



Building permit structural checks for seismic safety in developing countries

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ABSTRACT

This paper responds to the situation where local governments in developing countries have no mechanism for structural checks, particularly for low-rise buildings. This lack of quality assurance applies to both building permit applications and subsequent construction. Buildings cannot be expected to be structurally-safe, especially during earthquakes if there is no quality assurance at each of these stages.

There are many reasons for the current neglect of seismic safety by local government building departments, but an important one is their lack of technical resources. This can be due to a lack of qualified personnel and or inadequate numbers of staff to cope with building permit applications and consequent site inspections.

The paper reviews how local government building departments in New Zealand and in other countries face similar personnel constraints but have found ways to overcome them. Using in-house structural engineers and by forming partnerships with structural engineering consultants, building permit applications receive structural checks for seismic safety. The paper reviews some of these approaches in the hope they might be modified for adoption by building departments in developing countries. Of course, significant mitigation of seismic risk for housing and other low-rise construction requires more than a well-functioning structural checking system, but the introduction of such an activity represents an important step towards achieving seismically-safe buildings in developing countries.

1 INTRODUCTION

Many, if not most low-rise buildings in some developing countries do not receive any structural check at the building permit application stage. Local authorities (LAs) may check for compliance with planning and other regulations, but there may be no consideration of structural safety in the process. Consequently, the designs

of many buildings do not comply with national standards, and even if they do, a lack of quality assurance on the building site means that no one can have confidence that a newly-completed structure is safe, especially in the event of a damaging earthquake. Regarding design documentation, design flaws are possible at all stages of a design, beginning with an inadequate structural configuration, such as a soft-storey, through to non-compliant detailing, such as column ties being too small in diameter, spaced too far apart, or detailed with only 90 degree rather than 135-degree hooks.

The purpose of this paper is to review alternative models relevant to building departments of LAs so that permitted buildings are structurally sound. A traditional model, used by LAs in some countries, involves structural checks undertaken by structural engineers on the staff of the LAs. However, there are several serious issues to be overcome such as finding, keeping and developing such staff, and now some LAs commission local consulting engineers for this task. The paper argues that this second and more recent approach could be better in the context of developing countries.

The paper continues with an overview of the situation in New Zealand, and the practice in another country recently visited by the author, Croatia. These reviews also serve as a reminder of the complexity and challenges involved in achieving structurally-safe buildings. In both these countries structural checking as part of the building permit process is far from perfect and may be in need of significant improvement. Then, after outlining a very promising approach being taken by several LAs in Nepal, the findings of an international study conducted by the World Bank are presented and discussed. These are followed with some recent developments from the UK. Finally, after discussing the pros and cons of different approaches, the paper concludes with recommendations for consideration by LAs in developing countries.

2 STRUCTURAL CHECKING OF BUILDING CONSENT APPLICATIONS IN NEW ZEALAND

Currently, New Zealand LAs adopt a range of approaches towards ensuring structural safety at the stage of building permit applications. For most, if not all LAs, the process of attending to structural safety begins with the designer submitting full documentation including calculations and a producer statement (PS1). This document, whose template is available from professional bodies, and sometimes from LAs themselves, is completed and signed by the designer. The designer, whose evidence of competence is his or her registration by a professional body, certifies that the work complies with the relevant aspects of the New Zealand Building Code. The PS1 provides a LA with an initial degree of confidence that the design is technically sound. However, for all but the simplest and lowest-risk structures, such as houses, this ‘self-certification’ is deemed insufficient evidence of quality assurance. Further evidence is required. In many cases the building permit applicant must provide a second producer statement, a PS2. Signed off by an independent structural reviewer after a structural check, it confirms that the design complies with the New Zealand Building Code. Finally, a Regulatory Review will be undertaken by or on behalf of the LA.

Most LAs are fully satisfied when the two producer statements PS1 and PS2 are received. Yet in situations of higher risk, such design of a high-rise building, LAs might undertake additional checking with their in-house structural engineers or even request a further review by a second independent consultant. Sometimes the need for a PS2 might be waived and the LA’s own engineers, or commissioned consulting engineers, will check that the design documentation is code compliant. The use of these external consultants is the primary focus of this paper.

As indicated above, each LA handles the structural checking process differently. Often, guidelines are made available to designers to help them meet the requirements for a successful building permit application. For example, the Auckland Council’s guidelines are very comprehensive (Auckland Council 2015).

