[redacted]

9329/1

19 April 2018

[redacted]

Attention: [redacted]

Dear [redacted]

Initial Seismic Assessment Report: The Pavilion - 25 Laings Rd Lower Hutt

We have now completed an Initial Seismic Assessment (ISA) of the building at 25 Laings Rd, Lower Hutt using the Initial Evaluation Procedure (IEP) as described in Part B of the guideline document, *The Seismic Assessment of Existing Buildings-Technical Guidelines for Engineering Assessments*, dated August 2017. The assessment was carried out after reviewing original structural drawings and completing a site visit on Friday 10 November 2017.

A separate assessment has been made of bracing of the ceilings, services and plant. The report is titled *Structural Review of Non-Structural Elements in the Civil Defence Offices at The Pavilion, 25 Laings Road, Lower Hutt*, and was prepared by [redacted] for Urban Plus in January 2018.

Executive Summary

This building has been rated against the new building standard for a Post Disaster Structure. Post Disaster Structures are regarded as Importance Level 4 (IL4) in accordance with NZS1170.5:2004.

The assessed potential earthquake rating is 100%NBS (IL4) in two orthogonal directions, which gives it a seismic 'Grade A'. Therefore, the potential status of the building is not earthquake risk or earthquake prone.

A "Severe Structural Weakness" (SSW) is a structural weakness for which rupture would lead to a catastrophic collapse. No potential SSWs were identified in this building.

The Initial Seismic Assessment (ISA) is considered to provide a relatively quick, high-level and qualitative measure of the building's performance. A more reliable result will be obtained from a Detailed Seismic Assessment (DSA). A DSA could find structural aspects of concern that have not been identified from the IEP. Alternatively, a detailed structural assessment may show that structural aspects of potential concern identified in the IEP may have in fact been addressed in the design of the building.

Introduction

[redacted] has engaged [redacted] to carry out an Initial Seismic Assessment (ISA) of this building at 25 Laings Rd. This ISA is based on the Initial Evaluation Procedure (IEP) as defined in *Technical Guidelines for Engineering Assessments* referenced above.

[redacted]

[redacted]

Earthquake Prone Building (EPB) methodology is used to identify earthquake-prone buildings, and has been produced by the Ministry of Business, Innovation and Employment in accordance with the Building Act 2004. This ISA meets the requirements of an engineering assessment as prescribed in the EPB methodology.

Background to the IEP and Its Limitations

The IEP procedure was developed in 2006 by the New Zealand Society for Earthquake Engineering (NZSEE) and updated in 2017 to reflect experience with its application and also as a result of experience from the Canterbury earthquakes of 2010/11. It is a tool to assign a percentage of New Building Standard (%NBS) rating and associated grade to a building as part of an Initial Seismic Assessment of existing buildings.

The IEP enables building owners and managers to review their building stock as part of an overall risk management process.

Characteristics and limitations of the IEP include:

- An IEP assessment is primarily concerned with life safety. It does not consider the susceptibility of the building to damage, and therefore to economic losses.
- It tends to be somewhat conservative, identifying some buildings as earthquake prone, or having a lower %NBS score, which subsequent detailed investigation may indicate is less than actual performance. However, there will be exceptions, particularly when potential critical structural weaknesses (CSWs) are present that have not been recognised from the level of investigation employed.
- An IEP can be undertaken with variable levels of available information: e.g. exterior only inspection, structural drawings available or not, interior inspection, etc. The more information available, the more representative the IEP result is likely to be. The IEP records the information that has formed the basis of the assessment and consideration of this is important when determining the likely reliability of the result.
- It is an initial, first-stage review. Buildings or specific issues which the IEP process flags as being problematic or as potentially critical structural weaknesses need further detailed investigation and evaluation. A Detailed Seismic Assessment is recommended if the seismic status of a building is critical to any decision making.
- The IEP assumes that buildings have been designed and built in accordance with the building standard and good practice current at the time. In some instances, a building may include design features ahead of its time, leading to better than predicted performance. Conversely, some unidentified design or construction issues not picked up by the IEP process may result in the building performing not as well as predicted.
- It is a largely qualitative process, and should be undertaken or overseen by an experienced engineer. It involves considerable knowledge of the earthquake behaviour of buildings, and judgement as to key attributes and their effect on building performance. Consequently, it is possible that the %NBS derived for a building by independent experienced engineers may differ.
- An IEP may over-penalise some apparently critical features which could have been satisfactorily taken into account in the design.

[redacted]

- An IEP does not take into account the seismic performance of non-structural items such as ceilings, plant, services or general glazing that are not considered to present a significant life safety hazard.

Experience to date is that the IEP is a useful tool to identify potential issues and expected overall performance of a building in an earthquake. However, the process and the associated %NBS rating and grade should be considered as only providing an indicative indication of the building's compliance with current code requirements. A detailed investigation and analysis of the building will typically be required to provide a definitive assessment.

This IEP has been based on 1) a review of drawings, 2) calculations on two steel portal frames, 3) calculations on the Level 1 infill block wall, 4) an inspection of the exterior, and 5) an intrusive inspection of the interior. Therefore, this IEP can be considered to be a comprehensive assessment at the ISA level. The rating determined is greater than or equal to 34%NBS and therefore, if ratified by the TA, the building should not be considered as earthquake prone.

Basis for the Assessment

The information we have used for our IEP assessment includes:

- The building was built circa 1988. It has steel portal frames on four radial bracing lines and on seven perimeter bracing lines. The roof is steel framed and the floors are concrete.
- Site subsoil class E "Very soft soil sites" has been used based on Proceedings of the Ninth Pacific Conference on Earthquake Engineering,14-16 April, 2011, "NZS 1170.5:2004 site subsoil classification of Lower Hutt" D. Boon, N.D. Perrin, G.D. Dellow & R. Van Dissen.
- The period has been estimated as being 0.17 seconds using the Rayleigh Method in accordance with NZS 1170.5:2004 section 4.1.2.
- The building has an Importance Level 4 (Post Disaster Structure).
- A ductility capacity of μ = 3 has been adopted for both directions. The calculated ductility capacity is 3.9 in accordance with The Guidelines section C6.4.
- There is insignificant plan irregularity in each direction.
- There is insignificant vertical irregularity for actions in either direction.
- Adjustment factor (F) of 1.55 has been adopted in either direction because the structure appears over designed for earthquake actions. There are fifteen steel portal frames on the ground floor and thirty cantilever concrete encased steel columns from the upstairs floor to roof level. The frames and columns are expected to remain elastic at ULS level of shaking. i.e. their ductility is unlikely to be mobilised.
- Upstairs infill block walls were analysed, out of plane, as propped cantilevers. Each component is assessed as a %NBS (IL4 50yr) with a horizontal force of 2.3G for parts. The upstairs floor slab has a score of 100%NBS, the block wall is 100%NBS, the bond beam is 90%NBS, and the cantilever concrete encased column is 80%NBS.
- The frames and cantilever columns are more stiff than typical steel frame structures. Therefore, a horizontal force of 1.8G or less is likely if a 3D Modal Response Spectra Analysis is undertaken (i.e. a DSA).

Building Description

The building located at 25 Laings Rd, is a two-storey steel portal framed structure with concrete block infill walls. The roof is 12mm ply on steel framing, upstairs is a concrete floor and the concrete ground floor is on piled foundations. It was designed circa 1988 and used by two tenants, upstairs is a civil defence centre and the downstairs is in the fit-out process for a public bar.

[redacted]

The building footprint is an octagon shape with four radial bracing lines passing through the centre and each of the eight building corners. Around the perimeter of the building, seven of the eight sides are considered bracing lines. Each radial bracing line has two steel frames with 530UB92 portal legs and 410UB82 composite concrete-steel beams. Each perimeter bracing line has a 310UB46 portal frame.

The upstairs floor is 125mm thick concrete. The foundation is concrete slab on ground beams and piles. Cantilever concrete encased columns, of 530UB and 310UB steel sections, support the roof. The roof is butynol and 12mm ply on steel purlins and steel trusses.

The load path from the roof proceeds through a primary roof truss (there are eight primary roof trusses) to the two-supporting cantilever concrete encased 530UB92 steel columns, then into a primary portal frame along a radial bracing line. This load path is the same in eight positions, two per radial bracing line.

Evidence of settlement has not been observed. There are no surrounding buildings within the immediate vicinity. There were some significant structural alterations constructed circa 1996. The central opening in the upstairs floor slab was filled in with timber framed floor supported by two steel beams.

From the inspection it is evident that some infill concrete block walls have been added to the ground floor. The detailing of these walls is un-known and further investigation is required to ascertain their seismic score. The upstairs cantilever columns have nominal portal action with the roof truss and intermediate cantilever columns have nominal structural connection to the roof. Further investigation and analysis may be carried out in a Detailed Seismic Assessment.

IEP Assessment Result

Our IEP assessment of this building indicates the building can achieve 100%NBS (IL4 50yr) in each orthogonal direction. The IEP assessment of this building therefore indicates an overall earthquake rating of 100%NBS (IL4 50yr), corresponding to a 'Grade A' building as defined by the New Zealand Society for Earthquake Engineering (NZSEE) building grading scheme. This is above 34%NBS, and above the threshold for earthquake risk buildings (67%NBS) as recommended by the NZSEE.

The key assumptions made during our assessment are shown in Table 1 that follows. Refer also to the attached IEP assessment and engineering assessment technical summary.

Table 1: IEP Assessment Results

IEP Item	Assumption	Justification
Date of Building Design	1988	Original drawings
Soil Type	E	Proceedings of the Ninth Pacific Conference on Earthquake Engineering,14-16 April, 2011, "NZS 1170.5:2004 site subsoil classification of Lower Hutt" D. Boon, N.D. Perrin, G.D. Dellow & R. Van Dissen.
Building Importance Level	4	Post Disaster Structure, AS/NZS1170.0
Ductility of Structure	3	The Guideline section C6.5 and C6.6.
Plan Irregularity Factor, A	Not Significant	*The Seismic Assessment of Existing Buildings -Technical Guidelines for Engineering Assessments*, August 2017, Part B, Appendix BA, Figure BA.5

[redacted]

IEP Item	Assumption	Justification
Vertical Irregularity Factor, B	Not Significant	*The Seismic Assessment of Existing Buildings-Technical Guidelines for Engineering Assessments*, August 2017, Part B, Appendix BA, Figure BA.5
Short Columns Factor, C	No	Short columns were not observed.
Pounding Factor, D	1	There are no other structures within the immediate vicinity.
Site Characteristics	Not significant	*The Seismic Assessment of Existing Buildings-Technical Guidelines for Engineering Assessments*, August 2017, Part B, section B4.2. Settlement not observed. Slip hazard does not exist.
Factor F	1.55	There are thirty concrete encased steel columns upstairs and fifteen steel portal frames on the ground floor. Both the columns and the frames remain well within their elastic limit at ULS level shaking.

IEP Grades and Relative Risk

Table 2 taken from the Technical Guidelines referred to earlier provides the basis for a proposed grading system for existing buildings, as one way of interpreting the %NBS earthquake rating.

Table 2: Relative Earthquake Risk

Building Grade	Percentage of New Building Strength (*%NBS*)	Approx. Risk Relative to a New Building	Life-safety Risk Description
A+	>100	<1	low risk
A	80 to 100	1 to 2 times	low risk
B	67 to 79	2 to 5 times	low or medium risk
C	34 to 66	5 to 10 times	medium risk
D	20 to 33	10 to 25 times	high risk
E	<20	more than 25 times	very high risk

This building has been classified by the IEP as a 'Grade *A*' building and is therefore considered to be a low life-safety risk.

NZSEE (which provides authoritative advice to the legislation makers, and should be considered to represent the consensus view of New Zealand structural engineers) classifies buildings achieving greater than 67%NBS as "Low or medium Risk", and having "Acceptable (improvement may be desirable)" building structural performance.

Seismic Restraint of Non-Structural Items

During an earthquake, the safety of people can be put at risk due to non-structural items falling on them. These items should be adequately seismically restrained, where possible, to the NZS 4219:2009 "The Seismic Performance of Engineering Systems in Buildings".

[redacted]

A separate assessment has been made of bracing of the ceilings, services and plant. The report is titled *Structural Review of Non-Structural Elements in the Civil Defence Offices at The Pavilion, 25 Laings Road, Lower Hutt*, and was prepared by [redacted] in January 2018.

We have not checked whether tall or heavy furniture has been seismically restrained or not. These issues are outside the scope of this initial assessment but could be the subject of another investigation.

Other Issues

Other issues pertaining to the gravity support of the structure have not been identified.

Conclusion

Our ISA assessment for this building, carried out using the IEP indicates an overall score of 100%NBS (IL4 50yr), which corresponds to a 'Grade A' building, as defined by the NZSEE building grading scheme. This is *above* the threshold for Earthquake Prone Buildings (34%NBS) and the threshold for Earthquake Risk Buildings (67%NBS) as defined by the NZSEE and the New Zealand Building Code.

