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Improving building safety in Indonesia through regulatory controls: a survey of building industry stakeholders

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Abstract

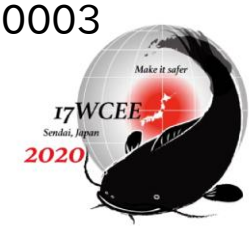
The introduction of Indonesia's first seismic code was almost forty years ago. Quite recent changes have been made to upgrade it and other material design codes, such as those for reinforced concrete and structural steel. However, both informal observations of construction details on building sites, and thoroughly researched as-detailed and as-built site analysis shows that the current standard of earthquake safety of new buildings remains low. It is clear that most buildings contain design and detailing features that do not comply with the Indonesian standards and therefore make the buildings vulnerable in the event of a damaging earthquake.

In order to improve existing practice, we explore the gap between code requirements and what is built on site by focusing upon the role played by building regulations. Our aim in this phase of the research is to determine the current situation regarding the role of building regulatory processes in helping achieve earthquake-safe buildings. We seek to understand the experiences of some groups of stakeholders in the building industry, namely civil and structural engineers, architects, contractors and building owners. The collected information from people with first-hand experience of the building process enables an accurate understanding of the current situation and means a base-line can be established, against which progress can be evaluated at some time in the future.

The research methodology consisted in surveying the stakeholders listed above. They were located in one large Indonesian city in Java, Yogyakarta. A group of 139 people was personally interviewed by senior architectural students as part of their course work. Of the twelve questions that comprised the survey, most focused upon the role of local building departments in helping to achieve structurally safer buildings. This focus upon building departments is because of their roles in implementing the procedures of building permit application and other requirements.

The detailed findings of the survey are provided in the paper. The effectiveness of building departments to ensure that the structures of buildings comply with the relevant codes of practice is outlined. It appears that gaps in the current regulatory processes require considerable attention if new buildings in Indonesia are to perform safely in earthquakes. The paper concludes with a number of suggestions for improvement. These, that not only apply to local government building departments, but to design professionals as well, are intended to lead to a more sustainable future for Indonesia.

Keywords: buildings; regulations; codes; building department; Indonesia



1. Introduction

This paper seeks to address the current situation where, in many areas of Indonesia, new buildings that may be unsafe in earthquakes are being constructed. By using the term 'unsafe' we mean that the requirements of Indonesian codes of practice are not being implemented. This discrepancy between code requirements and what is under construction may begin at the design office, but it is clearly observed on building sites. Any experienced engineer passing-by buildings under construction, be they using reinforced concrete (RC) or structural steel, can observe deficiencies. For example, the bending of column ties in RC columns use 90-degree hooks rather than the code-specified 135-degree bends. There is usually also a lack of confining steel in the way of additional ties or stirrups. This reinforcement is intended to enable a column to be damaged but not collapse during a medium-to-large earthquake.

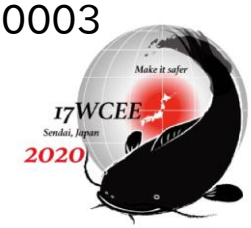
This serious situation has been confirmed recently by detailed research in the Sumatran city of Padang [1]. In this study that was completed in 2017, researchers visited the sites of 47 multi-storey buildings under construction. In a very detailed and thorough manner they compared the as-built details with those specified in the appropriate and current Indonesian codes. They focused on a total of 27 reinforcing details. On many, if not most buildings sites, reinforcing details that were crucial for earthquake-safe performance did not comply with the codes.

