Research Report for the ERI Visit from 01 December 2019 to 31 March 2020

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The main goal of my visit to ERI is to make a contribution to the global improvement of the performance based design of acceleration-sensitive non-structural components (NSCs) in buildings, with the special emphasis on the reinforced concrete (RC) ones. There is a need for the proper estimation of floor acceleration demands in terms of peak floor accelerations (PFAs) and floor acceleration spectra (FRS), which are in practice most commonly determined from code-defined formulas, or other appropriate direct approaches. One of such approaches, which is recognized and used in practice, was developed within my Ph.D. thesis completed in 2015. Nevertheless, it is mainly based on the theoretical results, meaning that it needs to be supported with the realistic ones as well. A visit to ERI gave me a unique opportunity to access a huge amount of data from instrumented buildings, which helped me to make an expansion of the previously obtained knowledge and findings.

In order to properly evaluate, validate and further improve the previously developed simple practice-oriented procedure for the estimation of PFAs and FRS by means of observed realistic structural and NSC responses, it is necessary to consider the available recorded data. In the first period of my stay at ERI, I participated in the shake table test of a three-storey RC building conducted at the E-Defense facility in Kobe, between 03 and 07 December 2019. The test was a part of the Tokyo Metropolitan Resilience Project (Theme II), and it was managed and supervised by Prof. Koichi KUSUNOKI. The building is also a subject of the Blind Prediction Competition organized by the KUSUNOKI Lab. The competition is coordinated by Dr. Trevor YEOW, and it is a part of the 17th World Conference on Earthquake Engineering. The results obtained during the experiment contributed to my better understanding of acceleration demands in stiff low-rise RC buildings. In particular, they confirmed several previous findings related to the influence of higher modes on the PFAs, but also revealed a completely new phenomenon related to FRS peaks. During the research, I also obtained knowledge on the steps that need to be taken in order to conduct a shake table test, got to see and participate in the overall experiment process, and learned useful techniques for processing of recorded

accelerations by using discrete and continuous wavelet transforms. The tested building is considered as a representative one in Japan, meaning that the lessons learned are beneficial for the further improvement of the global resilience-related knowledge. The second part of my stay was devoted to the study of the recorded data, which is available in the Structure Monitoring System developed by Prof. KUSUNOKI. The main idea was to select a set of representative buildings, and to use the recorded accelerations for the further expansion of the knowledge on floor acceleration demands. For the chosen buildings, the raw acceleration data was taken into account, it was filtered by using the continuous wavelet transform, and the results were analyzed in terms of PFAs and FRS. The latter were calculated by assuming 2% damping of NSCs, which covers a fairly wide range of NSCs present in today's practice. The obtained results confirmed the above mentioned phenomenon related to FRS peaks, which is a scientific novelty since, to my best knowledge, it was not reported in the literature so far. This fact is of great importance when it comes to the practical aspects of FRS generation and analysis and design of NSCs.

All results, findings and conclusions, that came from the research conducted during my stay at ERI, are currently being summarized and evaluated. The overall plan is to publish a conference paper on the application of wavelet transforms on acceleration records, as well as a journal paper on the floor acceleration demands that were observed in the considered buildings. Furthermore, during working with Prof. KUSUNOKI and his team, we realized that there is a possibility to continue and expand our collaboration in the future, and this is an opportunity I am looking forward to.

Acknowledgements

Taking a chance to come and work at ERI has been a big step and great experience for me. First of all, I wish to thank my host, Prof. Koichi KUSUNOKI, who helped me to prepare the application for the long-term visiting program, and generously supported me during my whole stay. It has been an honor to be a part of his team. I would like to thank my officemate, Dr. Trevor YEOW, for being supportive at all times. Finally, I am grateful to all the people from the ERI International Office, especially to Ms. Yuko YAMADA, for their time and efforts to make the whole visiting process easy and enjoyable.