BUILDING SAFETY EVALUATION FOLLOWING THE 30 SEPTEMBER 2009 PADANG EARTHQUAKE, INDONESIA

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SUMMARY

A ten-member team of engineers was deployed by NZAID and the New Zealand Society for Earthquake Engineering to assist Indonesian local and provincial agencies with rapid structural assessments of earthquake-affected buildings in and around Padang. This was the first time that a team of New Zealand engineers had been operationally deployed outside the Pacific region following a major earthquake.

An accompanying paper describes the earthquake and its impacts, and the general observations of the team. This paper outlines the experiences of a team of 10 New Zealand structural engineers deployed on a volunteer basis for two weeks to undertake the deployment process, the arrangements that the team operated under in Padang, the tasks undertaken and the outputs and outcomes achieved. The lessons for building safety evaluation processes in New Zealand are also presented, along with the resulting enhancements to arrangements.

1. INTRODUCTION

The 2009 Padang earthquake occurred off the western coast of Sumatra, between Padang City and the coastal town of Pariaman. The major shock hit at 17:16:09 local time on September 30, 2009 (10:16:09 UTC, September 30). It registered a moment magnitude (MW) of 7.5, with an epicentre 60 km west-north-west of Padang, 225 km southwest of Pekanbaru, and a focus at a depth of 81 km (USGS, 2009). The earthquake caused widespread building damage from shaking (well in excess of 40,000 buildings), as well as some from earthquake-induced landsliding, liquefaction and lateral spreading of soil (EERI 2009).

The earthquake and its impacts are described in more detail in the accompanying paper (Bothara, Beetham *et al.*, 2010), and lessons for steel structures outlined in an additional paper (Hyland and Wijanto, 2010). This paper outlines the experiences of a team of ten New Zealand structural engineers deployed for two weeks to undertake the assessment of earthquake-damaged buildings. The paper covers the arrangements that the team operated under in Padang, the tasks undertaken and the outputs and outcomes achieved, along with the subsequent involvement of New Zealand engineers in Padang. The lessons for building safety evaluation processes in New Zealand are also presented, along with the resulting enhancements to arrangements.

Contacts with Indonesia have been established since Indonesia achieved independence in the 1940s. In 2008, Indonesia and New Zealand celebrated 50 years of formal diplomatic relations, and promoted that through a two-day Disaster Management workshop held in Jakarta. Contributing toward the development of that relationship was the provision over a number of years of New Zealand technical advice to the geothermal sector, as well as in earthquake engineering. This mission strengthened further the long-established ties between the two countries, particularly in sharing common interests in understanding and mitigating natural hazards of earthquakes, tsunami, volcanic eruptions, flooding and storms.

2. DEPLOYMENT AND SCOPE OF ACTIVITIES

2.1 Briefing and Deployment of the NZ Team

Following the Padang earthquake, the United Nations Development Programme (UNDP), acting on behalf of the Government of Indonesia, requested New Zealand to provide

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engineers for rapid structural assessments of the earthquake-affected buildings in and around Padang. The request was made through the NZAID office in Jakarta. UNDP had been appointed chair of the Early Recovery Cluster Group. Earthquake Engineering New Zealand (EENZ) initiated a general call for volunteers through its membership and also through IPENZ (NZSEE and SESOC). The final team of ten was selected from over 30 responses. NZAID responded to the UNDP request by agreeing to fund the travel of six volunteer engineers. The remaining four were funded by EQC and Department of Building and Housing. NZSEE entered into the Padang Project contract with NZAID, under the Learning From Earthquakes Programme, on the basis of the expected benefits to NZSEE members and to New Zealand from the experience. NZSEE managed the Padang Project mission with assistance from EENZ.

