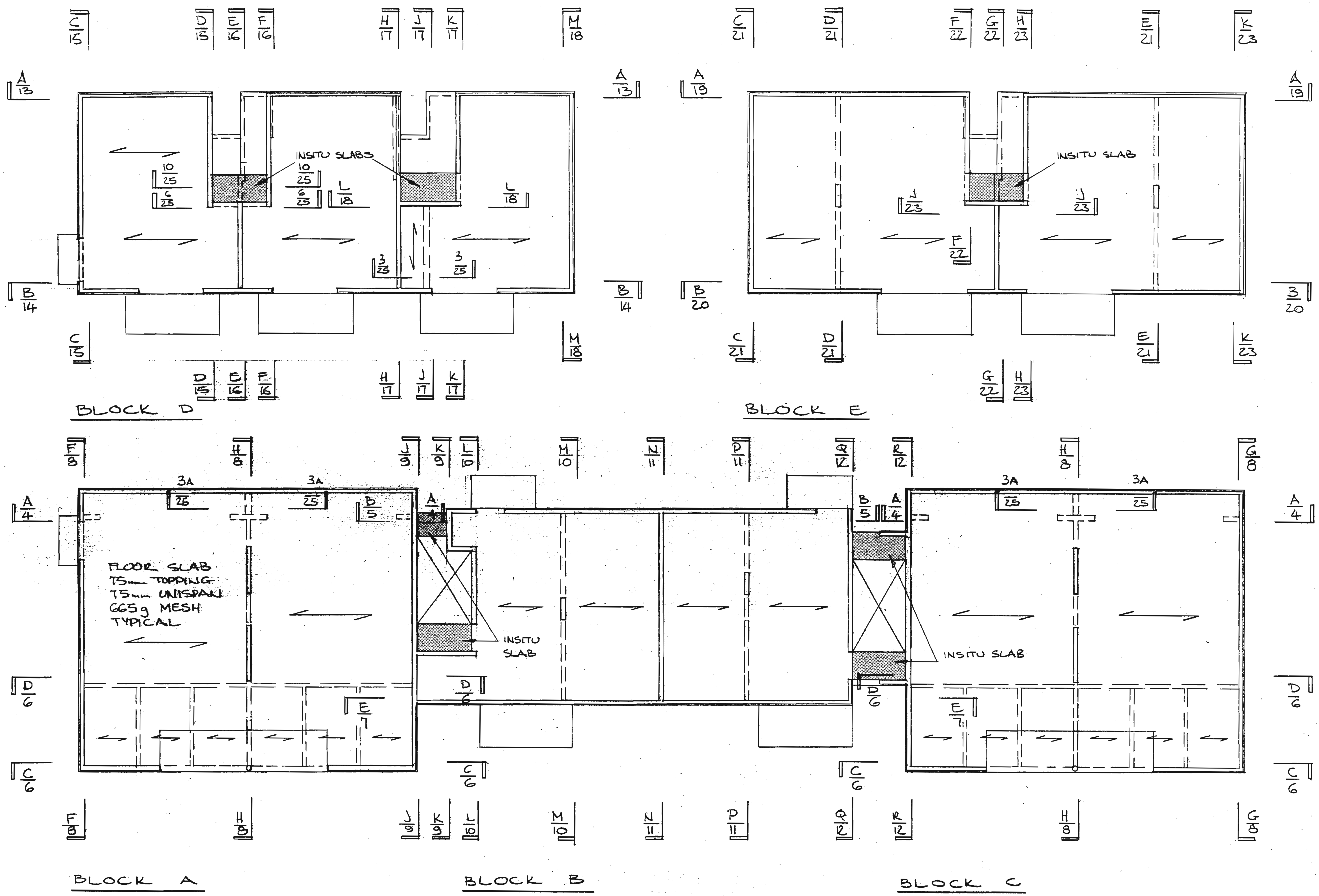


NOTE: · THESE DRAWINGS TO BE READ IN CONJUNCTION WITH THE ARCHITECTURAL DRAWINGS
· FOR ALL DIMENSIONS REFER TO ARCHITECTURAL DRAWINGS

RESIDENTIAL DEVELOPMENT

AT
GROUND FLOOR PLANS
FOR BRYNDWR BUILDERS LTD

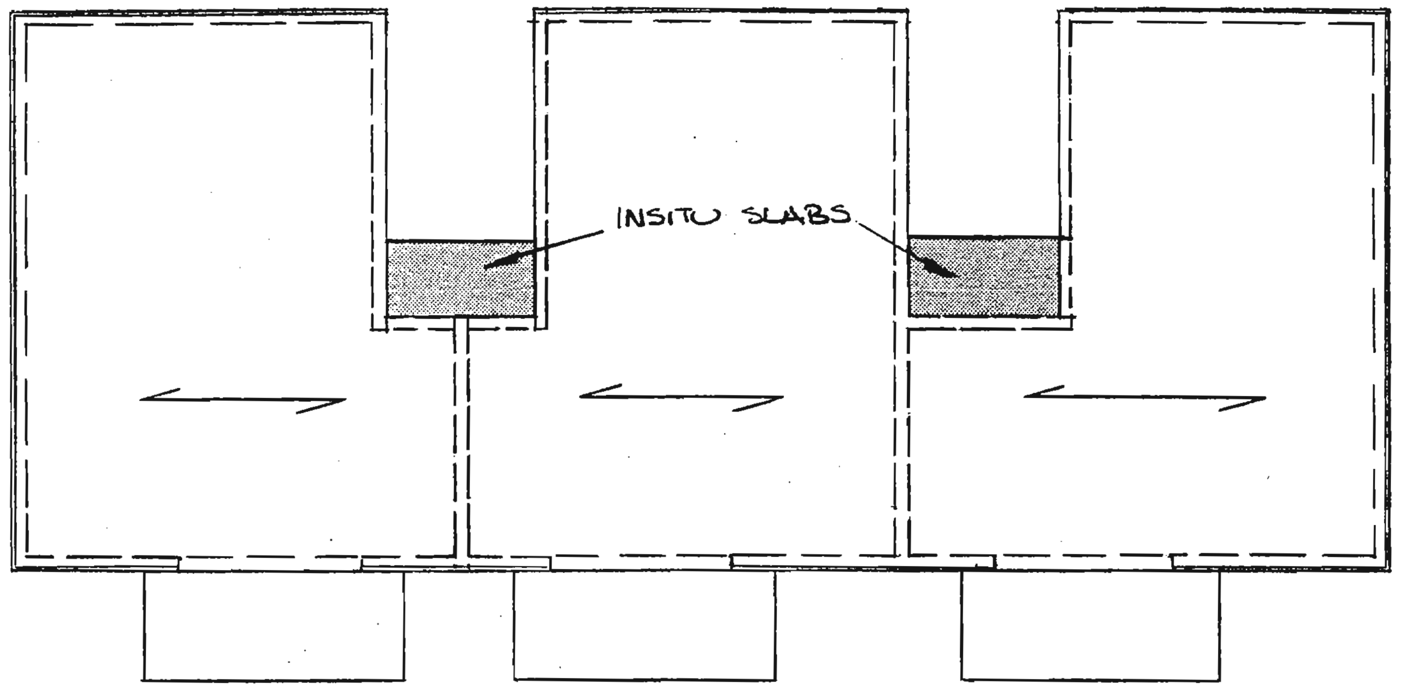
HARMAN HALLIDAY - CONSULTING CIVIL & STRUCTURAL ENGINEER
47 HEREFORD ST., PO BOX 2313 - PH 3653697, FAX 3664575 - CHRISTCHURCH
JULY 1998 - - SCALE 1:100 - JOB N° 67-5/1



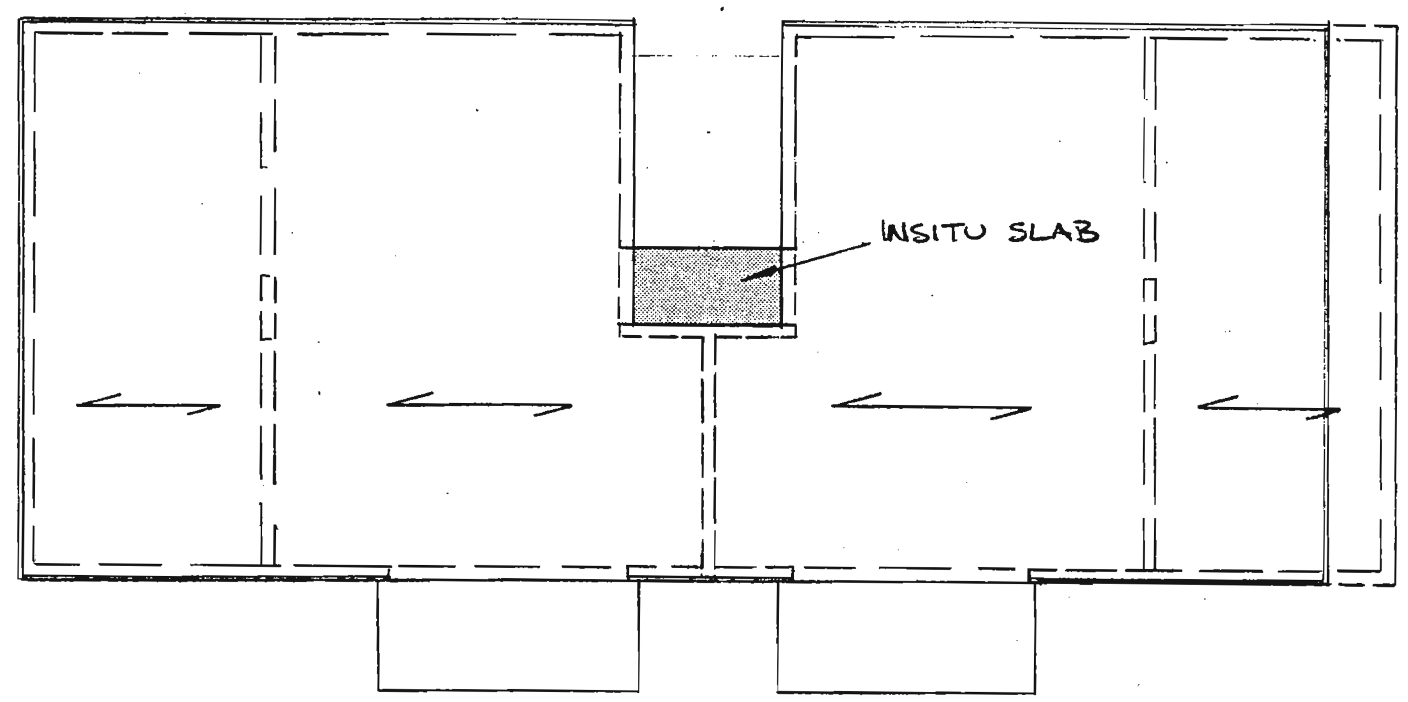
NOTE: FOR STAIR DETAILS REFER TO SHEETS 27 & 28
FOR STAIR LANDINGS REFER TO SHEET 25

RESIDENTIAL DEVELOPMENT
AT
FIRST FLOOR PLANS
FOR BRYNDWR BUILDERS LTD

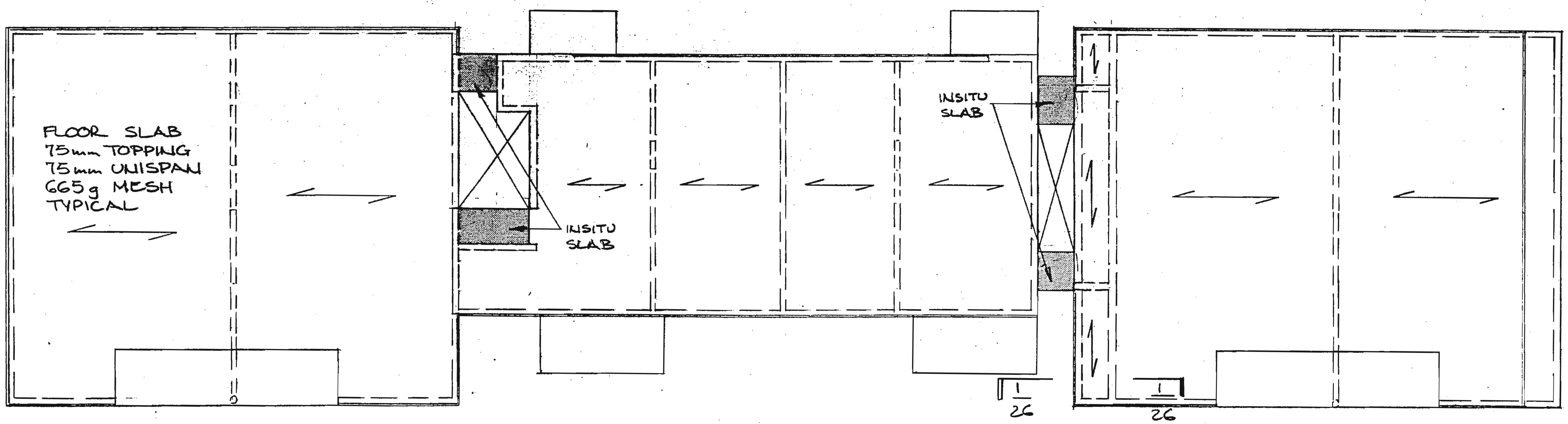
HARMAN HALLIDAY - CONSULTING CIVIL & STRUCTURAL ENGINEER
47 HEREFORD ST., PO BOX 2313 - PH 3653697, FAX 3664575 - CHRISTCHURCH
JULY 1998 - - SCALE 1:100 - JOB N° 67-5/2



BLOCK D



BLOCK E



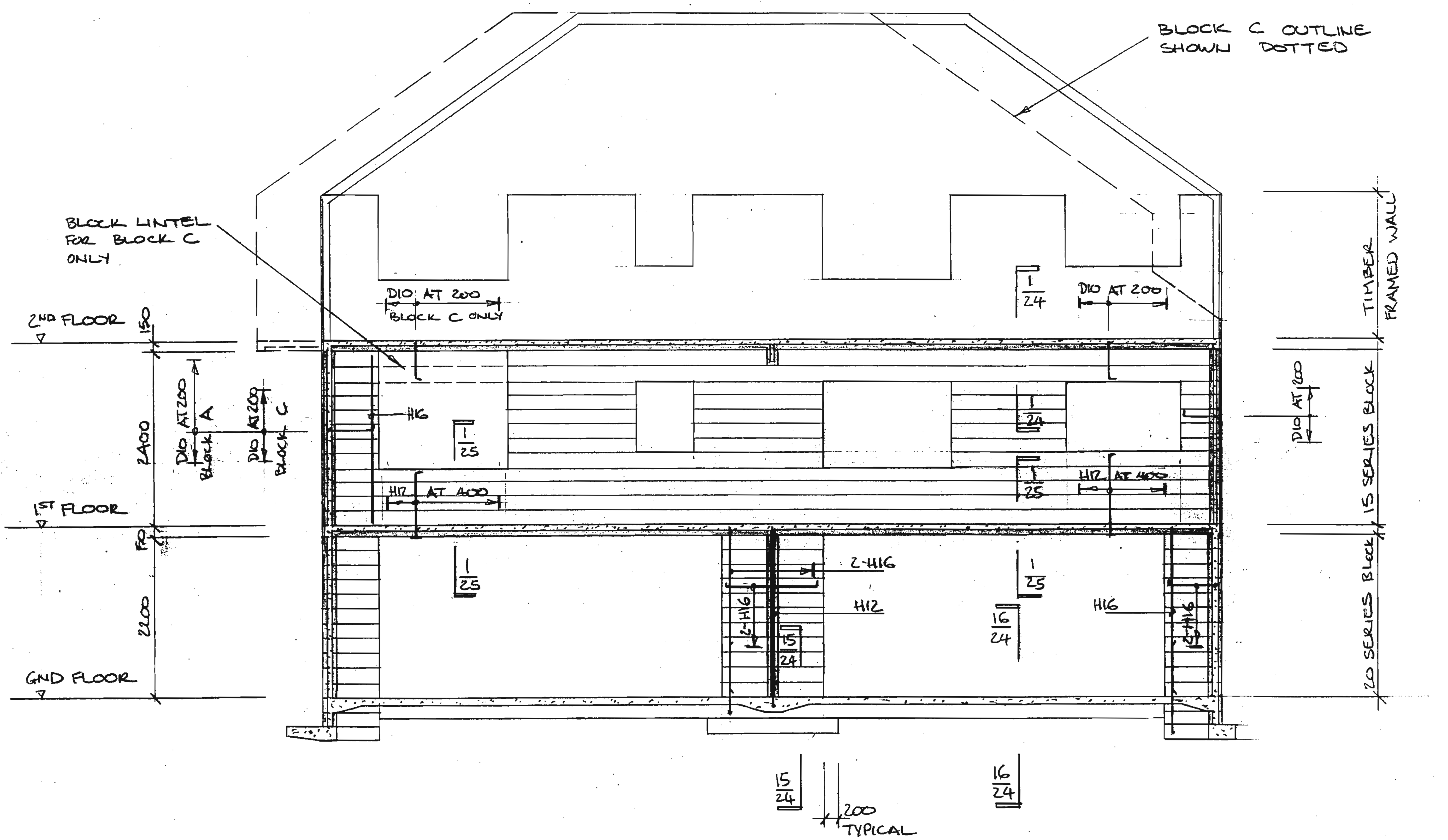
BLOCK A

BLOCK B

BLOCK C

RESIDENTIAL DEVELOPMENT
AT
SECOND FLOOR PLANS
FOR BRYNDWR BUILDERS LTD

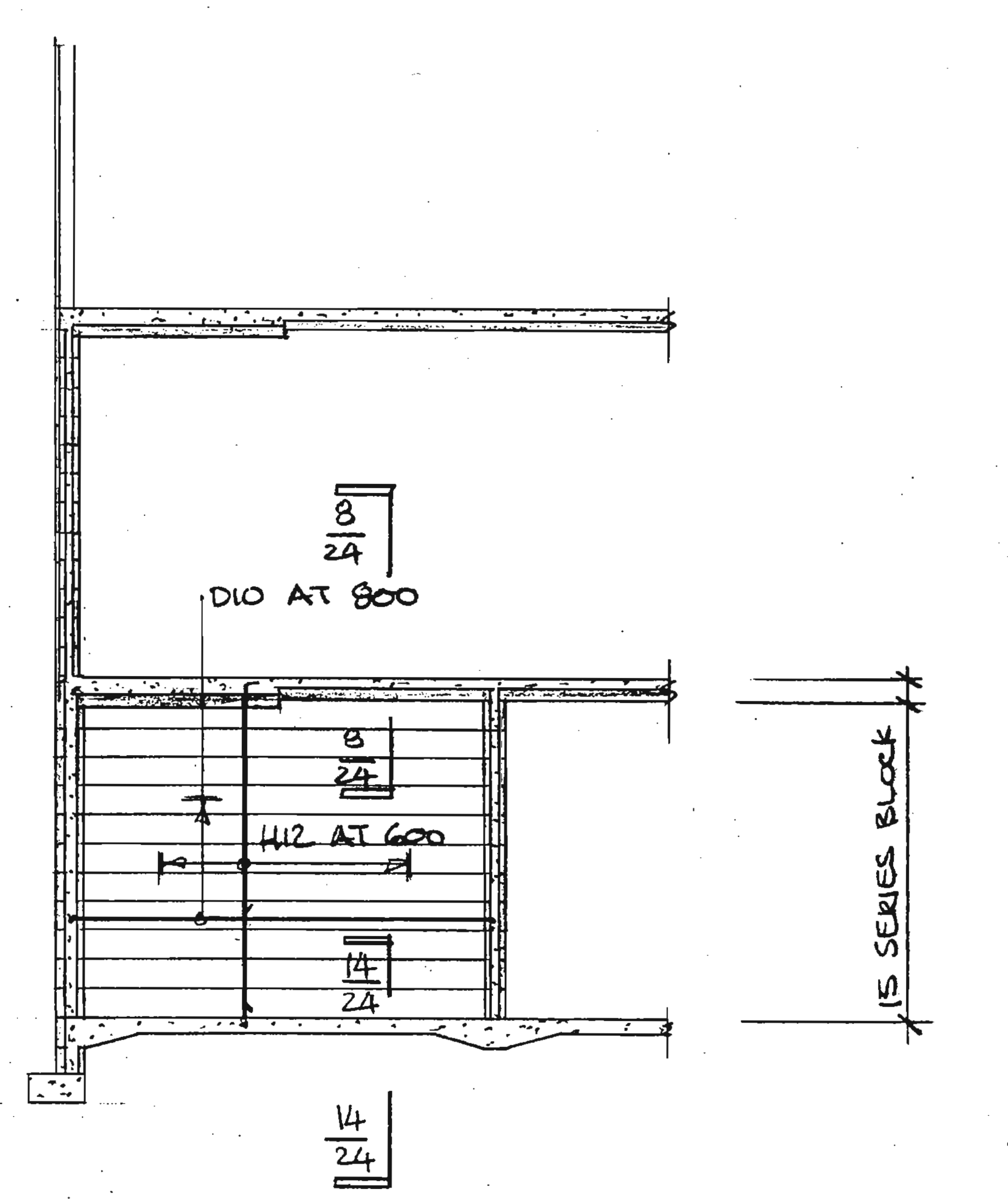
HARMAN HALLIDAY - CONSULTING CIVIL & STRUCTURAL ENGINEER
47 HEREFORD ST., PO BOX 2313 - PH 3653697, FAX 3664575 - CHRISTCHURCH
JULY 1998 - SCALE 1:100 - JOB Nº 67-5/3



BLOCK A - ELEVATION A - A

BLOCK C - ELEVATION A - A AS NOTED

NOTE : FIRST FLOOR WALL OFFSET FROM GROUND FLOOR WALLS



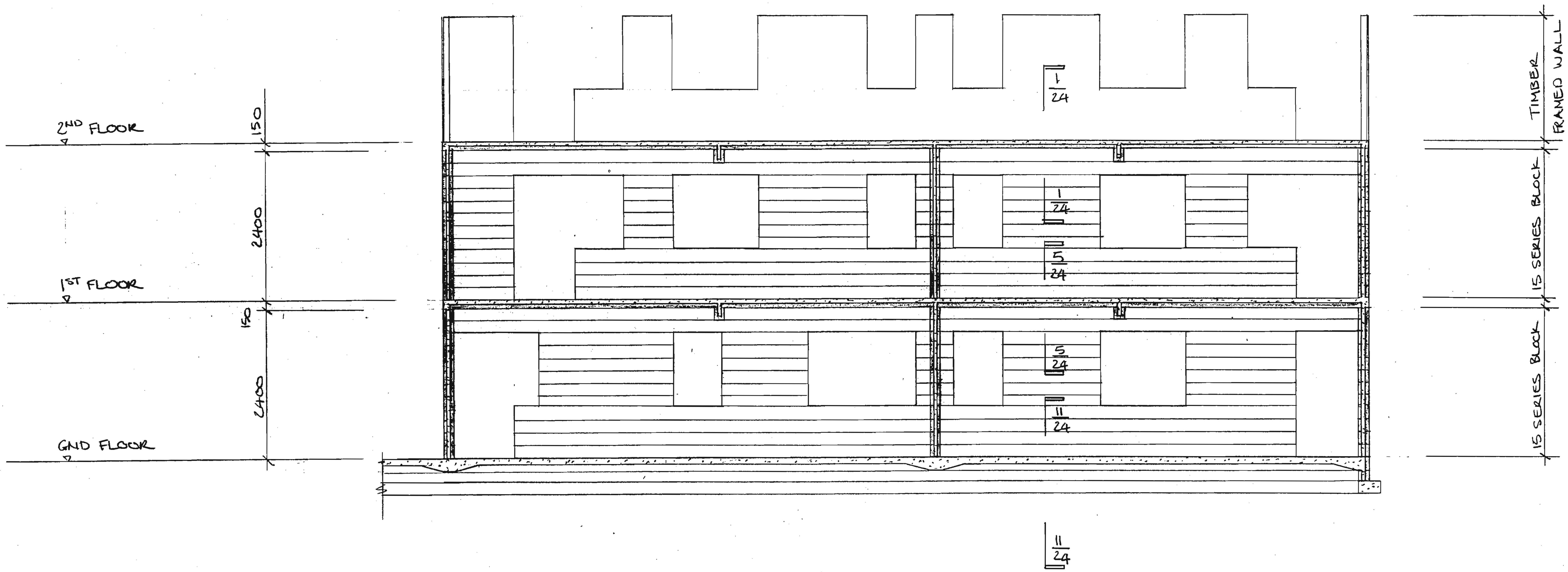
ELEVATION S - S

NOTE : TYPICAL WALL REINFORCING U.N.O.
20 SERIES BLOCK - H12 AT 600 VERTICAL
- H16 AT 800 HORIZONTAL
15 SERIES BLOCK - H12 AT 600 VERTICAL
- D10 AT 800 HORIZONTAL

RESIDENTIAL DEVELOPMENT

BLOCKS A & C - BLOCK WALL ELEVATIONS
FOR BRYNDWR BUILDERS LTD

HARMAN HALLIDAY - CONSULTING CIVIL & STRUCTURAL ENGINEER
47 HEREFORD ST, PO BOX 2313 - PH 3653697, FAX 3664575 - CHRISTCHURCH
JULY 1998 - - SCALE 1:50 - JOB Nº 67-3/4



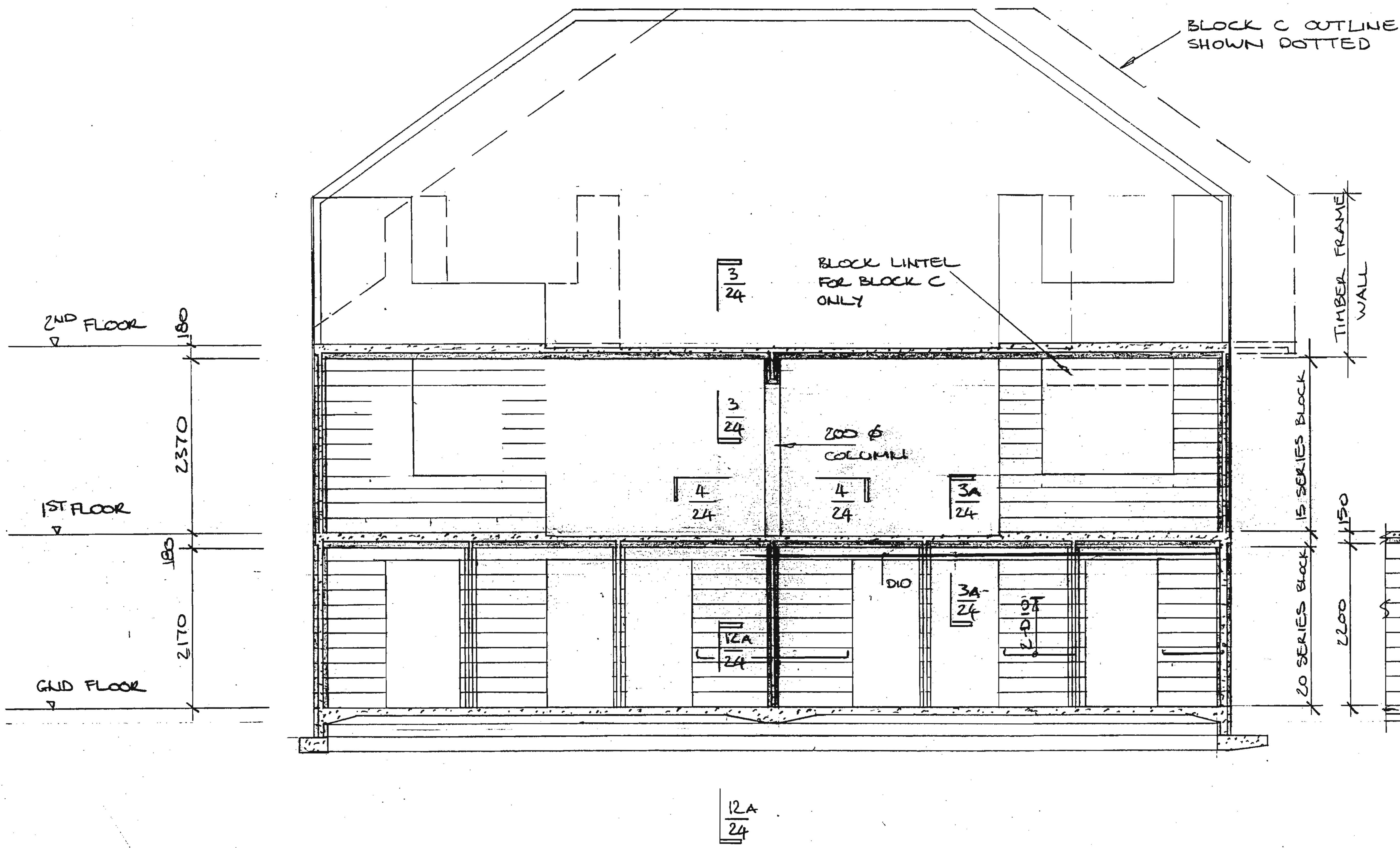
BLOCK B - ELEVATION B - B

RESIDENTIAL DEVELOPMENT

BLOCK B - BLOCK WALL ELEVATIONS
FOR BRYNDWR BUILDERS LTD

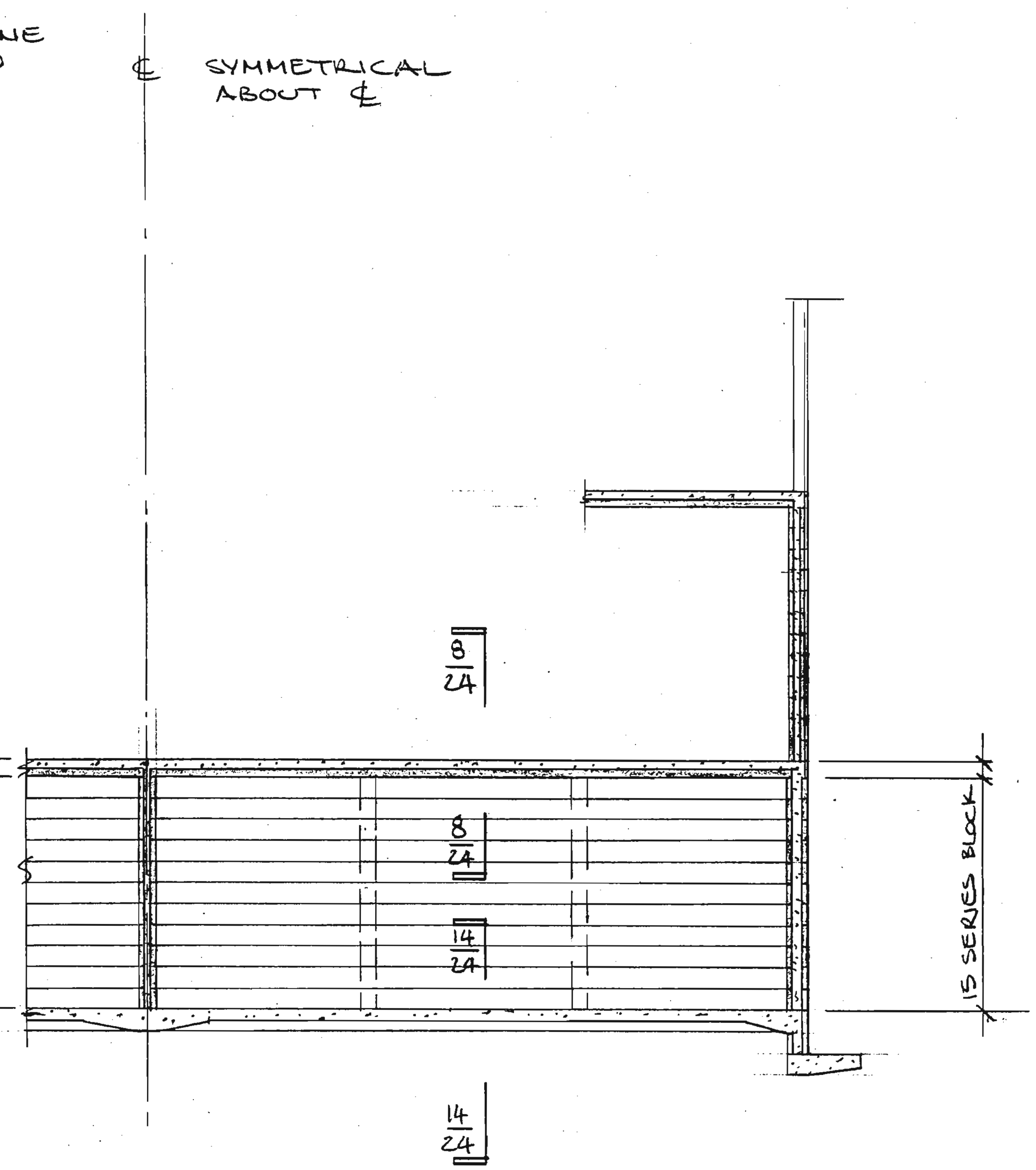
HARMAN HALLIDAY - CONSULTING CIVIL & STRUCTURAL ENGINEER
47 HEREFORD ST, PO BOX 2313 - PH 3653697, FAX 3664575 - CHRISTCHURCH

JULY 1998 - SCALE 1:50 - JOB Nº 67-5/5



BLOCK A - ELEVATION C - C

BLOCK C - ELEVATION C - C AS NOTED



PART ELEVATION D - D

NOTE : TYPICAL WALL REINFORCING U.N.O.
20 SERIES BLOCK - H12 AT 600 VERTICAL
- H16 AT 800 HORIZONTAL
15 SERIES BLOCK - H12 AT 600 VERTICAL
- D10 AT 800 HORIZONTAL

RESIDENTIAL DEVELOPMENT

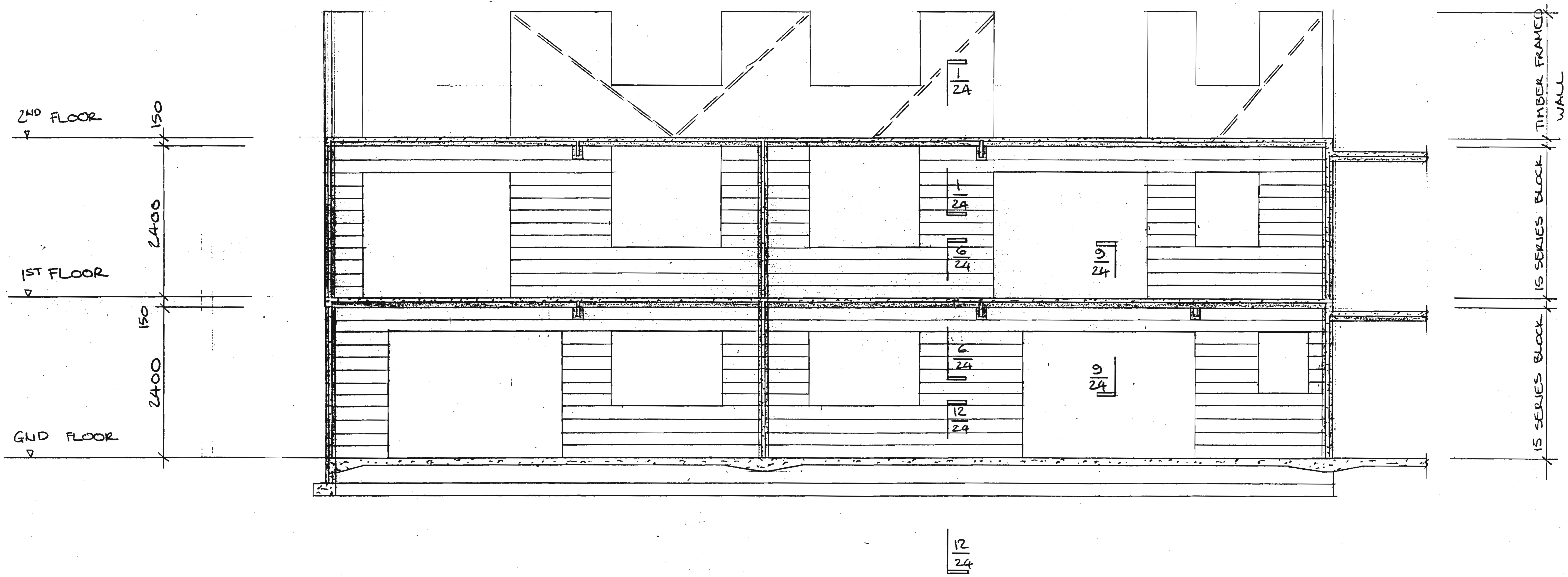
BLOCKS A & C - BLOCK WALL ELEVATIONS
FOR BRYNDWR BUILDERS LTD

HARMAN HALLIDAY - CONSULTING CIVIL & STRUCTURAL ENGINEER
47 HEREFORD ST, PO BOX 2313 - PH 3633657, FAX 3664575 - CHRISTCHURCH

JULY 1998 - SCALE 1:50 - JOB Nº 67-5/6

BRACING NOTES

- ALL INTERNAL WALL GREATER THAN 1.8m LONG TO BE BRACED TO WINSTONE WALL BOARDING LTD GIB 3 SPECIFICATION
- ALL EXTERNAL WALLS BRACE TO GIB 1 SPECIFICATION WHERE INDICATED DIAGONAL BRACES ON WALL ELEVATIONS.

