structex

Date: 21 October 2013

Airways ADC2

Quantitative Detailed Engineering Evaluation Report

ACENZ

strategy • engineering • design

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Revision No.	Date	Engineer	Description
-	21/10/13	GBu	Client Issue

Limitations of Report

Findings presented as part of this report are for the sole use of our client, as addressed above. The findings are not intended for use by other parties, and may not contain sufficient information for the purposes of other parties or other uses. Our professional services are performed using a degree of care and skill normally exercised, under similar circumstances, by reputable consultants practicing in this field at this time. No other warranty, expressed or implied, is made as to the professional advice presented in this report.

Executive Summary and Recommendations

Structex has been engaged to complete a detailed engineering evaluation of the Airways ADC2 Building at Sir William Pickering Drive, Christchurch. This report summarises our quantitative assessment of the building, which supersedes our initial qualitative IEP assessment, dated 20 February 2012.

Structex have separately analysed the available primary and secondary structural systems for earthquake loading across and along the building using standard elastic loadings of AS/NZ1170.5 and general equivalent static analysis methods for force distribution. The seismic assessment of the building components has been completed in accordance with New Zealand Society for Earthquake Engineering (NZSEE) guidelines. The building has been assessed based it being Importance Level 2.

In summary, the building as it currently stands has a seismic strength of at least **70% New Building Standard (NBS)**, and is therefore **not considered Earthquake Prone**, confirming the Initial Evaluation Procedure (IEP) estimation of seismic strength. The above-calculated building strength is limited by the in-plane bending capacity of the ground floor north and south wall piers. These elements could be considered secondary when compared to the main internal shear walls, which attract far greater seismic load. These primary walls have a calculated strength of 97% NBS, limited by bending capacity of the wall between grid 8 and 9 indicated by the plan of Appendix C. This assessment effectively supersedes our initial IEP strength prediction due to being more precise.

We have assessed the base connections of all panels for sliding or "shear friction" strength, which in some case proved to be lower than the limiting values given above. However we have considered the prospect of load shedding to other elements to potentially happen for a system like this in reality and therefore consider shear friction of individual elements to be non-governing compared to section capacities. See the summary calculations spread sheet in Appendix E for more information.

From a review of existing drawings and visual inspections of the building no critical structural weaknesses were identified. Site conditions appear to be good, with no signs of weakness such as lateral spread or liquefaction.

Repairs to restore pre-earthquake conditions to the building have been undertaken prior to the release of this report. This included crack injection works to the first floor beam and floor system rib elements and the façade panels, as well as suspended ceiling reinstatement and painting works.

Strengthening is not necessary to meet code requirements and may not be required in any subsequent future building consent. However, strengthening could be adopted, with the desired level to be discussed with the building owner, insurer and Christchurch City Council.

Contents

1 Introduction

1.1 Report Outline

Structex has been engaged to complete a detailed engineering evaluation (DEE) for the ADC2 Building at the Airways Technology Park, Sir William Pickering Drive, Christchurch. The evaluation was undertaken in accordance with guidelines prepared by the Post-Canterbury earthquake Engineering Advisory Group (EAG) "Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury". At the time of writing this report, these guidelines were in draft format (revision 7, released through CSG, 16th May 2012) and under review with the Ministry of Business Innovation and Employment (MOBIE).

This report is intended to be read as an addendum to the IEP Summary Report previously issued by Structex dated 20 February 2012. The scope of this report is to summarise our findings from the quantitative assessment and more specifically this report:

(a) Highlights Building Act requirements and the Christchurch City Council policy for earthquake-prone buildings

(b) Outlines the level of additional investigations undertaken following the qualitative assessment and where information was obtained

(c) Summarises in detail the existing building, the construction, and structural systems

(d) Summarises the type of analysis undertaken

(e) Presents the quantitative analysis results of the building's seismic strength relative to New Building Standard (NBS), commonly referred to as "current code"

(f) Identifies and quantifies critical structural weaknesses where present

(g) Makes recommendations for seismic strengthening where appropriate

Due to the technical nature of this assessment, this report is written using engineering terms and elaborated on within reason. Additional commentary for a non-engineering audience has been used where we think additional clarity or explanation is of use, this is indicated by *italics* as the last paragraph in the referring section.

1.2 Scope of Investigation

Our quantitative detailed engineering evaluation has been undertaken in accordance with New Zealand Society for Earthquake Engineering (NZSEE) guidelines "Assessment and Improvement of the Structural Performance of Buildings in Earthquakes" dated June 2006.

Our building evaluation has been based on the following information:

(a) Further inspections of the buildings carried out following the release of the IEP summary report and during general earthquake repairs, which included:

- Closer investigation of the structural elements within the ceiling space, including connection where possible
- Inspection of a selection of wall elements after linings were removed during repair work

(b) Full structural and architectural drawings obtained from the Christchurch City Council Property Files and the original building designers

(c) The previously released IEP Summary Report issued by Structex dated 20 February 2013

(d) The interim damage report for the Airways Technology Park Buildings by Structex

Non-structural aspects fall outside the scope of this report and have not been covered by this investigation and assessment. These include, but are not limited to, the following:

- An electrical safety review
- A fire safety review
- A weather tightness assessment

These items should be inspected and assessed by qualified trades people or specialists prior to any repair or strengthening works being carried out. We request such persons be instructed to identify loose and/or inadequate fixings, and to notify the engineers if these are found.

2 Building Description

2.1 Details

Building name:	ADC2
Address:	Sir William Pickering Drive, Christchurch
Building use:	Commercial
Storeys above ground:	2
Storeys below ground:	N/A
Roof construction	Lightweight steel roofing and cold formed steel purlins on steel portal frames or beam members
Wall construction:	Reinforced concrete panels
Suspended Floor construction:	Interspan concrete floor system on a reinforced concrete beam/column framework
Subfloor construction:	N/A
Foundation construction:	Reinforced concrete shallow pad and strip footing foundations
Year built:	2006
Approx. floor area:	1700 m^2
Building Importance:	2 (NZS1170.0) for occupancy less than 300
Alterations:	Possible minor internal fit-out alterations affecting structure

Structex provides further description and background of the building in the previously released Interim Earthquake Damage Report.

2.2 Structural System

- Gravity System:

The first floor is constructed of Interspan concrete flooring system supported by concrete beams and columns forming a framework that spans in an east-west manner. The first floor supports the lighter steelwork roof and portal frames above which span in the same direction. A roof level interspan floor is located on the eastern wall line that is used to support plant. This floor spans onto a larger steel beam and structural walls in the vicinity.

- Lateral System:

Lateral forces acting on the main building are primarily resisted by the main internal concrete shearwalls and the façade panels. The internal concrete framework and steelwork roof portals help to resist load acting across the building in the east-west direction.

