Australian Government
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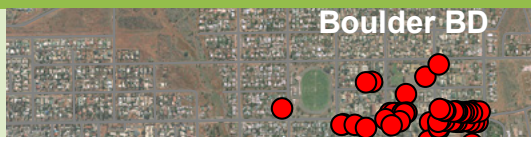
Survey of Kalgoorlie earthquake damage

Assessing the vulnerability of older buildings



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Australia has a low seismicity (or rate of occurrence of earthquakes) when compared to countries located along tectonic plate boundaries such as New Zealand or Indonesia. Seismic risk, however, is the combination of hazard, community exposure and infrastructure vulnerability. Older unreinforced masonry buildings are a particular subset of the built environment which may contribute disproportionately to community risk. Documented information on the damage to buildings caused by earthquake events is fundamental to understanding this risk.

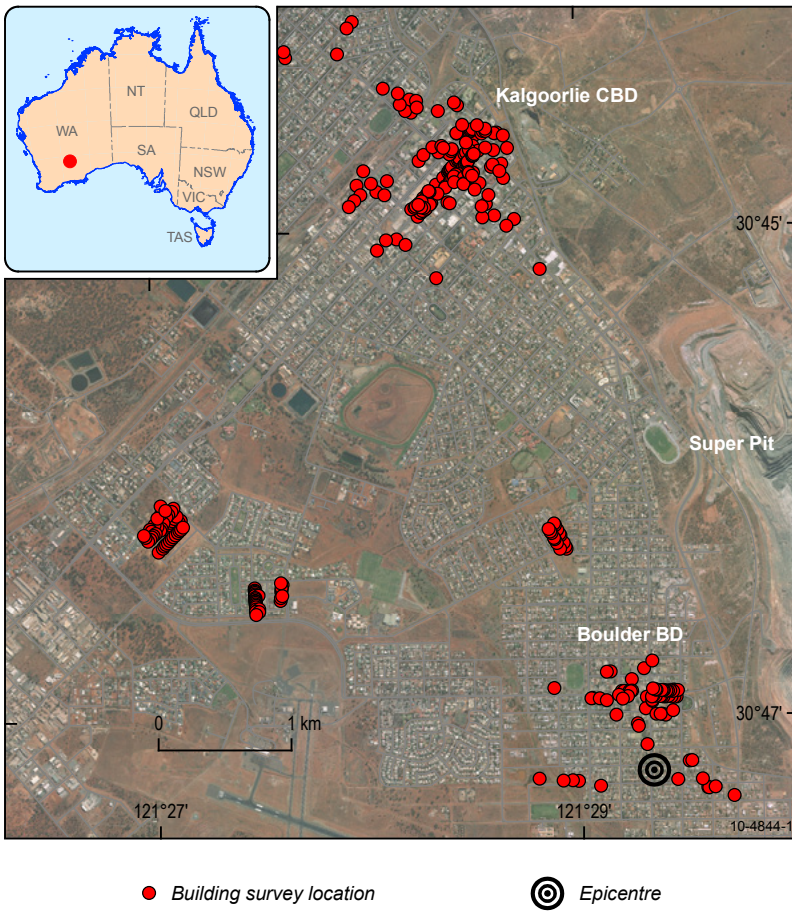

Figure 1. View of Kalgoorlie showing the epicentre of the 20 April 2010 earthquake and the location of the buildings surveyed between 18 and 22 May 2010. The 'Super Pit' open cut mine workings which are over 500 metres deep are visible to the right of the aerial view.

The earthquake

On the 20 April 2010 a magnitude 5.0 (M_L) earthquake shook the Western Australian goldfields town of Kalgoorlie. The earthquake was shallow (1.7 kilometres) and was located immediately south of the business district of the Kalgoorlie suburb of Boulder (figure 1). The severity of ground motion was found to vary markedly across the town with the older masonry building stock in Boulder experiencing a greater intensity of shaking than the corresponding building stock in the Kalgoorlie business district four kilometres away. The event has provided the best opportunity to examine the earthquake vulnerability of Australian buildings since the Newcastle Earthquake of 28 December 1989 more than twenty years ago.

Conducting the survey

Following the earthquake Geoscience Australia arranged a staged collaborative survey to capture information which would contribute to our knowledge of earthquake vulnerability. The initial reconnaissance team of two specialists from Geoscience Australia captured street-view imagery of 12 000 buildings

within Kalgoorlie between 28 April and 1 May. The team used a vehicle-mounted camera array developed by Geoscience Australia known as the Rapid Inventory Collection System (RICS). In total 230 000 geo-referenced high resolution images were captured within the urban area. This work was complemented by a detailed field survey which was conducted on foot between 18 and 22 May. Survey information was recorded using hand-held mini-computers which allowed the team of nine engineers and geographic information system (GIS) specialists to capture data about the damage caused. The team included two earthquake engineering researchers from the University of Adelaide and the University of Melbourne respectively. Over 400 buildings in four age categories were surveyed and assessments were made of the felt intensity in those locations. The survey locations are also shown in Figure 1.

Figure 2. Damage caused to a hotel in Boulder. The damage is typical for two storey unreinforced masonry buildings with toppling of parapets either outwards into the street or inwards through the roof. This building also sustained other types of damage such as cracking over doors and windows and substantial cracking to internal masonry walls.

"Preliminary findings from this work have shown that older masonry buildings are particularly vulnerable to the nature of the ground motion experienced in the Kalgoorlie event."

The findings

The field team found that the severity of shaking in the Boulder business district was approximately 6 on the Modified Mercalli scale. This level of shaking caused widespread damage to unreinforced masonry buildings built before World War One. The loss of chimneys, gables and parapets was widespread as well as extensive cracking of walls (figure 2). The timing of the event at 8:17am was fortunate as falling masonry would have landed on school children walking through the area if the earthquake had occurred just 15 minutes later. Only a few minor injuries resulted. More modern masonry residential buildings also experienced some damage. The severity of shaking beneath the Kalgoorlie business district was approximately 5 on the Modified Mercalli scale causing only slight damage to older masonry buildings. Preliminary findings from this work have shown that older masonry buildings are particularly vulnerable to the nature of the ground motion experienced in the Kalgoorlie event. Furthermore, more contemporary cavity brick construction was found to experience greater damage than equivalent wooden-framed construction, though damage was light.

Further analysis will incorporate information gleaned from seismic recordings of aftershocks that were obtained by Geoscience Australia over a period of 47 days following the earthquake. The work will also include estimates of the repair costs derived from the survey data that can be linked to the predicted shaking. The objective will be to derive the greatest benefit from the survey effort to inform future assessments of earthquake risk and mitigation.

For more information

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