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PROGRESS REPORT ON CASE STUDY CBD PRECINCT

Project A9: Cost-effective mitigation strategy development for building related earthquake risk

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Version	Release history	Date
1.0	Initial release of document	16/03/2020

Australian Government
Department of Industry, Science, Energy and Resources

Business Cooperative Research Centres Program

Publisher:
Bushfire and Natural Hazards CRC

March 2020

Citation: Wehner M., Ryu, H., Edwards, M. and Mohanty, I. (2020) Project A9: Cost-effective Mitigation Strategy Development for Building Related Earthquake Risk: Progress Report on Case Study CBD Precinct. Geoscience Australia. Canberra.

Cover: Christchurch after 4 September 2010 Darfield Earthquake, Geoscience Australia

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INTRODUCTION

The CRC Project A9 entitled "Cost-Effective Mitigation Strategy Development for Building Related Earthquake Risk" is seeking to address the need for an evidence base to inform decision making on the mitigation of the earthquake risk posed by vulnerable Australian buildings. It aims to develop information related to more vulnerable Australian building types in the following areas:

- retrofit strategy options for high risk buildings to reduce their vulnerability;
- the current and retrofitted performance of these buildings;
- the cost of implementing the retrogit strategies; and,
- the ability to assess the benefit of avoided societal costs through the implementation of these strategies.

This project also includes a case study to demonstrate the utility of the research with central Melbourne identified as the locality. Central Melbourne has a concentration of older unreinforced masonry buildings so the case study will examine the current risk posed by these and how they can be mitigated through application of the measures developed in this CRC project. Significantly this project will link to the concluding utilisation project on York and will integrate research outcomes on heritage value to be developed by the CRC project "Economics of Natural Hazards" led by the University of Western Australia. This progress report describes the scope, the research elements and status of these, and the process by which they are being integrated into the final research outcomes. It also provides background to a requested variation to delay the final deliverable and associated CRC payment to enable other research outputs to be integrated.

This report corresponds with the 30 September 2019 project milestone deliverable "Progress Report on Case Study CBSD Precinct", BNHCRC reference 3.1.2.

SCOPE

In this case study that is centered on the Melbourne central business district (CBD) three scenario earthquake events will be simulated. The magnitude and depth of the events will be selected to generate three target severities of bedrock shaking with associated likelihoods. The effects of overlying soil on the severity of shaking will also be incorporated onto the ground motion.

For each scenario event the following impacts will be simulated:

- Building damage
- Residential contents losses
- Casualties
- Rental losses
- Business disruption losses
- Health care costs

The losses will also be adjusted to take into consideration the access limitations imposed by cardoning.

For risk reduction action, the vulnerability changes effected by the retrofit of unreinforced masonry (URM), as developed through Project A9 research on URM buildings and in an aligned NDRP funded project in WA, will be virtually applied to the CBD to assess the reduced impact, emergency management consequences and long term risk associated with earthquake hazard.

Finally, the non-market values assessed through the BNHCRC project "Economics of Disasters" on the heritage value communities place of older buildings will be incorporated.

KEY RESEARCH ELEMENT

The key research elements of these case studies populate the impact and risk framework presented in Figure 1. How each of these elements will be developed for this case study is described below.

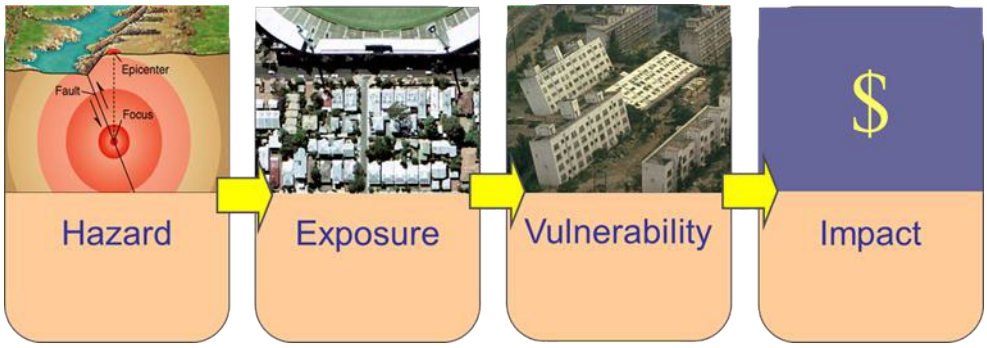

Figure 1: Impact and risk assessment framework in which an understanding of hazard, the elements of value and the susceptibility of these to hazard is combined analytically to model impact and long term risk from a natural hazard.