3 Seismic Assessment

3.1 Qualitative Assessment

Our previous qualitative assessment estimated the building strength as 64% NBS, indicating that it was considered unlikely to be earthquake prone. This estimate was based on the Initial Evaluation Procedure (IEP) from the New Zealand Society for Earthquake Engineering (NZSEE) "Assessment and Improvement of the Structural Performance of Buildings in Earthquakes" guidelines (June 2006), assuming an importance level 2 building.

This procedure provides an estimate of building seismic strength, relative to New Building Standard (NBS), based upon the buildings age, type of construction, and any known structural deficiencies. This procedure is used primarily for the purposes of assessing whether a further, more detailed quantitative assessment is required.

Structex have been engaged to progress with a quantitative assessment to calculate the seismic strength of the building in terms of current code standards in a more precise manner. The description and findings of our quantitative evaluation are summarised in the following section.

3.2 Quantitative Seismic Strength Analysis

A seismic analysis of the building was undertaken in accordance with the seismic loadings standard NZS1170.5:2004. The building has been modelled using the ETABS seismic modelling software with loadings taken from the equivalent static method to predict the seismic response. Elastic seismic loadings were applied to the structure, meaning all calculated element strengths are relative to this level of load. This is a conservative method as the age of the building and observed detailing suggests some inelastic behaviour could occur to a degree.

All strength assessments were undertaken using appropriate current material standards and first principles. The NZSEE guidelines were used in conjunction, and in particular for recommendations on strength reduction factors to produce 'probable' strengths.

The original concrete strength of 30MPa stated on the structural drawings was assumed and multiplied by a factor of 1.5 (consistent with NZSEE guidelines accounting for strength increase over time) to give 45MPa, which was used in the analysis. From observation of the exposed concrete elements, the general condition of the concrete gave little evidence to reduce this assumed strength.

The probable yield strength of the reinforcing steel was estimated with the use of the NZSEE guidelines at 540Mpa for grade 500 reinforcing.

AS/NZS1170.5:2005 was used to determine the applied loads to the building, assuming the following:

- A zone factor (Z) of 0.3 in accordance with changes to Section B1 of the Building Code, on the 19th May 2011
- Importance Level 2
- Subsoil class D

- Structural ductility factor of 1.25 for evaluation of the concrete and steelwork systems, and 2 for strength evaluation of foundations in bending

We note that while the Building Act "deems a building earthquake prone if its ultimate strength capacity is exceeded in a moderate earthquake, and the building would be likely to collapse", the NZSEE guidelines and CCC policy refer to a percentage of New Building Standard (%NBS). Currently 33% of NBS has been adopted as the threshold below which a building is considered earthquake-prone. The ultimate limit state capacity of the building has been assessed as a percentage of NBS to allow comparison.

The analysis undertaken is a process of effectively reverse engineering the structure to quantify the seismic strength of each element of the building or 'link in the chain'. Once the strength of each 'link' has been calculated, engineering judgement can be used to identify expected collapse (localised or global) scenarios and the level of 'current code design earthquake' at which this may occur.

We also note that the design level earthquake was increased on 19 May 2011 by 36%. This 'raised the bar' of what we compare the existing seismic strength to.

3.3 Analysis Results

Primary elements in the seismic load paths have been quantified to enable comparison with the expected demand based on the full current code design earthquake. This gives the strength as a percentage of 'New Building Standard' (NBS). The table below provides a condensed summary of the results below. Note that the table compares evaluated strengths to loading demands in both orthogonal directions of earthquake shaking.

Building Element Strength Summary:

Structural System	Strength relative to 'New Building Standard' (NBS)		Governing Element in System / notes:
	Along Direction EQ (North-South)	Across direction EQ (East-West)	
Primary internal shear walls, In Plane, ground floor	+100%	97%	Member bending of panel P38 between grids 8 & 9
Primary internal shear walls, In Plane, first floor	95%	+100%	Shear friction of P37 base
Façade panels, ground and first floor combined	70%	76%	Bending capacity of P30 and P13 piers
Concrete frames, ground to first floor	N/A	+100%	Low level of seismic load attracted – gravity loads are likely to govern
Steel portal frames, first floor only	N/A	+100%	
Roof bracing system	+100%	+100%	Tension of RB32 braces

The building strength classification is governed by in-plane lateral force resistance of the north and south façade panels, which at this stage are limited by the bending strength of the reinforced concrete pier sections of P30 and P13.

The façade panels could be considered secondary to the main internal shear wall elements that attract a far greater percentage of the overall load in our modelling analysis. The strength of these primary walls is limited to the bending capacity of panel P38 at 97% NBS.

Where appropriate, we have ignored shear friction demands on individual elements limiting strength as a certain amount of load shedding to other elements would occur under real earthquake loading conditions. This is particularly apparent when multiple elements exist along a gridline or in cases where wall elements are closely enclosed by concrete columns and would engage them in sharing friction requirements. This load shedding could be modelled in a more detailed modal analysis or push-over evaluation - therefore, we would consider the overall strength indications found from our two dimensional analysis to be a lower bound.

In summary, this quantitative assessment shows the relative strength of the building to be at least 70% NBS, and greater than 33%NBS, which agrees with the initial strength estimate of the IEP assessment. Hence, we do not consider the building to be 'earthquake prone' or an earthquake risk in its current condition as defined by the New Zealand Building Act.

3.4 Expected Damage

Earthquake damage repairs have been undertaken for the ADC2 building prior to the release of this report. However, from a review of the structural drawings and our understanding of the structural system based on visual non-intrusive inspections we would expect damage to the following areas after any additional major seismic events:

- General concrete cracking to frame and panel members, particularly the suspended floor ribs as previously experienced
- Internal fit-out and lining damages, particularly the suspended ceiling
- Cracking or misalignment of the floor slab
- Possible minor settling of the foundations

3.5 Critical Structural Weaknesses

From a review of our schematic drawings and visual inspections of the building, no critical structural weaknesses were identified.

4 Building Performance in recent Canterbury Earthquakes

4.1 Earthquake Damage

See the previously released Interim Earthquake Damage Report by Structex, covering the Airways ADC1, ADC2 and Andy Herd Buildings on Sir William Pickering Drive. The interim report, along with further observation on site, indicates the following general damage:

- Concrete cracking to the underside of the suspended first floor interspan ribs and primary concrete beams.
- Concrete cracking of the façade panels at points of known stress risers such as window frame corners
- Suspended ceiling grid damage and localised failures leading to dropping of tiles
- Minor damage to partitions and internal wall linings
- Damage to linings around the seismic joint at the interface with the ADC1 building

The Interim Earthquake Damage Report includes a representative photo catalogue; hence photos are not re-produced in this document. These photos are not meticulous or comprehensive records of all damage but have been included to provide an indication of the damage.

