

Detailed Seismic Assessment

7 Elmdale Lane, Linwood, Christchurch



28 July 2020

Change tracking:

Issue	Description	Date	Prep. by	Checked by
1	First issue	28/07/2020	DC	PM

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1 INTRODUCTION

SMC Design Studio has been engaged by Fitz Construction Ltd to carry out a detailed seismic assessment of the building at 7 Elmdale Lane, Linwood, Christchurch. The main purposes of the assessment were:

- Determine extent of the structural damage sustained by the building in the Canterbury earthquake sequence.
- Determine the current seismic capacity of the building in terms of percentage of New Building Standard (% NBS).
- Identify if the building has critical structural weaknesses in the seismic load resisting system that could affect performance of the building in a seismic event.
- Provide recommendations for further actions and seismic strengthening to 67% NBS.

2 BUILDING DESCRIPTION

The subject building is a single storey multi-unit precast concrete panel building. The building approximate plan dimensions are 34.6 m × 39.0 m.

The building importance level 2 is assumed.

The building consists of six workshop units designed in 1983 by Jon Aldridge (Architect) and Holmes, Wood, Poole & Johnstone (Structural Engineer). Architectural and structural drawings are available. This assessment is focused on Unit 7 only.



Figure 1: Aerial view (source – Canterbury maps)

2.1 Gravity force resisting system

The lightweight roof comprises longrun steel roofing sheets on steel channel purlins supported on concrete panels and, in some units, on steel roof beams.

2.2 Lateral force resisting system

The lateral force resisting system of the building consists of a combination of reinforced concrete panels and cantilevered reinforced concrete columns.

2.3 Foundations

The concrete panels are supported on foundation pads at each end. The cantilevered reinforced concrete columns are supported on concrete post holes.

3 SCOPE OF ASSESSMENT AND METHODOLOGY

The detailed seismic assessment included:

- Desktop study of the available architectural and structural design drawings.
- A walk-around visual inspection.
- A quantitative assessment of the seismic capacity of the building.

The available structural drawings are reasonably comprehensive.

A walk-around visual inspection of the exterior and the interior of the building was conducted by SMC engineers on 27 July 2020. The purpose of the inspection was to confirm the current state of the building and compare the original design drawings with the constructed building.

The inspection was limited to what is visible to the naked eye. No intrusive investigations or material testing was undertaken. No geotechnical assessment was carried out by as a part of this investigation.

This assessment excludes identifying of non-structural damage that can occur as a result of a seismic event.

In performing the quantitative assessment, SMC relied on a thorough examination of available drawings as well as visual observations made during the site visit. The assessment was carried out in accordance with the following documents:

- The Seismic Assessment of Existing Buildings, Technical Guidelines for Engineering Assessments, July 2017.
- NZS 3101:Part 1:2006. Concrete Structures Standard.
- NZS 3404:Part 1:1997. Steel Structures Standard.
- NZS 1170.5:2004. Structural design actions. Part 5: Earthquake actions – New Zealand.

The seismic capacity of the structure was assessed independently in two principal directions (north-south and east-west). The distribution of seismic forces by the diaphragm is based on tributary area to each line of LFRS.

4 DAMAGE ASSESSMENT RESULTS

No structural damage to the precast concrete was observed during our work-around inspection.

5 CRITICAL STRUCTURAL WEAKNESSES

The potential critical structural weaknesses (CSW) and their impact on the building are summarised in the table below.

Table 1: Critical Structural Weaknesses

Critical Structural Weakness	Assessment
Cantilevered reinforced concrete columns	The cantilevered columns supporting the precast concrete panels in the out-of-plane direction have a limited capacity available due to the relatively shallow post-hole foundations.
Internal precast concrete panels	The internal precast concrete panels span vertically between the floor slab and roof. However, the panels do not appear to be braced at the top.
Roof bracing	A substantial part of precast panels relies on roof fixings to provide the out-of-plane stability. Absence of roof bracing does not allow for the seismic force to be transferred to transverse panels

6 SEISMIC CAPACITY ASSESSMENT RESULTS

The quantitatively assessed lateral seismic capacity results are summarised in the table below.

Table 2: Assessed seismic capacity results

Element	% NBS	Notes
Unit 7		
Reinforced concrete panels, in-plane strength	45%	Governed by absence of roof bracing and lack of lateral support at the front of the unit
Reinforced concrete panels, out-of-plane strength	<15%	

The overall lateral seismic capacity of the building was found to be less than 34% NBS. Therefore, the unit is considered to be an earthquake-prone building.

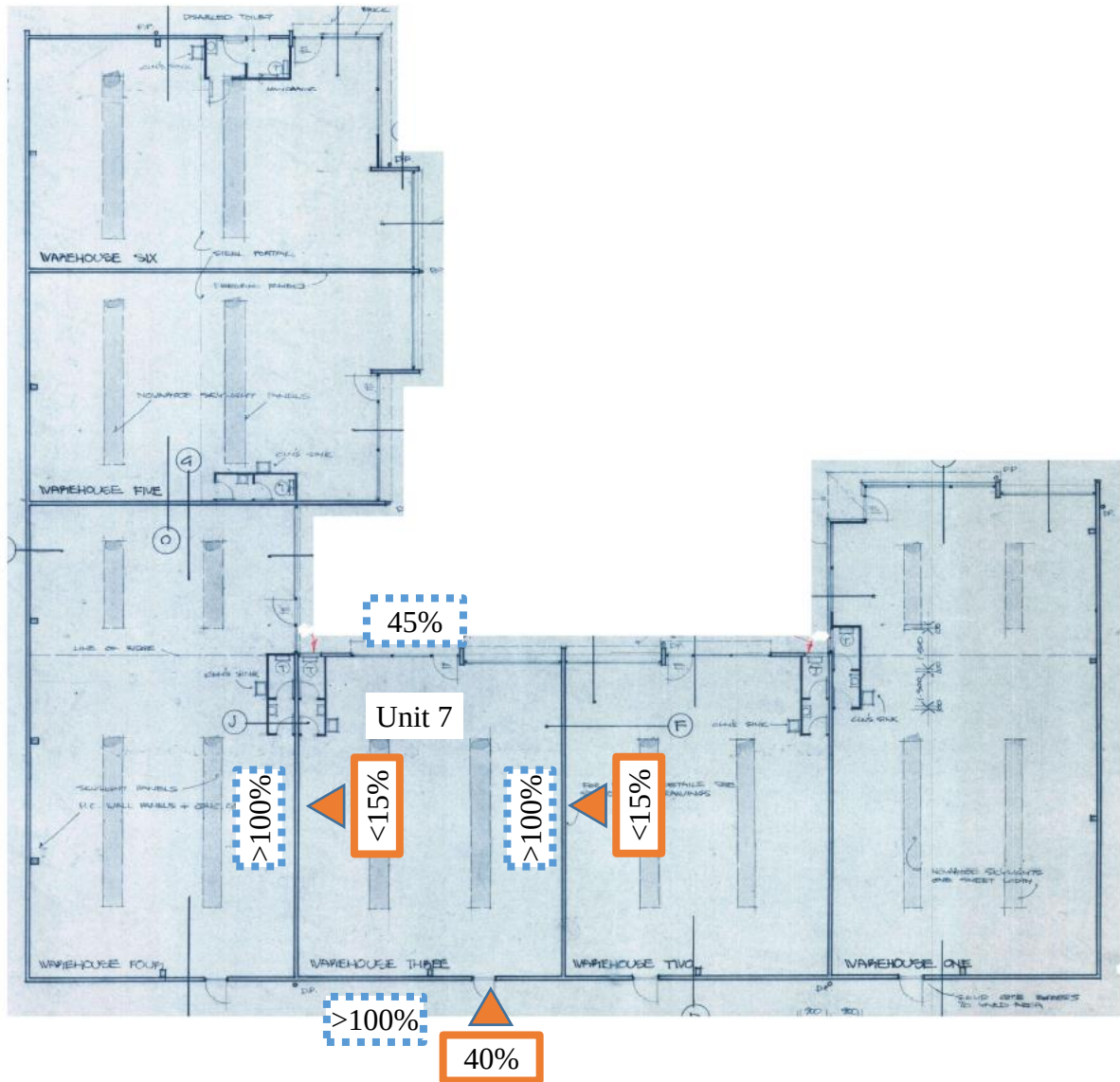
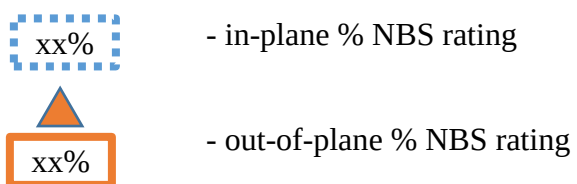


Figure 2: Assessed % NBS



7 RECOMMENDATIONS AND STRENGTHENING OPTIONS

It is generally recommended to strengthen existing buildings to at least 67% NBS to reduce the life-safety risk in an earthquake event to 'medium'. We strongly recommend to strengthen the unit to this level or higher.

The seismic strengthening will include the following:

- New steel whaler beams at the top of existing precast concrete panels.
- New steel rod roof level cross braces and steel struts.
- New cantilevered steel columns in post hole foundations

The assumptions made during our assessment are summarised in the Appendix B. Some of these assumptions may need to be verified during the seismic strengthening design.

8 SUMMARY

Unit 7 Elmdale Lane, Linwood, Christchurch was assessed by SMC engineers for structural damage and seismic lateral capacity in July 2020. No existing visible structural damage was identified.

The building is considered to be earthquake prone, as the minimum calculated seismic capacity is below 34% NBS.

The proposed strengthening measures consider the target strengthening level to be 67 %NBS. The assessment assumptions are summarised in the Appendix B and may need to be verified during the strengthening design stage.

9 LIMITATIONS

The detailed assessment and report are intended to evaluate *seismic* performance of the building under an ultimate limit state loading. Performance of the building under serviceability limit states, snow or wind loadings is not reviewed as a part of this assessment.

The assessment was based on a visual inspection of the exterior and the interior of the buildings. No material testing was undertaken at this stage.

A reasonable care was taken to verify whether the building was constructed in accordance with the available plans. However, some of the building dimensions may be different from those shown on the plans, as a complete building survey was not undertaken as part of the assessment. Similarly, the existing structure may vary from the plans where it was not visually available for an inspection.

Where structural members are hidden behind claddings and linings, it is assumed that such members are in satisfactory condition. For the fully clad structures with high exposure to elements, and where water egress issues may be not obvious, it is expected that a regular maintenance program is in place that allows for removing of claddings and thorough inspection of the structural members.