The ten-person team of engineers came from a range of consulting practices and other organisations, as listed below:

- Dave Brunsdon (Kestrel Group, Wellington), Team Leader
- Jitendra Bothara (Beca, Wellington), Co-Leader
- Mike Stannard (Department of Building and Housing, Wellington), Co-Leader
- Dick Beetham (GNS Science, Wellington)
- Roger Brown (CAL Engineering Management, Auckland)
- Clark Hyland (Hyland Fatigue & Earthquake Engineering, Auckland)
- Warren Lewis (Lewis and Barrow Ltd., Christchurch)
- Scott Miller (Silvester Clark, Wellington)
- Rebecca Sanders (Synergine, Auckland)
- Yakso Sulistio (Beca, Jakarta).

The majority of the team travelled to Jakarta on Sunday, 11 October. The team met with the UNDP Country Director and NZAID representative at the Jakarta NZ Embassy on Monday morning, along with a Jakarta-based consulting engineer. The main group of team members travelled to Padang on Monday afternoon, and were joined by the remaining team members at the end of Wednesday, 14 October.

The purpose of the mission was to assist with rapid structural assessments of the earthquake-affected buildings in and around Padang. This proved to be a wide brief, given the large number of buildings affected and the range of damage encountered. The early focus was on undertaking rapid structural assessments of public-owned and publicly accessible buildings, a surprising proportion of which had sustained significant damage (Bothara, Beetham *et al*., 2010).

The brief was to work closely with the Public Works departments of both Padang Municipal government and the West Sumatra provincial government. A conscious effort was therefore made to include local engineers from the Padang Municipal and Provincial Public Works agencies in the field assessment process.

The team worked out of the makeshift UNDP offices in Padang, and Figure 1 shows the tent that was the team's operational base.

At the end of the two-week period, all of the field data and associated information obtained was formally handed over to the Padang Municipal and Provincial Public Works agencies. An Exit Report was prepared for NZAID and UNDP. A debrief meeting was held in Jakarta with NZAID and UNDP on Saturday, 24 October before the team returned to New Zealand.

2.2 Approach Adopted

The New Zealand Rapid Building Safety Assessment methodology (NZSEE, 2009) is derived from the United States approach. It features three outcome categories of Green (Inspected), Yellow (Restricted Use) and Red (Unsafe). The assessments are typically undertaken at two levels—the initial Level 1, which is based just on an exterior inspection, and a more considered Level 2 assessment, which involves viewing the interior of the structure where it is safe to do so. The Level 2 Rapid Assessment is typically applied to critical facilities structures (e.g., Emergency Services and Emergency Operations Centres), and large or multi-storey structures.

The early rapid assessments undertaken in Padang by various agencies were essentially Level 1 Rapid Assessments in New Zealand terminology, with outputs either in the form of Green, Yellow and Red ratings, or Low, Medium or High damage level assessments.

