

**ADDENDUM TO REPORT**  
**INDEPENDENT ASSESSMENT ON EARTHQUAKE PERFORMANCE**  
**OF**

**43 LICHFIELD STREET**  
**(Ballentynes – Anderson Building)**

**FOR**  
**Royal Commission of Inquiry into building failure caused by the Canterbury**  
**Earthquakes**

**Report prepared by Peter C Smith and Vaughan England**  
**Spencer Holmes Limited**

**February 2012**

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## Background

Spencer Holmes Ltd prepared a report into the circumstances of the failure of several pre-cast panels from the south elevation of the carparking building at 43 Lichfield Street.

This addendum has been prepared following receipt of Richard Cusiel's statement of evidence providing background into the designers intent for restraint of the pre-cast concrete spandrel panels to the south face of the Lichfield Street carpark.

## Documentation For Precast Panels

The documentation for the construction of the pre-cast panels and the fixing of the pre-cast panels are shown on the Lovell-Smith and Cusiel Ltd plans appended to this addendum.

Also appended to the addendum is the Chas. S. Luney Ltd plans A70-000 and A70-003 that provide elevations and layouts for the carparking building.

The panels that failed during the 22<sup>nd</sup> February, 2011 earthquake were along the southern (Lichfield Street) frontage of the building at levels 5, 6 and 7 of the carpark. They are identified as spandrel panels S5 and S6 on drawing 4654-SP7. Essential features of these panels are as follows:

PANEL	PANEL LENGTH	PANEL THICKNESS	NUMBER FIXINGS DETAILED
S5	10530mm	150mm	4
S6	6465mm	150mm	4

The typical fixing details for the panels along Gridline 1 (the Lichfield Street frontage) are shown on drawing 4654-SP7 as "*Typical Connection Details Spandrel Panels Grid 1*".

The panel fixing is detailed with "*100x100x10 m.s. Angle cleat (x200 long) (4) Ex. 50x10 m.s. flat lugs (x250) with ragged ends (125 long) Fillet weld both sides to angle flanges.*". This 100x100x10 angle and attached metalwork was cast into the corner of the concrete columns.

The panels were detailed with a TCM insert cast into the panel for an M20 bolt. The panel was fixed to the angle embedded in the concrete column with a "*150x100x10 m.s. Angle Cleat with 60x20 Slotted hole*". The connection between the 150x100x10 mild steel angle and the 100x100x10 mild steel angle was detailed as a 6mm fillet weld all round to weldplate.

It is assumed that the length of the 150x100x10 mild steel angle was less than the 200mm length of 100x100x10 mild steel angle.

The fixing of the spandrel panels on Gridline 1 (South Wall) differed significantly from the spandrel panel fixing adopted for the support of the spandrel panels to Gridline F (East Wall). The connection of the panels to the east wall was achieved with H12-300 starters embedded in the pre-cast panel and subsequently cast into the 65mm topping to the floor. Refer typical sections for Pre-cast Spandrel Panels S1, S2, S3 on drawing 4654-SP7.

Temporary support for panels S1, S2, S3 was achieved using a seating bracket. In addition to the H12–300 starters cast into the topping of the floor, these panels were restrained by a short column constructed above the main transverse floor beams on Grids 1 to 7 respectively. These columns were 300x300mm reinforced concrete columns reinforced with 4xH12 rods and R10 stirrups at 200 centres. Details of the construction was shown in Section 11 on drawing 4654 SG6

We have undertaken an assessment of the capacity of panels S5 and S6 and of the fixings of these panels in accordance with NZS 4203:1992, the current code applicable at the time of design. In order to carry out our assessment we have assumed the primary building structure to have a period of 1.0 seconds, and from this have calculated the applicable design seismic coefficient for the panels to be 1.35g.

We summarise the assessed strength of panels and their fixings as follows:

PANEL	PERCENTAGE OF DESIGN CODE (NZS 4203:1992)	
	Panel Strength	Fixing Capacity
S5	27%	15%
S6	99%	33%

Clearly the panel fixings as detailed on the drawings did not comply with the current code NZS 4203:1992.