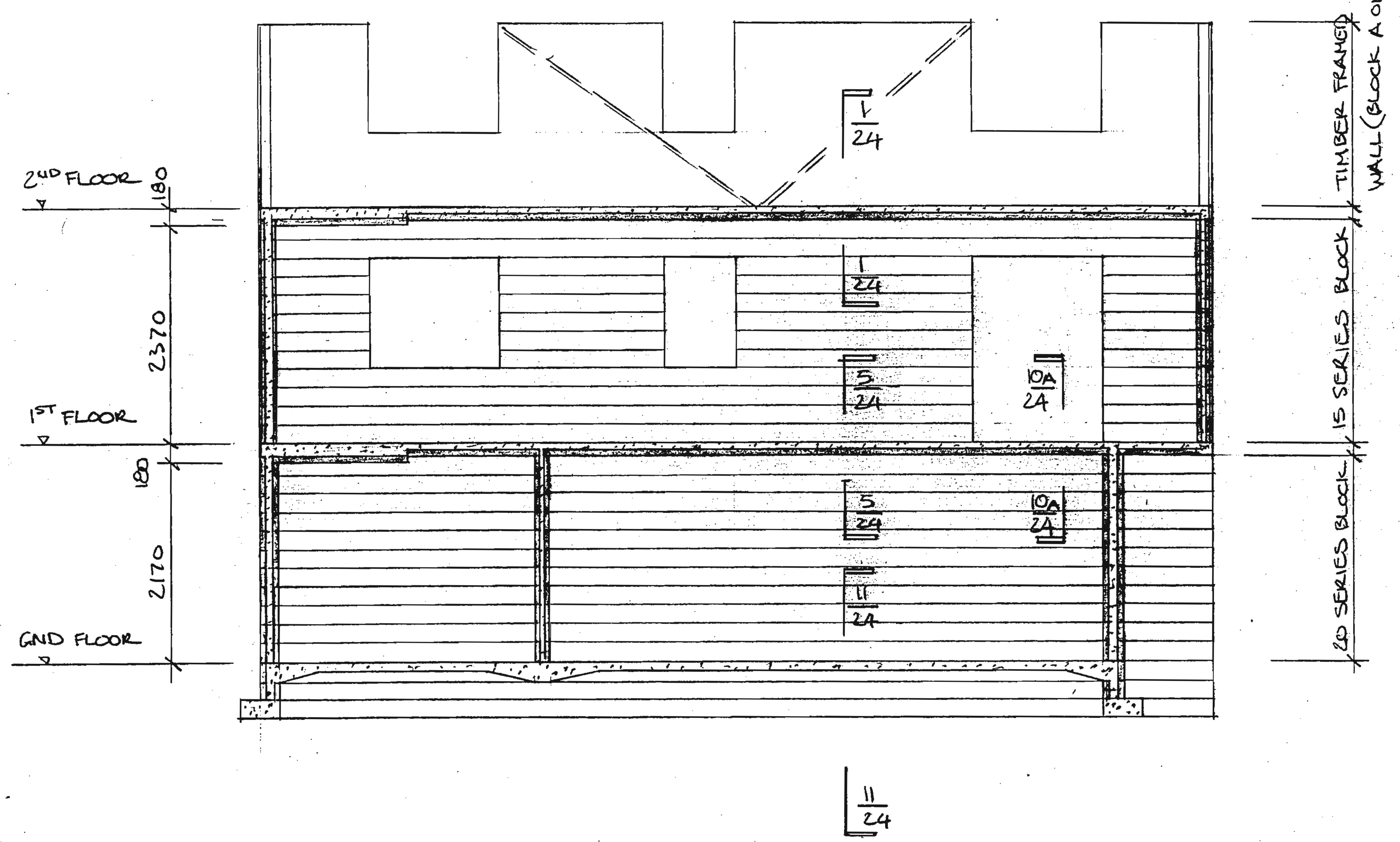


BLOCK B - ELEVATION E-E

RESIDENTIAL DEVELOPMENT

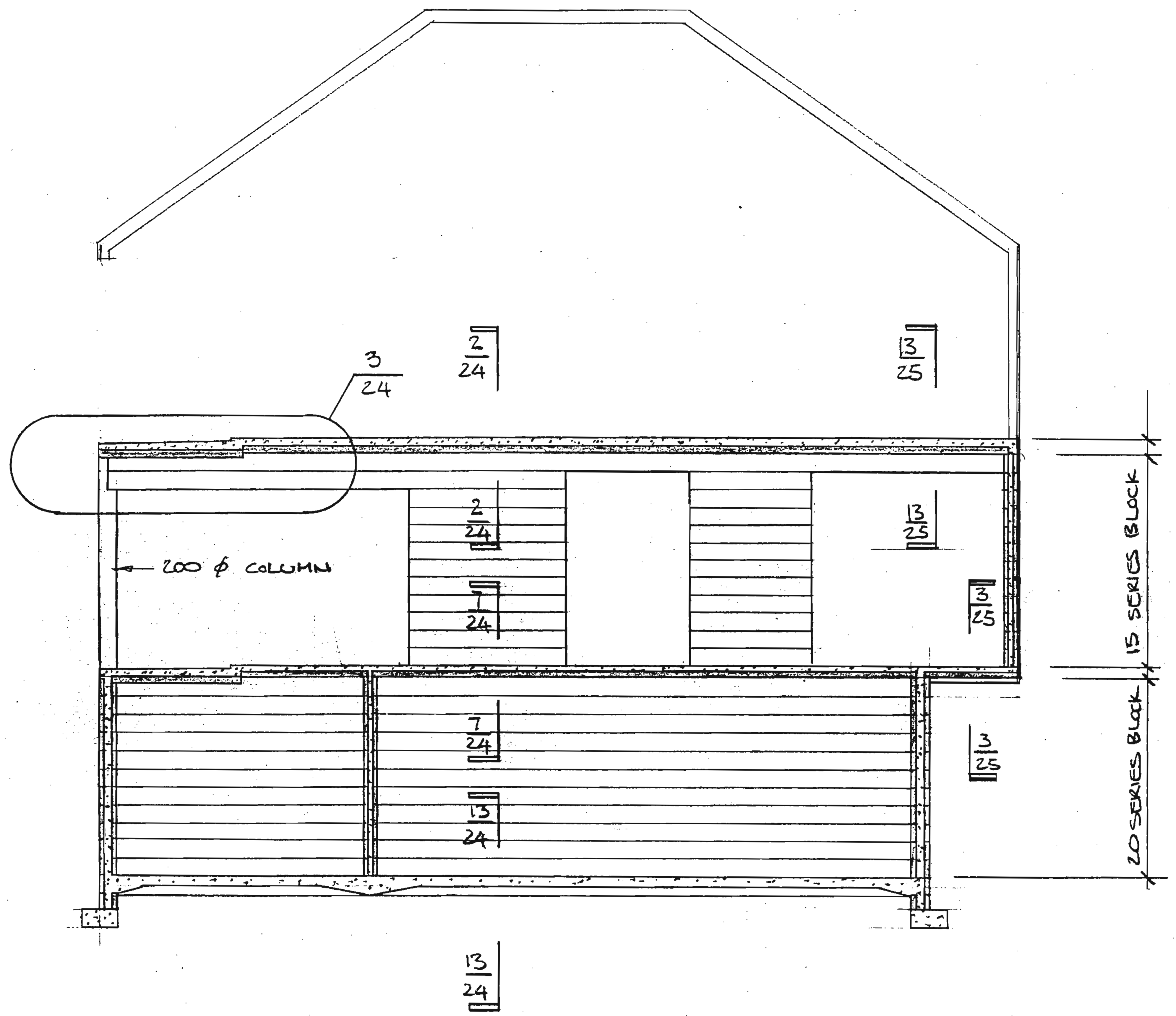
BLOCK B - BLOCK WALL ELEVATIONS
FOR BRYNDWR BUILDERS LTD

HARMAN HALLIDAY - CONSULTING CIVIL & STRUCTURAL ENGINEER
47 HEREFORD ST, PO BOX 2313 - PH 3653697, FAX 3664575 - CHRISTCHURCH
JULY 1998 - SCALE 1:50 - JOB Nº 67-5/7



BLOCK A - ELEVATION F-F

BLOCK C - ELEVATION G-G OPP. HAND

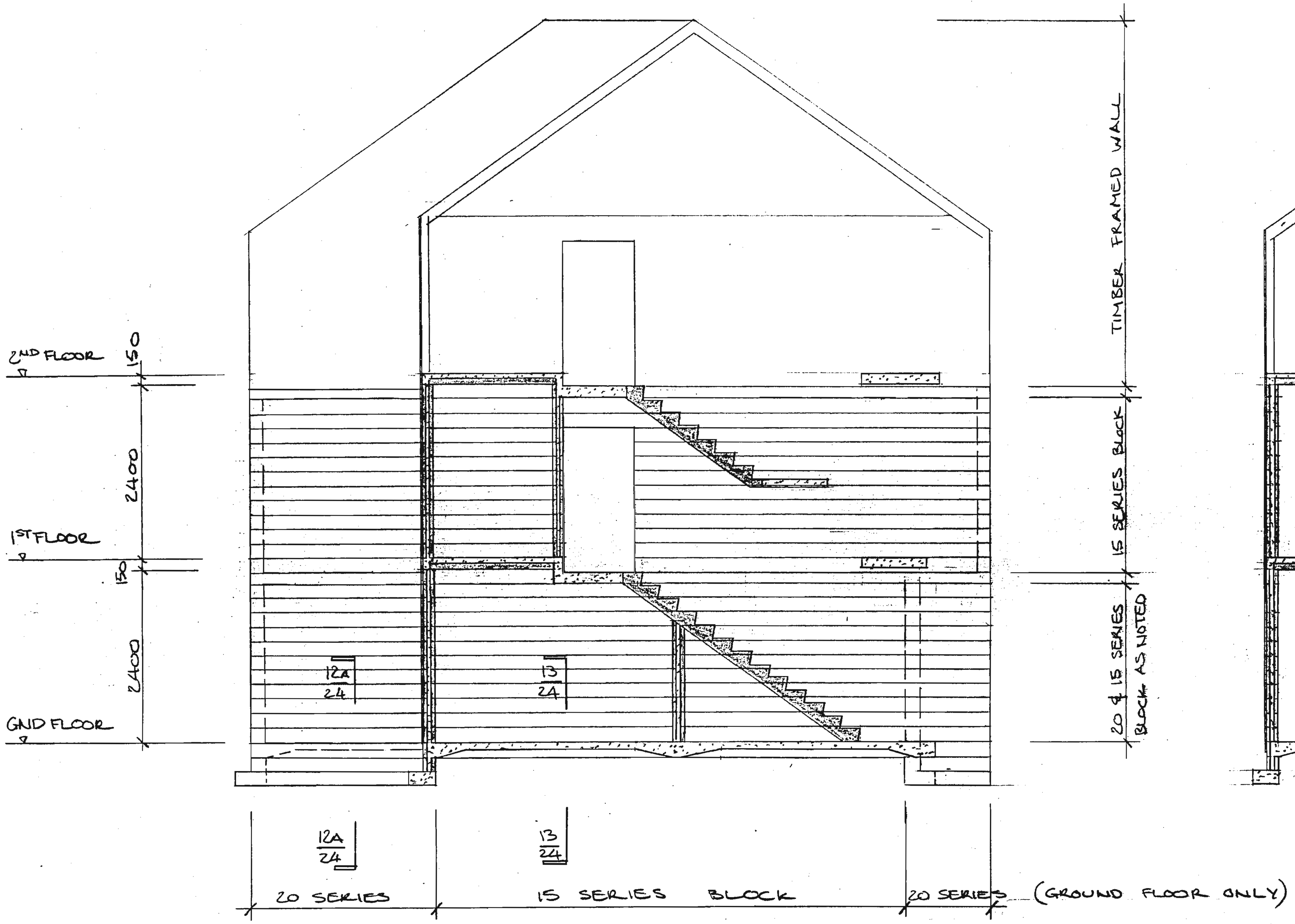


BLOCK A & C. - ELEVATION H-H

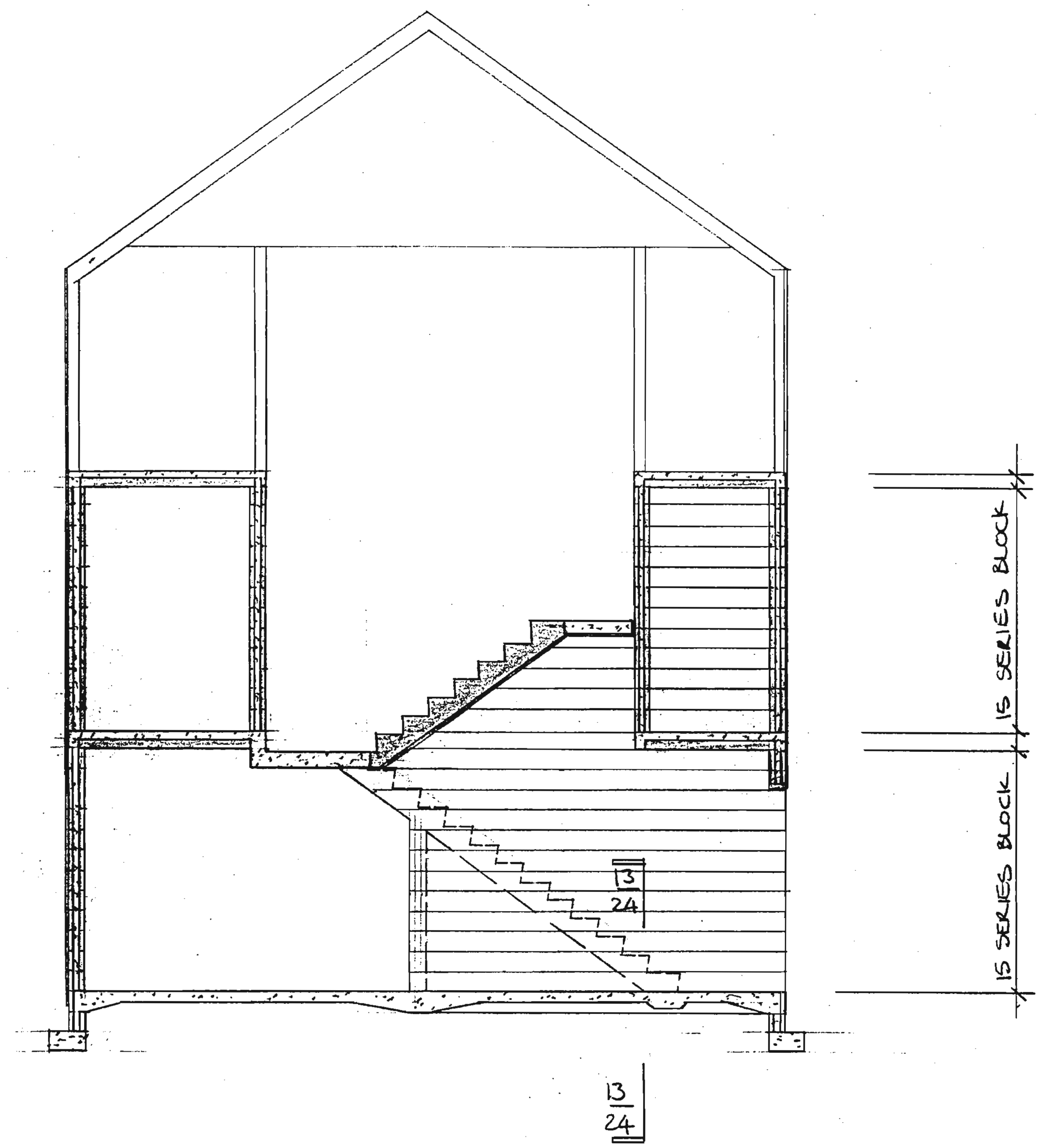
RESIDENTIAL DEVELOPMENT

BLOCKS A & C - BLOCK WALL ELEVATIONS
FOR BRYNDWR BUILDERS LTD

HARMAN HALLIDAY - CONSULTING CIVIL & STRUCTURAL ENGINEER
47 HEREFORD ST, PO BOX 2313 - PH 3653637, FAX 3664575 - CHRISTCHURCH
JULY 1998 - - SCALE 1:50 - JOB No 67-5/8



BLOCK B - ELEVATION J - J

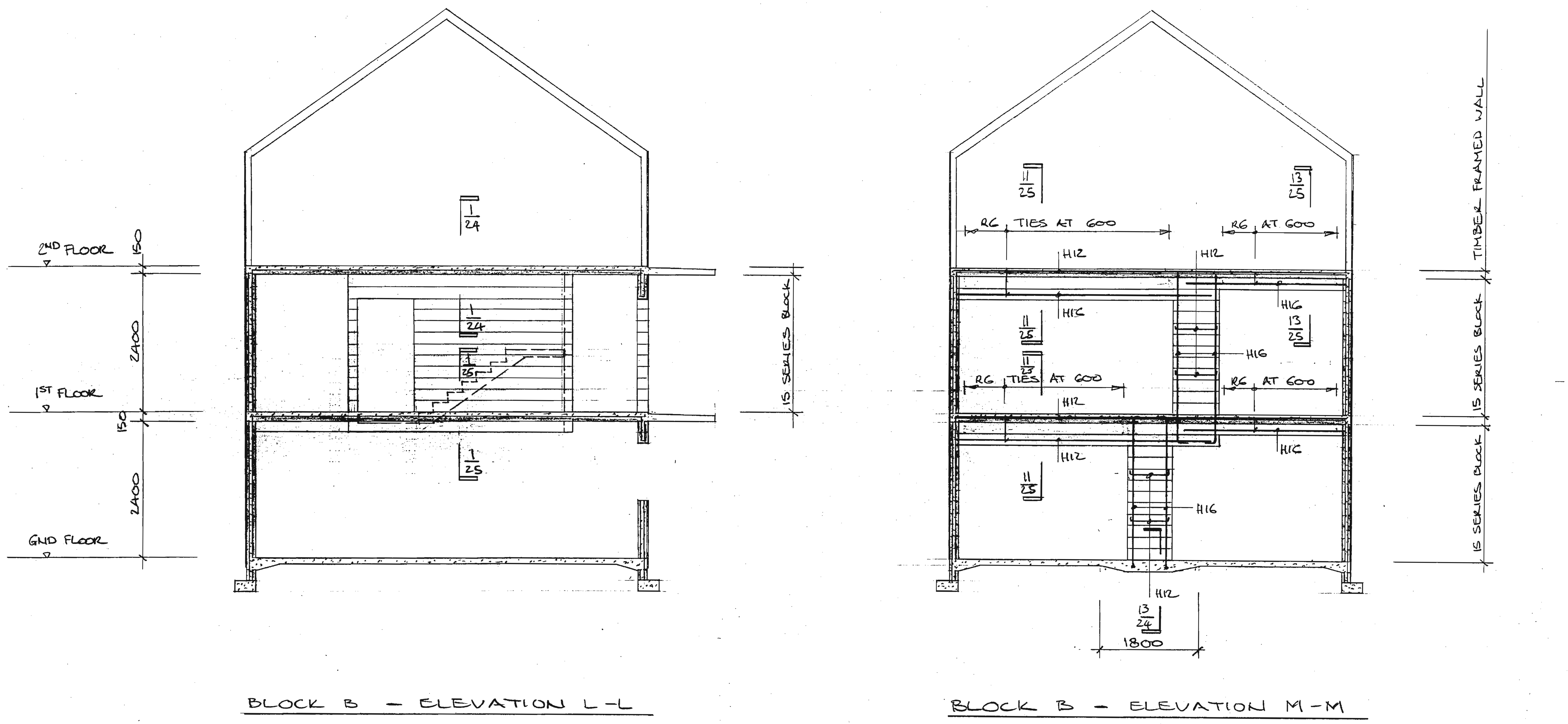


BLOCK B - ELEVATION K - K

RESIDENTIAL DEVELOPMENT

BLOCK B - BLOCK WALL ELEVATIONS
FOR BRYNDWR BUILDERS LTD

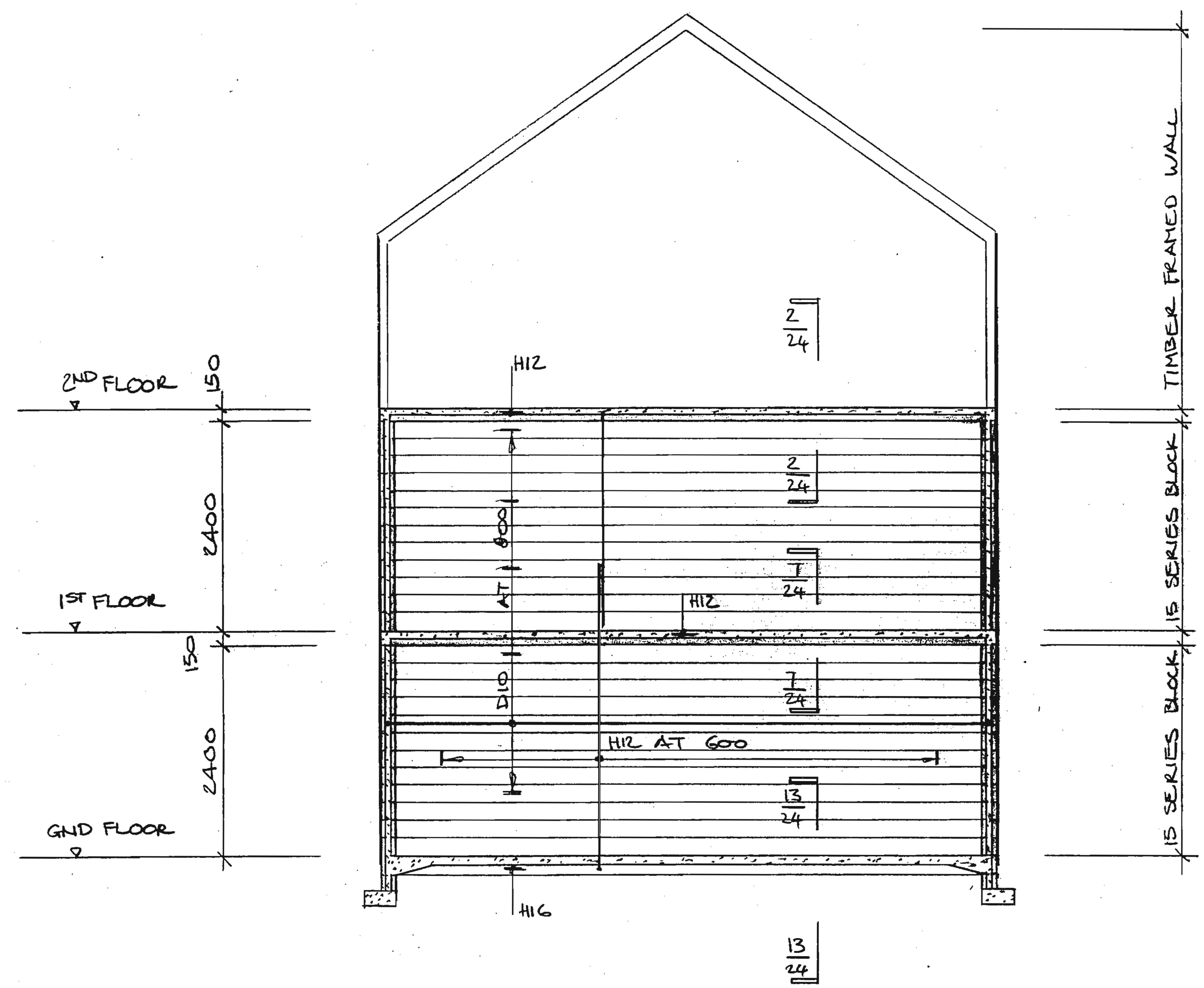
HARMAN HALLIDAY - CONSULTING CIVIL & STRUCTURAL ENGINEER
47 HEREFORD ST, PO BOX 2313 - PH 3653697, FAX 3664575 - CHRISTCHURCH
JULY 1998 - - SCALE 1:50 - JOB N° 67-5/9



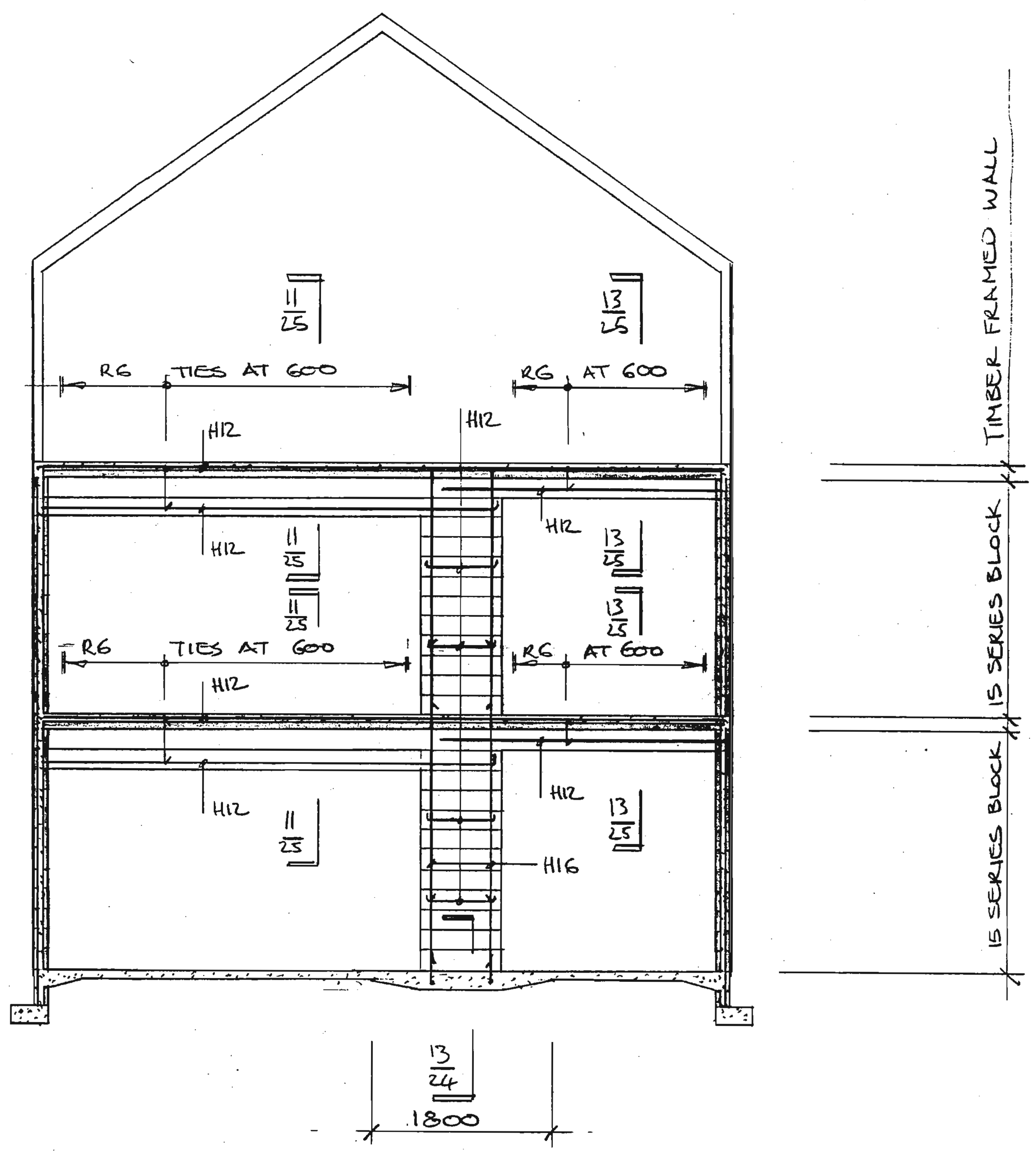
RESIDENTIAL DEVELOPMENT

BLOCK B - BLOCK WALL ELEVATIONS
FOR BRYNDWR BUILDERS LTD

HARMAN HALLIDAY - CONSULTING CIVIL & STRUCTURAL ENGINEER
47 HEREFORD ST., PO BOX 2313 - PH 3653697, FAX 3664575 - CHRISTCHURCH
JULY 1998 - SCALE 1:50 - JOB N° 67-5/10



BLOCK B - ELEVATION N-N

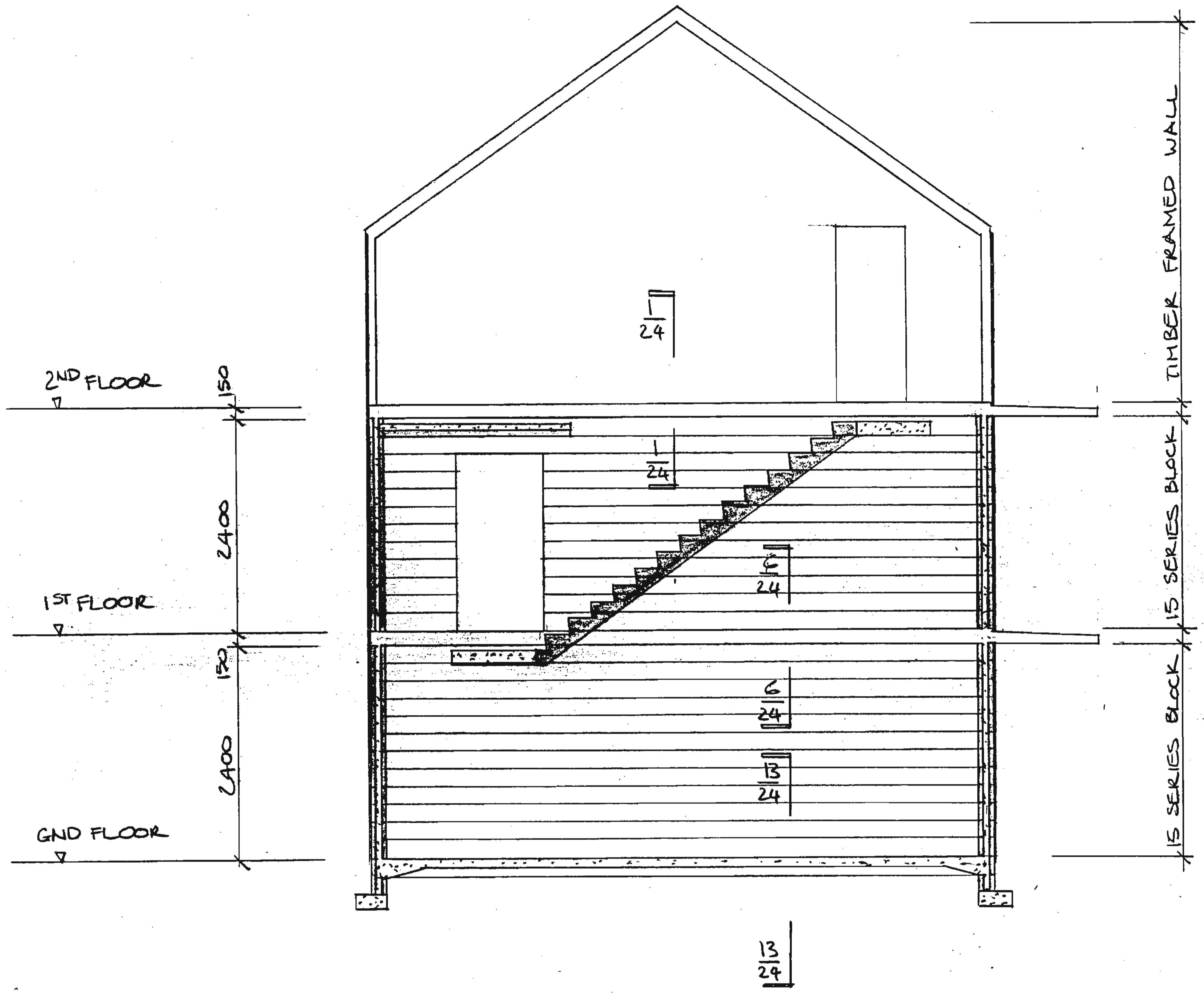


BLOCK B - ELEVATION P-P

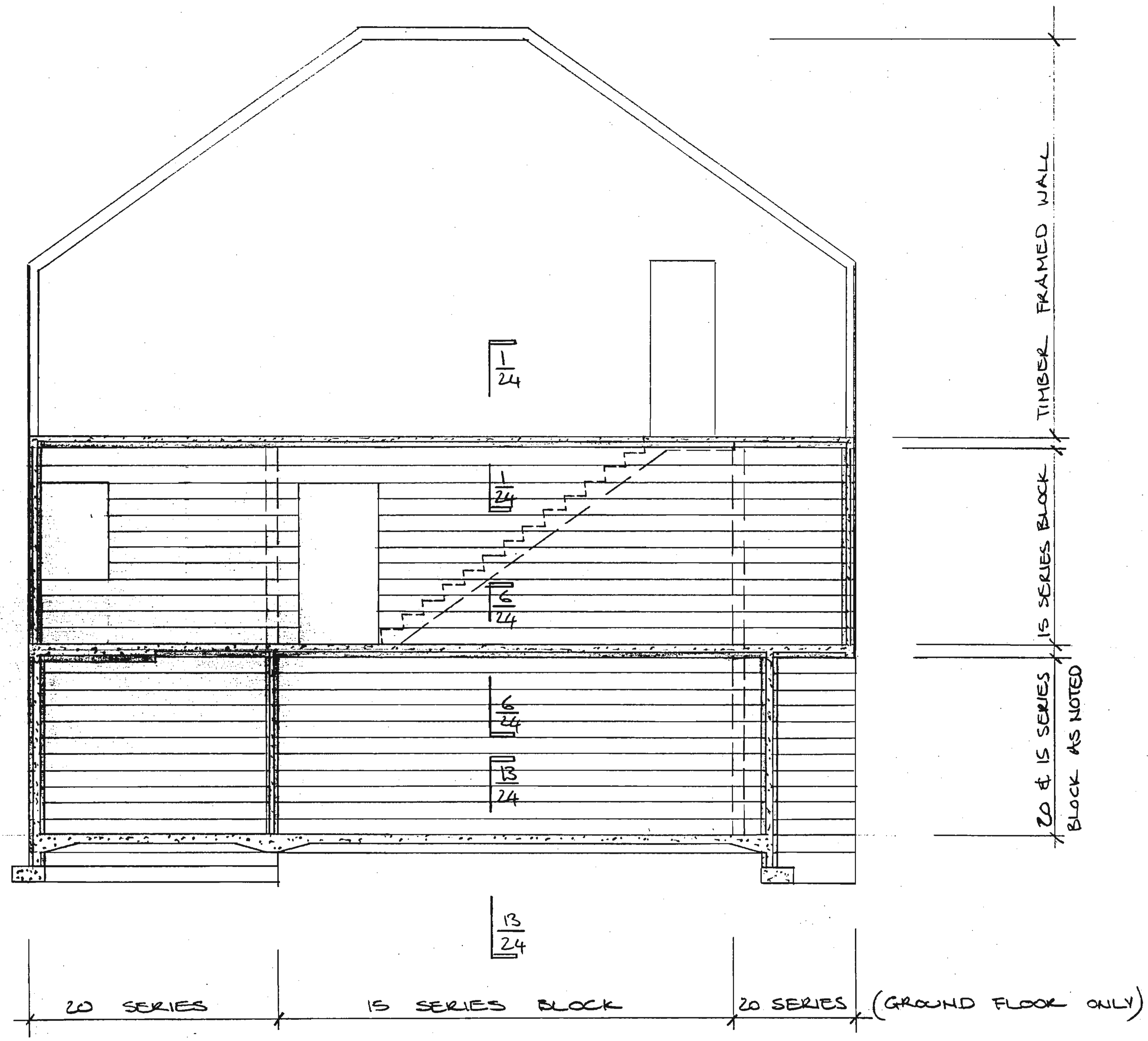
RESIDENTIAL DEVELOPMENT

BLOCK B - BLOCK WALL ELEVATIONS
FOR BRYNDWR BUILDERS LTD

HARMAN HALLIDAY - CONSULTING CIVIL & STRUCTURAL ENGINEER
47 HEREFORD ST., PO BOX 2313 - PH 3653697, FAX 3664575 - CHRISTCHURCH
JULY 1998 - - SCALE 1:50 - JOB Nº 67-5/11



BLOCK C - ELEVATION Q-Q

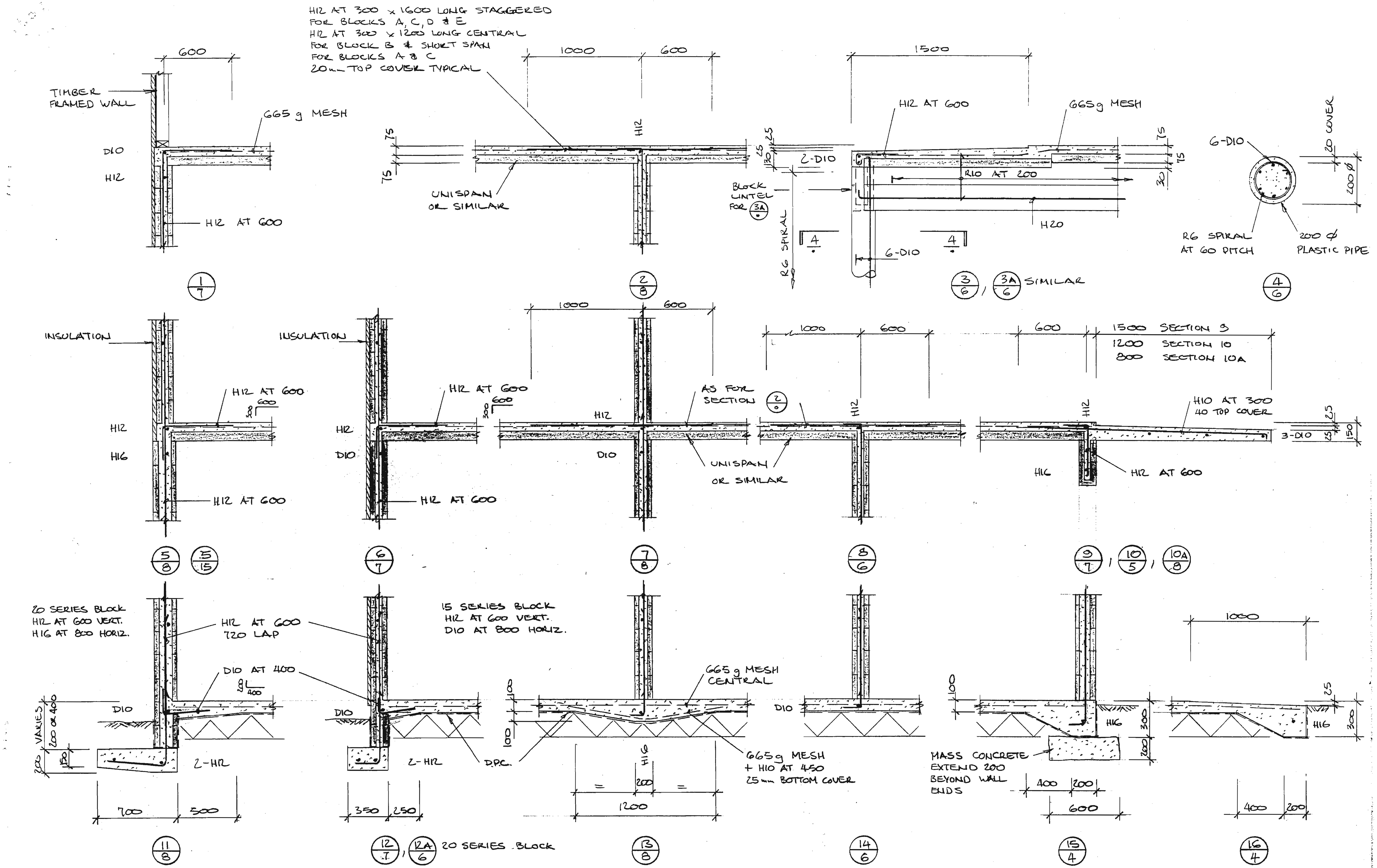


BLOCK C - ELEVATION R-R

RESIDENTIAL DEVELOPMENT

BLOCK C - BLOCK WALL ELEVATIONS
FOR BRYNDWR BUILDERS LTD

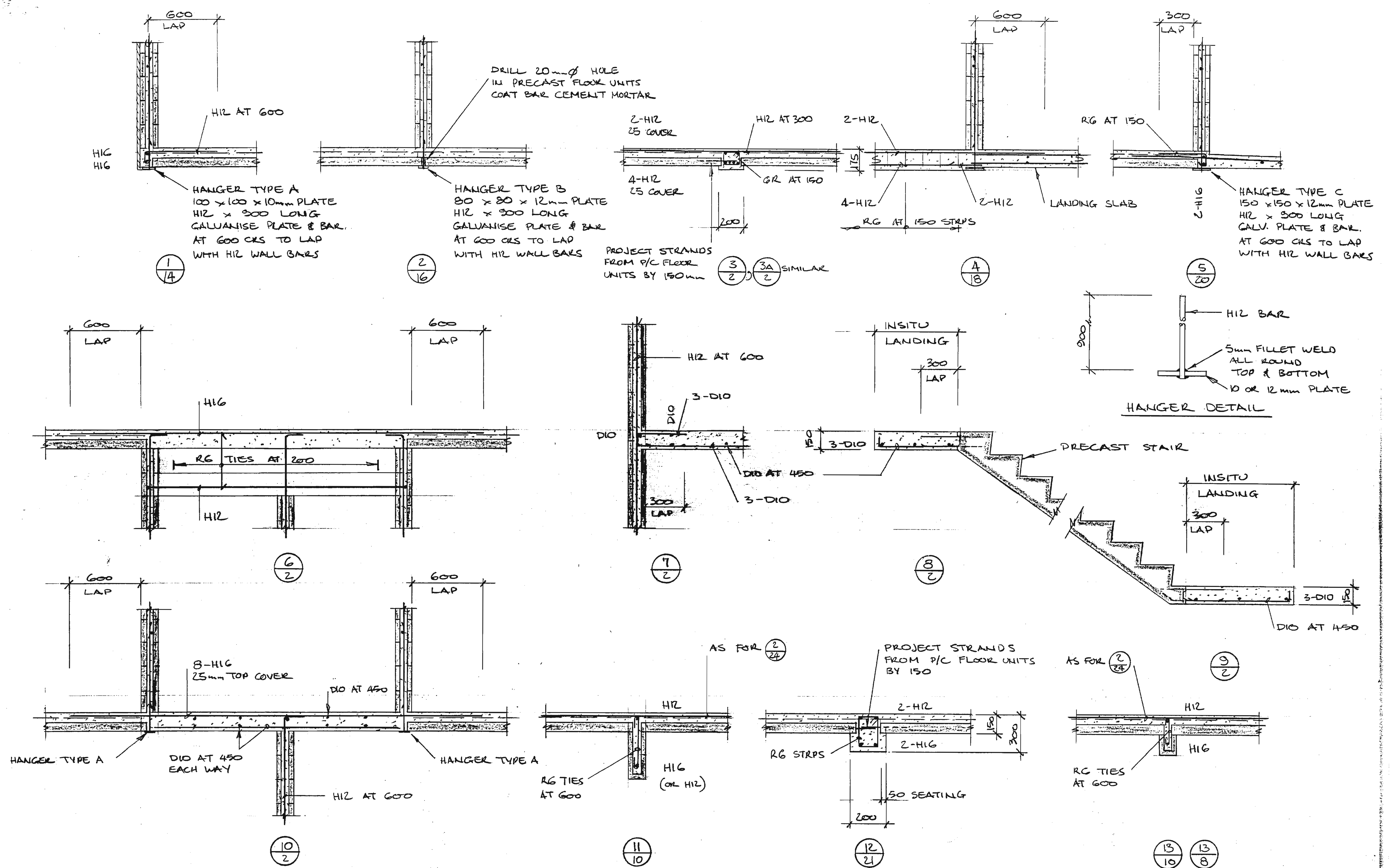
HARMAN HALLIDAY - CONSULTING CIVIL & STRUCTURAL ENGINEER
47 HEREFORD ST, PO BOX 2313 - PH 3653697, FAX 3664575 - CHRISTCHURCH
JULY 1998 - SCALE 1:50 - JOB Nº 67-5/12



