

Southland Museum & Art Gallery Trust Board  
PO Box 1012  
INVERCARGILL 9840

19 March 2018

Attention: Mr P. Horner  
Building Assets and Museum Manager

Dear Paul,

### **Southland Museum & Art Gallery: Review of November 2013 DEE Report**

As requested in your E-mail dated 2 March 2018, following my walk-through inspection of the Southland Museum & Art Gallery building at Gala Street, Invercargill, on 1 March 2018, I have carried out a review of the Detailed Engineering Evaluation – Quantitative Assessment Report prepared by Opus International Consultants Ltd dated 29 November 2013. This Opus report identified the various constructions that make up the Southland Museum & Art Gallery building, and assessed the earthquake resistant capacity of the building as a whole to be less than 34%NBS; hence ‘earthquake-prone’.

### ***Relationship of DEE to Current Seismic Assessment Methodology for Buildings***

Prior to the Canterbury Earthquake Sequence of 2010 – 11, the seismic resistant structural capacity of existing buildings was assessed using the 2006 Guidelines<sup>1</sup> published by the New Zealand Society for Earthquake Engineering, with earthquake loadings derived from the New Zealand Standard NZS 1170: Part 5<sup>2</sup>.

Immediately following the Canterbury Earthquakes engineers incorporated the ‘lessons learnt’ from the effects of the earthquake into supplementary documents to assist in the assessment of existing building damaged by the earthquake events and elsewhere in the country. A series of live documents<sup>3</sup> were produced by the Engineering Advisory Group to Government. These guideline documents were referred to as the DEE Guidelines.

These DEE Guidelines tended to be specific to the issues identified in Christchurch, Therefore, further development of the guidelines was carried out under the administration and financial support of MBIE, with technical input from the technical societies of Engineering New Zealand (previously the Institution of Professional Engineers New Zealand). The resultant series of publications *The Seismic Assessment of Existing Buildings (the Guidelines)* was

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<sup>1</sup> Assessment and Improvement of the Structural Performance of Buildings in Earthquakes: Prioritisation, Initial Evaluation, Detailed Assessment, Improvement Measures Recommendations of a NZSEE Study Group, June 2006.

<sup>2</sup> NZS 1170.5: 2004: Structural Design Actions Part 5: Earthquake Actions – New Zealand published by Standards New Zealand 2004

<sup>3</sup> Engineering Advisory Group, Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury, Part 2 Evaluation Procedure, Draft Prepared by the Engineering Advisory Group, Revision 7, May 2012.

and  
Engineering Advisory Group, Guidance on Detailed Engineering Evaluation of Nonresidential buildings, Part 3 Technical Guidance, Draft Prepared by the Engineering Advisory Group, Rev 3, May 2012.

published on 1 July 2017, to provides a technical basis for engineers to carry out seismic assessments of existing buildings within New Zealand. *The Guidelines* support seismic assessments for a range of purposes, including whether or not a building is earthquake-prone in terms of the Building Act 2004 [Building (Earthquake-prone Buildings) Amendment Act 2016], and more generally for property risk identification. The current building assessment guidelines are available from <http://www.eq-assess.org.nz/>

with earthquake loadings continued to be derived from the New Zealand Standard NZS 1170: Part 5<sup>2</sup>.

### ***DEE Assessment of the Southland Museum & Art Gallery Building:***

#### ***Relevance to Current Requirement for Seismic Assessment of Buildings***

I have reviewed the November 2013 DEE report prepared by Opus on the Southland Museum & Art Gallery building, and the available construction drawings that you provided for my review. The Opus report is comprehensive and identifies the 'Critical Structural Weakness' in each of the four structures that make up the museum & art gallery building. The methodology that Opus used for the assessment of the elements of the building was appropriate, and inline with developments taking place in 2013 that lead to the July 2017 Guidelines.

Further to the areas of structure covered by the Opus report, the consequential effect of the 14 November 2016 Kaikoura Earthquake on precast concrete flooring systems, has relevance for the Southland Museum & Art Gallery Building. A number of multi-storey buildings in Wellington, where the precast concrete flooring system was supported on a seismic resistant frame, sustained damage to the flooring units at their supports. As the frames swayed under the earthquake action, hinging occurred in the beams adjacent to the supporting columns. After a number of cycles of yielding at the beam hinges, the hinge zone grew in length with the potential for the flooring unit to come off their seating. This loss of support caused three flooring units to collapse in one Wellington building.

Considering the Southland Museum & Art Gallery building, there is the potential for a similar flooring system failure mechanism to occur in the 1960 and 1988 additions where 'Double TT' precast concrete flooring units are used to form the first and second floors. In addition, the 'Shell Beams' that form the main seismic frames of the 1960 and 1988 additions may be vulnerable to extensive damage at the hinge zones during a long duration seismic event. These potential areas of structural failure reinforce the Opus assessment of the Museum & Art Gallery building's seismic resistance as being less than 33%NBS.

In my opinion, the conclusions of the Opus report provide a supportable assessment that meets the criteria of the 2017 Guidelines for the seismic assessment of existing buildings. Therefore, under the current Building Act 2004, Building Amendment Act 2016 and Regulations, the Museum & Art Gallery building is probably 'earthquake-prone'. On the basis of seismic assessment reporting submitted to the Invercargill City Council, they will determine if the building is earthquake-prone.

### ***Consideration of Structural Strengthening or Replacement***

In section 10 Remedial Options of the Opus report, a series of items for structural strengthening are identified that must be addressed in the three main sections of the Southland Museum & Art Gallery building to achieve a seismic resistant capacity of 34%NBS or 67%NBS.

In my opinion, structural strengthening of the existing structures is unlikely to achieve the level of protection required for the valuable material currently contained in the building, or likely to be in the future. Any seismic resistant performance will be compromised by the inherent difficulties of achieving a consistent and reliable response from the various structures in any damaging earthquake event. Whatever strengthening work is carried out there will remain aspects of performance in the current four major structural elements that could lead to significant damage. The resilient capacity of the structures to withstand an earthquake that has an intensity of shaking greater than the design code seismic loading will not be as great as that of a well-designed structure to current loading and material code requirements. This aspect is very important to the survival of the building, the level of damage sustained, and protection provided for the building contents.

It is likely that the construction cost of such strengthening will only be marginally less than lifting the roof frame off to allow demolition of the three original structures and construction of a new structure to support the existing roof frame. Any new structure will have greater functionality for the museum, art gallery and service areas, and greater earthquake resistant capacity.

### ***Conclusion***

In my opinion, the Detailed Engineering Evaluation – Quantitative Assessment Report prepared by Opus International Consultants Ltd dated 29 November 2013 remains relevant for the assessment of the Southland Museum & Art Gallery building's seismic resistant capacity. The report provides a fair and supportable assessment, that essentially is aligned with the methodology set out in *The Seismic Assessment of Existing Buildings* guidelines published by MBIE on 1 July 2017 to meet the requirements of the Building Act 2004, Building (Earthquake-prone Buildings) Amendment Act 2016 and associated regulations. It is confirmed that the Southland Museum & Art Gallery building is probably 'earthquake-prone'.

I trust the review and conclusions outlined above assists you and the Trust Board to move forward with your planning to upgrade the Southland Museum & Art Gallery building. I would be pleased to answer any further queries you may have that are raised by my review.

Yours Sincerely,



**Win Clark**

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