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Post earthquake recovery of New Zealand houses

A.B. King

Structural Engineering Manager, BRANZ Ltd., New Zealand.

D.A. Middleton

General Manger, Earthquake Commission, New Zealand.

ABSTRACT: This paper outlines the fundamental principles which have driven the development of EQC's Catastrophe Response Programme and details the management structure and support mechanisms which EQC have developed to assist a fair and speedy recovery of the residential sector from a damaging earthquake in New Zealand.

The paper also describes BRANZ involvement in developing the Earthquake Damage Assessment Catalogue (EDAC). This is a key component of the documentation that will be used by the damage assessment estimators and insurance loss adjusters to establish an appropriate repair strategy, with costs, for damaged houses which have EQC insurance cover.

1 INTRODUCTION

The recovery phase that follows damaging earthquakes begins with an assessment of the damage incurred to buildings and the development of a repair strategy by which the building can be repaired. Residential property in New Zealand is automatically covered for earthquake damage when it is insured for fire damage. This cover is provided by the Earthquake Commission (EQC) a government agency established specifically to provide disaster insurance cover. Consequently over 90% of residential property in New Zealand is insured for earthquake-induced damage. The Earthquake Commission has developed a comprehensive programme to manage its role in the recovery phase, including the assessment of damage incurred. This covers repair methods and estimates of the quantum of work required to undertake those repairs.

This paper describes work undertaken at BRANZ developing an Earthquake Damage Assessment Catalogue (EDAC) that is to be used as a reference document by building damage estimators. These estimators will be engaged by insurance loss adjusters to formulate an appropriate repair strategy which is consistent with the damage observed. A common problem in such an assessment is that the visual damage indicators are predominantly surface features (e.g. damaged linings, claddings or gross building deformations). The EDAC has been prepared using a combination of experience, judgement and a limited laboratory-based experimental programme to guide the estimator to explore further than these surface features to verify the presence (or otherwise) of hidden building damage in an attempt to minimise 'hidden surprises'.

Recognising that it is difficult to provide a clear written description of building damage, the damage catalogue uses photographs and sketches to supplement the written explanations of damage, thereby enabling the estimator to recognise the specific characteristic being observed as being consistent with the description of damage described. A hierarchy of presentation was required to assist in the rapid retrieval of damage descriptors within the catalogue. This is greatly simplified within the electronic version which utilises purpose-made electronic database search criteria to rapidly retrieve the subset of damage associated with the particular component being considered.

2 THE EARTHQUAKE COMMISSION, EQC

The New Zealand Earthquake Commission is a body corporate set up under the Earthquake Commission Act (1993). It is one of the many organisations in the New Zealand Government sector called "Crown Entities". These were created during the reforms of the early nineties to establish financial management and accountability for the numerous public bodies that fell between core government departments and state-owned enterprises. The former carry out government policy, having proffered advice on the same; the latter trade as commercial enterprises. Crown Entities do a bit of both.

The Earthquake Commission took over the staff and assets of the Earthquake and War Damage Commission which had been in existence since 1945. This inheritance provided the new Commission with substantial reserves which have since grown to almost NZ$4 billion.

The Commission's role is to help develop safer communities by:

- facilitating research about matters relevant to natural disaster damage and its reduction
- educating the public on the risks they face and what mitigation measures can be taken
- assisting recovery from the effects of geological natural disasters by providing compulsory insurance cover in return for premiums paid.

3 THE EARTHQUAKE COMMISSION'S CATASTROPHE RESPONSE PROGRAMME

The final bullet point in the last section presents the Commission with a considerable challenge. The permanent staff of 16 people may be called upon one day to be the nucleus of the team handling 120,000 insurance claims in the event of a major New Zealand earthquake.

Extensive planning is a prerequisite of EQC's ability to handle all claims from a disaster within a tolerable time frame, (say 2 years). What that planning had to involve became clearer to the Commission after overseas visits to many organisations that had experienced disasters – insurance companies and government authorities in Australia, UK and USA. None provided a complete blueprint for EQC to adopt but a great deal was learned. EQC became a "virtual organisation", contracting out the services that would need to expand rapidly after a large disaster event, and developed a set of principles that became the basis for its Catastrophe Response Programme.