Figure 1: ***Operating base for the NZ Engineering Team in Padang.***

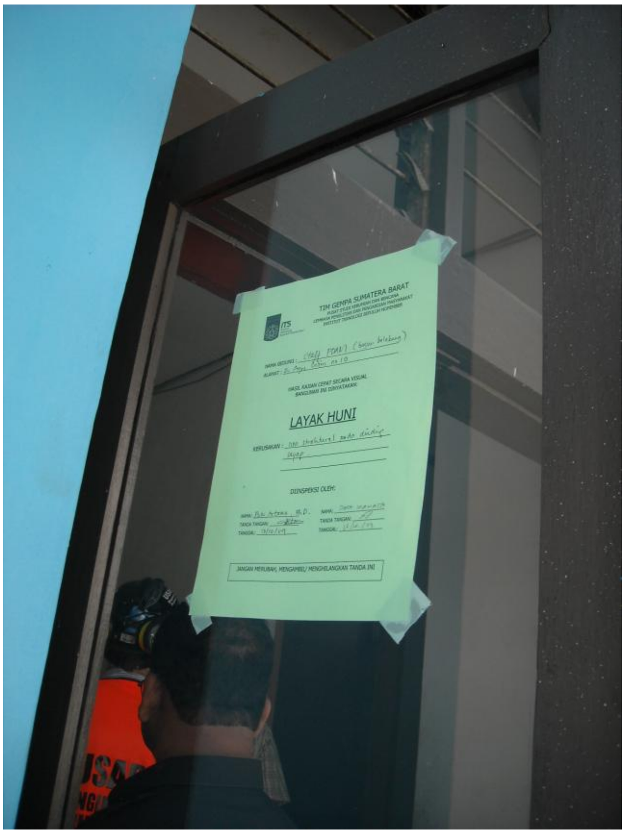


Figure 2: ***Example of a Rapid Assessment placard placed by local engineers.***

Local agencies had posted some placards of their own in the days following the earthquake—an example is shown in Figure 2. These had not been consistently applied across the areas of greatest damage (understandable given the sheer scale of the damage), and contained only limited information. The NZ Engineering Team developed draft placards, adapted from the New Zealand version and translated into Indonesian. However neither of the Public Works agencies supported the NZ Engineering Team posting placards, despite our encouragement to do this in order to define safe and unsafe areas more clearly in some marginal structures. Their reasons included the lack of regulatory backing and the uncertainty that they believed these additional placards would create amongst the public. We also acknowledged that we would only be posting placards on some structures, and that this would be introducing another placard type, potentially increasing the confusion.

In order to enhance the usefulness the early three-category assessments, the team developed the concept of six *Usability Categories* whilst travelling to Indonesia—two corresponding to each of the three base levels (refer Table 1). While still very broad, these Usability Categories assisted in conveying an additional level of status information beyond the three primary categories to the various agencies and building owners and managers. The Light/ Medium/ Heavy categories came from different methodologies to the Green/ Yellow/ Red categories, and it is noted that they do not necessarily correlate.

Other advisory comments regarding repair/reinstatement measures required or the approach needed for demolition were also included on the field assessment forms as a way of providing further information, and hence value. While the assessment of damage costs was outside the scope of the team's work, broad indications of the range of damage as per the forms were provided in some instances.

In order to encourage engagement with the local engineers, and to ensure the ongoing usability of the information, the assessment forms were translated into bilingual versions (English and Bahasa Indonesian).