The ISA is considered to provide a relatively quick, high-level and qualitative measure of the building's performance. In order to confirm the seismic performance of this building with more reliability you may wish to request a Detailed Seismic Assessment (DSA). A DSA would likely focus on issues such as the addition of infill block walls at ground level, a 3D model (Modal Response Spectra Analysis) of upstairs block walls out of plane, bending of the primary roof trusses, stair openings and central openings in the upstairs floor slab and a building torsional analysis.

A DSA would also investigate other potential weaknesses that may not have been considered in the initial seismic assessment.

We trust this letter and initial seismic assessment meets your current requirements. We would be pleased to discuss further with you any issues raised in this report. Please do not hesitate to contact us if you would like clarification of any aspect of this letter.

Yours faithfully

[redacted]

1. **Building Information**	
Building Name/ Description	The Pavilion
Street Address	25 Laings Road
Territorial Authority	Hutt City Council
No. of Storeys	2
Area of Typical Floor (approx.)	Approximately 400 square metres, the building footprint is octagonal in shape.
Year of Design (approx.)	1988
NZ Standards designed to	NZS4203:1984
Structural System including Foundations	The roof is butynyl and 12mm ply wood on steel purlins. Level1 Structural System consists of cantilever columns with some portal action provided by steel roof trusses. The Level1 floor is 125mm thick Dimond Hibond with composite action to all L1 steel beams. The Ground Level structural system consist of steel portal frames with 530UB92 legs and 460UB82 beams on radial bracing lines. Both Ground Level and Level 1 have perimeter steel portal frames are 310UB46. All portal legs and cantilever columns are concrete encased. The ground slab and ground beams are supported by pile foundations.
Does the building comprise a shared structural form or shares structural elements with any other adjacent titles?	no
Key features of ground profile and identified geohazards	none
Previous strengthening and/ or significant alteration	Removal of some infill concrete block walls at ground level. New infill concrete block walls at ground level. New timber floor in central Level 1 floor slab opening.
Heritage Issues/ Status	none
Other Relevant Information	none

2. Assessment Information	
Consulting Practice	[redacted]
CPEng Responsible, including: • Name • CPEng number • A statement of suitable skills and experience in the seismic assessment of existing buildings[1]	
Documentation reviewed, including: • date/ version of drawings/ calculations[2] • previous seismic assessments	1988 - Original Structural and Architectural Drawings 1988 – Structural Specification and Calculations 1996 – Timber Floor Addition Architectural Drawings 1996 – Timber Floor Addition Structural Calculations
Geotechnical Report(s)	none
Date(s) Building Inspected and extent of inspection	10 November 2017, exterior all around, exterior roof, interior at ground level with the removal of some linings and block walls, interior at level 1.
Description of any structural testing undertaken and results summary	none
Previous Assessment Reports	none
Other Relevant Information	none

[1] This should include reference to the engineer's Practice Field being in Structural Engineering, and commentary on experience in seismic assessment and recent relevant training
[2] Or justification of assumptions if no drawings were able to be obtained

3. Summary of Engineering Assessment Methodology and Key Parameters Used	
Occupancy Type(s) and Importance Level	Post Disaster Structure, Importance Level 4
Site Subsoil Class	E very soft soil
For an ISA:	
Summary of how Part B was applied, including: • Key parameters such as μ, S_p and F factors • Any supplementary specific calculations	Ductility, μ =3 Structural Performance, Sp = 0.7 F factor, F = 1.55 Supplementary calculations have been carried out in accordance with the Guidelines. The calculations include 1) assessment of two-steel portal frames at ground level 2) assessment of the level 1 concrete block wall out of plane.
For a DSA:	
Summary of how Part C was applied, including: • the analysis methodology(s) used from C2 • other sections of Part C applied	N/A
Other Relevant Information	none

4. Assessment Outcomes		
Assessment Status (Draft or Final)	Final	
Assessed *%NBS* Rating	100%NBS (IL4 50yr)	
Seismic Grade and Relative Risk (from Table A3.1)	Grade A – Low Risk	
For an ISA:		
Describe the Potential Critical Structural Weaknesses	none	
Does the result reflect the building's expected behaviour, or is more information/ analysis required?	Yes – the ISA is sufficient for the buildings behaviour.	
If the results of this ISA are being used for earthquake prone decision purposes, and elements rating <34*%NBS* have been identified:	**Engineering Statement of Structural Weaknesses and Location** N/A	***Mode of Failure and Physical Consequence* Statement(s)** N/A
For a DSA:		
Comment on the nature of Secondary Structural and Non-structural elements/ parts identified and assessed		
Describe the Governing Critical Structural Weakness		
If the results of this DSA are being used for earthquake prone decision purposes, and elements rating <34*%NBS* have been identified (including Parts)[3]:	**Engineering Statement of Structural Weaknesses and Location**	***Mode of Failure and Physical Consequence* Statement(s)**
Recommendations (*optional for EPB purposes*)	For resilience, focus on non-structural elements and building contents.	

[3] If a building comprises a shared structural form or shares structural elements with other adjacent titles, information about the extent to which the low scoring elements affect, or do not affect the structure.

[redacted]

Appendix 1: IEP Form

Initial Evaluation Procedure (IEP) Assessment - Completed for Urban Plus

WARNING!! *This initial evaluation has been carried out solely as an initial seismic assessment of the building following the procedure set out in the "The Seismic Assessment of Existing Buildings" Technical Guidelines for Engineering Assessments, July 2017. This spreadsheet must be read in conjunction with the limitations set out in the accompanying report, and should not be relied on by any party for any other purpose. Detailed inspections and engineering calculations, or engineering judgements based on them, have not been undertaken, and these may lead to a different result or seismic grade.*

Street Number & Name:	**25 Laings Road**	**Job No.:**	**8329/1**
AKA:	**The Pavilion**	**By:**	**UM**
Name of building:		**Date:**	**17/04/2018**
City:	**Lower Hutt**	**Revision No.:**	**original**

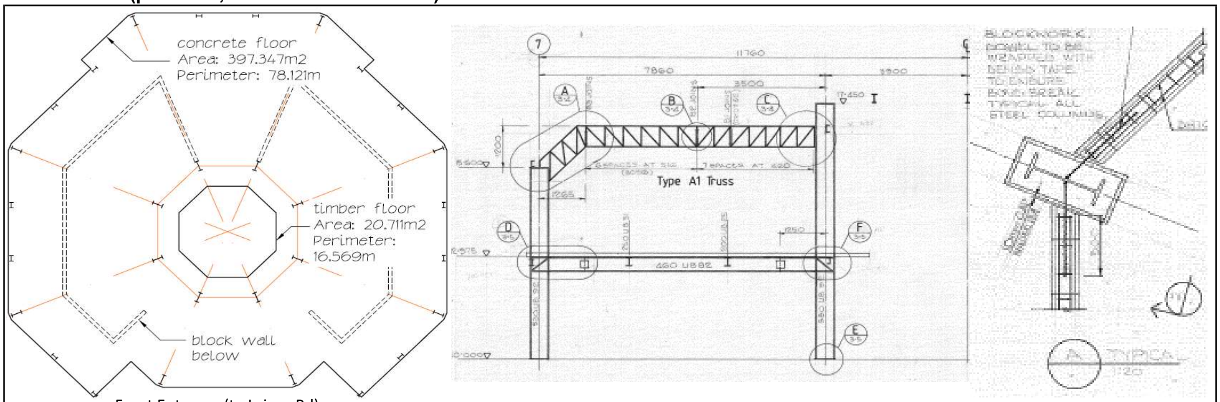
Table IEP-1 Initial Evaluation Procedure Step 1

Step 1 - General Information

1.1 Photos (attach sufficient to describe building)

NOTE: THERE ARE MORE PHOTOS ON PAGE 1a ATTACHED

1.2 Sketches (plans etc, show items of interest)



NOTE: THERE ARE MORE SKETCHES ON PAGE 1a ATTACHED

1.3 List relevant features (Note: only 10 lines of text will print in this box. If further text required use Page 1a)

The building is two storey with four bracing lines that pass through the centre of the building. These radial bracing lines are at 45 degrees to one another.
Lateral support to the Level1 Floor is provided by two steel portal frames on each radial bracing line, and seven additional steel portal frames around the perimeter .
Lateral support to the Level2 Roof is provided by concrete encased cantilever steel columns. These are 530UB92 or 310UB46.
Concentic bracing line portals cosist of 530UB92 legs and 460UB82 composite steel and concrete beams. Perimeter portals consist of 310UB46 portal legs and beams.

The main roof is butynol and 12mm ply on steel framing in the middle and on timber framing around the perimeter. The main roof is 2º in the middle and 45º around the perimeter.
There is a poptop roof in the centre. The trusses are comprised of rolled steel angles and there are eight primary trussess and fifteen secondary trussess.
The main Level1 floor is 125mm thick concrete slab with nelson studs connection to all gravity supporting steel beams. Either side of the front entrance are stairway openings in the slab.
In the centre of L1 Floor is an opening in the concrete slab, and this is filled in with a timber framed floor supported by two steel beams. The timber floor is an alteration.
Perimeter concrete block infill walls cantilever from the Ground slab. Perimeter block infill walls at Level1 cantilever from the Level1 slab and are propped by the cantilever columns.
The load path in each orthogonal direction is the same. Roof loads are carried via a ply diaphragm and steel truss portal to cantilever concrete encased steel columns.
Level1 Floor loads are carried via a concrete slab diaphragm, which is rigid relative to steel portal frames, to steel portal frames below.

1.4 Note information sources

Tick as appropriate

Visual Inspection of Exterior	☑	**Specifications**	☑
Visual Inspection of Interior	☑	**Geotechnical Reports**	☐
Drawings (note type)	☑	**Other (list)**	☐

Visual Inspection of Exterior excludes sides and rear. Visual inspection of interrior at Ground Level and Level1. Structural and Architectural drawings.

Initial Evaluation Procedure (IEP) Assessment - Completed for Urban Plus

Street Number & Name:	25 Laings Road	Job No.:	8329/1
AKA:	The Pavilion	By:	UM
Name of building:		Date:	17/04/2018
City:	Lower Hutt	Revision No.:	original

Table IEP-2 Initial Evaluation Procedure Step 2

Step 2 - Determination of *(%NBS)* $_b$

(Baseline *(%NBS)* for particular building - refer Section B5)

2.1 Determine nominal *(%NBS)* = *(%NBS)* $_{nom}$

	Longitudinal	Transverse
a) Building Strengthening Data		
Tick if building is known to have been strengthened in this direction	☐	☐
If strengthened, enter percentage of code the building has been strengthened to	N/A	N/A

b) Year of Design/Strengthening, Building Type and Seismic Zone

	Longitudinal	Transverse
Pre 1935	○	○
1935-1965	○	○
1965-1976	○	○
1976-1984	○	○
1984-1992	◉	◉
1992-2004	○	○
2004-2011	○	○
Post Aug 2011	○	○
Building Type:	**Not applicable**	**Not applicable**
Seismic Zone:	Zone A	Zone A

c) Soil Type

	Longitudinal	Transverse
From NZS1170.5:2004, Cl 3.1.3 :	D Soft Soil	D Soft Soil
From NZS4203:1992, Cl 4.6.2.2 : (for 1992 to 2004 and only if known)	**Not applicable**	**Not applicable**

d) Estimate Period, *T*

Comment:

Rayleigh period estimate T1 = 0.17sec

		Longitudinal	Transverse
	h_n =	7.45	7.45 m
	A_c =	1.00	1.00 m^2
Moment Resisting Concrete Frames:	$T = \max\{0.09h_n^{0.75}, 0.4\}$	○	○
Moment Resisting Steel Frames:	$T = \max\{0.14h_n^{0.75}, 0.4\}$	○	○
Eccentrically Braced Steel Frames:	$T = \max\{0.08h_n^{0.75}, 0.4\}$	○	○
All Other Frame Structures:	$T = \max\{0.06h_n^{0.75}, 0.4\}$	○	○
Concrete Shear Walls	$T = \max\{0.09h_n^{0.75}/A_c^{0.5}, 0.4\}$	○	○
Masonry Shear Walls:	$T \leq 0.4$sec	○	○
User Defined (input Period):		◉	◉
	T:	0.17	0.17

Where h_n = height in metres from the base of the structure to the uppermost seismic weight or mass.