RESIDENTIAL DEVELOPMENT

BLOCKS A TO E - DETAILS
FOR BRYNDWR BUILDERS LTD

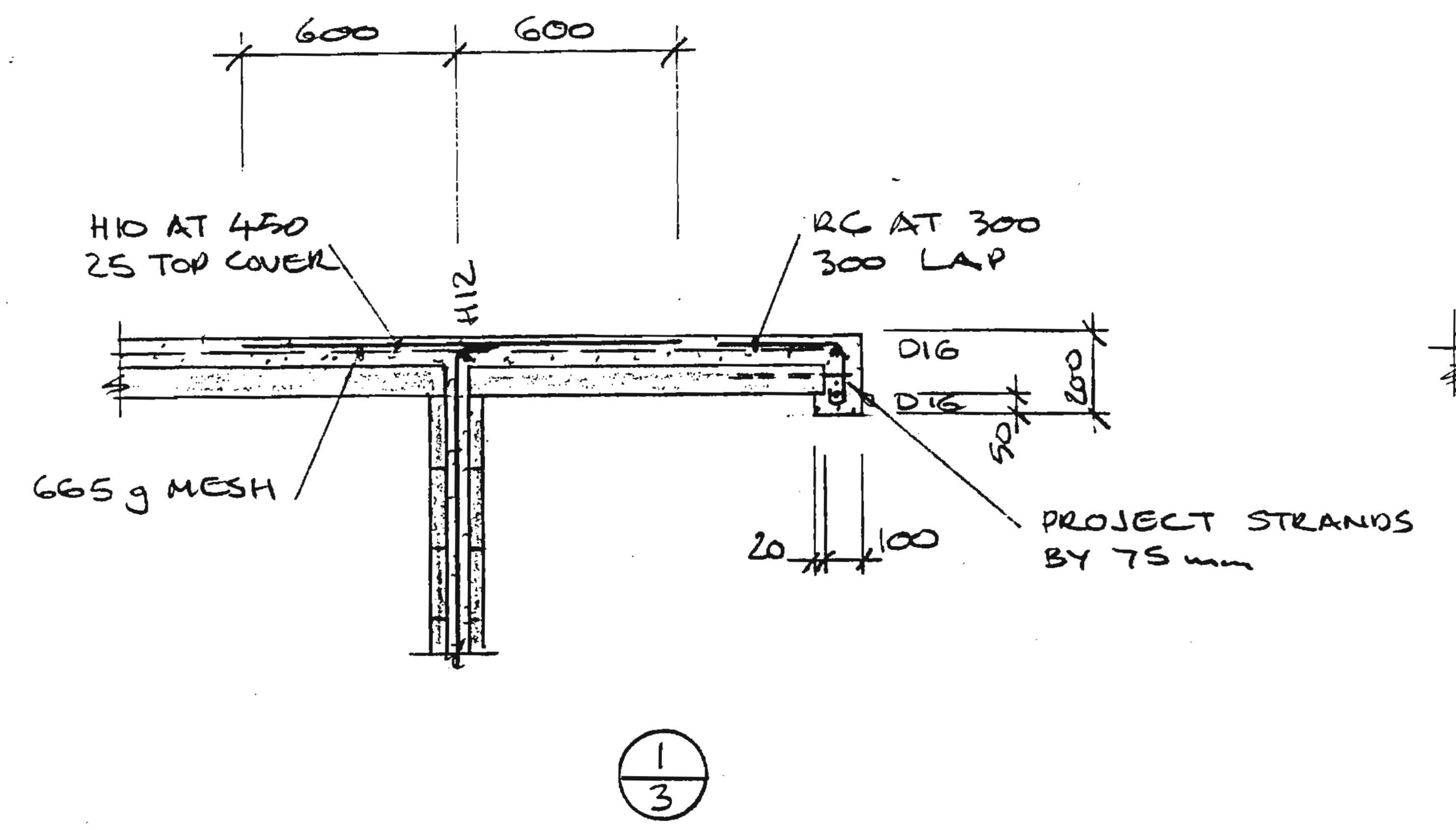
HARMAN HALLIDAY - CONSULTING CIVIL & STRUCTURAL ENGINEER
47 HEREFORD ST., PO BOX 2313 - PH 3653697, FAX 3664575 - CHRISTCHURCH
JULY 1998 - SCALE 1:20, 1:10 - JOB No 67-S/24

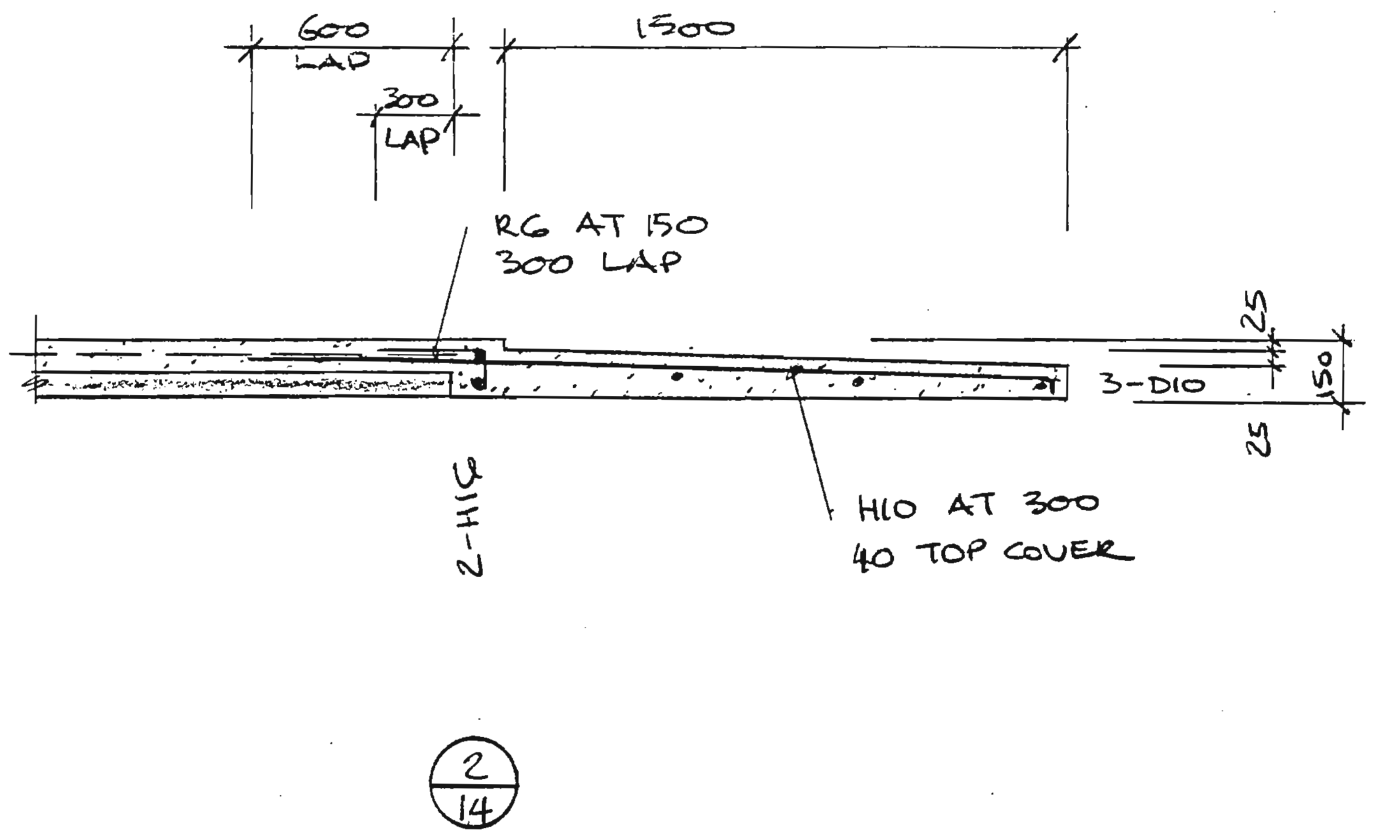


RESIDENTIAL DEVELOPMENT

BLOCKS A TO E — DETAILS
FOR BRYNDWR BUILDERS LTD

HARMAN HALLIDAY - CONSULTING CIVIL & STRUCTURAL ENGINEER
47 HEREFORD ST., PO BOX 2313 - PH 3653697, FAX 3664575 - CHRISTCHURCH
JULY 1998 - SCALE 1:20 - JOB N° 67-3/25





RESIDENTIAL DEVELOPMENT

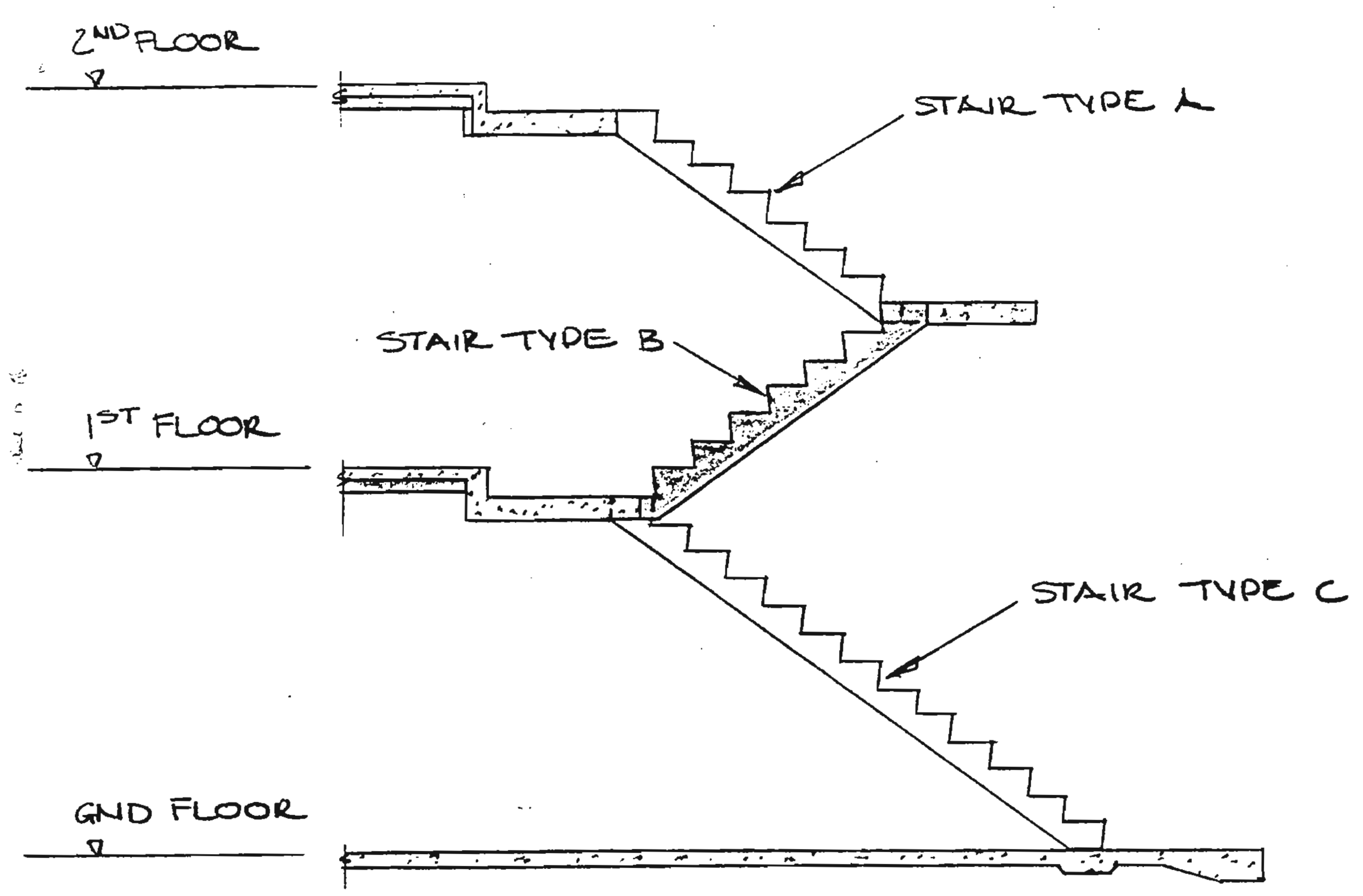
BLOCKS A TO E - DETAILS

FOR [illegible] BUILDERS LTD

HARMAN HALLIDAY - CONSULTING CIVIL & STRUCTURAL ENGINEER

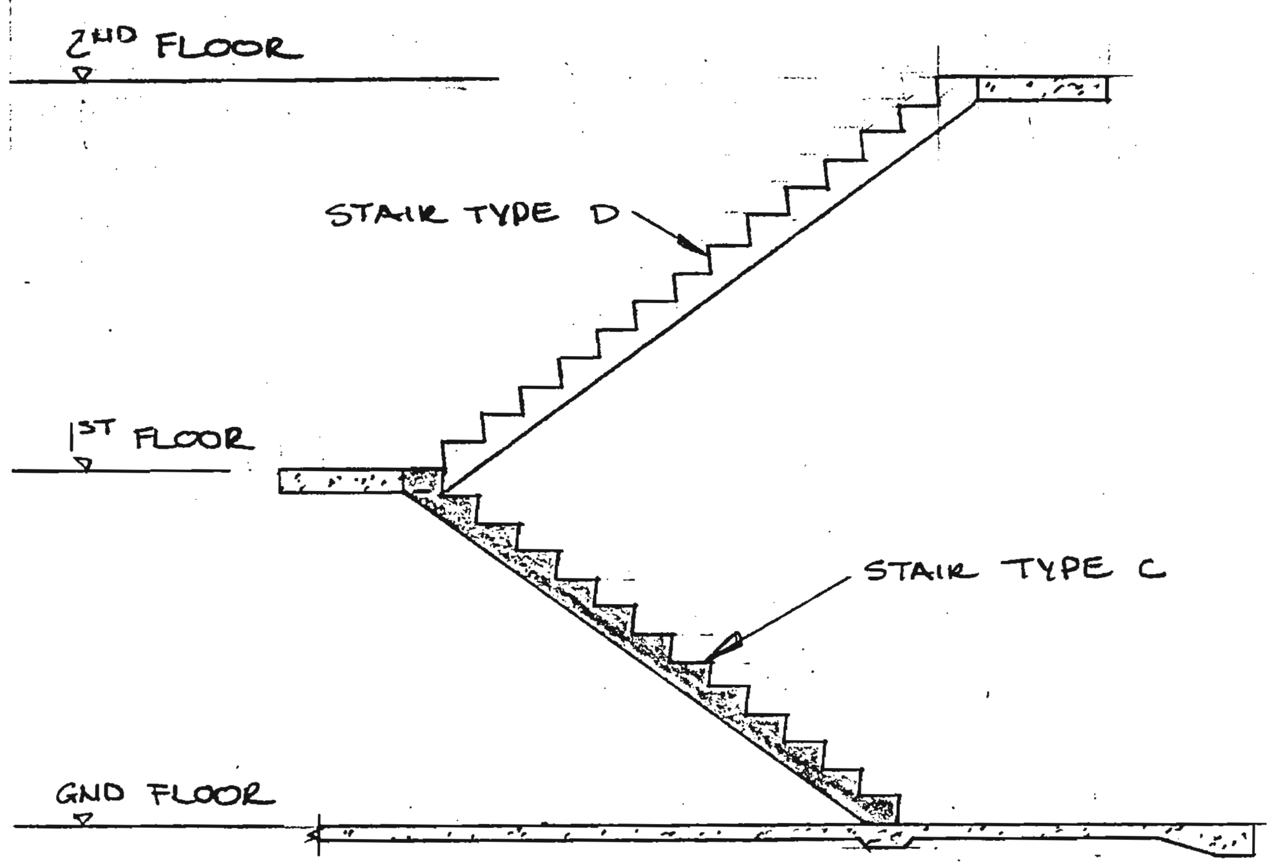
47 HEREFORD ST, PO BOX 2313 - PH 3653697, FAX 3664575 - CHRISTCHURCH

JULY 1998 - - SCALE 1:20 - JOB Nº 27-5/26



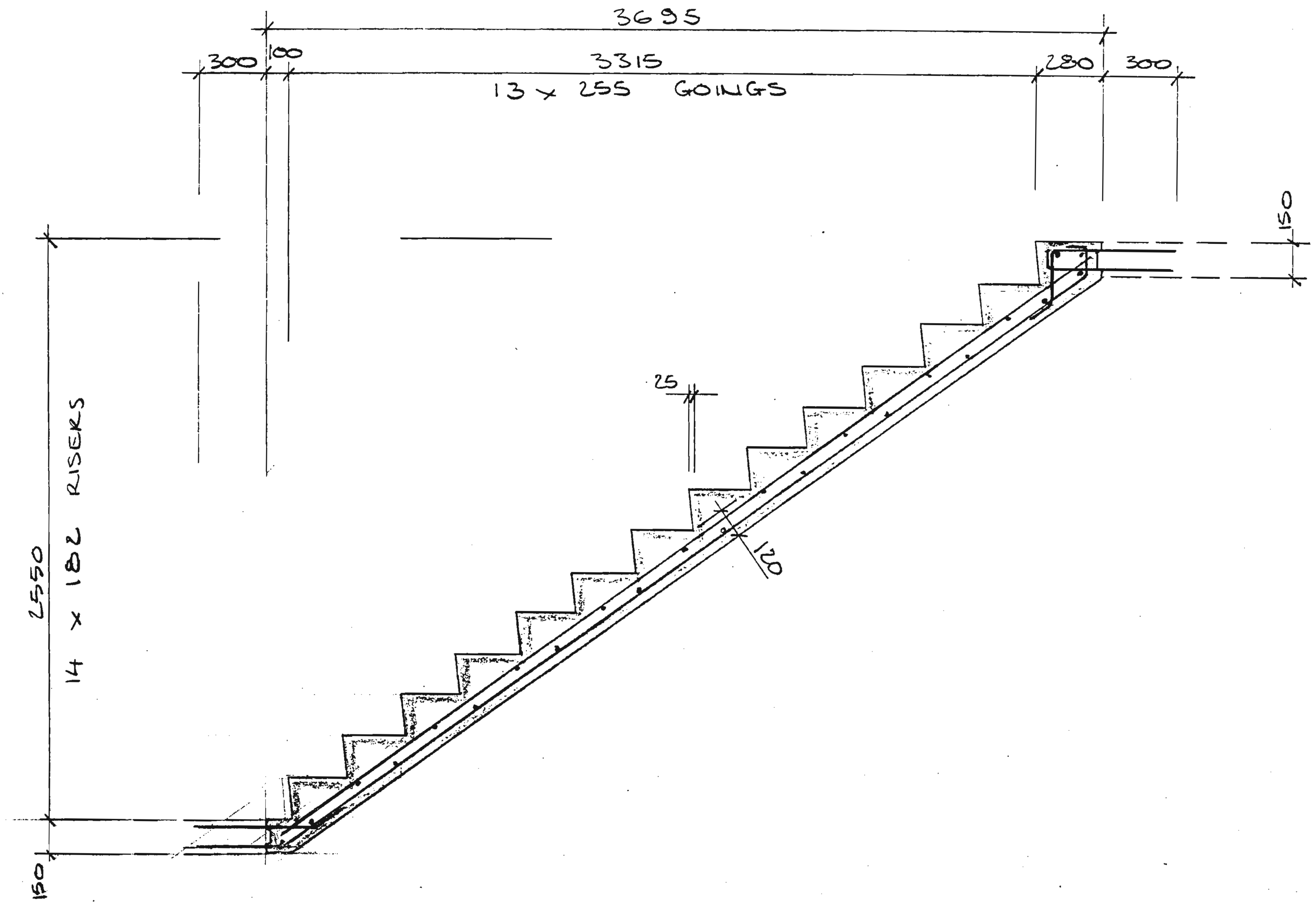
PRECAST STAIR ELEVATIONS

BLOCKS A & B



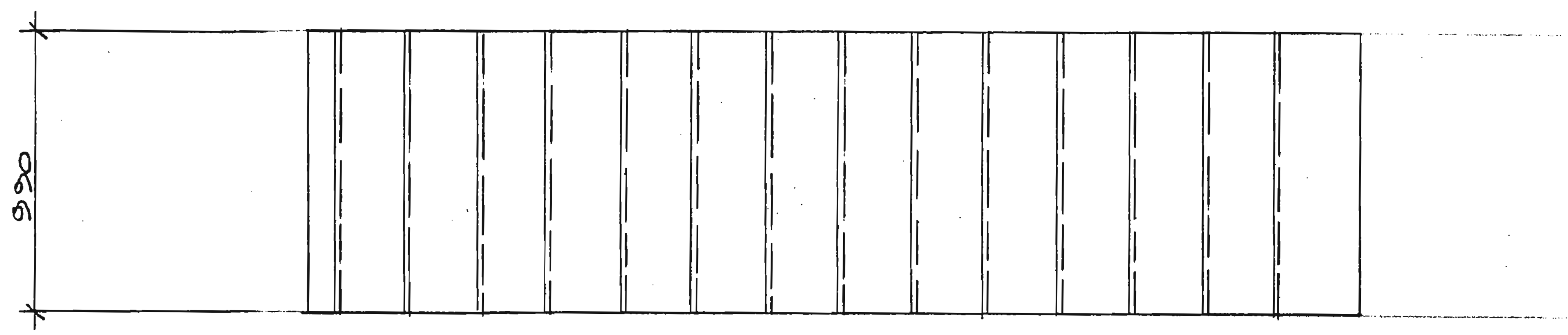
PRECAST STAIR ELEVATIONS

BLOCK C



PRECAST STAIR TYPE D

REINFORCING AS FOR STAIR TYPE C



PLAN STAIR TYPE D

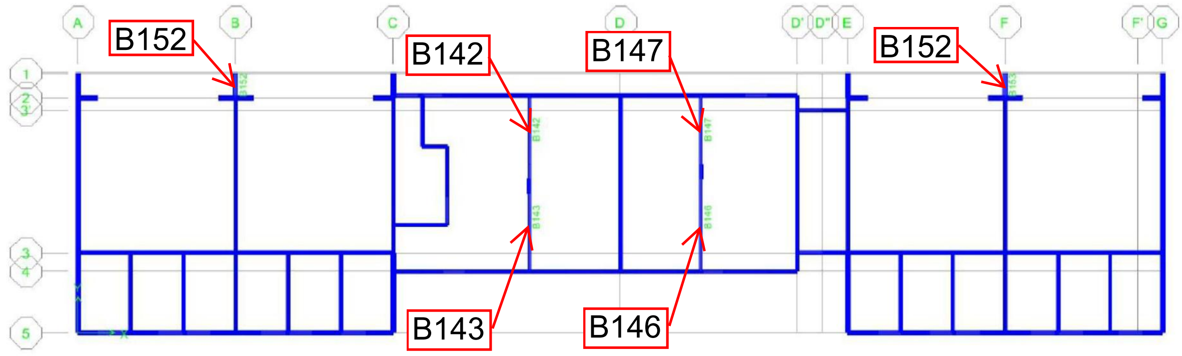
RESIDENTIAL DEVELOPMENT

BLOCKS A, B & C PRECAST STAIR DETAILS
FOR BRYNDWR BUILDERS LTD

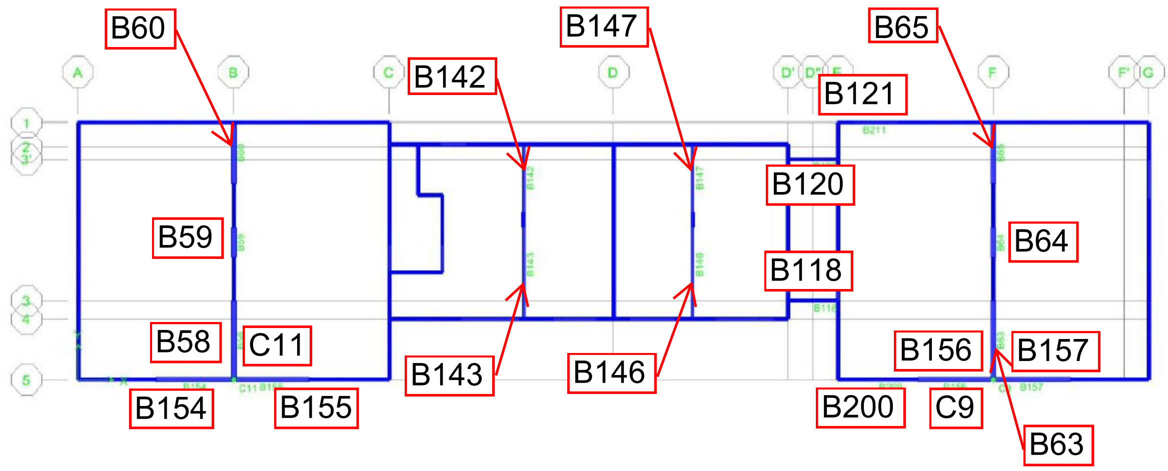
HARMAN HALLIDAY - CONSULTING CIVIL & STRUCTURAL ENGINEER
47 HEREFORD ST, PO BOX 2313 - PH 3653697, FAX 3664575 - CHRISTCHURCH
JULY 1998 - SCALE 1:50, 1:20 - JOB No 67-5/27

Appendix D

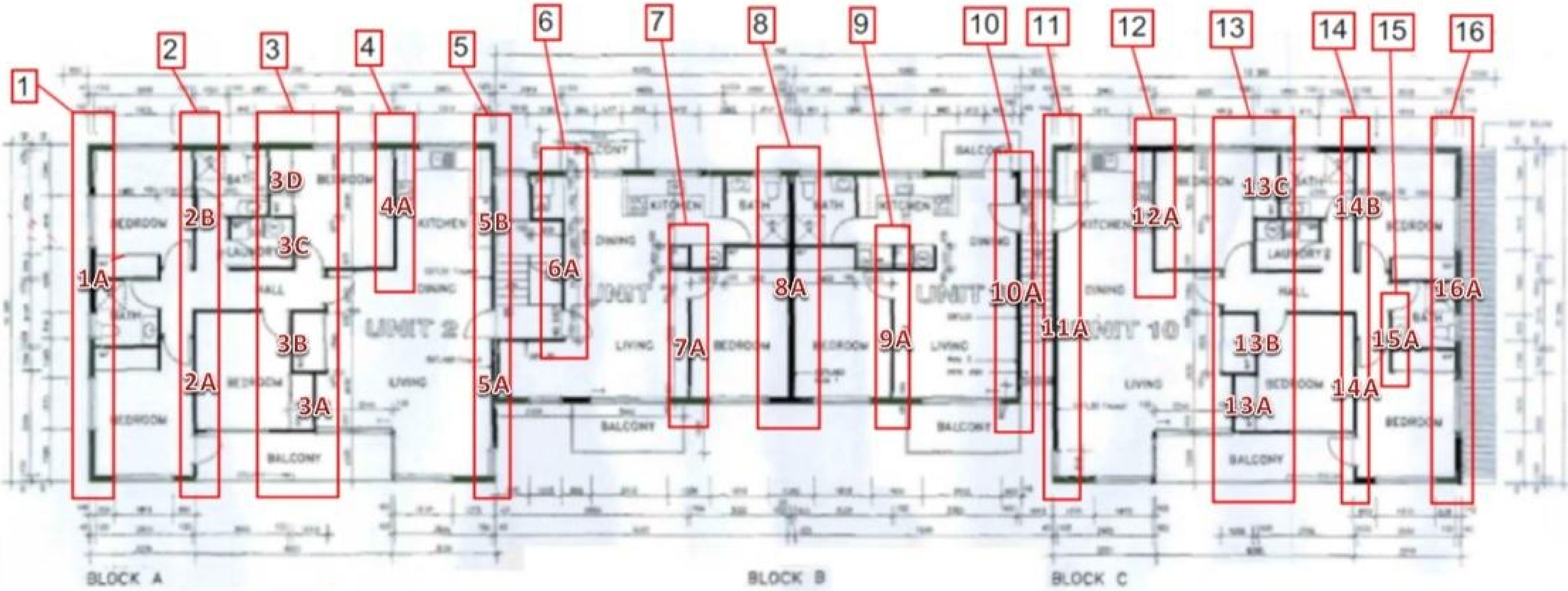
Key Drawings



Beams and Columns Designation at First Floor



Beams and Columns Designation at Second Floor

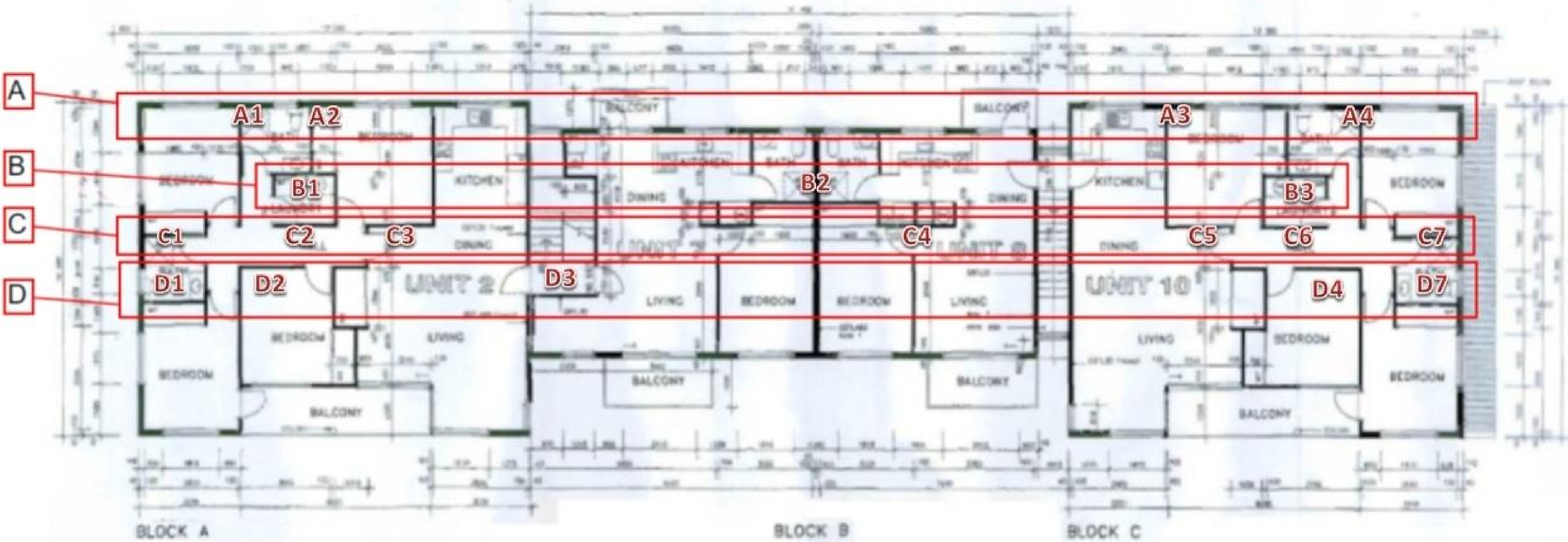


BRACING LINE ACROSS

SECOND FLOOR PLANS

SCALE 1:100

NOTE : LENGTH LESS THAN 1.80M IS NOT INCLUDED IN THE CALCULATIONS OF BRACING CAPACITIES.

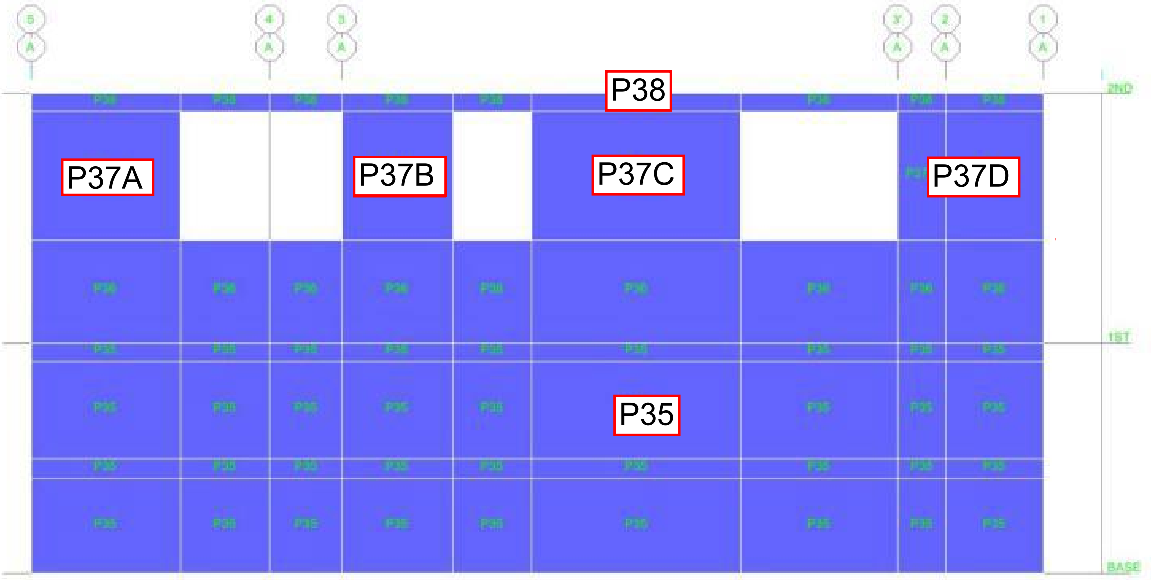


BRACING LINE ALONG

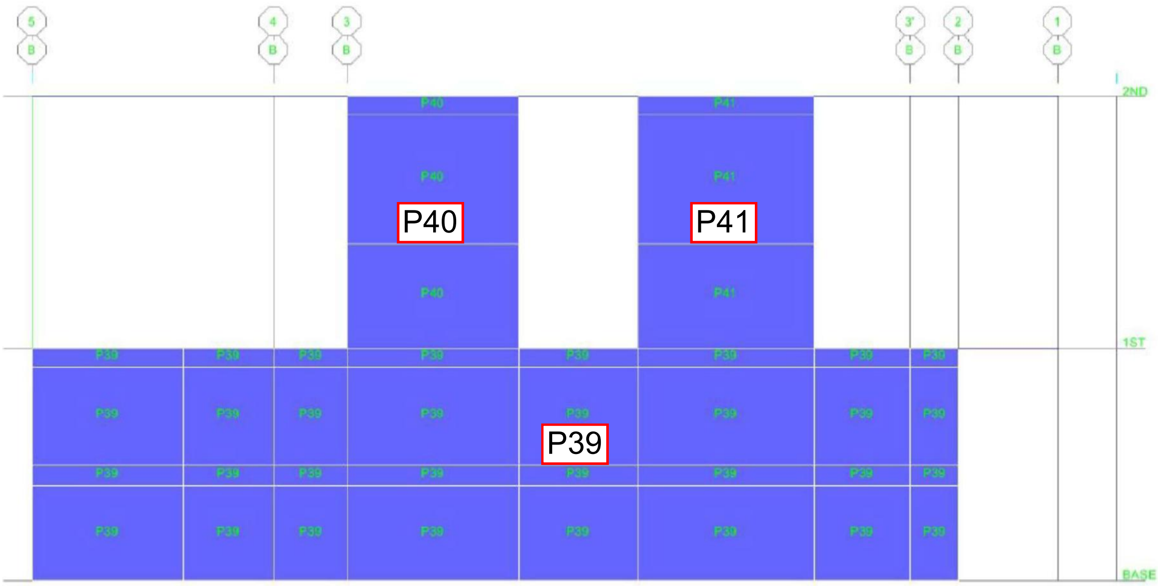
SECOND FLOOR PLANS

SCALE 1:100

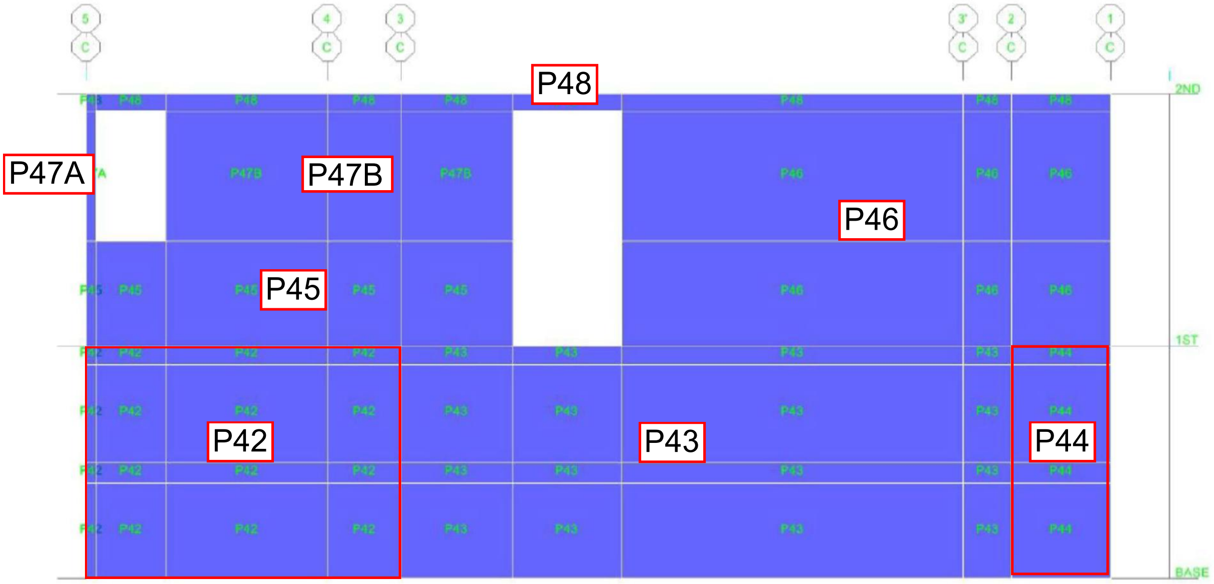
NOTE: LENGTH LESS THAN 1.80M IS NOT INCLUDED IN THE CALCULATIONS OF BRACING CAPACITIES



WALL AT GRID A

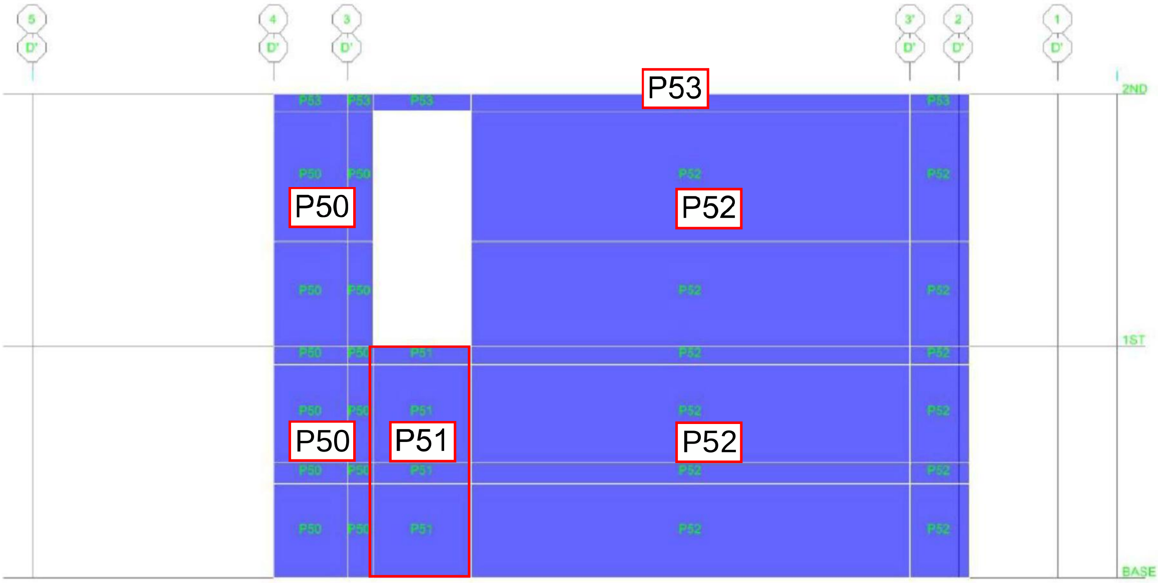


WALL AT GRID B

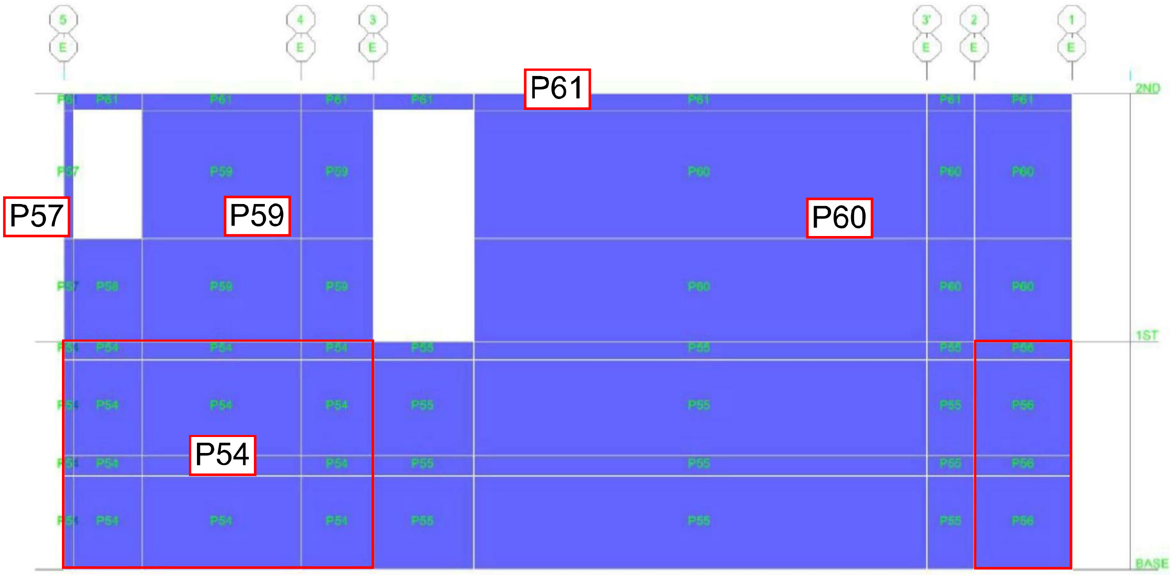


WALL AT GRID C

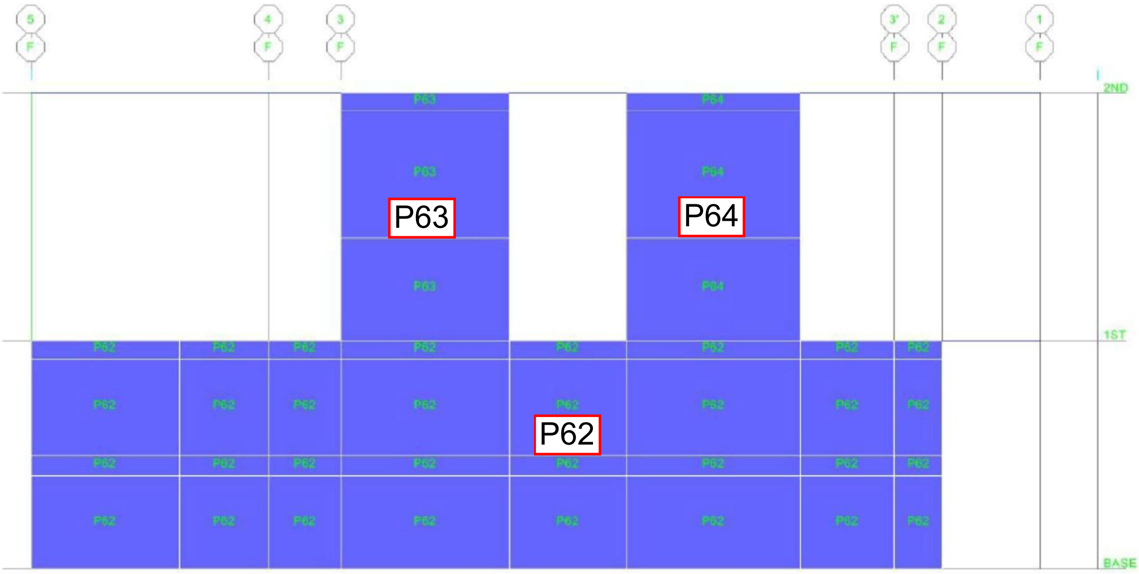
WALL AT GRID D



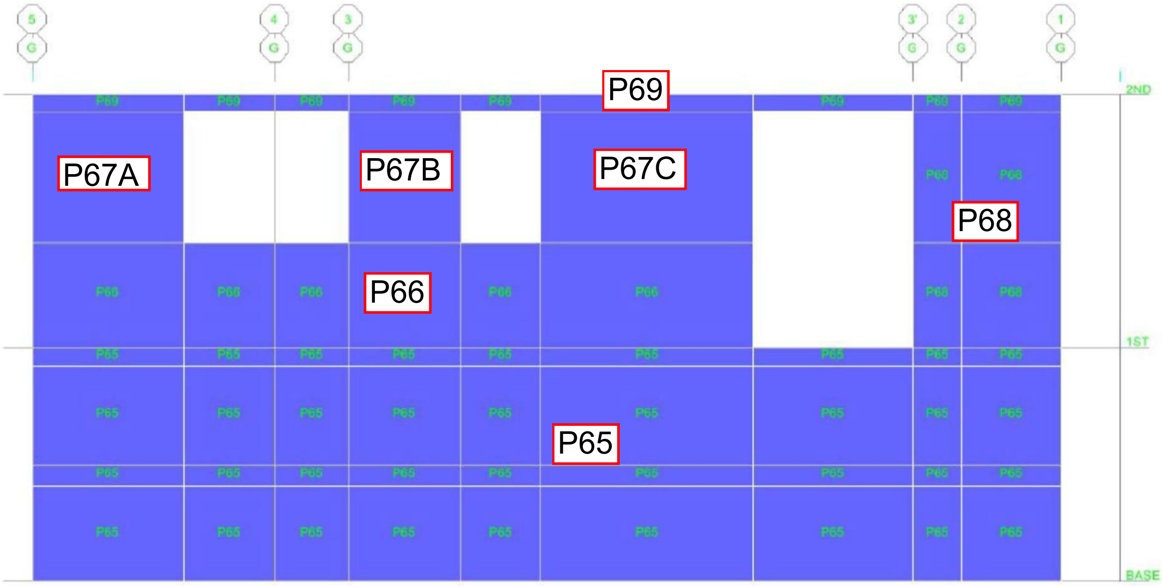
WALL AT GRID D’



