Structural Calculations

For

Proposed Seismic Strengthening
at
Block A, Sacred Heart College
65 Laings Road, Lower Hutt

These calculations are in accordance with:

AS/NZS 1170:2004 Structural Design Actions
NZS 3101:2006 Concrete Structures Standard
NZS 3404:1997 Steel Structures Standard
NZS 3603:1993 Timber Structures Standard
NZS 3604:2011 Timber Framed Buildings

Engineer:	**Initials:**
Stuart Preston	SRNP
Geert van de Vorstenbosch	GV

Preamble:
The project comprises proposed seismic strengthening to an existing 2-storey school block. The school block consists of three seismically separated structures, herein labelled the Main Block (which includes the 1975 extension), The Prefects Wing and the Staff Wing. Lastly, there is a brick wall along the south boundary that is supported by an in-situ reinforced concrete frame that is also proposed to be seismically strengthened.

These calculations pertain to the design of a new external egress stair to be built adjacent to the west façade of the 1975 addition of the Main Block.

These calculations are to be read in accordance with the structural calculations for seismic strengthening of the school block.

Date:
4 August 2016

Job No.
40249

Schedule of Inspections
For
Proposed Seismic Strengthening
at
Block A, Sacred Heart College
65 Laings Road, Lower Hutt

We confirm that CERTA Engineering Ltd have been engaged to undertake construction monitoring of the specific engineering design items to an IPENZ /ACENZ CM3 level and propose to undertake the following site inspections:

No.	Item of inspection	Timeframe
1	Posthole foundations	Pre-pour to check reinforcement
2	External egress stairs	Post construction

Notes:

a) The above items of inspections are the minimum required to enable CERTA Engineering Ltd to issue a PS4 – Producer Statement Construction Review for the specific engineering design items.

b) The above items of inspection do not cover work constructed in accordance with NZS 3604:2011, for which inspections are to be undertaken by the Building Consent Authority.

c) The Contractor/Builder is to provide CERTA Engineering Ltd at least 24 hours' notice of the requirement for an inspection. The above timeframes are indicative, the Engineer and Contractor are to agree the timing of inspection prior to work commencing on site.

d) The Contractor /Builder is to provide reasonable and safe access to enable works to be inspected.

e) The above schedule does not necessarily represent the actual number of inspections to be undertaken. The number of inspections will depend on the construction method, sequence of the works and whether or not unforeseen conditions or difficulties are encountered on site.

Date:
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40249

Building Code Clause(s) **B1**

J40249

PRODUCER STATEMENT - PS1 - DESIGN

(Guidance notes on the use of this form are printed on page 2)

ISSUED: CERTA Engineering Ltd

TO: **Mission Colleges Lower Hutt Trust Board**

(Owner / Developer)

TO BE SUPPLIED TO: Hutt City Council

(Building Consent Authority)

IN RESPECT OF: **Proposed Seismic Strengthening**

(Description of Building Work)

AT: **Block A, Sacred Heart College, 65 Laings Road, Lower Hutt**

(Address)

LOT 3 **DP** 26955 **SEC** 955 HUTT DIST BLK XIV;
LOT 1 **DP** 51495 **& LOT** 2 **DP** 473782 ETC. (SACRED HEART) F3/666

We have been engaged by the owner/developer referred to above to provide **structural design services and construction monitoring of specifically designed elements** in respect of the requirements of Clause B1 (B2 of specifically designed elements) of the building code for

☐ All ☑ ***Part only as specified of building work:***

- External Egress Stairs

The design carried out by us has been prepared in accordance with Compliance Documents issued by the Ministry of Business, Innovation & Employment B1, VM1 & VM4 (foundations and retaining walls loads), however strength has been designed to satisfy 67% of design seismic loadings criteria specified in AS/NZS 1170.

The proposed building work covered by this producer statement is decribed on the drawings

titled:**Seismic Strengthening Block A, Sacred Heart College, Lower Hutt** and numbered **S1** to **S6**.

On behalf of the Design Firm, and subject to:

(i) Site verification of the following design assumptions: Ultimate bearing capacity of excavated foundations to be a minimum of 150kPa.

(ii) All proprietary products meeting their performance specification requirements;

I believe on reasonable grounds that a) the building, if constructed in accordance with the drawings, specifications, and other documents provided will comply with the relevant provisions of the Building Code and b), the persons who have undertaken this design work have the necessary competency to do so. I also recommend the following level of construction monitoring:

☐CM1 ☐CM2 ☒ CM3☐ CM4 ☐ CM5 observation services.

(Engineering Categories)

I, Stuart Preston am CPEng # 138744

I am a member of: IPENZ and hold the following qualifications: BE(Civil), MIPENZ, CPEng

The design firm issuing this statement holds a current policy of Professional Indemnity Insurance no less than $500,000*.

The Design Firm is a member of ACENZ

SIGNED BY Stuart Preston ON BEHALF OF CERTA Engineering Ltd

Date 4 August 2016 (Signature)..

Note: this statement shall only be relied upon by the Building Consent Authority named above. Liability under this statement accrues to the Design Firm only. The total maximum amount of damages payable arising from this statement and all other statements provide to the Building Consent Authority in relation to this building work, whether in contract, tort or otherwise (including negligence), is limited to the sum of $500,000*.

This form is to accompany Form 2 of the Building (Forms) Regulations 2004 for the application of a Building Consent.

GUIDANCE ON USE OF PRODUCER STATEMENTS

Producer statements were first introduced with the Building Act 1992. The producer statements were developed by a combined task committee consisting of members of the New Zealand Institute of Architects, Institution of Professional Engineers New Zealand, Association of Consulting Engineers New Zealand in consultation with the Building Officials Institute of New Zealand. The original suite of producer statements has been revised as at the date of this form as a result of enactment of the Building Act (2004) by these organisations to ensure standard use within the industry.

