The 2016 IDEERS Seismic Design World Conference and Competition: A Report by New Zealand Postgraduate Team from the University of Auckland (UoA)

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2017NZSEE Conference

THE UNIVERSITY OF AUCKLAND NEW ZEALAND Te Whare Wānanga o Tāmaki Makaurau

IDEERS BACKGROUND

- Developed by the University of Bristol, Introducing and Demonstrating Earthquake Engineering Research in Schools (IDEERS) is a shaking table competition with an aim to communicate the challenge and excitement of earthquake engineering research to young people. Each participating team is required to construct a small-scale model of a building that can withstand the simulated earthquakes generated by a shaking table.
- Since 2001, this programme has attracted hundreds of Taiwanese and international students each year in Taiwan. The competition challenges students to design and build the most efficient model of a multi-storey building to withstand simulated earthquakes on a shaking table. This competition not only introduces the concept of engineering to secondary school students but it also develops and promotes interest in earthquake engineering for university students including undergraduate and postgraduate students. It has been increasingly successful since its inception, attracting more participants with each event.

IDEERS 2016

- IDEERS 2016 was supported by the British Council in Taiwan and the University of Bristol, and jointly organised by the National Applied Research Laboratories (NARL), the National Centre for Research on Earthquake Engineering (NCREE), and the National Science and Technology Centre for Disaster Reduction (NCDR) in Taiwan. The competition and conference was held in Taipei, Taiwan.
- All international participants had the opportunity to visit the 921 Earthquake Museum of Taiwan, in the geographical centre of Taiwan. This includes covering the accommodation and transport costs for the duration of the visit by the host organisers. The flight tickets and the model components costs were kindly covered by EQC and QuakeCoRE respectively.
- Total of 104 teams attended the conference/competition from all around the world. New Zealand was represented by a postgraduate team from the University of Auckland (UoA). This was mainly a QuakeCoRE-NZSEE Student Chapter activity generously funded by EQC.

IDEERS2016 POSTGRADUATE CONFERENCE AND COMPETITION

- The main objective of the postgraduate student teams' competition was to design and build an earthquake-resistant model building by applying advanced and innovative technologies, particularly seismic energy dissipaters and/or seismic base isolators. Moreover, the model building had to meet the practical issues such as space availability, feasibility, and cost-effectiveness. A conference was also held only for the postgraduate teams in which the building geometry, seismic design concepts and philosophy, validation procedure, and experimental results were presented and assessed by the IDDERS2016 judges.

NZ POSTGRADUATE TEAM'S PRESENTED MODEL

- The NZ team made the following oral presentations on their building model:

Design of a Low-Damage Seismic Resilient Building Model for IDEERS 2016.

- The University of Auckland postgraduate team based their model on the Sliding Hinge Joint (SHJ) developed by Associate Professor Clifton in 2005 at the UoA. The seismic base isolators and energy dissipators were also designed and installed on the model. The SHJ has been implemented in real-world buildings, and prevented any damage to Victoria University's Te Puni Village complex in the 2013 6.6 earthquake, which led to the demolition of several other buildings in Wellington. The performance was replicated by the NZ team in the IDEERS2016 competition, with their model building suffering no damage on the shaking table. The judges were impressed with the performance of the UoA building model, and commented that the behaviour of this joint model on the shaking table was one of the best they had seen.
- It is worth noting that the UoA team were only notified of their **acceptance into the competition six weeks before**, with their success doubly impressive due to this limited time frame, compared to the eight months preparation time of other teams. This cost them a higher place, as they had not been able to build and test their model prior to attending the competition, one of the requirements on which the marks were based. They were also incorrectly advised of the earthquake records to be used, as noted opposite.

THE SLIDING HINGE JOINT CONNECTION (SHJ)

- The Sliding Hinge Joint (SHJ) is a low-damage beam-column connection used in moment-resisting steel frames (MRSFs). In the event of a design level earthquake, sliding is expected to occur in the Asymmetric Friction Connections (AFCs) – located in the bottom web and bottom flange bolt groups as indicated by Figure 1. During sliding, energy is dissipated through friction, protecting the structure from damage.