HAZARD

In 2018, Geoscience Australia, together with contributors from the wider Australian seismology community, produced an updated National Seismic Hazard Assessment (NSHA 18). The NSHA18 update leverages advances in earthquake-hazard science in Australia and analogue tectonic regions over the last three decades (Ref 1). Figure 2 presents the bedrock hazard for Australia developed as part of NSHA18 in terms of peak ground acceleration. NSHA18 represents the best understanding of bedrock hazard available. This bedrock hazard will be used for the scenario and risk work of the Melbourne Case Study.

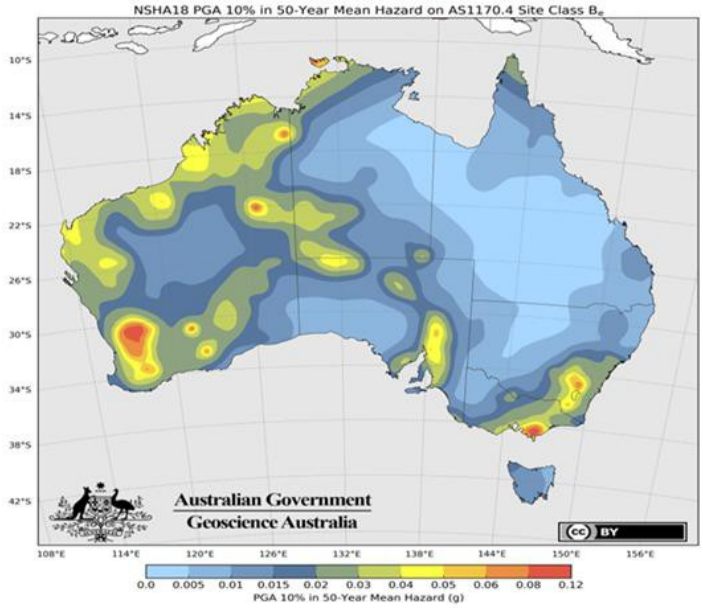

Figure 2: Australian bedrock hazard expressed In terms of the peak ground acceleration (PGA) having a 1/500 chance of being exceeded in a given year.

The ground-motion hazard in NSHA18 is calculated for an engineering rock site class, equivalent to a Soil Class Be (at VS30=760 m/s) as described in the earthquake loadings standard AS1170.4 (Ref 2). McPherson (Ref 3) has mapped surface geology to the NEHRP soil classes that can be related to those in the standard, enabling the effects of soil amplification of earthquake shaking to be included. For this case study the latest mapping of NEHRP classes by McPherson will be used. The national soil class is presented in Figure 3.

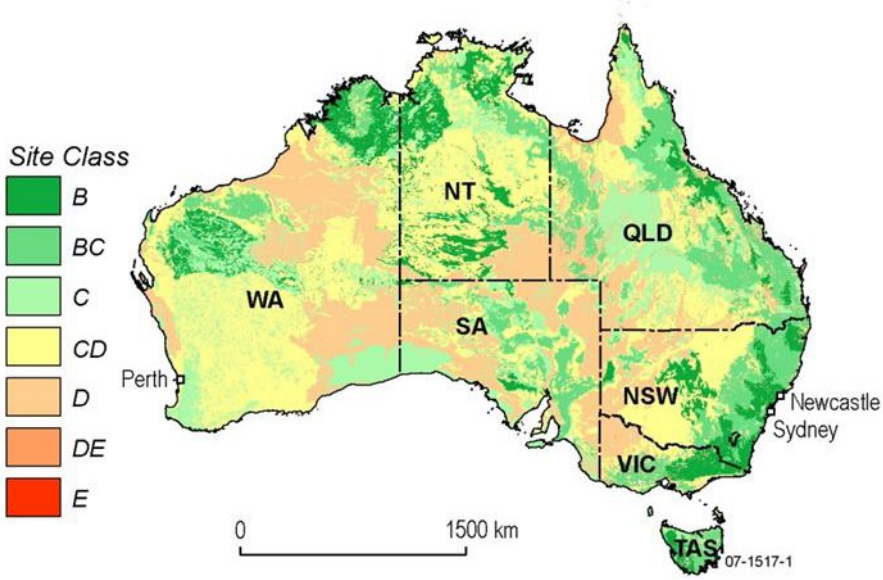

Figure 3: Australian NEHRP classes as assessed by McPherson (Ref 3)

EXPOSURE

The definition of the buildings and people will be based on an augmentation of the National Exposure Information System (NEXIS) (Ref 4). It will be augmented with business data from the CLUE survey conducted by the City of Melbourne (Ref. 5) and with detailed CBD building survey data captured by GA through its collaboration with the Australian Reinsurance Pool Corporation. The building level survey of the latter will enable the unreinforced masonry (URM) building types in the city for be identified, for the current vulnerability to be mapped and for the benefits of retrofit to be accurately attributed. Figure 4 shows the extent of the building survey in the Melbourne CBD area which has recently been updated. Further, the survey has been extended in December into the Southbank precinct as shown in Figure 5. Both survey data sets will be utilized with the area of retrofit limited to these precincts but the impact assessed for the greater central Melbourne region.