4.2 Review of Building Performance

In general, the ADC2 building has performed well in light of the recent Canterbury earthquakes. This is due to the favourable combination of the low rise, simple building construction and its young age, generally resulting in good detailing of structural elements. The surrounding ground and area has shown no signs of seismic weakness such as liquefaction or lateral spread.

Some noticeable hairline cracking in the concrete wall panels has been observed, which have mainly formed at points of obvious "stress-risers" such as door opening corners. It is possible that some cracks have been there since construction and installation due to normal drying shrinkage and the stresses of lifting. Earthquake shaking may have resulted in further opening of these cracks, but Structex has observed none that present loss of strength or other causes for concern. Cracking of this nature has been repaired by way of epoxy injection.

Non-structural elements within the building have been damaged as a result of movement of the superstructure. Internal lining damage such as has been observed in the ADC2 building has been widely viewed across Christchurch following the recent earthquake events and would be considered minor in this case. The suspended ceiling has shown localised failures mainly due to the movement incompatibilities between the building's overall structural system and the ceiling grid, resulting in squashing of the grid lines and subsequent falling of ceiling tiles or damages around restraint points.

4.3 Safety & Occupancy

To date, the observed damage to the building does not appear to indicate any appreciable degradation in strength to the structure or imminent hazards to the occupants, and our quantitative assessment has confirmed the building to be not considered earthquake-prone.

5 Earthquake Repairs and Temporary Support

5.1 Temporary Securing Measures

No areas were observed that required temporary securing measures for aspects of the building that presented an immediate hazard or limit further damage.

5.2 Repairs

Repairs have been previously suggested in the Interim Earthquake Damage Report for the damage viewed, and subsequently specified for and completed by a contractor prior to the release of this engineering evaluation report.

5.3 Strengthening to 100% NBS

The repairs completed to date were required to restore the building to its pre-earthquake damaged condition. Any seismic strengthening would be additional to this and is beyond the scope of this quantitative assessment.

As the building is not considered to be earthquake prone, additional seismic strengthening is not a statutory requirement as part of the earthquake repairs on the site requiring building consent.

6 Recommendations

6.1 Damage and Safety

We believe the current observed damage to the superstructure did not significantly reduce the seismic strength of the building. The structural damage seems confined mainly to basic cracking of the reinforced concrete elements of the building, which is to be expected in large earthquakes and in this case would be considered only minor. Repairs for this type of damage have already been undertaken.

Our quantitative assessment has confirmed the building to be not considered earthquake-prone. We see no obvious reason to restrict occupancy in the buildings' current state, but recommend that occupancy be reassessed following any significant earthquakes.

6.2 Repairs and Temporary Support

Repairs to restore pre-earthquake conditions to the ADC2 building have been completed to date.

As the building is considered not earthquake-prone, any building consent required for repairs or future alterations will not need to include strengthening as required by the Christchurch City Council's Earthquake-Prone Building Policy at this stage.

Strengthening is not necessary to meet code requirements but could be implemented. The level of any strengthening desired should be discussed with the building owner, insurer and Christchurch City Council. Once the level of strengthening has been agreed and any other specified alteration work has been defined, we can finalise the design and document the work for Building Consent.

6.3 Further Assessment and Investigations

The result of our quantitative analysis has confirmed the original IEP analysis result that building is not considered earthquake prone. Therefore we believe no further investigation is required to further confirm this result.

If strengthening is considered, further structural investigation, including intrusive investigation, is required. Further levels and verticality readings should be taken to confirm if any further movement has occurred compared to data already collected.

We recommend that the building be visually inspected following any subsequent significant earthquakes.

Appendix A: Christchurch City Council Compliance Schedule

This section highlights statutory requirements concerning existing and earthquake-prone buildings as laid out in the Building Act 2004, Building Code, and the Christchurch City Council's Earthquake-prone Building Policy 2010.

A.1 Building Act Requirements

The Building Act 2004 came into force on 31 March 2005 along with the Building Regulations. In considering the structure of existing buildings the relevant sections of the Act are as follows:

Section 124 – Powers of territorial authorities in respect of dangerous, earthquake-prone, or insanitary buildings

If the Territorial authority is satisfied that a building is dangerous or earthquake prone, the Territorial Authority may:

(a) Put up a hoarding or fence to prevent people approaching the building;
(b) Place a notice on the building warning people not to approach the building, or
(c) Give written notice requiring work to be carried out on the building to reduce or remove the danger.

Section 122 – Meaning of earthquake-prone building

This section of the Act deems a building earthquake prone if its ultimate strength capacity would be exceeded, and the building would be likely to collapse causing injury or death, in a "moderate earthquake". The size of a "moderate earthquake" is defined in the Building Regulations as one third the size of the earthquake used to design a new building at that site.

Section 112 – Alterations to Existing Buildings

This section requires that after any alterations, the building shall continue to comply with the structural provisions of the Building Code to at least the same extent as before the alteration. This means that alteration work cannot weaken the building. Additional building strength would therefore be required where structural elements are to be removed or weakened, or additional mass to be added. The building will also need to be assessed in terms of the egress from fire, and access for persons with disabilities provisions of the Building Code and upgraded to comply, as nearly as is reasonably practicable.

Section 67- Waivers and Modifications

This section allows the Territorial Authority to grant a Building Consent subject to waivers or modifications of the Building Code. The Territorial Authority may impose any conditions they deem appropriate with respect to the waivers or modifications.

The Building Act was also altered by the Canterbury Earthquake (Building Act) Order 2010, which, amongst other things, gave additional powers to the Territorial Authorities, extended the definition of a dangerous building and extended the Schedule 1 list of building work exempt from Building Consent.

A.2 Christchurch City Council (CCC) Requirements for Earthquake-Prone Buildings

The Christchurch City Council adopted a new policy for earthquake-prone buildings in September 2010.

The policy reflects the Christchurch City Council's determination to reduce earthquake risk to buildings and ensure that Christchurch "is a safe and healthy place to live in" and may be viewed on the CCC website.

In summary, the relevant items of the policy are as follows:

(a) Buildings are assessed using the New Zealand Society of Earthquake Engineering (NZSEE) guidelines with applied loadings from AS/NZS 1170.5 and are classed as earthquake prone if its strength is less than 33% of the applied loading from the loading standard AS/NZS 1170.5.

(b) It outlines the Council's approach to earthquake-prone buildings including identification, prioritisation, timeframes and implementation. In general, Importance Level 4 buildings (Post-disaster facilities, as defined by AS/NZS1170) will have 15 years from 1 July 2012 to either be strengthened or demolished. Importance Level 3 (crowd or high value) buildings will have 20 years and Importance Level 2 (normal) buildings will have 30 years. There are also additional triggers for requiring assessment and strengthening work to be undertaken at an earlier stage (including "significant" alterations or earthquake damage).

