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Whilst preservation remains at the core of what we do, we are at the intersection of materials-based conservation and values-based approaches.

At the 2018 NZCCM Conference in Auckland, we welcome discussion on current conservation practices and the challenges we face. This is an opportunity to share and hear about treatment methodologies, advances in the use and research of materials, solutions for display and storage, and ways in which the context of an artwork or object has informed decision making.

This article is a preprint of a presentation given at the NZCCM 2018 Conference "Living Heritage: Materials, Methods and Context", held at Auckland Art Gallery Toi o Tāmaki on October 24 - 26, 2018. Preprints from the conference were welcomed from all speakers, who included both full NZCCM members and affiliated professionals. Articles were not peer-reviewed; views presented are the authors' own and do not represent NZCCM or its members. Authors are responsible for the accuracy of and permissions required for the content of their articles, and retain copyright to their written ideas and photographs.

AFTER QUAKES: ALEXANDER TURNBULL LIBRARY TWO YEARS AFTER THE KAIKOURA EARTHQUAKE

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The National Library NZ Wellington building, that also houses the Alexander Turnbull Library, came through the 2016 Kaikoura earthquake very well. The magnitude 7.8 earthquake struck around midnight so the building posed no immediate danger to library staff. No library staff entered the building until authorised by structural engineers. At first assessment the recovery teams found that collections had fared well. Furniture and fittings in collection stores also appeared largely intact although there were pockets of disruption or damage.

The initial response proceeded; managers planned and communicated, there were safety briefings, collection care teams commenced setting collection stores to rights. A building close by was re-inspected and thought to be in danger of collapsing; the National Library building was placed within the hastily erected safety cordon. A week later this cordon was relaxed and staff returned to the National Library building. Storage spaces remained off limits due to safety concerns and expert advice was sought. Only a few weeks later the library building was re-opened to the public but it was three months before all collections were accessible again. This was due to questions relating to the seismic resilience of shelving and other fittings in another major seismic event.

Many other pertinent questions will be discussed in this paper: What lessons had been taken on board following the Canterbury earthquakes and the Seddon earthquake? How did seismic mitigation work fare once business as usual resumed? What was learnt from the Library building's specific situation? How were decisions made? What were the priorities? What actions have been taken? What actions are still to be taken?

In the months and years that have followed the earthquake the library has been on a journey navigating, prioritising and acting on decisions. A huge amount of time, energy and learning has gone completing seismic interventions in the collection stores of the Alexander Turnbull Library. We would like to share this information in the hope that it will be helpful to others working in the Galleries, Libraries, Archives and Museums (GLAM) sector.

KEYWORDS: *heritage collections; preventive conservation; earthquake preparedness; seismic restraints; seismic resilience; disaster recovery; Kaikoura earthquake; collection furniture; mobile shelving*

1. INTRODUCTION

The Alexander Turnbull Library (ATL) is New Zealand's preeminent research library. ATL is embedded in the organisational structure of the National Library of New Zealand Te Puna Mātauranga o Aotearoa (NLNZ). Both libraries will therefore be referred to as 'the Library' except when it is necessary to distinguish between their collections. The NLNZ collections and the ATL heritage collections are housed in a purpose-built facility in New Zealand's capital city, Wellington. Situated at the bottom of the North Island, Wellington is dissected by several large and active fault lines and has long prepared for a catastrophic seismic event.

This paper will follow the Library through several major seismic events, beginning with the 2010 Canterbury earthquake. Seismic protection measures that have been (or are about to be) undertaken in the collection stores since the 2016 Kaikoura earthquakes will be covered in more depth. The focus will be on collection storage furniture as well as observations relating to the recovery of the collections following the seismic event.

The earthquake preparedness measures undertaken by the Library prior to the Kaikoura earthquake provided effective protection to almost all collection items. The focus of this paper however is on what the Library learnt about improving seismic resilience following this event. In order to explore this theme the areas where issues occurred and changes were required to enhance collection protection will take precedence over the successes.

2. THE EARTHQUAKES

2.1. *"FAULT AWAKENS AFTER 16,000 YEARS OF INACTIVITY"*

Just after 4.30am on 4th September 2010 the Canterbury region in the South Island of New Zealand experienced a magnitude 7.1 earthquake. The rupture of a previously undetected fault-line caused injuries, widespread damage to buildings and infrastructure and large areas of liquefaction (Gorman 2010). Strict building codes, and the fact that most people were at home when the earthquake occurred, prevented large numbers of fatalities. Frequent aftershocks were felt in the following months (GNS Te Pū Ao, n.d., Wikipedia 2018a).

