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INQUIRY INTO FURTHER INQUIRY INTO THE REGULATION OF BUILDING STANDARDS

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INQUIRY INTO REGULATION OF BUILDING STANDARDS

Submission from Stephen Branch

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1.0 Introduction

Reference is made to the NSW Legislative Council's media release dated 1 July 2021 concerning the new inquiry into regulation of building standards. Refer Appendix A for a copy.

I have been a Consulting Structural and Civil Engineer for over 40 years and in that time have witnessed deterioration in the standard of care shown by Consultants, Builders, Suppliers and Authorities. I currently provide Expert Engineering services to assist Clients and the Courts with resolution of the many issues which arise as the result of this deterioration in the standard of care.

I have worked on some 'high profile' cases and without prejudicing any ongoing legal proceedings, will attempt to provide some insight into the fundamental reasons why major design / construction errors occur and the actual / potential consequences of those errors.

My submission includes the following topics:

1. Conditions required for building failure
2. Reasons for increased frequency and severity of building defects
3. Motivation of consultants, builders, suppliers and authorities
4. Shortcomings in current building regulations
5. Recommended improvements to building regulations

2.0 Conditions required for building failure

When I started work as a Consulting Structural and Civil Engineer, the senior Partner of Woolacotts Consulting Engineers told me that all three of the following conditions were required for a structural failure to occur:

1. A structural design error which is not questioned during construction
2. Construction errors in the same area as the design error
3. Overloading of the structure in the same area as the design error

A theoretical example of the above which would most likely result in structural failure is:

1. The structural engineer uses an incorrect scale and under sizes a beam depth by 25% and site staff do not question the design despite the beam depth looking inadequate
2. Reinforcement in the critical moment region is not adequately lapped and achieves only 75% of the bar capacity
3. The beam is overloaded by 50% through stacking of paper files over the beam

The reason all three conditions are required for failure to occur is the actual factor of safety on structural failure is generally between 2 - 3 and it is most unlikely that:

- the design will have less than 75% of the required capacity without someone questioning the design based on experience; and
- the construction will be so bad as to reduce the capacity by more than 75%; and
- the structure will have greater than 1.5 times the design load applied to it.

The result of the above is that for most of my working life there have been very few structural failures in buildings within Australia. Unfortunately, in the last 5 - 10 years the number of structural failures in buildings has dramatically increased and I believe this is because the probability of conditions 1 and 2 occurring has increased for the following reasons:

The probability of condition 1 occurring has increased due to:

- Reduced quantity and quality of design reviews within an organisation
- Decline in the competence of structural engineers associated with reduced mentoring and over reliance on paper qualifications and registration
- Increased use of ‘off-shore’ engineering with less local control.
- Over reliance on computer results which may not be based on actual support conditions and may not provide insight into the impact of local load transfer.
- Lack of building experience of Inspecting Engineers and Builder’s site staff, which reduces the probability of design errors being recognised during construction.

The probability of condition 2 occurring has increased due to:

- Increased use of 'off-shore' materials which are not subject to the same level of control as traditionally occurs in Australia
- Lack of building experience of Inspecting Engineers and Builder's site staff, which reduces the probability of design errors being recognised during construction

The above argument applies to failure of the building structure, however it is also true for failure of other building safety and amenity elements such as:

- Fire safety
- Access and Egress
- Stormwater Drainage
- Waterproofing
- Acoustics
- Condensation management
- Light and Ventilation
- Termite management
- Energy efficiency

In these other elements, the relevant Consultant replaces the Structural Engineer in condition 1 and an extreme event replaces overloading in condition 3. The remainder of the argument remains the same.

For example, a waterproofing failure will occur if:

- The Architect does not understand the impact of wind pressure on water ingress and does not detail sufficient upturn on a roof flashing and the Builder does not question the detail.
- The roofing sub-contractor does not provide sufficient lap to the flashing and does not seal the junction.
- A rain event with strong wind occurs which pushes the rainwater up and over the flashing into the ceiling space.

3.0 Reasons for increased frequency and severity of building defects

I provide the following reasons for the increased frequency and severity of building defects over the last 20 years.

3.1 Reduced quantity and quality of design reviews

When I started in consulting engineering the following design reviews occurred on all projects:

1. Initial sketch design checked by Senior Engineer
2. Final sketch design and detailed calculations reviewed by Chief Draftsman and rejected if incomplete or impractical
3. Input from experienced Draftsman on established normal building details and practical detailing. An experienced Draftsman would recognise an inadequate design and ask questions.
4. Detailed check of drawings by the Engineer
5. Check of final drawing (already amended as required to allow both the Draftsman and Engineer to sign off the drawing) by Senior Engineer / Partner.

Today the process is often:

1. Mark up of Architectural Drawings by the Structural Engineer
2. 3D structural model produced by a CAD Draftsman
3. 3D computer analysis of the model and review of results by the Engineer
4. Continued change of the 3D model in response to other discipline requirements
5. Conversion of the 3D model into 2D drawings which should be checked by the Engineer
6. Possible review of final drawings by Senior Engineer / Partner.