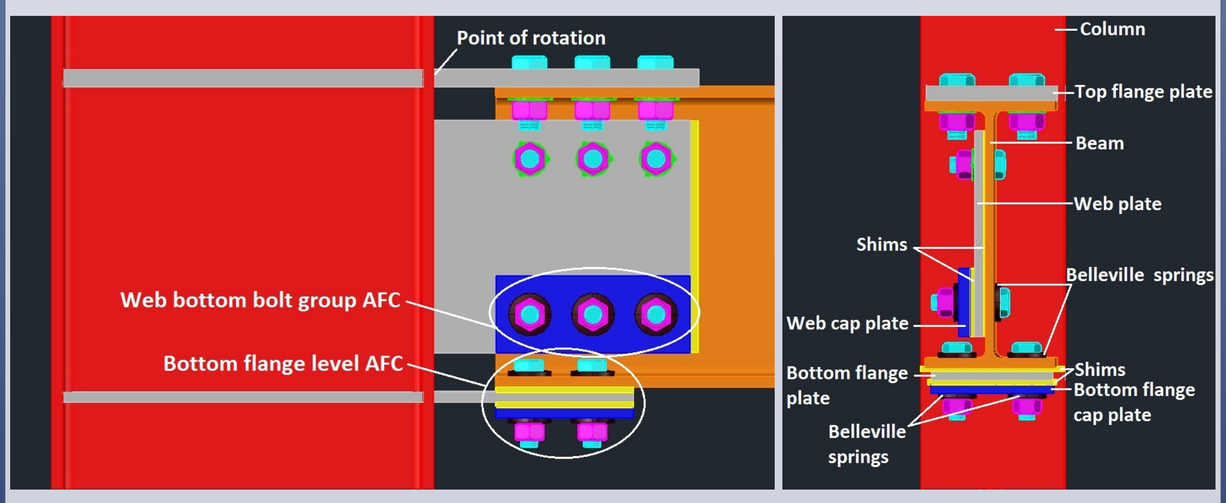


Figure 1: Sliding Hinge Joint (SHJ) with Asymmetric Friction Connections (AFCs)

SELF-CENTERING SHJ WITH RUBBER MEMBRANE

- *MDF floor diaphragm (point of rotation).*
- *Steel Square Hollow Section (SHS) beams.*
- *Rubber membrane as a replacement for the beam bottom flange AFC.*
- *Steel bolts to transfer the vertical loads to the columns.*

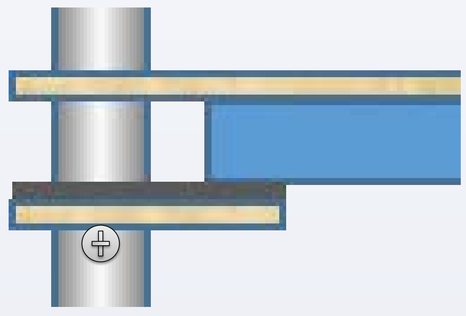


Figure 2: SCSHJ with Rubber membrane

DESIGN OBJECTIVES

- ***Floor Area, A:*** *230,000 mm² < A < 240,000 mm²*
- ***Total Height, H:*** *800 mm < H < 900 mm*
- ***Seismic Design Strength*** *of 1000 gals (PGA) based on the input ground motions provided by NCREE.*
- *Reduce peak* ***top floor acceleration*** *to 1/3 of peak ground acceleration.*

RUBBER SEISMIC ISOLATION AND FRICTION DAMPER

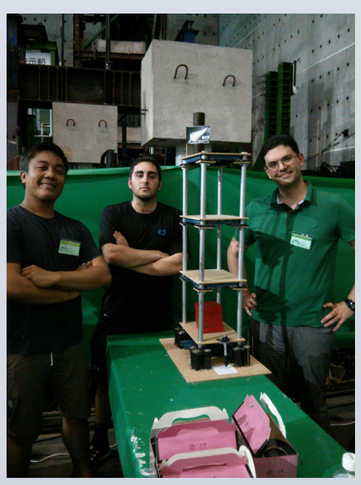
- *Four rubber bearings under each column base as seismic isolating system, and a friction energy dissipater below the ground level to reduce the acceleration, seismic induced forces, and inter-storey drifts. The friction energy dissipater was designed on the day of the shake table test as a solution to increase the damping ratio of the building not to be subjected to the resonance, given* ***the incorrect earthquake record initially given to the UoA team****.*
- *A combination of self-centering beam column connections and base isolation is used to achieve a low damage, resilient design*

Entrance to IDEERS competition at NCREE

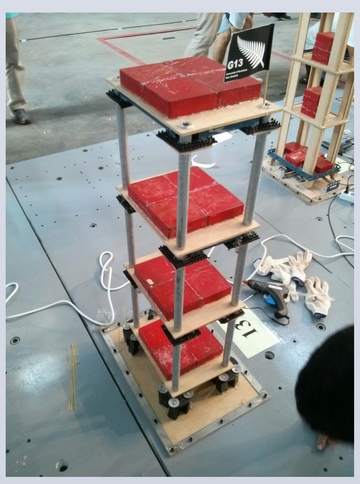
Base isolators and friction damper at the base level

IDEERS competition Area

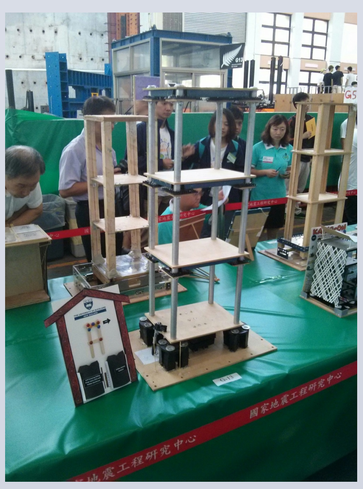
Shake table testing of postgraduate team models



University of Auckland Team with the finished structure



University of Auckland team structure loaded and attached to shake table



University of Auckland team structure at the IDEERS2016 exhibition

- *The New Zealand postgraduate team from the University of Auckland (UoA) received 5th place in the 2016 IDEERS Seismic Design World Conference and Competition held in Taipei, Taiwan.*
- *The UoA model did not fail even at the strongest level of shaking and achieved the highest score for the efficient use of occupiable space.*

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