The current situation of unsafe new buildings is not uncommon internationally. In other countries high levels of disregard for building regulations are also observed. Unfortunately, this type of non-compliance results in more deaths, casualties and damage in an earthquake and this has been demonstrated by comparing the outcomes after two different earthquakes of similar size [2]. This document presents a vision for transforming a country's whole building sector, especially local building departments. It sees a building department managing the core functions of building technical assistance including plan review, site inspection, permitting and enforcement, and this is what is new: "with the goal of facilitating voluntary compliance." Advisory services will be provided to informal sector builders. To achieve this vision local building departments' will need to modify their mission statements to become less self-serving and concentrate and take pride in helping their cities be safer during an earthquake that one day will strike. It is also assumed that there will be knowledge sharing between building departments and means to help them improve efficiency and to measure their effectiveness against their goals.

This compelling vision of the roles of building departments to achieve earthquake-safe buildings has been the inspiration for the research for this paper. Consequently, the survey questions were orientated towards the role and performance of building departments. Further, we hope that our results will complement future planned research intended to following up on the World Bank Document mentioned above [3,4]. The reason is that these Building Regulatory Capacity Assessments are mainly based on data obtained from bodies like the building departments themselves, rather than the other important and affected stakeholders involved in the building process, such as civil or structural engineers, architects, contractors and building owners. The findings of this paper can therefore sometime in the future, at least partially, complete a triangulation of the vision for transformed building departments, the capacity assessments from the perspectives of those building departments, and the experiences of the other stakeholders.

2. Survey Form and Process

Ideally this survey would have been completely random. To a large degree we believe this is the case, however the respondents were not selected by randomly using a statistically-robust procedure. Rather, groups of senior architecture students from the University of Gadjah Mada, Yogyakarta, were allocated a group of stakeholders, say architects, and then each student had to find an architect willing to complete the questionnaire. Any bias in the respondents therefore arises from the fact that the respondents could be expected to have some links to the students. Although the extent of this bias is unknown, we do not believe it to be significant.



The full survey form is shown in Appendix 1. After explaining the purpose of the survey, a short introductory paragraph sets the context for the survey by advising the respondents that their city is in a seismically-active region where buildings will be damaged and possibly collapse during an earthquake. In a simplified fashion, this introduction also defines safety as "buildings that comply with Indonesian codes and standards".

It was decided to use just one survey form for each of the four targeted stakeholder groups. This meant that although all the questions are relevant to professionals like civil engineers and architects, several questions were less relevant to contractors and even more so for building owners. For example, building owners would have found the question "Are you required to be licensed or certified?" to be irrelevant.

3. Survey Findings

After ignoring several survey forms that had been completed inappropriately, the following analysis is based upon 139 respondents of whom 21 were civil engineers, 37 architects, 44 contractors and 37 building owners. The findings from each group are considered in turn.

3.1 Civil Engineers

The sample consisted mainly of experienced engineers. 65% had practiced for at least 11 years. As far as the scale of construction was concerned, almost 50% of these experienced engineers were most familiar with buildings four-storeys and higher, followed by domestic construction up to three floors, and then two- to three-storey non-domestic buildings. As might be expected, the less experienced engineers had more experience in low-rise construction.

Over 90% of the engineers stated that they were aware of regulations for building design and construction. A similar percentage of senior engineers (11 years or more of experience) said they were required to be licensed or certified, however only 60% of less experienced engineers fell into this category. The survey did not explore the nature of the license, nor the criteria for obtaining one.

Regarding responsibility and accountability with respect to assuring compliance with building-related legislation, over 85% of the respondents agreed they played these roles. However, less than 70% had any formal education regarding earthquake-resistant construction. Several mentioned their knowledge was gained from their undergraduate or post-graduate education.

In response to the question "Do you believe building regulations are known and enforced in the city?" most disagreed, including 61% of the senior engineers and 88% of those less experienced. Regarding the knowledge of regulations, one engineer commented reasonably:

"only engineers need to know the codes", while three others focused on the enforcement part of the question:

"most contractors do not follow these rules",

"A design can be done by anyone including ordinary people. It is still accepted/approved without being examined properly – if there is money, then the building permit can be issued", and

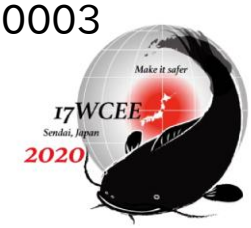
"Application is still lacking in low-rise buildings, especially in small cities".