Regarding the provision of quality assurance during the construction phase, for small buildings such as houses, LA building inspector staff conduct site checks at key stages of construction. Where a structural engineer is involved in a building design, a construction review producer statement (PS4) signed by the engineer monitoring construction must be submitted to the LA when construction is complete. The contractor may also need to complete a construction producer statement (PS3) where the LA has not been involved in construction monitoring.

Table 1 summarises the approaches taken by the LAs in New Zealand’s three largest cities. These notes are based upon informal discussions between the author and structural engineers who are involved in building permit structural checks.

Table 1: Notes on the structural reviews for building permits for low- to medium-rise buildings undertaken by three New Zealand LAs.

City	Notes on structural reviews for building permits
Wellington	<p>No LA in-house structural engineers undertake technical checks.</p> <p>The LA commissions several consulting firms whose chartered engineers act as technical advisors to the LA. The LA takes full responsibility for the work of these engineers who work part-time in the LA offices and use its IT systems.</p> <p>Consent applications are assessed for engineering complexity, and those embodying greater risk are reviewed by a chartered engineer. This review is not as detailed as a peer review, but is a regulatory check that consists of a high-level technical overview.</p> <p>Permit applications must include structural documentation that is accompanied by a producer statement (PS1) signed by a chartered engineer with Professional Indemnity (PI) insurance.</p> <p>For a complex building the LA may require a further review (PS2) in addition to a PS1. If this review, confirming that the design complies with the Building Code reveals matters of concern, then a further partial or full design review will be requested. This situation is reasonably common.</p> <p>Quality assurance of the building consent system occurs at various levels. For example, some structural checks are reviewed by more senior engineers and discussed informally between engineers, and quarterly meetings of the consultants’ principals improves consistency and also introduces some additional degree of quality assurance.</p>
Christchurch	<p>In-house structural engineers undertake technical review. Consulting engineers are commissioned and brought in to help at busy times.</p> <p>The extent of the in-house LA structural review is decided upon after reviewing the design engineer’s producer statement (PS1). LA staff undertake a regulatory (high-level) review and largely rely upon the PS1, but they may undertake a brief overview of submitted calculations and plans. If a more detailed check is required, it is done to a PS2 standard.</p>

Auckland	<p>In-house structural engineers manage approximately 70% of the technical reviews.</p> <p>The LA provides a comprehensive producer statement policy. Engineers submitting producer statements must be registered by the LA and generally be chartered engineers.</p> <p>For low-risk structures the LA will accept PS1s without any further technical review as part of the regulatory review. For medium-risk projects a PS1 and a PS2 is required. The LA accepts the PS2 as an adequate independent technical review and then merely undertakes a regulatory review. For a high-risk project, such as a multi-storey building, both producer statements must be provided. The LA also undertakes a high-level regulatory review, including some checking of structural calculations.</p> <p>Some auditing of design work submitted with producer statements is undertaken to maintain quality of the producer statement register.</p>
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However, despite the processes outlined above, some structural engineers are concerned that more needs to be done to improve structural quality. For example, Davidson (2018) describes how fee cutting is leading to cheap designs that do not always comply with the relevant standards, and therefore compromise safety. He notes that designers are driven to work quickly and cost effectively, but without any drivers “to do anything better”. He suggests introducing a system of random structural audits of building permit applications. The findings of all such audits should be published, presumably with confidentiality safeguards, and would be shared with bodies managing personal professional certification. Random checks would pressure designers to “get it right the first time”.

3 ASSURANCE OF BUILDING STRUCTURAL SAFETY IN CROATIA

All aspects of Croatian design and construction must be in accordance with the 2013 Building Act (Croatian Parliament 2013) which complies with European Union requirements. Quality assurance begins with all designers being registered, based on their qualifications and experience. Special registration, which is more difficult to acquire, is required of engineers who audit designs. Registered engineers and architects, who are members of their respective professional organizations, are required to carry PI insurance. Prior to an application for a building permit, design documentation that includes working drawings, calculations and specifications is audited by a registered structural auditor. Only after any revisions have been attended to is the application accepted by the LA. The LA does not undertake any structural checking prior to issuing a building permit. The competence of the structural designer and auditor is considered sufficient.

