Earthquake Resistant Structures Laboratory

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Key words	Reinforced concrete structures, Steel concrete composite structures, Seismic performance evaluation, seismic retrofit

This laboratory conducts research into the reduction of damage caused to structures by earthquakes. Our principle goals are to increase the seismic resistance capacity of concrete structures (reinforced concrete structures, steel concrete composite structures) and establish methods for evaluating their seismic resistance capacity, and we are advancing our research from the approach of both experiments (static and dynamic testing) and analysis (earthquake response analysis and FEM analysis). Our research themes also branch out across a diverse range, including the development of new building structure systems, the seismic retrofitting of existing buildings, and methods for evaluating existing building's seismic resistance capacity.

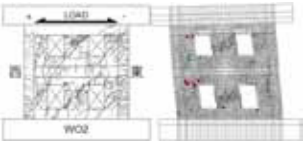
Theme 1 ▶ Development of composite concrete encased steel structural system

This research intends to develop a new structural system (CES structure), comprised of a steel frame and fiber reinforced concrete, offering excellent seismic resistance capacity. The current structural system of steel reinforced concrete is known for offering extremely good seismic resistance, but issues remain in terms of both construction and the length of time that construction takes due to the steel frame and rebar placing. In order to resolve these issues we are conducting ongoing research and development into a composite concrete encased steel structure that cuts out the rebar, with the ultimate aim of practical applications. As well as conducting parts testing in order to understand the structural capabilities of the CES structure, we also implement simulation analysis (FEM analysis), studying internal stresses that cannot be understood through just practical experiments.

Static loading test of CES beam-column joint

Theme 2 ▶ Structural performance of RC shear walls with multiple openings

This research intends to formulate a more logical structural performances evaluation method for reinforced concrete shear walls with multiple openings. Restrictions due to building plans etc. often result in shear walls having openings in them. Because those with openings display much more complex failure mechanism when compared to those with no openings, this makes them extremely hard to handle in regard to design. Therefore, in order to establish a more logical structural performances evaluation method we are implementing static loading test on RC shear walls with openings in different positions and of different sizes, investigating their structural performances. Alongside these tests we are also conducting numerical analysis, investigating the stress transfer mechanisms and numerical analysis models for RC shear walls with multiple openings.



FEM analysis of RC wall with multi openings : Crack situation (left ; experiment, right ; analysis)

Theme 3 ▶ Earthquake resistance seismic retrofitting via providing increased ductility to reinforced concrete walls using carbon fiber sheets

After the 2010 earthquake in Chile, much attention was drawn to the fact that concrete crushes due to bending and compression on multi-story shear walls without boundary columns in RC structures led to some buildings completely collapsing. Therefore, this research intends to develop a method for retrofitting these kinds of walls without columns against concrete flexural failure by using carbon fiber sheets. By conducting structural experiments on RC walls without boundary column retrofitted by being wrapped in carbon fiber sheets, we have confirmed a delay to the crush to the concrete at the bottom of the wall that occurs flexural failure, and an improvement in deformation capacity.

Static loading test of retrofitted wall using carbon fiber sheets