Action	Name	Signed	Date
Prepared by	Denis Chernyshov, Structural engineer, CMEngNZ, CPEng # 1025549		28/07/2020
Reviewed by	Paul Milkin, Director		28/07/2020

APPENDIX A – ABBREVIATIONS

CES	–	Canterbury Earthquake Sequence
CSW	–	Critical structural weakness
DSA	–	Detailed Seismic Assessment
EPB	–	Earthquake-prone building – refers to definition in the Building Act 2004 i.e. < 33%NBS
IEP	–	Initial Evaluation Procedure
IL	–	Importance level (as defined in NZS 1170.0)
ISA	–	Initial Seismic Assessment
LFRS	–	Lateral Force Resisting System
NBS	–	New Building Standard – i.e. the standard that would apply to a new building at the site. This includes loading to the full requirements of the Standard
NZS	–	New Zealand Standard
NZSEE	–	New Zealand Society for Earthquake Engineering
%NBS	–	Percentage of new building standard
(%NBS) _t	–	Target percentage of new building standard

APPENDIX B – ASSUMPTIONS

The following assumptions have been made for our seismic assessment. These assumptions may need to be further investigated if seismic strengthening of the building is considered.

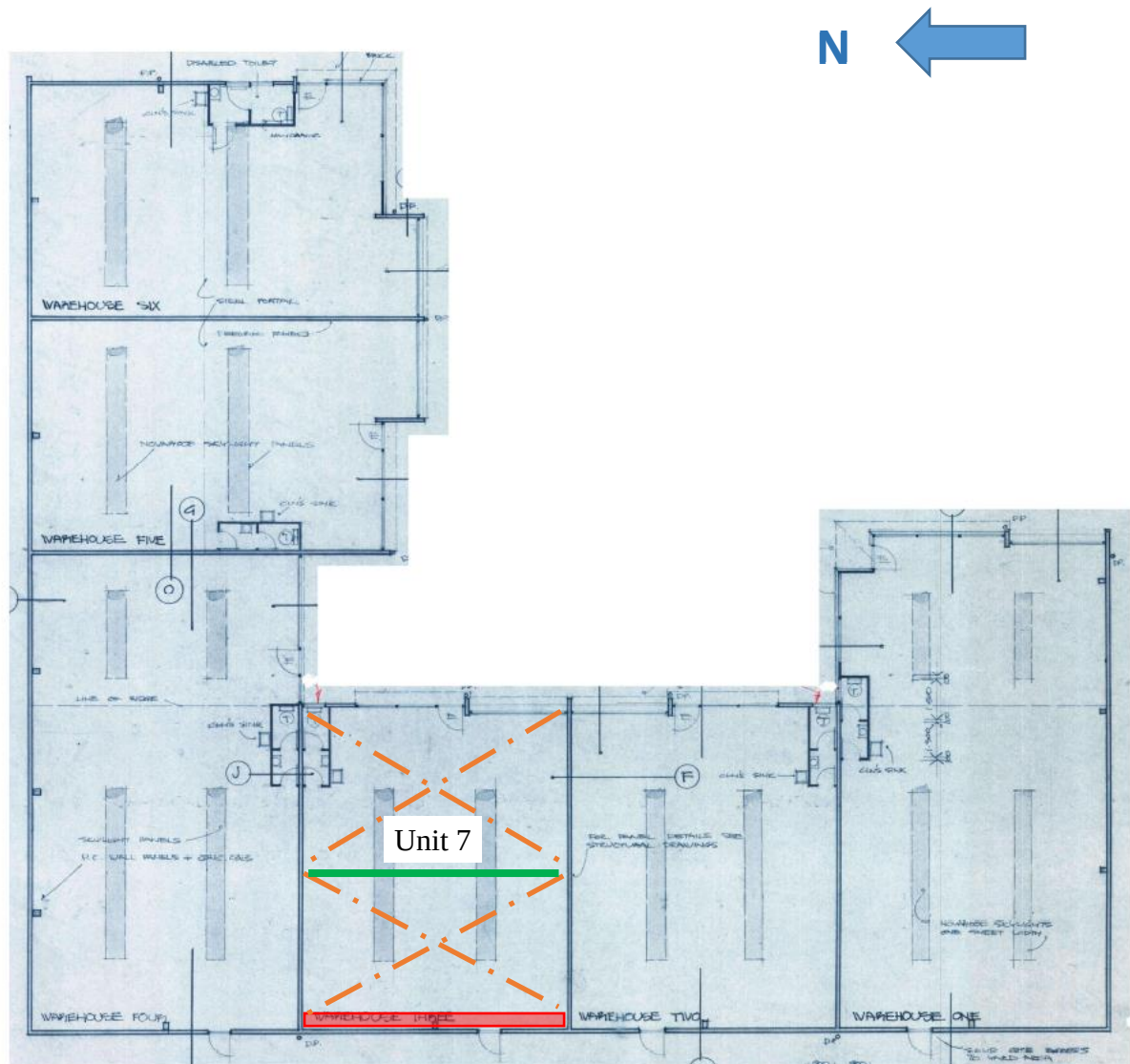
- | | | |
|--|-----|---------|
| • Site subsoil class (as defined in NZS 1170.5) | | D |
| • Available ultimate ground bearing capacity below foundations | | 200 kPa |
| • Building importance level | | IL2 |
| • Nominal concrete compressive strength | | 30 MPa |
| • Yield strength of bar reinforcement | (D) | 275 MPa |
| | (H) | 380 MPa |
| • Yield strength of steel mesh | | 485 MPa |
| • Displacement ductility factor for concrete columns and panels (in-plane) | | 1.25 |
| • Displacement ductility factor for concrete panels (out-of-plane) | | 1.25 |

APPENDIX C – PHOTOGRAPHS



Photo C 1 – Front façade (unit 7)

APPENDIX D – PROPOSED STRENGTHENING SKETCHES



SK-1 – Preliminary strengthening plan (67% NBS)

- steel channel waler beam along the top of precast panel
- steel bar cross brace at roof level below purlins
- cantilevered steel column in post-hole foundation
- steel strut between concrete panels at the roof bracing level