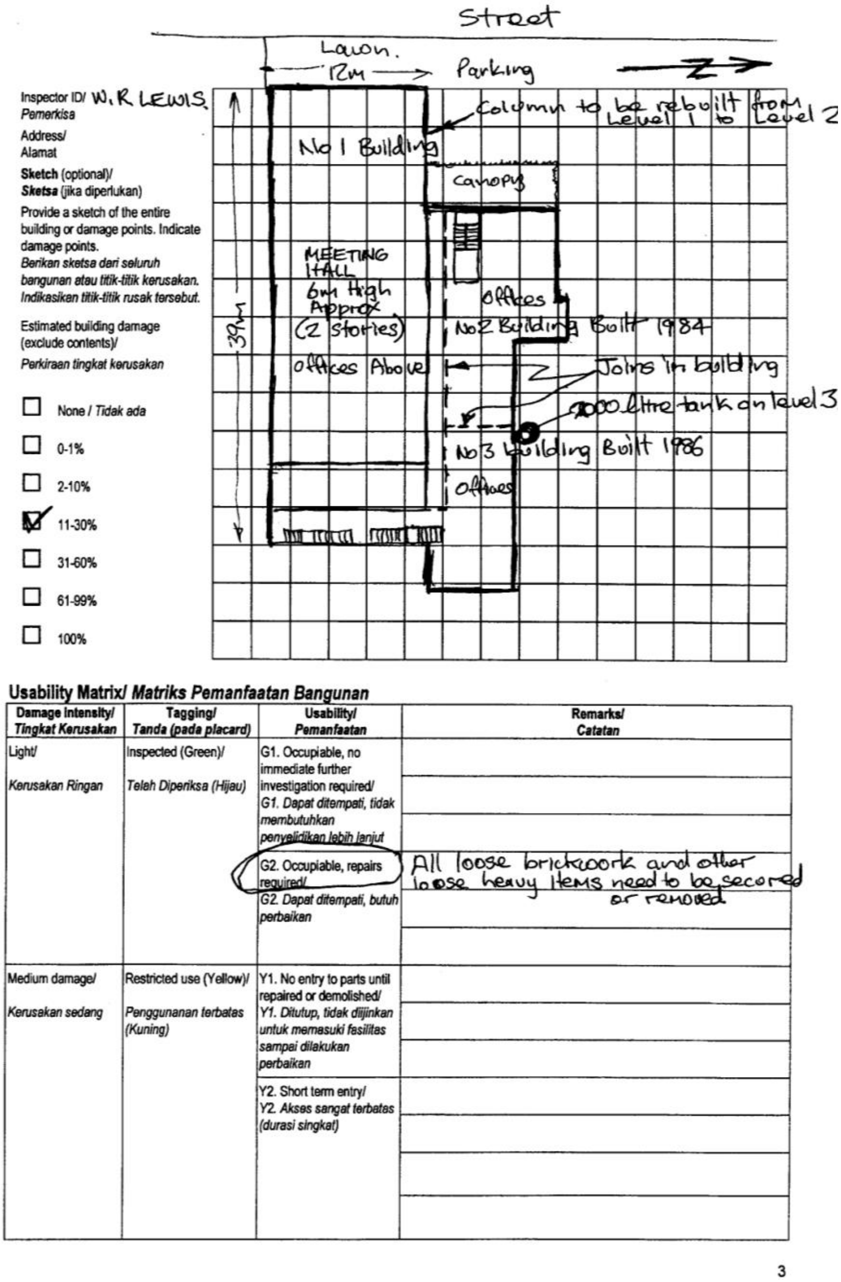
Once these modifications were included, the two-page NZ Level 2 Rapid Assessment form expanded into a five-page version. An example of one of the key pages for an assessed building is shown in Figure 3.

Relevant photographs that illustrated the key concerns in relation to each building were taken, noting that these did not constitute a full damage catalogue. GPS units brought from New Zealand were used to record locations of buildings inspected for reference and plotting.

The initial focus on the first day on the ground in Padang was on trialling the system proposed by the NZ Engineering Team. This saw the assessments on the first two days being undertaken by NZ-led teams of up to half a dozen engineers, comprising public works engineers and other local engineers, along with Australian Army and AusAid-contracted engineers. The Australian engineers provided excellent continuity between the earlier Level 1 Rapid Assessments that they had been involved in and the Level 2 process applied by the NZ Engineering Team. After three days of field work, the Australian personnel departed and smaller teams comprising New Zealand and local engineers undertook the field work.

Table 1: Correlation of Damage Intensity and Placard Category with Usability Category

Damage Intensity	Placard Category	Usability Category (Safety Focus)
Light	Green	G1 – Occupiable, no immediate further investigation required
		G2 – Occupiable, repairs required
Medium	Yellow	Y1 – No entry to parts until affected sections repaired or demolished
		Y2 – Short-term entry only
Heavy	Red	R1 – Significant damage – repairs/ strengthening possible
		R2 – Significant damage – demolition likely



Inspector ID/ Pemerkisa W. R LEWIS

Address/ Alamat

Sketch (optional)/ ***Sketsa*** (jika diperlukan)

Provide a sketch of the entire building or damage points. Indicate damage points.
Berikan sketsa dari seluruh bangunan atau titik-titik kerusakan. Indikasikan titik-titik rusak tersebut.