The National Library's Wellington building was undergoing a major refurbishment at that time so it was essential that knowledge gained from the Canterbury earthquakes was explored and implemented in the building improvements. The Library undertook a variety of projects to protect both staff and heritage collections from seismic events. An investigation was commissioned into the performance of the Library's shelving systems during and immediately after the 2010 earthquake. While the resulting report, National Library Shelving Investigation, indicated that the shelving had performed very well, it also recommended installing more bracing and other design components to improve seismic resilience (Department of Internal Affairs 2010).

2.2. *"WE JUST KNEW PEOPLE WOULD'VE DIED"* (Meek 2018, pers. comm.)

Around lunchtime on 22nd February 2011 a magnitude 6.3 aftershock struck the Canterbury region (fig. 1). The earthquake was shallow and centred only 10km from the city of Christchurch. There was widespread destruction in Christchurch, 185 people lost their lives and thousands were injured (Ministry for Culture and Heritage 2017).

FIG. 1: "Gillian Needham took this iconic photo from her home in Cashmere minutes after the 22 February 2011 earthquake struck Christchurch. It shows the city's central business district (CBD) enveloped in a cloud of dust. A number of contributors to Quake Stories who were in the CBD at the time of the earthquake saw the dust cloud and knew that it meant buildings would be down …" (Ministry for Culture and Heritage 2016, image courtesy Gillian Needham).

Looking on from Wellington the response was, 'how can we help?' But Canterbury was living day by day; many people were dealing with the loss of loved ones, homes and/or jobs. Access to basics such as shelter, water and food were paramount. Local infrastructure was severely impacted or uncertain, many suburbs had no running water and power was cut off. Roads were often hazardous or impassable and buses were not running. Schools and many other institutions and businesses were closed until further notice. Numerous large aftershocks rocked the region and kept people on edge or in shock for many months. Hospitalisations for heart attacks and for other cardiovascular-related diseases soared (Healthier Lives 2017).

In retrospect, if the Library had requested a shelving investigation similar to that carried out in 2010 after the 2011 earthquake, the answers may have been different and less reassuring. The deaths and devastation caused by the Christchurch earthquake and numerous aftershocks forced a re-think of the effect of major aftershocks on buildings and fittings. The fatigue caused to buildings by repeated seismic events became more widely known, and the huge variation between each earthquake and the resulting damage made further checks and analysis after each major seismic event essential.

Upon completion of the Library refurbishment in 2012 many new collection storage systems came into use. Library conservators had many discussions with Christchurch conservators on their successes and misses protecting collections from the earthquakes in Canterbury. Acting on advice from engineers a belt-and-brace restraint system for the rolled storage items was subsequently installed by the Library's conservators (fig. 2). This restraint consisted of Velcro that has been firmly attached to the racking system. The Velcro secures the bar that supports the rolled items onto the upright racking components.

