Presentation of the Expert Panel Report on the CTV Building Collapse

By Rob Jury – Panel Member (on behalf of the Panel)

Content

- The Panel
  - Membership
  - Role and responsibilities
  - How it functioned
- Key findings in relation to CTV
- Conclusions
- Differing views
- Recommendations

The Panel

- Appointed by the Department of Building and Housing
- Produce an overview report on the building investigations for CTV, PGC, HGC building and FB stair collapses:
  - Addressing matters relating to the investigations
  - Indicating issues for further consideration by DBH in its role as regulator

Panel Membership

- **Sherwyn Williams (Chair)** - *construction law expert*
- **Professor Nigel Priestley (Deputy Chair)** - *leading authority on the earthquake design of structures*
- **Dr Helen Anderson** - *specialist knowledge in seismology*
- **Marshall Cook** - *specialist knowledge of architectural building design for earthquake*
- **Peter Fehl** - *specialist knowledge of construction and construction industry practice*
- **Peter Millar** - *specialist knowledge of geotechnical engineering practice*
- **Professor Stefano Pampanin** - *specialist and leading authority on earthquake design of structures*
- **George Skimming** - *specialist knowledge of territorial authority roles in building procurement*
- **Dr Clark Hyland** - *specialist forensic and earthquake engineer*
- **Adam Thornton** - *specialist structural design engineer*
- **Rob Jury** - *specialist structural design engineer*

Panel Membership cont…

- The Panel activities were project managed by the Department of Building and Housing and its Project Manager Dr David Hopkins.

- Dr Hopkins was also principal editor of the Panel report.

Roles and Responsibilities

- Providing guidance and direction to assist in achieving overall objectives
- Advising on scope and extent of investigation
- Monitoring and reviewing the consultant's approaches, investigation, data and outputs.
- Recommending to DBH any changes in scope necessary to address the matters for investigation.
- Reviewing and approving consultant's report
- Overview report
- ***Was not a engineering peer review***

Process

- Met seven times between March and October 2011
- Meetings were run formally and minutes were taken
- Each meeting included a presentation from each consultant followed by discussion
- Panel members corresponded freely via email
- All Panel members given the opportunity to contribute
- Panel members given the opportunity to comment on the consultant's report

Process cont….

- Reliance on investigating consultant material
- Iterative process used to prepare Panel report.
  - Drafts were prepared with comments fed back and adjustments made and new drafts circulated.
  - Consistency, where possible, with the investigation report was the objective
- Once the findings had been agreed, the Panel met to discuss overall conclusions and recommendations
- Final Panel report approved by all Panel members

Key Findings

- Damage during the 4 September 2010 and 24 December 2010 earthquakes was unlikely to be a significant contributor to the collapse on 22 February 2011
- Earthquake shaking during the 22 February 2011 earthquake was stronger than design levels
- The columns and beam/column joints should have been detailed for ductility
- The columns did not meet minimum requirements for shear
- The centre of stiffness of designated primary seismic resisting elements was significantly eccentric to the centre of mass
- Ties between the floor diaphragms and north wall had been retrofitted after construction but only on Levels 4, 5 and 6

Key Findings cont…

- The building in its pre September 2010 condition was calculated to have achieved 40 to 50%*NBS*
- No evidence of liquefaction within the site or of significant movement of the foundations
- The following construction issues had the potential to introduce weaknesses into the building:
  - Low concrete strength in some columns
  - Non roughened construction joints
  - Poor connection of some beams to the north core on some levels
  - Non-achievement of intended structural/non-structural separations

Conclusions

- Collapse occurred because shaking caused forces and displacements in a critical column (or columns) sufficient to cause failure
- Once one column failed other columns rapidly became overloaded and failed
- Several collapse scenarios hypothesised

Conclusions cont…

- Factors that contributed (or may have contributed) included:
  - High horizontal ground motions
  - Exceptional vertical ground motions
  - Lack of detailing of columns and beam/column joints
  - High column axial stresses
  - Low concrete strengths in critical columns
  - Interaction between columns and spandrel panels
  - Separation of floor slabs from north core
  - Plan irregularity
  - Influence of masonry infill walls
  - Limited robustness and lack of redundancy

Conclusions cont…

- Factors that contributed (or may have contributed) included:
  - High horizontal ground motions
  - Exceptional vertical ground motions
  - **Lack of detailing of columns and beam/column joints**
  - High column axial stresses
  - **Low concrete strengths in critical columns**
  - **Interaction between columns and spandrel panels**
  - **Separation of floor slabs from north core**
  - **Plan irregularity**
  - **Influence of masonry infill walls**
  - **Limited robustness and lack of redundancy**

Differing Views

- The most likely initiation of the collapse
- The validity of modal response spectrum results in predicting performance during the earthquakes
- Relative importance/weighting of the identified potential contributors, particularly the influence of the spandrel panels and the timing of any separation of the floor slabs from the north core

Recommendations

- That the DBH take action to address the following:
  - Review design allowances for irregularity
  - Identification of existing buildings with non-ductile gravity columns
  - Identification of existing buildings with columns affected by part height spandrel panels
  - Design procedures for connections between floor slabs and structural walls
  - Review of measures to improve confidence in design and construction quality

Thank you