Many of these principles are applicable to the planning challenge others face, including requirements under the Civil Defence and Emergency Management which was enacted in November 2002 (NZ Government 2002).

3.1 Form follows function

It is necessary to decide what needs to be done before setting up the system or organisation to do it. Setting up the organisation first leads to difficulties like make-work, duplication of effort and responsibility vacuums.

3.2 Planned response becomes part of regular routines

A few years ago, EQC changed its Catastrophe Response Plan to its CR Programme to underline this point. In order to avoid the dilemmas associated with switching – when to do it, what's the trigger, how to do it, what to switch to etc. – it is necessary to do away with the need to switch altogether. For example the Commission has its claim management system mirrored on two IBM AS400 minicomputers in Wellington and Auckland and operates it all the time, in spite of having only about 4,000 claims to handle in a "normal" year. A PC of no great specification could cope with that. Another example of the application of this principle was EQC's decision to outsource its claims administration to a third party situated in Brisbane. They handle all EQC's claims. So, in both cases, EQC is faced with a scaling up process in the event of a disaster, not changes of systems, staff training, dormant contracts and decisions about which resources to bring on-stream.

3.3 **Constant review and practice is necessary**

The Commission has exercises and tests every month and there is a constant stream of corrections and adjustments as a result. The Civil Defence and Emergency Management Groups that are a feature of the new legislation would be well advised to make this a major part of their operations, and to involve all the external agencies that would be part of real event.

3.4 **Invoke procedures at every opportunity**

This principle has similar aims to the previous one in its objective of taking every chance to practice. It is also better to over-react and subsequently scale down than respond inadequately and face criticism which may dog the organisation not only for the duration of the event but long after.

3.5 **The implementers do the planning**

A plan should not be imposed from above. Those to be involved in implementation must also be involved in preparing the plans. Not only are they likely to be in the best position to complete practical and realistic plans, but their ownership of the plan will go a long way to ensuring its success when it is needed.

3.6 **Plans are written down and those expected to act on them are given copies and kept up to date.**

Rather obviously, plans should be recorded. They could be in the form of reports, memoranda, tables, action lists, flow charts, mind maps or any combination. Electronic forms should be replicated and produced in hard copy. This leads to a challenge to make sure all versions are the same and that each person has an up to date copy of something telling them what is required of them.

3.7 **Maintain standards and quality control**

If a process or system can be streamlined to operate adequately in a disaster recovery situation, then nothing more ought to be required in more normal times, provided no concession of quality or accuracy is being made. For example, if a local authority's system of issuing building consents can be simplified for coping with the enormous workload following a disaster, and still meet all the requirements for accuracy and quality, then it should be adopted as normal practice (see also principle 2).

3.8 **Leave specialist areas to the specialists**

This is akin to principle 5. The Commission has engaged loss adjusters to help plan the logistics of inspecting damaged properties, builders to assist with how repairs will be managed, a property management firm to contract for accommodation and catering facilities, and so on. All the relevant specialists are needed around the planning table in order to get their expertise and their input. This is why EQC is so committed to co-operation and collaboration in the disaster planning area.

3.9 **Plan the response around functional units**

This enables the scaling up approach to a response. There are other ways but EQC has found the team building/upscaling approach easiest to grasp and to plan for.

Although, conceptually, if, for EQC, a 10,000 claim event requires one team unit then a 30,000 claim event would require three team units, the reality is a little more complex. Large events present difficulties not present in smaller ones. However, this principle provides a sound platform on which to build the necessary complexity.

3.10 **Information is the currency of the disaster recovery**

Prepared press releases and advertisements are part of EQC's Catastrophe Response Programme pack. Preparations do not have to be based on sophisticated technology – posters on telegraph poles may be used – but high technology creates new avenues, for example libraries with their internet connections. A good plan for involving the news media is essential because, although it may be foolhardy to expect them to carry the preferred stories, they will be part of the disaster scene. Direct communications with other organisations involved in the recovery must be developed and directly and regularly reaching the casualties – in EQC's case, its claimants - must not be overlooked.