(c) The Council has a commitment to maintaining the intrinsic heritage values of Heritage buildings and has some discretion with regards to strengthening levels and methods. Each building will require discussion with Council Heritage team and Resource Consent prior to any strengthening or repair works being undertaken.

To date the Council has identified 67% of New Building Standard (NBS), or current Code, as the required level for strengthening of earthquake-prone buildings. However, the council may allow strengthening to levels between 33% and 67%, on a case by case basis, taking into account the following:

- The cost of strengthening
- Building use
- Level of danger presented by the building
- How much the building has been damaged

For buildings with a damaged building strength >33% of current code, it is recommended (but not required) that the building also be strengthened.

A.3 Recent Seismicity Changes for Christchurch

As a result of new information from the recent Canterbury earthquakes, changes have been made to Section B1 of the Building Code, increasing seismic code levels within areas covered by the Christchurch City, Selwyn District and Waimakariri District Councils. Such changes include:

- Increasing the zone hazard factor (Z) in AS/NZS1170.5 from 0.22 to 0.3, and serviceability limit state risk factor (R_s) from 1.25 to 1.33.

- Replacing Section 5 of NZS3604:1999 with NZS3604:2011 Section 5, adopting Earthquake Zone 2.

These changes came into effect on the 19th May 2011 and are interim code levels pending further seismological study and investigation. For further information on seismicity changes please refer to: http://www.dbh.govt.nz/b1-structure-urgent-changes-results

A.4 CERA Requirements

The CCC Earthquake Prone Building Policy has been somewhat superseded by CERA who have wide-ranging powers on these matters. CERA have currently given us verbal advice that the period within which they would require reporting of strength via a detailed engineering assessment (DEE) is no later than 30 June 2014. Official requirements for supplying a DEE to CERA will be contained in a letter sent to building owners in due course.

A.5 Ministry of Business, Innovation & Employment Policy

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Managing earthquake-prone buildings – policy decisions

On this page

- **Key decisions**
- **Consultation process and submissions received**

The Government has decided to introduce legislation to change the system for managing earthquake-prone buildings.

The changes follow recommendations by the Canterbury Earthquakes Royal Commission and a comprehensive review (including consultation) by the Ministry of Business, Innovation and Employment (MBIE).

Many earthquake-prone buildings in New Zealand are not being managed in a consistent, timely and cost effective way. A clear view has emerged that the current system is not achieving an acceptable level of risk in terms of protecting people from serious harm in moderate earthquakes.

The new system is designed to strike a better balance between protecting people from harm in an earthquake and managing the costs of strengthening or removing earthquake prone buildings.

It will give central Government a greater role in providing leadership and direction in relation to earthquake-prone buildings, to make better use of the resources and capability of central and local government.

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Key decisions

- To identify those that are earthquake-prone, territorial authorities will have to complete a seismic assessment of all non-residential buildings and all multi-unit, multi-storey residential buildings in their areas within five years of changes to the new legislation taking effect.
- All earthquake-prone buildings will have to be strengthened, or demolished, within 20 years of the new legislation taking effect (i.e. assessment by territorial authorities within five years and strengthening within 15 years of assessment).

- A publicly accessible register of earthquake-prone buildings will be set up by MBIE.
- Certain buildings will be prioritised for assessment and strengthening such as:
    - buildings likely to have a significant impact on public safety,e.g. those with potential falling hazards
    - strategically important buildings,e.g. those on transport routes identified as critical in an emergency.
- Owners of some buildings will be able to apply for exemptions from the national timeframe for strengthening. These will be buildings where the effects of them failing are likely to be minimal and could include farm buildings with little passing traffic.
- Owners of earthquake-prone category 1 buildings (listed on the register of historic places under the Historic Places Act 1993) and those on the proposed National Historic Landmarks List, will be able to apply for extensions of up to 10 years to the national timeframe for strengthening.

The Government intends to introduce legislation to amend the Building Act (2004) into Parliament later this year. If the Bill is passed into law, it is likely there will be a transition period before the law takes effect while detailed implementation issues are worked through. MBIE will be working with Territorial authorities and engineers on implementing these changes.

- **Read the Minister for Building and Construction's media release on the Beehive website**
- **Read Questions and Answers about the changes to the earthquake-prone building system** [PDF 91 KB, 5 pages]
- **Read the summary of submissions** [PDF 122 KB, 20 pages]
- **Read Volume 4 of the Royal Commission's final report**
- **Read the Cabinet Paper** [PDF 1.1 MB, 40 pages] which relates to these decisions
- **Read the Regulatory Impact Statement** [PDF 431 KB, 33 pages]
- **Read the Minute of Decisions** [PDF 683 KB, 7 pages]

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Consultation process and submissions received

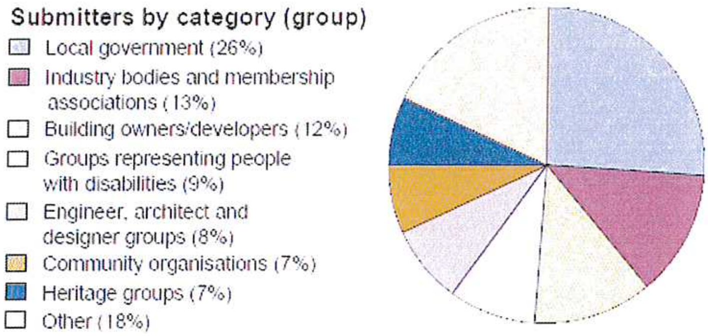
The Government consulted on its proposals to change the system. The consultation document, 'Building Seismic Performance', outlining proposals to improve the system for managing earthquake-prone buildings, was released on 7 December 2012, with a closing date for submissions of 8 March 2013.

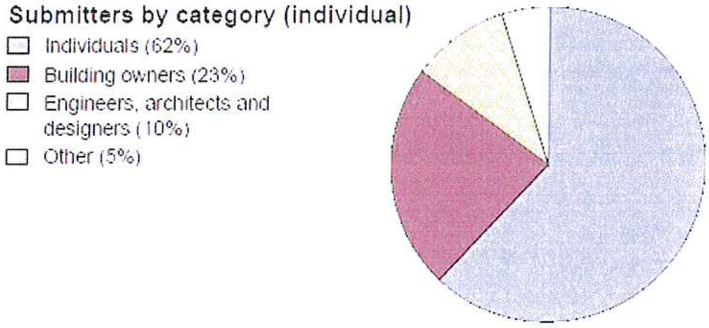
The consultation proposals arose from the Royal Commission's recommendations and MBIE's review.

- **Read details of the consultation that closed on 8 March 2013 »**
- **Read about the MBIE review »**

Public meetings were held in Auckland, Wellington, Christchurch, Dunedin, Hamilton, Palmerston North, and Napier in February 2013 to support the consultation process.

535 submissions were received from individuals and groups including: building owners, engineers, local government, architects, insurers and disability and heritage advocates.