			Longitudinal	Transverse
e) Factor A:	Strengthening factor determined using result from (a) above (set to 1.0 if not strengthened)	**Factor A:**	1.00	1.00
f) Factor B:	Determined from NZSEE Guidelines Figure 3A.1 using results (a) to (e) above	**Factor B:**	0.20	0.20
g) Factor C:	For reinforced concrete buildings designed between 1976-84 Factor C = 1.2, otherwise take as 1.0.	**Factor C:**	1.00	1.00
h) Factor D:	For buildings designed prior to 1935 Factor D = 0.8 except for Wellington and Napier (1931-1935) where Factor D may be taken as 1.0, otherwise take as 1.0.	**Factor D:**	1.00	1.00
(%NBS) $_{nom}$ **= AxBxCxD**		***(%NBS)*** $_{nom}$	20%	20%

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Initial Evaluation Procedure (IEP) Assessment - Completed for Urban Plus

Street Number & Name:	25 Laings Road	Job No.:	8329/1
AKA:	The Pavilion	By:	UM
Name of building:		Date:	17/04/2018
City:	Lower Hutt	Revision No.:	original

Table IEP-2 Initial Evaluation Procedure Step 2 continued

2.2 Near Fault Scaling Factor, Factor E

If $T \leq$ 1.5sec, Factor E = 1

		Longitudinal	Transverse
a) Near Fault Factor, *N(T,D)* (from NZS1170.5:2004, Cl 3.1.6)	N(T,D):	1	1
b) Factor E = 1/N(T,D)	Factor E:	1.00	1.00

2.3 Hazard Scaling Factor, Factor F

a) Hazard Factor, *Z*, for site

Location: Hutt Valley-south of Taita Gorge — **Refer right for user-defined locations**

Z = 0.4 (from NZS1170.5:2004, Table 3.3)

Z_{1992} = 1.2 (NZS4203:1992 Zone Factor from accompanying Figure 3.5(b))

Z_{2004} = 0.4 (from NZS1170.5:2004, Table 3.3)

b) Factor F

For pre 1992 = $1/Z$

For 1992-2011 = Z_{1992}/Z

For post 2011 = Z_{2004}/Z

	Longitudinal	Transverse
Factor F:	2.50	2.50

2.4 Return Period Scaling Factor, Factor G

a) Design Importance Level, I

(Set to 1 if not known. For buildings designed prior to 1965 and known to be designed as a public building set to 1.25. For buildings designed 1965-1976 and known to be designed as a public building set to 1.33 for Zone A or 1.2 for Zone B. For 1976-1984 set I value.)

b) Design Risk Factor, R_o

(set to 1.0 if other than 1976-2004, or not known)

c) Return Period Factor, R

(from NZS1170.0:2004 Building Importance Level) — *Choose Importance Level*

d) Factor G = IR_o/R

	Longitudinal	Transverse
I =	1	1
Category	Category 2a	Category 2a
R_o =	1.6	1.6
Importance Level	○1 ○2 ○3 ◉4	○1 ○2 ○3 ◉4
R =	1.8	1.8
Factor G:	0.89	0.89

2.5 Ductility Scaling Factor, Factor H

a) Available Displacement Ductility Within Existing Structure

Comment:

ducitlity =3.9 according to the guidelines C3.5.2 ductility of the beam governs. Ducility =3 has been adopted.

b) Factor H

		Longitudinal	Transverse
μ =		3.00	3.00
		k_μ	k_μ
For pre 1976 (maximum of 2)	=	1.49	1.49
For 1976 onwards	=	1	1
Factor H:		1.00	1.00

(where k_μ is NZS1170.5:2004 Inelastic Spectrum Scaling Factor, from accompanying Table 3.3)

2.6 Structural Performance Scaling Factor, Factor I

a) Structural Performance Factor, S_p

(from accompanying Figure 3.4)

Tick if light timber-framed construction in this direction

b) Structural Performance Scaling Factor = $1/S_p$

	Longitudinal	Transverse
Light timber-framed	☐	☐
S_p =	0.70	0.70
Factor I:	1.43	1.43

Note Factor B values for 1992 to 2004 have been multiplied by 0.67 to account for Sp in this period

2.7 Baseline *%NBS* for Building, $(\%NBS)_b$

(equals $(\%NBS)_{nom}$ x E x F x G x H x I)

	Longitudinal	Transverse
$(\%NBS)_b$	63%	63%

Initial Evaluation Procedure (IEP) Assessment - Completed for Urban Plus

Street Number & Name:	25 Laings Road	Job No.:	8329/1
AKA:	The Pavilion	By:	UM
Name of building:		Date:	17/04/2018
City:	Lower Hutt	Revision No.:	original

Table IEP-3 Initial Evaluation Procedure Step 3

Step 3 - Assessment of Performance Achievement Ratio (PAR)

(Refer Appendix B - Section B3.2)

a) Longitudinal Direction

potential CSWs — **Effect on Structural Performance** (Choose a value - Do not interpolate) — **Factors**

3.1 Plan Irregularity

Effect on Structural Performance ○ *Severe* ○ *Significant* ◉ *Insignificant* **Factor A** 1.0

Comment

3.2 Vertical Irregularity

Effect on Structural Performance ○ *Severe* ○ *Significant* ◉ *Insignificant* **Factor B** 1.0

Comment

3.3 Short Columns

Effect on Structural Performance ○ *Severe* ○ *Significant* ◉ *Insignificant* **Factor C** 1.0

Comment

3.4 Pounding Potential

(Estimate D1 and D2 and set D = the lower of the two, or 1.0 if no potential for pounding, or consequences are considered to be minimal)

a) Factor D1: - Pounding Effect

Note:
Values given assume the building has a frame structure. For stiff buildings (eg shear walls), the effect of pounding may be reduced by taking the coefficient to the right of the value applicable to frame buildings.

Factor D1 For Longitudinal Direction: 1.0

Table for Selection of Factor D1	Severe	Significant	Insignificant
Separation	0<Sep<.005H	.005<Sep<.01H	Sep>.01H
Alignment of Floors within 20% of Storey Height	○1	○1	◉1
Alignment of Floors not within 20% of Storey Height	○0.4	○0.7	○0.8

Comment

b) Factor D2: - Height Difference Effect

Factor D2 For Longitudinal Direction: 1.0

Table for Selection of Factor D2	Severe	Significant	Insignificant
	0<Sep<.005H	.005<Sep<.01H	Sep>.01H
Height Difference > 4 Storeys	○0.4	○0.7	○1
Height Difference 2 to 4 Storeys	○0.7	○0.9	◉1
Height Difference < 2 Storeys	○1	○1	○1

Comment

Factor D 1.0

3.5 Site Characteristics - *Stability, landslide threat, liquefaction etc as it affects the structural performance from a life-safety perspective*

Effect on Structural Performance ○ *Severe* ○ *Significant* ◉ *Insignificant* **Factor E** 1.0

Comment

3.6 Other Factors - *for allowance of all other relevant characterstics of the building*

For ≤ 3 storeys - Maximum value 2.5
otherwise - Maximum value 1.5.
No minimum.

Factor F 1.6

Record rationale for choice of Factor F:

There are many portal frames providing lateral support to Level1 and many cantilever columns providing lateral support to roof. Supporting calculations show that the lateral load resisting system has a capacity of more than twice the demand.

3.7 Performance Achievement Ratio (PAR)
(equals **A x B x C x D x E x F**)

PAR
Longitudinal **1.55**

Initial Evaluation Procedure (IEP) Assessment - Completed for Urban Plus

Street Number & Name:	25 Laings Road	Job No.:	8329/1
AKA:	The Pavilion	By:	UM
Name of building:		Date:	17/04/2018
City:	Lower Hutt	Revision No.:	original

Table IEP-3 Initial Evaluation Procedure Step 3

Step 3 - Assessment of Performance Achievement Ratio (PAR)

(Refer Appendix B - Section B3.2)

b) Transverse Direction

Factors

potential CSWs — **Effect on Structural Performance** **(Choose a value - Do not interpolate)**

3.1 Plan Irregularity

Effect on Structural Performance ○ *Severe* ○ *Significant* ◉ *Insignificant* **Factor A** 1.0

3.2 Vertical Irregularity

Effect on Structural Performance ○ *Severe* ○ *Significant* ◉ *Insignificant* **Factor B** 1.0

Comment

3.3 Short Columns

Effect on Structural Performance ○ *Severe* ○ *Significant* ◉ *Insignificant* **Factor C** 1.0

Comment

3.4 Pounding Potential

(Estimate D1 and D2 and set D = the lower of the two, or 1.0 if no potential for pounding, or consequences are considered to be minimal)

a) Factor D1: - Pounding Effect

Note:
Values given assume the building has a frame structure. For stiff buildings (eg shear walls), the effect of pounding may be reduced by taking the coefficient to the right of the value applicable to frame buildings.

Factor D1 For Transverse Direction: 1.0

Table for Selection of Factor D1	Severe	Significant	Insignificant
Separation	0<Sep<.005H	.005<Sep<.01H	Sep>.01H
Alignment of Floors within 20% of Storey Height	○1	○1	◉1
Alignment of Floors not within 20% of Storey Height	○0.4	○0.7	○0.8

Comment

b) Factor D2: - Height Difference Effect

Factor D2 For Transverse Direction: 1.0

Table for Selection of Factor D2	Severe	Significant	Insignificant
	0<Sep<.005H	.005<Sep<.01H	Sep>.01H
Height Difference > 4 Storeys	○0.4	○0.7	○1
Height Difference 2 to 4 Storeys	○0.7	○0.9	◉1
Height Difference < 2 Storeys	○1	○1	○1

Comment

Factor D 1.0

3.5 Site Characteristics - *Stability, landslide threat, liquefaction etc as it affects the structural performance from a life-safety perspective*

Effect on Structural Performance ○ *Severe* ○ *Significant* ◉ *Insignificant* **Factor E** 1.0

Comment

3.6 Other Factors - *for allowance of all other relevant characterstics of the building*

For ≤ 3 storeys - Maximum value 2.5
otherwise - Maximum value 1.5.
No minimum.

Factor F 1.55

Record rationale for choice of Factor F:

Same as for the Longitudinal direction.

PAR

3.7 Performance Achievement Ratio (PAR)
(equals **A x B x C x D x E x F**)

Transverse **1.55**

WARNING!! *This initial evaluation has been carried out solely as an initial seismic assessment of the building following the procedure set out in "The Seismic Assessment of Existing Buildings" Technical Guidelines for Engineering Assessments, July 2017. This spreadsheet must be read in conjunction with the limitations set out in the accompanying report, and should not be relied on by any party for any other purpose. Detailed inspections and engineering calculations, or engineering judgements based on them, have not been undertaken, and these may lead to a different result or seismic grade.*

Initial Evaluation Procedure (IEP) Assessment - Completed for Urban Plus

Street Number & Name:	25 Laings Road	Job No.:	8329/1
AKA:	The Pavilion	By:	UM
Name of building:		Date:	17/04/2018
City:	Lower Hutt	Revision No.:	original

Table IEP-4 Initial Evaluation Procedure Steps 4, 5, 6 and 7

Step 4 - Percentage of New Building Standard *(%NBS)*

		Longitudinal	Transverse
4.1	Assessed Baseline *%NBS (%NBS)* $_b$ (from Table IEP - 1)	63%	63%
4.2	Performance Achievement Ratio (PAR) (from Table IEP - 2)	1.55	1.55
4.3	PAR x Baseline *(%NBS)* $_b$	100%	100%
4.4	Percentage New Building Standard *(%NBS)* - Seismic Rating (Use lower of two values from Step 4.3)		100%

Step 5 - Is *%NBS* < 34?

NO

Step 6 - Potentially Earthquake Risk (is *%NBS* < 67)?

NO

Step 7 - Provisional Grading for Seismic Risk based on IEP

Seismic Grade: A

Additional Comments (items of note affecting IEP based seismic rating)

Supporting calculations show that the concrete block infill walls at Level 1 achieve 100% NBS (IL4 50yr) out of plane. However the supporting cantilever concrete encased steel columns have a score of 80% NBS (IL4 50yr) and the bond beam scores 90%NBS (IL4 50yr).

This assessment of the infill walls out of plane utlizes a parts coefficent of 2.3 (Fph = 2.3 Wp). This appears conservative because there are many stiff steel frames providing lateral support to Level1. The Level1 deflection was assessed as 3.7mm at ULS ductility=3.9 (IL4 50yr) which is less than half of the first yield deflection. The columns were assessed as cantilvers but there may be some connectivity at the top.

A higher level of study such as a 3D Modal Response Spectra Analysis may yield accelerations of 1.8G or less. Therefore the building may perform as 100% (NBS IL4) building.

Relationship between Grade and *%NBS* :

Grade:	A+	A	B	C	D	E
%NBS:	> 100	100 to 80	79 to 67	66 to 34	< 34 to 20	< 20

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Initial Evaluation Procedure (IEP) Assessment - Completed for Urban Plus

Street Number & Name:	25 Laings Road	Job No.:	8329/1
AKA:	The Pavilion	By:	UM
Name of building:		Date:	17/04/2018
City:	Lower Hutt	Revision No.:	original

Table IEP-5 Initial Evaluation Procedure Step 8

Step 8 - Identification of potential Severe Structural Weaknesses (SSWs) that could result in significant risk to a significant number of occupants

8.1	Number of storeys above ground level	2
8.2	Presence of heavy concrete floors and/or concrete roof? (Y/N)	N

Potential Severe Structural Weaknesses (SSWs):

Note: Options that are greyed out are not applicable and need not be considered.