Estimated building damage (exclude contents)/
Perkiraan tingkat kerusakan

- ☐ None / *Tidak ada*
- ☐ 0-1%
- ☐ 2-10%
- ☑ 11-30%
- ☐ 31-60%
- ☐ 61-99%
- ☐ 100%

Usability Matrix/ *Matriks Pemanfaatan Bangunan*

Damage Intensity/ *Tingkat Kerusakan*	Tagging/ *Tanda (pada placard)*	Usability/ *Pemanfaatan*	Remarks/ *Catatan*
Light/ *Kerusakan Ringan*	Inspected (Green)/ *Telah Diperiksa (Hijau)*	G1. Occupiable, no immediate further investigation required/ *G1. Dapat ditempati, tidak membutuhkan penyelidikan lebih lanjut*	
		G2. Occupiable, repairs required/ *G2. Dapat ditempati, butuh perbaikan*	All loose brickwork and other loose heavy items need to be secured or removed
Medium damage/ *Kerusakan sedang*	Restricted use (Yellow)/ *Penggunanan terbatas (Kuning)*	Y1. No entry to parts until repaired or demolished/ *Y1. Ditutup, tidak diijinkan untuk memasuki fasilitas sampai dilakukan perbaikan*	
		Y2. Short term entry/ *Y2. Akses sangat terbatas (durasi singkat)*	

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Figure 3: Example of one page of a completed form.

In the second week of the mission, the Provincial and Municipal Public Works agencies requested further input from the NZ Engineering Team on some of the buildings already assessed. This advice typically related to marginal structures—the buildings assessed as *Medium* damage or *Yellow* (Restricted Use) category. For buildings in this category, the removal of hazards such as loose high-level brickwork or temporary propping of some damaged columns would enable buildings to be opened up for wider use, or the further restriction of access upon receipt of more specific guidance.

At the request of UNDP at the beginning of the second week, the team looked at privately owned commercial buildings where large numbers of people could assemble—for example theatres, hotels and shopping malls. This was a less well-defined set of buildings—no specific list was provided, and official approval for access to such premises could only come after the owner requested an inspection via the Provincial and Municipal Public Works agencies. A list of these buildings was generated by our translators with local knowledge, and some owners were happy to have their premises inspected when the team turned up at these buildings.

The second week also involved assessing structures in badly affected areas outside of Padang, including school structures around the province. It was reported that there were approximately 2,250 damaged school classrooms (note that damage was reported by classroom, not building), and requests for assessments were received from UNICEF on behalf of the Department of Education. However it was only possible to assess approximately 103 school buildings at 51 schools in the three days available for this task.

General advice was also given to UNDP as they planned the resourcing of demolition operations for major structures.

Table 2: Summary of Buildings Surveyed in Each Usability Category

Placard Category	Usability Category (Safety Focus)	Approx. Percentage
Green	G1 – Occupiable, no immediate further investigation required	15%
	G2 – Occupiable, repairs required	37%
Yellow	Y1 – No entry to parts until repaired or demolished	21%
	Y2 – Short-term entry	4%
Red	R1 – Significant damage – repairs/ strengthening possible	8%
	R2 – Significant damage – demolition likely	15%

2.3 Information Recording and Management

A database which contains the key information from the field assessment forms was developed. This included the key section of notes, translated into Bahasa Indonesian, outlining the concepts for determining if repair or demolition is required, to provide the basis for subsequent detailed engineering input where required. It was however subsequently realised that these comments may have been of limited value, as they were effectively aimed at engineers with a certain level of experience in earthquake engineering. Few engineers with earthquake engineering experience were encountered during the time spent by the team in Padang.

Starting out on the second day of field assessments as a basic spreadsheet, this information was developed into a comprehensive database by the beginning of the second week. Keeping this database up to date and preparing for the handover of information was a major task, and occupied three to four members of the team in the second week, in addition to most of the Indonesian translators.

3. OUTPUTS AND OUTCOMES

3.1 Output Produced

A total of approximately 350 buildings were inspected by the NZ Engineering Team. These comprised 233 with full Level 2 Rapid Assessment forms and the remainder from a brief survey of buildings in the Chinatown district.