4 EQC DAMAGE ASSESSMENT STRATEGY

The catastrophe response programme developed by EQC with regard to damage assessment and settlement is outlined diagrammatically in Figure 1. For a major earthquake near a metropolitan city in New Zealand, EQC expects in excess of 80,000 claims to be lodged. They have established priority response agreements with insurance loss adjusters both within New Zealand and Australia and also from further afield. Response agreements are also in place with builder organisations (e.g. NZ Master Builders Federation and NZ Certified Builders) and other building-related professional bodies (e.g. New Zealand Institute of Quantity Surveyors) to assist building estimators, who will provide damage estimates to allow the extent of loss to be established. In cases of severe damage, specialist advisors such as structural engineers or geotechnical engineers will be available to provide guidance to the building estimator on the appropriate repairs necessary. Other arrangements are in place for acquiring management, administrative and logistical support.

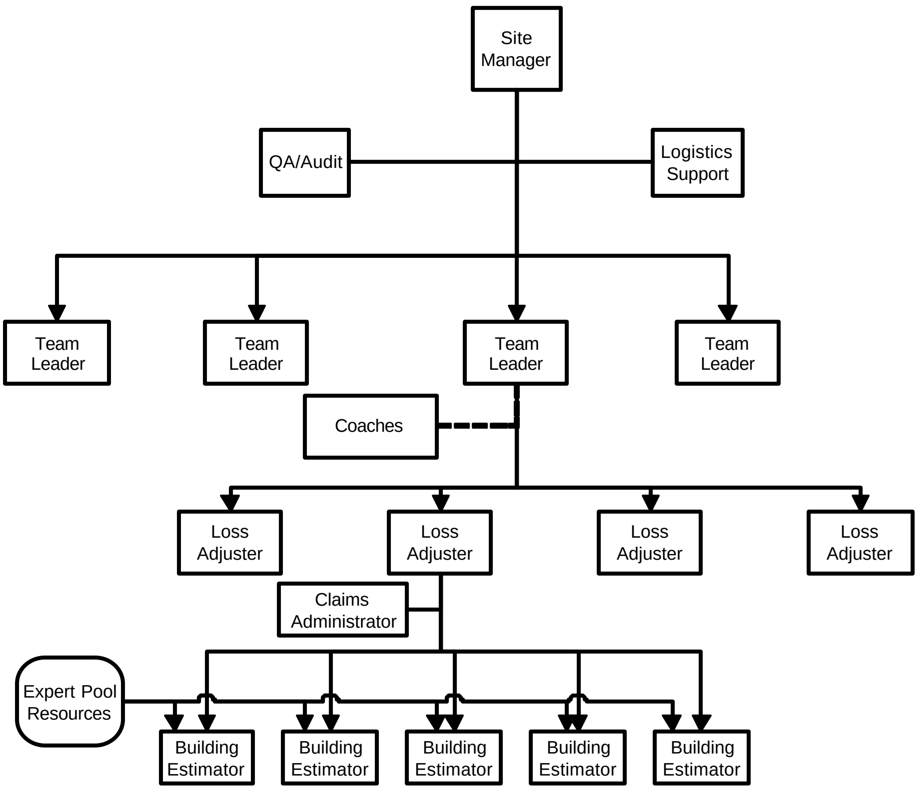

Figure 1: Proposed Damage Assessment Work Structure

The EQC primary objective is to settle claims fairly and quickly so that repairs can be undertaken promptly, thus minimising community disruption. The specific expertise of the damage inspection teams has been identified and will be applied to consider the extent of damage, develop an appropriate repair strategy and assign a fair value to the implementation of the required repairs. Thus the loss adjusters, who are familiar with the administration of insurance loss claims and the reporting expectations required with those claims, will continue to fulfil that role under the guidance of a team leader. Note that many teams will be established and deployed for large events, in some cases to several sites.

5 EARTHQUAKE DAMAGE ASSESSMENT CATALOGUE

The Earthquake Damage Assessment Catalogue is a reference source to be used by loss adjustors and building estimators during the assessment of damage to dwellings following earthquakes.

