Leadership in Sustainable Infrastructure
Leadership en Infrastructures Durables

Case Study

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SURVIVING THE EARTHQUAKES OF NEW ZEALAND – HOW ADVANCED COMPOSITE RETROFIT TECHNIQUES PROVIDED RESILIENT INFRASTRUCTURE

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1 Background Information

1.1 Overview

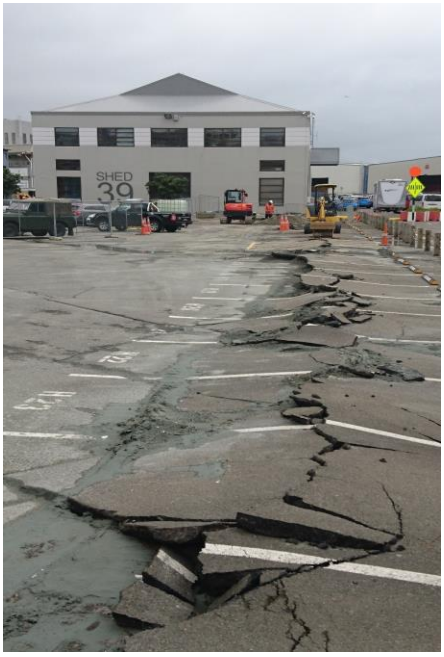
On November 14, 2016 the **M7.8 Kaikoura earthquake** hit near Wellington New Zealand and set off over 900 aftershocks. We received word that the severe ground displacements had caused damage to areas that contain structures that had been retrofitted with our advanced composite systems. Our local personnel surveyed some of the damage near an office building that was affected. The office building, Shed 39, not only survived the event, but was also fit to remain in service. An adjacent building that was only 10-years old will be demolished due to the sustained damage and several other nearby buildings were taken out of service due to safety concerns. The retrofit of the building included unique detailing that involved advanced composite anchors along with a technique to allow for movement across construction joints. We have sent our engineers to inspect several other structures in the area that were also retrofitted with our advanced composite systems and to work with the local engineers to learn from these events. This presentation will highlight the buildings and bridge structures that have been proof tested and quickly review the various design and detailing approaches that helped to create resilient structures. .

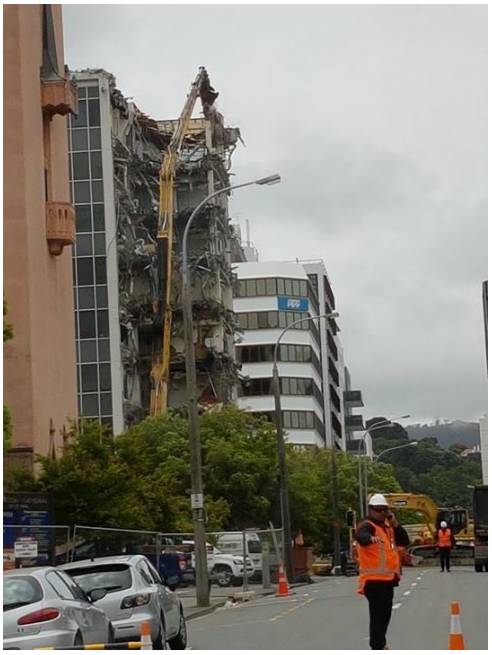
1.2 Earthquake and Project Locations

Shed 39 and several other structures are located near Wellington harbor where substantial ground motion was experienced and fault ruptures were evident after the major event.

1.3 Shed 39 and 81 Molesworth

Both of these buildings had seismic retrofits performed prior to the event. Each project utilized advanced composite strengthening with extremely unique detailing. They both required the development of tensile forces with the use of fiber anchors. These carbon fiber reinforced polymer (CFRP) anchors were designed and detailed to transfer the tension forces either into the reinforced concrete or through the concrete to provide continuity. In the case of Shed 39, we provided an alternate detail to that designed by the engineer of record that saved thousands of dollars and also performed as designed in the earthquake. In the case of 81 Molesworth, the anchors were used to properly transfer the tension forces through the beam-column connection.





2 Lessons Learned

Both of the highlighted projects proved that the innovative design and detailing would perform as designed while also showing the value of the seismic retrofit compared to the neighboring buildings that were either removed from service, pending repairs, or completely demolished. The photo below shows 81 Molesworth in the background (with the blue sign) while the neighboring building is demolished. It is worth noting that this building was in the process of getting a similar seismic retrofit designed, but it was clearly not in time