Output from the assessments included the following:

- A spreadsheet with a summary of all the building assessments with a unique identifier for each building,
- Hard-copy assessment forms filled out by the structural engineering assessors during the site inspection, along with any notes and sketches to assist with identifying repair or demolition methods,
- Scanned files of the assessment forms in pdf format, with a file for each building named using the unique building identifier of the assessment form, notes and sketches, and
- Image files of photographs taken during the site inspection for each building, filed using the unique building identifier.

The hard copy information was copied and filed in ring binders, organised according to the appropriate agency or sector (i.e., Municipal or Provincial, or Education). The original field assessment forms were left with UNDP.

All the electronic files were stored on large capacity datasticks and left with UNDP. This information, in both hard and soft copy form, was given to the Municipal and Provincial authorities, and to the Department of Education, as appropriate, with a formal covering letter of transmittal.

Other information to be provided included a sketch by one of the NZ Engineering Team indicating some practical details of how to tie the brick walls of single-storey school buildings together.

3.2 Summary of Assessments

All of the 233 Level 2 Rapid Building Assessment forms were entered into the database.

A broad analysis of the buildings assessed indicates that approximately 52% were Green or Occupiable, 25% Yellow or Restricted Use, and 23% Red or Unsafe. Table 2 shows the further breakdown into Usability Categories, noting that the set of buildings inspected does not represent the cross-section of buildings in Padang and Sumatra, and so these figures only represent an indicative analysis of the subset that the NZ Engineering Team assessed.

Virtually all of the buildings assessed as Green required minor repairs. Of the buildings assessed as Red, 8% of the total are considerable repairable from a structural and economic perspective (Usability Category R1). These would need careful and specific engineering input, which was beyond the scope of the team's activities.

3.3 Outcomes Achieved

The New Zealand team focused on providing rapid safety advice—particularly concerning which buildings can be occupied directly, or with minor hazard reduction work, or which should not be occupied because of other unrecognised damage. Useful additional information was provided to the local agencies in relation to:

- Short-term safety notification,
- Decisions on repair versus reconstruction,
- Early demolition planning, and
- Conceptual guidance for design repairs.

In developing the processes and transfer procedures used, emphasis was placed on engagement with local engineers, their managers and, where possible, building occupiers and managers.

The key to the overall long-term success of this project will be in how well the local agencies use and transfer the information provided. While considerable effort was put into making the output information usable and durable, the medium-term use of the information remains uncertain.

3.4 Advocacy for 'Building Back Better'

As noted earlier, and in the accompanying paper (Bothara, Beetham *et al*., 2009), the scale of damage was considerable, and the poor performance of major buildings constructed over the past two decades to modern structural design codes is of particular concern. Reinstatement of damaged buildings and construction of new buildings using methods from the past two decades is unlikely to avoid damage and casualties in future earthquakes. The NZ Engineering Team therefore actively advocated improved construction processes and techniques in order to encourage a 'Build Back Better' philosophy.

This earthquake was not the largest that this region can expect. Earthquakes of this nature and scale occur relatively frequently along the West Sumatra coast. An expected larger earthquake along the offshore subduction zone could generate a greater level of shaking intensity that new and repaired buildings in this region need to be capable of withstanding. The team identified that a combination of overall strategic guidance (from national level) and specific building implementation guidance (at provincial and local levels) was required in order to 'Build Back Better' during the recovery phase, and made specific recommendations to achieve more appropriate standards of new construction. The principal recommendation was to establish a process for the independent review of designs for building repairs and reconstruction, and for the monitoring of construction activity to provide reassurance that new construction is indeed 'built back better'.

4. SUBSEQUENT INVOLVEMENT OF NEW ZEALAND EARTHQUAKE ENGINEERS

As the NZ Engineering Team departed Padang, an international team of 13 engineers from Australia, New Zealand and Singapore, together with an expert team of eight university teaching engineers and 32 engineering students from Indonesia, arrived to undertake a three-week survey encompassing 4,000 buildings in the earthquake-affected region. The expenses for this project were funded by the intergovernmental Australia-Indonesia Facility for Disaster Reduction, and the team included one of the NZ Engineering Team members (Dick Beetham) and Dr Jason Ingham from University of Auckland.