The building owner is responsible for notifying the LA that construction is to commence, and advising the LA of the supervising engineer who has been commissioned and who will produce the final detailed and comprehensive construction report.

In a comparative review of the implementation of the Croatian Building Act, one of several factors identified as making the entire building permit process longer, less efficient and more complicated than it should be includes the “lack of project designers’ knowledge (especially legal) and the lack of officials’ technical knowledge” (Jovanović T., Aristovnik A. and Lugarić, R. 2016).

4 AN INTERNATIONAL REVIEW OF BUILDING REGULATORY SYSTEMS

In 2015 the World Bank and the Global Facility for Disaster Reduction and Recovery published “Building regulation for resilience: managing risks for safer cities” (WB/GFDRR 2015). Aimed at low- to middle-income countries, it reviews the current prevailing situation regarding building regulations from both national and LA perspectives and considers all aspects of the design and construction industries. Where addressing building code administration and institutional capacity, it notes that there is often a lack of qualified technical staff in LAs and notes: “many countries and cities fail to make effective use of private resources to augment government regulatory manpower”. The publication urges LAs to collaborate with engineering consultants to have qualified and experienced engineers available for ensuring building safety, at least at the building permit application stage. It also notes many other changes that are necessary for a well-functioning building permit system, and stresses the need for accountability. It is necessary that regulatory policy development, administration and enforcement are subject to public scrutiny so that regulators are accountable for their actions. Oversight procedures must also be transparent.

5 AN INITIATIVE IN NEPAL

The final review regarding improving building safety during the building permit and construction process is from Nepal. There, the National Society for Earthquake Technology Building Code Implementation Program began in 2007 (Shrestha, S. 2017). This initiative responded to Nepalese local municipalities’ lack of appropriate mechanisms and capacities to implement the Building Code. For example, in one LA two engineers were expected to service approximately 400 new building permits per year.

Generally, there was no mechanism for site verifications of drawings leading to most buildings designed and built without regard for seismic safety. In addition to these problems there was:

- “no specific enforcement framework in municipalities, a large variation in progress and accountability of staff
- a need for municipalities to communicate and mobilize masons and building owners
- a lack of political will
- a lack of community representatives on boards of municipalities to increase the will to improve enforcement
- some municipal engineers designing buildings with conflicts of interest
- the public and untrained masons unaware of the Building Code and earthquake- resistant construction techniques, and
- a national database of registered designers and supervisors needed, so designers can design in any city in Nepal.”

An important aspect in the success of the scheme was the introduction of a licensing system for local builders and masons after a four-day training session in earthquake-safe building. The system was strengthened by a reward and punishment system. Masons received prizes and certificates while home owners faced penalties and masons risked being suspended if certain procedures were not followed.

Given the difficulty of structurally checking all buildings, the Nepal Building Code Mandatory Rules of Thumb were simplified to five rules for each of reinforced concrete and masonry buildings. Also, now home owners must be present when registering a building permit and are briefed on requirements. During construction they sign, along with the mason, that compliance has occurred, and the municipality makes site visits. Finally, a simple check list for structural design checking by municipal authorities has been implemented. Designers first complete the list as a type of simple design features report, and if certain criteria are not met re-design is required.

During implementation of this program the following lessons were learnt:

- “accountability of municipal officials, supervisors, masons/ contractors need to be improved by preparing an enforcement framework
- the municipality should mobilize all stakeholders
- municipal engineers should not be engaged in the preparation of drawings
- only use trained masons
- owners need to be made aware of and involved in the process
- a construction monitoring mechanism is needed
- an improved building permit system must be introduced, and
- minimum qualifications for designers of different building types.”

This Nepalese case study could be very useful for other developing countries to learn from. However, it must be noted that the program was reliant upon major funding from USAID.

6 LEARNING FROM UK EXPERIENCE

A recent report reviewing building regulations, with particular attention to fire safety, opens a window on issues that are reducing the safety of the built environment in the UK (Hackitt 2018). The introduction to the report and the executive summary contain some very critical statements regarding the current situation. In her personal introduction, Dame Judith Hackitt writes: “In my interim report published in December 2017 I described how the regulatory system covering high-rise and complex buildings was not fit for purpose. In the intervening period, we have seen further evidence confirming the deep flaws in the current system”. And then from the opening paragraph of the executive summary: “The interim report identified that the current system of building regulations and fire safety is not fit for purpose and that a culture change is required to support the delivery of buildings that are safe, both now and in the future. The system failure identified in the interim report has allowed a culture of indifference to perpetuate.”