5.1 EDAC objectives and contents

The Earthquake Damage Assessment Catalogue was required to contain the following key items:

- A unique damage identification code which could be referenced by all parties who would use the assessment report (e.g. loss adjusters, supervisors, audit team, building owner, repair contractor)
- A pictorial description, accompanied by a written description for as many damage scenarios as could be envisaged for New Zealand houses.
- An outline of aspects of collateral or hidden damage which could be expected to accompany the visible damage available for assessment
- A repair strategy by which the damage identified could be economically repaired
- Identification, if practical, of when specialist advisors should be called to assist the estimator and what special skill these advisors would likely need.

The EDAC should furthermore provide some guidance as to damage that is likely to render a building unsafe to occupy and any other issues which may result in abnormal requirements.

It was acknowledged that both hard copy and electronic versions of the catalogue were needed since some users were likely to require a field reference source (hard copy) and other users would find an electronic search capability more convenient.

The search engine selected was the commercial package DBTextWorks produced by InMagic [InMagic 1999]. This software is very economical in its computer demand and file sizes when handling images and is offered with a RunTime module that enables the search engine to be transferred along with the final database as part of the primary licence. The search capability is also very flexible, enabling both key-word selections from a validation list or selections of text themselves to be used as the basis of the search. Similarly, the sorting capability can be applied to any field or combination of fields enabling the specific record of interest to be most readily identified.

The three key fields available for the search in the EDAC are the building subsystem, the component within that subsystem and the applicable material. Since the application of the EDAC, at least initially, was limited to housing units (this being the extent of EQC insurance cover in New Zealand) the building subsystems were simply the subfloor, floor, walls, roofs and appendages. The hard-copy version of the EDAC was printed once the records were sorted on building subsystem.

The user selects the damage scenario that most closely resembles that which he/she is observing from a range of images and brief accompanying descriptions. The full record can then be called up (Figure 2). Paramount is a four letter Damage Identification Code (letter plus three numerals) which uniquely identifies the particular damage being considered. The additional information includes:

- a more complete DAMAGE DESCRIPTION (enabling confirmation that the record and the observed damage are compatible)
- an outline of the REPAIR STRATEGY applicable for that specific damage
- a list of likely COLLATERAL DAMAGE which could be expected to accompany damage of this particular nature; and
- a list of OTHER ISSUES which need consideration during the assessment.

Where specialist expert advice is likely to be required, the category of the specialist is also identified.