The Australian and Indonesian-led International Team used groups of 4 to 5 to undertake inspections of damaged structures and interviews with occupants. Their objectives were not to make rapid structural assessments, but rather to gather and record information on damage and damage levels in different types of structures and situations, for a survey and analysis of building damage in Padang, ultimately for an enhanced understanding of the vulnerability of buildings to earthquakes in Indonesia. Although the goals of the New Zealand and the International teams were quite different, the damage information that was gathered by each team was similar, and the NZ Team member who joined the International team spent a significant proportion of his time with the International team merging the New Zealand-gathered data into the international survey. The International Team exit report (Weller, 2009) makes findings similar to those of the NZ Team as recorded in Bothara, Beetham *et al.* (2010).

Further discussions between Earthquake Engineering and Natural Hazards NZ and NZAID following the return of the initial team led to a subsequent assignment for four New Zealand engineers during the period December 2009 to February 2010. Funded by NZAID through UNDP, this mission undertook various tasks to build upon the work of the initial team, including:

- More detailed advice on the safety of buildings,
- Recommendations for rehabilitation,
- Preparation of a database for GIS,
- Preparation of a rural house post-earthquake assessment form, and
- Development of ideas for 'building back better'.

5. LESSONS AND RECOMMENDATIONS

The lessons brought back by the NZ Engineering team to Padang cover both future international deployments and enhancements to the processes in New Zealand for post-disaster building safety evaluation.

5.1 Future International Deployments

This mission was the first time that a team of New Zealand engineers had been operationally deployed outside the Pacific region following a major disaster event. The work undertaken by the team and subsequent involvements have underlined that New Zealand earthquake engineering knowledge and experience can be of considerable value in post-disaster situations.

A number of practical lessons in relation to engineers working overseas in post-disaster environments have been derived from this mission, and these will inform the planning of future deployments.

In more challenging conditions than this team encountered, a greater level of logistical support in-country would be required. A critical success factor for overseas deployments is having a suitably resourced and dedicated New Zealand-based support team, as was the case for this mission. For international deployments to countries where English is not the first language, early engagement of quality translators is vital, as was the case in Padang.

There is a need for standard and readily identifiable high-visibility vests and safety helmets to be provided to team members. These require preparation well in advance of deployment. Suggested generic wording is 'New Zealand Earthquake Engineering Team', noting that this form of identification can cover both operational and learning from earthquake missions.

The scope of the mission in terms of team deliverables needs to be carefully set and monitored against the expectations of the local agencies during the deployment. A New Zealand team working in a post-disaster context needs to establish clearly who they are working for in-country. While this mission was organised and tasked through the UNDP, much of the practical day-to-day interaction was with the Municipal and Provincial Public Works agencies. There was a regular need to balance the requirements of those local agencies against the broader objectives and priorities of the recovery process as organised by UNDP. It is, however, acknowledged that there are considerable pressures to change the scope of the work in a post-disaster situation, as the needs and hence expectations of the host country can change with time.

For example, while 'Build Back Better' is a good objective for the reconstruction phase, an undue focus on this can affect the emphasis needed for early rapid evaluation of building safety, which is the initial priority.

Another example relates to the provision of advice regarding repairs and demolition. There is a need to ensure the objectives are clear and, where possible, aligned with local expectations regarding output. The guiding questions here are: "What information is to be provided, and to what level of detail?" Similarly, the question of what level of damage indication is to be provided, and the level of any repair cost estimates needs to be addressed prior to the team's arrival in the affected country.

There is a need to be mindful of the level of earthquake engineering knowledge and experience of those who will be subsequently using the New Zealand team's output. With the benefit of hindsight, the New Zealand team realised that we tended to describe measures in terms useful to an experienced earthquake engineer, forgetting that we were trying to help less experienced personnel.