Figure 4: Buildings surveys in the Melbourne central business district with the capture of engineering parameters to enable mapping of earthquake vulnerability.

Figure 5: Buildings surveys in the Southbank business district survey with the capture of engineering parameters to enable mapping of earthquake vulnerability.

VULNERABILITY

The vulnerability of the URM buildings will be based on the research of this project (Ref 6). The mitigated vulnerability of these buildings will also be based on the utilisation project (Ref 7) and the outcomes of the recently commenced NDRP project in York, WA. The latter has been a successor to the concluded BNHCRC utilisation project.

INTEGRATION OF THE RISK ELEMENTS

The elements of hazard, exposure and vulnerability will be integrated using the software OpenQuake. This software is a seismic hazard and risk modeling software developed by the Global Earthquake Model Foundation (Ref 8). The software has been developed within a rigorous, test-driven framework and is designed to be both modular and flexible. Because of the open-source nature, users have access to peer-reviewed methods and models soon after their release and can also contribute back to the project with their own enhancements. The software is now the tool that underpins earthquake hazard and risk research at Geoscience Australia.

CORDONING MODEL

The direct costs of earthquakes are greater than just building and contents damage. Earthquake events disrupt economic activity due to direct damage to business premises rendering them unusable. They also potentially disrupt business activity after an event through restricted access to otherwise usable premises due to cordoning. Emergency managers in the aftermath of an earthquake may close streets due to the presence of rubble obstructing pedestrian traffic, the potential threat of falling masonry or glass, the threat of a taller damaged building falling on a lower less damaged one or damage to utility lifelines posing a threat. The nature of this access restriction is illustrated in Figure 6. The capture of this behaviour and its effect on the economic losses following an earthquake will form part of Melbourne CBD case study.

Figure 6: Initial central business district (CBD) building damage severity illustrated in the case of the Perth CBD. Damage severity to individual buildings is indicated as green (minor), yellow (major) and red (collapse) dots.

PROJECT LINKAGES

The key project linkage will be with the BNHCRC UWA project and the use of the "Value Tool of Natural Hazards" intangible values. Significantly it will draw on new CRC research by the UWA as part of their ongoing CRC research to assess the value that residents place on the heritage buildings in their community. Project A9 will contribute to the UWA by drawing on the utilisation project in York, WA, "Earthquake Mitigation of WA Regional Towns: York Case Study" to provide a scenario backdrop to key questions in the proposed survey instrument.

The second project linkage will be with the NDRP project that is building on the outcomes of the Project A9 York utilisation project to develop vulnerability and mitigation effectiveness information for three additional building types. The first additional types will be a four storey load bearing masonry building common in the Melbourne CBD. The outcomes for this building type will be used in the Melbourne Case Study.

FUTURE WORK

Future work will include:

- Augmentation of an exposure database for central Melbourne
- Assisting UWA with their research on heritage value
- Integrating the UWA outcomes and those of the NDRP project to assess the impacts of three earthquake scenarios impacts on central Melbourne with the present building stock
- Reassessing this impact of the scenarios after the implementation of earthquake retrofit of vulnerable URM building stock
- Assessing the long-term risk of earthquake in central Melbourne for the current building stock
- Assessing the long-term risk of earthquake in central Melbourne for the building stock after retrofit
- Reporting of the outcomes

SUMMARY

This progress report describes the scope, the research elements, the status of these, and the process by which they are being integrated into a CBD precinct case study on central Melbourne. It provides the background to the request to the BNHCRC for a change to milestone delivery dates and invoicing that will enable the outcomes of two other projects to be used for the study. Significantly, one of these is the BNCRC project "Economics of Natural Disasters" that is, in part, examining intangible values and which will be drawing on the York utilisation project to assess the value placed on heritage structures (completion May 2020). All work will be completed within the BNHCRC Project A9 funding and by the conclusion of project in December 2020.

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