The producer statement system is intended to provide Building Consent Authorities (BCAs) with reasonable grounds for the issue of a Building Consent or a Code Compliance Certificate, without having to duplicate design or construction checking undertaken by others.

PS1 Design — Intended for the use by a suitably qualified independent design professional in circumstances where the BCA accepts a producer statement for establishing reasonable grounds to issue a Building Consent;

PS2 Design Review — Intended for use by a suitably qualified independent design professional where the BCA accepts an independent design professional's review as the basis for establishing reasonable grounds to issue a Building Consent;

PS3 Construction — Forms commonly used as a certificate of completion of building work are Schedule 6 of NZS 3910:20031 ; or Schedules E1/E2 of NZIA's SCC 2007 2

PS4 Construction Review — Intended for use by a suitably qualified independent design professional who undertakes construction monitoring of the building works where the BCA requests a producer statement prior to issuing a Code Compliance Certificate. This must be accompanied by a statement of completion of building work (Schedule 6).

The following guidelines are provided by ACENZ, IPENZ and NZIA to interpret the Producer Statement.

Competence of Design Professional

This statement is made by a Design Firm that has undertaken a contract of services for the services named, and is signed by a person authorised by that firm to verify the processes within the firm and competence of its designers.

A competent design professional will have a professional qualification and proven current competence through registration on a national competence-based register, either as a Chartered Professional Engineer (CPEng) or a Registered Architect.

Membership of a professional body, such as the Institution of Professional Engineers New Zealand (IPENZ)or the New Zealand Institute of Architects (NZIA) provides additional assurance of the designer's standing within the profession. If the design firm is a member of the Association of Consulting Engineers New Zealand (ACENZ), this provides additional assurance about the standing of the firm.

Persons or firms meeting these criteria satisfy the term "suitably qualified independent design professional".

Professional Indemnity Insurance

As part of membership requirements, ACENZ requires all member firms to hold Professional Indemnity Insurance to a minimum level.

The PI insurance minimum stated on the front of this form reflects standard, small projects. If the parties deem this inappropriate for large projects the minimum may be up to $500,000.

Professional Services during Construction Phase

There are several levels of service which a Design Firm may provide during the construction phase of a project (CM1-5)3 (OL1-OL4)2. The Building Consent Authority is encouraged to require that the service to be provided by the Design Firm is appropriate for the project concerned.

Requirement to provide Producer Statement PS4

Building Consent Authorities should ensure that the applicant is aware of any requirement for producer statements for the construction phase of building work at the time the building consent is issued as no design professional should be expected to provide a producer statement unless such a requirement forms part of the Design Firm's engagement.

Attached Particulars

Attached particulars referred to in this producer statement refer to supplementary information appended to the producer statement.

Refer Also:

1 Conditions of Contract for Building & Civil Engineering Construction NZS 3910: 2003

2 NZIA Standard Conditions of Contract SCC 2007 (1st edition)

3 Guideline on the Briefing & Engagement for Consulting Engineering Services (ACENZ/IPENZ 2004)

www.acenz.org.nz
www.ipenz.org.nz
www.nzia.co.nz

F14-06/02

Date	Eng.	Job No.	Sheet No.
31 JUL 2016	GV	40249	E.S.1

Project

SEISMIC STRENGTHENING – BLOCK A, SACRED HEART COLLEGE

CALCULATIONS

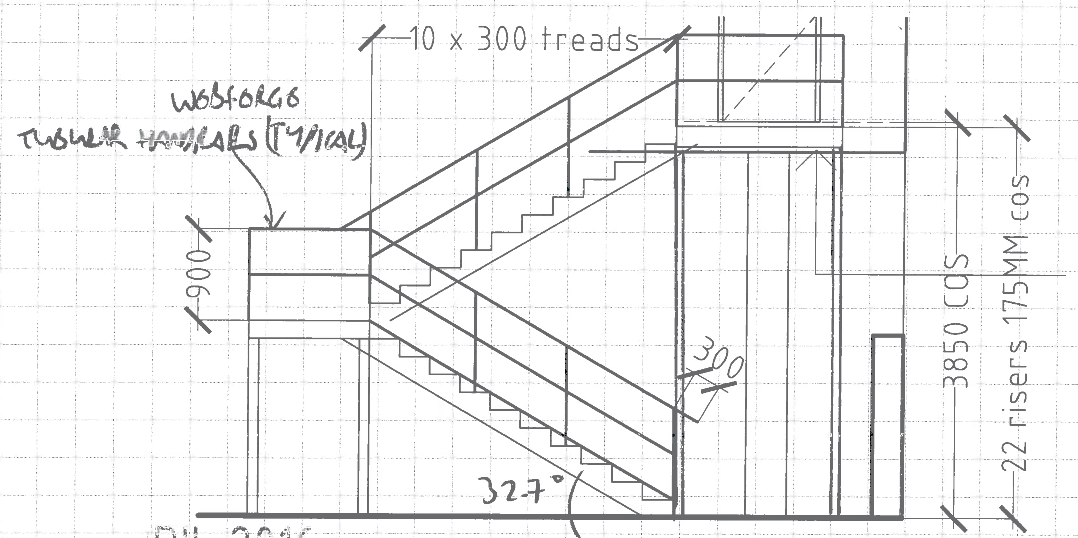
EXTERNAL FIRE STAIRS DESIGN

* LOAD CONSIDERATIONS:

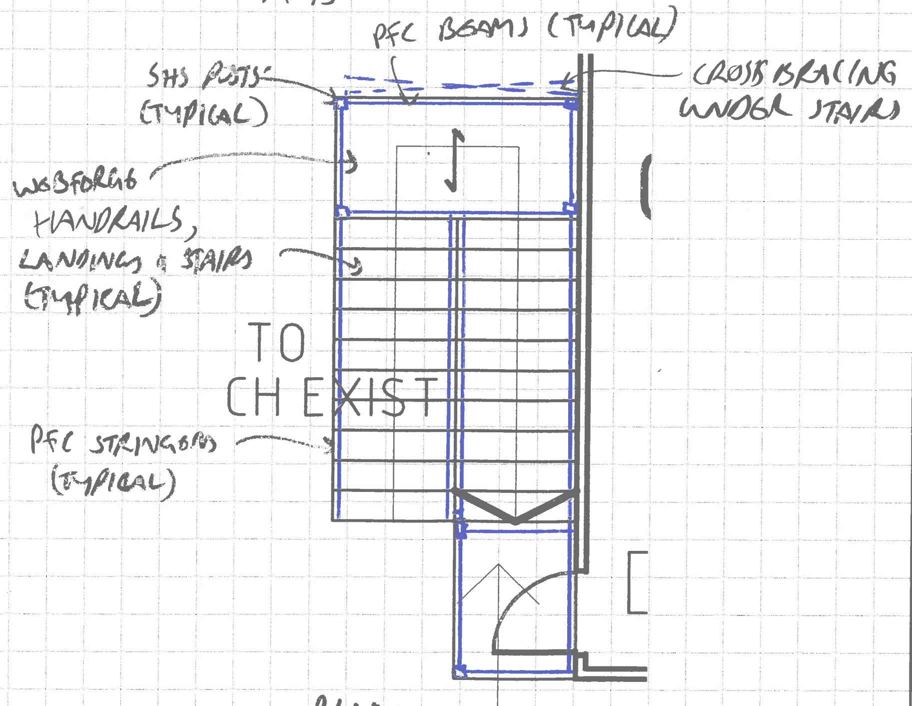
G – SELF WEIGHT ONLY

Q – 4.0kPa

Eu → USE ELASTIC LOADS GIVEN THIS IS AN EGRESS STAIR (μ=1)



ELEVATION
1:75



PLAN
1:75

F14-06/02

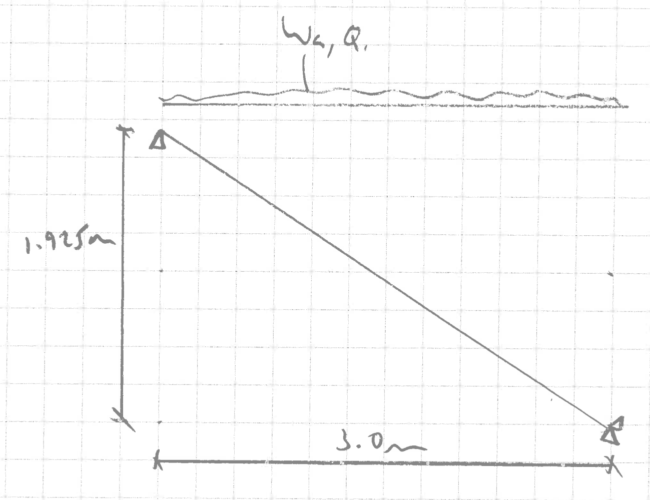
Date 31 JUL 2016	Eng. GW	Job No. 40249	Sheet No. ES.2

Project

SEISMIC STRENGTHENING - BLOCK A, SACRED HEART COLLEGE

CALCULATIONS

1. STRINGER DESIGN.



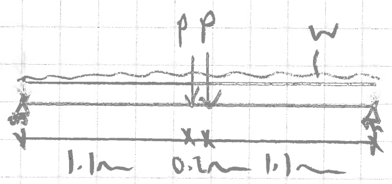
w_G = 1/2 STAIR + HANDRAIL (S/W INCLUDED IN SPACEGASS MODEL)
= 0.5(0.44kPa)(1.10m) + 0.20kN/m = 0.44kN/m

w_Q = 1/2 STAIR + HANDRAIL
= 4.0kPa (0.5)(1.10) + 0.75kN/m = 2.95kN/m

FROM SHEETS E.S.3 & E.S.4, 150 PFC OK BUT NEED TO USE 230PFC TO FIT STAIR TREADS

2. LANDING BEAMS DESIGN

WORST CASE IS AT MID-HEIGHT LANDING.