Unfortunately the failed panels and the remnants of the connections attached to the building were unable to be inspected to reliably identify the mode of failure. A review of the photos taken of the building following the earthquake indicated that at some connections the failure occurred between the 150x100x10mm Angle cleat and the 100x100x10mm Angle cast into the column, while in other instances the failure occurred through shear failure of the bolt connecting the 150x100x10mm Angle to the precast panel. In these instances the 150x100x10 Angle appears to have suffered little deformation.

While we remain of the opinion that interstorey deformations are likely to have contributed to the failure, it is evident that other failure modes occurred.

As the panels connections were significantly understrength and the earthquake shaking was in excess of the code design requirements failure of the panels was almost inevitable.

In reviewing the documentation for this project we were aware that there may have been additional fixings provided from the floor to the panel. A typical photograph of such a fixing which applied to a panel that did not fail in the 22<sup>nd</sup> February, 2011 earthquake is appended. It is evident that this fixing failed as a result of the loads imposed on 22<sup>nd</sup> February, 2011 earthquake. The failure appears to have been a failure of the proprietary fixing into the panel. It is evident that the metal cleat suffered severe distortion as a result of forces induced by the earthquake. We are uncertain as to the purpose of the slotted hole or of the location of the bolt located within the slotted hole securing the bracket to the floor at the time of construction.

We are uncertain as to whether a series of these brackets were placed at the junction of the precast panels and the floor during construction as a variation to the contract. As we have not had an opportunity of inspecting the building or the panels prior to removal, we are unable to

comment on whether sufficient of these connections were provided to achieve a restraint of the pre-cast panels under the code loading applying at the time of construction.

**Report Prepared By:-**

**Peter C Smith**  
BE FIPENZ CPEng IntPE  
Director

**Report Reviewed By:**

**Vaughan England**  
BE(Hons) GIPENZ  
Senior Structural Engineer

43 Lichfield Street - Addendum to Final Report - Feb '12

## **APPENDIX 1**

### **Condition of Building following 22<sup>nd</sup> February 2011**



## **APPENDIX 2**

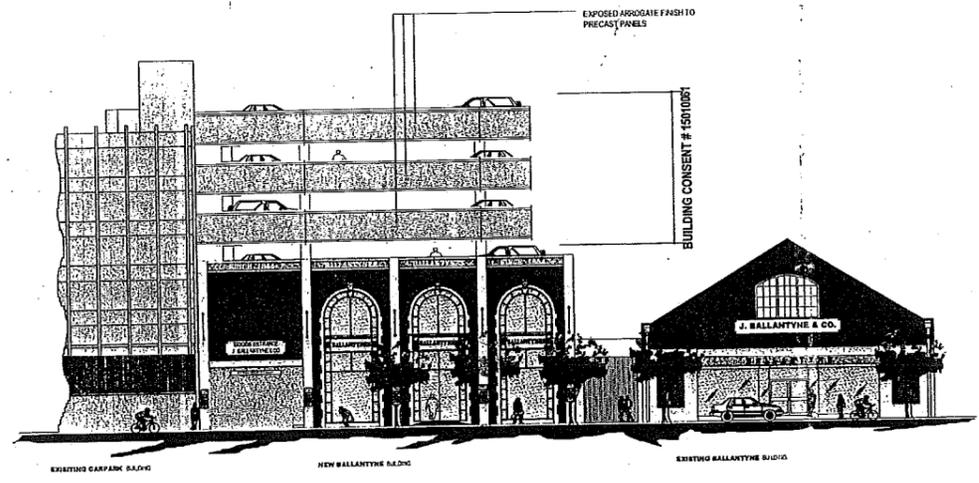
### **Additional Panel Fixings not Detailed**