Occupancy not considered to be significant - no further consideration required

Risk not considered to be significant - no further consideration required

The following potential Severe Structural Weaknesses (SSWs) have been identified in the building that could result in significant risk to a significant number of occupants:

1. None identified
2. Weak or soft storey (except top storey)
3. Brittle columns and/or beam-column joints the deformations of which are not constrained by other structural elements
4. Flat slab buildings with lateral capacity reliant on low ductility slab-to-column connections
5. No identifiable connection between primary structure and diaphragms
6. Ledge and gap stairs

IEP Assessment Confirmed by [redacted]

WARNING!! *This initial evaluation has been carried out solely as an initial seismic assessment of the building following the procedure set out in "The Seismic Assessment of Existing Buildings" Technical Guidelines for Engineering Assessments, July 2017. This spreadsheet must be read in conjunction with the limitations set out in the accompanying report, and should not be relied on by any party for any other purpose. Detailed inspections and engineering calculations, or engineering judgements based on them, have not been undertaken, and these may lead to a different result or seismic grade.*

Initial Evaluation Procedure (IEP) Assessment - Completed for Urban Plus

Street Number & Name:	25 Laings Road	Job No.:	8329/1
AKA:	The Pavilion	By:	UM
Name of building:		Date:	17/04/2018
City:	Lower Hutt	Revision No.:	original

Table IEP-1a Additional Photos and Sketches

Add any additional photographs, notes or sketches required below:

Note: print this page separately





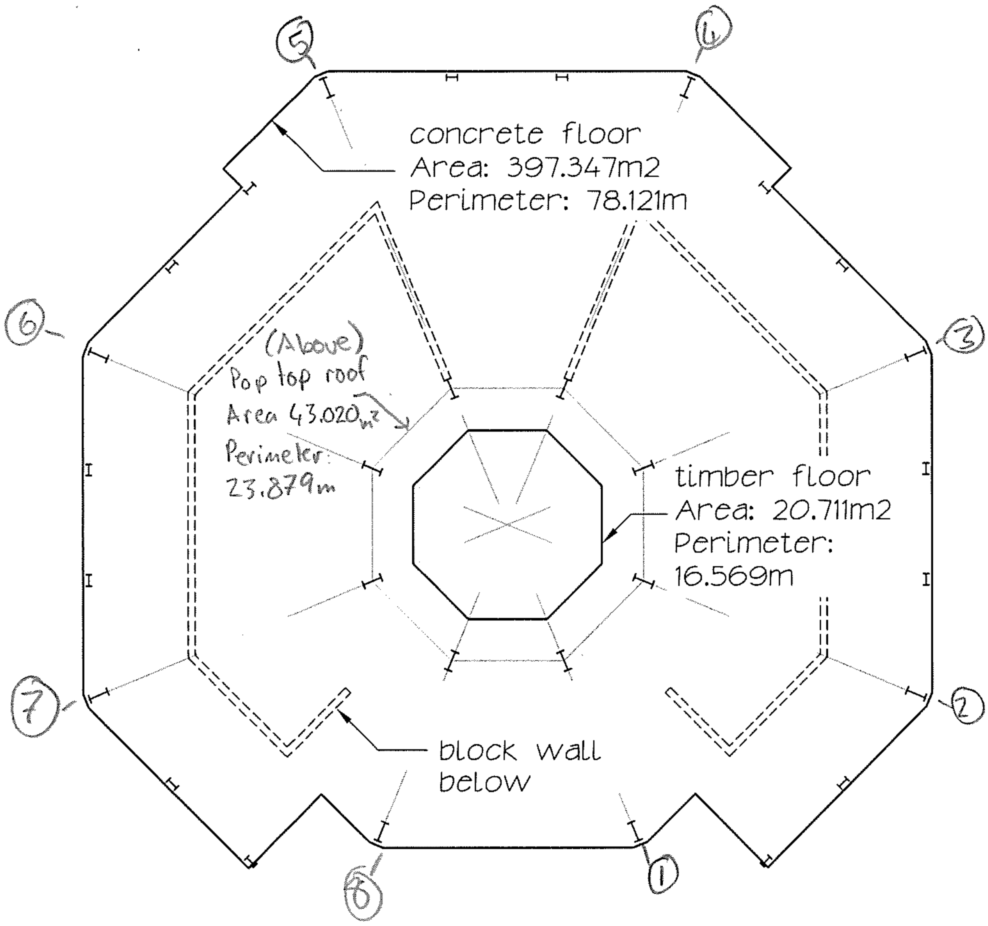

WARNING!! *This initial evaluation has been carried out solely as an initial seismic assessment of the building following the procedure set out "The Seismic Assessment of Existing Buildings" Technical Guidelines for Engineering Assessments, July 2017. This spreadsheet must be read in conjunction with the limitations set out in the accompanying report, and should not be relied on by any party for any other purpose. Detailed inspections and engineering calculations, or engineering judgements based on them, have not been undertaken, and these may lead to a different result or seismic grade.*

[redacted]

Appendix 2: Additional Calculations

Project	THE PAVILION 25 LAINGS ROAD INITIAL SIESMIC ASSESSMENT (IL4 50YR) APPENDIX2 - ADDITIONAL CALCULATIONS CONTENTS PAGE				[redacted]
		Date 19/04/18	***Project No.*** 9329/1	***By*** UM	***Page No.*** 0

CONTENTS

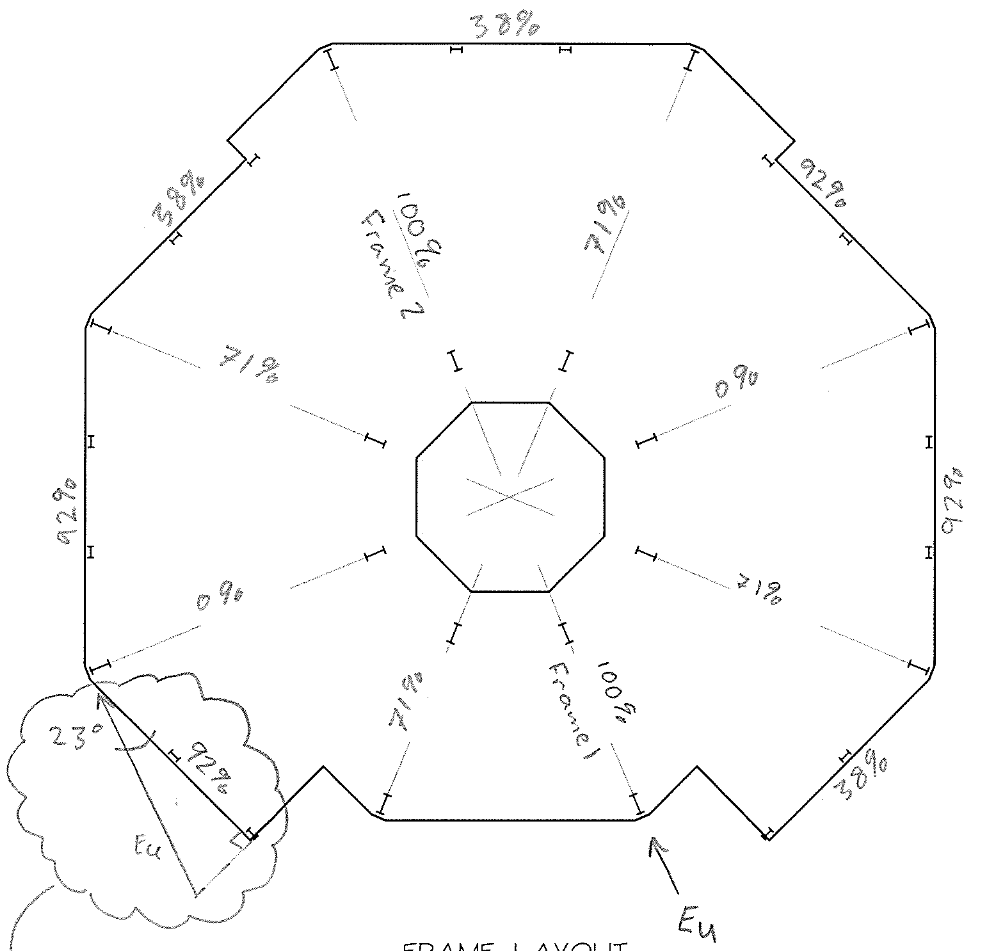


L1 FLOOR PLAN

THE PAVILION, Laings Rd
Initial Seismic Assessment

[redacted]	SCALE 1:200	DRAWN UM	REF 9329/1
	DATE 16/04/18	CHECKED	CALC 1

Assumed Frame Load distribution:



FRAME LAYOUT

Frame = cos(23)
= 92%

$\Sigma = 38 \times 3 + 92 \times 4 + 71 \times 4 + 100 \times 2$
$= 966\%$

NZS1170.5:2004 § 5.3.1.1 (b) for "seismic resisting systems not located along 2-perpendicular directions

THE PAVILION, Laings Rd
Initial Seismic Assessment

[redacted]	SCALE 1:200	DRAWN UM	REF 9329/1
	DATE 16/04/18	CHECKED	CALC 2

[redacted]

PROJECT	DATE	PROJECT NO.	BY	PAGE NO.
The Pavilion, Laings Rd ISA — Dead Load	14/04/18	9329/1	[redacted]	1.3

Dead Load

Roof (ply, Gib, Steel purlins, pop roof Steel roof truss) 0.4 kPa*

Blockwork (2.1 kPa table A2 AS/NZS 1170.1:2002 + $24 \text{ kN/m}^3 \times 0.19 \times 0.47$) 4.2 kPa

Windows (25.5 kN/m³ table A1 AS/NZS 1170.1:2002) 0.25 kPa
$25.5 \times 0.01 = 0.25$ kPa

L1 slab ($24 \times 0.125 = 3$ kPa + 0.2 kPa for steel & deck) 3.2 kPa

L1 timber floor (20 mm flooring, 200x50 @ 400crs, 16 mm fireline)
($5 \times 0.02 + 5 \times 0.2 \times 0.05 \div 0.4 + 0.1 \times {}^{16}/_{10}$) 0.4 kPa
($0.1 + 0.125 + 0.16$)

*Approximate roof pitch 45° for 20% and 3° for 80% ⇒ 11.4° average

$$H = \frac{1}{\cos 11.4}$$

$$= 1.02$$

Project	THE PAVILION LAINGS ROAD INITIAL SIESMIC ASSESSMENT DEAD LOAD			[redacted]	
		Date 16/04/18	*Project No.* 9329/1	*By* [redacted]	*Page No.* 1.4

ELEVATIONS

	R.L (m)	Height (m)
L3 Roof	17.450	1.850
L2 Roof	15.600	2.625
L1 Floor	12.975	2.975
G Floor	10.000	0.000

AREA & PERIMETER

	Area (m)	Perimeter (m)
L3 Roof	43.020	23.879
L2 Roof	354.327	78.121
L1 Floor T	20.711	16.569
L1 Floor C	376.636	78.121

DEAD LOAD UNIT WEIGHTS

	kPa
roof	0.4
block wall	4.2
Windows	0.25
L1 slab	3.2
timber floor	0.4

Dead Load

	multiplier	unit	Wunit (kPa)	Area (m^2) or Per (m)	Height (m)	Wi (kN)	Wi (kN)
L3 Roof	1	roof	0.4	43.020	1	17.208	
	1	windows	0.25	23.879	1.850	11.044	28.252
L2 Roof	1	roof	0.4	354.327	1	141.731	141.731
L1 Floor	0.3	windows	0.25	78.121	2.625	15.380	
	0.7	block wall	4.2	78.121	2.625	602.899	
	1	L1 Slab	3.2	376.636	1	1205.235	
	1	timber floor	0.4	20.711	1	8.284	1831.798

G2 = 169.983 kN
G1 = 1831.798 kN

	Area (m^2)	Perimeter (m)
at col 1	14	5

$N^* = 14 \times (0.4 + 3.2) + 5 \times (0.3 \times 0.25 + 0.7 \times 4.2)$
$= 50.4 + 15.1$
$= 65.51$ kN

PROJECT
The Pavilion, Laings Rd ISA
Live Load

[redacted]

DATE	PROJECT NO.	BY	PAGE NO.
16/04/18	9329/1	[redacted]	1.5

Live Load

- Live load L1 Floor, $Q_1 = 3kPa$
- Earthquake combination factor, $\psi_{E,roof} = 0$

  $\psi_{E,floor} = 0.3$
- Total Floor Area, $A_{L1} = 397.347\ m^2$
- Frame 1 Floor area, $A = \frac{100}{966} \times 397.347$

  $= 41.133\ m^2$
- Area reduction factor, $\psi_A = 0.3 \times \frac{3}{\sqrt{A}}$

