UNDER   THE COMMISSIONS OF INQUIRY ACT 1908

IN THE MATTER OF   ROYAL COMMISSION OF INQUIRY INTO
                             BUILDING FAILURE CAUSED BY
                             CANTERBURY EARTHQUAKES

                             KOMIHANA A TE KARAUNA HEI TIROTIRO I
                             NGA WHARE I HORO I NGA RUWHENUA O
                             WAITAHA

AND IN THE MATTER OF   THE CTV BUILDING COLLAPSE

FIRST STATEMENT OF EVIDENCE OF BARRY JOHN DAVIDSON

DATE OF HEARING: COMMENCING 25 JUNE 2012

FIRST STATEMENT OF EVIDENCE OF BARRY JOHN DAVIDSON

INTRODUCTION

1. My name is Barry John Davidson. I live in Auckland. I am a director of Compusoft Engineering Ltd (Compusoft).

2. I am a retired academic engineer with approximately twenty eight years of experience in teaching and researching in the fields of structural engineering, specialising in structural dynamics, finite element theory and earthquake engineering. I am also a professional engineer having started Compusoft in the mid 1980's. I have been the Director of Compusoft Engineering since that date.

3. I hold a Bachelor of Engineering with Honours Degree in the Engineering Science and a PhD in Engineering. I am a Fellow of IPENZ and the NZSEE. I am a past president of the New Zealand Society of Structural Engineers (SESOC) and a Life Member of that society.

4. The Royal Commission has asked Compusoft to carry out equivalent static and modal analyses of the CTV Building. These have been carried out by Derek Bradley and are described in his Third Brief of Evidence. In addition, I have been asked by the Royal Commission to:

   4.1. Comment on the interpretation of clauses 3.4.7, 3.5.2.6.1, 3.8.1.1 and 3.8.1.2 of NZS 4203:1984.

   4.2. Comment on some aspects of procedure relating to the use of ETABS in the 1980s.

5. I have read and agree to comply with the Code of Conduct for Expert Witnesses. I confirm that these matters are within my expertise.

6. The following experience is relevant:

   6.1. Prior to taking up a lectureship in structural engineering in 1979, I spent three years in California developing software, a large proportion of that time working on

a program that is now called "SAP2000". The professor who was the initial developer of the software with whom I worked quite closely was Professor Ed Wilson of UCB. He was also the developer of ETABS. When I returned to New Zealand, prior to taking up the lectureship with University of Auckland, I was employed by Murray North and partners to rewrite ETABS so that it would run on their "mini" computer. Through these two experiences I learnt the fundamentals of the analyses procedures included in the program ETABS and how it worked on different computers.

6.2. In the 1980s there were few computers in New Zealand and the most available version of ETABS would only run on a "mainframe" computer. The most available mainframes (with ETABS installed) were at the Universities of Auckland and Canterbury. At the University of Auckland Dr Ian Buckle and I were the contact staff through whom all ETABS run were made. Consequently, I was involved with the running of ETABS for many Auckland consultants. I became very conversant with the ETABS program and worked collaboratively with these consultants to develop building models that were consistent with the Codes of the day and the intended construction.

INTERPRETATION OF CLAUSES IN NZS4203:1984

My interpretation of Clause 3.4.7 of NZS4203:1984

7. This allows an equivalent static analysis for the CTV building but it recommends a modal analysis due to high eccentricity. My reading of these clauses (and my memory of interpretation) would be that the CTV would not be interpreted as "irregular" enforcing a three dimensional modal analysis. This enhanced form of analysis was encouraged by the Standard but was seldom required. My experience was that most designers undertook a modal response spectrum analysis to take advantage of the 10% reduction of base shear over that of the Equivalent Static Method. As ETABS had the capability of performing modal response spectral analysis in both two and three dimensions a three dimensional analysis was often chosen by engineering consultants.

My interpretation of Clause 3.5.2.6.1 of NZS4203:1984.

8. This clause was not always used. The reasons for this are: the clause can be used to give theoretically incorrect results, and, as the available version of ETABS (UBC) did not provide the "shear" as required by clause 3.5.2.3, in my experience, most engineers struggled to interpret that clause and calculate the appropriate "shear".

9. Clause 3.5.2.3 is suitable for use in Clauses 3.5.2.4 and 3.5.2.5. The shears as calculated per Clause 3.5.2.3 cannot be used on a theoretical basis to calculate any other response as inferred by 3.5.2.6.1. It is my recollection that the profession liked the idea of this clause (3.5.2.6.1) as it gave rise to a set of actions that were "in equilibrium", a set of numbers desirable from a design perspective. It is possible that such a set of theoretically incorrect actions would be approximately correct for low rise two dimensional structures (those that have little torsion). For three dimensional structures, the proposed procedure is unclear and open to a number of interpretations, all leading to incorrect results.

My interpretation of Clause 3.8.1.1

10. This requires that the computed deformations shall be those resulting from the application of the horizontal actions specified in section 3.4 or 3.5 multiplied by…etc. I believe in most circumstances this clause was implemented by scaling the output from an Equivalent Static analysis (section 3.4), or scaled Modal Response Spectrum analysis (section 3.5) (without the implementation of Clause 3.5.2.6.1) by K/SM. Some consultants may have used Clause 3.5.2.6.1, but I cannot recall ever discussing this approach with them.

My interpretation of Clause 3.8.1.2

11. As I stated above, I have no recollection of any consultant allowing for foundation rotation in their analyses by providing vertical soil springs. It is possible that Clause 3.8.1.2 when interpreted with Clause 3.8.1.1 was interpreted as that an analysis should not include foundation rotation.

GENERAL ETABS PROCEDURE

How would one use "Soil Springs" in ETABS analyses of the 1980's?

12. The version of ETABS available for use at the time (UBC) did not have the specific capability of including vertical springs to model soil flexibility. To provide that feature to an ETABS model, the analyst would be required to create a "dummy" floor level and mimic soil stiffness by way of adjusting column axial stiffness.

13. I would like to state that for the 50 + buildings that I would have analysed over that decade I have no memory of being asked to model the vertical flexibility of the soil by the consulting engineer. I did however sometimes model piles to allow for their rotational stiffness to be included in the building model. No vertical deformation other than what would have been calculated over a concrete pile length of depth "2D" would have resulted in their inclusion.

What was the generally accepted method of allowing for deformation of soils immediately below foundations in the mid 1980s?

14. I do not have recollection of the use of vertical soil springs. ETABS (UBC) had horizontal and rotational (about a vertical axis) springs at each level and I recall using these for basement structures and buildings cut into the side of hills.

Would an acceptably proficient structural engineer have allowed for foundation soil flexibility in the 1980s in determining design actions and then have removed the component of displacement due to deformation of foundation soils when calculating the design inter-storey drifts?

15. I have not seen this implemented. (i) The proposed process appears fraught with difficulties. The first that comes to mind, is that for most buildings the rotation(s) at each foundation would be different, so what rotation would the engineer remove? An average? The largest? (ii) The proposed process violates basic principles of mechanics and dynamics as implemented in the concepts of Earthquake Engineering.

Would TAs in major cities in New Zealand have accepted the process described in 2 above?

16. My main dealings were with the Auckland City Council. The contact engineers were Hugh McNaughton, Robert Gross and John Floyd. In my opinion the answer would be no.

Signed: ……………………………………

BARRY JOHN DAVIDSON

Date…7th August 2012