ReCast Floors
Seismic Assessment and Retrofit Development of Precast Floors

Mostafa M1, Bueker F1, Parr M2, Jenkins M1, Sarkis Fernandez A2, Hogan L1, Elwood K1, Bull D3, Brooke N4, Henry R1, Sullivan T3, Liu A3
1University of Auckland, 2University of Canterbury, 3Holmes Consulting, 4Compusoft Engineering, 5BRANZ

1. Motivation

Precast floors are the dominant flooring system in New Zealand’s multi-storey buildings stock, where hollow-core floors are the most ubiquitous flooring system. Following the 2016 Kaikoura Earthquake, significant damage was observed in multiple buildings that incorporated hollow-core floors. Hollow-core flooring systems vulnerability in regions of high seismicity was reinforced, and concerns regarding the performance of these floors in future seismic events were confirmed. As a response to those concerns the ‘ReCast Floors’ research group was formed with the objectives of improving the current understanding of the seismic performance of precast floors and develop suitable tested retrofit techniques. Results of the experimental investigations undertaken by the ‘ReCast Floors’ project so far are presented herein.

3. System Level Testing

- Two full scale specimens “Big frame” tests representing part of the floor and support structure of a typical frame building (Fig. 2a,b) have been planned to take part of this project.
- The first “Big frame” test had the key objective of experimentally validating some of the commonly used hollow-core floor retrofit solutions that have already been incorporated in existing buildings and some suggested retrofit solutions from previous research (Fig. 3a).

5. Double-Tee Floors

- The collapse of precast double-tee units in Statistics House (Wellington) during the Kaikoura Earthquake in 2016 reinforced concerns about floor to support connection. These units included the “loop bar” support detail (Fig. 7), which had rising concerns due to the unacceptable tension load path the loop bars generated across the topping interface (Fig. 8).
- Experiments on “loop bar” double tees to improve our understanding of the potential seismic support spalling and the effect of delamination on the gravity capacity of the precast units.
- These tests will be conducted in conjunction with retrofit testing.
- The investigation is expected to complete midway 2021.

4. Field Investigation

- Detailed review of a case study building that was damaged during the Kaikoura earthquake is currently taking place.
- Extensive damage documentation of the entire bare structure of the case study building has been conducted.
- Severity and distribution of the damage sustained in the building was captured by utilizing some of the available technologies as shown in Fig. 5 and 6 respectively (laser scanning and structure from motion techniques).
- This investigation will allow better understanding of the observed performance of buildings with precast floors.

6. FEM and Component Level Testing

- Detailed nonlinear finite element (FE) analyses, validated against experimental data are currently taking place.
- Component testing is underway to investigate various failure modes and retrofits to address them.

7. Conclusion

Output from the ReCast floors project have direct impact on the precast concrete industry with key objectives of:
- Providing properly validated retrofit solutions for precast floors to the construction industry.
- Provide a new State-Of-The-Art precast floors retrofit design guideline.
- Provide better understanding of the seismic behavior of precast floors to inform the current precast floors assessment guidelines with the purpose of amending as necessary.

References

Acknowledgements