  $= 0.3 \times \frac{3}{\sqrt{41.133}}$

  $= 0.77$
- Live Load, L1 floor, $Q = 3 \times 397.347$

  $= 1192.041\ kN$

Seismic weight

- Weight at Level 2 roof, $W_2 = G_2$

  $= 169.983\ kN$
- Weight at Level 1 Floor, $W_1 = G_1 + \psi_E \times \psi_A \times Q$

  $= 1831.798 + 0.3 \times 0.77 \times 1192.041$

  $= 2107.159\ kN$

[redacted]

Project	THE PAVILION LAINGS ROAD INITIAL SIESMIC ASSESSMENT STEEL FRAME CAPACITY (Ductility)	*Date* 16/04/18	*Project No.* 9329/1	*By* [redacted]	*Page No.* 1.6

BEAM **section: 460UB82**

section bending capacity

Ms = Zx*fprob	C6.6		Zx =	1610	*10^3 mm³
=	592.48	kNm	fy =	320	Mpa
			fyprob =	1.15	fy
			=	368	MPa

yield slope

Θy = (Lb/6)*(Ms/EIb)	C6.4		Lb =	4.9	m
=	6.50E-03	rad	E =	200	Gpa
			Ib =	372	*10^6 mm⁴

ductility

category:	1&2 (NZS3404 §12.4 & 12.5)		θy+θp =	0.045	rad table C6.4	
Δy = Lb*θy			Δprob =	Lb*(θy+θp)		
=	31.867	mm	=	220.500	mm	μΔ = 6.9

BEAM **section: 460UB82**

section bending capacity

Ms = Zx*fprob	C6.6		Zx =	1610	*10^3 mm³
=	592.48	kNm	fy =	320	Mpa
			fyprob =	1.15	fy
			=	368	MPa

yield slope

Θy = (Lb/6)*(Ms/EIb)	C6.4		Lb =	8.6	m
=	1.14E-02	rad	E =	200	Gpa
			Ib =	372	*10^6 mm⁴

ductility

category:	1&2 (NZS3404 §12.4 & 12.5)		θy+θp =	0.045	rad table C6.4	
Δy = Lb*θy			Δprob =	Lb*(θy+θp)		
=	98.163	mm	=	387.000	mm	μΔ = 3.9

COLUMN **section: 530UB92**

axial load assume fully restrained against local buckling (C6.5.4.3)

N* =	65.51	kN	N*/ΦNc =	0.03
ΦNc =	2337.7	kN		

section bending capacity

Ms = Zx*fprob			Sx =	2080	*10^3 mm³
=	789.36	kNm	fy =	300	Mpa
			fyprob =	1.15	fy
			=	345	MPa

yield slope C6.5

Θy = (Lc/6)*(Mprob/EIb)(1-N*/ΦNc)			Lc =	3	m
=	3.46E-03	rad	E =	200	Gpa
			Ic =	554	*10^6 mm⁴

ductility

category:	1&2 (NZS3404 §12.4 & 12.5)		θy+θp =	0.05	rad table C6.5	
Δy = Lc*θy			Δprob =	Lb*(θy+θp)		
=	10.387	mm	=	150.000	mm	μΔ = 14.4

[redacted]

Project	THE PAVILION LAINGS ROAD INITIAL SEISMIC ASSESSMENT (IL4 50 YR) COLUMN (Axial Load Capacity)	Date 16/04/18	Project No. 9329/1	By [redacted]	Page No. 1.7

Design Parameters

try:	530UB92.4	N^*_c=	65.51 kN	L =	3 m
N^*_t=	0 kN	P_{mid}=	0 kN	k =	0.75
Φ =	0.9	M* =	0 kNm	L_e =	2.25 m
α_b =	0.5 (Coefficient for residual stresses AS4100 Table 6.2.4)				

Section Properties

w_{slf} =	92.4 kg/m	9.24E-01	A_n =	11800 mm^2	1.18E-02 m^2
I_x=	554 $x10^6mm^4$	5.54E-04 m^4	I_y =	23.8 $x10^6mm^4$	2.38E-05 m^4
r_x =	217 mm	2.17E-01 m	r_y =	44.9 mm	0.0449 m
Zx =	2080 $x10^3mm^3$	2.08E-03 m^3	zy =	228 $x10^3mm^3$	2.28E-04 m^3
f_y =	300 Mpa	300000 kPa	k_f =	0.928	0.928
E =	200000 MPa	2.00E+08 kPa	G =	80000 Mpa	8.00E+07 kPa
J =	775 $x10^3mm^3$	7.75E-04 m^3	Iw =	1590 $x10^9mm^6$	0.00000159 m^6

Compression Strength Reduction Factor, αc

λ_n = L_e/r_y*sqrt(k_f)*sqrt(f_y/250)
= 52.88113747

α_a = 2100*(λ_n-13.5)/(λ_n^2-15.3*λ_n+2050)
= 20.48391416

λ = λ_n+α_b*α_a
= 63.12309455

η_1 = 0.00326*(λ-13.5)
= 0.161771288

η = max(η,0)
= 0.161771288

ξ = ((λ/90)^2+1+η)/(2*(λ/90)^2)
= 1.680861869

α_c = ξ*(1-SQRT(1-(90/(ξ*λ))^2))
= 0.790675365

Beam strength reduction Factors, α_s, α_m

Ms = f_y*Z_{ex}
= 624.00 kNm

α_1 = Ms/Mo
0.025885549

α_s = 0.6*sqrt(α_1^2+3)-α_1
1.013460987

M_{cr} = α_s *Ms
= 632.3996562 kNm

$M_{o,buckle}$ = (Pi()^2*E*Iy)/(Le^2)
= 9.28E+03

$M_{o,twist}$ = G*J
= 6.20E+04

$M_{o,warp}$ = (pi()^2*E*Iw)/(Le^2)
= 6.20E+02

M_o = sqrt($M_{o,buckle}$*($M_{o,twist}$+$M_{o,warp}$))
= 24106.11448 kNm

Conservatively assume: α_m = 1

Design Capacities

Compression ΦN_s = Φ*k_f*f_y*A_n = 2956.6 kN; ΦN_c = α_a *ΦN_s = 2337.7 kN

Tension ΦN_t = Φ*f_y*A_n = 3186.0 kN

Bending ΦM_s = Φ*M_s = 561.6 kNm; ΦM_b = Φ*min($\alpha_m M_{cr}$,M_s) = 561.6 kNm

Combined $N^*/(\Phi N_t)+M^*/(\Phi M_b)$ = 0.0

Deflection δ_{slf} = ((w*L)+P)*L^4/(185*E*I) = 0.0 mm; δ_{axial} = (N*/An)*L/E = 0.0 mm

Elongation εy = fy/Es = 0.15%; δaxial = εy *L*(N*t/ΦNt) = 0.0 mm

Project	THE PAVILION LAINGS RD INITIAL SEISMIC ASSESSMENT (IL4 50YR) EQUIVALENT STATIC METHOD (ESM)	[redacted]		
Date 16/04/18	Project No. 9329/1	By [redacted]	Page No. 1.8	

Spectral Shape Factor, $C_h(T)$

Analysis: ESM
Period: 0.40 sec
Soil Class: D

Ch(T) = 3.00
as per NZS 1170.5:2004 table 3.1

Return Period Factor, R_U and R_S

work life: 50 yrs
IL: 4

Limit State	APE	R_U or R_S
ULS	1/2500	1.8
SLS1	1/25	0.25
SLS2	1/500	1

as per AS/NZS 1170.0:2002 table 3.3
and as per NZS 1170.5:2004 table 3.5

Near Fault Factor, N

D = 0.6 km — ASSUME
Nmax(T) = 1 — as per NZS 1170.0:2004 Table 3.7
$N(T,D) = N_{max}(T)$ — D ≤ 2km
N(T,D) = 1+(Nmax(T) -1)*(20-D)/18 — 2km< D ≤20km
N(T,D) = 1 — D > 20km
N(T,D) = 1 — for APE < 1/250 as per NZS 1170.0:2004 section 3.1.6.2
for APE ≥ 1/250 N(T,D)=1 as per NZS 1170.0:2004 section 3.1.6.1

Ordinate of the elastic site hazard spectrum, C(T)

as per NZS 1170.0:2004 section 3.1.1

Location: Hutt Valley — Z= 0.4 — as per NZS 1170.0:2004 Table 3.3
C(T1) = $Z*R*N*C_h(T)$

Limit State	APE	Z	R_U or R_S	N	$C_h(T)$	$C(T_1)$
ULS	1/2500	0.4	1.8	1	3.00	2.16
SLS1	1/25	0.4	0.25	1	3.00	0.3
SLS2	1/500	0.4	1	1	3.00	1.2

Horizontal Design Action Coeffcient, $C_d(T_1)$

as per NZS1170.5 section 5.2.1.1

kμ = μ	for soil A,B,C,D and T_1 ≥ 0.7sec	Sp = 0.7	for μ<1
kμ = $(\mu-1)T_1/0.7+1$	for soil A,B,C,D and T_1 < 0.7sec	Sp = 1.3-0.3μ	for 1≤μ≥2
kμ = μ	for soil E and T_1≥1 or μ<1.5	Sp = 0.7	for 2<μ
kμ = $(\mu-1.5)T_1+1.5$	for soil E and T_1<1 and μ≥1.5	as per NZS1170.5:2004 section 4.4.2	

Limit State	μ	$C(T_1)$	Sp	kμ	$C_d(T_1)$	Cd(T1)/0.57
SLS1	1.25	0.30	0.700	1.14	0.18	0.32
SLS2	2.00	1.20	0.700	1.57	0.53	0.94
stability	1.00	2.16	1.000	1.14	1.89	3.32
ULS	3.00	2.16	0.700	2.14	0.71	1.24
ULS	3.90	2.16	0.700	2.66	0.57	1.00
ULS	4.00	2.16	0.700	2.71	0.56	0.98
ULS	4.50	2.16	0.700	3.00	0.50	0.89

Project	THE PAVILION LAINGS RD INITIAL SEISMIC ASSESSMENT (IL4 50YR) 0.00 LOADS - EQUIVALENT STATIC METHOD (ESM)	Date 16/04/18	Project No. 9329/1	By [redacted]	Page No. 1.9

[redacted]

Equivalent Static Method as per NZS1170.5:2004 section 6.2

μ = 3.90
Cd(T1) = 0.57

$V = C_d(T_1)Wt$
= 1296 kN

Ft = 0.04V
= 52 kN
$Fi = 0.92V*W_ih_i/\sum(W_ih_i)+F_t$

Level	Height hi (m)	Dead G (kN)	Live Qi=1Q (kN)	Wi=G+0.3Qi Wi (kN)	W_ih_i (kNm)	Fi (kN)	ESM scale
1	4.00	1832	1192	2107	8429	1044	0.50
2	10.00	170	0	170	1700	252	1.48
3	0.00	0	0	0	0	0	0.00
4	0.0	0	0	0	0	0	0.00
5	0.0	0	0	0	0	0	0.00
∑				2277	10128	1296	

PROJECT
The Pavilion, Laings Rd, ISA (IL4 50yr)

Frame 1 2D Analysis

[redacted]

DATE	PROJECT NO.	BY	PAGE NO.
16/04/18	9329/1	[redacted]	2.1

Frame 1

- Under 1000kN load,

$$\Delta_{max} = 23mm$$

- therefore: scale load by $F_{V_b} = \frac{1296}{1000} \times \frac{100\%}{966\%}$ for $\mu = 3.9$ (IL4 50yr)

$$= \frac{134}{1000}$$

$$= 0.134$$

stiffness $F_\Delta = \frac{27}{(23+27)} \times \frac{2000}{1000}$

$$= 1.08$$

Accidental, Ecc. = 1.10 (assumed)

- Therefore $E_u = 1000 \times 0.134 \times 1.08 \times 1.10$

$= 159.192$ kN for frame 1

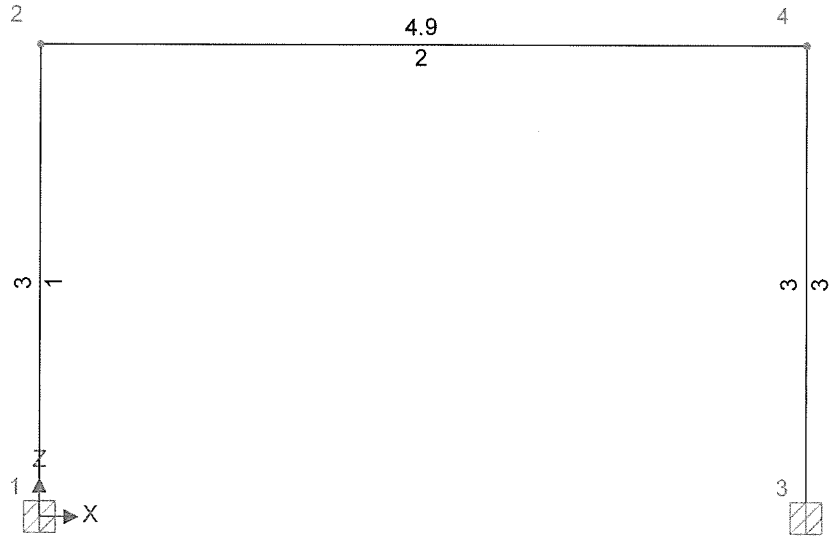
FRAME1 ANALYSIS

ANALYSIS

Tedds calculation version 1.0.23

Geometry

Geometry (m) - Steel (AS4100)