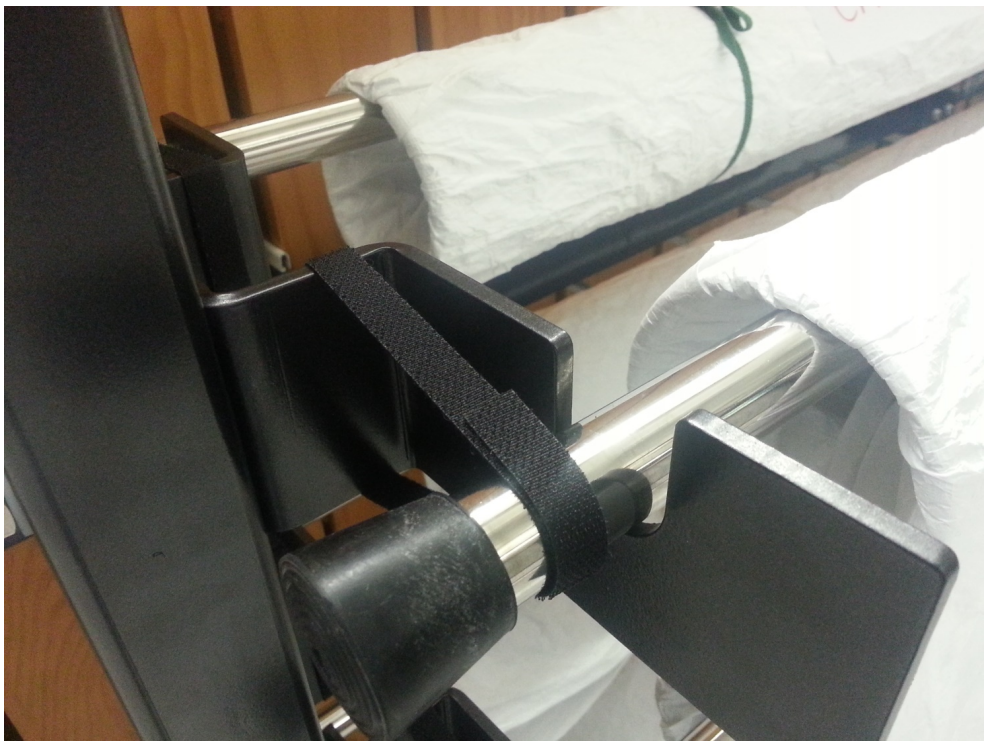

FIG. 2: The seismic restraint belt-and-brace system for rolled items was deceptively simple in appearance but it was strong, easy to install and ensured ease of access (courtesy Margaret Morris).

2.3. *THE EARTHQUAKE DOUBLET*

During the evening of 21st July 2013 the Seddon earthquake, magnitude 6.5, struck between the North and South Islands of New Zealand, in Cook Strait. Less than a month later, on 16th August, another earthquake, near the size of the first, occurred nearby at Lake Grassmere (Wikipedia 2018c). The earthquakes are considered a doublet due to their close proximity in time, location and intensity (Amos 2017). Numerous aftershocks inevitably followed both seismic events. There were some injuries and damage resulted on both sides of Cook Strait, with areas in the South being worst affected.

The Library's Wellington building was shaken violently but there was very little damage caused to the collections. Within the Library, collection storage cabinets, installed during the refurbishment, had been braced to the floor and to each other. This bracing significantly inhibited the movement of the cabinets and while some of the drawers opened the units remained upright. A small amount of damage was done to a painting frame when the plastic cleat on one side failed. Following discussions the older system of plastic cleats and S-hooks was replaced by stainless steel brackets and D-rings (fig. 3).

Following the earthquakes, collection care staff identified storage furniture with low-earthquake resilience. Furniture above 1.2 metres in height was braced and fixed to the building. New cabinets were designed that incorporated seismic safety features and all new furniture was braced as soon as it was installed. 170,000 glass negatives were repacked in their drawers to close gaps and prevent movement within the drawers (fig. 4 & 5). Rigid 'spacer' cards were added to enhance cushioning and support; the spacers could be removed to allow easy access to the items.

In the pre-earthquake mind-set accessing funding for improvements was challenging; after the earthquakes these projects were of primary importance with funds allocated accordingly.