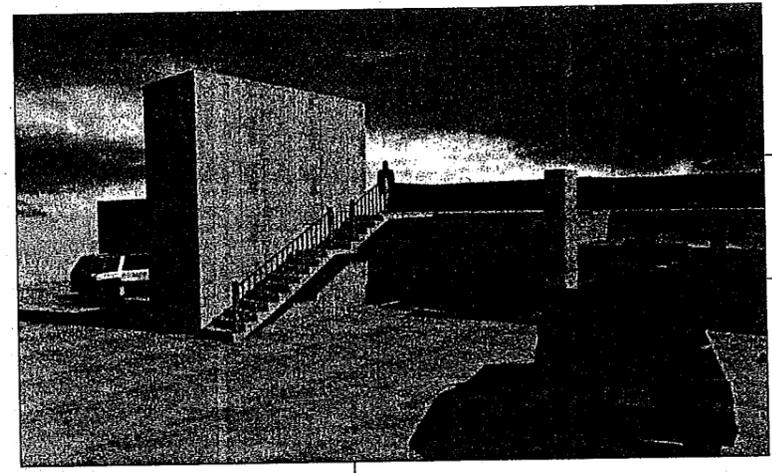
Example of typical additional fixing (not detailed in drawings) to panels that remained after 22<sup>nd</sup> February 2011 earthquake.

## **APPENDIX 3**

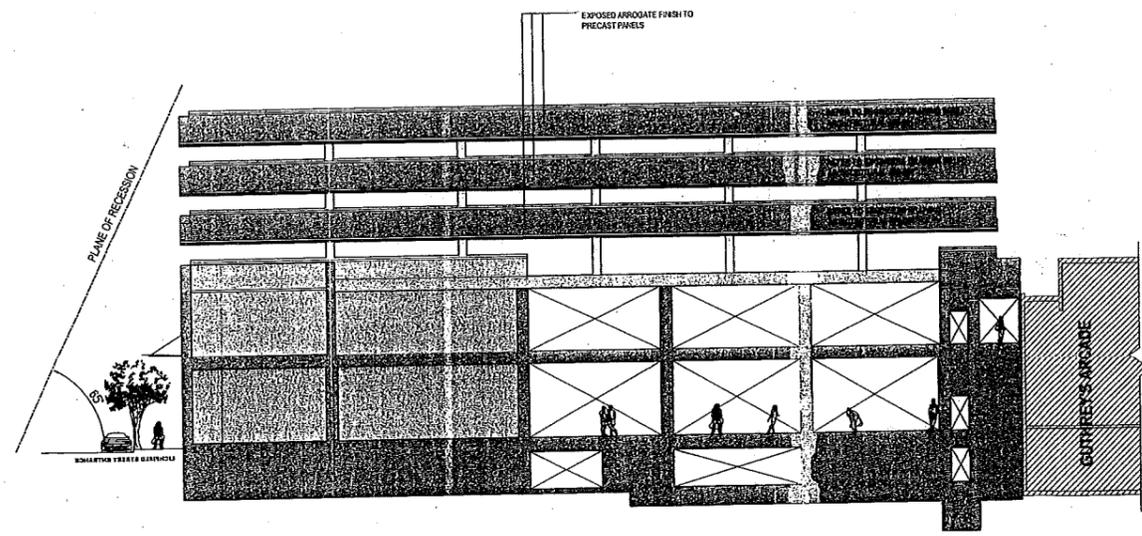
### **Original Drawings**



LICHFIELD STREET FACADE



EGRESS ROUTE FOR PUBLIC



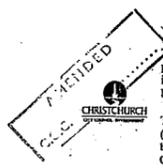
EAST WALL

FIFTH FLOOR SLAB LEVEL	3000
FOURTH FLOOR SLAB LEVEL	3000
THIRD FLOOR SLAB LEVEL	3000
SECOND FLOOR SLAB LEVEL	3000
FIRST FLOOR SLAB LEVEL	4600
GROUND FLOOR SLAB LEVEL	5105

K. THOMPSON  
Consent Officer

CHRISTCHURCH CITY COUNCIL  
CONSENT DOCUMENT  
08 MAY 2002

All building work shall comply with the New Zealand Building Code notwithstanding any inconsistencies which may occur in the drawings and specifications.



The building owner shall ensure that adequate provisions are taken to safeguard people from injury and other property from damage, caused by construction or demolition site hazards.

The Health and Safety in Employment (Construction) Regulations 1992 and related by the Department of Labour are relevant and a Code of Practice on demolition (if applicable) is available from Occupational Safety and Health.

Provide the International Access Symbol "...outside the building or so as to be visible from outside it", as required by the Building Act, section 47A, cl (5) and NZ Building Code F8/AS1.