Materials

Name	Density (kg/m³)	Youngs Modulus kN/mm²	Shear Modulus kN/mm²	Thermal Coefficient °C⁻¹
Steel (AS4100)	7850	200	80	0.0000117

Sections

Name	Area	Moment of inertia		Shear area	
		Major	Minor	A_y	A_z
	(cm²)	(cm⁴)	(cm⁴)	(cm²)	(cm²)
530x92.4 UB	118	55430	2379	59	54
460x82.1 UB	105	37100	1862	55	46

Nodes

Node	Co-ordinates		Freedom			Coordinate system		Spring		
	X (m)	Z (m)	X	Z	Rot.	Name	Angle (°)	X (kN/m)	Z (kN/m)	Rot. kNm/°
1	0	0	Fixed	Fixed	Fixed		0	0	0	0
2	0	3	Free	Free	Free		0	0	0	0
3	4.9	0	Fixed	Fixed	Fixed		0	0	0	0
4	4.9	3	Free	Free	Free		0	0	0	0

Elements

Element	Length (m)	Nodes		Section	Material	Releases			Rotated
		Start	End			Start moment	End moment	Axial	
1	3	1	2	530x92.4 UB	Steel (AS4100)	Fixed	Fixed	Fixed	
2	4.9	2	4	460x82.1 UB	Steel (AS4100)	Fixed	Fixed	Fixed	

[redacted]

Project	Job Ref.
THE PAVILION, LAINGS RD, ISA (IL4 50YR)	9329/1
Section	Sheet no./rev.
FRAME 1 & FRAME 5 2D ELASTIC ANALYSIS	2, 3

Calc. by	Date	Chk'd by	Date	App'd by	Date
[redacted]	16/04/2018				

Element	Length (m)	Nodes		Section	Material	Releases			Rotated
		Start	End			Start moment	End moment	Axial	
3	3	3	4	530x92.4 UB	Steel (AS4100)	Fixed	Fixed	Fixed	

Loading

Load combination factors

Load combination	Seismic
Eu (Strength)	1.00

Node loads

Node	Load case	Force		Moment
		X (kN)	Z (kN)	(kNm)
2	Seismic	159.2	0	0

Results

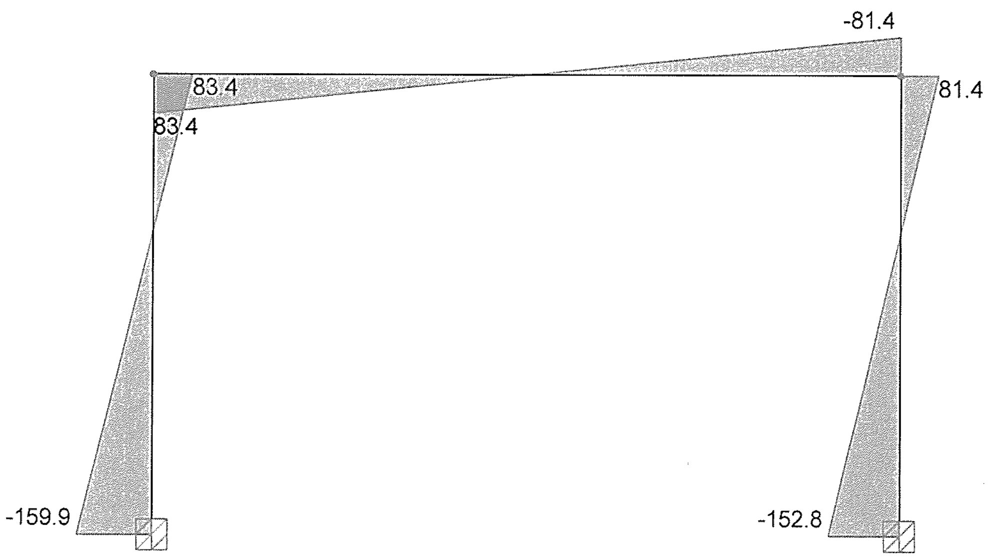
Node deflections

Load case: Seismic

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0	
2	3.7	0	0.05929	
3	0	0	0	
4	3.5	0	0.0554	

Forces

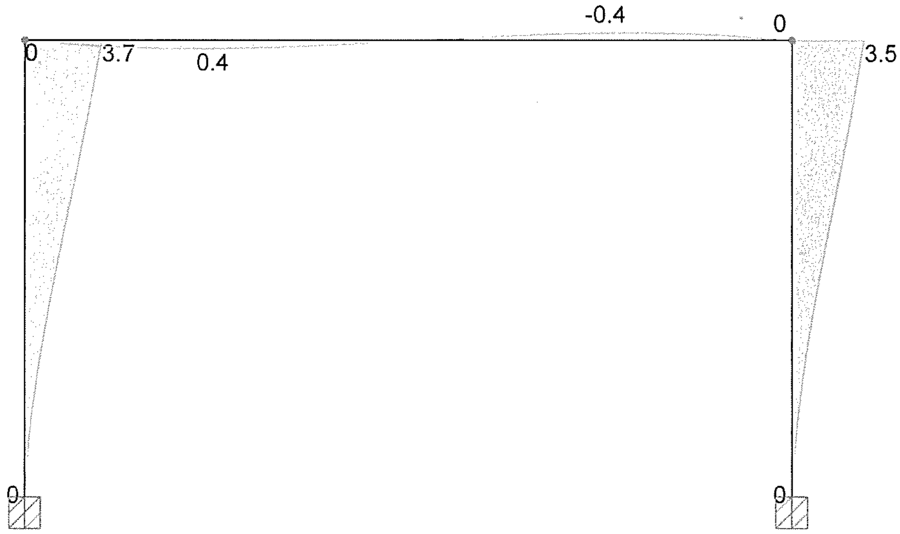
Seismic - Moment (kNm)



[redacted]	Project **THE PAVILION** , LAINGS RD, ISA (IL4 50YR)				Job Ref. 9329/1	
	Section FRAME 1 & FRAME 5 2D ELASTIC ANALYSIS				Sheet no./rev. 2.4	
	Calc. by [redacted]	Date 16/04/2018	Chk'd by	Date	App'd by	Date

Seismic - Shear (kN)

Seismic - Deflection (mm)



PROJECT

The Pavilion, Laings Rd, ISA (IL4 50yr)

Frame 5 2-D analysis

[redacted]

DATE	PROJECT NO.	BY	PAGE NO.
16/04/18	9329/1	[redacted]	2.5

Frame 5

- Under 1000 kN load

$$\Delta_{max} = 27mm$$

- Therefore scale load by $F_{V_b} = \frac{1296}{1000} \times \frac{100\%}{966\%}$ for $\mu = 3.9$ (IL4 50yr)

$$= 0.134$$

$$\text{Stiffness } F_\Delta = \frac{23}{(23+27)} \times \frac{2000}{1000}$$

$$= 0.92$$

Accidental Eccentricity = 1.10 (assumed)

- Therefore $F_u = 1000 \times 0.134 \times 0.92 \times 1.10$

$= 135.608$ kN for frame 5

[redacted]	Project **THE PAVILION** , LAINGS RD, ISA (IL4 50YR)			Job Ref. 9329/1	
	Section FRAME 1 & FRAME 5 2D ELASTIC ANALYSIS			Sheet no./rev. 2.6	
	Calc. by [redacted]	Date 16/04/2018	Chk'd by	Date	App'd by	Date

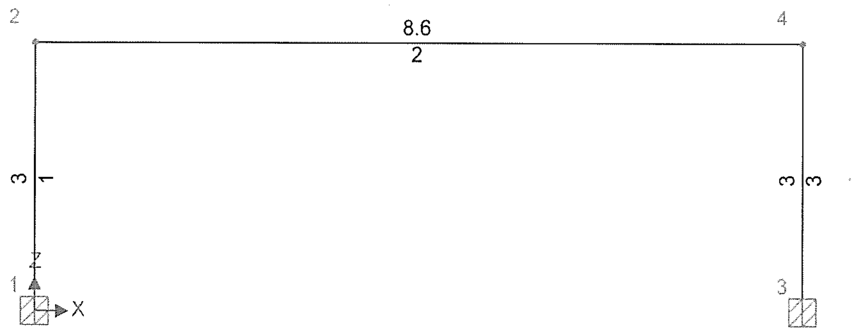
FRAME5 ANALYSIS

ANALYSIS

Tedds calculation version 1.0.23

Geometry

Geometry (m) - Steel (AS4100)



Materials

Name	Density (kg/m³)	Youngs Modulus kN/mm²	Shear Modulus kN/mm²	Thermal Coefficient °C⁻¹
Steel (AS4100)	7850	200	80	0.0000117

Sections

Name	Area	Moment of inertia		Shear area	
		Major	Minor	A_y	A_z
	(cm²)	(cm⁴)	(cm⁴)	(cm²)	(cm²)
530x92.4 UB	118	55430	2379	59	54
460x82.1 UB	105	37100	1862	55	46

Nodes

Node	Co-ordinates		Freedom			Coordinate system		Spring		
	X (m)	Z (m)	X	Z	Rot.	Name	Angle (°)	X (kN/m)	Z (kN/m)	Rot. kNm/°
1	0	0	Fixed	Fixed	Fixed		0	0	0	0
2	0	3	Free	Free	Free		0	0	0	0
3	8.6	0	Fixed	Fixed	Fixed		0	0	0	0
4	8.6	3	Free	Free	Free		0	0	0	0

Elements

Element	Length (m)	Nodes		Section	Material	Releases			Rotated
		Start	End			Start moment	End moment	Axial	
1	3	1	2	530x92.4 UB	Steel (AS4100)	Fixed	Fixed	Fixed	
2	8.6	2	4	460x82.1 UB	Steel (AS4100)	Fixed	Fixed	Fixed	
3	3	3	4	530x92.4 UB	Steel (AS4100)	Fixed	Fixed	Fixed	

[redacted]	Project THE PAVILION, LAINGS RD, ISA (IL4 50YR)				Job Ref. 9329/1	
	Section FRAME 1 & FRAME 5 2D ELASTIC ANALYSIS				Sheet no./rev. 2.7	
	Calc. by [redacted]	Date 16/04/2018	Chk'd by	Date	App'd by	Date

Loading

Node loads

Node	Load case	Force		Moment
		X (kN)	Z (kN)	(kNm)
2	Seismic	135.6	0	0

Results

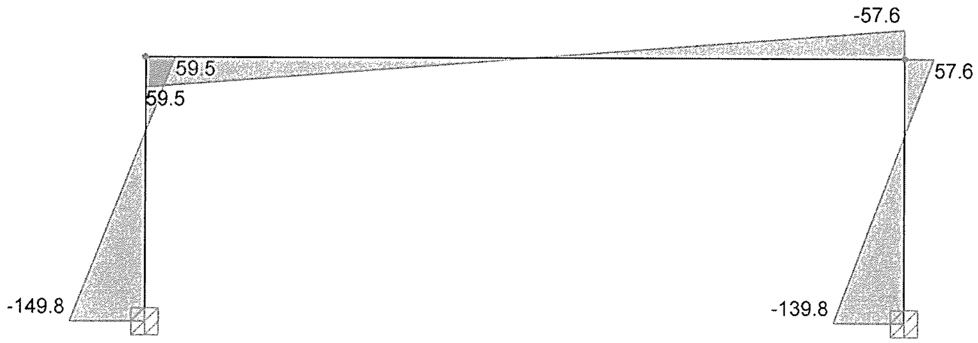
Node deflections

Load case: Seismic

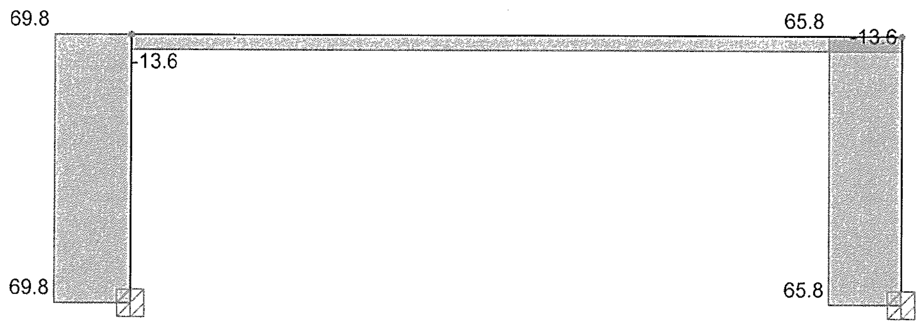
Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0	
2	3.7	0	0.07	
3	0	0	0	
4	3.4	0	0.06371	