What submitters said

Most of the proposals were supported by submitters and are included in the Government's proposals for legislative change. Some changes were made to the Government's original proposals as a result of feedback from the consultation.

Read the **Full report on the consultation process, Building Seismic Performance** [PDF 671 KB, 133 pages]

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A.6 Changes to Snow Loadings

The impact of heavy snowfalls on buildings at low altitudes in the central and southern South Island have led the Building and Housing department within the Ministry of Business, Innovation & Employment setting a minimum ground snow load (s_g) of 0.9kPa. This applies to regions N4 and N5 as defined in AS/NZS1170.3:2003.

Prior to this amendment to the Building Code, the ground snow load would likely be in the range of 0.5-0.7kPa. However, the design of buildings, in particular their roofs, is not always governed by snow loads and thus while the loading has increased the strength of the roof relative to current code may not have changed. We have not undertaken a snow loading review of this building. If desired, Structex can carry out further assessments to determine the capacity of the building relative to the current snow loading standards.

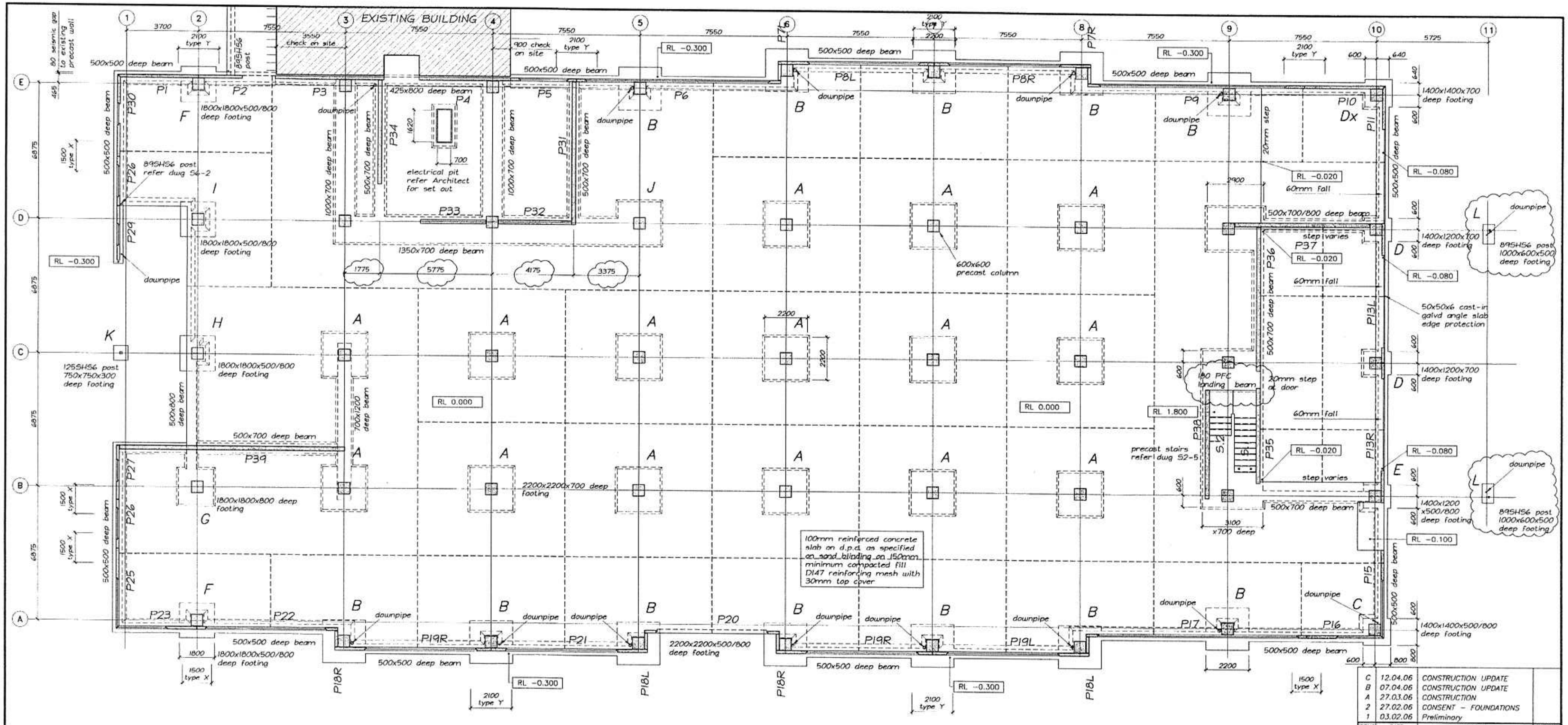
Appendix B: Recent Seismic Events

The table below lists the magnitude 5.0 and greater earthquakes within the Canterbury region since 4th September 2010 until the time of writing.

Table 1-Recent Seismic Events

Date	Time	Mag	Location	Depth (km)
25-05-2012	14:42	5.2	20km East of Christchurch	12
15-01-2012	2:47	5.0	10km East of Christchurch	9
07-01-2012	1:21	5.2	20km East of Christchurch	15
06-01-2012	14:20	5.0	10km North-East of Christchurch	15
02-01-2012	5:45	5.5	20km East of Christchurch	15
02-01-2012	1:27	5.1	20km North-East of Lyttelton	15
24-12-2011	6:37	5.1	10km East of Diamond Harbour	8
23-12-2011	16:50	5.0	20km North-East of Diamond Harbour	10
23-12-2011	15:18	6.0	10km East of Christchurch	6
23-12-2011	14:06	5.3	20km East of Christchurch	10
23-12-2011	13:58	5.8	20km East of Christchurch	8
09-10-2011	20:34	5.5	10km North-East of Diamond Harbour	12
22-07-2011	5:39	5.1	40km West of Christchurch	12
21-06-2011	22:34	5.4	10km South-West of Christchurch	8
15-06-2011	6:27	5.0	20km South-East of Christchurch	6
13-06-2011	14:20	6.3	10km South-East of Christchurch	6
13-06-2011	13:00	5.6	10km East of Christchurch	9
06-06-2011	9:09	5.5	20km South-West of Christchurch	15
10-05-2011	3:04	5.3	20km West of Christchurch	15
30-04-2011	7:08	5.2	60km North-West of Christchurch	9
16-04-2011	17:49	5.3	20km South-East of Christchurch	11
20-03-2011	21:47	5.1	10km East of Christchurch	10
22-02-2011	19:43	5.0	20km South-East of Christchurch	12
22-02-2011	16:04	5.0	Within 5km of Christchurch	12
22-02-2011	14:50	5.5	Within 5km of Lyttelton	5
22-02-2011	13:04	5.7	10km South of Christchurch	6
22-02-2011	12:51	6.3	10km South-East of Christchurch	5
20-01-2011	6:03	5.1	10km South-West of Christchurch	10
19-10-2010	11:32	5.0	10km South-West of Christchurch	9
13-10-2010	16:42	5.0	20km West of Christchurch	15
04-10-2010	22:21	5.0	30km East of Darfield	12
08-09-2010	7:49	5.1	10km North-West of Diamond Harbour	6
07-09-2010	3:24	5.4	20km South-East of Darfield	15
06-09-2010	23:40	5.4	20km South-West of Darfield	9
06-09-2010	23:24	5.2	20km South-East of Darfield	9
04-09-2010	16:55	5.4	10km South-West of Darfield	10
04-09-2010	11:14	5.3	10km South-East of Darfield	6
04-09-2010	11:12	5.3	10km East of Darfield	12
04-09-2010	7:56	5.2	20km West of Christchurch	7
04-09-2010	4:56	5.3	30km West of Christchurch	8
04-09-2010	4:35	7.1	40km West of Christchurch	11