The engineers were reasonably evenly divided over whether they believed that their Building Department had carefully reviewed their calculations and other documentation for regulation compliance. The following statements were made:

"Departments in the city usually don't fully understand buildings, sometimes [giving] just a glance, or even pretending to know",

"Limited expertise for checks",

"No more than 50% of buildings will be checked",



"In the regions I don't think it has gone well, especially by looking at the competence of regional officials".

The greatest differences in opinion between senior and less experienced engineers arose from the question "Did your Building Department or anyone else undertake any building inspections related to building safety during construction?" Seventy percent of senior engineers agreed but some qualified their responses by adding comments like:

"Some carry out inspections to fulfill their status mandate, [while] the rest are just formalities looking for 'small amounts of money", and

"But we don't know about their knowledge of buildings, they are not professionals in their fields".

However, only 38% of the less experienced engineers agreed and were far more critical:

"Authorities have not been serious about conducting inspections", and

"Inspections are not carried out in detail and don't deal with technical issues (beam/column dimensions and reinforcement, and most importantly if there is money then the inspections will run smoothly".

The final two questions of the survey were "What suggestions do you have for Building Departments to help achieve earthquake-safe buildings?" and "What are the three most important changes need to be made by yourself or others to achieve earthquake-safe buildings?". The first question yielded many constructive suggestions that were somewhat repeated in answers to the second question. The most helpful suggestions, with those more frequently made listed first, were:

- Disseminate earthquake information more proactively,
- Tighten up engineers' certification rules and publish lists of certified engineers
- Increase the engineering knowledge of officials
- Enforce building regulations strictly
- Share lessons learned from the checking process.

As for answers to the second question, the two most frequent changes suggested were, first, to supervise construction and building materials according to the designs, and secondly, to increase community awareness of earthquake.

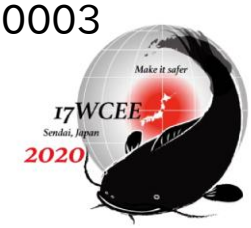
3.2 Architects

Among the 37 architects surveyed, half had 11 or more years of experience. Seventy percent of all architects were most familiar with domestic construction and only 19% were experienced in buildings over four storeys high. They all were aware of the building design and construction regulations, and almost 80% were licensed. Their comments suggested that a license was not needed when designing private houses but that it was mainly used for formalities and to win the trust of potential clients. Almost all the architects acknowledged their responsibilities with respect to complying with building regulations.

When it came to their earthquake design education, 53% of the more senior architects responded positively when compared to only 28% of the less experienced architects. Most noted their knowledge came from their university training and one recalled a reconstruction seminar attended after the 2006 Yogyakarta earthquake. There was a far more even response to the question about the knowledge and enforcement of building regulations. The most frequent comments can be summarized as:

- A lack of dissemination of knowledge about earthquake for both professionals, who need clearer and more easily found information, and the general public, and
- No strict enforcement of regulations.

Concerning Building Departments carefully reviewing plans and calculations, 54% of the architects believed this is not the case. Three negative responses were:



"There has never been a drawing or calculation examined",

"Checks are only made on basic regulatory compliance and not carried out in detail", and

"No – because of human resources limitations".

Half of the architects agreed that had been some type of building inspections related to building safety during construction. Several respondents, including a senior architect, said that they have never had a project inspected during construction. Others mentioned infrequent inspections, kickbacks, improved inspections for government buildings and the crucial role the contractor plays in complying with regulations and arranging for construction supervision.

The architects provided many constructive suggestions for Building Departments to help achieve earthquake-safe buildings. They included, with the most frequent listed first:

- Inform both professionals and public about building regulations,
- Link construction supervision requirements with issuing building permits,
- More stringent regulations and sanctions regarding issuing of building permits,
- Seminars and free advice from Building Departments, and
- Review bribing in the building permit process.

