The assessment method is uncertain and varies greatly with axial action and concrete strength.

Given the greater uncertainties with analysis of the joints, and given the results that had come out of the column analyses, it was decided that limiting the analysis to columns would be sufficient for the purposes of this investigation.

CONCLUSIONS

NTHA has been used to evaluate the response of the CTV Building to ground motions recorded at nearby sites in the Christchurch CBD on 4 September 2010 Darfield Earthquake and 22 February Lyttelton Aftershock. The results are subject to considerable uncertainty due to possible variations in the ground motion at the CTV site, real building response to ground motions, various assumptions made in the analysis, concrete strengths, Spandrel Panel gaps and other variables; however the analysis has indicated the following:

1. Maximum storey drifts around 1% for the 4 September Darfield Earthquake and around 3% for the 22 February Lyttelton Aftershock.

2. A highly irregular seismic resisting structure, with drifts for the 22 February Lyttelton Aftershock at the east, south and west sides being two to three times the drifts at the north side of the building.

3. The masonry infill walls, if fully engaged in the seismic response, were seen to introduce additional plan irregularity and vertical irregularity to the system. However, at the same time they also generated additional torsional resistance in tandem with the concrete shear walls and the concrete frame. The overall effect of the masonry was generally to reduce storey drifts, which were seen as the major factor leading to column collapse. It also would have increased the torsional response of the building so that the columns on Lines 1 and F experienced the greatest level of drift in the building.

4. It has been difficult to reconcile the damage predicted by the analysis with reports of damage by others after the Darfield Earthquake. The analysis generally indicated a higher level of damage than what was reported.

5. The analysis has given insights into the relative likelihood of various failure mechanisms.

6. The primary seismic resisting system (i.e. the concrete shear walls) did not fail prior to the collapse of other parts.

7. Some of the floor diaphragm connections were predicted to fail during the 4 September Darfield Earthquake, and all of the floor diaphragm connections were predicted to fail early on during the 22 February Lyttelton Aftershock.