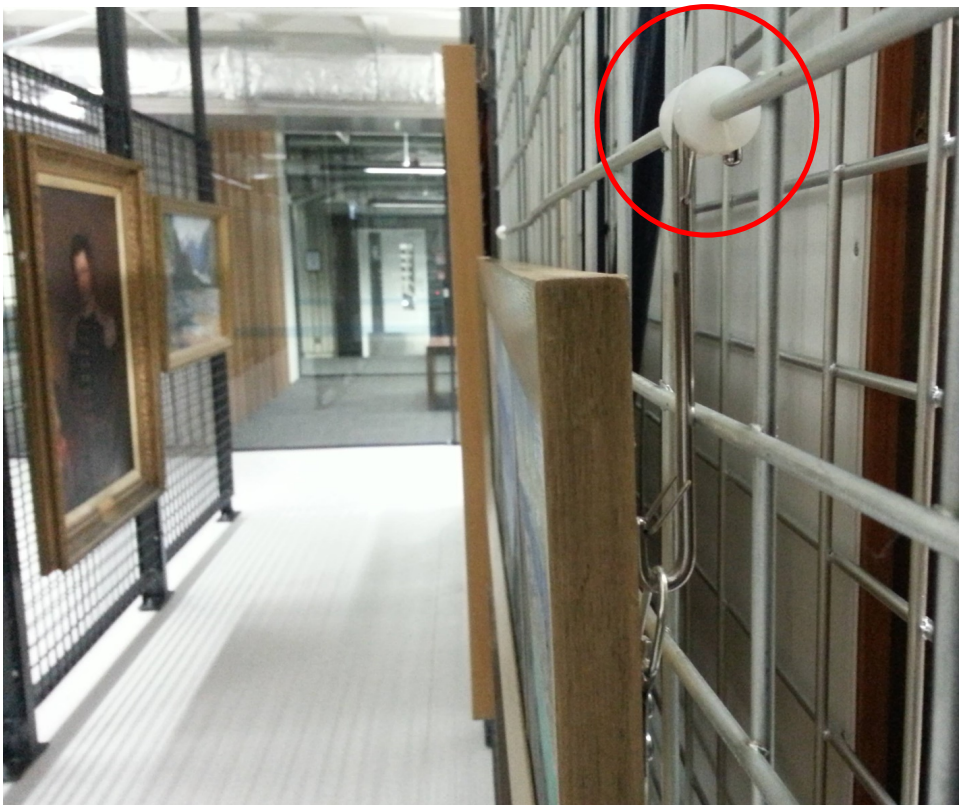

FIG. 3: The silicon bumper (circled) on each hanging hook significantly limits movement of the hook which protects the framed items from excessive movement during seismic activity (courtesy Margaret Morris).

FIG 4 (left): Before closing gaps and packing out drawers containing glass plate negatives.

FIG 5 (right): After the completion of the project; rigid 'spacer' cards were also added when items were removed to close the gap and support adjacent glass plates.

3. THE KAIKOURA EARTHQUAKE

3.1. *"MOST COMPLEX QUAKE EVER STUDIED"*

Just past midnight, in the early hours of 14th November 2016 the Wellington Region was shaken awake by a major earthquake. The magnitude 7.8 earthquake was centred 60km southwest of Kaikoura, a tourist town south of Cook Strait, on the east coast of New Zealand's South Island. The seismic activity lasted around two minutes and, largely because it ruptured over 20 faults, has been described as the "most complex earthquake ever studied" (Amos 2017). Two people were killed and nearly 60 others required treatment for injuries. The destruction of road and rail cut the main land links to the town of Kaikoura. The earthquake trigged a tsunami of up seven metres high and uplifted swathes of coastline by up to six metres. The ruptured faults released much of their energy far north of the earthquake epicentre, impacting Wellington city (Wikipedia 2018b).

3.2. *THE LIBRARY'S FIRST RESPONDERS*

Immediately after the earthquake the Library's Duty Disaster Manager (DDM) contacted on-site security. Until the situation had stabilised somewhat there was little she could do; she activated the Disaster Response call tree and got as much rest as she could. Authorised building access was gained the morning following the earthquake and first responders assembled at the Library. The central city was eerily quiet, as the general public had been advised to stay home.

First response staff for the Library included DIA Property, the Library leadership team, the DDM and other senior collection care staff. An inspection tour was undertaken to establish if there were any immediate threats to the collections, such as burst water pipes. No imminent threats were found but it was clear that all the collections had moved during the earthquake. In some areas cordons were put in place, for example where the drawers on a row of cabinets had opened causing the cabinets to topple into the aisle. During the 2013 Seddon earthquake the bracing on these cabinets had performed well (no cabinets toppled), however the drawers on many of them opened. During the larger Kaikoura earthquake the weight of the drawers opening caused the bracing to fail and the cabinets toppled (fig. 6).

Seismic restraints fitted to the rolled storage units and the open painting racks proved their worth. The store housing these collections was situated near the top of the building and endured some of the most violent shaking. The paintings with the new restraints fitted were not damaged (minor damage occurred to a few fragile painting frames in the closed racks). No rolled item was dislodged or damaged.

During early inspections of collection stores collection response staff and DIA Property noted that the shelving had moved enough to cause concern it was compromised and could be vulnerable to failure in future seismic events. Bracing on one range of shelving had partially

failed allowing it to move laterally and it was discovered that the shelving did not have cross bracing (fig. 7). It became imperative to find conclusive answers to what had happened to the shelving during the earthquake and why.

FIG. 6: Fallen two-part microfilm cabinets blocking the aisle and cordoned off (courtesy Margaret Morris).

FIG. 7: The partially failed range in a level 2 store was out of alignment with adjacent ranges. The engineers recommended the installation of cross bracing to improve seismic resilience (courtesy Laura Mirebeau).

3.3. *"KEEP AWAY, THAT BUILDING IS GOING TO COME DOWN"* (Willams, Flahive and Small 2016)

Initial inspections indicated the effect of the earthquake on the collections themselves was relatively minor. The DDM called up collection care staff, a group of around 10 people, rather than the much larger group of disaster response volunteers. As the DDM drove into the city again she saw ground water, released by the earthquake, pouring off the hills towering over Ngauranga Gorge. She wondered if she would be able to get home later that day.