P = STRINGER REACTION
P_G = 1.09kN
P_Q = 5.26kN

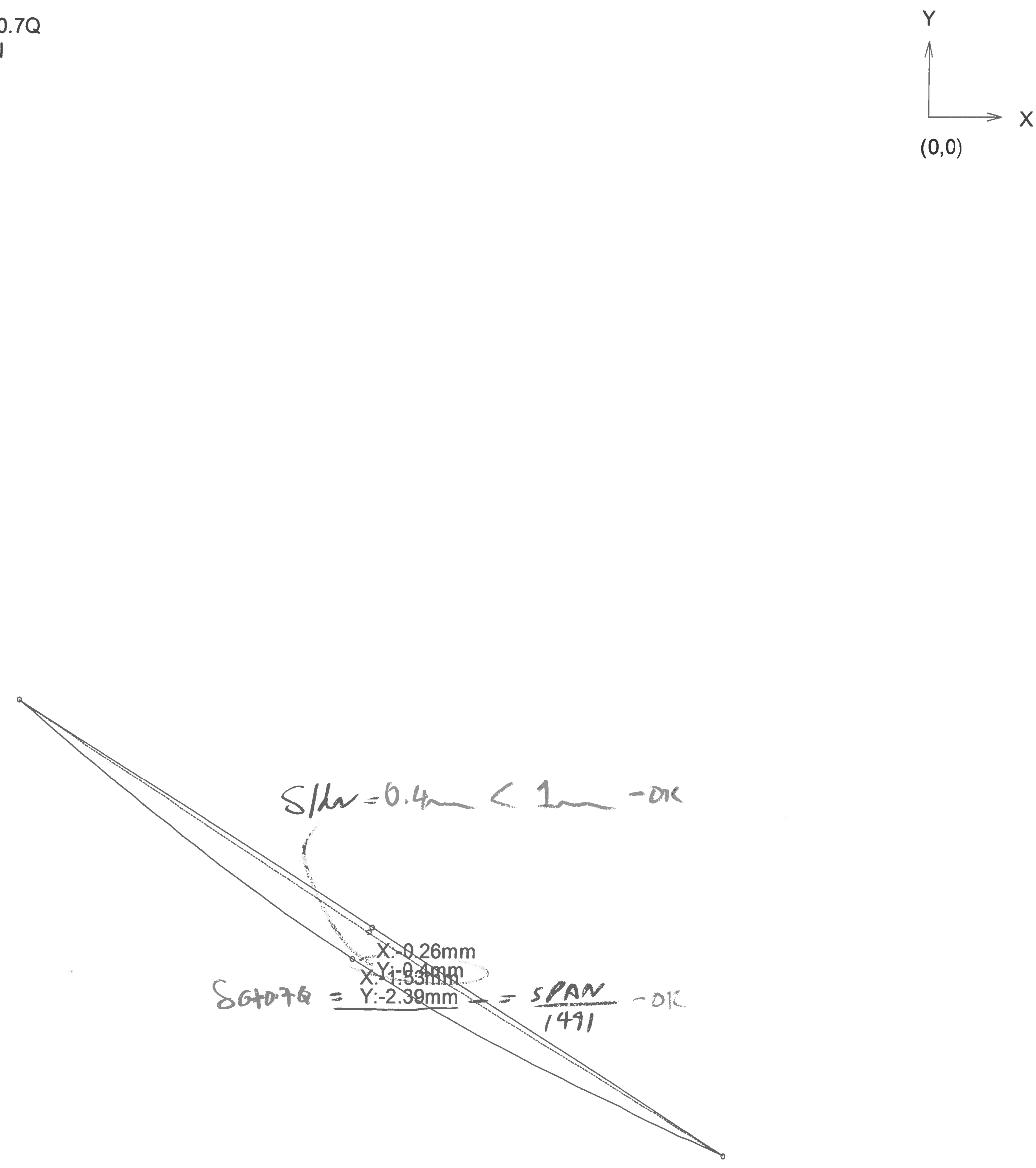
W = LANDING
W_G = 0.5(0.44kPa)(1.2m) = 0.26kN/m
W_Q = 0.5(4.0kPa)(1.2m) = 2.40kN/m

FROM SHEETS E.S.5 & E.S.6 150 PFC OK BUT USE SAME SIZE AS STRINGER → 230 PFC
(CONT'D E.S.7)

230 PFC BEAMS & STRINGERS

Load cases 3,5:

■ 3	———	(SW)	G+0.7Q
■ 5	········		1kN



Materials:
■ 1 STEEL

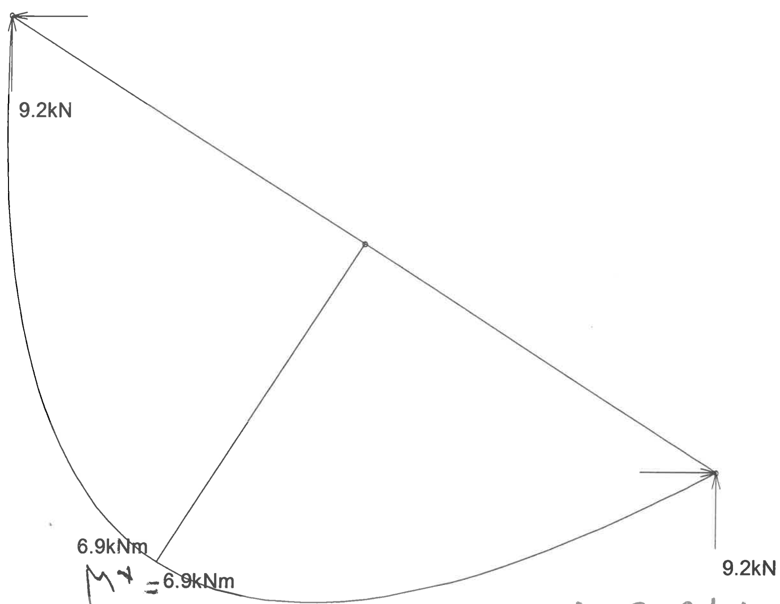
Sections:
■ 1 150 PFC

Job: I:\CERTA\JOBFILES\...\Seismic Strengthening\40249 External Stairs Stringer
Units - Len: m, Sec: mm, Mat: MPa, Dens: T/m^3, Temp: Celsius, Force: kN, Mom: kNm, Mass: T, Acc: g's, Trans: mm, Stress: MPa
Scales - Frame: 1:32, Load: None, Disp: 55.51115, Moment: None, Shear: None, Axial: None, Torsion: None

E.S.4

Load cases:
■ 4 ——— (SW) 1.2G+1.5Q

Y
X
(0,0)