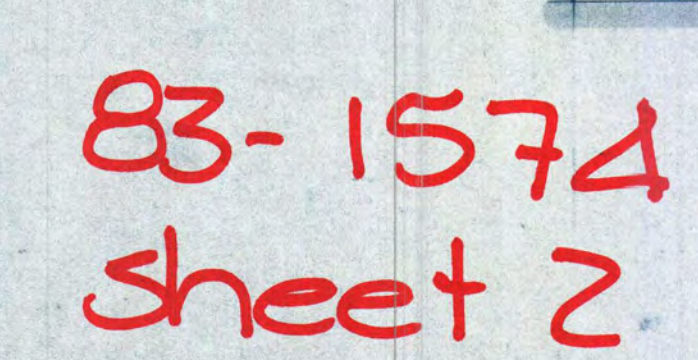
APPENDIX E – ORIGINAL DESIGN DRAWINGS

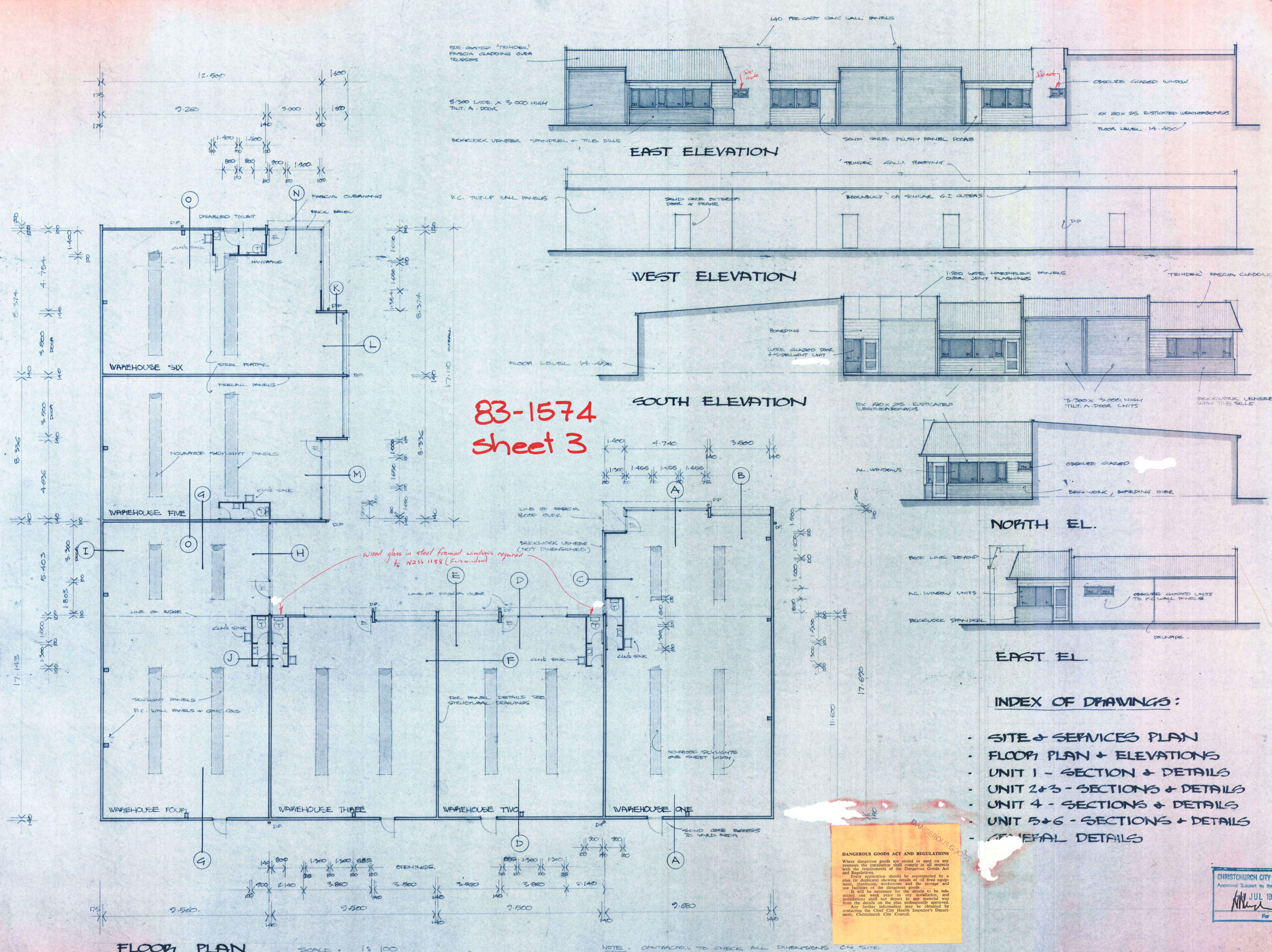
MEMBER OF THE R.B.L. GROUP

**RESEARCH
BUILD
LIMITED**

215 GLOUCESTER ST. CHRISTCHURCH
P.O. BOX 13-207 PHE 781-692

Fig. 1



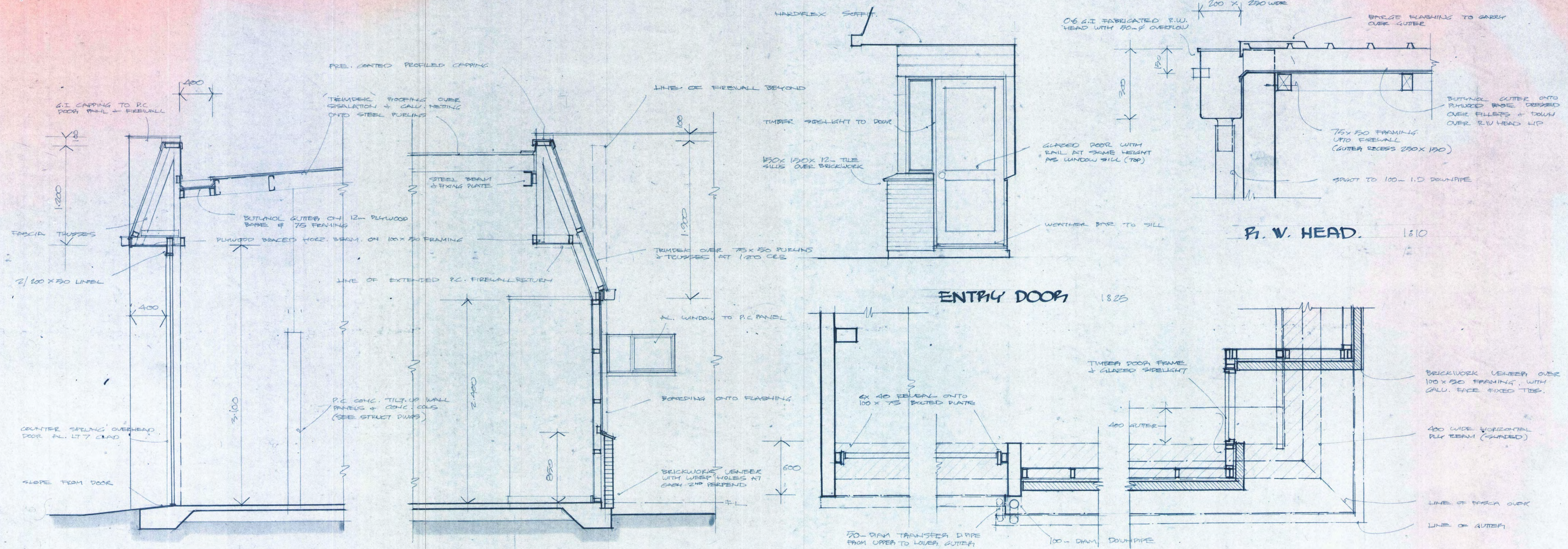


83-1574
sheet 3

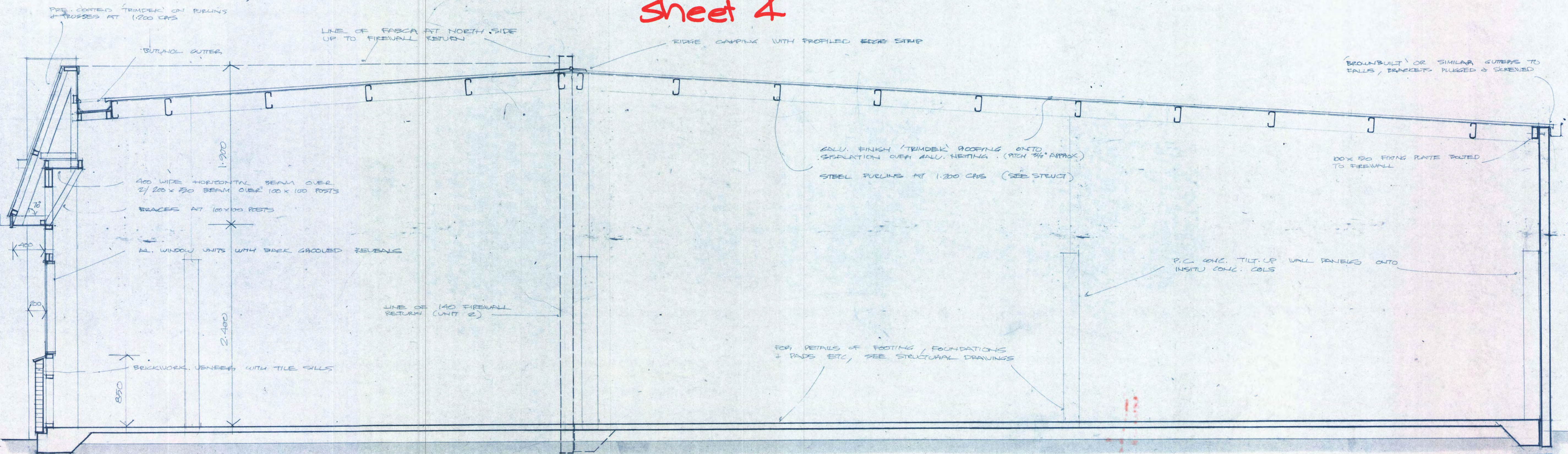
- INDEX OF DRAWINGS:**
- SITE & SERVICES PLAN
 - FLOOR PLAN & ELEVATIONS
 - UNIT 1 - SECTION & DETAILS
 - UNIT 2+3 - SECTIONS & DETAILS
 - UNIT 4 - SECTIONS & DETAILS
 - UNIT 5+6 - SECTIONS & DETAILS
 - GENERAL DETAILS

DANGEROUS GOODS ACT AND REGULATIONS
Where dangerous goods are stored or used on any premises the installation shall comply in all respects with the requirements of the Dangerous Goods Act and Regulations.
Every application should be accompanied by a plan (in duplicate) showing details of all fire equipment, plantrooms, workrooms and the storage and use facilities of the dangerous goods.
It will be necessary for the details to be submitted one week prior to any installation, and installations shall not depart in any material way from the details on the plan subsequently approved.
Any further information may be obtained by contacting the Chief City Health Inspector's Department, Christchurch City Council.

CHRISTCHURCH CITY COUNCIL
Approved Subject to the Bylaws
JUL 1983
For Engineer



83-1574
Sheet 4



CROSSSECTION A.

SCALE 1/8" = 1'-0"

NOTE: CONTRACTOR TO CHECK ALL DIMENSIONS ON SITE BEFORE STARTING ANY WORKS.



RESEARCH BUILD LIMITED
PROPERTY DEVELOPERS
P.O. BOX 13-207
CHRISTCHURCH

6 UNIT WAREHOUSE COMPLEX FOR
ESSEX DEVELOPMENT COMPANY



DESIGNED BY: JON ALFRED NEWMAN
ARCHITECTS
CHRISTCHURCH
DATE: APRIL 1983
ENGINEERS: HOLDING, WOOD, POOLE & SOUTHERN
CHRISTCHURCH

LINE OF FIREWALL STEP-UP AT FASCIA

FLASHING UNDER CARPING

HARDIFLEX SOFFIT OVER RLY BEAM

WALL LINE (FRAMING) BEYOND P.C. COL.

COUNTERSINKING OVERHEAD DOOR, 177 CLAD

SECTION E

TEMPER ROOFING WITH PROFILED FLASHING UNDER FASCIA CARPING

ROOFING ONTO SEALATION, NETTING & STEEL PURLINS

PURLIN FIXINGS, SEE STRUCT. DETAIL PAGE

FASCIA TRUSSES AT 1200 OVER BEAM

ENTRY SOLID CORE DOOR & FRAME

3,300 WIDE X 3,000 H OVERHEAD DOOR

EX 40 REVEAL OVER 100 X 75 S.B. FRAME

SECTION F

SCALE - 1:25

140 FIREWALL RETURN WITH REBATE & DIP

ALUMINIUM FRAMES OVER SEALANT TO REBATE

45° REBATED SILL TO OPENINGS

FIREWALL WINDOW

1:5

HARDIFLEX OVER RLY BEAM

CUTTER ONTO FASCIA RD.

50% DAM TRANSFER DOWNPIPE TO LOWER CUTTER

THREE REVEALS FOR FIXINGS (RUBBER)

HARDIFLEX PANEL BEHIND BRIDGE FLASHING

DOWNPIPE TO P.C. 600 COL

TRANSFER D.P.

1:10

STANDARD TEMPER ROOFING OVER SEALATION & GALL. NETTING

STEEL PURLINS ONTO FIREWALL

FIREWALL / ROOF

1:5

STEEL PURLINS AT 1200 C/S SEE STRUCT FOR END FIXINGS

P.C. TILT-UP CONC. WALL PANELS WITH CONC. HALF C/S (SEE STRUCT FOR JOINT DETAILS)

SEE STRUCT FOR ALL FOUNDATION & FOOTING DETAILS

'BROWNBILT' OR SIMILAR G.I. OUTERS TO FALLS / BRACKETS FIXED TO FIREWALL PANELS

100x50 FIXING PLATED BOLTED WITH TEMPORARY FIXINGS AT ROOFS

LINE OF BOUNDARY

DRAINAGE EASEMENT

CROSSSECTION D.

SCALE - 1:25

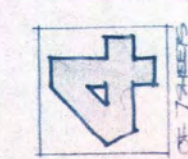
NOTE: CONTRACTOR TO CHECK ALL DIMENSIONS ON SITE BEFORE STARTING ANY WORKS.