The author then proposes a new framework designed to “create a more simple and effective mechanism for driving building safety ..., provide stronger oversight of duty holders with incentives for the right behaviours, and effective sanctions for poor performance ..., and reassert the role of residents ...” The model of responsibility proposed is that building safety is ultimately the responsibility of those who “procure, design, create and maintain.” It is they who must achieve Government-set safety standards to satisfy a policing regulator, and with residents having some input.

The problems exposed within the UK building industry and the recommendations for change have relevance for other countries that desire to improve the safety of their buildings. The Confidential Reporting on Structural Safety scheme (CROSS), whose reports were studied as part of the review mentioned above, offers a list of hazards, albeit deliberately incomplete, leading to unsafe buildings.

In introducing the list, the SCROSS committee states (SCROSS 2017): “Human error is persistent and invidious. People make mistakes, take short-cuts, are put in a role they are not qualified to undertake, fail to carry out effective checks, fail to ensure they are understood, fail to understand what others have done, and fail to ensure design interfaces are defined and controlled (‘I thought someone else was doing that’). Checking procedures break down, audits fail to detect errors, safeguards fail to operate, quality management systems and procedures are circumvented. Complacency, lack of knowledge, programme and commercial pressures all play their part in generating hazards.”

7 DISCUSSION

This paper reviews current practice with respect to structural safety checking for building permits beginning by considering New Zealand practice. Although each city takes a slightly different approach, certain commonalities exist. For example, to some extent each LA uses external structural engineering consultants for structural checking. In Wellington, consultants check 100% of building permit applications. In Auckland, they deal with approximately 30%. The consultants function as co-opted LA staff. Much of the checking undertaken by the LA, either with in-house or consultant-provided technical resources, is a high-level regulatory review given that a designer has submitted a Producer Statement (PS1), and in some cases a PS2, or obtained a peer review by an independent consulting engineer. Consulting engineers are required to undertake construction monitoring.

In Croatia the model is different. For a building permit application to be accepted by the LA the structural design must be reviewed by an independent engineer. The LA accepts the competence of both the designer and the technical reviewer. Once construction commences, consultants are responsible for construction quality, and the LA limits its involvement to administration.

Note that in both Croatia and New Zealand, structural engineers must demonstrate technical competence in order to become registered by their professional body. Also, in both countries, engineers must carry PI insurance to protect their clients. Another common feature is that both countries insist upon quality assurance during construction. Generally, consultants are responsible and liable for construction quality, but in New Zealand LA technical staff undertake construction checking of small buildings, such as houses.

Even though these two countries implement structural checking systems, the paper shows evidence that there is still plenty of room for improvement. Clearly, a similar situation occurs in the UK, and no doubt every country can learn from its recent experience and subsequent reports.

Given that the focus of this paper is on developing country LAs using consulting engineers to help improve building safety, two sections of the paper are particularly relevant: first, the World Bank Group and GFDRR report. Based on in-depth knowledge of construction industry practices in developing countries the report takes a very positive view of local consultants providing technical resource for LAs. Where a LA has inadequate resources then this is a viable means of improving structural safety. Finally, there is much for a developing country to learn from the Nepalese initiative. Rather than LAs employing structural consultants, structural documentation and checking has been simplified. Although the Nepalese construction culture and permitting processes are very different from those in say New Zealand and Croatia, some themes emerge that are common to all countries. These include professional registration of designers (and contractors, including masons), the need for construction quality assurance, and finally the need for transparency in the building permit application process, again reinforced in the UK reviews.

8 CONCLUSIONS

The case-studies and resources drawn upon for this paper show that LAs take the issue of building structural (seismic) safety very seriously, most likely due to legislative requirements. Regulatory processes, that begin outside the authority of LAs, such as registration of designers, aim to ensure structurally-safe designs and quality assured construction.

LAs have different approaches towards using either in-house technical staff or external consulting engineers. One way may be no better than another, and perhaps *all* technical checking is left to professionals outside of LAs who then just administer the process. But whatever approach a LA in a developing country, or any country for that matter, embraces, a crucial goal of the building permit process is that building designs comply with local code requirements and are therefore safe, and that construction is in accordance with checked design documentation.

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