The architects also had many ideas regarding the three most important changes they or others need to make for the sake of earthquake safety. They included:

- Raising social awareness of earthquake hazards and updating knowledge of professionals,
- Implement site supervision,
- Follow design codes, and
- Organizations like universities to develop design guidelines for simple and safe buildings.

3.3 Contractors

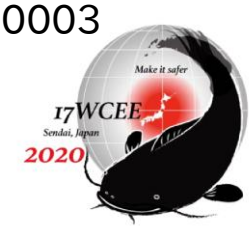
Fourty-four contractors completed the survey. The majority, 59%, can be classified as experienced, with at least 11 years' experience. Just over half the contractors were more familiar with domestic construction while 35% were experienced in buildings four storeys and higher. Almost all of them said they were aware of building regulations and their responsibility to comply with them. Some of them recalled specific regulations and codes. Over 90% of the senior contractors were licensed compared to 67% of those less experienced. Licenses are apparently necessary for government work, and although not mandatory for private construction, they demonstrate competence and help win clients' trust. Approximately two-thirds of the contractors had some formal earthquake engineering education. For some, this had occurred during their civil engineering training.

Nearly 60% of the contractors did not believe building regulations were known and enforced in the city. They commented that many buildings do not have building permits nor comply with regulations due to the additional costs involved. One respondent noted:

"If building regulations were enforced, 80% of buildings have the potential to require demolition".

Yet, a similar percentage (63%) believed that the building department carefully reviewed calculations and building plans. Those who disagreed mentioned lack of human resources, any checks were little more than glances and a lack of detailed checking for low-rise construction. Another reason suggested for a lack of checking was that the responsibility for project documentation is actually the responsibility of the engineer and architect.

Opinion was equally divided regarding building inspections during construction. It seemed that periodic supervision occurred on government projects, but not on private work. Here any supervision appears



limited to a check at building permit stage unless a consultant is involved at the request of the client. One contractor stated his construction sites had never been visited for the purpose of supervision.

The contractors also had plenty of advice to Building Departments to help achieve earthquake-safe buildings. Listed in order of the frequency of suggestions, they included:

- Education regarding earthquake (presumably for both Building Department officials and the public.
- Free assistance to discuss small buildings,
- Obey regulations and be firm in their application, and
- Provide simple guidelines and a checklist for earthquake resistant buildings when granting building permits.

Regarding the three most important changes need to be made to achieve earthquake-safe buildings, the following ideas were the most prevalent:

- Construction to be in accordance with codes and documentation,
- Increase public awareness about earthquakes,
- Improve knowledge about earthquake-resistant buildings, and
- Regulations should be enforced.

One comment that deserves consideration is that community leaders (RWs and RTs in Indonesian society) might have some involvement in monitoring construction.

3.4 Building Owners

Thirty-seven building owners completed the survey. Almost 90% owned low-rise domestic-scale houses and were aware of building regulations, even though some admitted to knowing very little. Regarding being licensed, some interpreted that as possessing a building permit, which they did. Almost 20% of the owners said they had had some earthquake engineering education, and for some of them, this had been part of a degree in civil engineering. Approximately 60% believed that building regulations are known and enforced. Some stated that they just didn't know and others noted that there are many non-compliant buildings, and enforcement of regulations is lacking. The same percentage believed that the Building Department had carefully reviewed design documentation for regulatory compliance, but others commented on careless checking, a lack of construction supervision and building inspections, and on how government officials can be bribed.

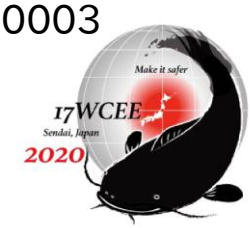
When asked specifically about building inspections for safety during construction just under half the building owners stated that inspections did occur. Comments ranged from noting that a Building Expert Team (for high-rise construction) conducted surveys and that only multi-storey buildings were inspected, to no inspections at all and inspectors being bribed so inspections go smoothly.