At the Library collection care staff split into teams, logged their intended locations and set off to work in the collection stores. The building interior was quiet, lifts were not working and teams were business-like but sombre. Within a short period another large aftershock hit but work was able to continue. Teams were reassured to see that the collections had come through the seismic events very well. They documented the situation in the stores and recovered items from the floor. That afternoon, driving home up Molesworth Street, responders noticed small groups of people in high-visibility vests looking up at the nine-story building at number 61.

That same evening Molesworth Street was declared unsafe, access to the Library building was lost again and the 'second wave' of collection responders were stood down (fig. 8). The first responders worked hard to manage the new scenario. It was unlikely that 61 Molesworth Street would fall directly onto the Library building however a basement connected to the Library extends up Molesworth Street to number 61. The basement area directly under the Library building houses ATL collections and the much larger, adjacent basement houses NLNZ collections. The main fear was that the collapse of the building at number 61 would cause a 'dust bomb' that could breach the space between the two basements and affect the ATL heritage collections. The two basements were isolated from each other by sandbagging the fire doors linking them. All penetrations between the basements were closed and taped up to create a dust barrier. This work could only be carried out from the ATL basement as the adjacent basement was within the safety cordon for the unsafe building.

Some days later the large safety cordon surrounding 61 Molesworth Street was relaxed, an in-depth survey of the earthquake damage had found that the building was not in imminent danger of collapse (although it was later demolished). Just over a week after the cordon had gone into place collection response teams were able to recommence work in the collection stores.

FIG. 8: View from National Library building (70 Molesworth Street), showing the southern end of the safety cordon on Molesworth Street due to the unsafe building at number 61 (courtesy Mark Strange).

4. COLLECTION SHELVING AND FITTINGS

4.1. *INVESTIGATING SHELVING*

The Library's leadership commissioned an engineering report to investigate key questions formulated by DIA Property and collection care. Until these questions were answered the Library closed access to the collection stores to ensure staff safety. An engineering team toured the collection stores, noted collection care's observations and engaged with the shelving manufacturer. Their resulting report, National Library Shelving Investigation 2017, calculated the acceleration of the earthquake up through the Library building, assessed the design of the shelving systems and laid out the likely building and shelving behaviours during the earthquake.

The engineers stated that the Library building was well within its design tolerance for seismic load.

> "Based on near-by monitoring stations the shaking experienced at the National Library is estimated to be between 30 and 50% of the load level that a new Importance Level 3 building would be designed to. The National Library is considered an Importance Level 3 building due to containing contents of high value to the community" (Holmes Consulting 2017, 1).

The engineer's report also noted that the minor buckling of a shelving range on level 2 of the Library building was only one unit out of 800 similar units (Holmes Consulting 2017, 6).

Ultimately the engineers provided recommendations that would improve the earthquake resilience of the Library's collection furniture. This information assisted the Library's leadership and collection care in improving the safety of staff working within collection stores. It is important to understand, however, that engineers' reports in general will not definitively state that a risk is acceptable. Engineers will simply state the risk and provide information on assessing and/or mitigating it. The final decisions and actions taken are the prerogative and responsibility of the group who commissioned the report.

4.2. *ANTI-TILT MOBILE SHELVING*

During the 2010-2012 National Library refurbishment new shelving was installed on the middle levels of the Wellington building. This new shelving had anti-tilt railing, meaning that the mechanisms allowing the ranges to move were essentially enclosed by the floor tracking. This made the shelving less able to pull away from the tracking and topple in a seismic event. However, large blocks of 1980s shelving were identified in the basement. This older shelving was not anchored to the floor tracking but was simply held on the tracking by its own, considerable weight. Collection care staff made maps of the basement stores to identify and cordon off areas of shelving that did not incorporate anti-tilt railing.

The National Library Shelving Investigation 2017 showed that earthquake energy accelerates as it travels further up the building. While it was accepted that there were some risks to staff working in the unsecured ranges the hazards were reduced because of the basement location. Additionally, ranges that bordered egress routes were strapped closed to stop them toppling in an earthquake and preventing staff exiting the basement. This measure is currently open-ended while the Library seeks further information regarding the extent of these risks.