$M^* = 6.9$kNm

ϕM_b(150PFC, L_e=3.564m, α_m=1.13) = 21.3kNm – OK

Materials:
■ 1 STEEL

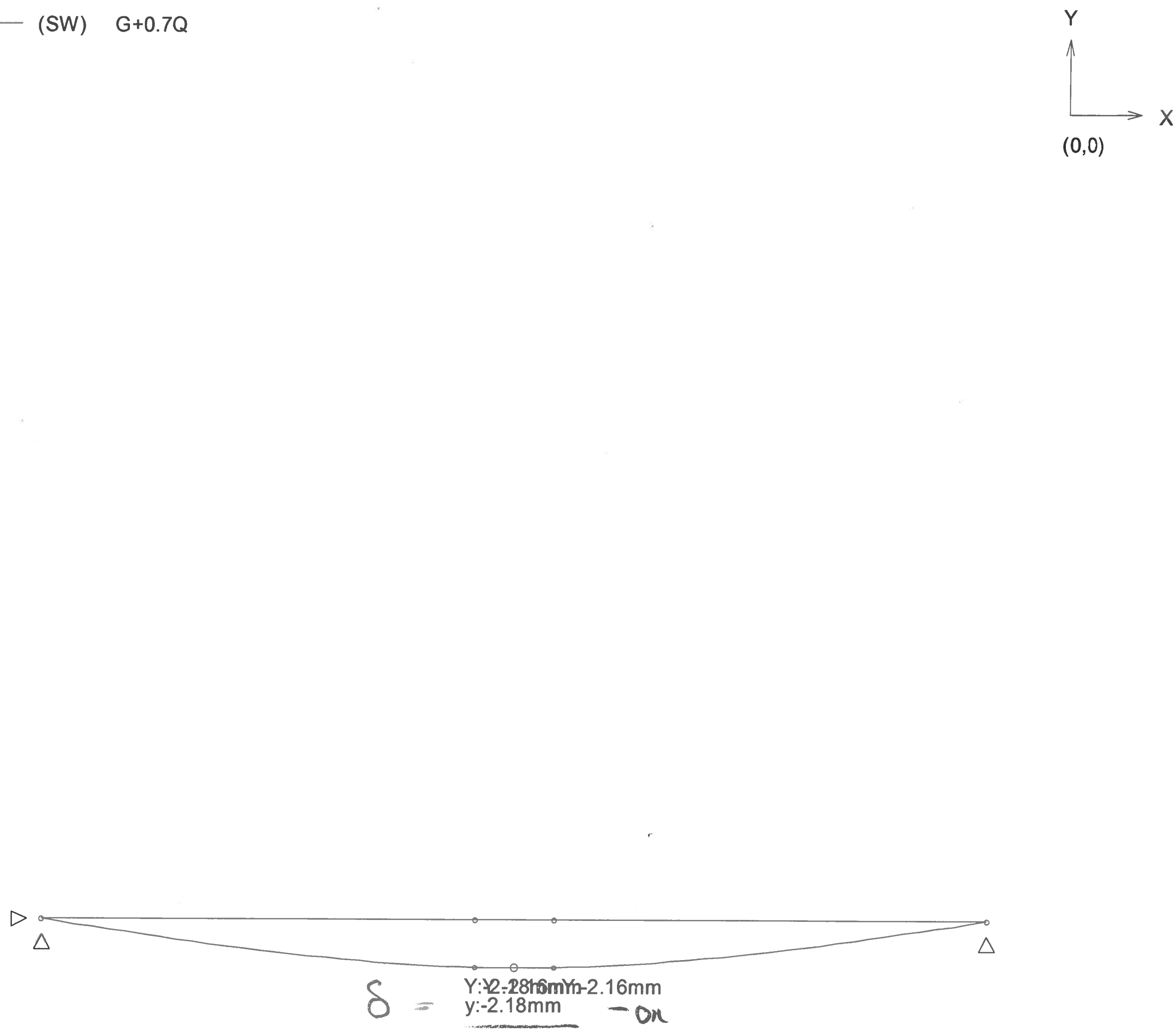
Sections:
■ 1 150 PFC

Job: I:\CERTA\JOBFILES\...\Seismic Strengthening\40249 External Stairs Stringer
Units - Len: m, Sec: mm, Mat: MPa, Dens: T/m^3, Temp: Celsius, Force: kN, Mom: kNm, Mass: T, Acc: g's, Trans: mm, Stress: MPa
Scales - Frame: 1:32, Load: None, Disp: None, Moment: 0.137743, Shear: None, Axial: None, Torsion: None

SPACE GASS 12.27 - CERTA Engineering LTD

1 Aug 2016, 10:59 am

Load cases:
■ 3 ——— (SW) G+0.7Q



No general restraint

Materials:
■ 1 STEEL

Sections:
■ 1 150 PFC

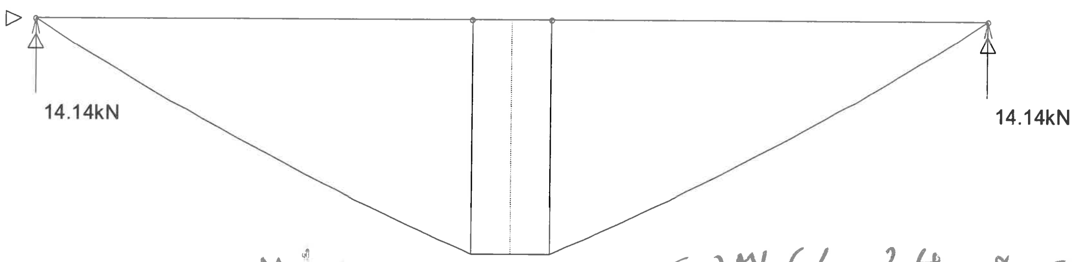
Job: I:\CERTA\JOBFI...\Seismic Strengthening\40249 External Stairs Landing Beam
Units - Len: m, Sec: mm, Mat: MPa, Dens: T/m^3, Temp: Celsius, Force: kN, Mom: kNm, Mass: T, Acc: g's, Trans: mm, Stress: MPa
Scales - Frame: 1:19, Load: None, Disp: 55.51115, Moment: None, Shear: None, Axial: None, Torsion: None