To make matters worse the structural design continues to be changed in response to input from the Builder and their sub-contractors. Some of this input benefits the project, however all of the input changes to original design intent and the impact of the changes must be checked in detail to ensure they do not result in potential failure.

Recent partial structural failure of a high-profile multi-storey residential tower was created to some extent through design change promoted by the Builder. In this case a section of curtain wall was replaced with precast concrete and the Builder promoted the idea that the original concrete columns behind the curtain wall could be deleted as the precast concrete panels could take the vertical load.

In principle this structural change is feasible, however if looked at in greater detail the issue of load transfer from concrete columns to precast concrete walls needed further detailed design and thicker concrete sections to comply with AS3600. This work was NOT done and resulted in partial structural failure after occupation of the building.

3.2 Decline in the competence of building Consultants

I believe there has been a general decline in the competence of building consultants over the last 20 years for the following reasons:

- Reduced opportunities for training in the workplace due to Government Departments no longer having strong internal Architectural and Engineering Departments which offered scholarships and large Consulting firms not training junior staff.
- Reduced wages (relative to other professions) offered to building consultant staff due to reduced fees paid to Consulting firms.
- Increase in 'off-shore' procurement of building consulting services
- Lowered prestige of building consulting as a profession
- Poorer calibre of students entering the profession
- Increased time pressures in the building industry which minimises the time available to train junior staff

This decline in the average level of the competence of building consultants increases the probability of design errors being made and reduces the likelihood that those errors will be picked up and corrected before drawings arrive on site.

3.3 Over reliance on computer results

The extensive use of 3D drafting models which are used as the input to 3D structural analysis and design packages, removes the experienced structural engineer from the process of confirming the veracity of the computer model and the results provided.

One very simple example is the analysis and design of an arched footbridge provided to me by a junior engineer. The bridge spanned approximately 30m and the proposed design had beams of only 300mm depth. My response was that the design was grossly inadequate, however the junior engineer showed me the computer output which confirmed acceptable bending strength and deflection of the structure.

We worked through the computer output and discovered that the arch form of the bridge had been modelled with infinitely stiff (pinned) end supports which transferred most of the structural action into high compression loads in the beams resulting in large buttress forces at the supports. This

design assumption was flawed as the foundation conditions did not allow infinitely stiff end supports and once the end supports moved the bridge would collapse.

This is a simple example of how mis-leading computer analysis can be if unrealistic support conditions are accidentally included in a 3D model.

Another theoretical example is a multi-storey building structure is analysed in 3D with the structural elements such as concrete columns, walls, slabs and beams being designed automatically. The results for each structural element can meet the requirement of AS3600, however failure (and non-compliance with the bearing requirements of AS3600) can occur through local crushing / splitting of concrete in the areas where load is transferred between structural elements.

3.4 Inspecting Consultants and Contractors lack of experience

When I started in consulting structural engineering, our company had a full-time experienced engineer who inspected all of our projects during construction. He had the knowledge and experience to deal with contractors who wanted to take short cuts and to question any design items he believed were impractical or simply inadequate. Therefore, we had confidence that our design intent was implemented and obtained feedback on the quality of the design we provided.

Today there is pressure on consultants to spend less time on site as the fees available for the structural engineering construction services have been reduced from approximately 0.25% of actual project cost to less than 0.10% of project cost at the time of project inception.

In my opinion the effort required to ensure compliance of construction with the approved design has not decreased, however most structural engineering consultants have reduced their input during this stage by a factor of 2 to maintain profitability. This has been done by reducing the number of inspections, reliance on site photographs and Builder's quality assurance records, using junior staff for site inspections etc. There is no doubt this has contributed to the increase in the number of building defects.

Not only has the effort by consulting engineers reduced, but the quality of the Builder's site supervision staff has reduced. These staff tend to be sub-contract managers rather than site staff with years of building experience. The competence of some Builder's site staff is so poor that I have had to show them how to read structural drawings.

Ten years ago, it was necessary to explain to an aggressive young site engineer why a dotted outline meant that the nominated vertical structural element (such as a load bearing wall) was below the plan element (such as a slab). After this episode, we added a note to our drawings to advise that the drafting conventions used on our drawings conforms with AS1100 Technical Drawing to avoid any future contractual arguments.

3.5 Increased use of ‘off-shore’ materials and fabrication

Builder’s often source materials and fabricated building elements from overseas because it costs less. This has resulted in some spectacular failures due to the testing, certification and the ethics of some of the overseas suppliers not being to the standard we have traditionally enjoyed in Australia.

Most technical specifications will no longer accept certification of compliance provided by overseas companies and require testing and certification within Australia. In my experience this has been particularly necessary for structural steel and steel bolts, but it is also part of the reason we now find it necessary to replace large areas of building cladding.

A well-documented failure of high strength steel bolts resulted in all of the bolts in a very large industrial complex needing to be replaced at great expense after the complex was operational. The first sign of a problem was bolts fracturing and falling out of the large span steel portal frames onto the floor of the operational industrial complex. Testing of the bolts eventually showed that they did not comply with the ductility requirements of Australian Standards despite being supplied with test certificates which stated they did.