4.3. *MOBILE SHELVING LOCKING MECHANISMS*

The new shelving ranges installed during the building refurbishment also have a locking mechanism that prevents ranges moving and accidently closing access aisles. However,

following the Kaikoura earthquake it was discovered that this mechanism had not been seismically tested. The locks were designed "to prevent units moving under minor lateral loads" (Holmes Consulting 2017, 7) i.e. to protect staff while they were accessing collections between the ranges.

Given that the locking mechanisms were not designed as earthquake restraints, is there any advantage in locking the ranges in case of an earthquake? Could unlocked mobile ranges absorb significant energy by moving freely during an earthquake? These questions belie the complex relationship between seismic events and the resulting effects within buildings. The movement of locked or unlocked shelving ranges during an earthquake depends on many, many factors including the type of earthquake and its magnitude, the type of building and its compliance with building codes, how high up the building the shelving is situated, whether the shelving is full or empty and the earthquake direction relative to the orientation of the shelving.

The Library's policy is to lock all mobile ranges when they are not in use. Security footage captured during earthquakes shows that unlocked shelving ranges moved very quickly and to the fullest extent that the hardware allowed. Locked ranges also move somewhat during an earthquake so it is possible that they could absorb some earthquake energy as they move. It is also important to note that some blocks of ranges in the Library's collection stores are 50 rows long. The combined weight of all these unlocked ranges moving freely in a major earthquake could be devastating.

The older shelving in the basement stores does not have locking mechanisms so aisle safety blocks were employed. This was an in-house initiative to protect staff working in the basement mobile shelving. A safety block could be placed over the tracking at each end of the range opening to prevent the ranges accidently closing and injuring staff. Each block must accurately fit the range gap to be effective.

4.4. *STAFF SAFETY IS THE PRIORITY*

The mobile ranges retain some hazards for staff therefore many procedural changes were implemented to keep staff safe while working in the collection stores. Plans were drawn up to identify areas of unacceptable risk and these areas were cordoned off and signage warned staff the areas were out of bounds. A 'buddy system' was initially enforced for all staff working in the collection stores. In/out boards were installed outside every store and staff were required to lock all ranges in the block where they were working or use the aisle blocks provided. Over time all egress routes within collection stores were upgraded so that shelving along these routes was fitted with safety bars to prevent the contents of the shelving falling during an earthquake (fig. 9).

Further checks were done of existing cabinetry and remediation carried out. Existing furniture was modified, such as installing guards to prevent drawers opening in a seismic event (fig. 10 and 11).

Major projects to replace cabinets that didn't meet in-house standards were begun. The previously mentioned bank of cabinets that toppled were two-part, base-and-top units. They were replaced by a newly designed, integrated cabinet that was lower than the old two-part cabinets were. The new cabinets were attached to the floor and braced together in blocks of four. These small groups of braced cabinets avoided the creation of a braced 'wall' of 40 cabinets that could pull each other down through their combined weight during an earthquake.

FIG. 9: Safety bars were installed on shelving along all collection store egress routes to protect staff from falling items and to ensure egress routes remained viable in a major earthquake (courtesy Alexander Turnbull Library).

FIG. 10 (left): Cabinets on an upper floor after the Kaikoura earthquake in 2016 (courtesy Bronwyn Officer).

FIG. 11 (right): Retrofitted drawer guards prevent drawers opening in a seismic event. The guard is opened by lifting it up vertically and then swinging it to the side, out of the path of the drawer. Staff find the drawer guards quick and easy to use (courtesy Alexander Turnbull Library).

4.5. *SHELVING OWNERSHIP*

Once the dust had figuratively settled after the Kaikoura earthquake the Library leadership moved to prevent issues with collection storage furniture recurring in the future. The Library wanted greater clarity around which parts of the organisation had responsibility for shelving and other storage furniture. A high-level property working group was set up to provide a framework for the management of "All equipment and structures relating to shelving, storage and retrieval" in the Library.

The resulting report, "Shelving Ownership: Agreement and Guideline 2018", covers (among other things) assurance and reporting, maintenance, installation and incidents and events. Overarching requirements are also discussed including health & safety and collection protection (Department of Internal Affairs 2018). The report recommends the development of in-house, 'fit-for-purpose' (i.e. context specific) standards for storage furniture. Unique identifiers for each collection storage unit will be required to track the entire life of every unit within the Library, from installation to decommissioning. An inspection schedule, two categories of incident management (minor and large) and an Issues Resolution Process are also outlined.