The building owners also gave constructive comments to their Building Departments, including:

- Increase awareness of public and contractors to regulations and benefits of earthquake resistance,
- Provide periodic inspections during construction,
- Clarify and enforce regulations, and
- Provide technical advice to the public and outreach with guidelines to achieve safe buildings.

When asked what changes are necessary for achieving earthquake-safe buildings the following suggestions were made:

- Increase public awareness including outreach,
- Use light-weight building materials,



- Use good quality building materials,
- Awareness of soil conditions and the need for strong foundations, and
- Supervision during construction

4. Discussion

In this section we comment on the findings from the questions that are most relevant to the research question at the heart of this paper. Namely, how to improve building safety in earthquakes through regulatory controls. Since the purpose of the first seven questions were designed to enable us to understand the survey respondents, this discussion concentrates on the last five questions. But before moving to them comment must be made on the professionals' lack of formal education regarding earthquake design. Over 30% of engineers and over 60% of the architects fell into this category. It is very serious when so many design professionals lack this knowledge.

4.1 Knowledge and enforcement of building regulations (Question 8)

A large percentage of each stakeholder group believed that knowledge and enforcement was lacking, ranging from 75% of civil engineers to 40% of building owners. Clearly this is an area needing attention. Although most of the responsibility falls on the Building Department, professional associations can also help with public awareness.

4.2 Careful review of calculations and other documents for regulation compliance? (Question 9)

There was a surprising degree of agreement on this question among the four groups. Approximately 60% stated there had been careful review. However, especially for private projects the anecdotal evidence suggests major improvements should be made in the interests of improved building safety.

4.3 Technical building inspections during construction? (Question 10)

Twice as many senior engineers as less experienced engineers agreed that inspections took place. The discrepancy may be due to more frequent and better-quality inspections in the higher-rise buildings that were more likely to have senior engineer input. About 50% of architects, contractors and building owners reported a lack of or inadequate site inspections. Some mention was made of a lack of Building Departments' human resources. Perhaps, like in other countries, Building Departments should consider withdrawing from offering site inspections and formalize a process where this function is undertaken by others, like consultants or construction experts who are properly qualified and licensed to do this type of work.

4.4 Suggestions to Building Departments to achieve earthquake-safe buildings (Question 11)

A summary of the common suggestions from the four groups of stakeholders is presented in Table1. What is of note is that each group wants Building Departments to engage in educational activities. Presumably there is almost nothing of this nature in existence. To implement this suggestion, some restructuring of Building Departments may be required to create sections that specialize in such educational and public awareness raising activities.

All the other suggestions seem totally reasonable. They would be a good place for a responsive Building Department to begin to improve the earthquake-safety of its city.

4.5 The three most important changes needing to be made by yourself or others to achieve earthquake-safe buildings (Question 12)

The summary of the most frequently mentioned changes is shown in Table 2. Like the answers to the previous Question (11), the most urgent change was that of education. That is, both community awareness raising and professional upskilling. The need for improved supervision and generally following codes of practice also feature prominently.

Table 1 - Summary of suggestions to Building Departments to achieve earthquake-safe buildings

Engineers	Architects	Contractors	Building Owners
Disseminate earthquake information more proactively Tighten up engineers' certification rules and publish lists of certified engineers Increase the engineering knowledge of officials Enforce building regulations strictly Share lessons learned from the checking process	Inform both professionals and public about building regulations Link construction supervision requirements with issuing building permits More stringent regulations and sanctions regarding issuing of building permits Seminars and free advice from Building Departments Review bribing in the building process	Education regarding earthquake (presumably for both Building Department officials and the public Free assistance to discuss small buildings Obey regulations and be firm in their application Provide simple guidelines and a checklist for earthquake resistant buildings when granting building permits	Increase awareness of public and contractors to regulations and benefits of earthquake resistance Provide inspections during construction Clarify and enforce regulations Provide technical advice to the public and outreach with guidelines to achieve safe buildings