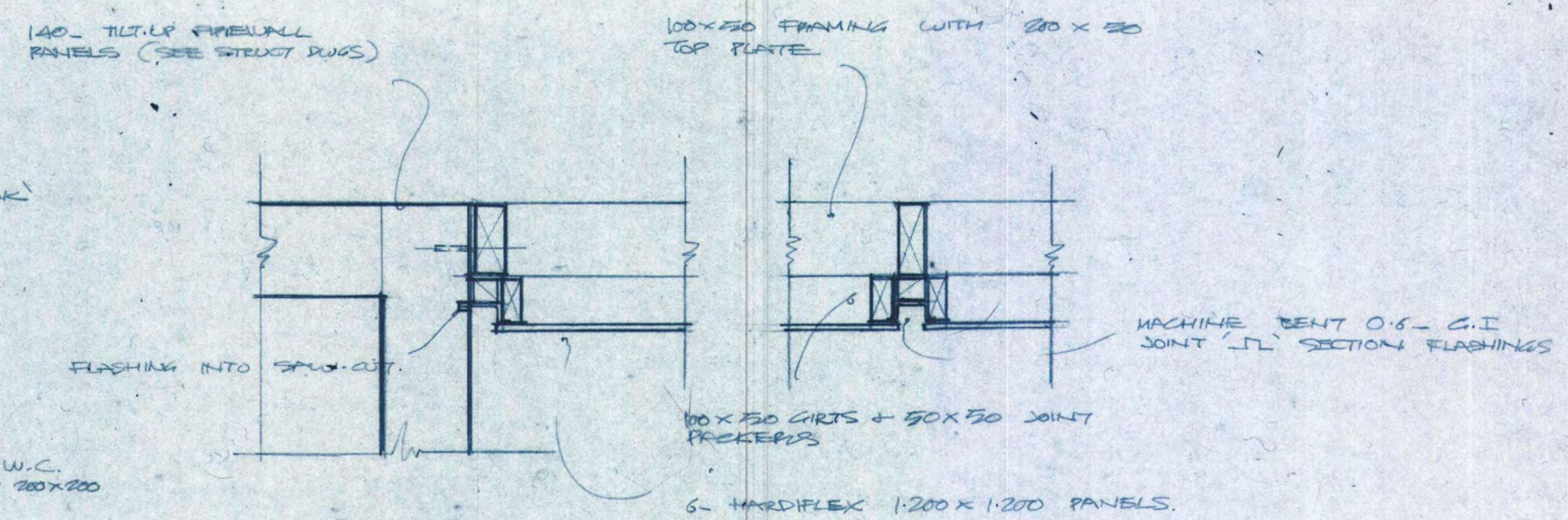


6 UNIT WAREHOUSE COMPLEX FOR
ESSEX DEVELOPMENT COMPANY

RESEARCH BUILD LIMITED
PROPERTY DEVELOPERS
P.O. BOX 13-207
CHRISTCHURCH

DESIGNER: JON MARRAS, 1000 MARSHALL RD, BOX 13-207, CHRISTCHURCH, 781
DATE: APRIL 1983
ENGINEER: JON MARRAS, 1000 MARSHALL RD, BOX 13-207, CHRISTCHURCH, 781





Hand-drawn architectural sketches showing details of a parapet wall and roof edge.

Left Sketch (Parapet Wall Detail):

- EDGE FLASHING OVER ROOFING
- 10" X 50" FIXING PLATE BOLTED AT 8" O.C.
- 140 CONG. WALL PANELS

Right Sketch (Roof Edge Detail):

- MACHINE BENT 0.62 GI FIREWALL PARAPET CAPPING (PANEL NOTED)
- ROOF EDGE
- BROWN-BUILT OR SIMILAR GUTTERS TO FALLS

SECTION J.

PARAPET / GUTTER DETAIL 1:10

Architectural drawing of a building elevation, likely a side or rear view, showing a structure with a gabled roof and a large window. The drawing includes numerous handwritten annotations and dimensions.

Annotations:

- INTERIOR CUTTER SEE SHEET 6.
- FLASHING TO BACK OF FACIA + OVER ROOFING
- STEEL PURLINS ONTO STEEL BEAM (FIXINGS SEE STRUCT)
- STEEL PURLINS AT 1200 C/S
- ROOF FLASHINGS
- STANDARD GALL. 'TIMBER' ROOFING OVER DOUBLE SPEED SEALANT + GALL. NETTING
- LINE OF FACIA
- 150. DRAIN VENTS TO OUTSIDE FROM LOBBY + W.C. SPACE
- FIXING RATE ONTO PS CONC. WALL PANELS
- 6X 40 REVEALS OVER 100 X 75 SUB-FRAME BOLTED TO CONC. PANELS / COLS
- 3.000
- WIDE SPEED DOOR + SIDE LIGHT
- 3.300 W X 3.000 H OVERHEAD DOOR
- 1.800
- 800 DOOR + SIDELIGHT
- GIB. BOARD LINING OVER 100 X 50 FARMING
- SKIRTINGS AS REQUIRED
- FOR DETAILS OF WALL PANELS, FOOTINGS & FOUNDATIONS SEE STRUCT. DRAWINGS
- CONC. HALF COLS

Dimensions:

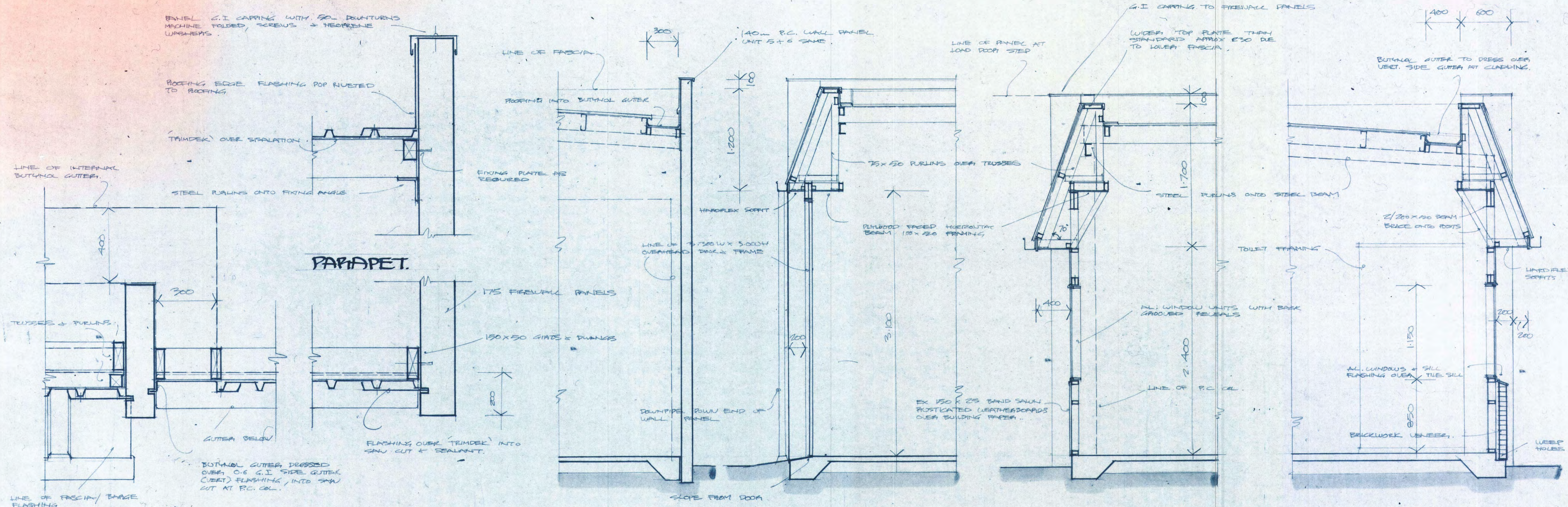
- 1.800
- 3.000
- 3.300 W X 3.000 H OVERHEAD DOOR

Other Notes:

- sheet 6
- sheet 7

CROSSSECTION 4. DATE: 10/25

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1983
For Engineer



PLAN DETAIL

1:10

PLAN FIREWALL

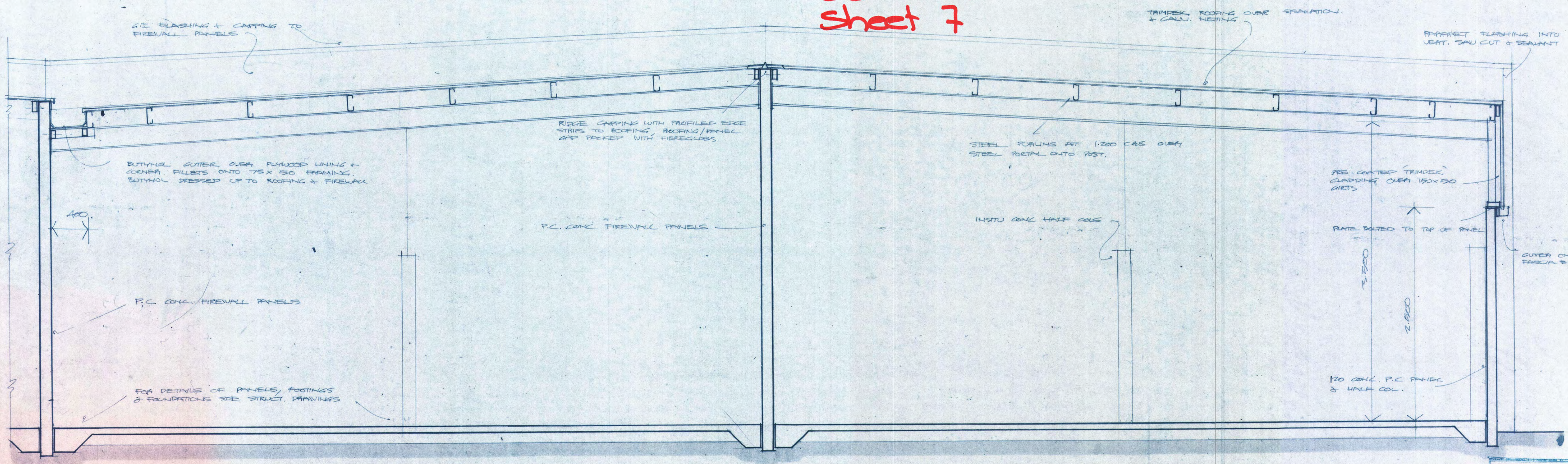
SECTION K

SECTION L

SECTION M

SECTION N

83-1574
Sheet 7



CROSSSECTION O.