Appendix C: ADC2 Sample Floor Plan

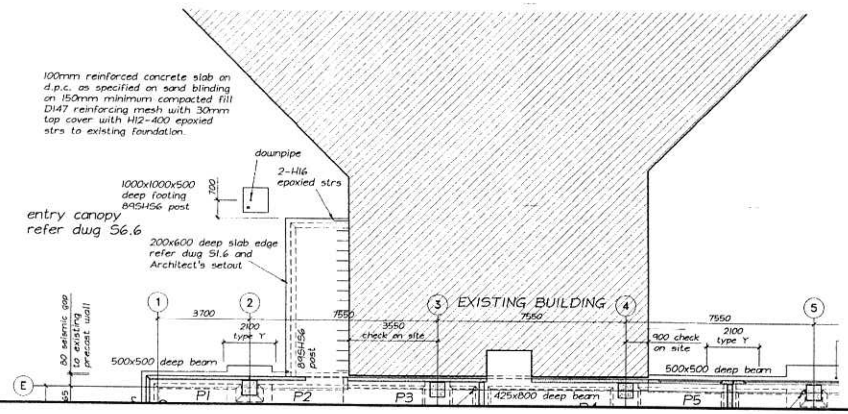


Ground Floor RL 0.000 = RL 33.000 on Architectural drawings.

refer dwg S1-2 for footing reinforcing

refer Architectural drawings for all downpipe and sewer pipe details

- - - - - - denotes 3x30mm deep slab sawcut located mid-grid as shown. grout fill prior to placing floor coverings



ISSUE	DATE	AMENDMENT	CHECKED
C	12.04.06	CONSTRUCTION UPDATE	
B	07.04.06	CONSTRUCTION UPDATE	
A	27.03.06	CONSTRUCTION	
2	27.02.06	CONSENT - FOUNDATIONS	
1	03.02.06	Preliminary	

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IAN KRAUSE ARCHITECTS LIMITED

AIRWAYS NEW ZEALAND TECHNOLOGY PARK
CHRISTCHURCH

GROUND FLOOR PLAN

CONTRACTOR MUST VERIFY ALL DIMENSIONS ON SITE

SCALES:	DESIGNED		
1:100	DRAWN	KD	01/06
	CHECKED		

SET	JOB NO.	SHEET NO.	ISSUE
	050818	S1-1 OF - SHEETS	C

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DATE PRINTED: 11.02.2006

Appendix D: IEP Report Summary

Detailed Engineering Evaluation Summary Data V1.10

Location

Building Name:	Airways - ADC2 Building	Reviewer:	Geoff Bunn
	Unit / No: 26 / Street: Sir William Pickering Drive	CPEng No:	
Building Address:		Company:	Structex
Legal Description:		Company project number:	3472
		Company phone number:	3418952
GPS south: (Degrees / Min / Sec)		Date of submission:	
GPS east:		Inspection Date:	
		Revision:	
Building Unique Identifier (CCC):		Is there a full report with this summary?	no

Site

Site slope:	flat	Max retaining height (m):	
Soil type:	sandy silt	Soil Profile (if available):	Assume similar to Andy Herd Building
Site Class (to NZS1170.5):	D		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	8.00

Building

No. of storeys above ground:	2	single storey = 1 / Ground floor elevation (Absolute) (m):	0.50
Ground floor split?	no	Ground floor elevation above ground (m):	0.00
Storeys below ground	0		
Foundation type:	pads with tie beams	if Foundation type is other, describe:	
Building height (m):	7.20	height from ground to level of uppermost seismic mass (for IEP only) (m):	8
Floor footprint area (approx):	1790		
Age of Building (years):	6	Date of design:	2004-
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	commercial	Brief strengthening description:	
Use (upper floors):	commercial		
Use notes (if required):			
Importance level (to NZS1170.5):	IL2		

Gravity Structure

Gravity System:	frame system		
Roof:	steel framed	rafter type, purlin type and cladding	460UB67, DHS purlin, light roofing
Floors:	precast concrete with topping	unit type and depth (mm), topping	125 interspan unit, 100mm topping
Beams:	cast-insitu concrete	overall depth x width (mm x mm)	depth - 250mm, width - 870mm
Columns:	precast concrete	typical dimensions (mm x mm)	600mm x 600mm
Walls:	load bearing concrete		#N/A

Lateral load resisting structure

East-west	Lateral system along:	concrete shear wall	note total length of wall at ground (m):	30m approx
	Ductility assumed, μ:	1.25	wall thickness (m):	0.15
	Period along:	0.50 #### enter height above at H30	estimate or calculation?	estimated
	Total deflection (ULS) (mm):		estimate or calculation?	
	maximum interstorey deflection (ULS) (mm):		estimate or calculation?	
North-south	Lateral system across:	concrete shear wall	note total length of wall at ground (m):	30m approx
	Ductility assumed, μ:	1.25	wall thickness (m):	0.15
	Period across:	0.50 #### enter height above at H30	estimate or calculation?	estimated
	Total deflection (ULS) (mm):		estimate or calculation?	
	maximum interstorey deflection (ULS) (mm):		estimate or calculation?	