SPACE GASS 12.27 - CERTA Engineering LTD

1 Aug 2016, 10:59 am

Load cases:
■ 4 ——— (SW) 1.2G+1.5Q

Y
X
(0,0)



$M^* = 13.06\text{kNm} < \phi M_b (L_e = 2.4\text{m}, \alpha_m = 1.30) = 31\text{kNm}$ - ok

No general restraint

Materials:
■ 1 STEEL

Sections:
■ 1 150 PFC

Job: I:\CERTA\JOBFI...\Seismic Strengthening\40249 External Stairs Landing Beam
Units - Len: m, Sec: mm, Mat: MPa, Dens: T/m^3, Temp: Celsius, Force: kN, Mom: kNm, Mass: T, Acc: g's, Trans: mm, Stress: MPa
Scales - Frame: 1:19, Load: None, Disp: None, Moment: 0.420359, Shear: None, Axial: None, Torsion: None

F14-06/02

Date	Eng.	Job No.	Sheet No.
1 - AUG 2016	GW	40249	E.S.7

Project: SEISMIC STRENGTHENING: BLOCK A, SACRED HEART COLLEGE

CALCULATIONS

3. POST DESIGN

FROM ANALYSIS & SET OUT WORST CASE POST IS AT TOP OF LOWER FLIGHT:

$R^* = 9.2 + 14.14 + (1.2 \times 0.20kN/m \times 0.6m + 1.5 \times 0.75kN/m \times 0.6m) = 24.2kN$
(HANDRAIL)

ϕN_c (75x5 SHS, $L_e = 1.75m$) $= \phi N_s \alpha_c$; $\phi N_s = \phi k_f A_n f_y$

$= 0.9(1.0)(1310)(350MPa) = 412.65kN$

$\alpha_c \rightarrow \lambda_n = \frac{L_e}{r_x}\sqrt{k_f}\sqrt{\frac{f_y}{250}} = \frac{1750}{28}\sqrt{\frac{350}{250}} = 74$ (k_f = 1.0)

$\alpha_b = -1.0 \rightarrow \alpha_c = 0.840$

$\rightarrow \phi N_c = 347kN >> N^* = 24kN$ - OK

CHECK 3.65m HIGH $\rightarrow \lambda_n = \frac{3650}{28}\sqrt{\frac{350}{250}} = 154 \rightarrow \alpha_c = 0.324$

$\rightarrow \phi N_c = 134kN$ - STILL AMPLE.

75x5 POSTS

4. SEISMIC DESIGN

a). TOP LANDING.

* ALLOW TOP LANDING TO BE BRACED BE EXISTING BUILDING

$\rightarrow$ TOTAL SEISMIC DEMAND = $C_d(T_1) W_t$

$C_d(T_1) = 1.20$ ($\mu = 1$)

$W_t = G + SLL$ FOR TOP LANDING & 1/2 OF FIRST FLIGHT

LANDINGS + STAIRS	= 0.44kPa (1.2m x (1.6+1.5)m)	=	1.64kN
HANDRAILS	= 0.2kN/m (1.2+1.6+3.564/2 x2)	=	1.27kN
BEAMS (150PFC)	= 0.17kN/m (1.2+1.6x2+3.564/2x2)	=	1.35kN
POSTS (75x5 SHS)	= 0.10kN/m (3.65m/2 x 2)	=	0.37kN
SLL	= 4.0kPa (1.2 x 3.1) $\psi_E \psi_A$	=	4.46kN
		W_t =	9.09kN

; $\psi_E = 0.3$, $\psi_A = 0.3 + \frac{3}{\sqrt{1.2 \times 3.1}} = 1.86 = 1.0$

$\rightarrow V_{en} = 10.9kN$ @ $\mu = 1$ (NEGLIGIBLE FOR EXTG BUILDING)

F14-06/02

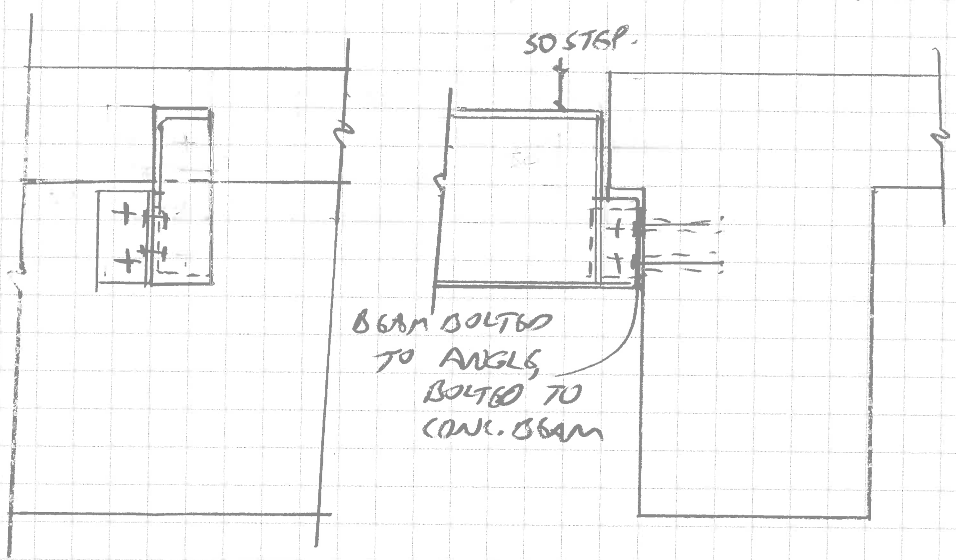
Date	Eng.	Job No.	Sheet No.
1 - AUG 2016	GW	40249	E.S. 8