Forces

Seismic - Moment (kNm)



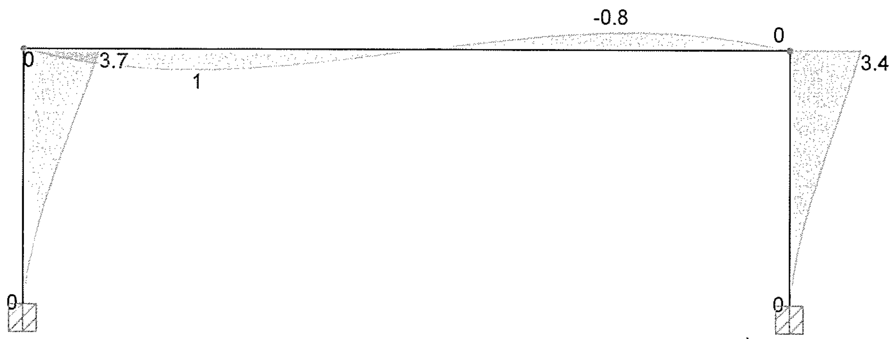
Seismic - Shear (kN)



[redacted]

Project				Job Ref.	
THE PAVILION , LAINGS RD, ISA (IL4 50YR)				9329/1	
Section				Sheet no./rev.	
FRAME 1 & FRAME 5 2D ELASTIC ANALYSIS				2.8	
Calc. by	Date	Chk'd by	Date	App'd by	Date
[redacted]	16/04/2018				

Seismic - Deflection (mm)



PROJECT The Pavilion, Laings Rd, ISA (IL4 50yr) [redacted]

Frame % NBS

DATE	PROJECT NO.	BY	PAGE NO.
16/04/18	9529/1	[redacted]	2.9

Frame 1

$\Theta = 0.05929^\circ$

$= 0.00103$ rad

$< \Theta_{y\,min} = 0.00346$ rad

$>$ 100% NBS (IL4 50yr)

$M^*_{beam} = 83$ kNm

$M_{prob,s} = 592$ kNm — $>$100% NBS (IL4 50yr)

$M^*_{col} = 160$ kNm

$M_{prob,s} = 789$ kNm — $>$100% NBS (IL4 50yr)

$\Delta = 3.7$mm $\ll 2.5\% \times 3000 = 75$mm OK ✓

Frame 5

$\Theta = 0.07^\circ$

$= 0.00122$ rad

$< \Theta_{y\,min} = 0.00346$ rad

$>$100% NBS (IL4 50yr)

$M^*_{beam} = 60$ kNm

$M_{prob,s} = 592$ kNm — $>$100% NBS (IL4 50yr)

$M^*_{col} = 150$ kNm

$M_{prob,s} = 789$ kNm — $>$100% NBS (IL4 50yr)

$\Delta_2 = \Delta_1$

$= 3.7$mm $\ll$ 75mm (2.5% Δ) OK ✓

Project	THE PAVILION LAINGS RD INITIAL SEISMIC ASSESSMENT (IL4 50YR) SEISMIC LOADS RAYLEIGH METHOD	[redacted]			
		Date 17/04/18	Project No. 9329/1	By [redacted]	Page No. 2.10

Staad.Pro Results:

N-S: Zdir — N-S: T = 0.17 sec
E-W: Xdir — E-W: T = 0.17 sec

Level	Height hi (m)	Wi=G+0.3Q Wi (kN)	N-S: Zdir d_i (mm) Xdir	E-W: Xdir d_i (mm) Zdir
5	0.0	0	0	0
4	0.0	0	0	0
3	0.0	0	0	0
2	10.0	170	8	8
1	3.0	2107	4	4
∑Wi=		2277		

Use Excel Goal Seek:

N-S: T1 = 0.16 sec
N-S: T-T1 = 0.01 sec

E-W: T1 = 0.17 sec
E-W: T-T1 = 0.00 sec

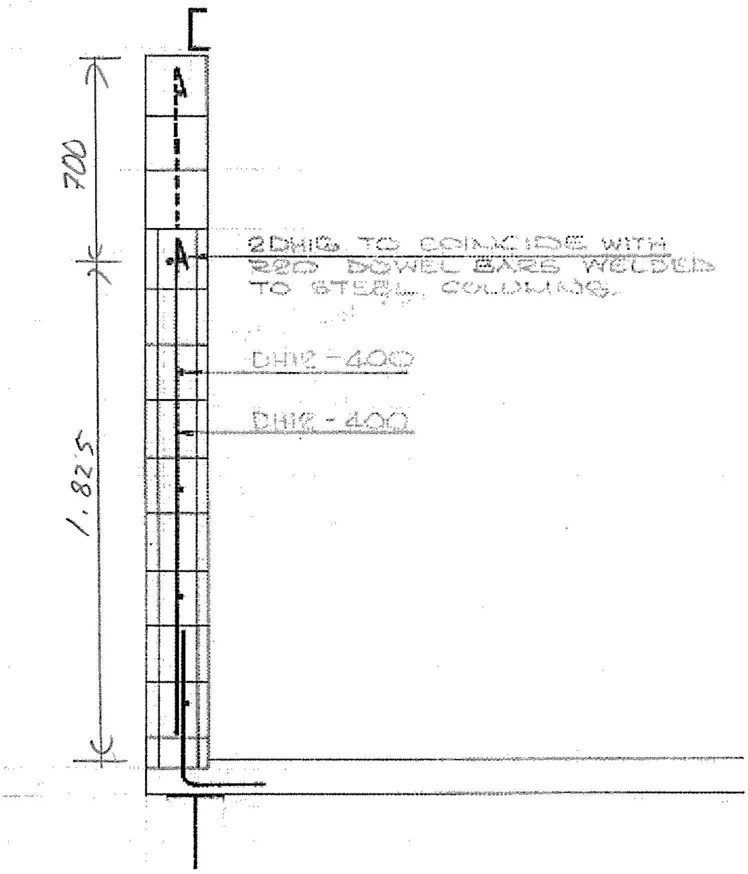
Rayleigh Method:

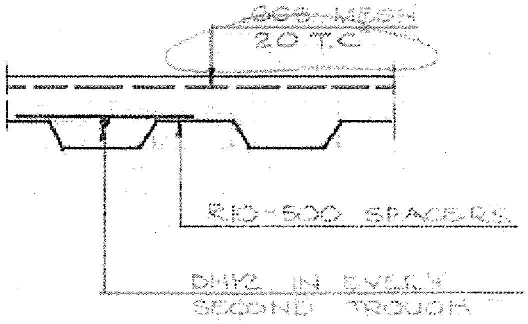
Level	Height hi (m)	Wi=G+0.3Q Wi (kN)	F_i (kN)	N-S: Zdir di (mm)	$W_i d_i^2$	$F_i d_i$
5	0.0	0	0	0	0.00	0.00
4	0.0	0	0	0	0.00	0.00
3	0.0	0	0	0	0.00	0.00
2	10.0	170	252	8	0.01	2.02
1	3.0	2107	1044	4	0.03	3.86
Total		2277	1296		0.04	5.88

Level	Height hi (m)	Wi=G+0.3Q Wi (kN)	F_i (kN)	E-W: Xdir di (mm)	$W_i d_i^2$	$F_i d_i$
5	0.0	0	0	0	0.00	0.00
4	0.0	0	0	0	0.00	0.00
3	0.0	0	0	0	0.00	0.00
2	10.0	170	252	8	0.01	2.02
1	3.0	2107	1044	4	0.03	4.18
Total	0	2277	1296		0.04	6.19

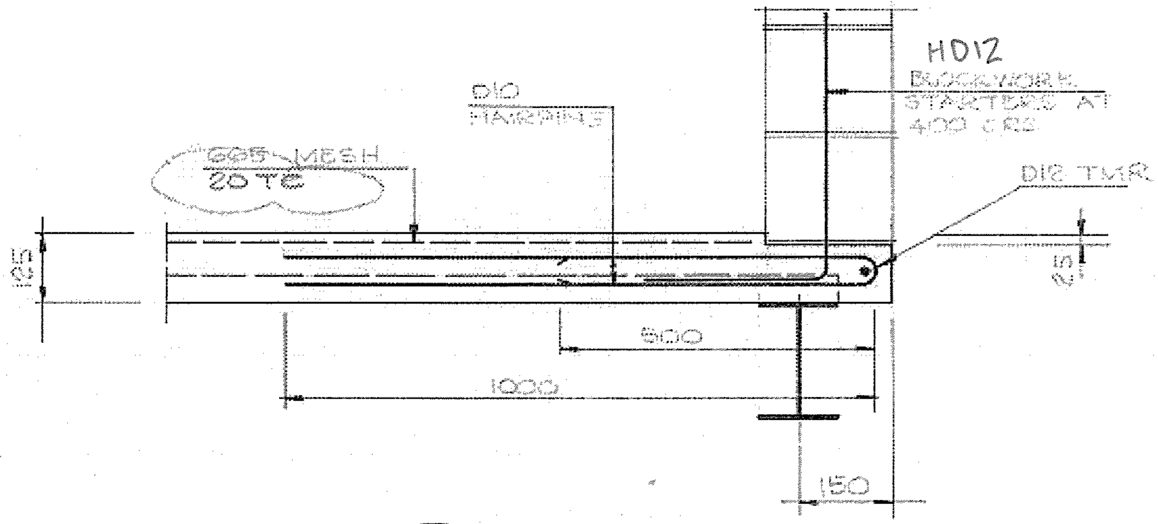
[redacted]

Project	THE PAVILION LAINGS ROAD INITIAL SIESMIC ASSESSMENT BLOCK WALL SKETCH	Date 17/04/18	Project No. 9329/1	By [redacted]	Page No. 3.1





2 TYPICAL SLAB REINFORCING



1 PERIMETER EDGE

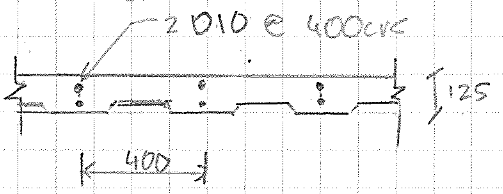
PROJECT
The Pavilion, Laings Rd, ISA (IL4 50yr)
Blockwall out-of-plane

[redacted]

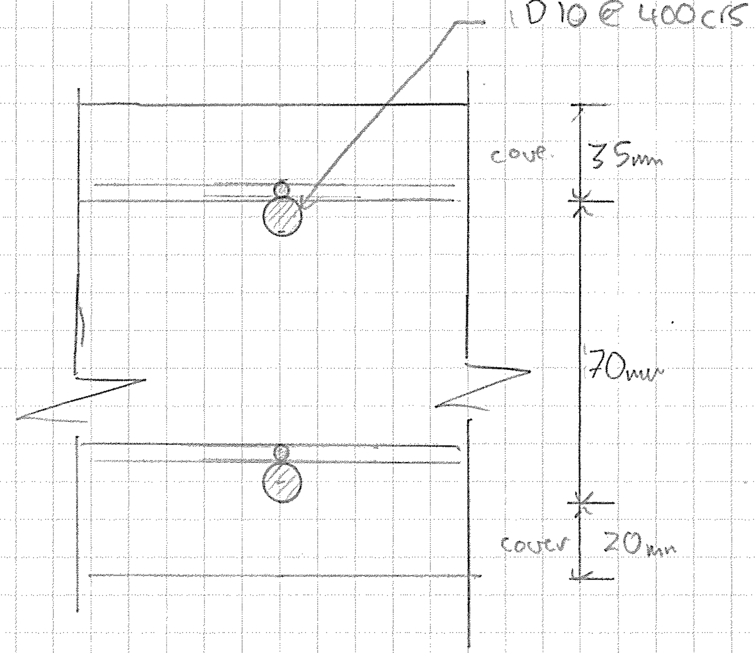
DATE	PROJECT NO.	BY	PAGE NO.
17/04/18	9329/1	[redacted]	3.2

Blockwall - propped cantilever

- RL L2 Roof = 15.6m
- RL L1 block = 13.075
- height of wall 15.6 - 13.075 = 2.525m
- Slab details:

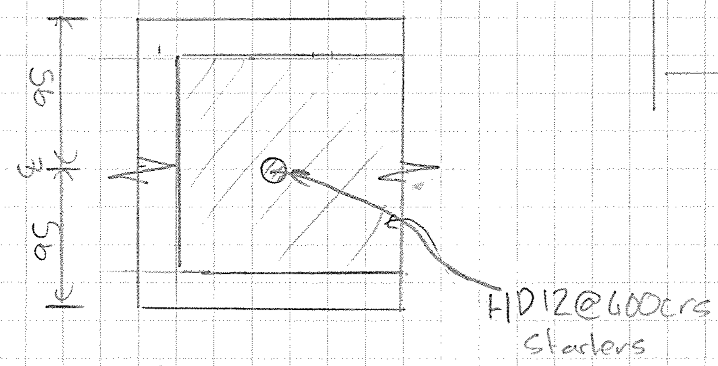


L1 Slab Section
1:20



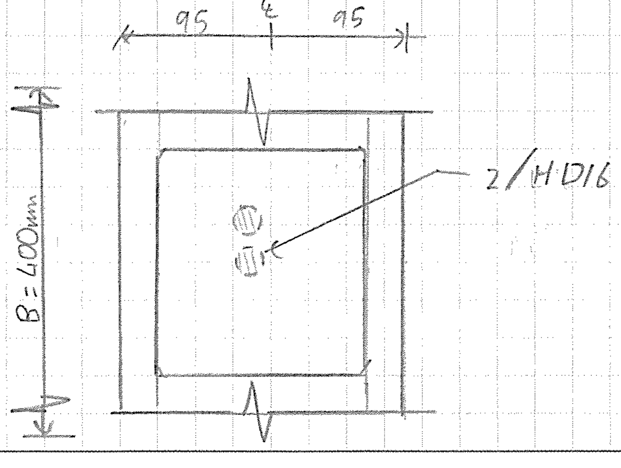
L1 Slab Section
1:2

- Blockwall details:



Blockwall
1:5

- Bond beam Details:



Pg 3.3

Building Parts Seismic Coefficient Determination | **Refer to NZS 1170.5 Section 8**

INPUT CELLS

Job: The Pavilion | Project No: 9329/1
Line 1 Laings Rd | By: [redacted]
Line 2 Initial Siesmic Assessment (IL4 50yr) | Date: 17/04/2018
Line 3 Level1 Cantilever Block Wall | In Canterbury? 1=Y 0

1	**Classification of Part - Refer Table 8.1**	P. 1		
	Criteria		**Part Risk Factor Rp ref. Table 8.1**	**Structure limit state**
	ULS Part representing a hazard to life outside the structure e.g. cladding, glazing, veranda, signs, vessels containing hazardous materials.		1.0 (2xR_u for P6 type parts)	ULS

2	**Elastic Site Spectra for the Building**				
	Site Subsoil Class: Table3.1 NZS1170.5		D	Deep or Soft Soil α (ref 3.2)	1.5
	Spectral shape factor Ch(0). Ref Table 3.1, NZS1170.5, Note 1.		1.12	Spectral shape factor $C_v(0.1)$ for Eqtn 3.2(2)	3
	Hazard Factor	Z	0.4	table 3.3 of NZS1170.5	0.4
	Building Importance Level	"I"	4	table 3.2 of AS/NZS1170.0	4
	Design working life		50 years	table 3.3 of AS/NZS1170.0	50 years
	ULS/SLS1/SLS2 annual probability of exceedance		1/2500	table 3.3 of AS/NZS1170.0	
	Risk Factor, R for the structure = Rs or Ru		1.80	table 3.5 of NZS1170.5	1.80
	Near-fault factor	N(T,D)	1.0	eqtn 3.1(2), 3.1(3) of NZS1170.5	1.0
	Note	ZRu =	0.7	(maximum value is 0.7)	0.7
	C(T) = Ch(T) z R N(T,D) so				
	C(0) = Ch(0) z R N(T,D) =		**0.784**	C(0.1) = Ch(0.1) z R N(T,D) =	**2.1**

3	**Floor Height Cofficient C_{Hi}**			
	Height of structure, m	h_n	7.45	
	Height of part, m	h_i	4.3	
	Floor Height Coeficcient	C_{Hi}	**1.716667**	eqtn 8.3 (1) or (2) or (3) of NZS1170.5

4	**Part Spectral Shape Coefficient**			
	Period of the Part, sec	Tp	0.30	Note: use the period of the part, not the building period.
	Part Spectral Shape Coefficient Ci (Tp)		**2.0**	eqtn 8.4.1 of NZS1170.5

5 Ductility of the Part — Referring to Table C8.2 of NZS1170.5

5A	**Description of Part - ULS**	**Ru**	μ_p for C_{ph} ULS, (max value)	Indicative deformation limits for onset of damage
	Vertical cantilever- heavyweight wall or partition	1.80 1/2500	2.00	L/600

5B	**Description - SLS1**	**Rs**	μ_p for Cph SLS1 (or by special study)	Indicative deformation limits for onset of damage
	Vertical cantilever- heavyweight wall or partition	0.25 1/25: 1/500	1.00	L/600

2.00

Limit State for Part type P1 is ULS.

μ for Cph	1.25		μ for Cpv	1
Cph =	**0.85**		Cpv =	**1.00**

6 Part Response Factor, Cph, (refer table 8.2) = Cph = **0.85**

7 Design Response Coefficient for the Part — **Cp(Tp)**

Cp(Tp) = C(0) C_{Hi} C_i(Tp) = 0.784 x 1.7166667 x 2.0

= **2.692**

8 The Horizontal Earthquake Load on the Part

$F_{ph} = C_p (T_p) C_{ph} R_p W_p$ = (but<3.6Wp) = **Fph =** ***2.288 Wp***

8.1 Ductile Fixings. μ = 1.25; Cph = 0.85; **Fph** for ductile fixings = ***2.288 Wp***

8.2 Concrete Fixings. μ = 1.0; Cph = 1.0; **Fph** for concrete fixings = ***2.692 Wp***

Sp = 0.90

9 The Vertical Earthquake Load on the Part — α = 0.9 for soil class A, B,C. α = 1.5 for soil class D, E.

Equation 3.2(2) (Conservatively take worst Case) Site Hazard Spectra $C_v(T)$ = α C(T=0.1 sec)

Cv(Tv) = (alpha)CTzRN(T,D) for Ru/Rs = (alpha)2.1 = 3.15

Now, refer to section 5.4.2. $C_{vd} = C_v(T_v)Sp = C(T)Sp$ = 2.835 | G&E

$F_{pv} = C_{pv} C_{vd} R_p W_p$ = (but<2.5Wp) = **(μ = 1 for all items) Fpv =** ***2.500 Wp*** | 3.500

[redacted]

PROJECT
The Pavilion, Laings Rd, ISA (IL4 50yr)
Blockwall out-of-plane

DATE	PROJECT NO.	BY	PAGE NO.
17/04/18	9329/1	[redacted]	3.4

Bending capacity Blockwall

- $C = T$

$B f'_m \alpha \beta C = f_y A_s$

$C = \dfrac{f_y A_s}{f'_m \alpha \beta B}$

$= \dfrac{540 \times 282.7}{18 \times 0.85 \times 0.85 \times 1000}$

$= 152658 / 13{,}005 = 11.738$ mm

$a = \beta C$

$= 0.85 \times 11.738$ mm

$= 10.0$

$f_{y\,prob} = 1.08 f_y$

$= 1.08 \times 500$

$= 540$ MPa

$A_s = \pi \times \dfrac{d_b^2}{4} \div crs$

$= \pi \times \dfrac{12^2}{4} \div 0.4$

$= 282.7$ mm^2

$\therefore M_{prob} = A_s f_y (jD - \frac{a}{2})$

$= 540 \times 282.7 \times (95 - \frac{10}{2})$

$= 152{,}658 \times 90 \times 10^{-6}$

$= 13.739$ kNm

$f'_m = 12$ MPa NZS4230 table 8.1

$f'_{m\,prob} = 1.5 \times 12$ MPa

$= 18$ MPa

$\alpha = 0.85$

$\beta = 0.85$

$B = 1000$ mm

Bending Capacity of L1 Slab

$C = \dfrac{f_y A_s}{f'_c \alpha \beta B}$

$= \dfrac{324 \times 196.3}{37.5 \times 0.85 \times 0.79 \times 1000}$

$= \dfrac{63\,601.2}{25\,181.3}$

$= 2.526$ mm

$\dfrac{a}{2} = \dfrac{\beta C}{2}$

$= 0.79 \times 2.526 / 2$

$= 1.00$ mm

$f_{y\,prob} = 1.08 \times f_y$

$= 1.08 \times 300$

$= 324$ MPa

$A_s = \pi \times \dfrac{d_b^2}{4} \div crs$

$= \pi \times \dfrac{10^2}{4} \div 0.4$

$= 196.3$ mm^2

$\therefore M_{prob} = A_s f_y (jD - \frac{a}{2})$

$= 63601.2 \times (85 - 1) \times 10^{-6}$

$= 5.343$ kNm

$f'_c = 25$ MPa The Guidelines Table C5.3

$f'_{c\,prob} = 1.5 \times 25$

$= 37.5$ MPa

$\alpha = 0.85$

$\beta = 0.85 - 0.008 (f'_c - 30)$

$= 0.79$

$D = 1000$ mm

PROJECT	DATE	PROJECT NO.	BY	PAGE NO.
The Pavilion, Laings Rd, ISA (IL4 50yr) Blockwall out-of-plane	17/04/18	9329/1	[redacted]	3.5

[redacted]

Bond Beam Bending capacity

$c = \frac{A_s f_y}{f'_m \alpha \beta B}$

$= \frac{402.1 \times 540}{18 \times 0.85 \times 0.85 \times 400}$

$= \frac{217,134}{5202}$

$= 41.740\,mm$

$\frac{a}{2} = \beta c/2$

$= 0.85 \times 41.740/2$

$= 17.7395\,mm$

$f_{y\,prob} = 1.08 \times f_y$

$= 1.08 \times 500$

$= 540\,MPa$

$A_s = \pi \times \frac{d_b^2}{4}$

$= 2 \times \pi \times \frac{16^2}{4}$

$= 402.1\,mm^2$

$f'_m = 12\,MPa$ NZS4230 table 8.1

$f'_{m\,prob} = 1.5 \times 12$

$= 18\,MPa$

$\alpha = 0.85$

$\beta = 0.85$

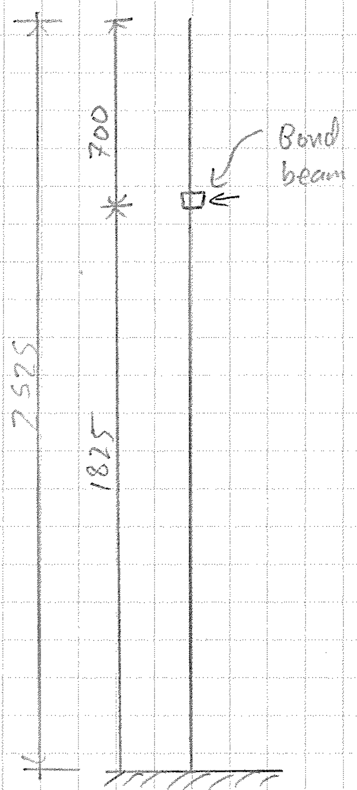
$B = 400\,mm$

$M_{prob} = A_s f_y \left(jd - \frac{a}{2}\right)$

$= 217,134 \times (95 - 18) \times 10^{-6}$

$= 16.719\,kNm$

Bending demand



$\omega = F_{ph} = 2.288 \times W_p$

$= 2.288 \times 4.1 \times 1$

$= 9.381\,kN/m$

$M^*_{slab} = \frac{\omega L^2}{8}$

$= 9.381 \times \frac{1.825^2}{8}$

$= 3.906\,kNm$

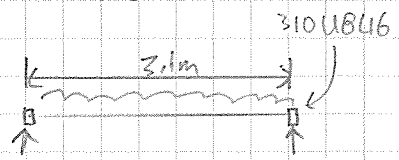
$\Rightarrow 5.343/3.906 > 100\%\,NBS$

$M^*_{block} = \frac{9}{128} \times \omega L^2$

$= 2.197\,kNm$

$\Rightarrow 13.739/2.197 > 100\%\,NBS$

Bond Beam:



$\omega = \left(0.7 + \frac{1.825}{2}\right) \times 9.381$

$= 1.613 \times 9.381$

$= 15.127\,kN/m$

$M^*_{bond} = \frac{\omega L^2}{8}$

$= 15.127 \times \frac{3.1^2}{8}$

$= 18.171\,kNm$

$\Rightarrow 16.719/18.171$

$= 92\%\,NBS$

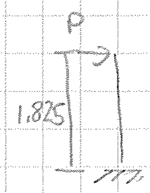
PROJECT	[redacted]			
The Pavilion, Laings Rd, ISA (IL4 50yr)	DATE	PROJECT NO.	BY	PAGE NO.
Block Wall out-of-plane	17/04/18	9329/1	[redacted]	3.6

Bending Demand

- 310 UB 46 concrete encased

P = 3.1 × 15.127

= 46.894 kN



$M^* = 1.825 \times 46.894$

$= 85.582$ kNm

Bending Capacity

- Concrete encased, weak axis

$S_y = 166 \times 10^3\ mm^3$

$f_y = 320$ MPa

$f_{yprob} = 1.15 \times f_y$

$= 368$ MPa

$M_{prob} = 1.1\ S_y\ f_{yprob}$ — The guidelines C6.6

$= 1.1 \times 166 \times 368 \times 10^{-3}$

$= 67.197$ kNm

$= \frac{67}{86} = 78\%$ NBS