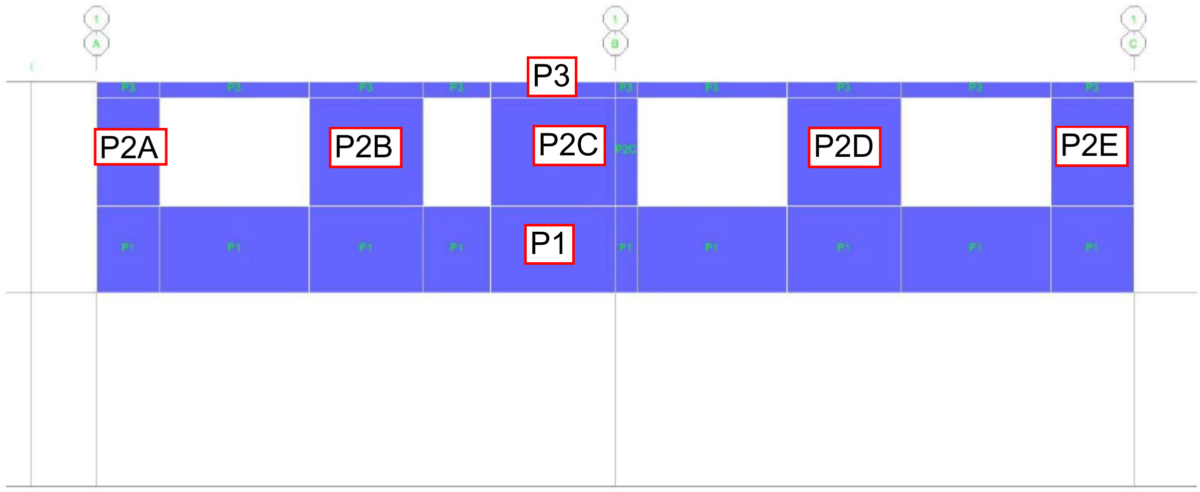
WALL AT GRID E



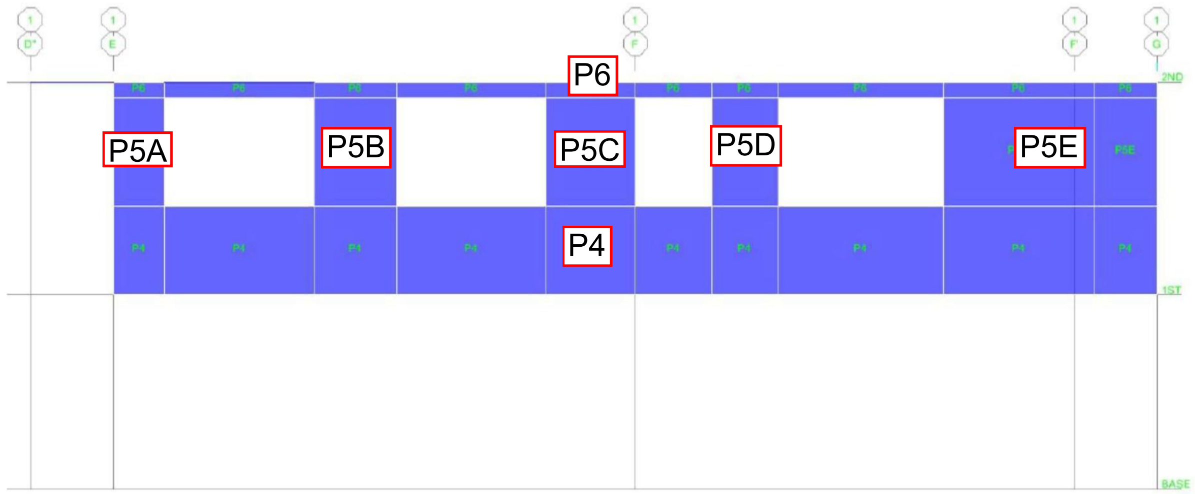
WALL AT GRID F



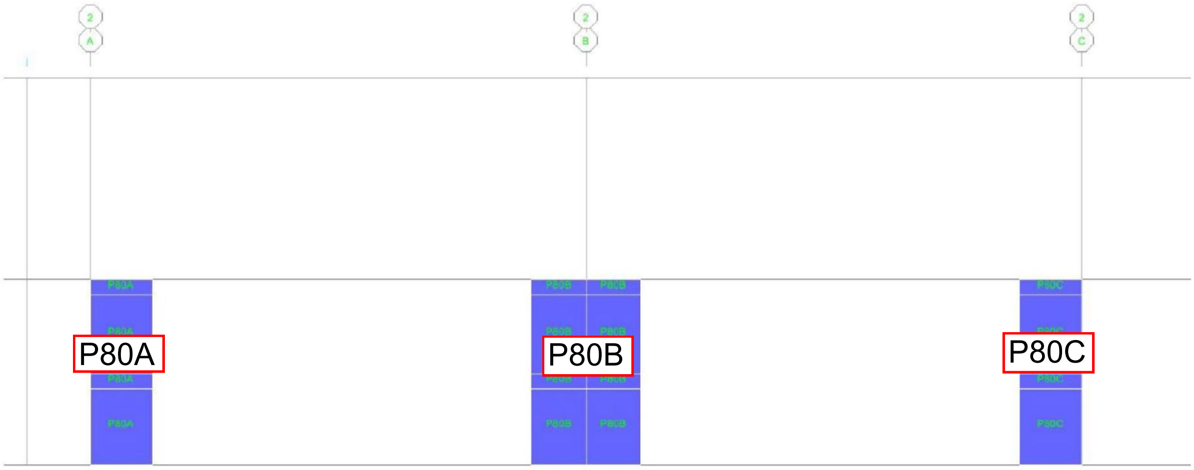
WALL AT GRID G



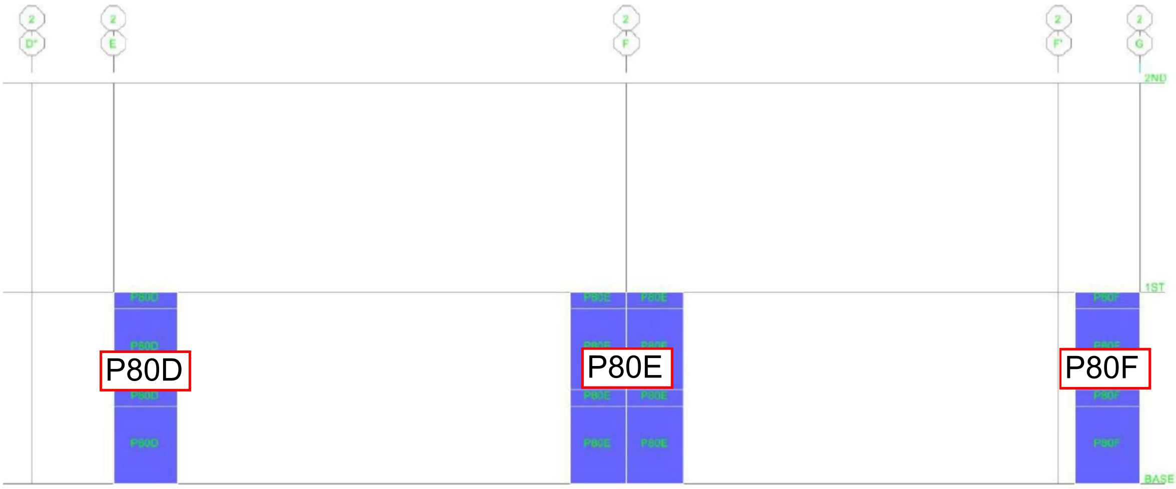
WALL AT GRID 1 – LEFT SIDE



WALL AT GRID 1 – RIGHT SIDE

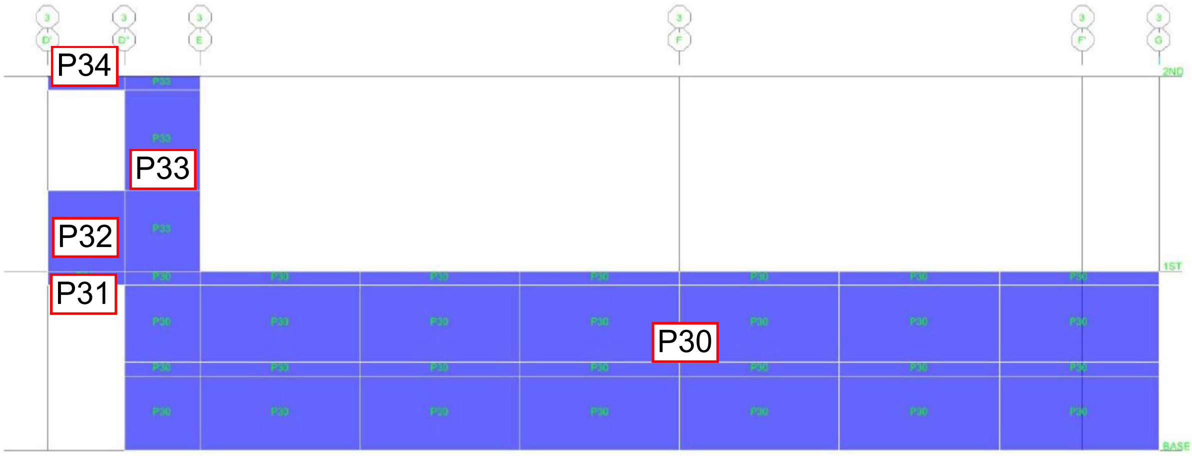


WALL AT GRID 2 – LEFT SIDE

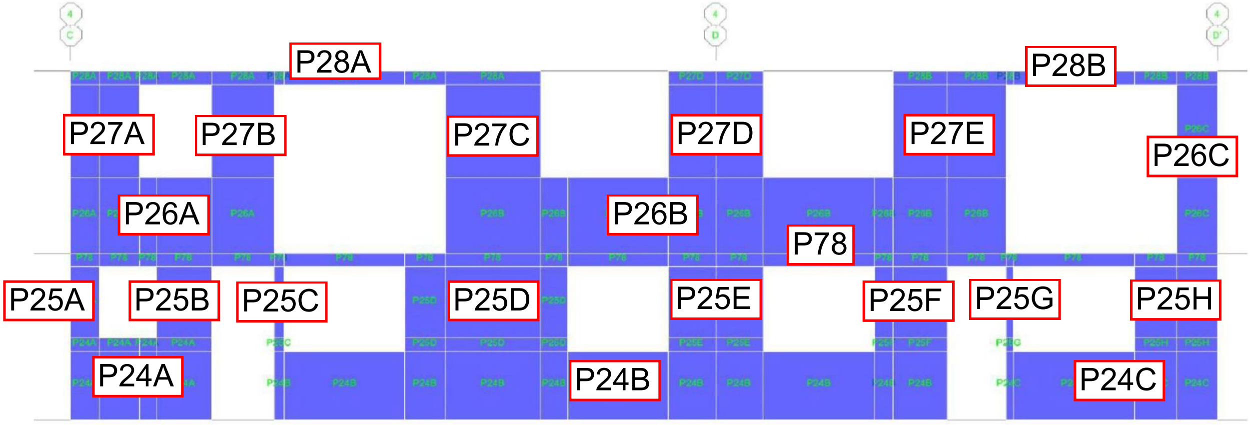


WALL AT GRID 2 – RIGHT SIDE

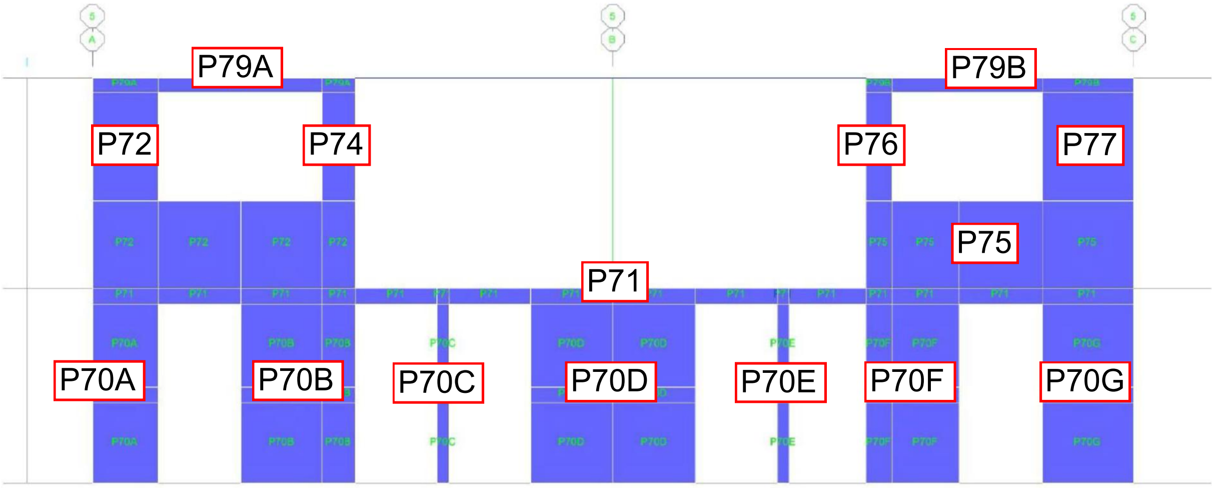
WALL AT GRID 3 0 LEFT SIDE



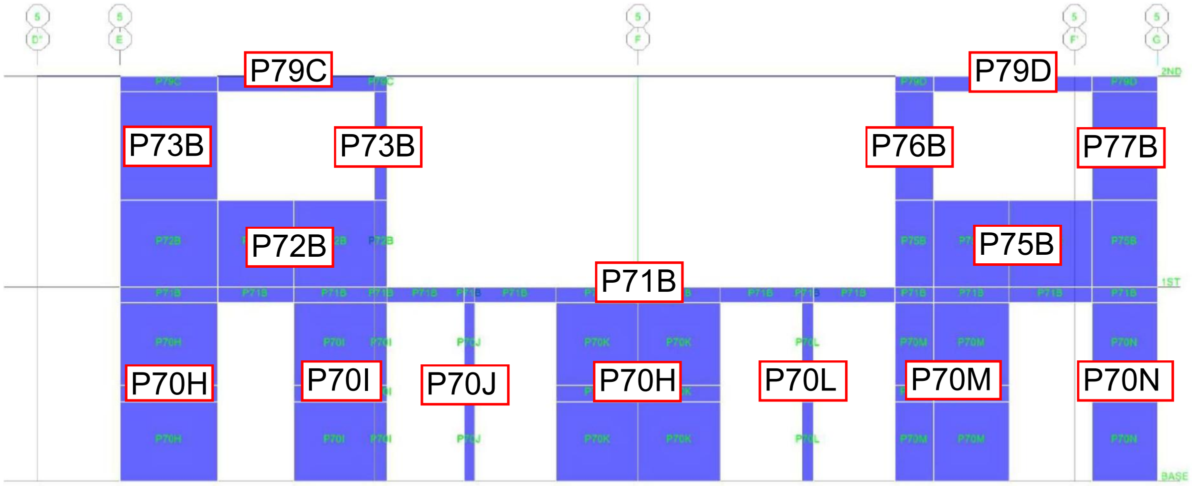
WALL AT GRID 3 – RIGHT SIDE



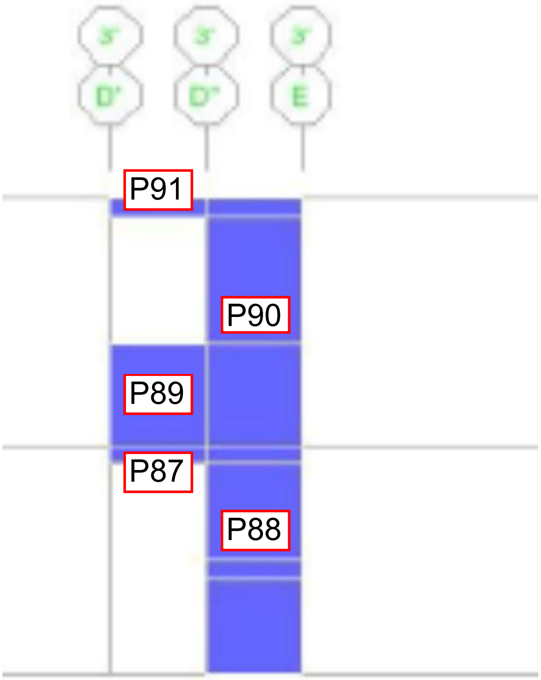
WALL AT GRID 4



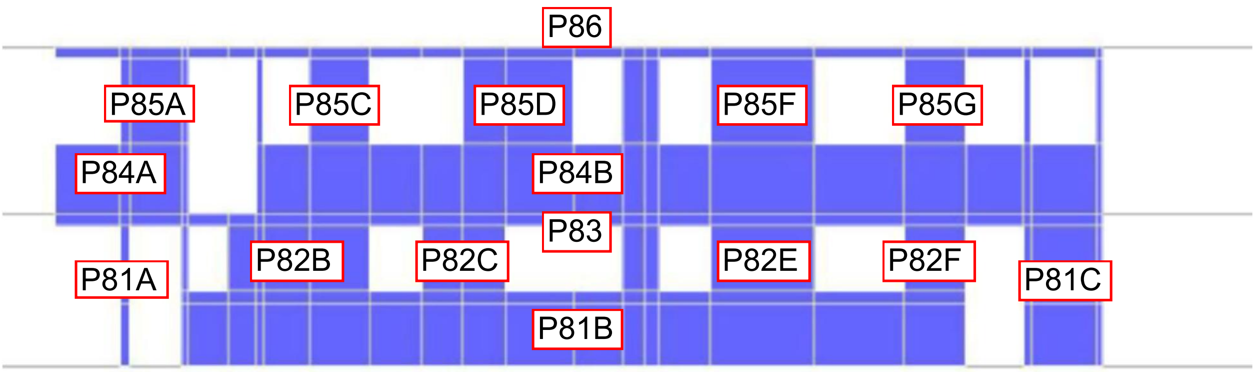
WALL AT GRID 5 – LEFT SIDE



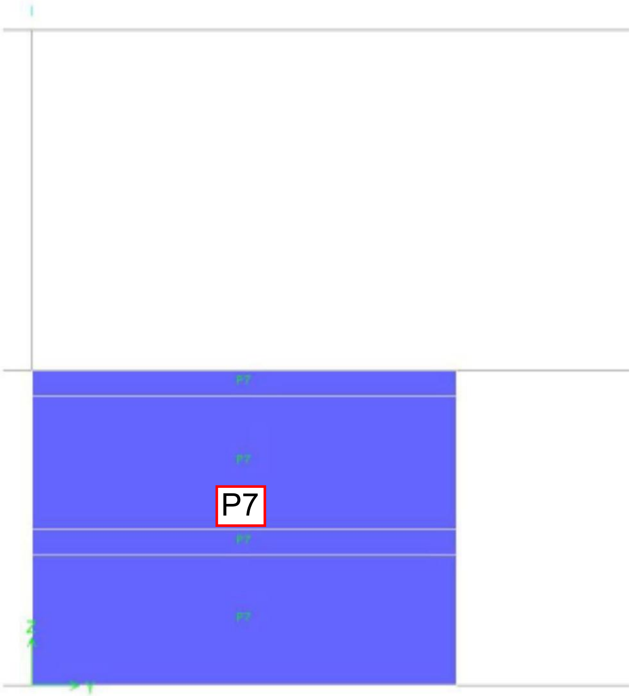
WALL AT GRID 5 – RIGHT SIDE



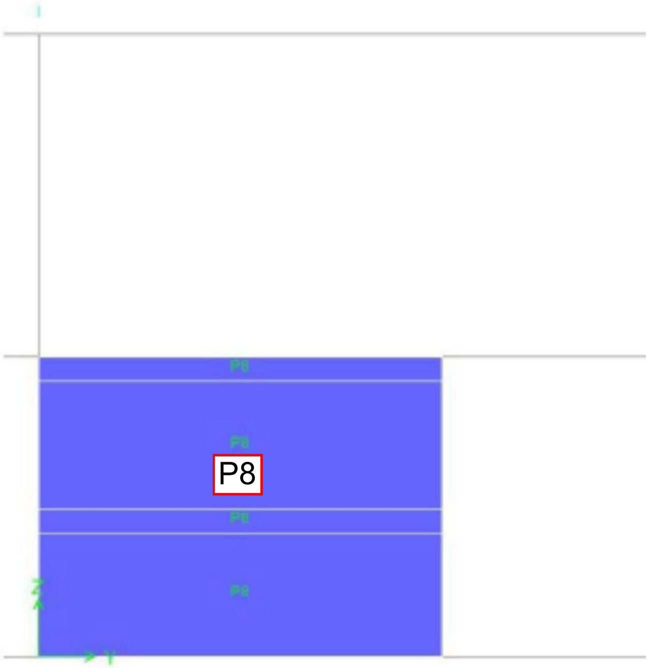
WALL AT GRID 3’



WALL AT GRID 2’

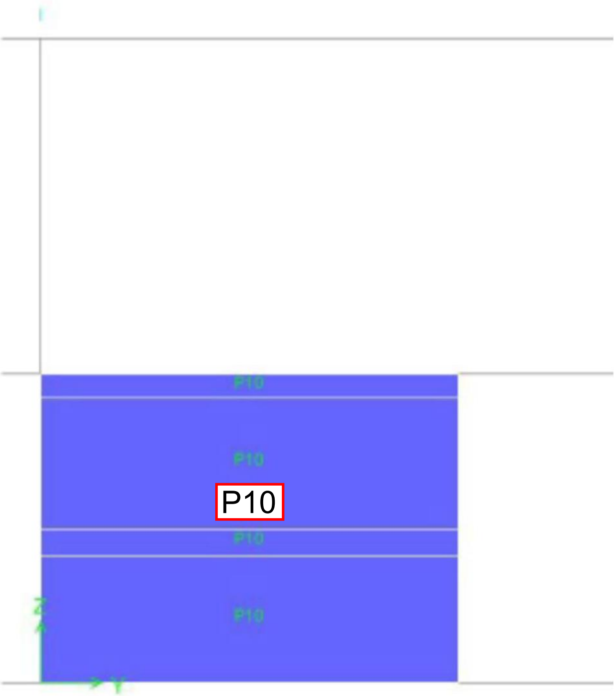


WALL AT PARTITION BETWEEN GRID A AND B

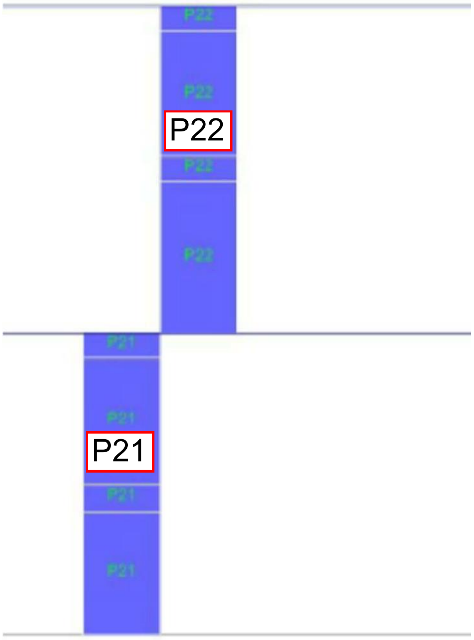


WALL AT PARTITION BETWEEN GRID A AND B

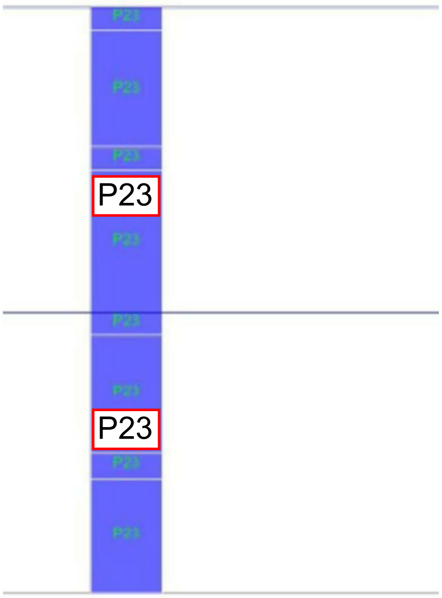
WALL AT PARTITION BETWEEN GRID B AND C



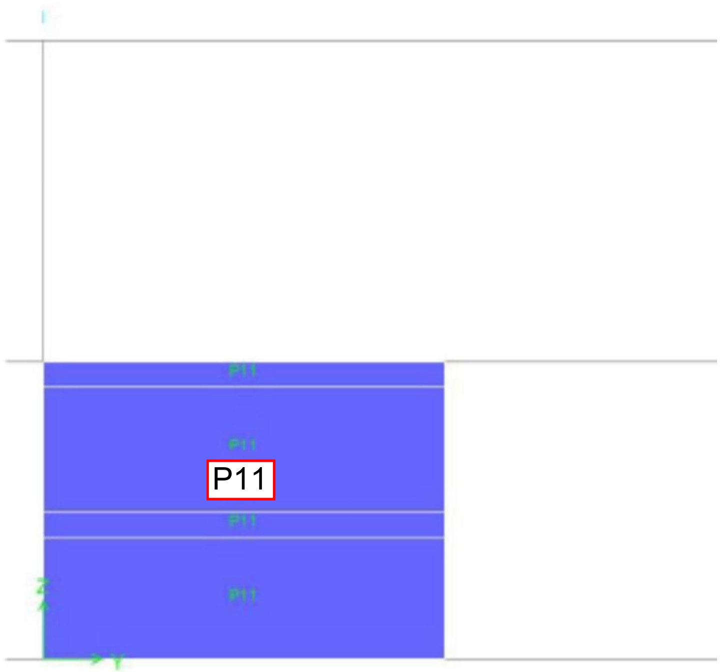
WALL AT PARTITION BETWEEN GRID B AND C



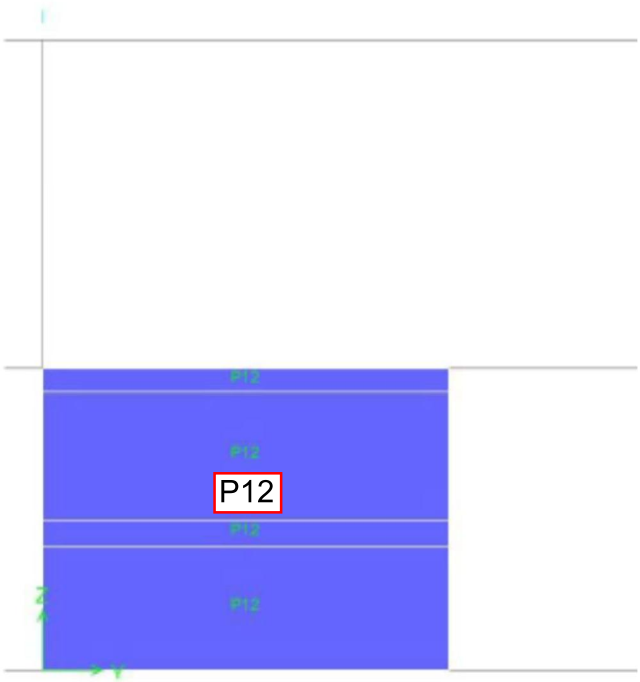
WALL AT PARTITION BETWEEN GRID C AND D



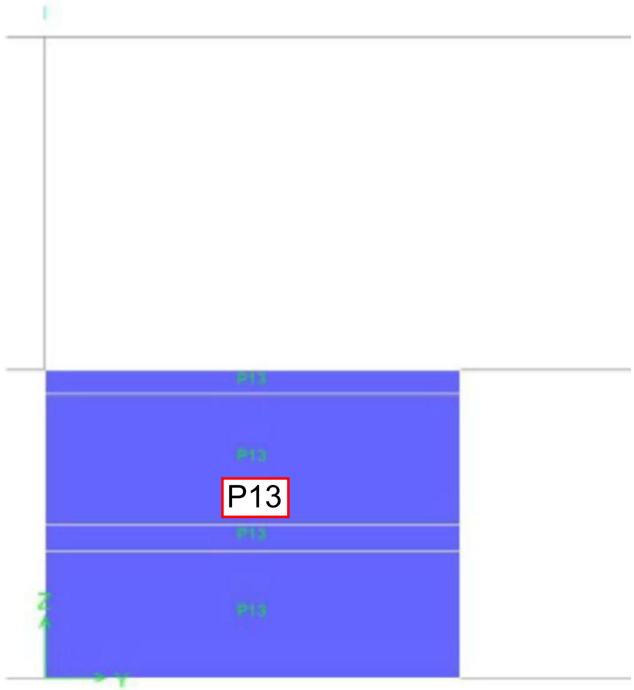
WALL AT PARTITION BETWEEN GRID D AND D’



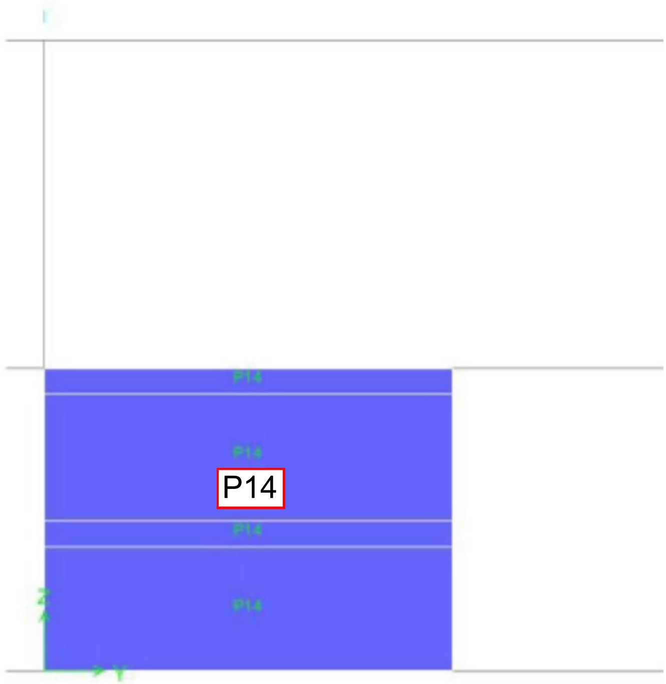
WALL AT PARTITION BETWEEN GRID E AND F



WALL AT PARTITION BETWEEN GRID E AND F

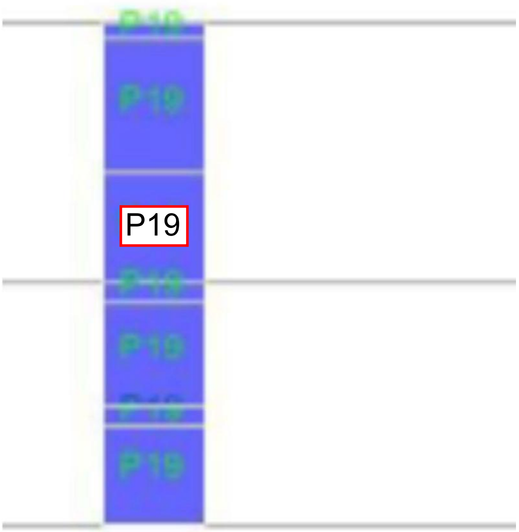


WALL AT PARTITION BETWEEN GRID F AND G



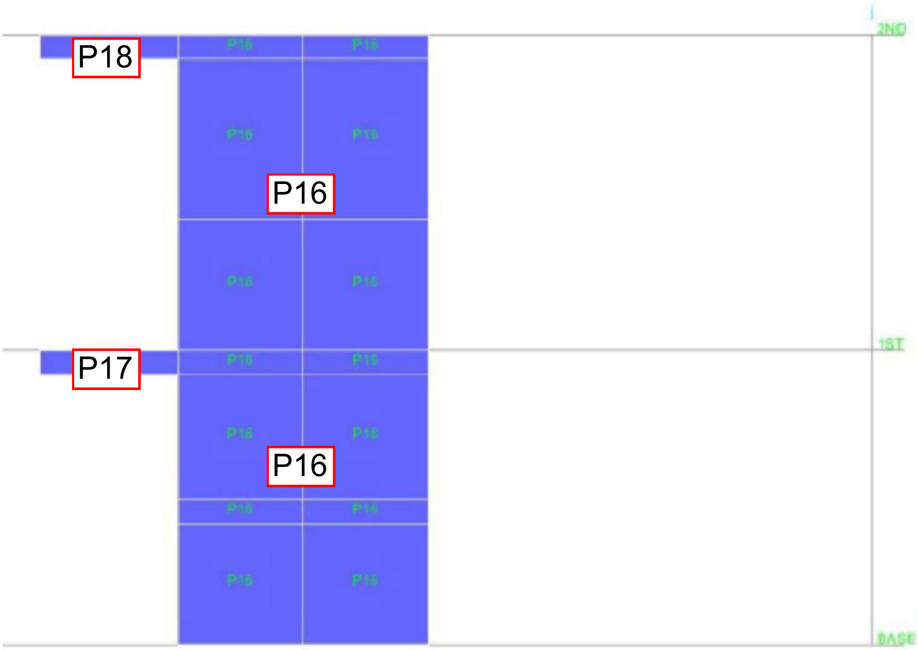
WALL AT PARTITION BETWEEN GRID F AND G

WALL AT STAIR BETWEEN GRID 2 AND 3



WALL AT STAIR BETWEEN GRID 2 AND 3

WALL AT STAIR BETWEEN GRID C AND D



WALL AT STAIR BETWEEN GRID C AND D

Appendix E

Structural Calculations

Note: (refer to basis of Design for the material strength, properties, codes and standards, and loads and loading combinations considered in the checking)

CALCULATIONS

Client	Christchurch City Council	Job No.	51/30596/36	Sheet	1 of 30
Project	Structural Investigation of Gloucester Courts Block A	Calc. by	MBJ	Date	9-Jul-12
Subject	Calculations of Seismic Loads	Chec ked by	DMC	Date	9-Jul-12

Imposed Action : 1.50 kPa.
Roof Live Load : 0.25 kPa.
Earthquake Imposed Action (Ψ_E) : 0.30 -other apllication
(Section 4.2-NZS 1170.5:2004)
Reduction Factor (Ψ_a) : 1.00
(Section 3.4.2-NZS 1170.1:2002)

Note: Seismic Weight is the summed between the mid-heights of adjacent storeys

		Seismic Weight		
Level/Description		**Deadload**	**Liveload**	**Total (DL+0.30LL)**
Roof Level (AtRoof= 385)				
	Concrete Column	1.63		
	Concrete Beam (Roof)			
	Conc. Topping (Roof)			
	Masonry Block Wall			
	Concrete Stair			
	GIB Brace Line	4.69	28.88	
	Gib Wall	10.82		
	Timber - Wall	27.96		
	Precast Slab (Roof)			
	In-situ Slab (Roof)			
	Timber Beam (Roof)	4.70		
	Truss (Roof)	7.07		
	Roofing (Roof)	98.05		
	Sub-Total (1)	***154.93***	***28.88***	***183.80***
2nd Level (At2nd= 385)				
	Concrete Column	3.56		
	Concrete Beam (2nd Level)	53.41		
	Conc. Topping (2nd Level)	245.68		
	Masonry Block Wall	382.92		
	Concrete Stair	18.52		
	GIB Brace Line	4.69	173.25	
	Gib Wall	10.82		
	Timber Frame - Wall	29.17		
	Precast Slab (2nd Level)	1417.77		
	In-situ Slab (2nd Level)	40.78		
	Timber Beam (2nd Level)			
	Truss (2nd level)	0.51		
	Roofing (2nd level)	2.60		
	Sub-Total (2)	***2210.44***	***173.25***	***2383.69***
1st Level (At1st= 385)				
	Concrete Column	3.71		
	Concrete Beam (1st level)	18.85		
	Conc. Topping (1st level)	246.01		
	Masonry Block Wall	1133.31		
	Concrete Stair	35.60		
	GIB Brace Line		173.25	
	Gib Wall			
	Timber Frame - Wall	1.21		
	Precast Slab (1st level)	1417.77		
	In-situ Slab (1st level)	40.78		
	Timber Beam (1st level)			
	Truss (1st level)	0.55		
	Roofing (1st level)	1.51		
	Sub-Total (3)	***2899.29***	***173.25***	***3072.54***
Total		**5264.66**	**375.38**	**5640.03**

CALCULATIONS

Client	**Christchurch City Council**	Job no.	**51/30596/36**	Sheet	2-5	of	30
Project	**Structural Investigation of Gloucester Courts Block A**	Calcs by	MBJ	Date	09-Jul-12		
Subject	**Calculations of Seismic Loads**	Checked by	DMC	Date	09-Jul-12		

1.0 Input Data:

1.a. Seismic Parameters;

Location	:	Christchurch
Site Classification	:	D
Hazard Factor, Z	:	0.30
(Table 3.3 NZS 1170.5:2004)		
Importance Level, I	:	2
(Table 3.1 NZS 1170.0.2002)		
Annual Probability of Exceedance (ULS)		
(Table 3.3 NZS 1170.0.2002)		
for Ultimate limit State, ULS	:	1/500
for Serviceability limit State, SLS	:	1/25
Return Period Factor;		
(Table 3.5 NZS 1170.5:2004)		
for Ultimate limit State, R_u	:	1.00
for Serviceability limit State, R_s	:	0.33
Structural Ductility Factor		
Longitudinal Wall, μ	:	1.50
Structural Performance Factor, S_p	:	0.87
Translational Period of structure, T	:	0.40 s.