5. RECOVERING THE COLLECTIONS

Once the in situ documentation and assessment of furniture and fittings was complete the recovery of collections began. Collection care teams documented the effects of the earthquake on collection items, removed items from damaged, dangerous or un-braced furniture and retrieved fallen items. Many useful observations were made during the recovery of the collections items.

5.1. *SLIPPERY BOOK WRAPPERS*

Books covered with protective plastic wraps had slid towards the edge of the shelves. The hard, smooth, polyester covers were slippery and caused the books to move more during the earthquake than books without these wraps (fig. 12). As a result newly acquired books are now covered in a light-card wrapper to mitigate this issue. The existing polyester wrappers remain as replacing these is a lesser priority compared to other seismic-protection measures.

FIG. 12: Two books with slippery polyester wrappers, protruding from the shelving after the earthquake (courtesy Laura Mirebeau).

5.2. *WHEN BOOKS FALL*

In the collection stores on level 2 the main issue involved books falling from shelving and, sometimes, falling between the ranges of shelving. A small 'fist sized' gap had been left on each shelf to allow for the extra space needed as items were boxed. Unfortunately these gaps increased the movement of books during the earthquake; if the shelves had been full the books would have supported each other inhibiting movement along the shelving. Another factor in the books falling was bookends that were not strong enough to withhold the weight of many books shifting sideways along the shelf. Many bookends bent which left whole shelves of books tilted to one side and caused some books to fall off the shelving (fig. 13).

Prior to the earthquake some staff weren't completely closing the gap between the shelving ranges, during the earthquake these gaps allowed some books to fall between the ranges (fig. 14). An unpackaged book falls freely and will often fall flat on its cover but a book constricted between ranges of shelving, will tend to fall directly downwards taking the impact on the head, tail or corners, causing damage to these areas. Packaged items that fell were undamaged because the packaging absorbed the impact.

FIG. 13:Partially full shelves where the books have moved along the shelf in the earthquake and have tilted (courtesy of Mark Strange).

FIG. 14: Items suspended between ranges and some that have fallen through the gaps onto the floor (courtesy of Alexander Turnbull Library).

Some unpackaged books became stuck between ranges of shelves because the covers opened and became wedged but the text block was able to fall through the gap between the shelves (fig. 15). A few fragile books that were caught between shelving in this way had their covers torn off by the weight of the text block hanging through the shelving gap. Also, as it took some time for the recovery team to open and check between every range, the distortion caused to books that were stuck between ranges may not be easily reversed (fig. 16).

A small number of fallen books were damaged as recovery teams moved the ranges to inspect the collections and/or retrieve fallen items. In one store a box containing newsletters fell to the floor and became stuck under the range. Due to safety concerns that store was off-limits so no retrieval could be carried out for some time.

Some shelves in the collection stores had been fitted with seismic restraint bars to prevent items falling in an earthquake (fig. 17). On one shelf an older design of safety bar was sitting below a third of the way down the spine of the books, this allowed the books to topple over the bar and fall. This was considered an isolated case and has since been remedied. The vast

majority of the older earthquake bars and all the newer bar designs performed effectively and prevented shelf contents from falling.

FIG. 15 & 16: Distortion caused to books that were able to fall from the shelving due to the gaps left between ranges when they were not completely closed together. Shelf restraints would also have prevented these items falling from the shelf (courtesy Nick Guy).

FIG 17: Seismic restraints on shelving prevented the books that had shimmied forward on the shelf from falling onto the floor (courtesy Alexander Turnbull Library).

5.3. *ANTI-SLIP SHELF LINERS*

Following the building's refurbishment in 2012, thin sheets of foam (physically blown polyester, 3mm thickness) were used to line the shelves of newly installed mobile ranges. Primarily shelf liners created friction that restricted movement of collections as ranges were shifted for access. However it was also hoped that the liners would help keep items on the shelves during earthquakes.

There are three issues with the liners during everyday use:

1. The liner inhibits the retrieval of some items; it can move, bulge, come off the shelf and/or fold up.
2. The surface of the liner creates friction so it can be abrasive to fragile materials (e.g. leather bound books), it is therefore very important to package fragile items if shelf liners are in use.
3. Heavier items sink into the surface of the liner somewhat, which can increase the difficulty of retrieving these items.

The assessment of the shelf lining during the period 2013-2016 indicated that the liners lessened the movement of shelved collections during earthquakes. Objective comparisons would need to take into account many variations, such as the type and weight of shelved items, their location within the building, item/packaging surfaces, etc. Static shelving had not been provided with shelf liners and it was observed that this shelving shed its contents at a greater rate than mobile shelving that had shelf liners. But did the static shelving shed its contents because of the lack of liners or was it because static shelving cannot move as much as mobile shelving during a seismic event?

