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A SUBMISSION TO THE

CANTERBURY EARTHQUAKES

ROYAL COMMISSION

BACKGROUND TO THE SUBMITTER

This submission is made by Rod Fulford on behalf of Precast NZ Inc.

I was engaged in structural consulting for several years in NZ and overseas before becoming engineer, manager, and eventually half owner of Stahlton, the second largest supplier of precast prestressed concrete flooring systems in NZ.

My qualifications were

BE, C Eng, MICE, MIStructE, MIPENZ, Registered Engineer.

I am currently semi retired and have let my professional qualifications lapse. I continue to fill several roles in the construction industry and elsewhere. I am currently Executive Director of Precast NZ Inc, the national body of the precast concrete industry.

I spent two weeks in Christchurch following the 22 Feb event. The second week was as local liaison to a team from Prestressed Concrete Institute (of America) and I was involved in close inspection of many damaged buildings in the CBD red zone.

My interest is as a former resident of Christchurch, a structural engineer, a representative of the precast concrete industry in NZ, and as a designer and supplier of prestressed concrete flooring systems to many of the high rise buildings constructed in NZ.

I have read the Royal Commission Interim Report, the SESOC ENG.SESOC.0002.1, the Des Bull report on Stairs and Access Ramps, the Buchanan et al Base Isolation etc ENG.ACA.0010.Final.1 as well as other reports, publications etc.

A considerable quantity of expert technical considerations have already been provided. My comments are limited to requirements for future buildings.

THE SUBMISSION

Expectations for improvements to building design must be met, and establishing the criteria for building performance should balance cost, benefits and probability. With a few exceptions, buildings constructed in accordance with modern building codes performed pretty much as expected.

The 22 Feb earthquake was estimated to be a 1 in10,000 year event and it would not be reasonable to require all future buildings to be able to survive 1 in 10,000 year events undamaged.

Improvements can be made through better detailing. Additionally, damage avoidance design concepts exist and will continue to be developed.

MULTISTOREY AND LOW RISE

Much of the research and design thinking is understandably around extending boundaries, and tends to focus on high rise buildings. Much of what has been incorporated in modern design codes is concerned with multistory ductile frame buildings. Performance of high rise buildings is vital to our society, but the majority of buildings constructed are low and medium rise. The performance of the structures of low and medium rise buildings built to modern codes has generally been as intended by the building codes and the designers.

- Requirements for high rise buildings should not be inappropriately imposed on low and medium rise buildings.

STAIRS AND RAMPS

These need more careful design consideration than they have previously been given. Their ability to function after extreme events and in an emergency is paramount.

- Stair stringer support should be designed to accommodate a much more conservative allowance of interstorey drift.

- Details should consider post construction activities. For instance stair stringers seated into recesses with an allowance for seismic movement failed because the recesses had been inadvertently filled at some later stage.

- Stair stringers are required to slide to accommodate interstorey drift. Failures were caused by compression induced by this sliding, or the sliding being restricted. Design of stair stringers should consider this compression.

SUPERVISION, CONSTRUCTION INSPECTION AND MAINTENANCE

There were instances where problems had occurred because construction details had not been completed as intended by the designer. For instance, slots in fixings that were intended to allow movement had been made inoperable by subsequent welding. That may have occurred during initial construction, or at some later date.

In previous times, clerks of works provided close inspection of details during construction.

Current practices do not require independent inspection of details during construction with sometimes disastrous results. Self regulation and lack of adequate independent inspection certainly contributed to failures.

There were instances where the bottom of stair stringers were set in to recesses in the landing and the gap to accommodate seismic movement had been filled at a later stage, possibly when floor coverings were being replaced.

- Self regulation and lack of construction inspection for major structures should be reconsidered.
- Future work by people who may not appreciate the significance of critical details is an issue that requires consideration.

PRECAST FLOORING SYSTEMS

Performance of precast flooring systems has been adversely commented on in some reports with suggestions that their use for some applications should be reconsidered or their use restricted.

There were no instances that I am aware of where collapse was initiated by failure of a precast floor system to perform. I am aware of a floor acting as a ramp failing because the detailing of the structure did not accommodate interstorey movements. This is a common issue, but it is a failure to provide suitable detailing rather than a failure of precast flooring systems.

The Clarendon Tower has been quoted as a failure of a precast floor. I was fortunate to be able to briefly inspect floors up to about level 9 where the worst damage had been reported. Beam elongation pushing out corner columns had opened up wide cracks and in some areas there was no obvious means of floor support. Despite this there was no obvious vertical displacement at the supports and no indications that failure of the floor to perform had initiated any collapse. It was unfortunate that my time in the Clarendon Tower was restricted as I feel further investigation would be useful.

Mesh in floor toppings was unable to accommodate any but minor cracks without fracturing.

My views from observations

- Mesh should not be used in floor topping where the floors are likely to be subject to seismic deformation. – That is a requirement of current codes but was not applied to many earlier buildings.

- Elongation of the structural beams reduces seating of precast flooring units. Although this did not lead to collapses, it would be prudent to consider a more conservative approach to seating lengths for structures subject to beam elongation.

- Testing has shown that precast floor systems can be detailed to cope with complete loss of support without collapse.

- Regardless of floor type, beam elongation will cause cracks to open up in the floor. A wide crack in any type of floor effectively becomes a loss of support, relying on transfer of shear forces via reinforcing. This is not restricted to floors incorporating precast units.

- Support rotation causes degradation of the seating – that is significantly reduced by use of low friction seating strips as required by current codes, and a conservative approach to seating lengths would also help.

- Changes already incorporated into NZS3101:2006 following the Matthews Test (Canterbury University 2003) – including tying back columns with no orthogonal beam, thin slabs to adjacent parallel spanning beams to accommodate deformation incompatibility would cover a number of problems observed.

- Because precast floors are used in such a high proportion of buildings, many of the problems seen in floors have been in floors incorporating precast components. A number of the issues observed used detailing that was not currently code compliant, and some would occur regardless of the type of floor used. There does not appear to be strong evidence for restricting the use of precast flooring systems, but appropriate detailing is required.

INDUSTRY INVOLVEMENT – CONSULTATION

During inspection of buildings it was obvious that some repairs carried out following the 4 September 2010 earthquake were inappropriate. For instance many cracks in suspended floor units had been epoxy injected despite the fact that they had occurred during construction and not during any of the earthquakes and were of no structural significance.

I had reports of failures of flange supports of double tee flooring systems from well qualified academics and others. In each case a close inspection showed otherwise and in each of those instances my conclusions were agreed with after discussion and further consideration.

Conclusions were drawn from initial appraisal that were clearly incorrect. Without my specialist experience these incorrect conclusions would have been reported and accepted.

My concern is that changes could be imposed based on evidence that has been misinterpreted because of the sheer scope of matters under consideration and the urgent drive for quick answers prior to reconstruction.

In the precast and prestressed concrete industry there are people with in depth knowledge and experience. Those people are willing to assist but their involvement so far has been minimal. Engineers within the industry have years of experience from dealing with all aspects of design, liaison with consultants and builders, dealing with construction issues, remedial works, testing etc. They can provide a useful balance between theory, manufacture and construction.

Following issues arising from the Matthews test at Canterbury University 2003, industry was involved in developing and testing practical details for incorporation into NZS3101:2006

- I believe there should be more industry involvement in assessment of earthquake damage.
- I believe there should be more industry involvement in developing future detail requirements.

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