1.b. Load Summary;

Item	Level	Seismic Weight (kN)		Total Load (G+0.30Q)
		Permanent Action (G)	Imposed Action (Q)	
1.0	Level 1	2899.29	173.25	3072.54
2.0	Level 2	2210.44	173.25	2383.69
3.0	Roof Level	154.93	28.88	183.80
Total		5264.66	375.38	5640.03

1.c. Storey Height;

Item	Level	Span	Height	
			per level	accumulated
1.0	Level 1	Ground - Level 1	2.36	2.36
2.0	Level 2	Level 1 - Level 2	2.56	4.92
3.0	Roof Level	Level 2 - Roof Level	2.16	7.08

2.0 Preliminary Calculations:

2.a. Solving for Translational Period of strucrure, T

T = 1.25*kt*(hn)^0.75 -- C 4.1.2.2 (NZS 1170.5:2004 Commentary)

where;

Kt = 0.05 -- C 4.1.2.2 (NZS 1170.5:2004 Commentary)

hn = height in m from the base of the structure to the upper,most seismic weight or mass

= 7.08

therefore:

T = 0.27 s NOTE: T = 0 s (Etabs Result)

but:

T should not be less than 0.4s

therefore:

T = 0.40 s

2.a. Solving for Elastic Site Hazard Spectrum for hor. Loading, C(T)

$C(T) = C_h(T)*Z*R*N(T,D)$ --- 3.1(1) (NZS 1170.5:2004)

where;

$C_h(T)$ = Spectral shape factor *(Clause 3.1.2 & Table 3.1 NZS 1170.5:2004)*

= *3*

Z = Hazard Factor

= *0.30*

R = Return period factor *(Table 3.5 NZS 1170.5:2004)*

Ru = *1.00*

Rs = *0.33*

N(T,D) = Near-fault factor *(Clause 3.1.6 NZS 1170.5:2004)*

ULS = *1.00*

SLS = *1.00*

Item	Category	$C_h(T)$	Z	R	N(T,D)	C(T)
1.0	ULS	3	0.30	1.00	1.00	0.9
2.0	SLS	3	0.30	0.33	1.00	0.297

2.b. Solving for Inelastic Spectrum Scaling Factor, kμ

** Since the site falls to category D and the period T is less than 0.7s, we use;

$$k\mu = \frac{(\mu-1)T}{0.7} + 1$$

where;

μ = Structural Ductility Factor

μ = *1.500*

T = Translational Period of structure

= *0.400*

Item	Type	**μ**	T_1	**kμ**
1.0	Wall	1.25	0.40	1.14

2.c. Solving for horizontal design action coefficient, $C_d(T_1)$

$$C_d(T_1) = \frac{C(T_1)S_p}{k\mu}$$ ---------- 5.2(1) (NZS 1170.5:2004)

$\geq$ $(Z/20 + 0.02)R_u$ but not less than $0.03R_u$ ---------- 5.2(2) (NZS 1170.5:2004)

where;

C(T1) = ordinate of the elastic site hazard spectrum *(Clause 3.1.1 NZS 1170.5:2004)*

ULS = *0.900*

SLS = *0.297*

Sp = structural performance factor

= *0.70 except where 1.0 < μ <2.0* ---------- 4.4.1 (NZS 1170.5:2004)

Therefore:

Sp = *0.871* NZS 3101 Section 2.6.2.2.1

= *0.871*

Sp = *0.871*

Z = Hazard Factor

= *0.30*

Item	Category	Type	C(T1)	Sp	**kμ**	Cd(T1)	(Z/20+.02) R	0.03R	Remarks
1.0	ULS	Wall	0.900	0.87	1.14	0.69	0.22	0.0300	Ok!!
2.0	SLS	Wall	0.297	0.87	1.14	0.23	0.07	0.0099	Ok!!

3.0 Calculation of Seismic Forces:

3.a. Solving for Equivalent Static Hor. Force @ each Level;

Item	Level	Height (hi)	Total Load (Wi)	Wihi	Wihi / Σ (Wihi)	Ft	0.92V	Fi
1.0	Level 1	2.36	3072.54	7251.20	0.36	0	5188.8	1855.27
2.0	Level 2	4.92	2383.69	11727.75	0.58	0	5188.8	3000.62
3.0	Roof Level	7.08	183.80	1301.31	0.06	451.20	5188.8	784.15
Total			5640.03	20280.26	1.00			5640.03

3.b. Solving for Horizontal Seismic Shear;

Item	Level	Horizontal Design Action Cd(Ti)		Horizonta Seismic Shear per storey, Vi	
		X-dir	Z-Dir	Along	Across
1.0	Level 1	0.69	0.69	1272.55	1272.55
2.0	Level 2	0.69	0.69	2058.16	2058.16
3.0	Roof Level	0.69	0.69	537.86	537.86
Total				3868.57	3868.57

CALCULATIONS

Client	Christchurch City Council	Job no.	51/30596/36	Sheet	6	of 30
Project	Structural Investigation of Gloucester Courts Block A	Calcs by	MBJ	Date	28-Jun-12	
Subject	Calculations of Bracing Demand	Checked by	DMC	Date	09-Jul-12	

1.0 Input Data:

Roof Pitch	:	35	deg
Cladding Types	:	Light	
Roof Types	:	Light	
Floor Area	:	416.00	m
Roof Height	:	2.58	m
Height to Apex	:	9.5	m
Height of Studs	:		
Length of Building	:	40	m
Width of Building	:	10.4	m

Note: Where a building has a concrete masonry lower storey. The bracing demand for the timber framed upper storey shall be calculated as a single storey building using5.8,5.9 & 5.10 of NZS 3604:2011 assuming a heavy subfloor cladding - 5.3.4.2 NZS 3604:2011

2.0 Earthquake Bracing Demand:

Earthquake Zone	:	2	NZS 3604:2011 Figure 5.4
Soil Class	:	D	

Determining Earthquake Demand

Earthquake Demand for Subfloor Structure : 14.4 NZS 3604:2011 Table 5.8

NOTE: The above values is already multiply by 0.80 (NZS 3604:2011 Table 5.8 NOTE)

Earthquake Demand for Single Storey Walls : 9.6 NZS 3604:2011 Table 5.8

NOTE: The above values is already multiply by 0.80 (NZS 3604:2011 Table 5.8 NOTE)

Earthquake Bracing Demand = Multiplication factor x Floor Area of the Building

Subfloor Structure : 5990

Single Storey Walls : 3994

- Bracing Demands calculated using GIB Bracing Spreadsheet are almost similar (using 40m x 10.39m building dimensions)

CLIENTS | PEOPLE | PERFORMANCE

Client	**Christchurch City Council**	Job no.	51/30596/36	Sheet	7 of 30
Project	**Gloucester Courts Block A, Christchurch, New Zealand**	Calcs by	MBJ	Date	28/06/2012
Subject	**Tabulation of Timber wall Demand/Capacity Ratios**	Checked by	DMC	Date	7/09/2012

References:

NZS 3604:2011

NZSEE Manual 2006

Note:

- Refer to Bracing Demand Spreadsheet for the calculations of the Bracing Units
- Where a building has a concrete masonry lower storey, the bracing demand for the timber framed upper storey shall be calculated as a single - storey building using tables 5.8 assuming a heavy subfloor cladding ………. NZS 3604:2011
- No Bracing Line shall have a bracing capacity less than the greater of 100 bracing units or 50% of the total bracing demand divided by the number of bracing lines in the direction being considered …………………………………. (5.4.7) NZS 3604:2011
- Wall less than 1.80m length is not included in the Bracing Capacity Calculations.
- Refer to table K1 of NZS 3604:1990 for values of the Bracing Capacities.

Formulas:

C = Total Available wall length * (Bracing Capacity /m)

D = see table

FOS = C/D

% NBS = FOS * 100

BRACING UNITS FOR SINGLE STOREY - ALONG (WALL)

STOREY/ LEVEL	Line Label	Line Element	Total Available Wall Length (m)	Height (m)	Bracing Capacity / m (BU)	Bracing Units Achieved Earthquake - BU (C)	Minimum Demand Bracing Units per Bracing Line Earthquake - BU	C/D Ratio	% NBS
Second Floor	A	A1	1.8	2.16	42	75.6			
		A2	1.8	2.16	42	75.6			
		A3	1.99	2.16	42	83.58			
		A4	1.8	2.16	42	75.6			
	Total A		7.39			310.38	499.25	0.6217	**62.17**
	B	B1	2.28	2.16	42	95.76			
		B2	4	2.16	42	168			
		B3	2.28	2.16	42	95.76			
	Total B		8.56			359.52	499.25	0.7201	**72.01**
	C	C1	1.8	2.16	42	75.6			
		C2	2.28	2.16	42	95.76			
		C3	2.28	2.16	42	95.76			
		C4	2.28	2.16	42	95.76			
		C5	2.1	2.16	42	88.2			
		C6	2.1	2.16	42	88.2			
		C7	2.1	2.16	42	88.2			
	Total C		14.94			627.48	499.25	1.2568	**125.68**
	D	D1	1.8	2.16	42	75.6			
		D2	2	2.16	42	84			
		D3	2	2.16	42	84			
		D4	2.1	2.16	42	88.2			
		D5	2.1	2.16	42	88.2			
	Total D		10			420	499.25	0.8413	**84.13**
TOTAL BRACING CAPACITY =			**1717.38 BU**					0.4300	**43.00**
TOTAL BRACING DEMAND = 3994 BU (Refer to Bracing Demand Spreadsheet)									

OVERALL CAPACITY CHECK

Client	Christchurch City Council	Job no.	51/30596/36	Sheet	8 of 30
Project	Gloucester Courts Block A, Christchurch, New Zealand	Calcs by	MBJ	Date	28/06/2012
Subject	Tabulation of Timber wall Demand/Capacity Ratios	Checked by	DMC	Date	7/09/2012

References:

NZS 3604:2011

NZSEE Manual 2006

Note:

- Refer to Bracing Demand Spreadsheet for the calculations of the Bracing Units
- Where a building has a concrete masonry lower storey, the bracing demand for the timber framed upper storey shall be calculated as a single - storey building using tables 5.8 assuming a heavy subfloor cladding ………. NZS 3604:2011
- No Bracing Line shall have a bracing capacity less than the greater of 100 bracing units or 50% of the total bracing demand divided by the number of bracing lines in the direction being considered ……………………………………. (5.4.7) NZS 3604:2011
- Wall less than 1.80m length is not included in the Bracing Capacity Calculations.
- Refer to Table K1 of NZS 3604:1990 for values of the Bracing Capacities.

Formulas:

C = Total Available wall length * (Bracing Capacity /m)

D = see table

FOS = C/D

% NBS = FOS * 100

BRACING UNITS FOR SINGLE STOREY - ACROSS (WALL)

STOREY/ LEVEL	Line Label	Line Element	Total Available Wall Length (m)	Height (m)	Bracing Capacity / m (BU)	Bracing Units Achieved - Earthquake (C)	Minimum Demand Bracing Units per Bracing Line Earthquake - BU	C/D Ratio	% NBS
Second Floor	1	1A	1.99	2.16	42	83.58			
	Total 1		1.99			83.58	124.81	0.6696	66.96
	2	2A	3.8	2.16	42	159.6			
		2B	3.8	2.16	42	159.6			
	Total 2		7.6			319.2	124.81	2.5574	255.74
	3	3A	1.82	2.16	42	76.44			
		3B	1.82	2.16	42	76.44			
		3C	1.82	2.16	42	76.44			
		3D	1.82	2.16	42	76.44			
	Total 3		7.28			305.76	124.81	2.4498	244.98
	4	4A	3.8	2.16	42	159.6			
	Total 4		3.8			159.6	124.81	1.2787	127.87
	5	5A	3.34	2.16	42	140.28			
		5B	4.8	2.16	42	201.6			
	Total 5		8.14			341.88	124.81	2.7391	273.91
	6	6A	2.74	2.16	42	115.08			
	Total 6		2.74			115.08	124.81	0.9220	92.20
	7	7A	3	2.16	42	126			
	Total 7		3			126	124.81	1.0095	100.95
	8	8A	7.19	2.16	42	301.98			
	Total 8		7.19			301.98	124.81	2.4195	241.95
	9	9A	3	2.16	42	126			
	Total 9		3			126	124.81	1.0095	100.95
	10	10A	5.32	2.16	42	223.44			
	Total 10		5.32			223.44	124.81	1.7902	179.02
	11	11A	6.38	2.16	42	267.96			
	Total 11		6.38			267.96	124.81	2.1469	214.69
	12	12A	3.63	2.16	42	152.46			
	Total 12		3.63			152.46	124.81	1.2215	122.15
	13	13A	1.8	2.16	42	75.6			
		13B	1.8	2.16	42	75.6			
		13C	2	2.16	42	84			
	Total 13		5.6			235.2	124.81	1.8844	188.44
	14	14A	3.8	2.16	42	159.6			
		14B	3.63	2.16	42	152.46			
	Total 14		7.43			312.06	124.81	2.5002	250.02
	15	15A	1.8	2.16	42	75.6			
	Total 15		1.8	2.16		75.6	124.81	0.6057	60.57
	16	16A	1.99	2.16	42	83.58			
	Total 16		1.99			83.58	124.81	0.6696	66.96
TOTAL BRACING CAPACITY =			3229.38 BU					0.8086	80.86
TOTAL BRACING DEMAND = 3994 BU (Refer to Bracing Demand Spreadsheet)									

OVERALL CAPACITY CHECK

GIB EzyBrace® 2011 Software

Demand Calculation Sheet — single storey — V06/11

Job Details

Name	Assessment of Gloucester Courts Block A
Street and Number	250 Gloucester Street
Lot and DP Number	
City/Town/District	Christchurch
Designer	MBJavier
Company Name	GHD Pty Ltd
Date	4/05/2012

BRANZ Appraised
Appraisal No.294 [2011]

Select Lining Option: 10 or 13 mm GIB® Plasterboard

Building Specification

Number of storeys	single
Floor Loading	2kPa
Foundation Type	subfloor
Cladding Weight (subfloor)	heavy

	Single Floor	Complete Single Floor Column only
Cladding Weight	light	
Roof Weight	light	
Room in Roof Space	no	
Roof Pitch (degrees)	35	
Roof height above eaves (m)	2.6	
Building height to apex (m)	4.7	
Ground to lower floor level (m)		
Stud Height (m)	2.2	
Building Length (m)	40.0	
Building Width (m)	10.4	
Building Plan Area (m2)	385	

Building Location

Wind Zone	***Medium***
Select by Building Consent Authority Map or Preference	Not Available
Wind Region	A
Lee Zone	no
Ground Roughness	Urban
Site Exposure	Sheltered
Topographic Class	T2

Earthquake Zone: 2

Soil Type: D&E (deep to very soft)

Annual exceedance probability: 1/500 (NZS3604:2011 default)

Bracing Units required for Wind

Demand W (BU)

	subfloor	Walls single
along	633	435
across	2278	1574

Bracing Units required for Earthquake

Demand along / across E (BU)

subfloor	Walls single
3898	3898

GIB EzyBrace® 2011 Software

SINGLE OR UPPER STOREY WALLS ALONG

V06/11

Lines		Bracing Elements							
1	2	3	4	5	6	7	8	9	10
Line Total Check	Line Label	Bracing Element No.	Available Wall Length L (m)	Angle to Bracing line (degrees)	Element Height H (m)	Bracing Type	Supplier	Bracing Units Achieved	
								W	E
-177	A	1	1.8		2.16	Custom	Custom	76	76
		2	1.8		2.16	Custom	Custom	76	76
		3	1.99		2.16	Custom	Custom	84	84
		4	1.8		2.16	Custom	Custom	76	76
-128	B	1	2.28		2.16	Custom	Custom	96	96
		2	4		2.16	Custom	Custom	168	168
		3	2.28		2.16	Custom	Custom	96	96
627	C	1	1.8		2.16	Custom	Custom	76	76
		2	2.28		2.16	Custom	Custom	96	96
		3	2.28		2.16	Custom	Custom	96	96
		4	2.28		2.16	Custom	Custom	96	96
		5	2.1		2.16	Custom	Custom	88	88
		6	2.1		2.16	Custom	Custom	88	88
		7	2.1		2.16	Custom	Custom	88	88
-67	D	1	1.8		2.16	Custom	Custom	76	76
		2	2		2.16	Custom	Custom	84	84
		3	2		2.16	Custom	Custom	84	84
		4	2.1		2.16	Custom	Custom	88	88
		5	2.1		2.16	Custom	Custom	88	88

					Wind	Earthq.
Totals Achieved	W	395%	EQ		1717	1717
Timber Floor, design limit of 120 BU/m			***declined***		*OK*	*not enough*
Totals Required (from Demand)					435	3898

GIB EzyBrace® 2011 Software

SINGLE OR UPPER STOREY WALLS ACROSS

V06/11

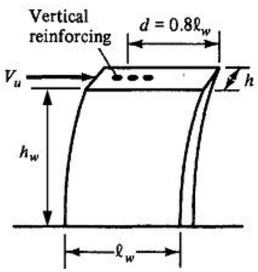
Lines		Bracing Elements							
1	2	3	4	5	6	7	8	9	10
Line Total Check	Line Label	Bracing Element No.	Available Wall Length L (m)	Angle to Bracing line (degrees)	Element Height H (m)	Bracing Type	Supplier	Bracing Units Achieved	
								W	E
-38	**1**	1	1.99		2.16	Custom	Custom	84	84
319	**2**	1	3.8		2.16	Custom	Custom	160	160
		2	3.8		2.16	Custom	Custom	160	160
306	**3**	1	1.82		2.16	Custom	Custom	76	76
		2	1.82		2.16	Custom	Custom	76	76
		3	1.82		2.16	Custom	Custom	76	76
		4	1.82		2.16	Custom	Custom	76	76
160	**4**	1	3.8		2.16	Custom	Custom	160	160
342	**5**	1	3.34		2.16	Custom	Custom	140	140
		2	4.8		2.16	Custom	Custom	202	202
-7	**6**	1	2.74		2.16	Custom	Custom	115	115
126	**7**	1	3		2.16	Custom	Custom	126	126
302	**8**	1	7.19		2.16	Custom	Custom	302	302
126	**9**	1	3		2.16	Custom	Custom	126	126
223	**10**	1	5.32		2.16	Custom	Custom	223	223
268	**11**	1	6.38		2.16	Custom	Custom	268	268
152	**12**	1	3.63		2.16	Custom	Custom	152	152
235	**13**	1	1.8		2.16	Custom	Custom	76	76
		2	1.8		2.16	Custom	Custom	76	76
		3	2		2.16	Custom	Custom	84	84
312	**14**	1	3.8		2.16	Custom	Custom	160	160
		2	3.63		2.16	Custom	Custom	152	152
-46	**15**	1	1.8		2.16	Custom	Custom	76	76
-38	**16**	1	1.99		2.16	Custom	Custom	84	84

						Wind	Earthq.
Totals Achieved	W	205%	EQ			3229	3229
Timber Floor, design limit of 120 BU/m			***declined***			*OK*	*not enough*
Totals Required (from Demand)						1574	3898

CLIENTS | PEOPLE | PERFORMANCE

Client	**Christchurch City Council**	Job no.	51/30596/36	Sheet	**12 & 13 of 30**
Project	**Gloucester Courts Block A, Christchurch, New Zealand**	Calcs by	MBJ	Date	**11/07/2012**
Subject	**Masonry Wall Demand-Capacity Ratio (20 Series Masonry)**	Checked by	DMC	Date	**13/07/2012**

Typical Masonry Wall Section Diagram:



Design Parameters:

f'_m =	15.00	MPa	: compressive strength of masonry
f_{y1} =	430.00	MPa	: yield strength of steel for 12mmØ and larger bars
f_{y2} =	300.00	MPa	: yield strength of steel for 10mmØ and smaller bars
ϕ =	1.00		: reduction factor for bending (NZSEE Design Manual)
ϕ =	0.85		: reduction factor for shear (NZSEE Design Manual)
$Ø_{b1}$ =	12	mm	: vertical rebar diameter
$Ø_{b2}$ =	10	mm	: horizontal rebar diameter
s_v =	600	mm	: vertical spacing of reinforcement
s_h =	800	mm	: horizontal spacing of reinforcement

Formulas:

$P_{Ucap} = \phi\, 0.50 f'_m A_g\, [1 - (L_n/40b)^2]$: ultimate axial capacity

$M_{Ucap} = \phi\, R_u\, b_w\, d^2$: ultimate moment capacity

$R_U = f'_m\, \omega\, (1-0.59\omega)$: coefficient of resistance

$\omega = \rho\, f_y / f'_m$

$V_{Ucap} = \phi\, v_n\, b_w\, d$: ultimate shear capacity

where, $v_n = v_m + v_p + v_s$

$v_m = (C_1 + C_2) * v_{bm}$

$v_{bm} = 0.20\sqrt{f'_m}$ = 0.77 MPa

$C_1 = 33\rho_w f_y / 300$ $\rho_w > 0.07\%$

$C_2 = 1.0$

$v_p = (0.90 P_{Ucap} \tan\theta)/(b_w d)$ $\leq 0.10 f'_m$ = 1.50

$v_s = C_3 A_v f_y / b_w s$ C_3 = 0.80

FOS = C / D : moment capacity of member

%NBS = FOS * 100 : Ratio of capacity over demand (Factor of Safety)

References:

NZS 4230:2004

NZSEE Manual 2006

Legend:

Ln = Clear vertical distance between lines of effective horizontal support or clear horizontal distance between lines of effective vertical support, mm (Height)

Lw = Horizontal length of wall, mm (width/length)

STOREY/LEVEL	Location	ETABS Mark	Dimensions				Design Forces (Based on Etabs Results)			Axial Strength			Moment Strength						Shear Strength									
			b_w (t) mm	L_n (mm)	L_w (mm)	d = 0.80L_w mm	P_u (kN)	V_u (kN)	M_u (kN-m)	$P_{u.cap}$ (kN)	C/D Ratio	%NBS	ρ	ω	R_U	$M_{u.cap}$ (kN-m)	C/D Ratio	%NBS	h_e/L_w	C_1	C_2	v_{bm}	v_p	v_s	v_n	$V_{u.cap}$ (kN)	C/D Ratio (FOS)	%NBS
Ground Floor to First Floor	Grid A	P35	190	2360	10390	8312	859.3	526.6	1828.7	13378	15.57	1557%	0.000992	0.02844	0.4194	5505.9	3.01	301%	0.227	0.04693	1.5	1.198	0.0076	0.124	1.330	1785	3.390	339%
	Grid C	P42	190	2360	3190	2552	253.3	148.4	170.2	4107	16.21	1621%	0.000992	0.02844	0.4194	519.02	3.05	305%	0.740	0.04693	1.1	0.916	0.0076	0.124	1.048	432	2.910	291%
	Grid C	P44	190	2360	1000	800	212.6	31.3	21.6	1288	6.06	606%	0.000992	0.02844	0.4194	51.004	2.36	236%	2.360	0.04693	1.0	0.811	0.0076	0.124	0.943	122	3.892	389%
	Grid E	P54	190	2360	3190	2552	252.9	138.3	168.5	4107	16.24	1624%	0.000992	0.02844	0.4194	519.02	3.08	308%	0.740	0.04693	1.1	0.916	0.0076	0.124	1.048	432	3.123	312%
	Grid E	P56	190	2360	1000	800	203.6	36.1	23.2	1288	6.32	632%	0.000992	0.02844	0.4194	51.004	2.19	219%	2.360	0.04693	1.0	0.811	0.0076	0.124	0.943	122	3.378	338%
	Grid G	P65	190	2360	10390	8312	750.4	503.1	1586.1	13378	17.83	1783%	0.000992	0.02844	0.4194	5505.9	3.47	347%	0.227	0.04693	1.5	1.198	0.0076	0.124	1.330	1785	3.548	355%
	Grid 5	P70A	190	2170	790	632	88.0	27.2	23.2	1034	11.75	1175%	0.000992	0.02844	0.4194	31.831	1.37	137%	2.747	0.04693	1.0	0.811	0.0077	0.124	0.943	96	3.532	353%

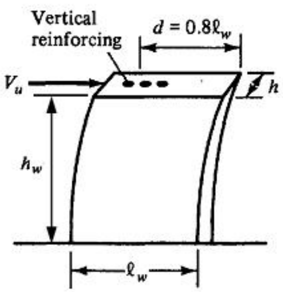
CLIENTS | PEOPLE | PERFORMANCE

Client	Christchurch City Council	Job no.	51/30596/36	Sheet	12 & 13 of 30
Project	Gloucester Courts Block A, Christchurch, New Zealand	Calcs by	MBJ	Date	11/07/2012
Subject	Masonry Wall Demand-Capacity Ratio (20 Series Masonry)	Checked by	DMC	Date	13/07/2012

Ground Floor to First Floor	Grid 5	P70B	190	2170	1390	1112	156.0	61.9	76.2	1819	11.66	1166%	0.000992	0.02844	0.4194	98.544	1.29	129%	1.561	0.04693	1.0	0.811	0.0077	0.124	0.943	169	2.735	274%
	Grid 5	P70C	190	2170	140	112	13.4	1.2	0.9	183	13.67	1367%	0.000992	0.02844	0.4194	0.9997	1.14	114%	15.500	0.04693	1.0	0.811	0.0077	0.124	0.943	17	14.210	1421%
	Grid 5	P70D	190	2170	1990	1592	117.1	72.7	152.5	2605	22.25	2225%	0.000992	0.02844	0.4194	201.98	1.32	132%	1.090	0.04693	1.0	0.811	0.0077	0.124	0.943	242	3.335	333%
	Grid 5	P70E	190	2170	140	112	13.8	1.3	0.9	183	13.28	1328%	0.000992	0.02844	0.4194	0.9997	1.1	110%	15.500	0.04693	1.0	0.811	0.0077	0.124	0.943	17	13.218	1322%
	Grid 5	P70F	190	2170	1130	904	130.9	40.5	50.8	1479	11.30	1130%	0.000992	0.02844	0.4194	65.126	1.28	128%	1.920	0.04693	1.0	0.811	0.0077	0.124	0.943	138	3.402	340%
	Grid 5	P70G	190	2170	1110	888	134.1	50.5	45.3	1453	10.84	1084%	0.000992	0.02844	0.4194	62.841	1.39	139%	1.955	0.04693	1.0	0.811	0.0077	0.124	0.943	135	2.676	268%
	Grid 5	P70H	190	2170	790	632	144.1	55.6	51.9	1034	7.18	718%	0.000992	0.02844	0.4194	31.831	0.61	61%	2.747	0.04693	1.0	0.811	0.0077	0.124	0.943	96	1.730	173%
	Grid 5	P70I	190	2170	1390	1112	130.6	40.2	50.7	1819	13.93	1393%	0.000992	0.02844	0.4194	98.544	1.94	194%	1.561	0.04693	1.0	0.811	0.0077	0.124	0.943	169	4.209	421%
	Grid 5	P70J	190	2170	140	112	12.6	1.2	0.9	183	14.54	1454%	0.000992	0.02844	0.4194	0.9997	1.15	115%	15.500	0.04693	1.0	0.811	0.0077	0.124	0.943	17	14.210	1421%
	Grid 5	P70K	190	2170	1990	1592	101.6	72.9	152.4	2605	25.64	2564%	0.000992	0.02844	0.4194	201.98	1.33	133%	1.090	0.04693	1.0	0.811	0.0077	0.124	0.943	242	3.324	332%
	Grid 5	P70L	190	2170	140	112	12.9	1.3	0.9	183	14.20	1420%	0.000992	0.02844	0.4194	0.9997	1.07	107%	15.500	0.04693	1.0	0.811	0.0077	0.124	0.943	17	13.117	1312%
	Grid 5	P70M	190	2170	1130	904	160.2	61.7	76.0	1479	9.23	923%	0.000992	0.02844	0.4194	65.126	0.86	86%	1.920	0.04693	1.0	0.811	0.0077	0.124	0.943	138	2.231	223%
	Grid 5	P70N	190	2170	1110	888	77.7	28.5	23.2	1453	18.70	1870%	0.000992	0.02844	0.4194	62.841	2.71	271%	1.955	0.04693	1.0	0.811	0.0077	0.124	0.943	135	4.737	474%
	Grid 5	P71	190	190	12590	10072	306.5	227.4	163.2	17930	58.50	5850%	0.000992	0.02844	0.4194	8084.5	49.5	4954%	0.015	0.04693	1.5	1.198	0.0084	0.124	1.331	2165	9.520	952%
	Grid 5	P71B	190	190	12590	10072	305.4	229.8	405.4	17930	58.70	5870%	0.000992	0.02844	0.4194	8084.5	19.9	1994%	0.015	0.04693	1.5	1.198	0.0084	0.124	1.331	2165	9.419	942%
	Grid 2	P80A	190	2360	790	632	96.0	18.1	18.2	1017	10.59	1059%	0.000992	0.02844	0.4194	31.831	1.75	175%	2.987	0.04693	1.0	0.811	0.0076	0.124	0.943	96	5.304	530%
	Grid 2	P80B	190	2360	1390	1112	123.5	32.2	63.6	1790	14.49	1449%	0.000992	0.02844	0.4194	98.544	1.55	155%	1.698	0.04693	1.0	0.811	0.0076	0.124	0.943	169	5.257	526%
	Grid 2	P80C	190	2360	790	632	131.1	29.8	24.8	1017	7.76	776%	0.000992	0.02844	0.4194	31.831	1.28	128%	2.987	0.04693	1.0	0.811	0.0076	0.124	0.943	96	3.225	323%
	Grid 2	P80D	190	2360	790	632	137.9	26.7	22.1	1017	7.38	738%	0.000992	0.02844	0.4194	31.831	1.44	144%	2.987	0.04693	1.0	0.811	0.0076	0.124	0.943	96	3.603	360%
	Grid 2	P80E	190	2360	1390	1112	118.9	34.8	66.1	1790	15.06	1506%	0.000992	0.02844	0.4194	98.544	1.49	149%	1.698	0.04693	1.0	0.811	0.0076	0.124	0.943	169	4.867	487%
	Grid 2	P80F	190	2360	790	632	90.8	36.8	20.4	1017	11.20	1120%	0.000992	0.02844	0.4194	31.831	1.56	156%	2.987	0.04693	1.0	0.811	0.0076	0.124	0.943	96	2.615	262%

Client	**Christchurch City Council**	Job no.	51/30596/36	Sheet	**14 & 15 of 30**
Project	**Gloucester Courts Block A, Christchurch, New Zealand**	Calcs by	MBJ	Date	**11/07/2012**
Subject	**Masonry Wall Demand-Capacity Ratio (15 Series Masonry)**	Checked by	DMC	Date	**13/07/2012**

Typical Masonry Wall Section Diagram:



Design Parameters:

f'_m =	**15.00**	MPa	: compressive strength of masonry
f_{y1} =	**430.00**	MPa	: yield strength of steel for 12mmØ and larger bars
f_{y2} =	**300.00**	MPa	: yield strength of steel for 10mmØ and smaller bars
ϕ =	**1.00**		: reduction factor for bending (NZSEE Design Manual)
ϕ =	**0.85**		: reduction factor for shear (NZSEE Design Manual)
$Ø_{b1}$ =	**12**	mm	: vertical rebar diameter
$Ø_{b2}$ =	**10**	mm	: horizontal rebar diameter
s_v =	**600**	mm	: vertical spacing of reinforcement
s_h =	**800**	mm	: horizontal spacing of reinforcement

Formulas:

$P_{Ucap} = \phi\, 0.50 f'_m A_g\, [1 - (L_n/40b)^2]$: ultimate axial capacity

$M_{Ucap} = \phi\, R_u\, b_w\, d^2$: ultimate moment capacity

$R_U = f'_m\, \omega\, (1\text{-}0.59\omega)$: coefficient of resistance

$\omega = \rho\, f_y / f'_m$

$V_{Ucap} = \phi\, v_n\, b_w\, d$: ultimate shear capacity

where, $v_n = v_m + v_p + v_s$

$v_m = (C_1 + C_2) * v_{bm}$

$v_{bm} = 0.20\sqrt{f'_m}$ = 0.77 MPa

$C_1 = 33\rho_w f_y / 300$ $\rho_w > 0.07\%$

$C_2 = 1.0$

$v_p = (0.90 P_{Ucap} \tan\theta)/(b_w\, d)$ $\leq 0.10 f'_m$ = 1.50

$v_s = C_3 A_v f_y / b_w s$ C_3 = 0.80

FOS = C / D : moment capacity of member

%NBS = FOS * 100 : Ratio of capacity over demand (Factor of Safety)

References:

NZS 4230:2004

NZSEE Manual 2006

Legend:

Ln = Clear vertical distance between lines of effective horizontal support or clear horizontal distance between lines of effective vertical support, mm (Height)

Lw = Horizontal length of wall, mm (width/length)

STOREY/LEVEL	Location	ETABS Mark	Dimensions				Design Forces (Based on Etabs Results)			Axial Strength		
			b_w (t) mm	L_n (mm)	L_w (mm)	d = $0.80L_w$ mm	P_u (kN)	V_u (kN)	M_u (kN-m)	$P_{u.cap}$ (kN)	C/D Ratio	%NBS
	Partition	P7	140	2360	3190	2552	93.7	126.3	110.4	2755	29.39	2939%
	Partition	P8	140	2360	3190	2552	95.2	127.7	120.1	2755	28.95	2895%
	Partition	P9	140	2360	3190	2552	94.4	125.0	116.7	2755	29.19	2919%
Ground Floor to First Floor	Partition	P10	140	2360	3190	2552	115.2	124.9	122.0	2755	23.91	2391%
	Partition	P11	140	2360	3190	2552	111.8	123.9	115.6	2755	24.64	2464%
	Partition	P12	140	2360	3190	2552	91.7	124.6	108.7	2755	30.03	3003%
	Partition	P13	140	2360	3190	2552	94.7	108.0	112.1	2755	29.10	2910%

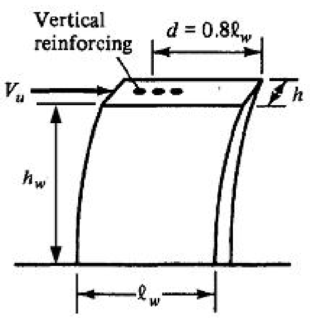
ETABS Mark	Moment Strength						Shear Strength									
	ρ	ω	R_U	$M_{u.cap}$ (kN-m)	C/D Ratio	%NBS	h_e/L_w	C_1	C_2	v_{bm}	v_p	v_s	v_n	$V_{u.cap}$ (kN)	C/D Ratio (FOS)	%NBS
P7	0.001346	0.0386	0.5658	515.85	4.672	467%	0.740	0.06368	1.1	0.929	0.0069	0.1683	1.105	335	2.657	266%
P8	0.001346	0.0386	0.5658	515.85	4.294	429%	0.740	0.06368	1.1	0.929	0.0069	0.1683	1.105	335	2.628	263%
P9	0.001346	0.0386	0.5658	515.85	4.421	442%	0.740	0.06368	1.1	0.929	0.0069	0.1683	1.105	335	2.683	268%
P10	0.001346	0.0386	0.5658	515.85	4.227	423%	0.740	0.06368	1.1	0.929	0.0069	0.1683	1.105	335	2.687	269%
P11	0.001346	0.0386	0.5658	515.85	4.463	446%	0.740	0.06368	1.1	0.929	0.0069	0.1683	1.105	335	2.708	271%
P12	0.001346	0.0386	0.5658	515.85	4.744	474%	0.740	0.06368	1.1	0.929	0.0069	0.1683	1.105	335	2.693	269%
P13	0.001346	0.0386	0.5658	515.85	4.601	460%	0.740	0.06368	1.1	0.929	0.0069	0.1683	1.105	335	3.107	311%

CLIENTS | PEOPLE | PERFORMANCE

Client	**Christchurch City Council**	Job no.	51/30596/36	Sheet	**14 & 15 of 30**
Project	**Gloucester Courts Block A, Christchurch, New Zealand**	Calcs by	MBJ	Date	**11/07/2012**
Subject	**Masonry Wall Demand-Capacity Ratio (15 Series Masonry)**	Checked by	DMC	Date	**13/07/2012**

	Partition	P14	140	2360	3190	2552	106.5	115.5	103.6	2755	25.86	2586%	0.001346	0.0386	0.5658	515.85	4.979	498%	0.740	0.06368	1.1	0.929	0.0069	0.1683	1.105	335	2.904	290%
	Stair	P15	140	2360	2040	1632	160.4	36.7	57.9	1762	10.99	1099%	0.001346	0.0386	0.5658	210.96	3.643	364%	1.157	0.06368	1.0	0.824	0.0069	0.1683	0.999	194	5.292	529%
	Stair	P16	140	2360	2020	1616	212.3	34.0	58.3	1744	8.22	822%	0.001346	0.0386	0.5658	206.85	3.547	355%	1.168	0.06368	1.0	0.824	0.0069	0.1683	0.999	192	5.650	565%
	Stair	P17	140	190	1100	880	58.9	24.1	10.4	1154	19.57	1957%	0.001346	0.0386	0.5658	61.338	5.878	588%	0.173	0.06368	1.5	1.211	0.0084	0.1683	1.388	145	6.031	603%
	Stair	P19	140	2360	1000	800	49.6	33.9	25.9	864	17.42	1742%	0.001346	0.0386	0.5658	50.693	1.961	196%	2.360	0.06368	1.0	0.824	0.0069	0.1683	0.999	95	2.804	280%
	Stair	P20	140	2360	2150	1720	242.3	71.2	121.5	1857	7.66	766%	0.001346	0.0386	0.5658	234.33	1.929	193%	1.098	0.06368	1.0	0.824	0.0069	0.1683	0.999	205	2.872	287%
	Stair	P21	140	2360	600	480	201.4	17.3	27.3	518	2.57	257%	0.001346	0.0386	0.5658	18.249	0.669	67%	3.933	0.06368	1.0	0.824	0.0069	0.1683	0.999	57	3.305	330%
	Stair	P23	140	2360	600	480	207.1	4.7	7.3	518	2.50	250%	0.001346	0.0386	0.5658	18.249	2.497	250%	3.933	0.06368	1.0	0.824	0.0069	0.1683	0.999	57	12.143	1214%
	Grid 4	P24A	140	1170	1980	1584	170.8	53.0	75.1	1988	11.64	1164%	0.001346	0.0386	0.5658	198.74	2.646	265%	0.591	0.06368	1.2	1.014	0.0081	0.1683	1.191	224	4.236	424%
	Grid 4	P24B	140	1000	9480	7584	513.2	287.6	944.4	9637	18.78	1878%	0.001346	0.0386	0.5658	4555.8	4.824	482%	0.105	0.06368	1.5	1.211	0.0082	0.1683	1.388	1252	4.354	435%
	Grid 4	P24C	140	1000	2980	2384	169.6	68.3	104.2	3029	17.87	1787%	0.001346	0.0386	0.5658	450.17	4.322	432%	0.336	0.06368	1.4	1.160	0.0082	0.1683	1.336	379	5.553	555%
	Grid 4	P25A	140	1000	400	320	22.7	20.9	10.5	407	17.90	1790%	0.001346	0.0386	0.5658	8.1108	0.77	77%	2.500	0.06368	1.0	0.824	0.0082	0.1683	1.000	38	1.826	183%
	Grid 4	P25B	140	1200	770	616	108.9	28.1	14.2	771	7.09	709%	0.001346	0.0386	0.5658	30.056	2.119	212%	1.558	0.06368	1.0	0.824	0.0081	0.1683	1.000	73	2.608	261%
	Grid 4	P25C	140	1200	130	104	43.7	2.1	1.3	130	2.98	298%	0.001346	0.0386	0.5658	0.8567	0.67	67%	9.231	0.06368	1.0	0.824	0.0081	0.1683	1.000	12	5.980	598%
	Grid 4	P25D	140	1200	2290	1832	211.2	151.3	136.2	2294	10.86	1086%	0.001346	0.0386	0.5658	265.84	1.952	195%	0.524	0.06368	1.3	1.052	0.0081	0.1683	1.229	268	1.771	177%
	Grid 4	P25E	140	1200	1340	1072	180.2	93.8	61.8	1342	7.45	745%	0.001346	0.0386	0.5658	91.024	1.472	147%	0.896	0.06368	1.0	0.841	0.0081	0.1683	1.017	130	1.383	138%
	Grid 4	P25F	140	1200	1030	824	145.4	44.7	29.7	1032	7.10	710%	0.001346	0.0386	0.5658	53.78	1.809	181%	1.165	0.06368	1.0	0.824	0.0081	0.1683	1.000	98	2.197	220%
	Grid 4	P25G	140	1200	100	80	36.7	1.0	0.6	100	2.73	273%	0.001346	0.0386	0.5658	0.5069	0.815	81%	12.000	0.06368	1.0	0.824	0.0081	0.1683	1.000	10	9.428	943%
	Grid 4	P25H	140	1200	1170	936	143.9	66.4	42.0	1172	8.15	815%	0.001346	0.0386	0.5658	69.393	1.654	165%	1.026	0.06368	1.0	0.824	0.0081	0.1683	1.000	111	1.677	168%
	Grid 3	P29	140	2360	12590	10072	502.8	946.1	808.1	10872	21.62	2162%	0.001346	0.0386	0.5658	8035.2	9.944	994%	0.187	0.06368	1.5	1.211	0.0069	0.1683	1.386	1662	1.756	176%
	Grid 3	P30	140	2360	13590	10872	537.6	1000.4	1292.7	11735	21.83	2183%	0.001346	0.0386	0.5658	9362.3	7.243	724%	0.174	0.06368	1.5	1.211	0.0069	0.1683	1.386	1794	1.793	179%
Ground Floor to First Floor	Grid 3	P31	140	190	1010	808	33.8	25.2	10.1	1059	31.38	3138%	0.001346	0.0386	0.5658	51.712	5.106	511%	0.188	0.06368	1.5	1.211	0.0084	0.1683	1.388	133	5.292	529%
	Grid B	P39	140	2360	9390	7512	620.8	386.4	801.2	8108	13.06	1306%	0.001346	0.0386	0.5658	4469.7	5.579	558%	0.251	0.06368	1.5	1.208	0.0069	0.1683	1.383	1236	3.199	320%
	Grid C	P42	140	2360	3190	2552	253.3	148.4	170.2	2755	10.87	1087%	0.001346	0.0386	0.5658	515.85	3.031	303%	0.740	0.06368	1.1	0.929	0.0069	0.1683	1.105	335	2.260	226%
	Grid C	P43	140	2360	6200	4960	435.3	244.2	313.0	5354	12.30	1230%	0.001346	0.0386	0.5658	1948.6	6.225	623%	0.381	0.06368	1.4	1.134	0.0069	0.1683	1.309	773	3.164	316%
	Grid D	P49	140	2360	7040	5632	416.3	227.1	593.6	6079	14.60	1460%	0.001346	0.0386	0.5658	2512.4	4.233	423%	0.335	0.06368	1.4	1.160	0.0069	0.1683	1.335	895	3.940	394%
	Grid D'	P50	140	2360	1000	800	89.8	38.8	20.0	864	9.61	961%	0.001346	0.0386	0.5658	50.693	2.53	253%	2.360	0.06368	1.0	0.824	0.0069	0.1683	0.999	95	2.455	245%
	Grid D'	P51	140	2360	1000	800	82.4	80.4	27.2	864	10.48	1048%	0.001346	0.0386	0.5658	50.693	1.861	186%	2.360	0.06368	1.0	0.824	0.0069	0.1683	0.999	95	1.183	118%
	Grid D'	P52	140	2360	5040	4032	298.5	152.5	391.7	4352	14.58	1458%	0.001346	0.0386	0.5658	1287.7	3.287	329%	0.468	0.06368	1.3	1.084	0.0069	0.1683	1.259	604	3.963	396%
	Grid E	P55	140	2360	6200	4960	415.9	252.3	415.5	5354	12.87	1287%	0.001346	0.0386	0.5658	1948.6	4.69	469%	0.381	0.06368	1.4	1.134	0.0069	0.1683	1.309	773	3.062	306%
	Grid F	P62	140	2360	9390	7512	648.1	359.2	830.0	8108	12.51	1251%	0.001346	0.0386	0.5658	4469.7	5.385	539%	0.251	0.06368	1.5	1.208	0.0069	0.1683	1.383	1236	3.442	344%
	Grid 2'	P81A	140	2170	140	112	18.9	0.9	0.5	125	6.62	662%	0.001346	0.0386	0.5658	0.9936	1.911	191%	15.500	0.06368	1.0	0.824	0.0072	0.1683	0.999	13	15.310	1531%
	Grid 2'	P81B	140	1170	12090	9672	661.1	525.0	1295.2	12140	18.37	1837%	0.001346	0.0386	0.5658	7409.7	5.721	572%	0.097	0.06368	1.5	1.211	0.0081	0.1683	1.388	1597	3.042	304%
	Grid 2'	P81C	140	1170	1200	960	158.0	67.3	54.9	1205	7.63	763%	0.001346	0.0386	0.5658	72.997	1.33	133%	0.975	0.06368	1.0	0.796	0.0081	0.1683	0.972	111	1.651	165%
	Grid 2'	P82A	140	2170	300	240	43.9	16.6	8.8	268	6.10	610%	0.001346	0.0386	0.5658	4.5623	0.516	52%	7.233	0.06368	1.0	0.824	0.0072	0.1683	0.999	29	1.716	172%
	Grid 2'	P82B	140	1000	2190	1752	180.1	168.7	112.9	2226	12.36	1236%	0.001346	0.0386	0.5658	243.13	2.153	215%	0.457	0.06368	1.3	1.091	0.0082	0.1683	1.267	264	1.566	157%
	Grid 2'	P82C	140	1000	1290	1032	109.0	105.2	55.0	1311	12.03	1203%	0.001346	0.0386	0.5658	84.358	1.533	153%	0.775	0.06368	1.1	0.909	0.0082	0.1683	1.086	133	1.268	127%
	Grid 2'	P82D	140	1000	540	432	73.0	45.4	23.7	549	7.52	752%	0.001346	0.0386	0.5658	14.782	0.623	62%	1.852	0.06368	1.0	0.824	0.0082	0.1683	1.000	51	1.134	113%
	Grid 2'	P82E	140	1000	1590	1272	143.6	133.0	79.1	1616	11.26	1126%	0.001346	0.0386	0.5658	128.16	1.621	162%	0.629	0.06368	1.2	0.993	0.0082	0.1683	1.169	177	1.331	133%
	Grid 2'	P82F	140	1000	930	744	81.6	66.5	38.9	945	11.58	1158%	0.001346	0.0386	0.5658	43.844	1.128	113%	1.075	0.06368	1.0	0.824	0.0082	0.1683	1.000	89	1.332	133%
	Grid 2'	P83	140	190	16150	12920	690.0	593.6	955.2	16938	24.55	2455%	0.001346	0.0386	0.5658	13222	13.84	1384%	0.012	0.06368	1.5	1.211	0.0084	0.1683	1.388	2134	3.595	359%
	Grid 3'	P87	140	190	1010	808	47.4	29.5	10.6	1059	22.37	2237%	0.001346	0.0386	0.5658	51.712	4.884	488%	0.188	0.06368	1.5	1.211	0.0084	0.1683	1.388	133	4.524	452%
	Grid 3'	P88	140	2360	1000	800	107.0	40.9	31.5	864	8.07	807%	0.001346	0.0386	0.5658	50.693	1.611	161%	2.360	0.06368	1.0	0.824	0.0069	0.1683	0.999	95	2.325	233%