SCALE 1:25

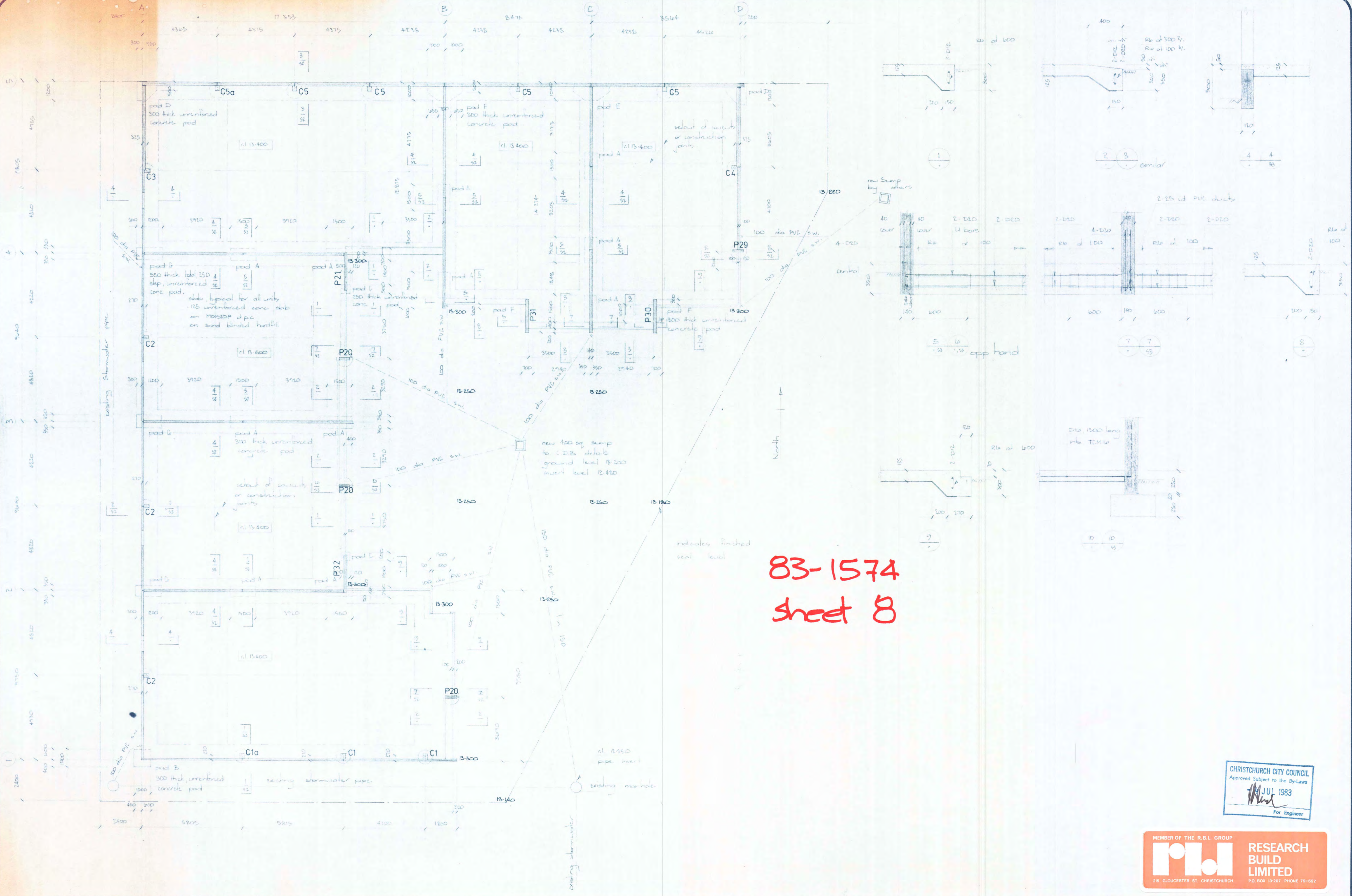
NOTE: CONTRACTOR TO CHECK ALL DIMENSIONS ON SITE BEFORE STARTING ANY WORKS.

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Approved Subject to the Exchange
14 JUL 1983
For Engineer

RESEARCH BUILD LIMITED
PROPERTY DEVELOPERS
P.O. BOX 13-207
CHRISTCHURCH

6 UNIT WAREHOUSE COMPLEX FOR
ESSEX DEVELOPMENT COMPANY

DESIGNER: JON ALDRIDGE, NEEDHAM ROAD, CHRISTCHURCH, DUNEDIN 71
DATE: MAY 1983
DRAWN BY: JON ALDRIDGE, NEEDHAM ROAD, CHRISTCHURCH, DUNEDIN 71



CHRISTCHURCH CITY COUNCIL
Approved Subject to the By-Laws
JUL 1983
For Engineer

MEMBER OF THE R.B.L. GROUP
RESEARCH BUILD LIMITED
210, GLOUCESTER ST. CHRISTCHURCH P.O. BOX 13 207 PHONE 791 692

RESEARCH BUILD LTD.
and
JON ALDRIDGE
NZCO (Arch) MNZFAD

Holmes Wood Poole & Johnstone Ltd
Consulting Civil & Structural Engineers
Christchurch Wellington & Auckland

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SITE & FLOOR PLAN

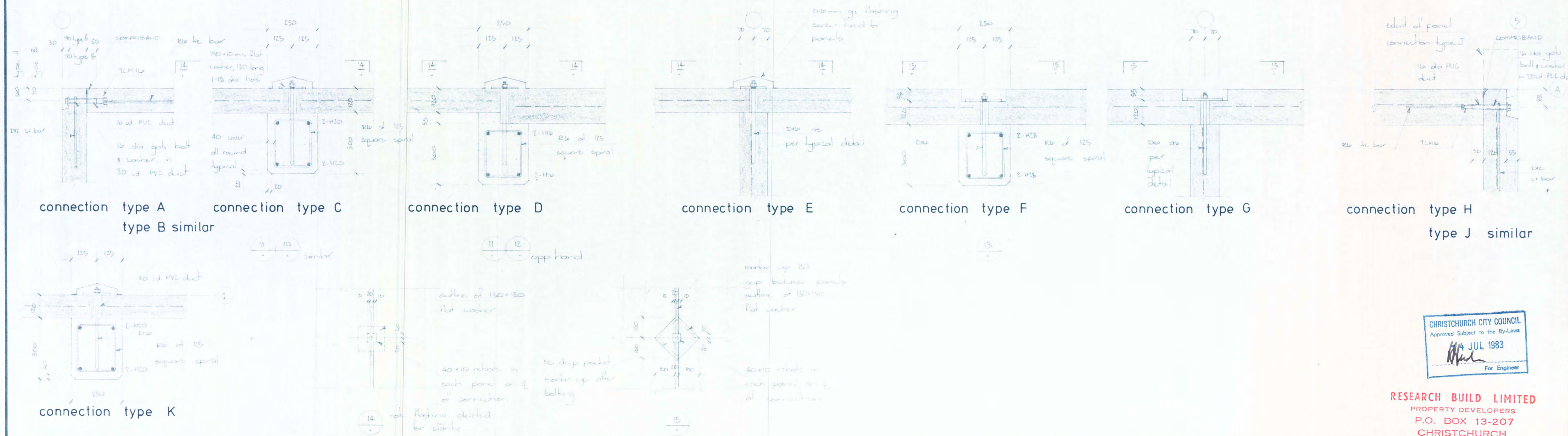
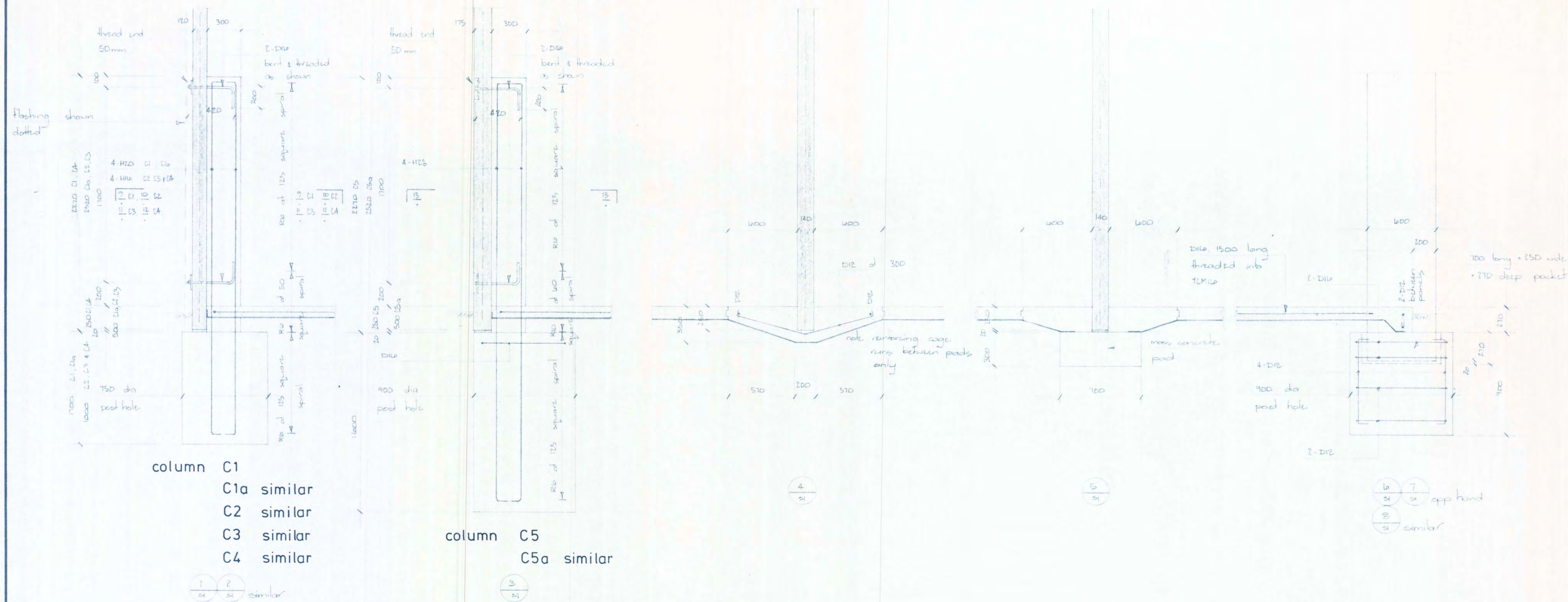
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Drawn H.M.F.
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Approved

D	
C	
B	
A	

10 5 83 Contract

2052/S1

The Contractor shall verify all dimensions prior to commencing work



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For Engineer

RESEARCH BUILD LIMITED
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NZCD (Arch) MNZFAD

Holmes Wood Poole & Johnstone Ltd
Consulting Civil & Structural Engineers
Christchurch Wellington & Auckland

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COLUMNS C1 - C5a
CONNECTIONS A - K