A partial answer could be found when observing two ranges of static shelving at basement level. These two ranges were nearly identical to each other; they were side by side, made by the same manufacturer, installed at the same time and contained very similar collections. The difference was that one range had anti-slip shelf liners while the adjacent range did not. The books on the range with liners remained upright and no books were dislodged from the shelf. The books on the range of shelves without liners were all tilted this way and that, and although most of these books remained on the shelves, some others fell to the floor (fig. 18).

The effectiveness of shelf liners cannot compete with fully packed shelves and earthquake restraints. The two latter measures especially out-perform liners during major seismic events and when collections are stored higher up in a building. The reality is that seismic restraints are expensive and they are one of the most effective ways to prevent collections falling from shelving during earthquakes.

FIG. 18: These shelves are part of a static range at the end of ranges of mobile shelves. The arrow indicates the transition between the bays with anti-slip shelf liners and the five bays (in the foreground) that have no shelf liners. The books on the background shelves stayed upright and none fell from the shelving (courtesy Alexander Turnbull Library).

5.4. *RETURNING TO BUSINESS AS USUAL*

The Library's return to BAU was staggered. Initially the first responders assessed the situation, planned and made decisions. Then collection care staff worked to recover the collection items that required prompt attention. General staff were allowed back into the Library building a short time later. The collections took much longer to open due to the safety concerns outlined above. Various areas within collection stores were opened over time, largely according to the Library's ability to keep staff safe when working in the collections. Approximately three months after the earthquake all collections were accessible again.

This staggered approach to BAU was potentially complex to manage as the public had access to some collections but not others, and the situation changed as more collections became available. Library leadership held regular meetings to monitor and discuss the fluid situation. As collections were reopened to the public, notices were displayed on the National Library website

to explain which collections were available and which ones remained closed. Regular internal announcements updated desk and research access staff who were able to personally inform the visiting public regarding collection availability.

As collections areas re-opened the library assistants were able to carry out several large projects across earthquake-affected areas. They systematically straightened up the shelves of tilted books, returned displaced items to their permanent locations and repacked shelves so that no gaps remained. Library assistants also changed their retrieval procedures somewhat. Book ends are now used only when an item is retrieved; the gap left by the retrieved item is closed up and a book end is placed at the end of the shelf to ensure the items are supported in an upright position.

Preventive seismic work is ongoing and still impacts the everyday work of collection care staff. Currently many cabinets that do not comply with in-house standards are being replaced which involves decanting hundreds of thousands of items. A secondary bracing project is pending for some of the Library's shelving. While more projects will be carried out into the foreseeable future, significant progress has been to increase seismic resilience of Library collection furniture in the two years since the Kaikoura earthquake.

6. CONCLUSION

New Zealand legislation requires all 'reasonable and practicable' steps to be taken to protect people in their place of work and effective seismic protection is especially critical for the safety of staff working in collection stores. All Gallery, Archives, Library and Museum collections require seismic protection in this earthquake-prone country; it's no longer 'if there's an earthquake …' it's 'when there's an earthquake what happens to staff and collections?' Increasing seismic resilience in collection stores can be expensive in terms of capital funding, gaining access to expertise and staffing resources. However the use of restraints, bracing and new furniture designs are the most effective ways to protect collections from earthquake-induced damage. The more affordable and practical measures (such as ensuring there are no gaps on shelving) cannot replace physical restraints but may enhance the protection of collections during seismic events.

The identification of shelving issues after the Kaikoura earthquake has changed the way the Library thinks about storage furniture. All furniture renewal and installation must now be considered as engineered systems. Shelving in particular must meet all compliance and collection protection and access requirements. "These are far more complex considerations than just choosing an off-the-shelf system." (Whitehead, pers. comm.). It is therefore the Library's responsibility to stipulate specifications and ensure that installation, testing and evaluation of storage furniture is fully incorporated into programmes of work. Projects must include personnel who have the right level of expertise and knowledge to specify what is

required and ask the pertinent questions such as "What happens in the event of a major earthquake?" Finally and crucially, post-installation, all shelving must be assessed by engineers as an integral part of project/building sign off.

The Library is more prepared for major earthquakes now than ever before. The challenge will be to sustain and enhance this level of preparedness as the memories fade and new staff replace those who experienced these events.

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