**CHAS.S.LUNEY LTD**

BUILDING & CIVIL ENGINEERING CONTRACTORS  
200 MACES ROAD, BROMLEY P.O. BOX 205  
CHRISTCHURCH 8006  
Phone : (03) 3899018  
Fax : (03) 381 0347

**BALLANTYNES CARP**

Amendments

- 1 CONSENT ISSUE
- 2 INFO ADDED TO DRAWING
- 3
- 4
- 5
- 6

Information

o DRAWN BY : MATTHEW CHARLES  
o CHECKED BY :  
o DATE : 28-03-2002

Job Title

BALLANTYNE AND CO. LTD  
PROPOSED DEVELOPMENT  
ON LICHFIELD STREET

Drawing of

CARPARKING LEVELS  
REVISED LICHFIELD STREET FACADE  
EAST ELEVATION TYPICAL

Cost Sheet Number

FILE COPY

Drawing Number amend

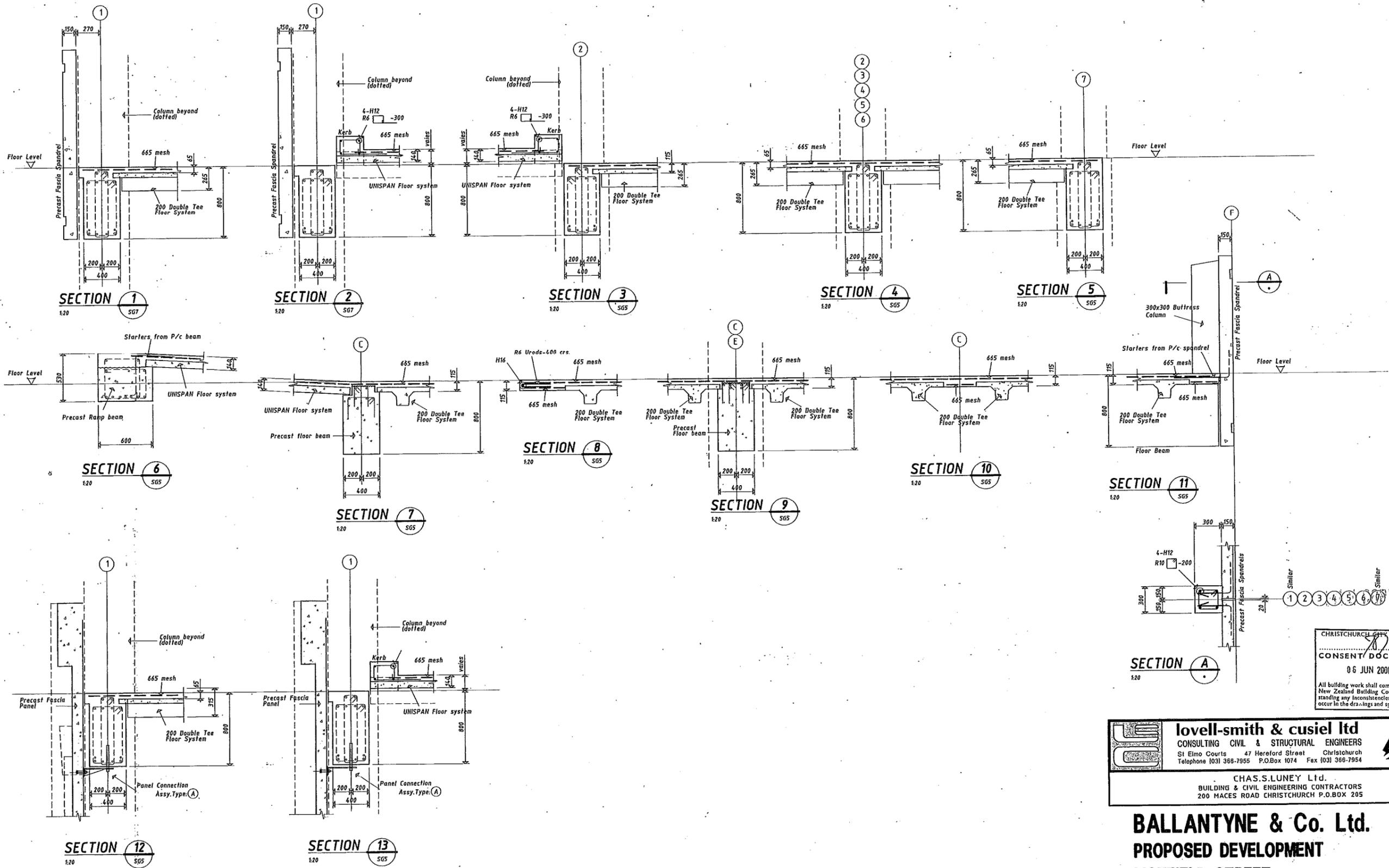
**A 70 - 000 (2)**

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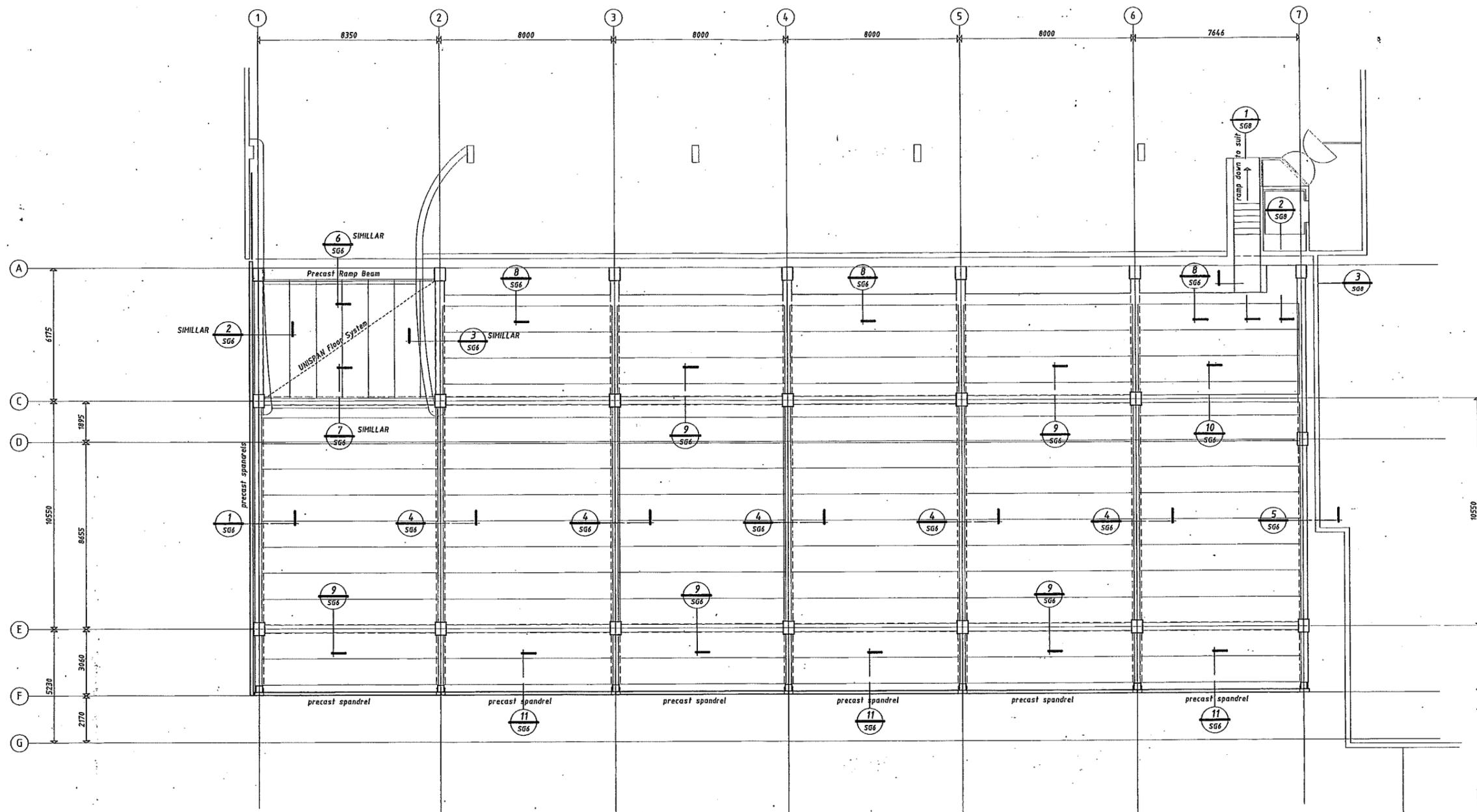
CHRISTCHURCH CITY COUNCIL  
**CONSENT DOCUMENT**  
 06 JUN 2001  
 All building work shall comply with the New Zealand Building Code notwithstanding any inconsistencies which may occur in the drawings and specifications.