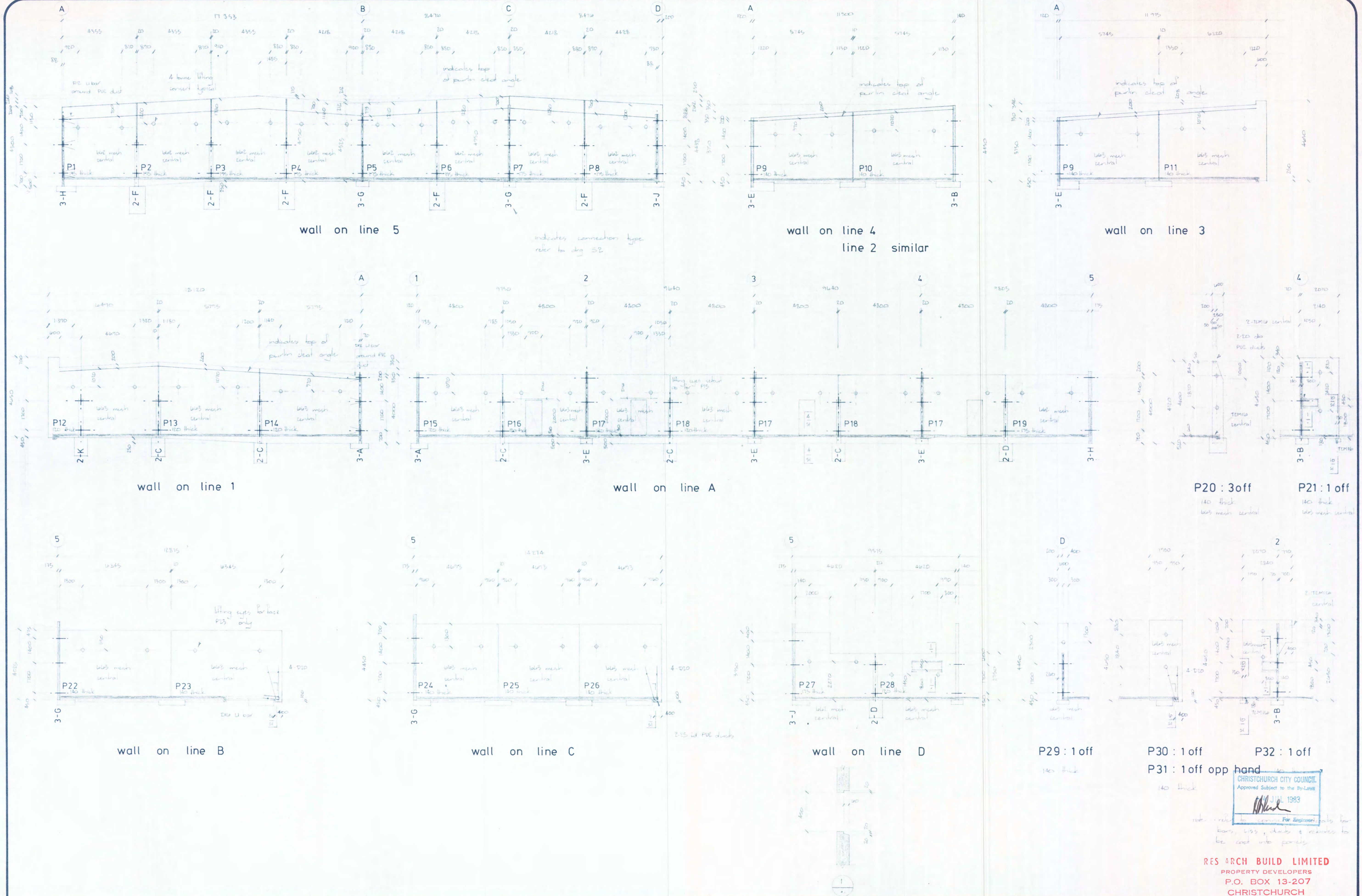
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Traced
Approved

D
C
B
A

10 5 83 Contract

2052/S2

The Contractor shall verify all dimensions prior to commencing work



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WALL ELEVATIONS

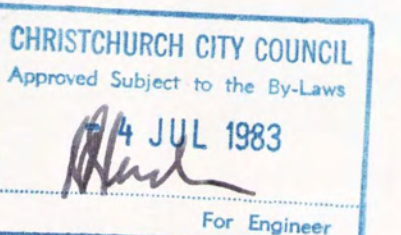
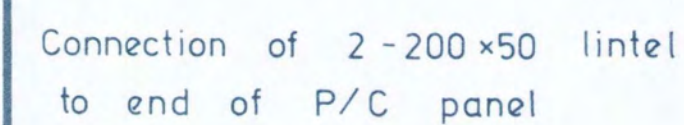
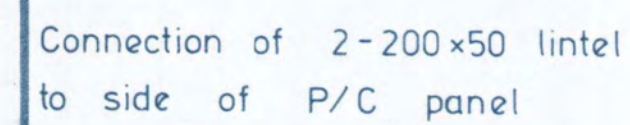
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Approved

D
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10.5.83 Contract

2052/S3

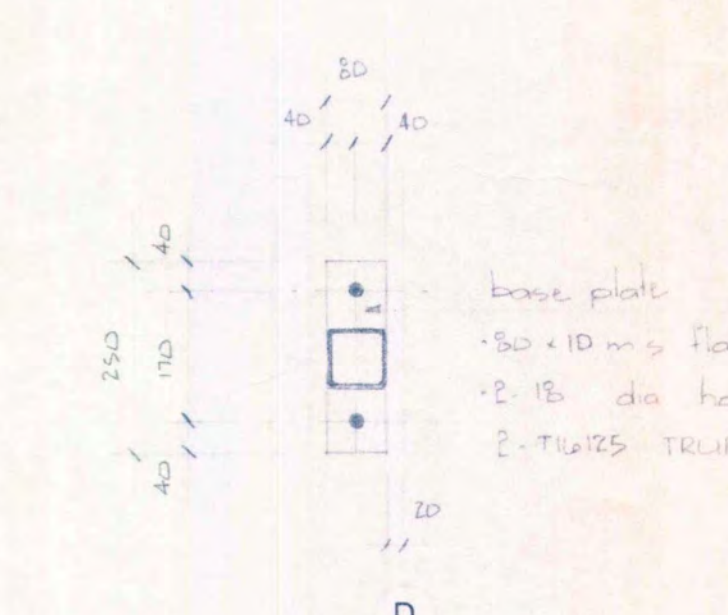
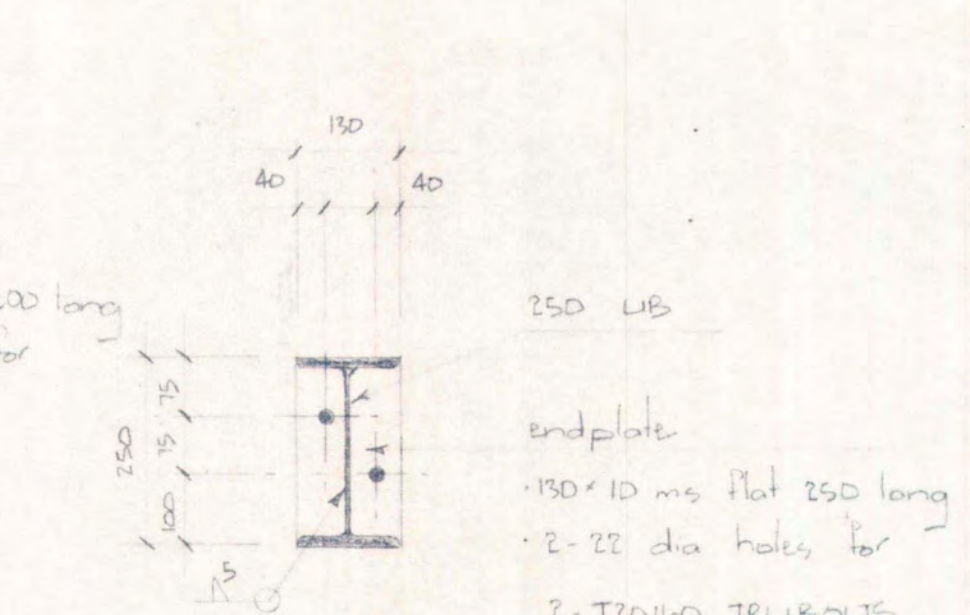
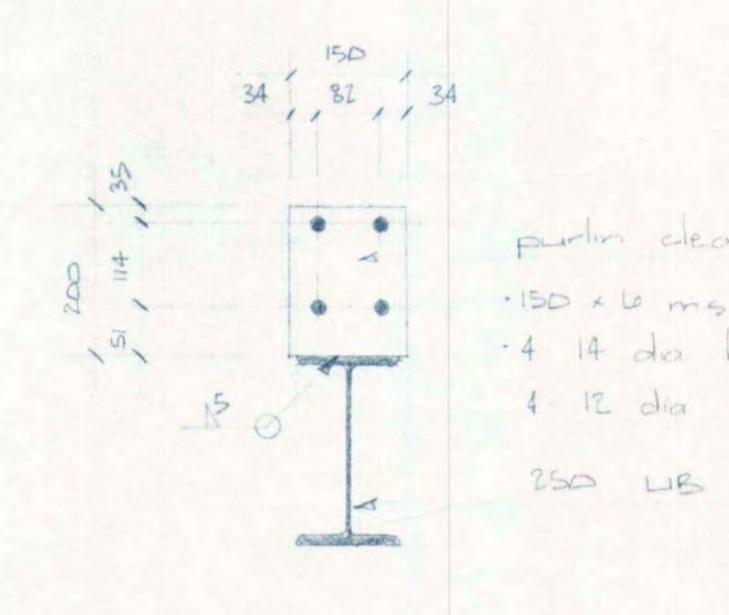
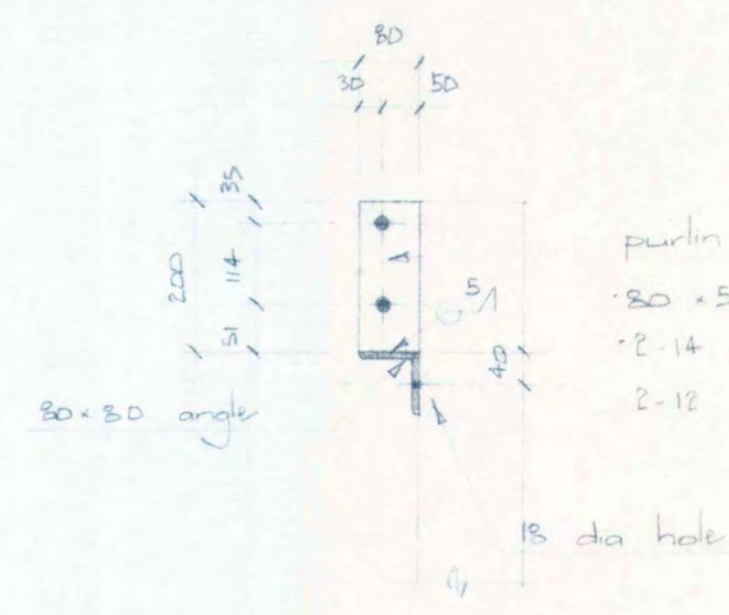
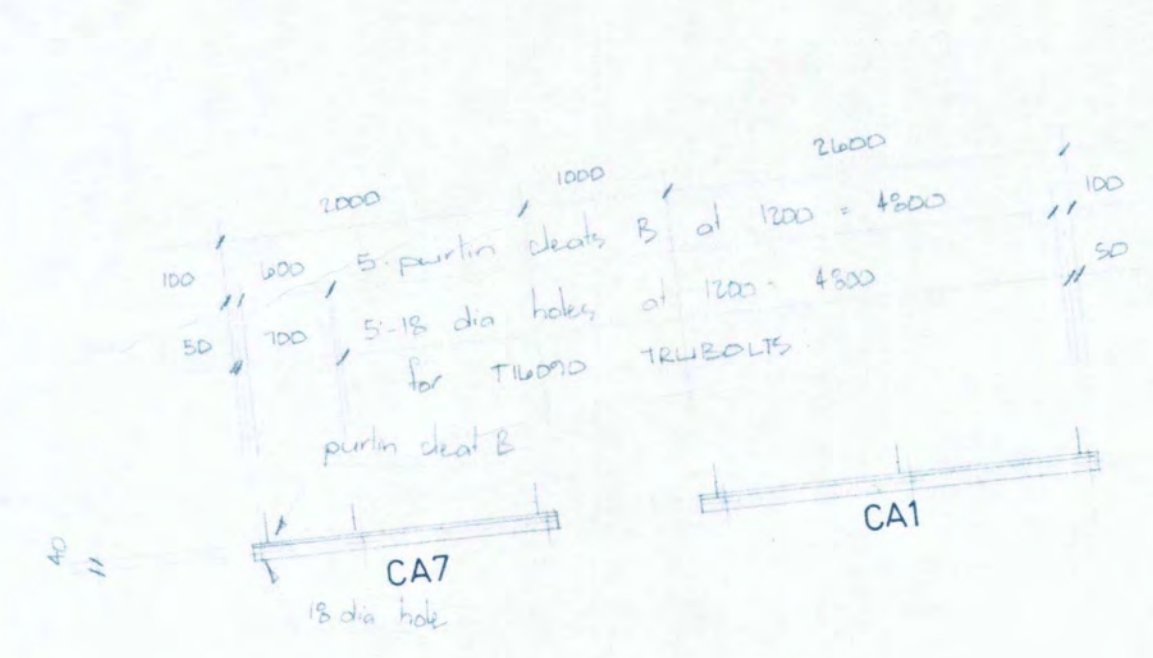
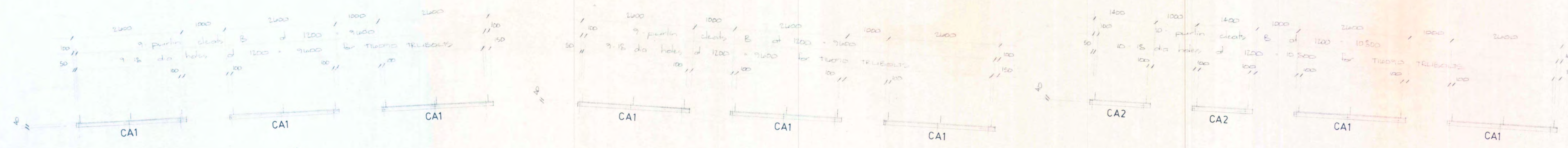
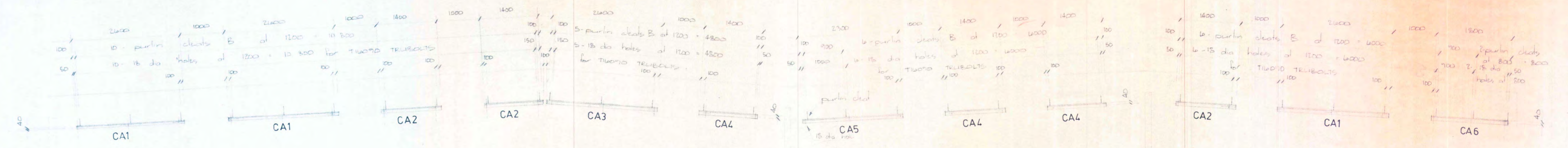
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P.O. BOX 13-207
CHRISTCHURCH