The practicality and desirability of New Zealand teams issuing or posting placards in another country also needs consideration. This is only really practicable if the local jurisdiction(s) have implemented an agreed form of placarding.

5.2 Enhancing New Zealand's Arrangements for Building Safety Evaluation

In terms of the outcomes for New Zealand, an enhanced practical and implementation knowledge of effective processes for evaluating building safety after a disaster has been gained from this project.

The NZ Engineering team has made the following recommendations to enhance New Zealand's post-disaster building safety evaluation arrangements:

1. Each New Zealand local authority should prepare specific arrangements for managing a building safety evaluation operation that may extend over several weeks in the event of a major earthquake or other disaster, as outlined in the NZSEE and DBH Guidelines document (NZSEE, 2009).
2. Local authority arrangements should include a default priority list of buildings to check as part of their initial building safety evaluation response. As well as assisting the initial local evaluation teams, a list of this nature will greatly enhance the prompt utilisation of out-of-region resources.
3. The data spreadsheet and database developed for the Padang mission should be converted into a form suitable for use by any New Zealand local authority (and for future overseas deployments).
4. The NZ Level 2 Rapid Assessment Form should be updated to incorporate the new features from the Padang forms, including the addition of Usability Categories.
5. Other elements of the NZ Building Safety Evaluation package should also be updated, including:
   - the Guidelines for Territorial Authorities base document,
   - the draft Field Guide and accompanying training material for Building Officials with illustrations of typical earthquake damage,
   - Preparation of an on-the-day induction module and Level 2 Rapid Assessment training module, to build upon the existing training courses that have been delivered in Dunedin, Christchurch, Wellington and Hastings.

The Department of Building and Housing has subsequently provided funding to implement recommendations (3), (4) and (5). An updated version of the 2009 Guidelines document and associated material is due in the second half of 2010.

6. CONCLUSIONS

This mission and the subsequent involvements have underlined that New Zealand earthquake engineering knowledge and experience can have considerable value in post-disaster situations. It has also shown that experienced Chartered Professional Engineers with a broad knowledge of structures, seismic design and earthquake engineering can quickly become familiar and confident with building safety evaluation processes.

The NZ Engineering Team gained many practical insights on how the post-disaster building safety evaluation process is applied in a city with widespread damage. These insights will greatly assist in the enhancement of arrangements in New Zealand.

The complexity of managing a post-disaster building safety evaluation process has also been highlighted. The recording and management of field data from a building safety evaluation operation is a substantial task, and its effectiveness will typically define the success or failure of the operation. There is a considerable level of preparation required by central government agencies (for both on-shore and off-shore events), local authorities and the engineering profession. Each New Zealand local authority should prepare specific arrangements for managing a building safety evaluation operation that may extend over several weeks in the event of a major earthquake or other disaster. Local authority arrangements should include a default priority list of buildings to check as part of their initial building safety evaluation response.

The basic data management spreadsheet and database developed by the NZ Engineering Team in Padang is considered suitable for use as a common tool by New Zealand local authorities. The US-based NZ Level 2 Rapid Assessment Forms can also be enhanced by the addition of the six Usability Categories developed for the Padang deployment.

As with all off-shore disaster projects and reconnaissance missions, the knowledge gained by the individual team members and heightened awareness that they bring back to their offices and colleagues cannot be underestimated. Although not quantifiable, it is of considerable value to New Zealand.

ACKNOWLEDGEMENTS

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Individual team members would also like to acknowledge the support of their employing organisations during the course of this volunteer assignment.

The assistance of representatives from NZAID, the NZ Society for Earthquake Engineering, and Earthquake and Natural Hazards New Zealand in preparing the team in New Zealand and supporting it while in Padang is particularly appreciated.

The team of six local Padang translators provided dedicated service to the NZ team, and undertook a range of tasks in addition to spoken and written translation. Our team could not have done our work and produced our outputs without their extremely valuable contribution.

The authors are grateful to NZAID for this opportunity to offer assistance and to learn as professional engineers.

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