Typical Masonry Wall Section Diagram:



Formulas:

$P_{Ucap} = \phi\, 0.50 f'_m A_g [1 - (L_n/40b)^2]$: ultimate axial capacity

$M_{Ucap} = \phi\, R_u\, b_w\, d^2$: ultimate moment capacity

$R_U = f'_m\, \omega\, (1\text{-}0.59\omega)$: coefficient of resistance

$\omega = \rho\, f_y / f'_m$

$V_{Ucap} = \phi\, v_n\, b_w\, d$: ultimate shear capacity

where, $v_n = v_m + v_p + v_s$

$v_m = (C_1 + C_2) * v_{bm}$

$v_{bm} = 0.20\sqrt{f'_m}$ = 0.77 MPa

$C_1 = 33\rho_w f_y / 300$ $\quad \rho_w > 0.07\%$

$C_2 = 1.0$

$v_p = (0.90 P_{Ucap} \tan\theta)/(b_w d)$ $\quad \leq 0.10 f'_m$ = 1.50

$v_s = C_3 A_v f_y / b_w s$ $\quad C_3 =$ 0.80

FOS = C / D : moment capacity of member

%NBS = FOS * 100 : Ratio of capacity over demand (Factor of Safety)

References:

NZS 4230:2004

NZSEE Manual 2006

Design Parameters:

f'_m =	15.00	MPa	: compressive strength of masonry
f_{y1} =	430.00	MPa	: yield strength of steel for 12mmØ and larger bars
f_{y2} =	300.00	MPa	: yield strength of steel for 10mmØ and smaller bars
ϕ =	1.00		: reduction factor for bending (NZSEE Design Manual)
ϕ =	0.85		: reduction factor for shear (NZSEE Design Manual)
$Ø_{b1}$ =	12	mm	: vertical rebar diameter
$Ø_{b2}$ =	10	mm	: horizontal rebar diameter
s_v =	600	mm	: vertical spacing of reinforcement
s_h =	800	mm	: horizontal spacing of reinforcement

Legend:

Ln = Clear vertical distance between lines of effective horizontal support or clear horizontal distance between lines of effective vertical support, mm (Height)

Lw = Horizontal length of wall, mm (width/length)

STOREY/LEVEL	Location	ETABS Mark	Dimensions				Design Forces (Based on Etabs Results)			Axial Strength			Moment Strength						Shear Strength									
			b_w (t) mm	L_n (mm)	L_w (mm)	d = $0.80L_w$ mm	P_u (kN)	V_u (kN)	M_u (kN-m)	$P_{u.cap}$ (kN)	C/D Ratio	%NBS	ρ	ω	R_U	$M_{u.cap}$ (kN-m)	C/D Ratio	%NBS	h_e/L_w	C_1	C_2	v_{bm}	v_p	v_s	v_n	$V_{u.cap}$ (kN)	C/D Ratio (FOS)	%NBS
First Floor to Second Floor	Grid 1	P1	140	1000	12590	10072	64.1	560.4	349.2	12798	199.66	19966%	0.001346	0.0386	0.5658	8035.2	23	2301%	0.079	0.06368	1.5	1.211	0.0082	0.168	1.388	1663	2.968	297%
	Grid 1	P2A	140	1310	850	680	42.2	135.7	107.4	844	19.97	1997%	0.001346	0.0386	0.5658	36.625	0.34	34%	1.541	0.06368	1.0	0.824	0.0080	0.168	1.000	81	0.596	60%
	Grid 1	P2B	140	1310	1390	1112	71.4	187.2	163.7	1380	19.33	1933%	0.001346	0.0386	0.5658	97.943	0.6	60%	0.942	0.06368	1.0	0.814	0.0080	0.168	0.990	131	0.700	70%
	Grid 1	P2C	140	1310	1790	1432	21.5	141.6	121.4	1777	82.79	8279%	0.001346	0.0386	0.5658	162.42	1.34	134%	0.732	0.06368	1.1	0.934	0.0080	0.168	1.110	189	1.337	134%
	Grid 1	P2D	140	1310	1390	1112	67.0	207.7	192.0	1380	20.59	2059%	0.001346	0.0386	0.5658	97.943	0.51	51%	0.942	0.06368	1.0	0.814	0.0080	0.168	0.990	131	0.631	63%
	Grid 1	P2E	140	1310	1010	808	45.7	167.2	131.0	1002	21.92	2192%	0.001346	0.0386	0.5658	51.712	0.39	39%	1.297	0.06368	1.0	0.824	0.0080	0.168	1.000	96	0.575	58%
	Grid 1	P3	140	190	12590	10072	219.0	561.3	193.3	13204	60.30	6030%	0.001346	0.0386	0.5658	8035.2	41.6	4158%	0.015	0.06368	1.5	1.211	0.0084	0.168	1.388	1664	2.964	296%

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Client	Christchurch City Council	Job no. 50/30596/36	Sheet 16 - 19 of 30
Project	Gloucester Courts Block A, Christchurch, New Zealand	Calcs by MBJ	Date 11/07/2012
Subject	Masonry Wall Demand-Capacity Ratio (15 Series Masonry)	Checked by DMC	Date 13/07/2012

	Grid 1	P4	140	1000	12590	10072	115.3	548.7	694.0	12798	110.99	11099%	0.001346	0.0386	0.5658	8035.2	11.6	1158%	0.079	0.06368	1.5	1.211	0.0082	0.168	1.388	1663	3.031	303%
	Grid 1	P5A	140	1310	850	680	36.4	133.7	101.1	844	23.18	2318%	0.001346	0.0386	0.5658	36.625	0.36	36%	1.541	0.06368	1.0	0.824	0.0080	0.168	1.000	81	0.605	61%
	Grid 1	P5B	140	1310	990	792	50.3	162.0	131.4	983	19.55	1955%	0.001346	0.0386	0.5658	49.684	0.38	38%	1.323	0.06368	1.0	0.824	0.0080	0.168	1.000	94	0.582	58%
	Grid 1	P5C	140	1310	1075	860	16.5	114.2	88.9	1067	64.55	6455%	0.001346	0.0386	0.5658	58.582	0.66	66%	1.219	0.06368	1.0	0.824	0.0080	0.168	1.000	102	0.896	90%
	Grid 1	P5D	140	1310	810	648	53.2	95.7	76.2	804	15.12	1512%	0.001346	0.0386	0.5658	33.259	0.44	44%	1.617	0.06368	1.0	0.824	0.0080	0.168	1.000	77	0.806	81%
	Grid 1	P5E	140	1310	2580	2064	99.1	305.1	301.4	2561	25.85	2585%	0.001346	0.0386	0.5658	337.43	1.12	112%	0.508	0.06368	1.3	1.062	0.0080	0.168	1.238	304	0.996	100%
	Grid 1	P6	140	190	12590	10072	282.2	531.9	370.8	13204	46.80	4680%	0.001346	0.0386	0.5658	8035.2	21.7	2167%	0.015	0.06368	1.5	1.211	0.0084	0.168	1.388	1664	3.128	313%
	Stair	P15	140	2560	2040	1632	75.2	78.9	57.2	1694	22.54	2254%	0.001346	0.0386	0.5658	210.96	3.69	369%	1.255	0.06368	1.0	0.824	0.0067	0.168	0.999	194	2.459	246%
	Stair	P16	140	2560	2020	1616	111.1	67.5	64.7	1678	15.10	1510%	0.001346	0.0386	0.5658	206.85	3.2	320%	1.267	0.06368	1.0	0.824	0.0067	0.168	0.999	192	2.846	285%
	Stair	P18	140	190	1100	880	40.8	34.2	7.0	1154	28.26	2826%	0.001346	0.0386	0.5658	61.338	8.77	877%	0.173	0.06368	1.5	1.211	0.0084	0.168	1.388	145	4.250	425%
	Partition	P19	140	2560	1000	800	27.0	48.6	26.8	831	30.78	3078%	0.001346	0.0386	0.5658	50.693	1.89	189%	2.560	0.06368	1.0	0.824	0.0067	0.168	0.999	95	1.955	196%
	Partition	P20	140	2560	2150	1720	136.6	103.3	73.4	1786	13.08	1308%	0.001346	0.0386	0.5658	234.33	3.19	319%	1.191	0.06368	1.0	0.824	0.0067	0.168	0.999	204	1.980	198%
	Partition	P22	140	2560	600	480	98.3	10.4	37.9	498	5.07	507%	0.001346	0.0386	0.5658	18.249	0.48	48%	4.267	0.06368	1.0	0.824	0.0067	0.168	0.999	57	5.470	547%
	Partition	P23	140	2560	600	480	104.5	11.8	16.8	498	4.77	477%	0.001346	0.0386	0.5658	18.249	1.09	109%	4.267	0.06368	1.0	0.824	0.0067	0.168	0.999	57	4.823	482%
	Grid 4	P26A	140	1000	2870	2296	122.9	93.3	92.8	2917	23.75	2375%	0.001346	0.0386	0.5658	417.55	4.5	450%	0.348	0.06368	1.4	1.152	0.0082	0.168	1.329	363	3.891	389%
	Grid 4	P26B	140	1000	7890	6312	293.1	196.6	439.4	8020	27.36	2736%	0.001346	0.0386	0.5658	3155.7	7.18	718%	0.127	0.06368	1.5	1.211	0.0082	0.168	1.388	1042	5.303	530%
	Grid 4	P26C	140	2370	570	456	63.5	20.3	17.4	491	7.73	773%	0.001346	0.0386	0.5658	16.47	0.94	94%	4.158	0.06368	1.0	0.824	0.0069	0.168	0.999	54	2.677	268%
	Grid 4	P27A	140	1310	970	776	34.7	49.3	40.3	963	27.72	2772%	0.001346	0.0386	0.5658	47.697	1.18	118%	1.351	0.06368	1.0	0.824	0.0080	0.168	1.000	92	1.873	187%
First Floor to Second Floor	Grid 4	P27B	140	1310	890	712	56.6	53.2	37.5	883	15.60	1560%	0.001346	0.0386	0.5658	40.154	1.07	107%	1.472	0.06368	1.0	0.824	0.0080	0.168	1.000	85	1.592	159%
	Grid 4	P27C	140	1310	1340	1072	95.6	74.8	78.6	1330	13.92	1392%	0.001346	0.0386	0.5658	91.024	1.16	116%	0.978	0.06368	1.0	0.794	0.0080	0.168	0.970	124	1.654	165%
	Grid 4	P27D	140	1310	1340	1072	65.6	72.8	106.1	1330	20.27	2027%	0.001346	0.0386	0.5658	91.024	0.86	86%	0.978	0.06368	1.0	0.794	0.0080	0.168	0.970	124	1.700	170%
	Grid 4	P27E	140	1310	1590	1272	101.8	85.0	92.7	1578	15.51	1551%	0.001346	0.0386	0.5658	128.16	1.38	138%	0.824	0.06368	1.1	0.882	0.0080	0.168	1.058	160	1.884	188%
	Grid 4	P28A	140	190	6620	5296	119.9	192.3	258.5	6943	57.91	5791%	0.001346	0.0386	0.5658	2221.6	8.59	859%	0.029	0.06368	1.5	1.211	0.0084	0.168	1.388	875	4.548	455%
	Grid 4	P28B	140	190	4570	3656	139.1	86.1	36.8	4793	34.45	3445%	0.001346	0.0386	0.5658	1058.7	28.8	2877%	0.042	0.06368	1.5	1.211	0.0084	0.168	1.388	604	7.014	701%
	Grid 3	P32	140	1000	1010	808	48.3	70.3	37.9	1027	21.28	2128%	0.001346	0.0386	0.5658	51.712	1.36	136%	0.990	0.06368	1.0	0.787	0.0082	0.168	0.963	93	1.318	132%
	Grid 3	P33	140	2560	1000	800	69.3	65.7	13.2	831	11.98	1198%	0.001346	0.0386	0.5658	50.693	3.85	385%	2.560	0.06368	1.0	0.824	0.0067	0.168	0.999	95	1.447	145%
	Grid 3	P34	140	190	1010	808	16.9	69.1	11.5	1059	62.61	6261%	0.001346	0.0386	0.5658	51.712	4.49	449%	0.188	0.06368	1.5	1.211	0.0084	0.168	1.388	133	1.933	193%
	Grid A	P36	140	1000	10390	8312	492.3	311.6	959.3	10562	21.46	2146%	0.001346	0.0386	0.5658	5472.4	5.7	570%	0.096	0.06368	1.5	1.211	0.0082	0.168	1.388	1373	4.405	440%
	Grid A	P37A	140	1310	1530	1224	80.1	67.1	74.2	1519	18.96	1896%	0.001346	0.0386	0.5658	118.67	1.6	160%	0.856	0.06368	1.1	0.863	0.0080	0.168	1.039	151	2.256	226%
	Grid A	P37B	140	1310	1140	912	66.8	74.4	63.1	1131	16.94	1694%	0.001346	0.0386	0.5658	65.88	1.04	104%	1.149	0.06368	1.0	0.824	0.0080	0.168	1.000	109	1.460	146%
	Grid A	P37C	140	1310	2140	1712	119.8	140.6	148.8	2124	17.73	1773%	0.001346	0.0386	0.5658	232.15	1.56	156%	0.612	0.06368	1.2	1.002	0.0080	0.168	1.178	240	1.708	171%
	Grid A	P37D	140	1310	1500	1200	126.3	73.6	59.0	1489	11.79	1179%	0.001346	0.0386	0.5658	114.06	1.93	193%	0.873	0.06368	1.0	0.853	0.0080	0.168	1.030	147	1.997	200%
	Grid A	P38	140	190	10390	8312	224.1	316.9	74.0	10897	48.63	4863%	0.001346	0.0386	0.5658	5472.4	74	7396%	0.018	0.06368	1.5	1.211	0.0084	0.168	1.388	1373	4.332	433%
	Grid B	P40	140	2560	1740	1392	206.8	46.5	72.4	1445	6.99	699%	0.001346	0.0386	0.5658	153.48	2.12	212%	1.471	0.06368	1.0	0.824	0.0067	0.168	0.999	165	3.555	356%
	Grid B	P41	140	2560	1790	1432	183.4	30.1	76.8	1487	8.11	811%	0.001346	0.0386	0.5658	162.42	2.12	212%	1.430	0.06368	1.0	0.824	0.0067	0.168	0.999	170	5.648	565%
	Grid C	P45	140	1000	4330	3464	199.5	235.0	314.1	4402	22.07	2207%	0.001346	0.0386	0.5658	950.43	3.03	303%	0.231	0.06368	1.5	1.211	0.0082	0.168	1.388	572	2.434	243%
	Grid C	P46	140	1000	4960	3968	315.4	267.6	489.3	5042	15.99	1599%	0.001346	0.0386	0.5658	1247.1	2.55	255%	0.202	0.06368	1.5	1.211	0.0082	0.168	1.388	655	2.449	245%
	Grid C	P47A	140	1310	300	240	10.1	8.9	5.8	298	29.54	2954%	0.001346	0.0386	0.5658	4.5623	0.78	78%	4.367	0.06368	1.0	0.824	0.0080	0.168	1.000	29	3.210	321%

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Client	Christchurch City Council	Job no.	50/30596/36	Sheet 16 - 19 of 30
Project	Gloucester Courts Block A, Christchurch, New Zealand	Calcs by	MBJ	Date 11/07/2012
Subject	Masonry Wall Demand-Capacity Ratio (15 Series Masonry)	Checked by	DMC	Date 13/07/2012

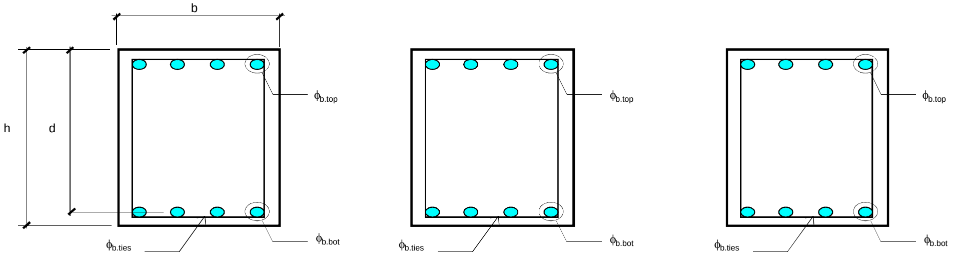
	Grid C	P47B	140	1310	3520	2816	158.8	223.3	211.3	3494	22.00	2200%	0.001346	0.0386	0.5658	628.1	2.97	297%	0.372	0.06368	1.4	1.139	0.0080	0.168	1.315	441	1.974	197%
	Grid C	P48	140	190	10390	8312	306.2	474.5	317.4	10897	35.58	3558%	0.001346	0.0386	0.5658	5472.4	17.2	1724%	0.018	0.06368	1.5	1.211	0.0084	0.168	1.388	1373	2.893	289%
	Grid D	P49	140	2560	7040	5632	215.0	540.1	612.4	5847	27.20	2720%	0.001346	0.0386	0.5658	2512.4	4.1	410%	0.364	0.06368	1.4	1.144	0.0067	0.168	1.319	884	1.636	164%
	Grid D'	P50	140	2370	1000	800	45.5	35.1	29.4	862	18.96	1896%	0.001346	0.0386	0.5658	50.693	1.72	172%	2.370	0.06368	1.0	0.824	0.0069	0.168	0.999	95	2.712	271%
	Grid D'	P52	140	2370	5040	4032	174.4	323.7	549.4	4344	24.91	2491%	0.001346	0.0386	0.5658	1287.7	2.34	234%	0.470	0.06368	1.3	1.083	0.0069	0.168	1.258	604	1.865	186%
	Grid D'	P53	140	190	7040	5632	113.3	355.8	106.7	7383	65.17	6517%	0.001346	0.0386	0.5658	2512.4	23.6	2355%	0.027	0.06368	1.5	1.211	0.0084	0.168	1.388	930	2.615	261%
	Grid E	P57	140	2370	300	240	9.2	9.9	6.5	259	28.20	2820%	0.001346	0.0386	0.5658	4.5623	0.7	70%	7.900	0.06368	1.0	0.824	0.0069	0.168	0.999	29	2.885	289%
	Grid E	P58	140	1000	710	568	57.2	47.6	26.9	722	12.61	1261%	0.001346	0.0386	0.5658	25.554	0.95	95%	1.408	0.06368	1.0	0.824	0.0082	0.168	1.000	68	1.421	142%
	Grid E	P59	140	2370	2380	1904	102.8	166.4	140.5	2051	19.95	1995%	0.001346	0.0386	0.5658	287.14	2.04	204%	0.996	0.06368	0.9	0.784	0.0069	0.168	0.959	217	1.306	131%
	Grid E	P60	140	2370	6170	4936	366.8	491.6	897.2	5318	14.50	1450%	0.001346	0.0386	0.5658	1929.8	2.15	215%	0.384	0.06368	1.4	1.132	0.0069	0.168	1.307	768	1.562	156%
	Grid E	P61	140	190	10390	8312	300.3	667.1	262.8	10897	36.29	3629%	0.001346	0.0386	0.5658	5472.4	20.8	2083%	0.018	0.06368	1.5	1.211	0.0084	0.168	1.388	1373	2.058	206%
	Grid F	P63	140	2560	1740	1392	249.0	57.1	119.1	1445	5.80	580%	0.001346	0.0386	0.5658	153.48	1.29	129%	1.471	0.06368	1.0	0.824	0.0067	0.168	0.999	165	2.896	290%
	Grid F	P64	140	2560	1790	1432	196.5	44.3	105.3	1487	7.57	757%	0.001346	0.0386	0.5658	162.42	1.54	154%	1.430	0.06368	1.0	0.824	0.0067	0.168	0.999	170	3.845	385%
	Grid G	P66	140	1000	7280	5824	117.0	62.2	169.8	7400	63.26	6326%	0.001346	0.0386	0.5658	2686.6	15.8	1582%	0.137	0.06368	1.5	1.211	0.0082	0.168	1.388	962	15.452	1545%
	Grid G	P67A	140	1310	1530	1224	42.0	20.3	27.2	1519	36.14	3614%	0.001346	0.0386	0.5658	118.67	4.37	437%	0.856	0.06368	1.1	0.863	0.0080	0.168	1.039	151	7.469	747%
	Grid G	P67B	140	1310	1140	912	8.5	12.2	12.7	1131	133.27	13327%	0.001346	0.0386	0.5658	65.88	5.18	518%	1.149	0.06368	1.0	0.824	0.0080	0.168	1.000	109	8.919	892%
	Grid G	P67C	140	1310	2140	1712	14.6	55.0	57.4	2124	145.68	14568%	0.001346	0.0386	0.5658	232.15	4.04	404%	0.612	0.06368	1.2	1.002	0.0080	0.168	1.178	240	4.368	437%
	Grid G	P68	140	2370	1500	1200	170.1	41.5	42.1	1293	7.60	760%	0.001346	0.0386	0.5658	114.06	2.71	271%	1.580	0.06368	1.0	0.824	0.0069	0.168	0.999	143	3.435	343%
First Floor to Second Floor	Grid G	P69	140	190	10390	8312	8.3	67.6	51.5	10897	1309.73	130973%	0.001346	0.0386	0.5658	5472.4	106	10624%	0.018	0.06368	1.5	1.211	0.0084	0.168	1.388	1373	20.297	2030%
	Grid 5	P72	140	1000	3180	2544	146.7	93.1	97.0	3233	22.04	2204%	0.001346	0.0386	0.5658	512.62	5.28	528%	0.314	0.06368	1.4	1.172	0.0082	0.168	1.348	408	4.385	438%
	Grid 5	P72B	140	1000	3240	2592	120.1	82.6	148.5	3294	27.41	2741%	0.001346	0.0386	0.5658	532.15	3.58	358%	0.309	0.06368	1.5	1.175	0.0082	0.168	1.351	417	5.049	505%
	Grid 5	P73	140	1500	790	632	56.4	67.4	46.4	770	13.64	1364%	0.001346	0.0386	0.5658	31.637	0.68	68%	1.899	0.06368	1.0	0.824	0.0078	0.168	1.000	75	1.116	112%
	Grid 5	P73B	140	1310	1190	952	41.6	64.3	63.0	1181	28.37	2837%	0.001346	0.0386	0.5658	71.786	1.14	114%	1.101	0.06368	1.0	0.824	0.0080	0.168	1.000	113	1.762	176%
	Grid 5	P74	140	1500	400	320	60.8	21.7	15.1	390	6.41	641%	0.001346	0.0386	0.5658	8.1108	0.54	54%	3.750	0.06368	1.0	0.824	0.0078	0.168	1.000	38	1.758	176%
	Grid 5	P74B	140	1310	300	240	47.6	17.7	12.0	298	6.26	626%	0.001346	0.0386	0.5658	4.5623	0.38	38%	4.367	0.06368	1.0	0.824	0.0080	0.168	1.000	29	1.618	162%
	Grid 5	P75	140	1000	3240	2592	118.7	97.8	128.3	3294	27.74	2774%	0.001346	0.0386	0.5658	532.15	4.15	415%	0.309	0.06368	1.5	1.175	0.0082	0.168	1.351	417	4.262	426%
	Grid 5	P75B	140	1000	3180	2544	132.9	76.9	115.6	3233	24.32	2432%	0.001346	0.0386	0.5658	512.62	4.43	443%	0.314	0.06368	1.4	1.172	0.0082	0.168	1.348	408	5.309	531%
	Grid 5	P76	140	1500	320	256	51.3	21.2	14.4	312	6.08	608%	0.001346	0.0386	0.5658	5.1909	0.36	36%	4.688	0.06368	1.0	0.824	0.0078	0.168	1.000	30	1.438	144%
	Grid 5	P76B	140	1310	470	376	86.2	24.0	17.0	466	5.41	541%	0.001346	0.0386	0.5658	11.198	0.66	66%	2.787	0.06368	1.0	0.824	0.0080	0.168	1.000	45	1.864	186%
	Grid 5	P77	140	1500	1110	888	35.2	75.1	62.1	1082	30.70	3070%	0.001346	0.0386	0.5658	62.458	1.01	101%	1.351	0.06368	1.0	0.824	0.0078	0.168	1.000	106	1.407	141%
	Grid 5	P77B	140	1310	790	632	60.4	60.2	42.4	784	12.98	1298%	0.001346	0.0386	0.5658	31.637	0.75	75%	1.658	0.06368	1.0	0.824	0.0080	0.168	1.000	75	1.250	125%
	Grid 4	P78	140	190	12590	10072	600.7	389.3	529.5	13204	21.98	2198%	0.001346	0.0386	0.5658	8035.2	15.2	1518%	0.015	0.06368	1.5	1.211	0.0084	0.168	1.388	1664	4.273	427%
	Grid 5	P79A	140	190	3180	2544	88.1	73.8	62.9	3335	37.87	3787%	0.001346	0.0386	0.5658	512.62	8.15	815%	0.060	0.06368	1.5	1.211	0.0084	0.168	1.388	420	5.697	570%
	Grid 5	P79B	140	190	3240	2592	62.9	85.9	92.9	3398	54.03	5403%	0.001346	0.0386	0.5658	532.15	5.73	573%	0.059	0.06368	1.5	1.211	0.0084	0.168	1.388	428	4.984	498%
	Grid 5	P79C	140	190	3240	2592	61.6	85.4	79.6	3398	55.18	5518%	0.001346	0.0386	0.5658	532.15	6.68	668%	0.059	0.06368	1.5	1.211	0.0084	0.168	1.388	428	5.011	501%
	Grid 5	P79D	140	190	3180	2544	144.3	51.9	57.5	3335	23.12	2312%	0.001346	0.0386	0.5658	512.62	8.91	891%	0.060	0.06368	1.5	1.211	0.0084	0.168	1.388	420	8.093	809%
	Grid 2'	P84A	140	1060	2050	1640	117.5	74.1	101.2	2075	17.66	1766%	0.001346	0.0386	0.5658	213.04	2.11	211%	0.517	0.06368	1.3	1.056	0.0081	0.168	1.233	241	3.247	325%
	Grid 2'	P84B	140	1060	13050	10440	417.8	594.3	1075.8	13212	31.62	3162%	0.001346	0.0386	0.5658	8633.1	8.03	803%	0.081	0.06368	1.5	1.211	0.0081	0.168	1.388	1724	2.901	290%
	Grid 2'	P85A	140	1310	1040	832	33.0	65.6	57.5	1032	31.27	3127%	0.001346	0.0386	0.5658	54.829	0.95	95%	1.260	0.06368	1.0	0.824	0.0080	0.168	1.000	99	1.510	151%
	Grid 2'	P85B	140	1310	400	320	26.9	29.6	19.7	397	14.78	1478%	0.001346	0.0386	0.5658	8.1108	0.41	41%	3.275	0.06368	1.0	0.824	0.0080	0.168	1.000	38	1.287	129%

GHD CLIENTS | PEOPLE | PERFORMANCE

Client	**Christchurch City Council**	Job no.	50/30596/36	Sheet	**16 - 19 of 30**
Project	**Gloucester Courts Block A, Christchurch, New Zealand**	Calcs by	MBJ	Date	**11/07/2012**
Subject	**Masonry Wall Demand-Capacity Ratio (15 Series Masonry)**	Checked by	DMC	Date	**13/07/2012**

First Floor to Second Floor	Grid 2'	P85C	140	1310	940	752	57.1	55.6	52.2	933	16.35	1635%	0.001346	0.0386	0.5658	44.792	0.86	86%	1.394	0.06368	1.0	0.824	0.0080	0.168	1.000	90	1.609	161%
	Grid 2'	P85D	140	1310	1690	1352	63.1	153.5	156.9	1677	26.57	2657%	0.001346	0.0386	0.5658	144.78	0.92	92%	0.775	0.06368	1.1	0.909	0.0080	0.168	1.086	175	1.138	114%
	Grid 2'	P85E	140	1310	540	432	23.7	63.7	44.1	536	22.58	2258%	0.001346	0.0386	0.5658	14.782	0.34	34%	2.426	0.06368	1.0	0.824	0.0080	0.168	1.000	51	0.807	81%
	Grid 2'	P85F	140	1310	1590	1272	54.3	152.2	135.7	1578	29.05	2905%	0.001346	0.0386	0.5658	128.16	0.94	94%	0.824	0.06368	1.1	0.882	0.0080	0.168	1.058	160	1.052	105%
	Grid 2'	P85G	140	1310	930	744	45.9	91.3	74.3	923	20.10	2010%	0.001346	0.0386	0.5658	43.844	0.59	59%	1.409	0.06368	1.0	0.824	0.0080	0.168	1.000	89	0.970	97%
	Grid 2'	P85H	140	1310	300	240	20.4	17.7	11.6	298	14.63	1463%	0.001346	0.0386	0.5658	4.5623	0.39	39%	4.367	0.06368	1.0	0.824	0.0080	0.168	1.000	29	1.618	162%
	Grid 2'	P85I	140	1310	410	328	24.5	36.1	24.6	407	16.64	1664%	0.001346	0.0386	0.5658	8.5214	0.35	35%	3.195	0.06368	1.0	0.824	0.0080	0.168	1.000	39	1.081	108%
	Grid 2'	P86	140	190	16150	12920	284.6	669.9	128.0	16938	59.51	5951%	0.001346	0.0386	0.5658	13222	103	10329%	0.012	0.06368	1.5	1.211	0.0084	0.168	1.388	2134	3.186	319%
	Grid 3'	P89	140	1060	1010	808	52.9	77.5	45.4	1023	19.33	1933%	0.001346	0.0386	0.5658	51.712	1.14	114%	1.050	0.06368	1.0	0.824	0.0081	0.168	1.000	96	1.241	124%
	Grid 3'	P90	140	2560	1000	800	55.9	43.7	8.3	831	14.87	1487%	0.001346	0.0386	0.5658	50.693	6.13	613%	2.560	0.06368	1.0	0.824	0.0067	0.168	0.999	95	2.178	218%
	Grid 3'	P91	140	190	1010	808	21.6	76.8	7.7	1059	49.09	4909%	0.001346	0.0386	0.5658	51.712	6.71	671%	0.188	0.06368	1.5	1.211	0.0084	0.168	1.388	133	1.738	174%

Typical Beam Section Diagram:



@ left-end support　　@ center　　@ right-end support

Design Parameters:

f'c =	30.00	MPa	: compressive strength of concrete
fy =	430.00	MPa	: yield strength of steel in bending
fy =	300.00	MPa	: yield strength of steel in shear
cover end=			: concrete cover
ϕ =	1.00		: reduction factor for bending (NZSEE Design Manual)
ϕ =	0.85		: reduction factor for bending (NZS 3101)

Formulas:

$d = h - c - \Phi_V - \Phi_b/2$: distance from extreme comp. fiber to centroid of tension reinf.

$a = A_s{*}f_y/(0.85{*}f'_c{*}b)$: depth of equivalent stress block

$\phi M = \phi * A_s * f_y * (d - a/2)$: moment capacity of member

FOS = C / D : Ratio of capacity over demand (Factor of Safety)

%NBS = FOS * 100

STOREY/LEVEL	Beam Location	ETABS Mark	Beam Forces Location	Dimension									Design Forces (Based on Etabs Results)			FLEXURAL STRENGTH – Provided Top Bars						FLEXURAL STRENGTH – Provided Bottom Bars						Shear Strength						
				b mm	h mm	ϕ_V mm	dt mm	db mm	ct mm	cb mm	at mm	ab mm	$M_{u.top}$ (kN-m)	$M_{u.bottom}$ (kN-m)	Vu (kN)	n_{prov}	Φ_b mm	A_s (mm^2)	$M_{u.cap}$ (kN-m)	C/D Ratio (FOS)	%NBS	n_{prov}	Φ_b mm	A_s (mm^2)	$M_{u.cap}$ (kN-m)	C/D Ratio (FOS)	%NBS	No. of Legs	Spacing	Vc (kN)	Vs (kN)	Vu (kN)	C/D Ratio (FOS)	%NBS
Second Floor	Grid B	B58	@ left end	200	500	6	463	461	25	25	10	17	-	19.6	19.00	1	12	113.097	22.10	-	-	1	16	201.062	39.30	2.009	201%	1	600	101.44	0.01	86.23	4.539	454%
			@center	200	500	6	463	461	25	25	10	17	17.14	37.1	82.91	1	12	113.097	22.10	1.289	129%	1	16	201.062	39.30	1.059	106%	1	600	101.44	0.01	86.23	1.040	104%
			@ right end	200	500	6	463	461	25	25	10	17	0.00	-	82.32	1	12	113.097	22.10			1	16	201.062	39.30	-	-	1	600	101.44	0.01	86.23	1.048	105%
	Grid B	B59	@ left end	200	500	6	463	461	25	25	10	17	0.00	-	1.26	1	12	113.097	22.10			1	16	201.062	39.30	-	-	1	600	101.44	0.01	86.23	68.440	6844%
			@center	200	500	6	463	461	25	25	10	17	0.58	3.0	4.92	1	12	113.097	22.10	38.045	3805%	1	16	201.062	39.30	13.312	1331%	1	600	101.44	0.01	86.23	17.527	1753%
			@ right end	200	500	6	463	461	25	25	10	17	0.00	-	5.77	1	12	113.097	22.10			1	16	201.062	39.30	-	-	1	600	101.44	0.01	86.23	14.945	1495%
	Grid B	B60	@ left end	200	500	6	463	461	25	25	10	17	-	0.0	21.72	1	12	113.097	22.10	-	-	1	16	201.062	39.30			1	600	101.44	0.01	86.23	3.970	397%
			@center	200	500	6	463	461	25	25	10	17	-	16.9	20.56	1	12	113.097	22.10	-	-	1	16	201.062	39.30	2.322	232%	1	600	101.44	0.01	86.23	4.194	419%
			@ right end	200	500	6	463	461	25	25	10	17	0.00	-	9.87	1	12	113.097	22.10			1	16	201.062	39.30	-	-	1	600	101.44	0.01	86.23	8.737	874%
	Grid F	B63	@ left end	200	500	6	463	461	25	25	10	17	-	33.8	15.28	1	12	113.097	22.10	-	-	1	16	201.062	39.30	1.162	116%	1	600	101.44	0.01	86.23	5.644	564%
			@center	200	500	6	463	461	25	25	10	17	15.66	47.0	104.00	1	12	113.097	22.10	1.411	141%	1	16	201.062	39.30	0.837	84%	1	600	101.44	0.01	86.23	0.829	83%
			@ right end	200	500	6	463	461	25	25	10	17	-	0.0	103.58	1	12	113.097	22.10	-	-	1	16	201.062	39.30			1	600	101.44	0.01	86.23	0.833	83%
	Grid F	B64	@ left end	200	500	6	463	461	25	25	10	17	-	0.0	3.66	1	12	113.097	22.10	-	-	1	16	201.062	39.30			1	600	101.44	0.01	86.23	23.561	2356%
			@center	200	500	6	463	461	25	25	10	17	6.36	5.3	26.49	1	12	113.097	22.10	-	-	1	16	201.062	39.30	7.362	736%	1	600	101.44	0.01	86.23	3.255	326%
			@ right end	200	500	6	463	461	25	25	10	17	0.00	-	26.01	1	12	113.097	22.10			1	16	201.062	39.30	-	-	1	600	101.44	0.01	86.23	3.315	332%
	Grid F	B65	@ left end	200	500	6	463	461	25	25	10	17	-	0.0	11.12	1	12	113.097	22.10	-	-	1	16	201.062	39.30			1	600	101.44	0.01	86.23	7.755	775%
			@center	200	500	6	463	461	25	25	10	17	-	16.5	20.02	1	12	113.097	22.10	-	-	1	16	201.062	39.30	2.385	238%	1	600	101.44	0.01	86.23	4.307	431%
			@ right end	200	500	6	463	461	25	25	10	17	0.00	-	21.18	1	12	113.097	22.10			1	16	201.062	39.30	-	-	1	600	101.44	0.01	86.23	4.072	407%