	<b>lovell-smith &amp; cusiel ltd</b> CONSULTING CIVIL & STRUCTURAL ENGINEERS St Elmo Courts 47 Hereford Street Christchurch Telephone (03) 366-7955 P.O.Box 1074 Fax (03) 366-7954	
	CHAS.S.LUNEY Ltd. BUILDING & CIVIL ENGINEERING CONTRACTORS 200 MACES ROAD CHRISTCHURCH P.O.BOX 205	

**BALLANTYNE & Co. Ltd.**  
 PROPOSED DEVELOPMENT  
 LICHFIELD STREET

Typical Floor Sections			
DESIGNED	D.CUSIEL	JOB No.	<b>4654</b>
DRAWN	R.L.CRAW	SHEET No.	<b>SG6</b>
CHECKED		OF	<b>41</b>
DATE	June 2000		
REV	DATE	BY	AMENDMENT

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TYPICAL FLOOR PLAN THIRD thru. FIFTH  
1:100

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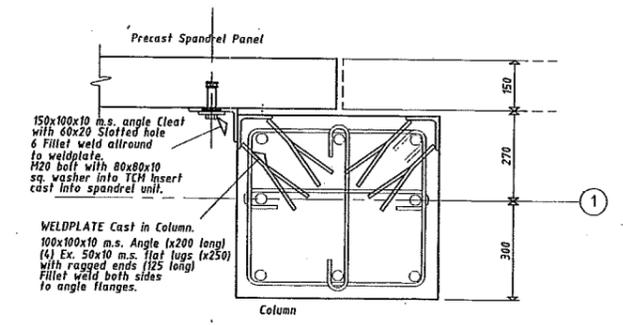
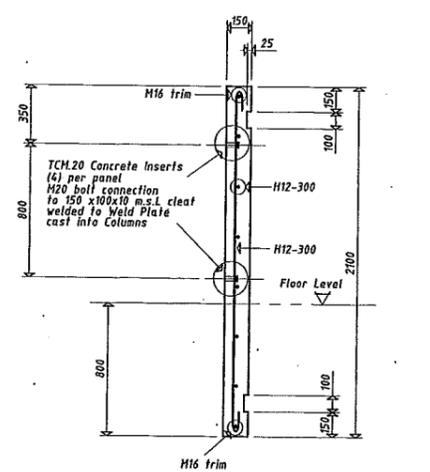
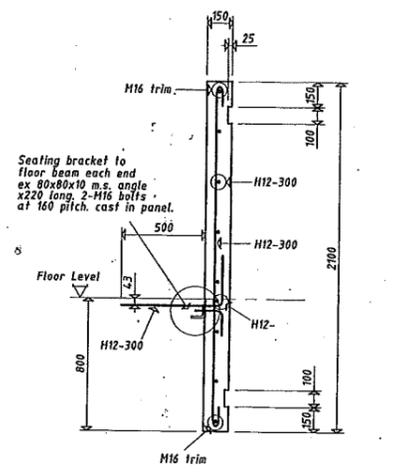
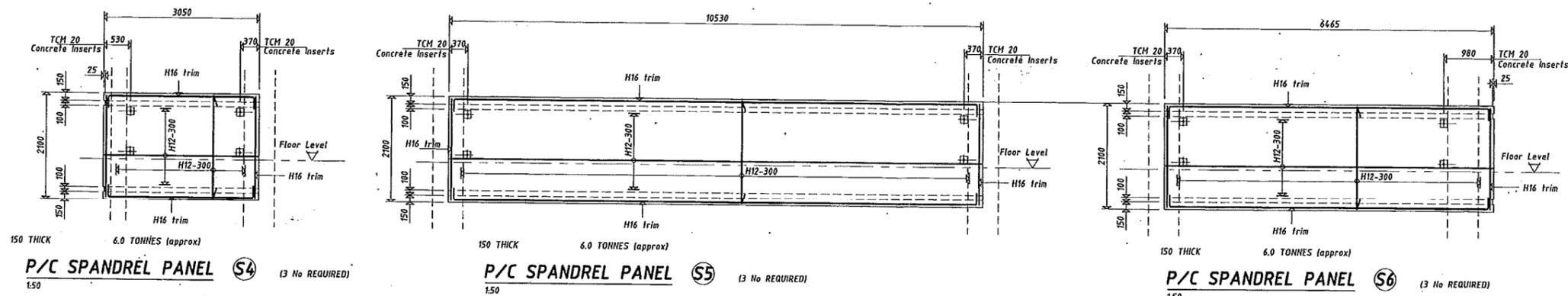
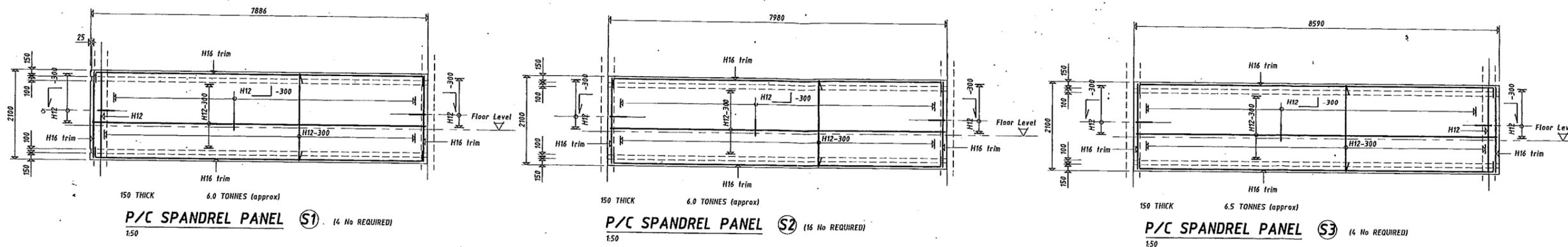
**lovell-smith & cusiel ltd**  
 CONSULTING CIVIL & STRUCTURAL ENGINEERS  
 St Elmo Courts 47 Hereford Street Christchurch  
 Telephone (03) 366-7955 P.O.Box 1074 Fax (03) 366-7954