Table 2 - The three most important changes needing to be made by the interviewees or others to achieve earthquake-safe buildings

Engineers	Architects	Contractors	Building Owners
Supervise construction in accordance with the design Awareness raising in the community regarding earthquake hazard and its effects	Awareness raising in the community regarding earthquake hazard and its effects Site supervision (by engineer) Follow codes of practice Update knowledge for all stakeholders	Construction to be in accordance with codes and the plans Update knowledge of earthquake resistant requirements Awareness raising in the community regarding earthquake hazard and its effects	Awareness raising in the community regarding earthquake hazard and its effects Build using lightweight materials Use good quality construction materials

5. Conclusions

At the beginning of this paper, anecdotal evidence and academic research findings were reported to show how building practices, likely to be unsafe during an earthquake, are prevalent in Indonesia. To a large degree the results of the survey of civil engineers, architects, contractors and building owners in Yogyakarta support that information. The survey shows that the current system for achieving safe buildings is inadequate and in need of significant improvement. A large percentage of the stakeholders interviewed believed that knowledge and enforcement of building regulations, technical review of construction documents to ensure building safety and adequate technical site inspections are lacking.

During the survey, stakeholders were asked to suggest changes that Building Departments could make to in order to improve building safety during earthquake. The inadequacies noted above attracted comment. However, in addition there were many suggestions that Building Departments take on an educational role. Information including earthquake hazard, effects of earthquakes on buildings and building regulations related to building safety should be readily available to all stakeholders as well as the staff of building departments themselves.

The constructive suggestion regarding education was one of many other suggestions listed in Table 1. To implement them in coming years we recommend greater collaboration between Building Departments, universities and professional bodies. It is essential that the theory and knowledge of building safety for earthquake be taught, learnt and then implemented in buildings under construction. Building regulatory processes should promote and aim for correct implementation.

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Appendix 1. The questionnaire used in the survey of building stakeholders

Survey of engineers, architects, contractors and building owners

Please note that this survey is completely anonymous and the form will be destroyed after data from it is extracted.

Purposes: 1. To consider how to improve the safety of new buildings

2. To educate architecture students about achieving earthquake-safe buildings.

Context: Since this city is located in a seismically-active area, in the future a damaging earthquake will affect the city, damaging and collapsing buildings. Buildings that comply with Indonesian codes and standards are considered to be safe in this scenario.

Questionnaire:

1. What is your primary involvement in the building industry? (tick one)

   O Engineer O Architect O Contractor O Building owner O Other ……

2. How many years of experience in the building industry?

   O 0-5 O 6-10 O 11-20 O >20

3. What scale of construction are your most familiar with?

   O single or 2 or 3 storeys domestic O 2 or 3 storeys non domestic O 4 or 5 storeys O > 5

4. Are you aware of regulations for building design and construction? Comments:
5. Are you required to be licensed or certified? Comments:
6. Do you have any responsibility have responsibility, accountability and liability with respect to assuring compliance with building-related legislation? Comments:
7. Have you any formal education, continuing professional development regarding design or construction of earthquake-safe construction? Comments:
8. Do you believe building regulations are known and enforced in the city? Comments:
9. Do you believe your Building Department has carefully reviewed your calculations and or building plans and specifications for regulation compliance? Comments:
10. Did your Building Department or anyone else undertake any building inspections related to building safety during construction? Comments:
11. What suggestions do you have for Building Department to help achieve earthquake-safe buildings? Comments:
12. What are the three most important changes need to be made by yourself or others to achieve earthquake-safe buildings? Comments:

Thank you so much for your participation