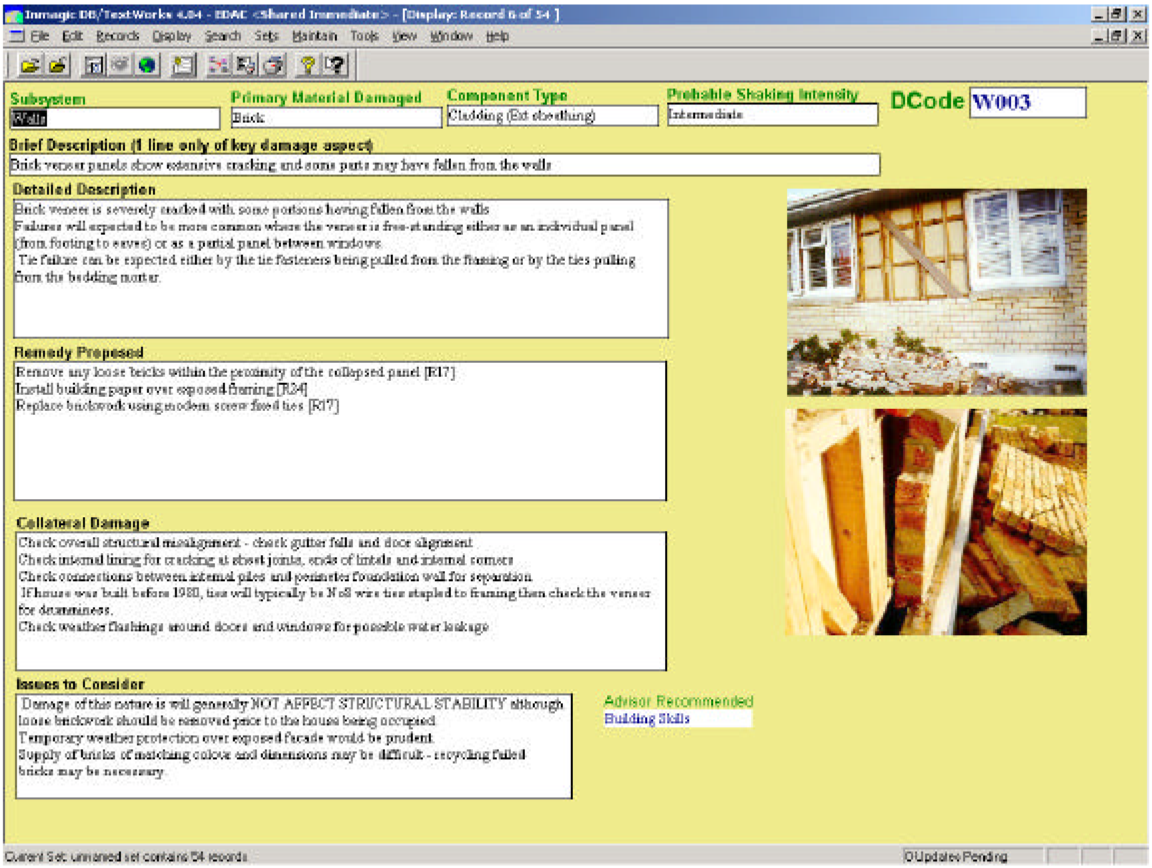

Figure 2: Earthquake Damage Assessment Catalogue (EDAC) database record

6 THE REPAIR STRATEGY

The necessity to determine hidden damage by inference from the surface damage was recognised when preparing the EDAC. So while visible surface damage is the EDAC indicator it is supplemented by identifying probable hidden damage which can inferred from the visible damage. Once the full extent of the damage has been determined, the assessor is required to decide upon an appropriate repair strategy. EQC is keen that repairs be consistent with each other. Thus if floor coverings are required to be replaced in one instance, they should similarly be replaced in other houses with similar damage. The EDAC therefore proposes repair strategies consistent with the damage indicators observed. BRANZ has attempted to develop repair strategies which are consistent with both good practice and post earthquake damage experience, particularly from Edgecumbe (1987) and Dannevirke (1990), these being two most recent damaging earthquakes in New Zealand.

The real event experiences were supplemented with an experimental programme which has been undertaken at BRANZ and reported by Beattie (Beattie 2002). Within the first phase of this study, three different wall configurations and one foundation system were built and subjected to in-plane cyclic racking action sufficient to induce damage consistent with the descriptors used in the EDAC. Each specimen, once damaged, was inspected and a repair strategy developed. In most cases the repaired specimen was retested to ensure the required levels of structural integrity were maintained.

The four experimental configurations are shown in Figures 3 to 6. The essential features of each configuration and the key findings from the investigation are as follows:

Specimen 1: comprised a wood-framed wall with fibrecement sheet cladding and gypsum plasterboard lining, complete with return walls and a window opening representing a common modern exterior wall form (Figure 3). Crack development typically commenced at the corners of the window openings, often migrating along the joints in the internal lining. Cracking also became apparent from movement within the filled joints of the external sheet cladding. Both sets of cracks were able to repaired by gouging along the crack length to provide a key for the repair compound and the reinforcing strips reinstated. This proved somewhat more difficult than expected within the gypsum linings where the crack moved into the body of the sheet at larger displacement cycles. In such cases the finish level required for painting was not achieved without complete sheet replacement. Replacement of the external jointing compound was more straight forward and resulted in a satisfactory repair.