Project

SEISMIC STRENGTHENING: BLOCK A, SACRED HEART COLLEGE

CALCULATIONS

BOLT PFC'S INTO EXISTING CONCRETE EDGE BEAM:
→ WORST CASE IS ON OUTSIDE BEAM @ CORNER OF BUILDING



ϕN_{ur} (M12 CHEMSET, EPCON C6, 150mm EMBEDMENT) = 34 kN > $\frac{10.9}{4}$ = 2.73kN

ϕV_{ur} (" " " " ") = 4.3kN > $\frac{V^*}{4}$ = 4.7kN - OK

WHERE $V^* = 1.2G + 1.5Q = 1.2\frac{(1.64+1.27+1.35+0.37)}{2} + 1.5(4.0 \times 0.6 \times (1.6+1.5) + 0.75 \times (0.6 + \frac{3.564}{2}))$

= 16.6kN

COMBINED ACTIONS (SEISMIC) = $\frac{2.73}{33.8} + \frac{9.09/2/4}{4.7}$ = 0.32 ≤ 1.2 - OK.

> 2-M12 CHEMSETS EPCON C6, 150mm EMBEDMENT

b) <u>MIDDLE LANDING</u>

* ALLOW PFC STRINGERS TO BRACE LANDING LONGITUDINALLY.
* FOR BRACING ACROSS USE CROSS BRACING BETWEEN POSTS.

$V_{EU} = C_d(T_1)\,W_t$

W_t = MIDDLE LANDING + 2 × ½ STAIR FLIGHTS

LANDINGS + STAIRS	= 0.44kPa	(2.4×1.2 + 1.1 × 3.0/2×2)	= 2.72kN
HANDRAILS	= 0.10kN/m	(2.4 + 2×1.2 + 3.564/2×4)	= 1.19kN
BEAMS (150 PFC)	= 0.17kN/m	(2.4×2 + 1.2×2 + 3.564/2×4)	= 2.44kN
POSTS (75×5 SHS)	= 0.10kN/m	(1.75m × 4)	= 0.70kN
SLL	= 4.0kPa	((2.4×1.2 + 1.1×3.0/2×2)×0.3×1.0)	= 7.42kN

W_t = 14.5kN

F14-06/02

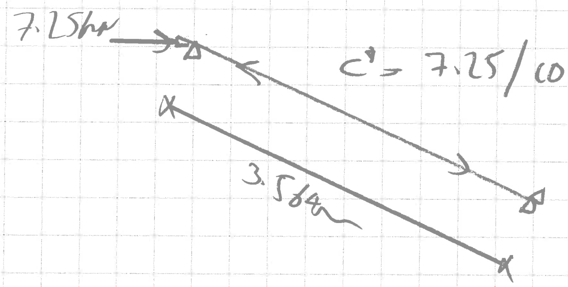
Date	Eng.	Job No.	Sheet No.
4 AUG 2016	GV	40249	E.S. 9

Project

SEISMIC STRENGTHENING – BLOCK A, SACRED HEART COLLEGE (?)

CALCULATIONS

a) CHECK 230 PFC STRINGERS FOR AXIAL LOAD:

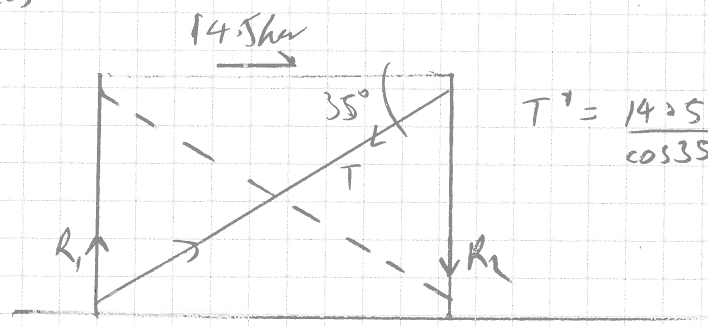


$C' = 7.25 / \cos 33° = 8.64$ kN

ϕN_{cy} (230PFC, L_e = 3.564m) ≈ 195kN – AMPLE

b) CROSS BRACES: (TENSION ONLY)

(i) BRACES



$T' = \frac{14.5}{\cos 35°} = 18$ kN

ϕN_t (RB12G) = 56.5kN – OK

RB12 CROSS BRACES

(ii) CHECK UPLIFT:

$R_1 = R_2 = 14.5 \times \frac{1.6m}{2.3m} = 10.1$ kN

0.9G (350φ x 2.2m PILE) = $23.5(0.35^2 \frac{\pi}{4} \times 2.2)$ = 5.0kN

0.9G (STAIRWELL) = 0.9(14.5) = 13.0 kN

Σ = 18kN > 10kN – OK

J402A E.5.10

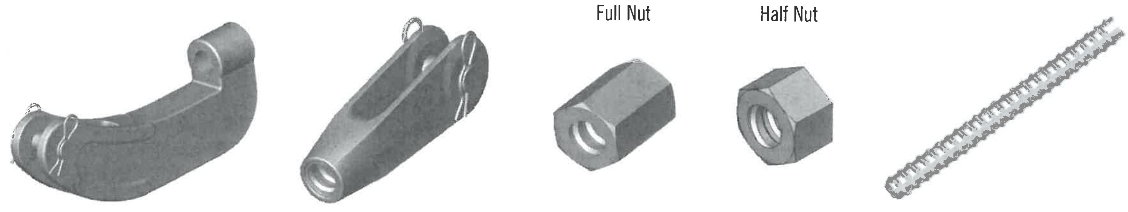
4 AUG 2016

CONSTRUCTION SYSTEMS

Reidbrace™ Bracing & Tie System

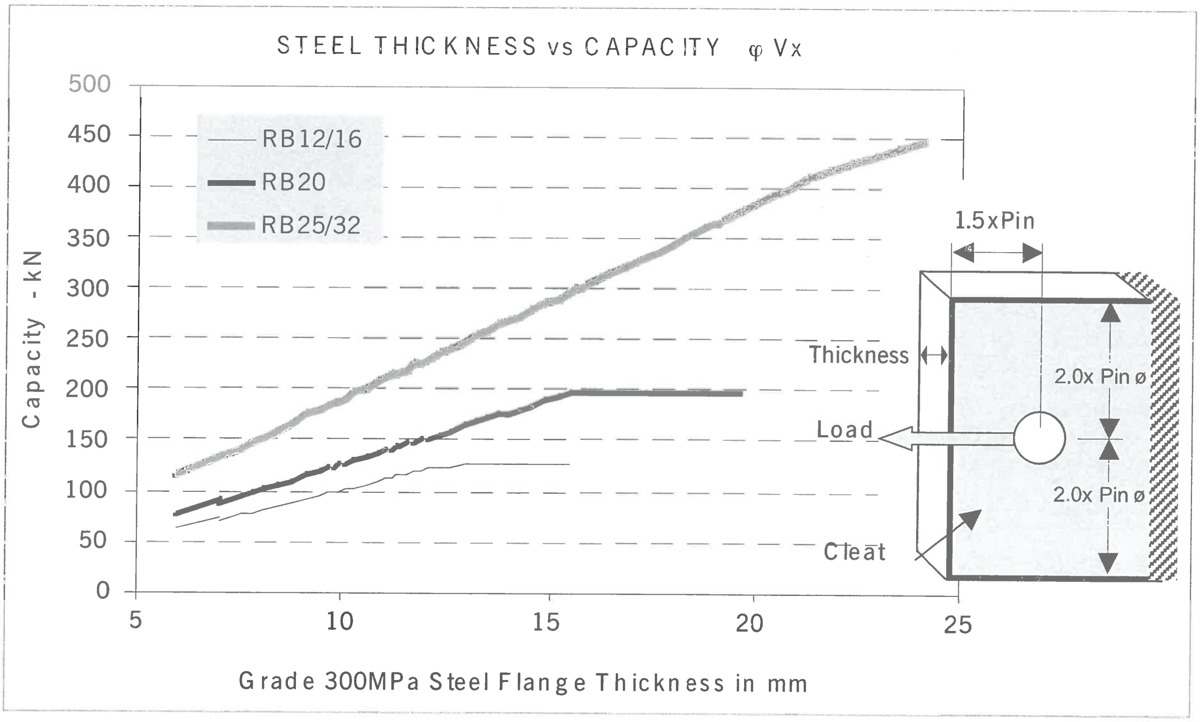
Table 28.

Reidbrace™ System						
	Reidbrace™	Reidbrace™ End	Reidbar™ Nuts		Reidbar™	
			Full Nut	Half Nut		
Product Codes						
12mm	RBRACE12/16	RBRACE12-END	RB12N	RB12NH	RB12	RB12G
16mm	RBRACE12/16	RBRACE16-END	RB16N	RB16NH	RB16	RB16G
20mm	RBRACE20	RBRACE20-END	RB20N	RB20NH	RB20	RB20G
25mm	RBRACE25/32	RBRACE25-END	RB25N	RB25NH	RB25	RB25G
32mm	RBRACE25/32	RBRACE32-END	RB32N	RB32NH	RB32	RB32G
Characteristic strengths – min ultimate strength in kN					Min Yield	Min UTS
12mm	>116	>65	65.0	33.9	56.5	65.0
16mm	>116	>116	115.6	60.4	100.6	115.6
20mm	>181	>181	180.6	94.2	157.0	180.6
25mm	>430	>283	343.7	147.2	245.5	282.3
32mm	>430	>462	462.3	241.2	402.0	462.3



G suffix is hot dipped galvanised product

Graph 3. – Pin Flange Connection Capacity φVx



Graph 1.

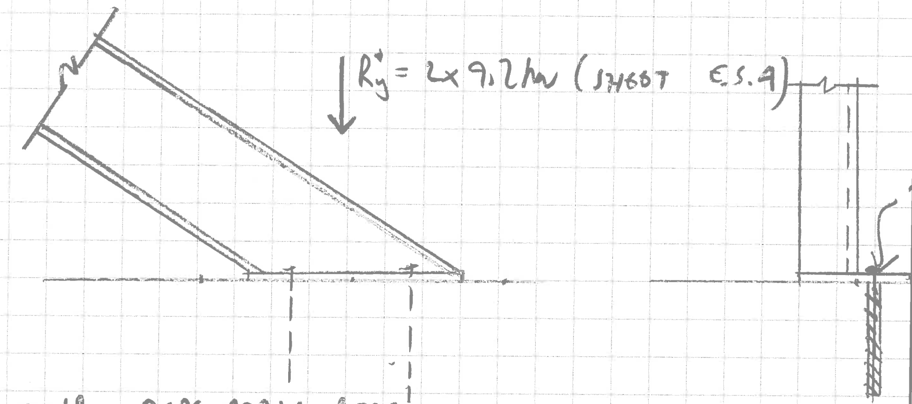
Date	Eng.	Job No.	Sheet No.
1 - AUG 2016	GV	40249	E.S. 11

Project

SEISMIC STRENGTHENING: BLOCK A, SACRED HEART COLLEGE

CALCULATIONS

5. FOOTING FOR BASE OF STRINGERS (LOWER FLIGHT)



→ ALLOW 50 kPa DEPENDABLE BEARING.

$A_{REQ'D} = \frac{18.4}{50} = 0.368 m^2$

A (1500x400 PAD) = $0.6 m^2$ → $p^* = \frac{18.4}{0.6} = 31$ kPa — OK

1.5L x 0.4W x 0.4D FOOTING