**CHASS.LUNEY Ltd.**  
 BUILDING & CIVIL ENGINEERING CONTRACTORS  
 200 MACES ROAD CHRISTCHURCH P.O.BOX 205

**BALLANTYNE & Co. Ltd.**  
 PROPOSED DEVELOPMENT  
 LICHFIELD STREET

Typical Floor Plan Third thru. Fifth		DESIGNED	JOB No.
		D. CUSIEL	4654
		DRAWN	
		R.L. CRAW	
		CHECKED	SHEET No. OF
			SG7 41
		DATE	June 2000
REV	DATE	BY	AMENDMENT

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CONSENT DOCUMENT  
06 JUN 2001

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**lovell-smith & cusiel Ltd**  
CONSULTING CIVIL & STRUCTURAL ENGINEERS  
St Elmo Courts 47 Hereford Street Christchurch  
Telephone (03) 366-7955 P.O.Box 1074 Fax (03) 366-7954

**CHAS.S.LUNEY Ltd.**  
BUILDING & CIVIL ENGINEERING CONTRACTORS  
200 MACES ROAD CHRISTCHURCH P.O.BOX 205

**BALLANTYNE & Co. Ltd.**  
PROPOSED DEVELOPMENT  
LICHFIELD STREET

Precast Spandrel Panels			
DESIGNED D.CUSIEL	JOB No. <b>4654</b>		
DRAWN R.L.CRAW	SHEET No.		
CHECKED	DATE		
07.12.00 07.07.00	June 2000	OF	<b>SP7</b> 41
REV	DATE	BY	AMENDMENT

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