Figure 3: Exterior wood-framed wall with sheet cladding and plaster lining

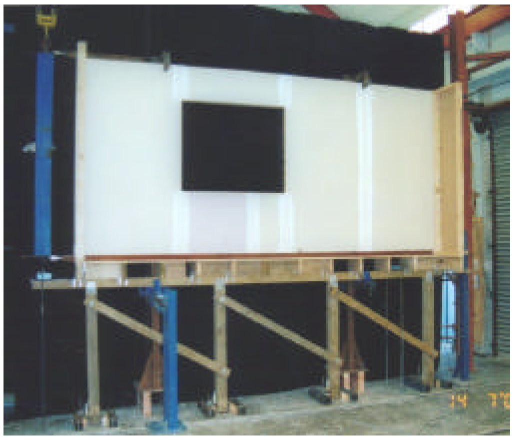

Figure 4: Wooden subfloor system with wood cross-bracing and piles.

Figure 5: Brick veneer corner element with plasterboard lined wood-framed supporting walls

Figure 6: 1960s two-storey wood-framed duplex unit (central wall at both levels was evaluated)

Specimen 2: comprised an elevated platform on a pile subfloor system with lateral cross braces (Figure 4). This configuration proved to be very robust and damage was limited to flexural yielding of the 12 mm bolt shank at the interface between pile and brace and local crushing of the timber at the bolt face. Such damage was only apparent when the specimen has disassembled and is unlikely to be noticed during inspection. Attempts to repair the resulting enlarged bolt holes using epoxy filler proved unsuccessful (with the filler simply crushed during subsequent testing. The preferred repair method selected involved enlarging the bolt hole and installing a 16 mm replacement bolt.

Specimen 3 comprised a brick veneer corner element complete with support framing and simulated ceiling (Figure 5). The top plate and ceiling was racked to simulate the response of the timber framed system to earthquake. The lining damage observed was similar to that in Specimen 1. However only the top two rows of veneer ties showed any sign of damage, and this was only visible by inspection of within the cavity, a region not usually available for inspection. A subsequent testing phase involved dynamic shaking of the specimen thereby more correctly representing the inertia response of the veneer. Diagonal shear cracks were observed rising from the veneer corner. The conventional ties were cut and replaced by externally installed spiral helix ties which, on retesting, performed below expectations with the spiral reaming the insert hole particularly within the brickwork.

Specimen 4: The fourth specimen, which proved to be by far the most challenging, was a complete two storey 1960s wood-framed duplex unit which was due for demolition because of fire damage in one unit (Figure 6). Longitudinal walls first at the upper level and later at the lower level were isolated from the remainder of the structure and subjected in in-plane racking actions. Through a combination of circumstances (particularly the inability to truly separate the test walls from the remainder of the structure) the racking loads imposed on both test walls was approximately three times that for which the wall would have been rated as a bracing panel. Damage to the wall was limited to slight tearing of the wall linings around the door openings. The bottom plate was also seen to lift as the panel rocked under the transverse load.

7 PROPOSED FUTURE DEVELOPMENTS

Several areas of ongoing development of the EDAC are being considered. These will include access being provided via the web, the ability to download a stand-alone version onto a notebook or desk-top PC, an expansion of the descriptors to include Australian building terminology (since it is recognised a significant presence of Australian estimators is likely), the integration of the damage and repair strategy more closely with the costing database, and an expansion of the collateral damage suggestions to more specific directions for the estimator to follow.

Additional experimental verification that the proposed repair strategies will be effective is also essential. This is however expensive to undertake and will be rolled out over time.

There is also a need for a similar guide to be prepared for specialists who will be called upon to advise the estimators. A consequence of the success of the Timber Framing Standard, NZS 3604 (SNZ 1999) means that very few structural engineers are well versed in timber framed building behaviour under earthquake attack. Guidance as to how to evaluate the residual capacity of partially damaged buildings is urgently required.

8 CONCLUSIONS

Preparedness for disaster recovery is never complete nor can all aspects of a response plan be fully detailed. However, the act of planning and the clear focus on specific post-disaster procedures is placing EQC and its advisors in a considerably stronger position that many of their counterparts. The Earthquake Damage Assessment Catalogue is but one tool in an overall approach which is now operational. Additional development is required and will be undertaken over time. Meanwhile it provides a tool and a reference source to enable response teams to be trained and made aware of the expectations being placed upon them during the critical post disaster response phase.

9 ACKNOWLEDGEMENTS

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