Seperations:

north (mm):		leave blank if not relevant
east (mm):		
south (mm):		
west (mm):		

Non-structural elements

Stairs:	precast, half height	describe supports	built into floor topping and wall support
Wall cladding:	precast panels	thickness and fixing type	150, bolted onto frame
Roof Cladding:	Other (specify)	describe	uncertain, assumed lightweight
Glazing:	aluminium frames		
Ceilings:	light tiles		hung
Services(list):	typical - sprinklers, lights, ducting etc		

Available documentation

Architectural	partial	original designer name/date	Ian Krause Architects, 2006
Structural	full	original designer name/date	Powell Fenwick Consultants Ltd, 2006
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	partial	original designer name/date	indication on Powell-Fenwick drawing

Damage

Site:
(refer DEE Table 4-2)

Site performance:	good	Describe damage:	cracking - cladding, lining, floor
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	none apparent	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	none apparent	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:	0%	Describe how damage ratio arrived at:	estimation of damage seen
	Describe (summary):	Quantitatiove calculations completed		
Across	Damage ratio:	0%		
	Describe (summary):	Quantitatiove calculations completed		
Diaphragms	Damage?:	yes	Describe:	minor floor cracking
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	linings, cladding panels, services

$$Damage\_Ratio = \frac{(\%NBS\ (before) - \%NBS\ (after))}{\%NBS\ (before)}$$

Recommendations

	Level of repair/strengthening required:	minor non-structural	Describe:	completed
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before:	70%	#### %NBS from IEP below	
	Assessed %NBS after:	70%		
Across	Assessed %NBS before:	76%	#### %NBS from IEP below	
	Assessed %NBS after:	76%		

IEP

Age of Building (from above): 2004-

hn from above: 8m

Seismic Zone, if designed between 1965 and 1992:

Design Soil type from NZS1170.5:2004, cl 3.1.3:
not required for this age of building

	along	across
Period (from above):	0.5	0.5
(%NBS)nom from Fig 3.3:		

Note:1 for buildings designed prior to 1976 as public buildings, to code at time, use 1.25
Note 2: for RC buildings designed between 1976-1984, use 1.2
Note 3: for buildngs designed prior to 1935 use 0.8, except in Wellington (1.0)

	along	across
Final (%NBS)nom:	0%	0%

2.2 Near Fault Scaling Factor

Near Fault scaling factor, from NZS1170.5, Table 3.3):

	along	across
Near Fault scaling factor (1/N(T,D), **Factor A**:	#DIV/0!	#DIV/0!

2.3 Hazard Scaling Factor

Hazard factor Z for site from AS1170.5, Table 3.3:
Z_{1992}, from NZS4203:1992
Hazard scaling factor, **Factor B**: #DIV/0!

2.4 Return Period Scaling Factor

Building Importance level (from above): 2
Return Period Scaling factor from Table 3.1, **Factor C**:

2.5 Ductility Scaling Factor

	along	across
Assessed ductility (less than max in Table 3.3)		
Ductility scaling factor (if pre-1976):		
Ductiity Scaling Factor, **Factor D**:	1.00	1.00

2.6 Structural Performance Scaling Factor:

	along	across
Sp:		
Structural Performance Scaling Factor **Factor E**:	#DIV/0!	#DIV/0!

2.7 Baseline %NBS, (NBS%)b = (%NBS)nom x A x B x C x D x E

	along	across
%NBSb:	**#DIV/0!**	**#DIV/0!**

Global Critical Structural Weaknesses: (refer to NZSEE IEP Table 3.4)

3.1. Plan Irregularity, factor A:	insignificant	1
3.2. Vertical irregularity, Factor B:	insignificant	1
3.3. Short columns, Factor C:	insignificant	1

3.4. Pounding potential

Pounding effect D1, from Table to right: 1.0
Height Difference effect D2, from Table to right: 1.0

Therefore, Factor D: 1

3.5. Site Characteristics insignificant 1

Table for selection of D1	Severe	Significant	Insignificant/none
Separation	0<sep<.005H	.005<sep<.01H	Sep>.01H
Alignment of floors within 20% of H	**0.7**	**0.8**	**1**
Alignment of floors not within 20% of H	**0.4**	**0.7**	**0.8**

Table for Selection of D2	Severe	Significant	Insignificant/none
Separation	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

3.6. Other factors, Factor F

	Along	Across
For ≤ 3 storeys, max value =2.5, otherwise max value =1.5, no minimum		
Rationale for choice of F factor, if not 1		

Detail Critical Structural Weaknesses: (refer to DEE Procedure section 6)
List any:

	Along	Across
3.7. Overall Performance Achievement ratio (PAR)	**0.00**	**0.00**
4.3 PAR x (%NBS)b: PAR x Baselline %NBS:	**#DIV/0!**	**#DIV/0!**

4.4 Percentage New Building Standard (%NBS), (before) **#DIV/0!**

Appendix E: ADC2 Strength Analysis Summary Spreadsheet

3472 - ADC2 Strength Summaries

Aug/Sept 2013

loading demands below taking directly from the model at ductility 1, these have been scaled down where appropriate:

Ductility Multipliers	$\mu = 1.25$	0.81
	$\mu = 2$	0.44

MAIN INTERNAL SHEAR WALLS - N-S

Item	Member Capacities					Connections, shear friction taken over entire panel					Overal Governing capacity
	M* (μ=1)	ΦMn	%NBS $_{\mu=1.25}$	V* (μ=1)	ΦV	%NBS $_{\mu=1.25}$	Starters ΦMn	%NBS $_{\mu=2}$	Friction ΦV	%NBS $_{\mu=1.25}$	
Grid D, 9-10, P37	5212	7424	176%	2484	3363	167%	7040	307%	1835	91%	Shear friction at base, P37 91% NBS
Grid D, p 32-33	10193	11229	136%	1589	3841.6	298%	8752	195%	1313	100%	Shear Friction of the top section of this
Grid D, p 41(top)	4487	9702	267%	1425	3763	326%	8167	414%	1101	95%	wall line, P41 95% NBS
Grid B-c, P39	13296	19573	182%	3773	4531	148%	12800	219%	3300	108%	friction, influence of columns on grid B

MAIN INTERNAL SHEAR WALLS - E-W

Item	Member Capacities					Connections, shear friction taken over entire panel					Overal Governing capacity
	M* (μ=1)	ΦMn	%NBS $_{\mu=1.25}$	V* (μ=1)	ΦV	%NBS $_{\mu=1.25}$	Starters ΦMn	%NBS $_{\mu=2}$	Friction ΦV	%NBS $_{\mu=1.25}$	
Grid 3a, top P42	2941	2494	105%	902	2157	295%	2058	159%	596	82%	Shear Friction of top section 82% NBS
Grid 3a, base P34	10269	8600	103%	2035	2493	151%	8432	187%	1792	109%	
Grid 4a, top P40	3747	7681	253%	1190	3371	350%	4204	255%	636	66%	Friction at top ignored (load shed to
Grid 4a, base P31	15524	12351	98%	3274	2971	112%	12184	178%	4651	175%	frames), bending in bottom section 98%
Grid 8a, P38	6177	4863	97%	1716	2688	193%	4830	178%	955	69%	member bending 97% NBS
Grid 9a, P35	4404	4095	115%	1223	2690	272%	3301	170%	704	71%	Shear Friction 146% NBS due to columns
Grid 9a, P36	7912	8931	139%	2753	3763	169%	7361	211%	1091	49%	including P38 above