note: refer to contract For Engineers' details for
bars, LSS, etc. & refer to be cast into panels

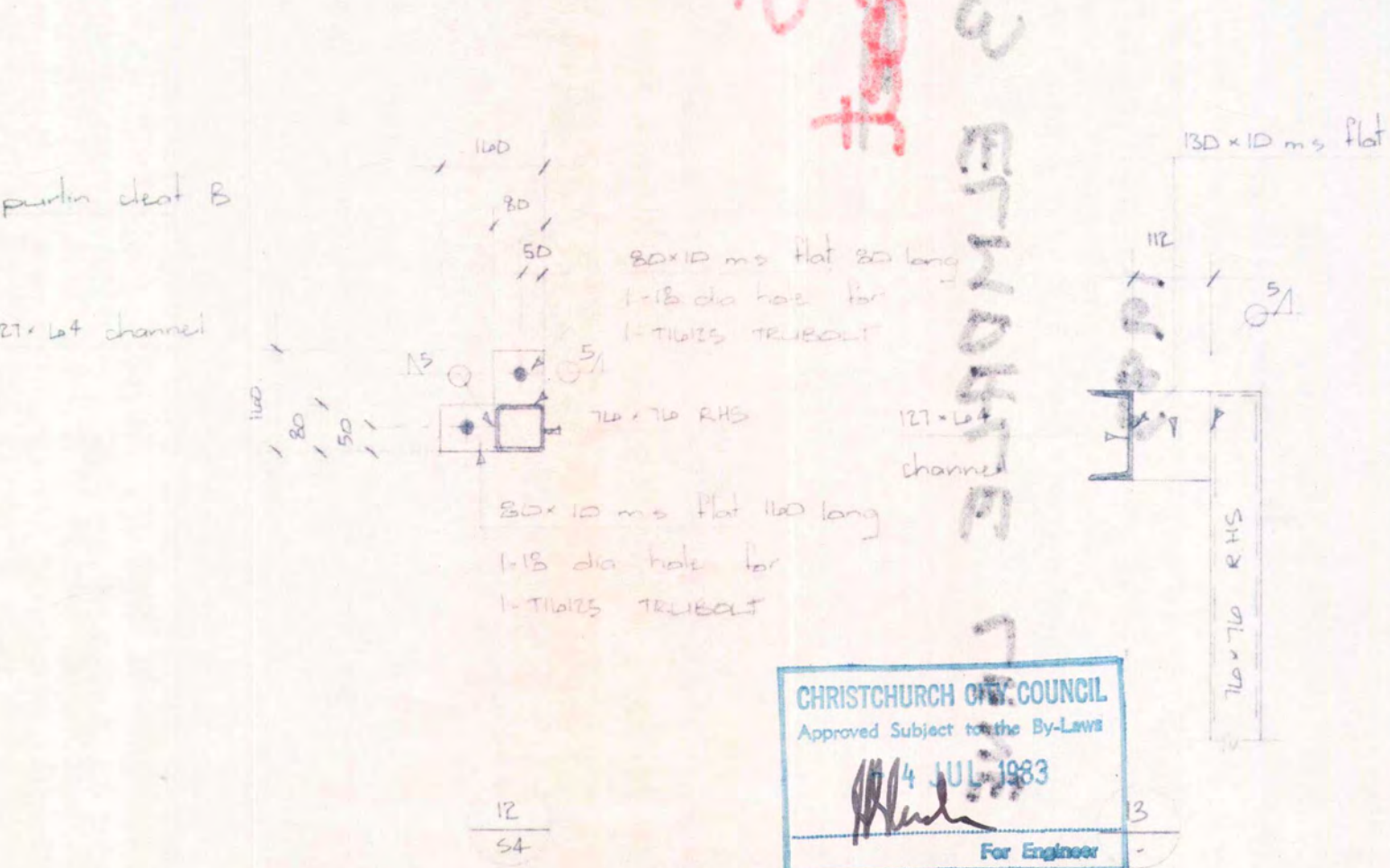
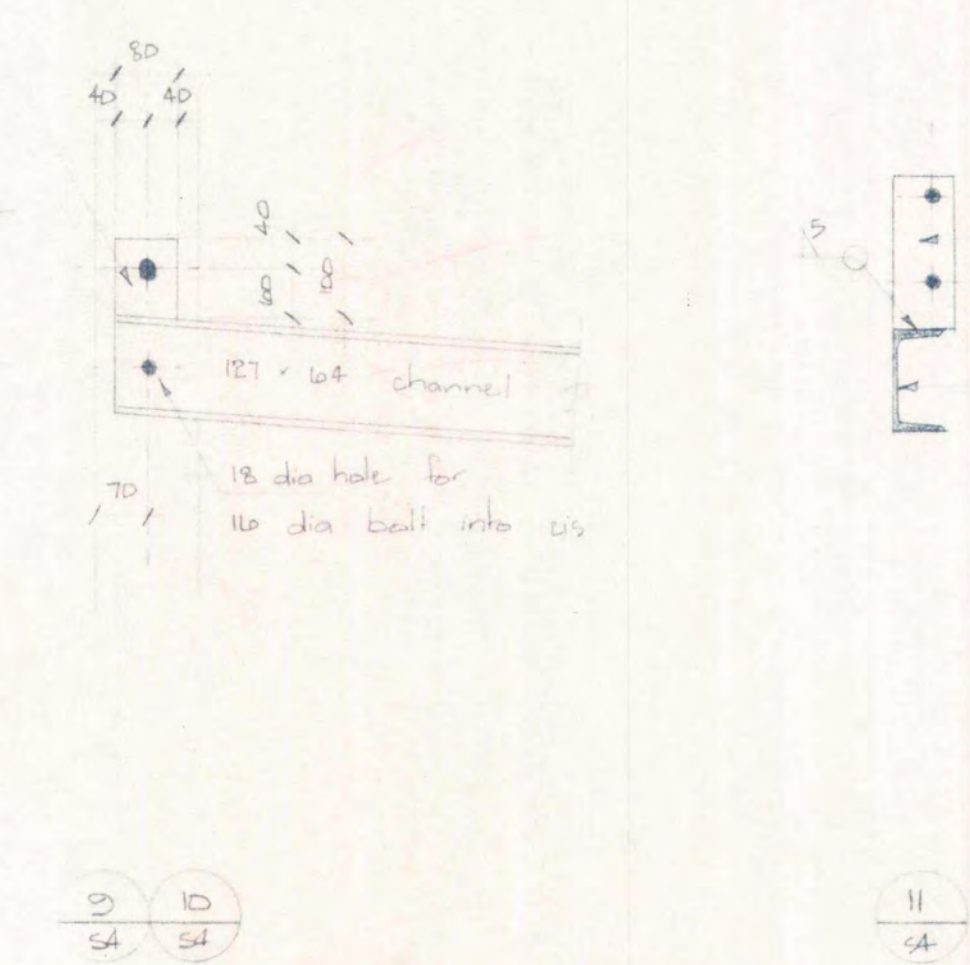
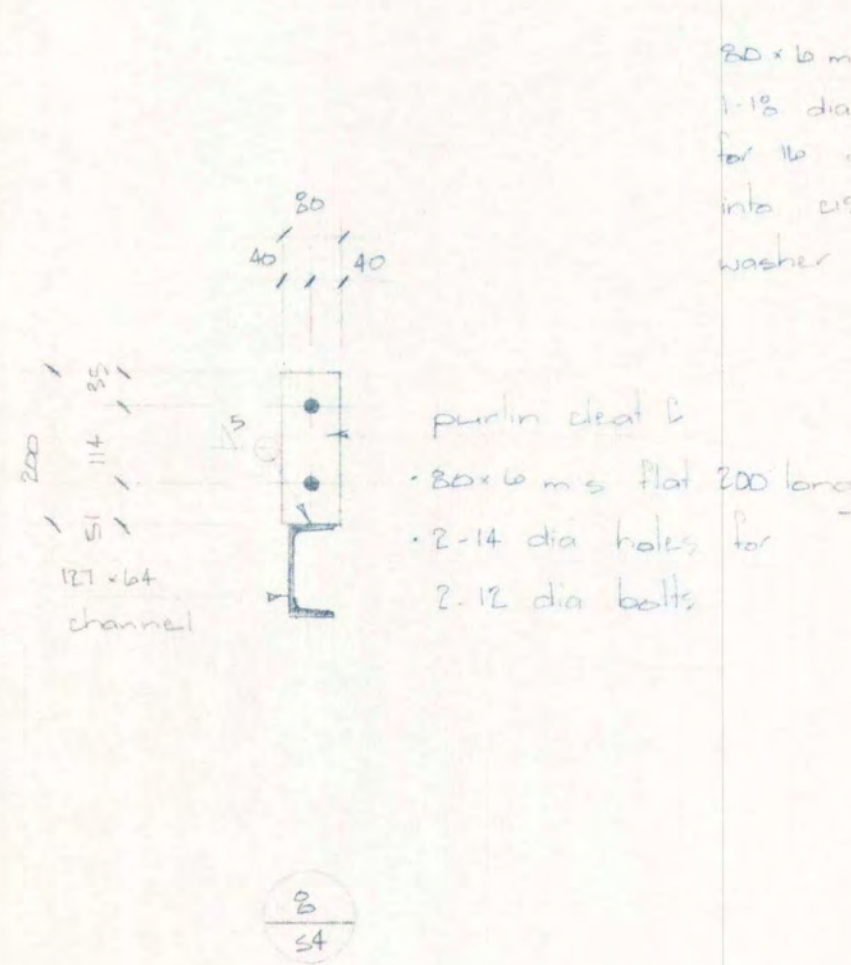
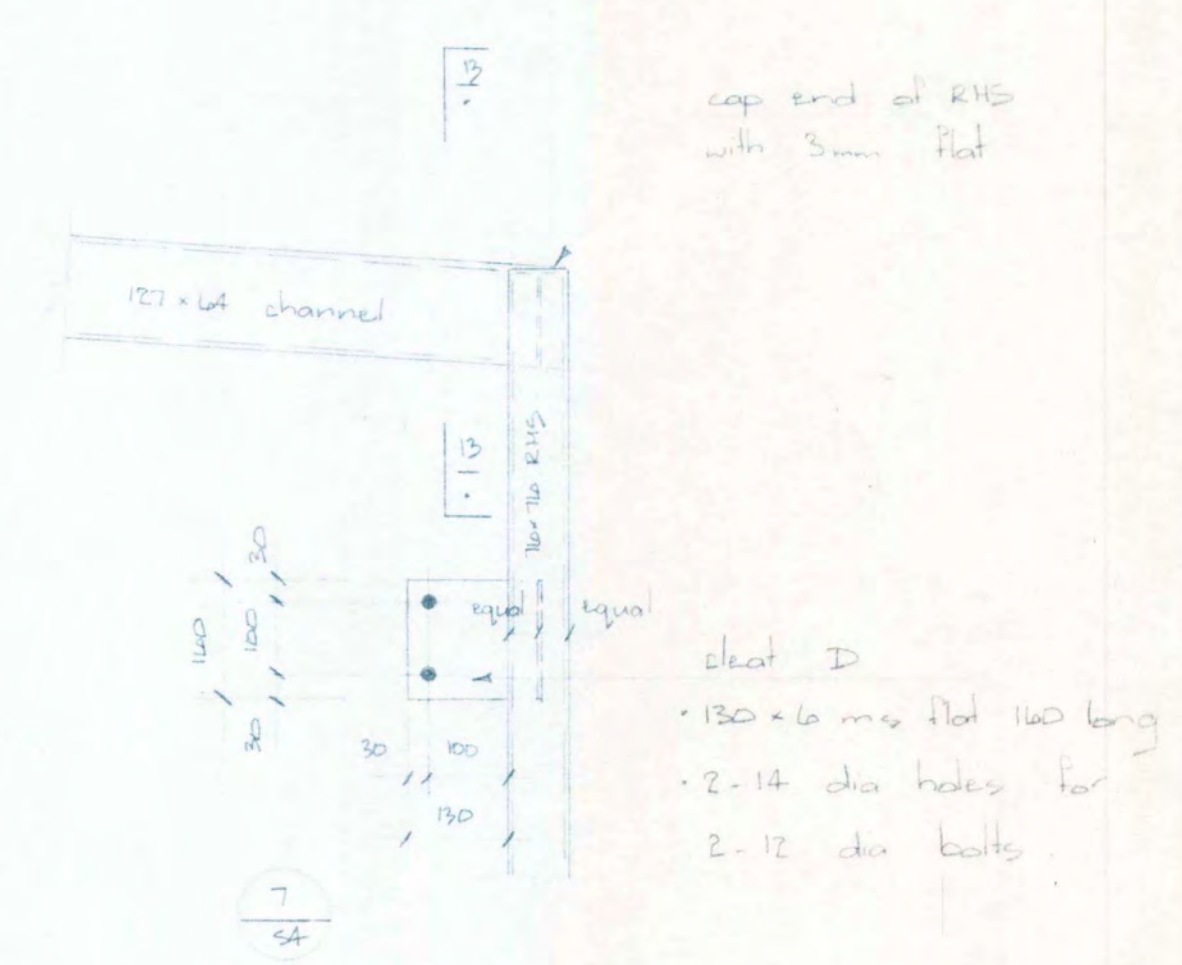
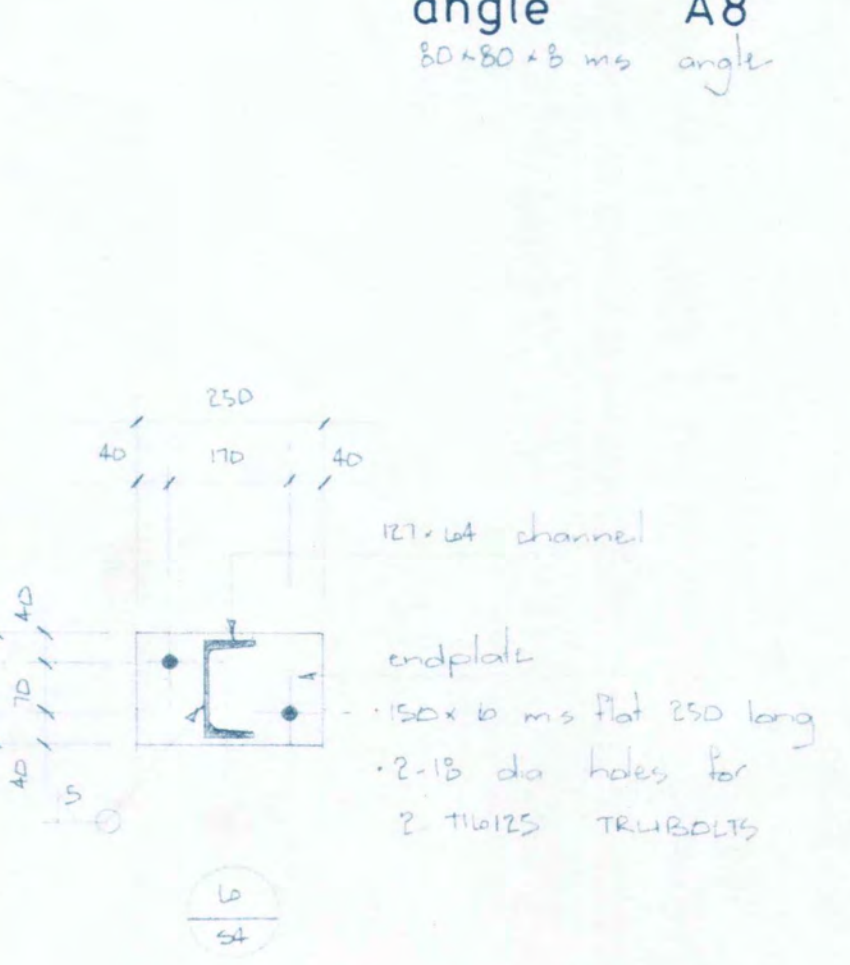


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88-12-14



Schedule of angles		
angle	no	off
CA1	22	
CA2	9	
CA3	1	
CA4	3	
CA5	1	
CA6	1	
CA7	1	



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14 JUL 1983
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and
JON ALDRIDGE
NZCD(Arch) MNZFAD

Holmes Wood Poole & Johnstone Ltd
Consulting Civil & Structural Engineers
Christchurch Wellington & Auckland

6 UNIT WAREHOUSE COMPLEX FOR
ESSEX DEVELOPMENT COMPANY

ANGLE ELEVATIONS
DETAILS

Scale 1:50 1:10
Drawn H M F
Traced
Approved

D
C
B
A
10.5.83 Contract

2052/S5
The Contractor shall verify all dimensions prior to commencing work