STOREY/LEVEL	Beam Location	ETABS Mark	Beam Forces Location	Dimension b mm	h mm	ϕ_V mm	dt mm	db mm	ct mm	cb mm	at mm	ab mm	Design Forces (Based on Etabs Results) $M_{u.top}$ (kN-m)	$M_{u.bottom}$ (kN-m)	Vu (kN)	FLEXURAL STRENGTH: Provided Top Bars n_{prov}	Φ_b mm	A_s (mm^2)	$M_{u.cap}$ (kN-m)	C/D Ratio (FOS)	%NBS	Provided Bottom Bars n_{prov}	Φ_b mm	A_s (mm^2)	$M_{u.cap}$ (kN-m)	C/D Ratio (FOS)	%NBS	Shear Strength: No. of Legs	Spacing	Vc (kN)	Vs (kN)	Vu (kN)	C/D Ratio (FOS)	%NBS
Second Floor	Grid 3	B118	@ left end	120	200	6	161	161	25	25	28	28	0.13	0.3	0.63	1	16	201.062	12.70	96.198	9620%	1	16	201.062	12.70	37.792	3779%	1	600	21.16	0.01	18.00	28.574	2857%
			@center	120	200	6	161	161	25	25	28	28	0.50	-	3.14	1	16	201.062	12.70	25.195	2519%	1	16	201.062	12.70	-	-	1	600	21.16	0.01	18.00	5.733	573%
			@ right end	120	200	6	161	161	25	25	28	28	3.02	-	6.92	1	16	201.062	12.70	4.207	421%	1	16	201.062	12.70	-	-	1	600	21.16	0.01	18.00	2.601	260%
	Grid 3'	B120	@ left end	120	200	6	161	161	25	25	28	28	0.64	-	4.94	1	16	201.062	12.70	19.966	1997%	1	16	201.062	12.70	-	-	1	600	21.16	0.01	18.00	3.644	364%
			@center	120	200	6	161	161	25	25	28	28	0.03	0.3	1.54	1	16	201.062	12.70	437.867	43787%	1	16	201.062	12.70	48.466	4847%	1	600	21.16	0.01	18.00	11.689	1169%
			@ right end	120	200	6	161	161	25	25	28	28	2.14	-	8.01	1	16	201.062	12.70	5.928	593%	1	16	201.062	12.70	-	-	1	600	21.16	0.01	18.00	2.247	225%
	Grid C-D	B142	@ left end	100	150	6	113	113	25	25	19	19	1.33	-	2.37	1	12	113.097	5.03	3.778	378%	1	12	113.097	5.03	-	-	1	600	12.38	0.01	10.53	4.445	444%
			@center	100	150	6	113	113	25	25	19	19	0.55	0.6	2.22	1	12	113.097	5.03	9.165	917%	1	12	113.097	5.03	8.471	847%	1	600	12.38	0.01	10.53	4.745	474%
			@ right end	100	150	6	113	113	25	25	19	19	0.00	-	0.16	1	12	113.097	5.03			1	12	113.097	16.83	-	-	1	600	12.38	0.01	10.53	65.836	6584%
	Grid C-D	B143	@ left end	100	400	6	363	361	25	25	19	34	0.00	-	3.94	1	12	113.097	16.83			1	16	201.062	29.92	-	-	1	600	39.76	0.01	33.81	8.582	858%
			@center	100	400	6	363	361	25	25	19	34	10.47	11.0	19.75	1	12	113.097	16.83	1.607	161%	1	16	201.062	29.92	2.720	272%	1	600	39.76	0.01	33.81	1.712	171%
			@ right end	100	400	6	363	361	25	25	19	34	2.75	-	0.32	1	12	113.097	16.83	6.122	612%	1	16	201.062	29.92	-	-	1	600	39.76	0.01	33.81	105.662	10566%
	Grid C-D	B146	@ left end	100	400	6	363	361	25	25	19	34	0.00	-	1.54	1	12	113.097	16.83			1	16	201.062	29.92	-	-	1	600	39.76	0.01	33.81	21.956	2196%
			@center	100	400	6	363	361	25	25	19	34	17.05	8.9	23.12	1	12	113.097	16.83	0.987	99%	1	16	201.062	29.92	3.365	336%	1	600	39.76	0.01	33.81	1.462	146%
			@ right end	100	400	6	363	361	25	25	19	34	0.09	-	0.05	1	12	113.097	16.83	184.933	18493%	1	16	201.062	8.95	-	-	1	600	39.76	0.01	33.81	676.240	67624%
	grid C-D	B147	@ left end	100	150	6	113	113	25	25	19	19	0.59	-	1.97	1	12	113.097	5.03	8.586	859%	1	12	113.097	5.03	-	-	1	600	12.38	0.01	10.53	5.347	535%
			@center	100	150	6	113	113	25	25	19	19	0.25	0.7	1.78	1	12	113.097	5.03	20.289	2029%	1	12	113.097	5.03	7.077	708%	1	600	12.38	0.01	10.53	5.918	592%
			@ right end	100	150	6	113	113	25	25	19	19	-	0.0	0.43	1	12	113.097	5.03	-	-	1	12	113.097	5.03			1	600	12.38	0.01	10.53	24.497	2450%
	Grid 5	B154	@ left end	200	500	6	463	461	25	25	10	17	0.00	-	16.97	1	12	113.097	22.10			1	16	201.062	39.30	-	-	1	600	101.44	0.01	86.23	5.082	508%
			@center	200	500	6	463	461	25	25	10	17	13.11	11.4	104.00	1	12	113.097	22.10	1.687	169%	1	16	201.062	39.30	3.445	344%	1	600	101.44	0.01	86.23	0.829	83%
			@ right end	200	500	6	463	461	25	25	10	17	13.11	11.4	104.00	1	12	113.097	22.10	1.687	169%	1	16	201.062	39.30	-	-	1	600	101.44	0.01	86.23	0.829	83%
	Grid 5	B155	@ left end	200	500	6	463	461	25	25	10	17	13.11	11.4	104.00	1	12	113.097	22.10	1.687	169%	1	16	201.062	39.30	-	-	1	600	101.44	0.01	86.23	0.829	83%
			@center	200	500	6	463	461	25	25	10	17	13.11	11.4	104.00	1	12	113.097	22.10	1.687	169%	1	16	201.062	39.30	3.445	344%	1	600	101.44	0.01	86.23	0.829	83%
			@ right end	200	500	6	463	461	25	25	10	17	0.00	-	15.76	1	12	113.097	22.10			1	16	201.062	39.30	-	-	1	600	101.44	0.01	86.23	5.472	547%
	Grid 5	B156	@ left end	200	500	6	463	461	25	25	10	17	0.00	-	13.93	1	12	113.097	22.10			1	16	201.062	39.30	-	-	1	600	101.44	0.01	86.23	6.191	619%
			@center	200	500	6	463	461	25	25	10	17	9.23	8.5	18.53	1	12	113.097	22.10	2.395	240%	1	16	201.062	39.30	4.598	460%	1	600	101.44	0.01	86.23	4.654	465%
			@ right end	200	500	6	463	461	25	25	10	17	9.23	8.7	18.53	1	12	113.097	22.10	-	-	1	16	201.062	39.30	4.520	452%	1	600	101.44	0.01	86.23	4.654	465%
	Grid 5	B157	@ left end	200	500	6	463	461	25	25	10	17	9.23	8.7	18.53	1	12	113.097	22.10	-	-	1	16	201.062	39.30	4.520	452%	1	600	101.44	0.01	86.23	4.654	465%
			@center	200	500	6	463	461	25	25	10	17	9.23	8.7	18.53	1	12	113.097	22.10	2.395	240%	1	16	201.062	39.30	4.520	452%	1	600	101.44	0.01	86.23	4.654	465%
			@ right end	200	500	6	463	461	25	25	10	17	0.00	-	11.83	1	12	113.097	22.10			1	16	201.062	8.95	-	-	1	600	101.44	0.01	86.23	7.289	729%

STOREY/LEVEL	Beam Location	ETABS Mark	Beam Forces Location	Dimension									Design Forces (Based on Etabs Results)			FLEXURAL STRENGTH												Shear Strength						
																Provided Top Bars						Provided Bottom Bars												
				b mm	h mm	ϕ_v mm	dt mm	db mm	ct mm	cb mm	at mm	ab mm	$M_{u.top}$ (kN-m)	$M_{u.bottom}$ (kN-m)	Vu (kN)	n_{prov}	Φ_b mm	A_s (mm^2)	$M_{u.cap}$ (kN-m)	C/D Ratio (FOS)	%NBS	n_{prov}	Φ_b mm	A_s (mm^2)	$M_{u.cap}$ (kN-m)	C/D Ratio (FOS)	%NBS	No. of Legs	Spacing	Vc (kN)	Vs (kN)	Vu (kN)	C/D Ratio (FOS)	%NBS
First Floor	Grid C-D	B142	@ left end	100	150	6	113	113	25	25	19	19	0.59	-	1.57	1	12	113.097	5.03	8.485	849%	1	12	113.097	5.03	-	-	1	600	12.38	0.01	10.53	6.709	671%
			@center	100	150	6	113	113	25	25	19	19	0.09	0.8	1.37	1	12	113.097	5.03	58.508	5851%	1	12	113.097	5.03	5.983	598%	1	600	12.38	0.01	10.53	7.689	769%
			@ right end	100	150	6	113	113	25	25	19	19	0.00	-	0.13	1	12	113.097	5.03			1	12	113.097	16.83	-	-	1	600	12.38	0.01	10.53	81.029	8103%
	Grid C-D	B143	@ left end	100	400	6	363	361	25	25	19	34	0.00	-	1.61	1	12	113.097	16.83			1	16	201.062	29.92	-	-	1	600	39.76	0.01	33.81	21.001	2100%
			@center	100	400	6	363	361	25	25	19	34	10.06	6.1	16.33	1	12	113.097	16.83	1.673	167%	1	16	201.062	29.92	4.895	489%	1	600	39.76	0.01	33.81	2.071	207%
			@ right end	100	400	6	363	361	25	25	19	34	-	0.1	0.36	1	12	113.097	16.83	-	-	1	16	201.062	29.92	360.459	36046%	1	600	39.76	0.01	33.81	93.922	9392%
	Grid C-D	B146	@ left end	100	400	6	363	361	25	25	19	34	0.00	-	1.54	1	12	113.097	16.83			1	16	201.062	29.92	-	-	1	600	39.76	0.01	33.81	21.956	2196%
			@center	100	400	6	363	361	25	25	19	34	17.05	8.9	23.12	1	12	113.097	16.83	0.987	99%	1	16	201.062	29.92	3.365	336%	1	600	39.76	0.01	33.81	1.462	146%
			@ right end	100	400	6	363	361	25	25	19	34	0.09	-	0.05	1	12	113.097	16.83	186.988	18699%	1	16	201.062	8.95	-	-	1	600	39.76	0.01	33.81	676.240	67624%
	Grid C-D	B147	@ left end	100	150	6	113	113	25	25	19	19	0.62	-	2.01	1	12	113.097	5.03	8.077	808%	1	12	113.097	5.03	-	-	1	600	12.38	0.01	10.53	5.241	524%
			@center	100	150	6	113	113	25	25	19	19	0.28	0.7	1.82	1	12	113.097	5.03	17.780	1778%	1	12	113.097	5.03	7.168	717%	1	600	12.38	0.01	10.53	5.788	579%
			@ right end	100	150	6	113	113	25	25	19	19	0.00	-	0.27	1	12	113.097	5.03			1	12	113.097	5.78	-	-	1	600	12.38	0.01	10.53	39.014	3901%
	Grid B	B152	@ left end	200	175	6	138	138	25	25	19	38	-	1.3	3.30	2	12	226.195	11.57	-	-	4	12	452.389	23.13	18.060	1806%	2	150	30.23	0.11	25.80	7.817	782%
			@center	200	175	6	138	138	25	25	19	38	0.49	-	3.79	2	12	226.195	11.57	23.511	2351%	4	12	452.389	23.13	-	-	2	150	30.23	0.11	25.80	6.806	681%
			@ right end	200	175	6	138	138	25	25	19	38	2.51	-	4.29	2	12	226.195	11.57	4.603	460%	4	12	452.389	23.13	-	-	2	150	30.23	0.11	25.80	6.013	601%
	Grid F	B153	@ left end	200	175	6	138	138	25	25	19	38	1.22	-	3.33	2	12	226.195	11.57	9.505	950%	4	12	452.389	23.13	-	-	2	150	30.23	0.11	25.80	7.746	775%
			@center	200	175	6	138	138	25	25	19	38	0.73	-	2.83	2	12	226.195	11.57	15.803	1580%	4	12	452.389	23.13	-	-	2	150	30.23	0.11	25.80	9.115	911%
			@ right end	200	175	6	138	138	25	25	19	38	-	0.6	2.34	2	12	226.195	11.57	-	-	4	12	452.389	23.13	39.819	3982%	2	150	30.23	0.11	25.80	11.024	1102%
	Grid 5	B209	@ left end	100	150	6	113	113	25	25	19	19	0.00	-	1.17	1	12	113.097	5.03			1	12	113.097	5.03	-	-	1	600	12.38	0.01	10.53	9.003	900%
			@center	100	150	6	113	113	25	25	19	19	0.31	0.4	2.81	1	12	113.097	5.03	16.127	1613%	1	12	113.097	5.03	13.103	1310%	1	600	12.38	0.01	10.53	3.749	375%
			@ right end	100	150	6	113	113	25	25	19	19	-	0.0	1.47	1	12	113.097	5.03	-	-	1	12	113.097	5.03			1	600	12.38	0.01	10.53	7.166	717%
	Grid 1	B211	@ left end	100	150	6	113	113	25	25	19	19	0.00	-	0.33	1	12	113.097	5.03			1	12	113.097	5.03	-	-	1	600	12.38	0.01	10.53	31.921	3192%
			@center	100	150	6	113	113	25	25	19	19	0.45	0.4	3.14	1	12	113.097	5.03	11.282	1128%	1	12	113.097	5.03	13.977	1398%	1	600	12.38	0.01	10.53	3.355	335%
			@ right end	100	150	6	113	113	25	25	19	19	0.00	-	1.41	1	12	113.097	5.03			1	12	113.097	5.03	-	-	1	600	12.38	0.01	10.53	7.471	747%

Level	Location	ETABS Mark	Section	D/C Ratio	C/D Ratio	% NBS
Second Floor to Roof Level	Grid B	C12	200 Dia.	0.036	27.778	2778%
	Grid F	C13	200 Dia.	0.773	1.294	129%
First Floor to Second Floor	Grid B	C11	200 Dia.	0.257	3.891	389%
	Grid F	C9	200 Dia.	0.420	2.381	238%

Note:

D is Demand while C is Capacity. D/C ratio is the default Etabs generated analysis and design result. Thus, reciprocal of D/C shall be the C/D ratio which is equivalent to FOS (Factor of Safety). Also, multiplying the C/D ratio (FOS) of 100 shall be the %NBS

CLIENTS | PEOPLE | PERFORMANCE

Client	Christchurch City Council	Job no.	51/30596/36	Sheet	24 of 30
Project	Gloucester Courts Block A, Christchurch, New Zealand	Calcs by	MBJ	Date	7/11/2012
Subject	Beam/Column Joint Design Capacity Ratio	Checked by	DMC	Date	13/7/2012

Design Parameters:

f'_C =	30 MPa	Compressive Strength of Concrete
f_Y =	430 MPa	Lower Characteristic Yield Strength of Reinforcement
f_{YH} =	300 MPa	Lower Characteristic Yield Strength of Horizontal Joint Shear Reinf.
f_{YV} =	300 MPa	Lower Characteristic Yield Strength of Vertical Joint Shear Reinf.
α_i =	1.4	
C_J =	0.5	Column In Compression
ϕ =	0.75	For Shear

Formulas:

FOS = C / D : Ratio of capacity over demand (Factor of Safety)

%NBS = FOS * 100

STOREY/LEVEL	Joint Beam/ Column Location	ETABS Mark	Reinforcement						P_U (kN- Max Axial)	V_U (kN- Max Shear)	b_j	h	k	V_{pjh}	%NBS
			Column		Beam										
					Top		Bottom								
			# (pc)	ϕ_{CT} (mm)	# (pc)	ϕ_{BT} (mm)	# (pc)	ϕ_{BB} (mm)			m	m		kN	
First - Second Floor	**GL B/5**	**C11**	6	10	1	12	1	12	63.98	104.00	0.2	0.2	0.4	259	249%
	GL F/5	**C9**	6	10	1	12	1	12	41.79	18.53	0.2	0.2	0.4	236	1274%

CLIENTS | PEOPLE | PERFORMANCE

Client	**Christchurch City Council**	Job no.	51/30596/36	Sheet	25 of 30
Project	**Gloucester Courts Block A, Christchurch, New Zealand**	Calcs by	MBJ	Date	11/07/2012
Subject	**Calculations of Stair Checking (Near Grid D') - Type C**	Checked by	DMC	Date	13/07/2012

References:

NZS 3604:2011

NZSEE Manual 2006

1. Determine tension capacity of dowel

Tension Capacity of Dowel (T) = 0.90 As fy

where:

As =	Area of Rebar	=	904.78	mm^2
Ɵ =	diameter of rebar	=	12	mm
N =	No. of Rebar	=	8	pcs
fy =	Yield Strength of Steel	=	430	Mpa

therefore: T = 350.15 kN

2. Determine Displacement of stair landing

Displacement at Stair Landing (δ) = 0.4 mm (From E-tabs)

3. Determine Tension induced by displacement of landing

P = (δ AE) / L

where:

L =	Length of stairs	=	4000	mm
δ =	Displacement at landing	=	0.4	mm
A =	Cross section of stair	=	165000	mm^2
W =	Width of Stair	=	1100	mm
Tk =	Thickness of Stair	=	150	mm
E =	Concrete modulus of elasticity	=	25084.39	Mpa

Note:

E = (3320 (f'c^1/2)) + 6900 NZS 3101: Part 1: 2006

where:

f'c = Compressive Strength of Concrete = 30 Mpa

therefore: P = 413.89 kN

4. Determine % NBS

% NBS = T/P = 84.60 %

References:

NZS 3604:2011

NZSEE Manual 2006

1. Determine tension capacity of dowel

Tension Capacity of Dowel (T) = 0.90 As fy

where:

As =	Area of Rebar	=	904.78	mm^2
Ɵ =	diameter of rebar	=	12	mm
N =	No. of Rebar	=	8	pcs
fy =	Yield Strength of Steel	=	430	Mpa

therefore: T = 350.15 kN

2. Determine Displacement of stair landing

Displacement at Stair Landing (δ) = 0.3 mm (From E-tabs)

3. Determine Tension induced by displacement of landing

P = (δ AE) / L

where:

L =	Length of stairs	=	4000	mm
δ =	Displacement at landing	=	0.3	mm
A =	Cross section of stair	=	165000	mm^2
W =	Width of Stair	=	1100	mm
Tk =	Thickness of Stair	=	150	mm
E =	Concrete modulus of elasticity	=	25084.389	Mpa

Note:

E = (3320 (f'c^1/2)) + 6900 NZS 3101: Part 1: 2006

where:

f'c = Compressive Strength of Concrete = 30 Mpa

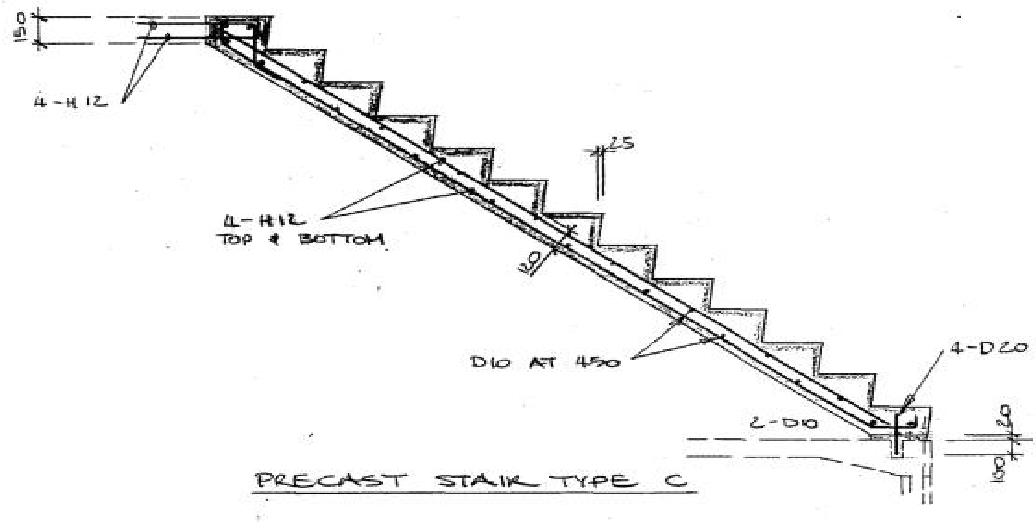
therefore: P = 310.4193 kN

4. Determine % NBS

% NBS = T/P = 112.80 %

Client	Christchurch City Council	Job no.	51/30596/36	Sheet	27 of 30
Project	Gloucester Courts Block A, Christchurch, New Zealand	Calcs by	MBJ	Date	06-Aug-12
Subject	Dowel of Stair at Ground for Type C - Checking for Shear Resistance	Checked by	MBD	Date	06-Aug-12

1.0 Check for Horizontal Shear



t	=	150	mm	f'c	20.00	Mpa
w	=	990	mm	fy	430.00	Mpa

Vc = 495000

ϕV_c = **420.75** kN

From Etabs Output

Vu = **77.43** kN

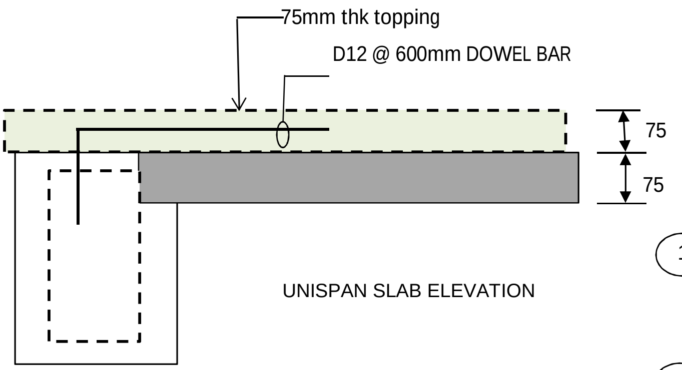
Add the 4-D20 dowel bar

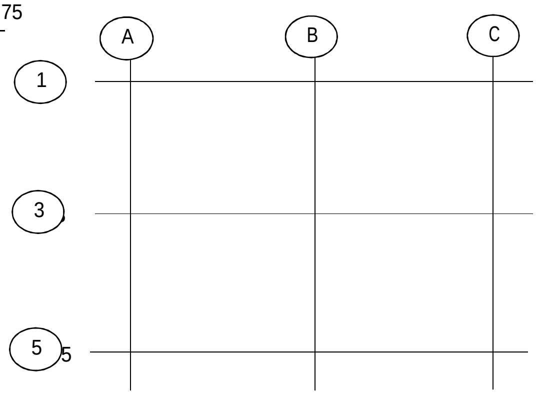
Vs = 0.85Avfy 459068 N

= **459.07** kN

Therefore , Resisting shear equal to 879.82 kN > 77.43 kN, SAFE

Client	Christchurch City Council	Job no.	51/30596/36	Sheet	28 & 29 of 30
Project	Gloucester Courts Block A, Christchurch, New Zealand	Calcs by	MBJ	Date	06-Aug-12
Subject	Unispan Slab - Checking for Shear Resistance	Checked by	MBD	Date	06-Aug-12





1.0 Check for Vertical Shear

PARTIAL PLAN

Existing Slab Properties

f'_c	20	Mpa
f_y	430	Mpa
Mesh	665	with D12 dowel bar @ 400 mm, anchor to wall & beams

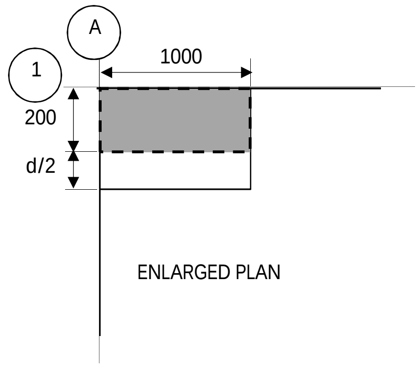
V_c = $(1/3)f'_c{}^{0.5} \times b_o \times d$

b_o = L + B + d/2 Wall dimension + d (consider 1 m length of wall)

= 1255 mm

Data: (Typical floor)

T = 75 mm



t = 75 mm

V_c = 420939.8 N

= 140313.3 N

ϕV_c = 119266.3 N

= **119.27** kN per meter strip

From the Etabs Model :

Max Vu = **109.78** kN per meter strip

Since $\phi V_c > V_u$ therefore concrete alone is safe in terms of Vertical shear or punching shear

2.0 Check for Horizontal Shear of the existing Unispan Slab

For 1.0 meter strip of the slab along Z - direction
t = 75 mm thk of Unispan slab

f'c = 20 Mpa

Shear Resistance @ slab edge :

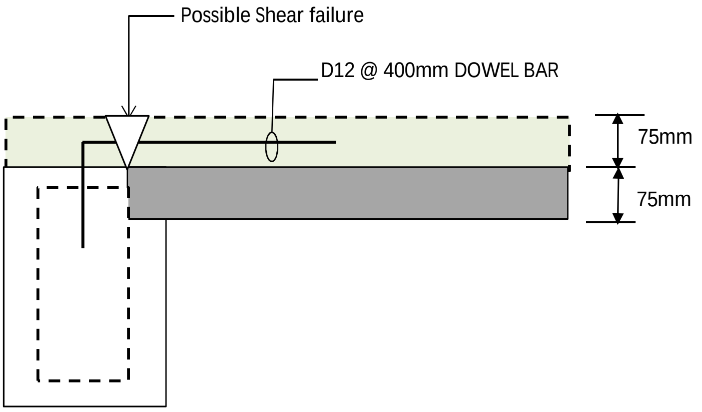
At t = 75 mm
d 75-20
d 55 mm

Vc = 1100000 N
ϕV_c = **935** kN per meter strip

From Etabs Output :
Vu = 540.1 kN / 7.04 M = 76.72 kN per meter strip
= 76.72 kN

Therefore, existing Unispan slab is safe in terms of Horizontal shear.

3.0 Check for Horizontal Shear of the 65 mm thk Topping



t	=	75	mm	f'c	20.00 Mpa
				fy	430.00 Mpa

Assume 1.0 meter strip only

Vc = 250000
ϕV_c = **212.5** kN per meter strip > 76.72 Kn

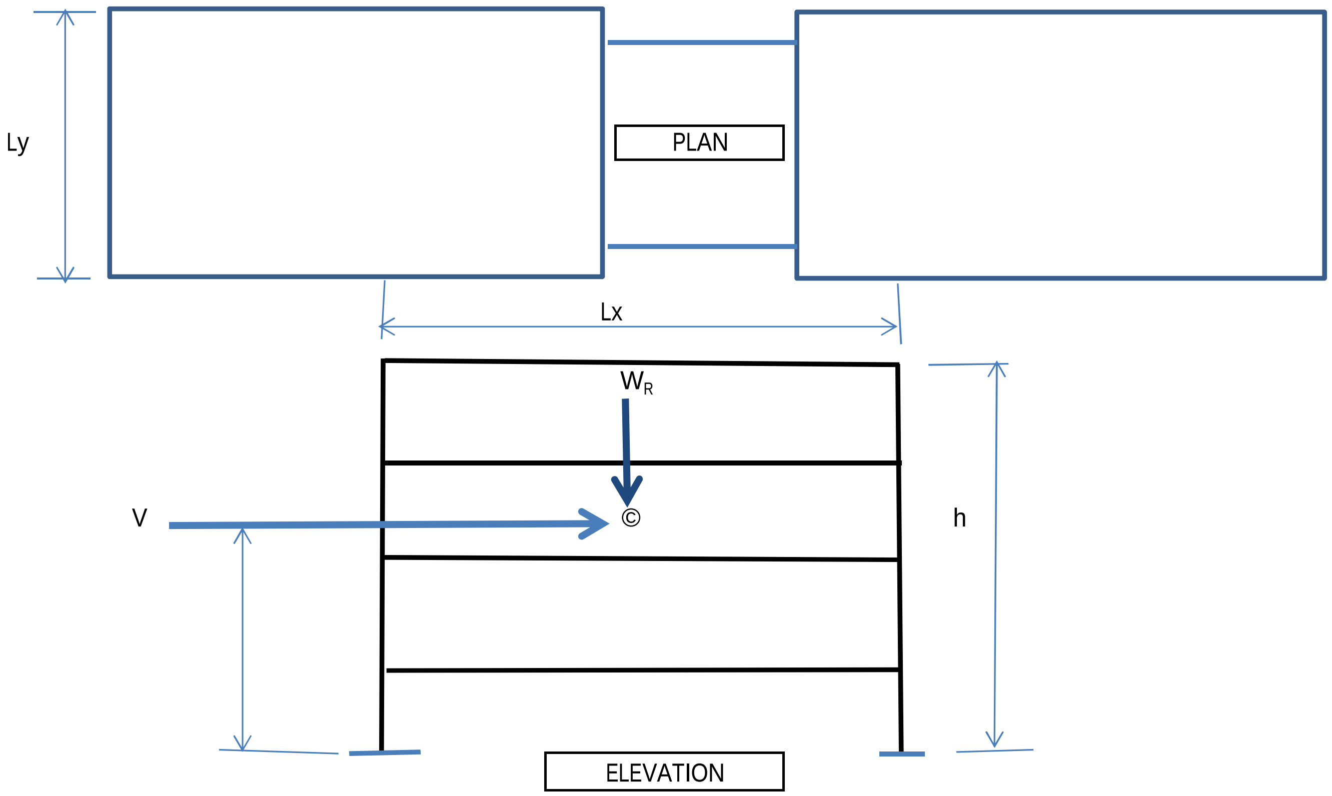
Add the D12 dowel bar @ 400 mm on center

Vs = 0.85Avfy 82603 N
= **82.60** kN

Therefore , Resisting shear of 65 mm thk topping is equal to 295.10 kN > 76.72 kN, SAFE

Client	**Christchurch City Council**	Job no.	**51/30596/36**	Sheet	30 of 30
Project	**Gloucester Courts Block A, Christchurch, New Zealand**	Calcs by	MBJ	Date	11-Jul-12
Subject	**Overturning Check**	Checked by	DMC	Date	13-Jul-12

Building Illustration:



Building Data:

h = 9.5 m

Lx = 40 m

Ly = 11 m

Base Shear From Etabs Output:

Vx = 3604.3 kN

Vy = 3604.3 kN

Dead Weight Forces From Etabs Output:

W_R = 6267 kN

- Check Overturning moment in X-direction:

OM_x = 3604.3 x 9.50 / 2

OM_x = 17120 kN-m

Resisting Moment:

RM_x = 6266.6 x 40.00 / 2

RM_x = 125331 kN-m

$FOS = \frac{RM_x}{OM_x}$ = 7.32 = 732.1% NBS

- Check Overturning moment in Y-direction:

OM_x = 3604.26 x 9.50 / 2

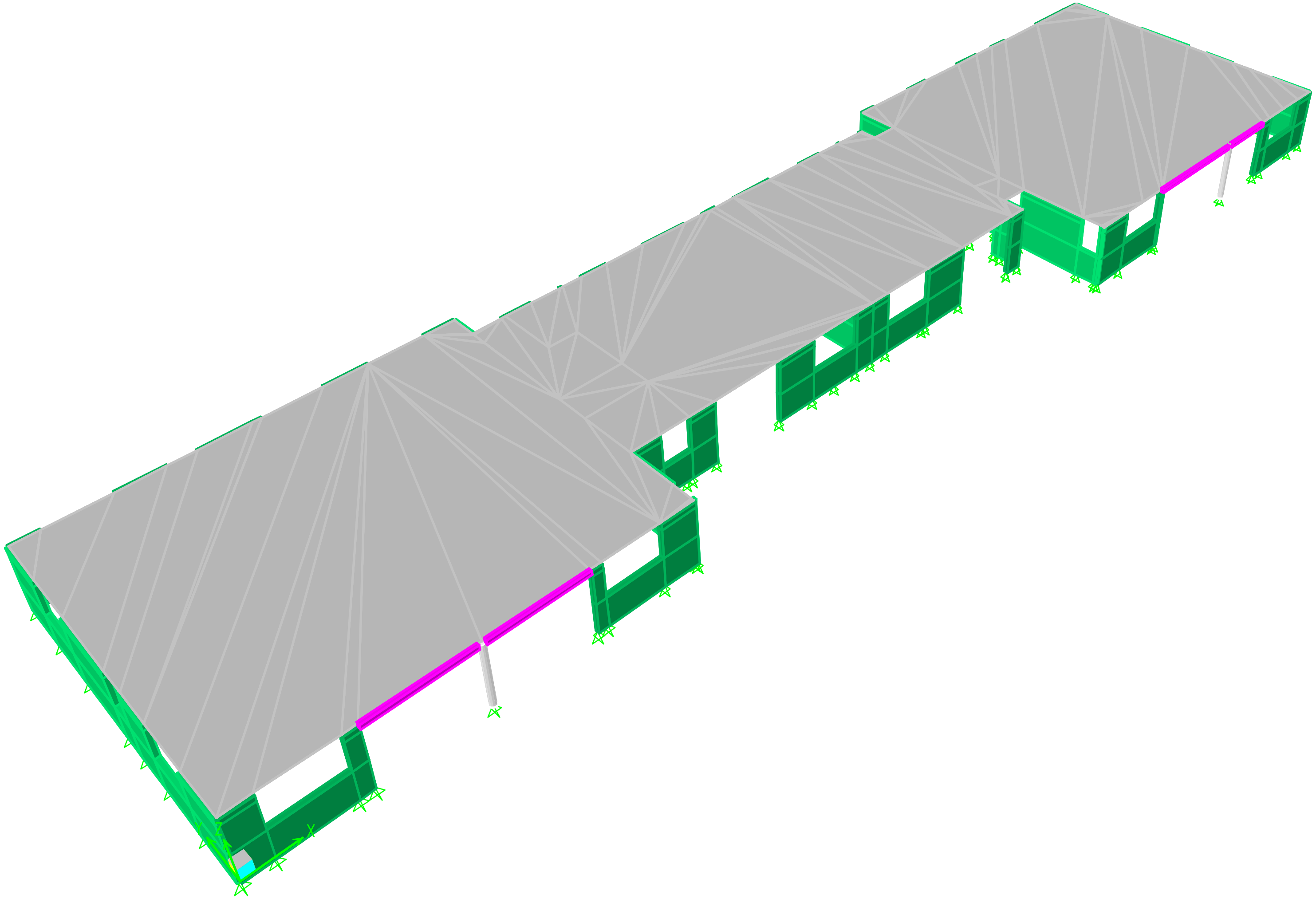
OM_x = 17120.2 kN-m

Resisting Moment:

RM_x = 6266.56 x 11.00 / 2

RM_x = 34466.1 kN-m

$FOS = \frac{RM_x}{OM_x}$ = 2.01 = 201.3% NBS



ETABS v9.7.2 File:71-11354 GLOUCESTER COURTS BLOCK A_QUANTITATIVE_TIMBER WALL_REV (JULY 11,2012) Units:KN-m July 13, 2012 11:24 PAGE 1

PROJECT INFORMATION

Company Name = GHD

ETABS v9.7.2 File:71-11354 GLOUCESTER COURTS BLOCK A_QUANTITATIVE_TIMBER WALL_REV (JULY 11,2012) Units:KN-m July 13, 2012 11:24 PAGE 2

S T O R Y D A T A

STORY	SIMILAR TO	HEIGHT	ELEVATION
APEX - ROOF	None	2.420	4.580
ROOF	None	2.160	2.160
BASE	None		0.000

ETABS v9.7.2 File:71-11354 GLOUCESTER COURTS BLOCK A_QUANTITATIVE_TIMBER WALL_REV (JULY 11,2012) Units:KN-m July 13, 2012 11:24 PAGE 3

S T A T I C L O A D C A S E S

STATIC CASE	CASE TYPE	AUTO LAT LOAD	SELF WT MULTIPLIER	NOTIONAL FACTOR	NOTIONAL DIRECTION
DEAD	DEAD	N/A	0.6500		

ETABS v9.7.2 File:71-11354 GLOUCESTER COURTS BLOCK A_QUANTITATIVE_TIMBER WALL_REV (JULY 11,2012) Units:KN-m July 13, 2012 11:24 PAGE 4

M A S S S O U R C E D A T A

MASS FROM	LATERAL MASS ONLY	LUMP MASS AT STORIES
Loads	Yes	Yes

M A S S S O U R C E L O A D S

LOAD	MULTIPLIER
DEAD	1.0000
LIVE	0.3000
SDL	1.0000

ETABS v9.7.2 File:71-11354 GLOUCESTER COURTS BLOCK A_QUANTITATIVE_TIMBER WALL_REV (JULY 11,2012) Units:KN-m July 13, 2012 11:24 PAGE 5

D I A P H R A G M   M A S S   D A T A

STORY	DIAPHRAGM	MASS-X	MASS-Y	MMI	X-M	Y-M
ROOF	ROOF	0.000E+00	0.000E+00	0.000E+00	21.013	5.470

ETABS v9.7.2 File:71-11354 GLOUCESTER COURTS BLOCK A_QUANTITATIVE_TIMBER WALL_REV (JULY 11,2012) Units:KN-m July 13, 2012 11:24 PAGE 6

A S S E M B L E D   P O I N T   M A S S E S

STORY	UX	UY	UZ	RX	RY	RZ
APEX - ROOF	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ROOF	3.206E+01	3.206E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BASE	5.220E+00	5.220E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Totals	3.728E+01	3.728E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00

ETABS v9.7.2 File:71-11354 GLOUCESTER COURTS BLOCK A_QUANTITATIVE_TIMBER WALL_REV (JULY 11,2012) Units:KN-m July 13, 2012 11:24 PAGE 7

C E N T E R S   O F   C U M U L A T I V E   M A S S   &   C E N T E R S   O F   R I G I D I T Y

STORY	DIAPHRAGM	/----------CENTER OF MASS----------/			/--CENTER OF RIGIDITY--/	
LEVEL	NAME	MASS	ORDINATE-X	ORDINATE-Y	ORDINATE-X	ORDINATE-Y
ROOF	ROOF	0.000E+00	0.000	0.000	21.208	2.451

ETABS v9.7.2 File:71-11354 GLOUCESTER COURTS BLOCK A_QUANTITATIVE_TIMBER WALL_REV (JULY 11,2012) Units:KN-m July 13, 2012 11:24 PAGE 8

M O D A L   P E R I O D S   A N D   F R E Q U E N C I E S

MODE	PERIOD	FREQUENCY	CIRCULAR FREQ
NUMBER	(TIME)	(CYCLES/TIME)	

(RADIANS/TIME)

Mode 1 0.34536 2.89556
18.19337

ETABS v9.7.2 File:71-11354 GLOUCESTER COURTS BLOCK
A_QUANTITATIVE_TIMBER WALL_REV (JULY 11,2012) Units:KN-m July
13, 2012 11:24 PAGE 9

M O D A L P A R T I C I P A T I N G M A S S R A T I O S

MODE NUMBER	X-TRANS %MASS <SUM>	Y-TRANS %MASS <SUM>	Z-TRANS %MASS <SUM>	RX-ROTN %MASS <SUM>	RY-ROTN %MASS <SUM>	RZ-ROTN %MASS <SUM>
Mode 1	0.01 < 0>	4.62 < 5>	0.00 < 0>	4.62 < 5>	0.01 < 0>	5.97 < 6>

ETABS v9.7.2 File:71-11354 GLOUCESTER COURTS BLOCK
A_QUANTITATIVE_TIMBER WALL_REV (JULY 11,2012) Units:KN-m July
13, 2012 11:24 PAGE 10

M O D A L L O A D P A R T I C I P A T I O N R A T I O S
(STATIC AND DYNAMIC RATIOS ARE IN PERCENT)

TYPE	NAME	STATIC	DYNAMIC
Load	DEAD	0.0000	0.0000
Load	LIVE	0.0000	0.0000
Load	SDL	0.0000	0.0000
Load	SEISMICX	0.1273	0.0083
Load	SEISMICY	18.8183	4.6203
Accel	UX	0.1273	0.0083
Accel	UY	18.8183	4.6203
Accel	UZ	0.0000	0.0000
Accel	RX	18.8183	4.6203
Accel	RY	0.1273	0.0083
Accel	RZ	26.9211	5.9714

ETABS v9.7.2 File:71-11354 GLOUCESTER COURTS BLOCK
A_QUANTITATIVE_TIMBER WALL_REV (JULY 11,2012) Units:KN-m July
13, 2012 11:24 PAGE 11

TOTAL REACTIVE FORCES (RECOVERED LOADS) AT ORIGIN

LOAD	FX	FY	FZ	MX	MY	MZ
DEAD	-4.813E-13	-1.765E-12	9.665E+01	5.722E+02	-2.037E+03	-5.417E-11
LIVE	3.677E-12	1.516E-11	1.850E+02	1.000E+03	-3.884E+03	5.046E-10

SDL 4.244E-12 1.747E-11 2.135E+02 1.154E+03 -4.482E+03 5.817E-10
SEISMICX -1.764E+02 4.046E-09 -1.800E-11 -8.883E-09 -3.810E+02 9.647E+02
SEISMICY 1.609E-11 -1.764E+02 -1.478E-12 3.810E+02 3.356E-11 -3.706E+03

ETABS v9.7.2 File:71-11354 GLOUCESTER COURTS BLOCK A_QUANTITATIVE_TIMBER WALL_REV (JULY 11,2012) Units:KN-m July 13, 2012 11:24 PAGE 12

S T O R Y   F O R C E S

STORY	LOAD	P	VX	VY	T	MX	MY
APEX - ROOF	SEISMICX	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ROOF	SEISMICX	-1.800E-11	-1.764E+02	4.046E-09	9.647E+02	-8.883E-09	-3.810E+02
APEX - ROOF	SEISMICY	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ROOF	SEISMICY	-1.478E-12	1.609E-11	-1.764E+02	-3.706E+03	3.810E+02	3.356E-11

ETABS v9.7.2 File:71-11354 GLOUCESTER COURTS BLOCK A_QUANTITATIVE_TIMBER WALL_REV (JULY 11,2012) Units:KN-m July 13, 2012 11:24 PAGE 13