E-W : NORTH WALL PANELS - Grid 1A

Item	Member Capacities					Connections, shear friction taken over entire panel					Overal Governing capacity
	M* (μ=1)	ΦMn	%NBS $_{\mu=1.25}$	V* (μ=1)	ΦV	%NBS $_{\mu=1.25}$	Starters ΦMn	%NBS $_{\mu=2}$	Friction ΦV	%NBS $_{\mu=1.25}$	
P30/P26 Pier	902	507.1	69%	580	672	143%	686	173%	928	100%	Bending capacity of P30 pier member
P27/P29 Pier	242	168	86%	275.6	287	129%	91	85%	814	88%	considering μ = 1.25 (nominal) loading
P30 Spandrel	476	774	201%	893	712	98%	N/A		N/A		70% NBS
P29 Spandrel	153	155	125%	106	101	118%	N/A		N/A		

E-W : SOUTH WALL PANELS - Grid 10A

Item	Member Capacities					Connections, shear friction taken over entire panel					Overal Governing capacity
	M* (μ=1)	ΦMn	%NBS $_{\mu=1.25}$	V* (μ=1)	ΦV	%NBS $_{\mu=1.25}$	Starters ΦMn	%NBS $_{\mu=2}$	Friction ΦV	%NBS $_{\mu=1.25}$	
P13L pier 1	515	420.2	101%	346	579	207%	241	106%	4210	330% total grid 10/10a	section bending strength of the smaller
P13L pier 2	272	155	70%	214	206	119%	97	81%			pier of P13 at 70% NBS
Spandrel P13L/R	600	523	108%	232	520	277%	N/A		N/A		

N-S : WEST ELEVATION - Grid A1 / A2

Item	Member Capacities					Connections, shear friction taken over entire panel					Overal Governing capacity
	M* (μ=1)	ΦMn	%NBS μ=1.25	V* (μ=1)	ΦV	%NBS μ=1.25	Starters ΦMn	%NBS μ=2	Friction ΦV	%NBS μ=1.25	
P19/21 pier 1	189	385	251%	243	572	291%	N/A		696	103% total grid A1	Shear friction resistance considered for whole 'worst case' panel
P19/21 pier 2	144	145	124%	184	271	182%	N/A				
Spandrel P21	369	228	76%	135	288	263%	N/A		N/A		Bending of smaller spandrel on P21 76%
Base beam P21	240	191	98%	85	249	362%	N/A		N/A		Bending of base spandrel on P19/21 98%
P20 legs	177	134.5	94%	181	263	179%	96	123%	293	121%	Bending of leg section at 94% NBS
P20 spandrel	568	583	127%	182	515	349%	N/A		N/A		all +100% NBS
P22 leg Upper	172	135.4	97%	213	263	152%	N/A		N/A		Bending of upper leg section at 97% NBS
P22 leg lower	146	135.4	114%	178	263	182%	N/A		488	178%	friction over P22+P23
P22 Spandrel	566	583	127%	168	515	378%	N/A		N/A		all +100% NBS

N-S : EAST ELEVATION - Grid E1 / E2

Item	Member Capacities					Connections, shear friction taken over entire panel					Overal Governing capacity
	M* (μ=1)	ΦMn	%NBS μ=1.25	V* (μ=1)	ΦV	%NBS μ=1.25	Starters ΦMn	%NBS μ=2	Friction ΦV	%NBS μ=1.25	
Grid E2, P8 legs	128	143	138%	164	192	145%	N/A		726	120% total grid E2	Shear friction resistance considered for whole 'worst case' panel. All +100% NBS
E2, P8 spandrel	375	583	192%	130	515	489%	N/A				
Grid E1, P3 top	725	3542	603%	530	1583	369%	1887	592%	369	86%	Shear friction okboth top and bottom (+100%NBS) considering load shed ability along gridline
Grid E1, P3 base	3455	3773	135%	758	1583	258%	2876	189%	569	93%	
Grid E1 north sec	V* TOTAL ALONG BASE OF GRIDLINE =			2109	N/A - shear friction checked only				1837	108%	
Grid E1 north sec	V* TOTAL ALONG TOP SECTION =			743	N/A - shear friction checked only				683	113%	
Grid E1, P2	580	587	125%	295	785	329%	758	297%	As above		all +100% NBS

E-W INTERNAL FRAME WORK - worst cases only

Item	Member Capacities						Overal Governing Items
	M* (μ=1)	ΦMb	%NBS μ=1.25	N*	ΦN	%NBS μ=1.25	
Grid 7 beam	266	259	120%	N/A			Steel frames all +100% NBS - column capacity taken over 3m height un restrained but considers an αm = 1.75 factor for triangular BMD shape. Same for beam sections over the unrestrained length when compression occurs on the bottom flange - worst case at grid 7 where le = 6.5m.
Grid 7 column	433	399	114%	N/A			
Roof bracing	N/A			75	332	547%	
Concrete Beams	50	143	353%	N/A			Concrete elements are easily +100% NBS. These frames are liley to be governed by gravity loads rather than earthquake demands.
Concrete column	76	242	393%	N/A			

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20 February 2012

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Commercial Investment Properties Ltd
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Auckland City 1143

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Dear Raewyn, Sam

Re: AIRWAYS ADC2 Building– Engineering Evaluation

To date, Structex have had general involvement in the Andy Herd, ADC1 and ADC2 Airways Corporation Buildings at a rapid assessment level following each magnitude 5+ earthquake event, advising on safety and continued occupancy issues where required. An Interim Earthquake Evaluation Report has been produced, which highlights damage observed, occupancy risks, temporary and permanent remedial works.

As requested, we have now begun the Detailed Engineering Evaluation (DEE) of the buildings to gain an indication of how the current strength compares to New Building Standards (NBS).

The first step in the DEE process is an Initial Evaluation Procedure (IEP) assessment of each of the airways buildings. This report covers the IEP of the **ADC2 Building only**, as indicated by the enclosed aerial photo. The IEP procedure was carried out to the NZSEE guidelines and is intended as a coarse screening to identify earthquake prone buildings (<33% NBS) as established by the Building Act.

According to the IEP procedure, the building as it currently stands has a seismic strength of at least 64% NBS, and is therefore not considered to be earthquake-prone.

IEPs for all three Airways Buildings are now complete. The next step in the DEE process is to complete more detailed quantitative assessments of the airways buildings, which will give more accurate readings of each building's capacity and highlight critical areas that could be strengthened to improve capacity, if required. We will report the results of these to you in due course.

If you have any queries please do not hesitate to contact the undersigned.

Yours sincerely
Structex Harvard Ltd

Geoff Bunn
Structural Engineer
GIPENZ

Reviewed by:

Geoff Banks
Director
Structex Harvard Ltd
MIPENZ, CP Eng #66808

enc: IEP aerial photo – ADC2 building
IEP procedure spreadsheet and results