Seismic Assessment of Earthquake Damaged Heritage Buildings

In dealing with New Zealand's heritage building stock, much of which is unreinforced masonry (URM), structural engineers may find themselves in a dilemma trying to balance both life safety and heritage obligations. Engineers have an ethical responsibility to respect and respond to value judgments that society has made. Society considers it unacceptable to sustain significant loss of life in an earthquake. This is and must remain the top priority. However, society also considers that significant heritage buildings should be respected and retained when possible and appropriate.

With the heightened seismic awareness that has followed the Christchurch series of events, engineers are increasingly being asked by clients/occupiers to participate in decision making regarding continued occupancy within low seismic-resistant and earthquake prone buildings (damaged and undamaged). For engineers dealing with heritage buildings this can appear difficult, but it is necessary to address both life safety and heritage retention issues without compromising either.

Prior to the 2010 Darfield earthquake, society had defined acceptable earthquake risk through the Building Act and territorial authorities' earthquake prone building policies. The Canterbury earthquake sequence may bring about a review of the accepted minimum risk levels.

Despite any changes in acceptable risk level that may occur, the engineer's role when assessing the relative risk that the structure carries is to translate that risk to the client/occupier in terms that they and others can comprehend. This will include assessment against the current standards that society has set via regulation. However, it is the owner in conjunction with the regulator, acting on the risk and cost advice provided by the engineer, who must make the decision to occupy and, in some cases, to demolish.

Structural engineering is a wide discipline and so experience and competencies vary widely. Dependable seismic assessment and retrofit, particularly of older heritage buildings, can be extremely complex, requiring experience and skills only achieved through a number of years' practice, knowledge of national and international best practice and recently developed cost-effective technologies. Sympathetic treatment of heritage buildings and fabric can add significantly to the complexity. Engineers must be mindful of their relevant competency prior to undertaking seismic assessment, and where required, consult and rely upon best available expertise in the sector.

Engineers assessing the risks posed by heritage and other URM buildings need to consider the nature and consequences of failure that are specific to building type. Brick masonry buildings with a small number of extensive cracks may be unsafe and require demolition, but this is not necessarily the case. Sufficient consideration should be given to overall stabilisation and adequate tying to make the building sufficiently secure in the interim, so that time is available for the development of appropriate retrofit solutions to complete the final strengthening of the structure.

Significant developments have been achieved in the recent past with seismic retrofit and strengthening of existing buildings. Solutions are becoming more reliable, less invasive and economical affordable.

Reporting of building assessments and remedial solutions to owners or authorities should provide a clear assessment of the building's critical structural weakness and capacity to resist earthquake effects. A range of viable repair and/or retrofit options should be well considered, with soundly based evidence provided to support the conclusions reached. Where a building is assessed with a low apparent capacity for

seismic resistance but has obviously survived major ground shaking, the analysis and report should provide a rational explanation for the mismatch of assessment and actual performance. The converse may also be true; a strengthened URM building may have performed disappointingly such as in repeated small events. In either case, the damage mechanisms and how they relate in risk to both life safety and the retention of the heritage fabric must be explicitly identified when reporting on these structures.

The lessons from the September 2010 and February 2011 events, and in more general terms from the whole Canterbury earthquake sequence, cannot be ignored.

In summary, when assessing our heritage structures engineers should be mindful of not only life safety, which is the principal priority, but also other wider values that society may consider to be important. In some cases engineers may feel pressured by a number of stakeholders to make a speedy decision, but once the immediate life safety issues have been addressed, care should be taken to give well-considered, ethically appropriate advice.

Dr Stefano Pampanin MIPENZ (President, New Zealand Society for Earthquake Engineering Inc.)

John Hare MIPENZ (President, Structural Engineering Society New Zealand Inc.)