STORY DRIFTS

STORY	DIRECTION	LOAD	MAX DRIFT
ROOF	X	SEISMICX	1/237
ROOF	Y	SEISMICY	1/104

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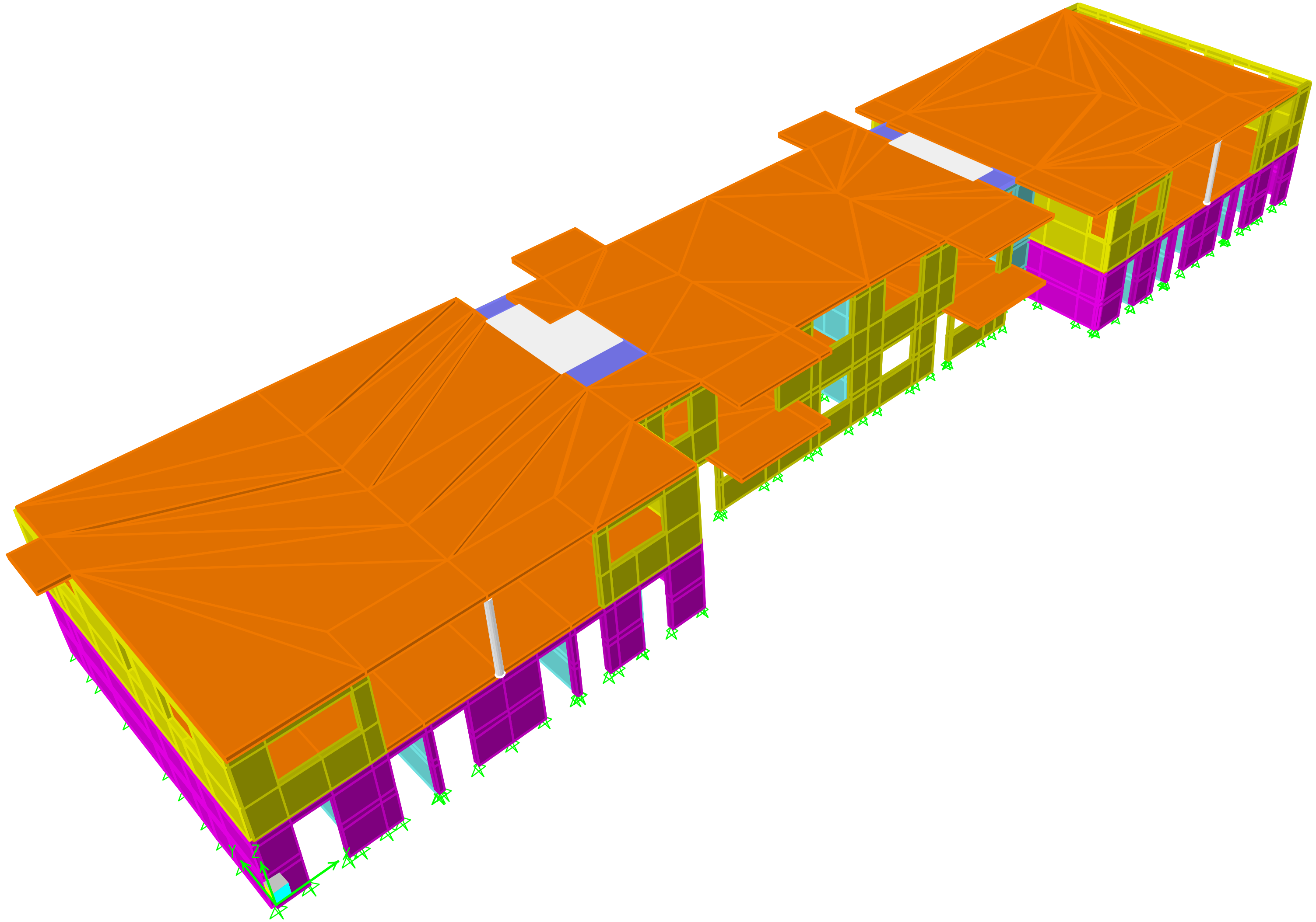
DISPLACEMENTS AT DIAPHRAGM CENTER OF MASS

STORY	DIAPHRAGM	LOAD	UX	UY	RZ
ROOF	ROOF	SEISMICX	0.0000	0.0000	0.00000
ROOF	ROOF	SEISMICY	0.0001	0.0002	-0.00002

ETABS v9.7.2 File:71-11354 GLOUCESTER COURTS BLOCK A_QUANTITATIVE_TIMBER WALL_REV (JULY 11,2012) Units:KN-m July 13, 2012 11:24 PAGE 15

STORY MAXIMUM AND AVERAGE LATERAL DISPLACEMENTS

STORY	LOAD	DIR	MAXIMUM	AVERAGE	RATIO
ROOF	SEISMICX	X	0.0091	0.0046	1.997
ROOF	SEISMICY	Y	0.0208	0.0104	2.003


X
Y
Z

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PROJECT INFORMATION

Company Name	=	GHD
Client Name	=	Christchurch City Council
Project Name	=	Quantitative Analysis of Gloucester Court Block A
Project Number	=	51/30596/36
Engineer	=	MBJavier

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S T O R Y D A T A

STORY	SIMILAR TO	HEIGHT	ELEVATION
2ND	None	2.560	4.920
1ST	None	2.360	2.360
BASE	None		0.000

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S T A T I C L O A D C A S E S

STATIC CASE	CASE TYPE	AUTO LAT LOAD	SELF WT MULTIPLIER	NOTIONAL FACTOR	NOTIONAL DIRECTION
DEAD	DEAD	N/A	1.0000		
LIVE	LIVE	N/A	0.0000		
SDL	SUPER DEAD	N/A	0.0000		
SEISMICX	QUAKE	NZS1170 2004	0.0000		
SEISMICY	QUAKE	NZS1170 2004	0.0000		

ETABS v9.7.2 File:71-11354 GLOUCESTER COURTS BLOCK A_QUANTITATIVE REV (JULY 11,2012) Units:KN-m July 13, 2012 11:32 PAGE 4

M A S S S O U R C E D A T A

MASS FROM	LATERAL MASS ONLY	LUMP MASS AT STORIES
Loads	Yes	Yes

M A S S   S O U R C E   L O A D S

LOAD	MULTIPLIER
DEAD	1.0000
LIVE	0.3000
SDL	1.0000

ETABS v9.7.2 File:71-11354 GLOUCESTER COURTS BLOCK A_QUANTITATIVE REV (JULY 11,2012) Units:KN-m July 13, 2012 11:32 PAGE 5

D I A P H R A G M   M A S S   D A T A

STORY	DIAPHRAGM	MASS-X	MASS-Y	MMI	X-M	Y-M
2ND	2ND	2.754E+02	2.754E+02	4.765E+04	20.733	5.498
1ST	1ST	3.205E+02	3.205E+02	6.098E+04	21.567	5.234

ETABS v9.7.2 File:71-11354 GLOUCESTER COURTS BLOCK A_QUANTITATIVE REV (JULY 11,2012) Units:KN-m July 13, 2012 11:32 PAGE 6

A S S E M B L E D   P O I N T   M A S S E S

STORY	UX	UY	UZ	RX	RY	RZ
2ND	2.823E+02	2.823E+02	0.000E+00	0.000E+00	0.000E+00	4.765E+04
1ST	3.205E+02	3.205E+02	0.000E+00	0.000E+00	0.000E+00	6.098E+04
BASE	7.937E+01	7.937E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Totals	6.822E+02	6.822E+02	0.000E+00	0.000E+00	0.000E+00	1.086E+05

ETABS v9.7.2 File:71-11354 GLOUCESTER COURTS BLOCK A_QUANTITATIVE REV (JULY 11,2012) Units:KN-m July 13, 2012 11:32 PAGE 7

C E N T E R S   O F   C U M U L A T I V E   M A S S   &   C E N T E R S   O F   R I G I D I T Y

STORY	DIAPHRAGM	/----------CENTER OF MASS----------/			/--CENTER OF RIGIDITY--/	
LEVEL	NAME	MASS	ORDINATE-X	ORDINATE-Y	ORDINATE-X	ORDINATE-Y
2ND	2ND	2.754E+02	20.733	5.498		

```
19.352        7.579
 1ST          1ST            3.205E+02      21.567       5.234
21.947        3.779

 ETABS v9.7.2  File:71-11354 GLOUCESTER COURTS BLOCK
A_QUANTITATIVE REV (JULY 11,2012)  Units:KN-m  July 13, 2012
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 M O D A L   P E R I O D S   A N D   F R E Q U E N C I E S

 MODE                          PERIOD              FREQUENCY
CIRCULAR FREQ
 NUMBER                        (TIME)          (CYCLES/TIME)
(RADIANS/TIME)

 Mode 1                       0.19297                5.18214
32.56038

 ETABS v9.7.2  File:71-11354 GLOUCESTER COURTS BLOCK
A_QUANTITATIVE REV (JULY 11,2012)  Units:KN-m  July 13, 2012
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 M O D A L   P A R T I C I P A T I N G   M A S S   R A T I O S

 MODE                X-TRANS         Y-TRANS         Z-TRANS
RX-ROTN         RY-ROTN         RZ-ROTN
 NUMBER            %MASS <SUM>     %MASS <SUM>     %MASS <SUM>     %
MASS <SUM>     %MASS <SUM>     %MASS <SUM>

 Mode 1             0.43 <  0>      0.00 <  0>      0.00 <  0>
0.00 <  0>      0.71 <  1>      0.00 <  0>

 ETABS v9.7.2  File:71-11354 GLOUCESTER COURTS BLOCK
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 M O D A L   L O A D   P A R T I C I P A T I O N   R A T I O S
 (STATIC AND DYNAMIC RATIOS ARE IN PERCENT)

 TYPE         NAME               STATIC     DYNAMIC

 Load         DEAD               0.0589      0.0000
 Load         LIVE               0.0674      0.0000
 Load         SDL                0.0624      0.0000
 Load         SEISMICX          12.9200      0.7441
 Load         SEISMICY           0.0001      0.0000
 Accel        UX                 9.2552      0.4301
 Accel        UY                 0.0001      0.0000
 Accel        UZ                 0.0000      0.0000
 Accel        RX                 0.0001      0.0000
 Accel        RY                12.5044      0.7116
 Accel        RZ                 0.0013      0.0000
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 ETABS v9.7.2  File:71-11354 GLOUCESTER COURTS BLOCK
A_QUANTITATIVE REV (JULY 11,2012)  Units:KN-m  July 13, 2012
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 TOTAL REACTIVE FORCES (RECOVERED LOADS) AT ORIGIN

 LOAD                  FX           FY           FZ           MX
MY          MZ

 DEAD           6.177E-10   9.927E-09   5.562E+03   2.898E+04  -
1.194E+05  -2.720E-08
 LIVE           1.830E-10   4.254E-09   1.416E+03   7.663E+03  -
3.028E+04   3.297E-08
 SDL           -1.254E-12   2.123E-09   7.043E+02   3.816E+03  -
1.506E+04   2.192E-08
 SEISMICX      -3.604E+03  -6.430E-08  -7.027E-08   2.571E-07  -
1.474E+04   1.955E+04
 SEISMICY       4.727E-10  -3.604E+03  -3.838E-08   1.474E+04
2.139E-06  -7.705E+04

 ETABS v9.7.2  File:71-11354 GLOUCESTER COURTS BLOCK
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 S T O R Y   F O R C E S

 STORY       LOAD                  P           VX           VY
T           MX           MY

 2ND         SEISMICX      -5.079E-08  -2.435E+03  -6.475E-08
1.344E+04   1.679E-07  -6.234E+03
 1ST         SEISMICX      -7.027E-08  -3.604E+03  -6.430E-08
1.955E+04   2.571E-07  -1.474E+04
 2ND         SEISMICY       3.900E-08   5.426E-10  -2.435E+03  -
5.184E+04   6.234E+03  -1.326E-07
 1ST         SEISMICY      -3.838E-08   4.727E-10  -3.604E+03  -
7.705E+04   1.474E+04   2.139E-06

 ETABS v9.7.2  File:71-11354 GLOUCESTER COURTS BLOCK
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 STORY DRIFTS

 STORY       DIRECTION   LOAD           MAX DRIFT

 2ND         X           SEISMICX          1/256
 1ST         X           SEISMICX        1/15187
 2ND         X           SEISMICY        1/13453
 2ND         Y           SEISMICY         1/9563
 1ST         Y           SEISMICY        1/28580

 ETABS v9.7.2  File:71-11354 GLOUCESTER COURTS BLOCK
A_QUANTITATIVE REV (JULY 11,2012)  Units:KN-m  July 13, 2012
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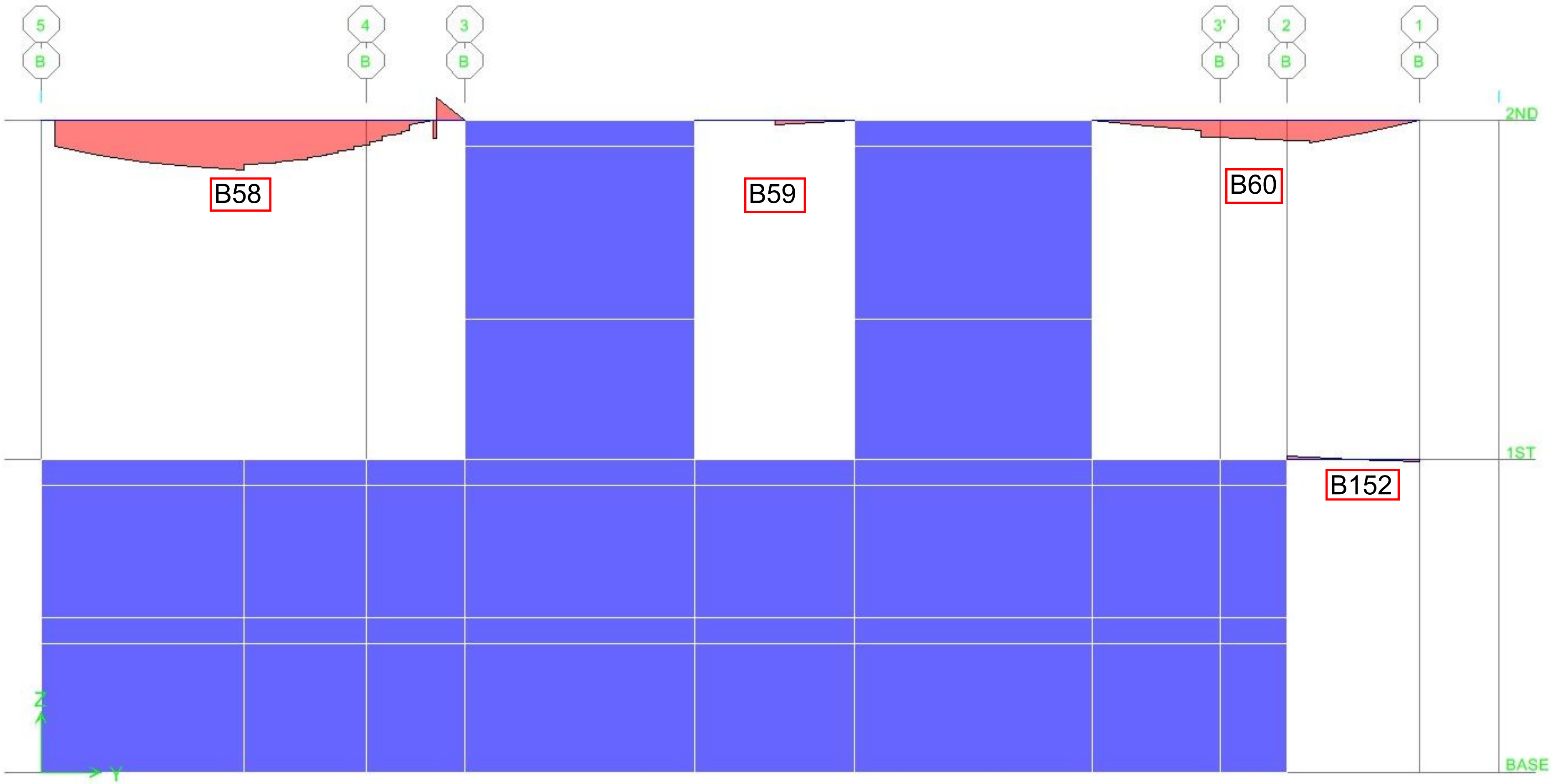
DISPLACEMENTS AT DIAPHRAGM CENTER OF MASS

STORY	DIAPHRAGM	LOAD	UX	UY	RZ
2ND	2ND	SEISMICX	0.0004	0.0000	0.00000
1ST	1ST	SEISMICX	0.0002	0.0000	0.00000
2ND	2ND	SEISMICY	0.0000	0.0003	0.00000
1ST	1ST	SEISMICY	0.0000	0.0001	0.00000

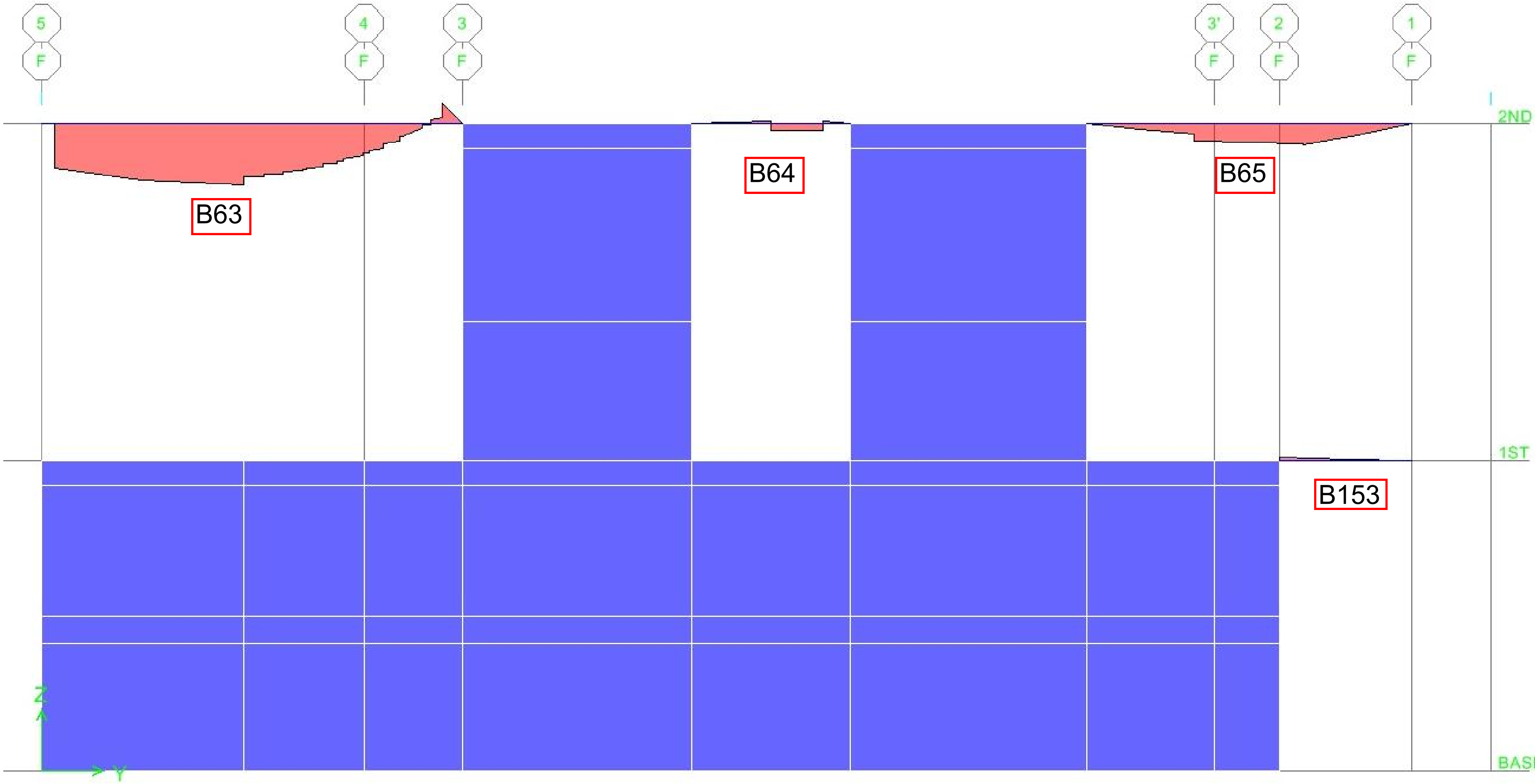
ETABS v9.7.2 File:71-11354 GLOUCESTER COURTS BLOCK A_QUANTITATIVE REV (JULY 11,2012) Units:KN-m July 13, 2012 11:32 PAGE 15

STORY MAXIMUM AND AVERAGE LATERAL DISPLACEMENTS

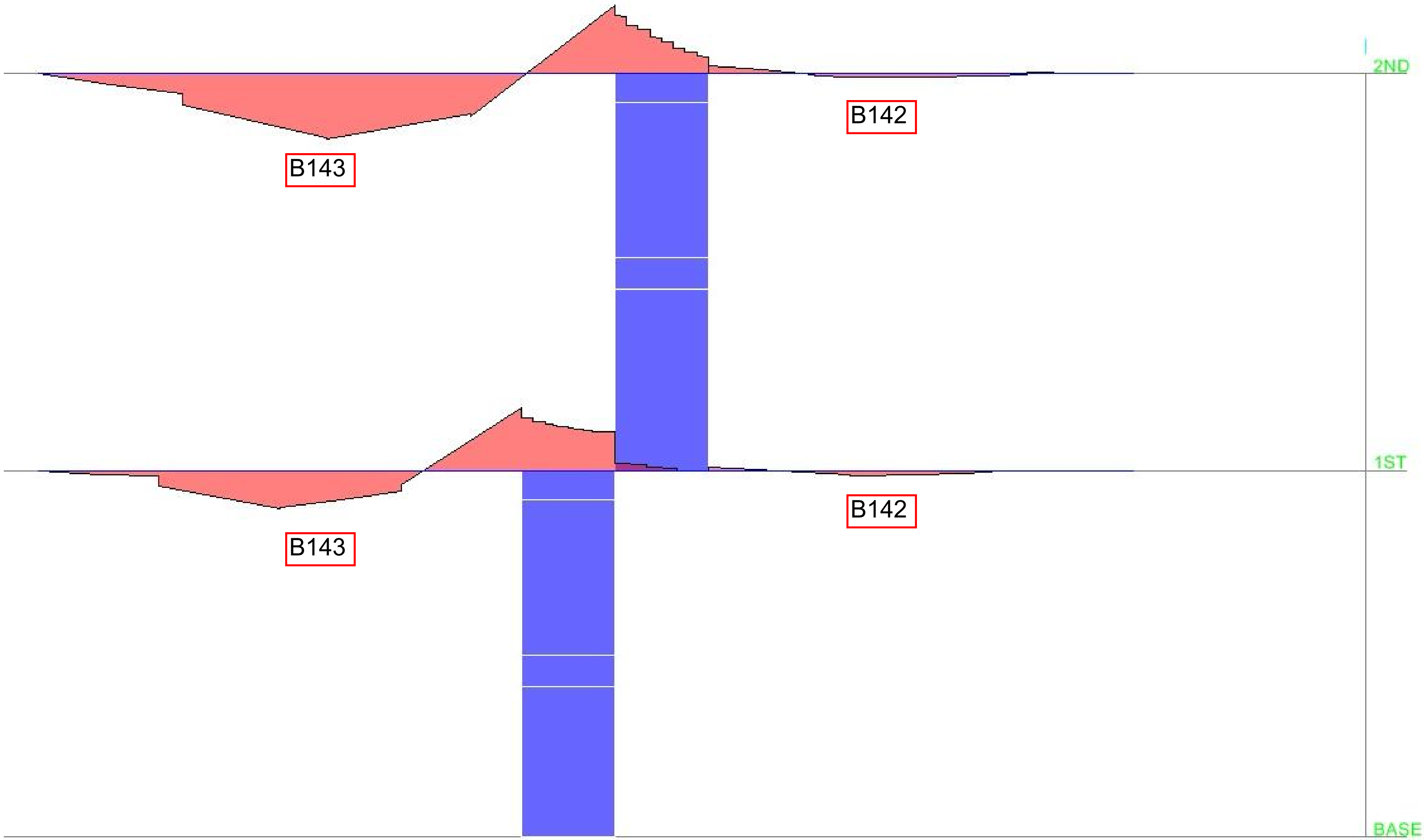
STORY	LOAD	DIR	MAXIMUM	AVERAGE	RATIO
2ND	SEISMICX	X	0.0004	0.0004	1.042
1ST	SEISMICX	X	0.0002	0.0002	1.012
2ND	SEISMICY	Y	0.0003	0.0003	1.181
1ST	SEISMICY	Y	0.0001	0.0001	1.058



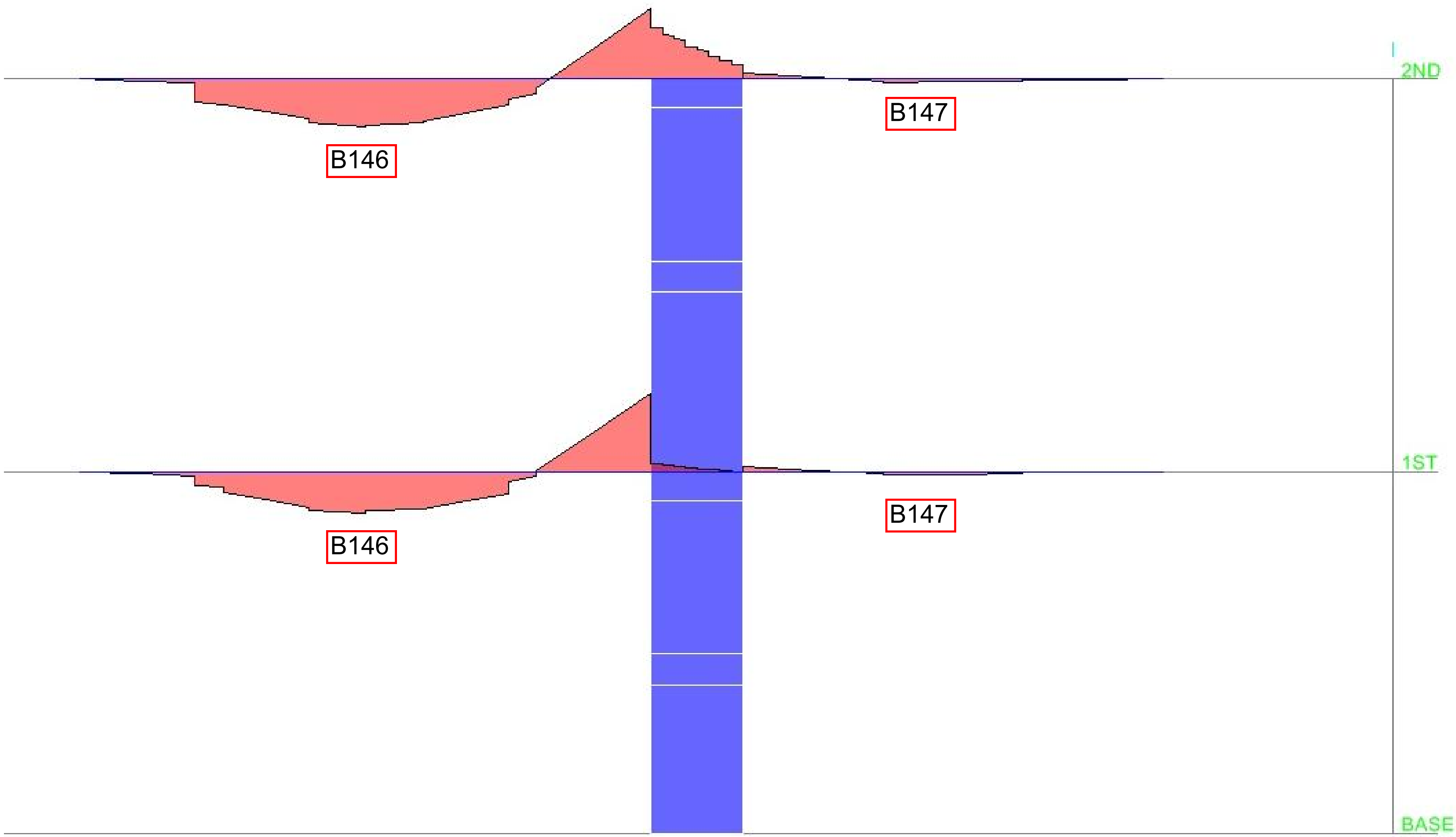
MOMENT DIAGRAM
AT GRIDLINE B



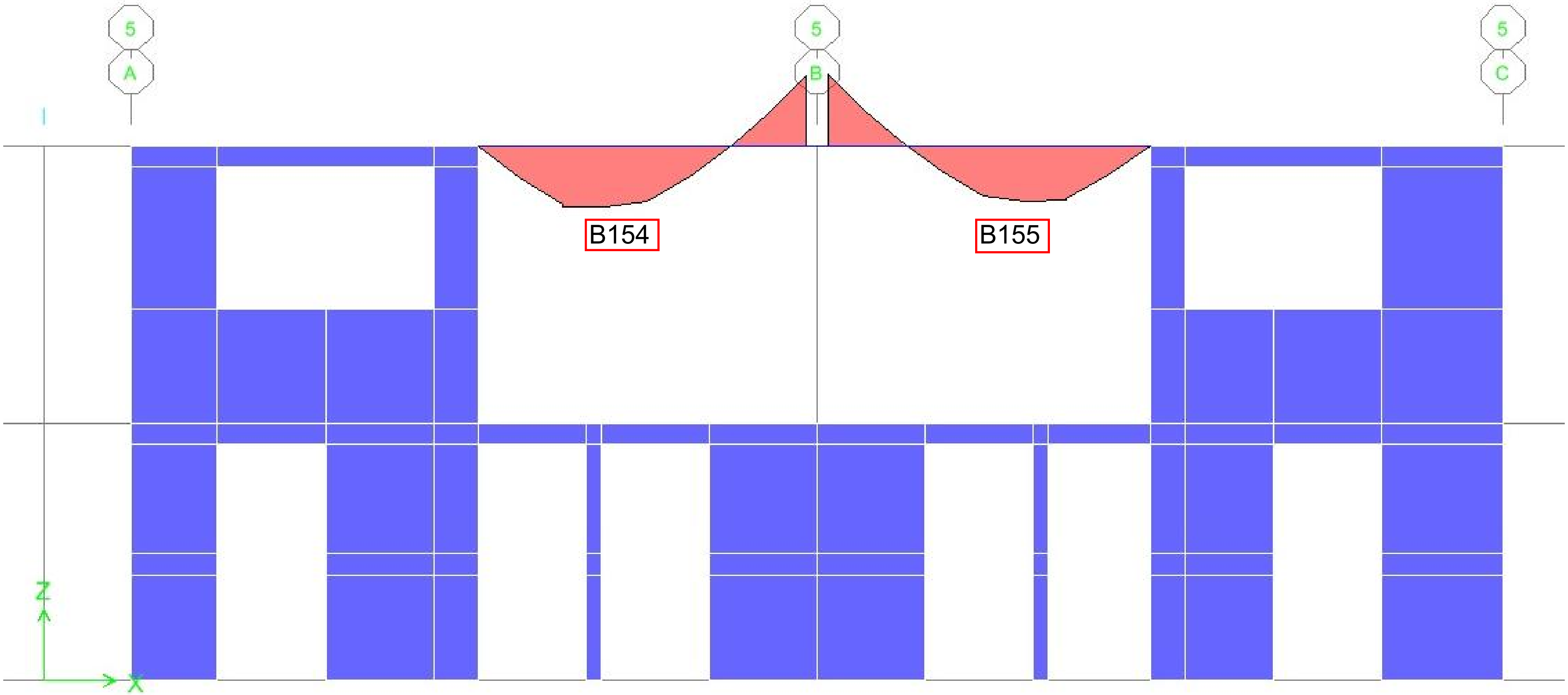
MOMENT DIAGRAM
AT GRIDLINE F



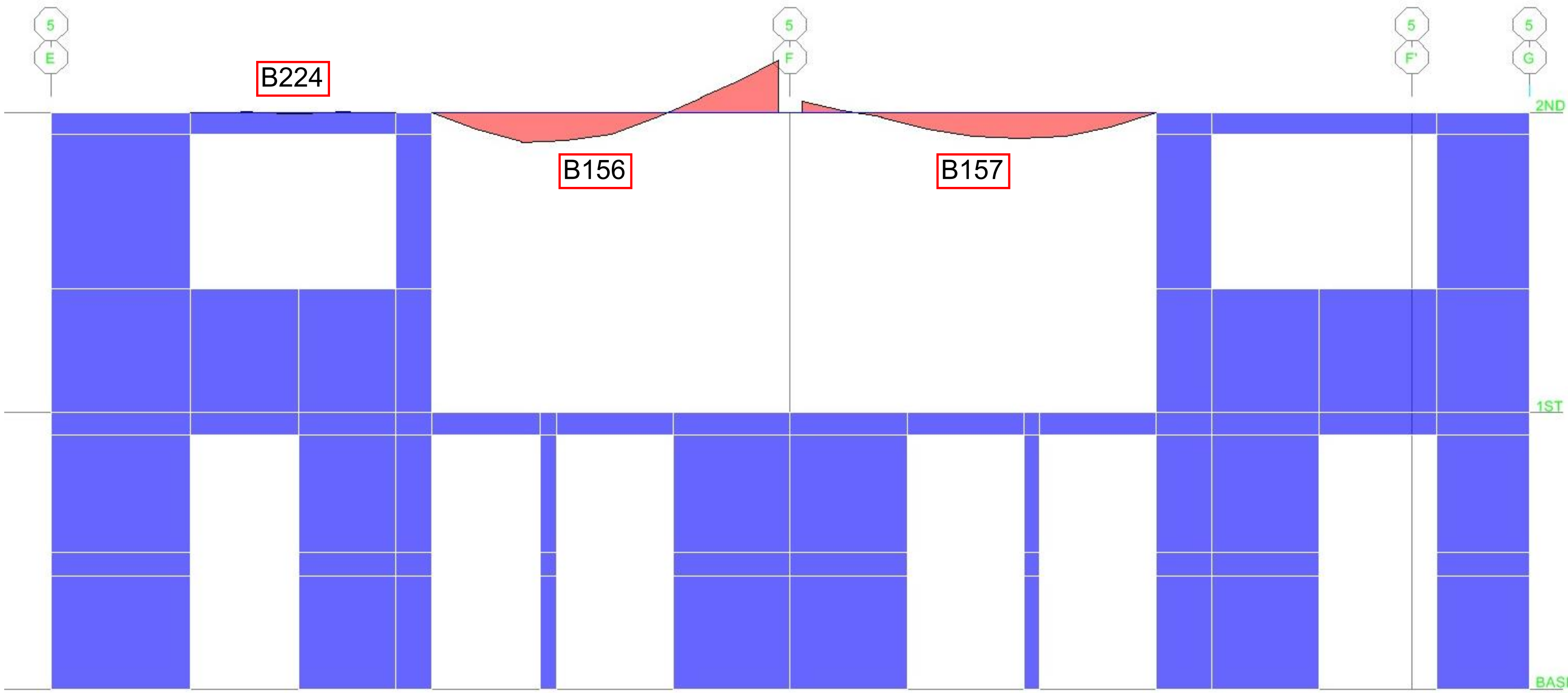
MOMENT DIAGRAM
BETWEEN GRIDLINE C AND D



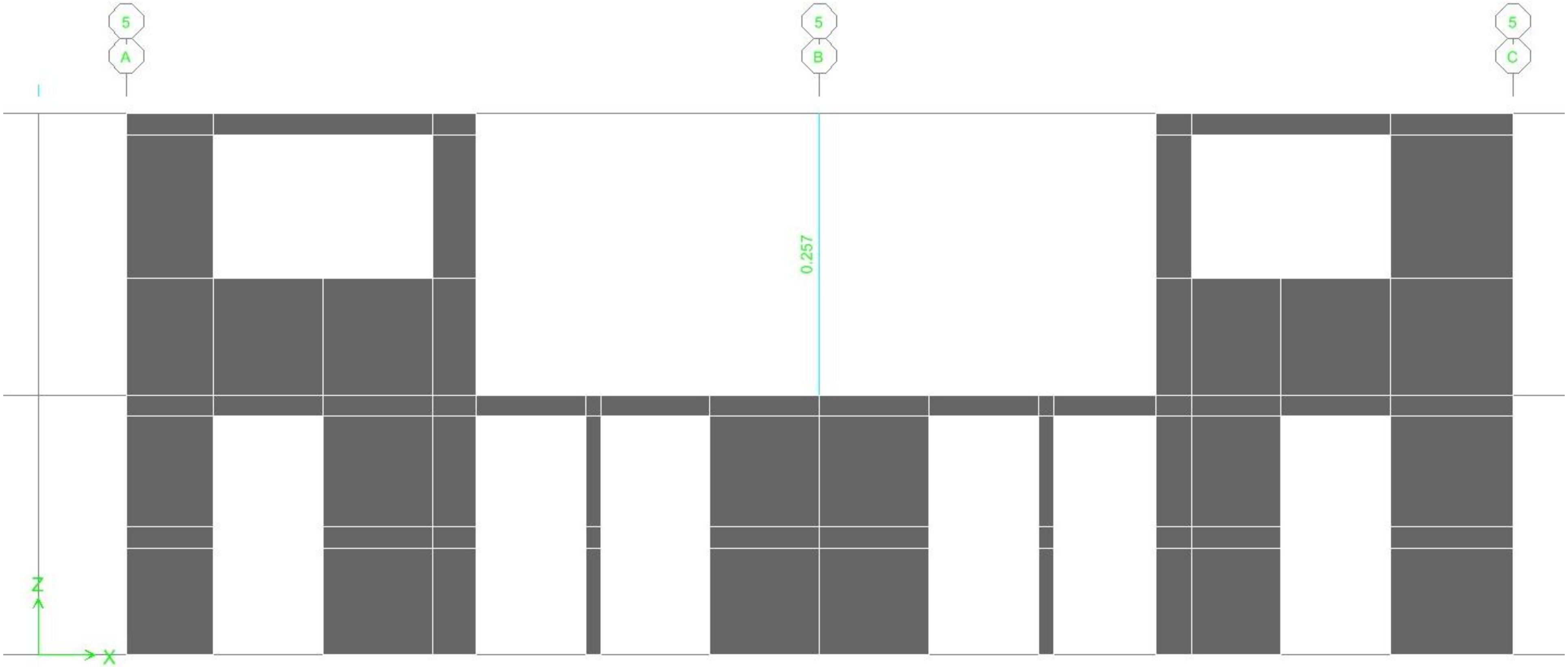
MOMENT DIAGRAM
BETWEEN GRIDLINE D AND D'



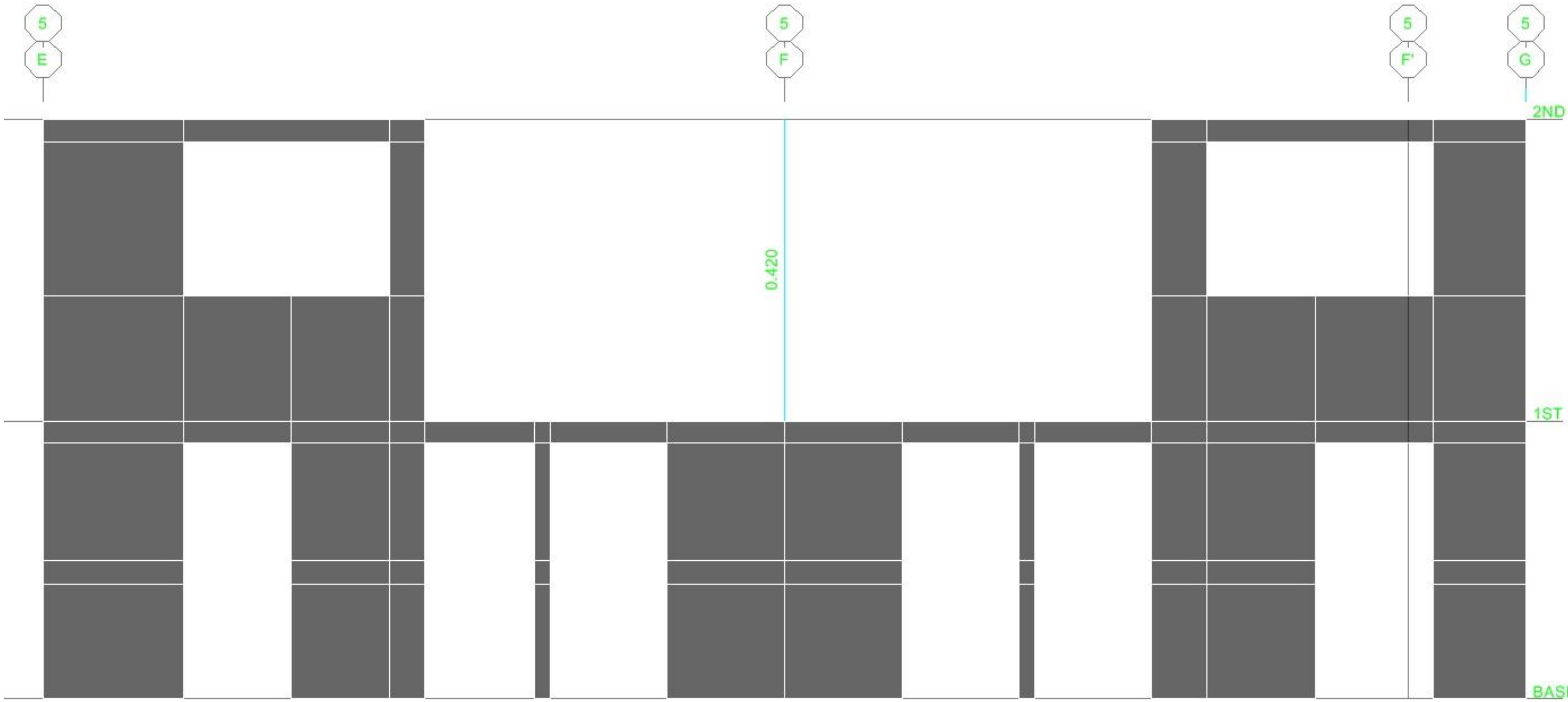
MOMENT DIAGRAM
AT GRIDLINE 5 - LEFT



MOMENT DIAGRAM
AT GRIDLINE 5 - RIGHT



DEMAND / CAPACITY RATIO AT
GRIDLINE 5 - LEFT



DEMAND / CAPACITY RATIO AT
GRIDLINE 5 - RIGHT

GHD

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
FINAL	Michael Javier	Stephen Lee		Nick Waddington		7/09/2012