One very good example of the potential lack of ethics shown by ‘off shore’ fabricators is that of a fabricated steel truss made from square hollow sections. The trusses were designed by an Australian consultant, arrived in a container, were erected on site and then displayed excessive deflection. The Builder immediately assumed the consultant’s design was the cause of the problem and challenged the consultant to propose rectification at their cost.

The consultant checked their design, could not explain the measured deflection and eventually requested that the wall thickness of the square hollow sections be checked. A hole was drilled in one of the sections and water poured out. The wall thickness was found to be half what was specified with the remainder of the self-weight of the ‘as designed’ truss being made up by the weight of the water. This fraud could have resulted in complete failure and potentially death.

3.6 Over reliance on Certification

Regulation of the building industry tends to rely on certification rather than verification of critical building elements. At their worst, the Principal Certifying Authority simply collects all the required certificates from various consultants / sub-contractors and then relies on their ability to join those consultants / sub-contractors in any legal action taken against them.

This is approach does NOT detect and rectify building defects.

Builders also use certification as a means to justify cheaper (and often non-compliant) building components and will use certification provided by a captive or favoured consultant to counter advice from the clients' consultant.

I have been in the situation where a Builder promoted the use of pile caps with a substantially reduced depth to our design based on an 'alternate' design provided by their structural engineer. Our company reviewed the proposed 'alternate' design and advised our client that the reduced pile cap depth did not satisfy the punching shear requirements of AS3600. The response from the Builder was to suggest that our design was too conservative and that the footings should be taken out of our contract and certified by their structural engineer.

Had this occurred, with the pile caps being constructed to the 'alternate' design, then punching shear failure of the footings would most likely have taken place resulting in dramatic settlement of a portion of the building.

Punching shear design is a very basic concrete design requirement and the fact that the Builder's structural engineer did not understand its importance and was willing to certify their design as compliant with AS3600 is of great concern. It also most probably means that non-compliant pile caps have been used in a number of other projects as this was not the first time the Builder had used this structural engineer to provide a cheaper 'alternate' detail.

4.0 Motivation of consultants, builders, suppliers and authorities

I believe it is important to look at the motivation of the main participants in the building industry to assist with understanding current issues and formulating methods to improve conditions in the future.

4.1 Consultants

In the last 40 years consulting firms have effectively changed from companies run by professionals to companies run primarily for profit.

When a company is run by professionals operating within their area of expertise, the company's main motivation is to provide the best service to their Clients and to ensure that staff who work for them have the required skills and professional ethics required to achieve this goal.

Once a company is run primarily for profit, then the main motivation is to increase the number of projects and increase the speed at which those projects can be closed out. This puts pressure on staff to cut corners and pressure on managers of the company to conduct staff reviews based on project profitability rather than the quality of work produced.

Some good examples of local 'professional' consulting firms being turned in consulting companies making money for shareholders not involved in the provision of professional services are:

- The increased number of company mergers
- Purchase of local companies by large overseas consulting firms
- Increased use of 'off shore' cheaper design and documentation to reduce costs
- Very few scholarships and cadet training offered by consulting companies

4.2 Builders

In the last 40 years Builders have effectively changed from companies run by experienced building staff with in-house building skills to companies run as contract administrators which maximise profit by aggressive use of the cheapest sub-contractors.

When a Building company is run by experienced building staff, the company's main motivation is to provide a quality building that will require minimum long-term maintenance. Return business by reputation is key to success. This approach tends to reduce the number of building defects.

Once a Building company is run by contract administrators, the company's main motivation is profit and being able to litigate against consultants and sub-contractors if profits are not made or building defects occur. This approach does nothing to reduce the number of building defects and tends to increase the amount of legal action post completion.

4.3 Suppliers

Suppliers have always promoted new products, however in the last 40 years they have increased their marketing and have decreased their technical expertise.

There are numerous examples of new products which have, in the long-term, created serious building defects. It has always been the role of consultants to advise Clients on the benefits promised by new products and the risks associated with being effectively the first full scale prototype. Unfortunately, these days the fees available to consulting firms are limited and therefore the time available to counter claims by well organised suppliers is limited.

I have recently had to argue strenuously against alternate products and systems promoted by sub-contractors to Builders as cost saving measures. In one particular case the proposed alternate waffle raft slab formwork system had no structural merit because it did not allow for continuous waffle ribs and therefore provided very limited raft slab stiffness. The supplier was very aggressively marketing their product which had no fundamental structural merit.

4.4 Authorities

Building approval authorities that are paid by Developers and Builders with the primary interest of gaining occupancy certificates as soon as possible are not motivated to delay approval to resolve building defects.

Many of these building approval authorities are content to be collators of certificates provided by consultants and sub-contractors with the prime motivation of ensuring they can join others in legal action taken against them. Certificates do not minimise the occurrence of building defects.

The threat of being de-registered does not appear to motivate the current crop of building approval authorities.

5.0 Shortcomings in current building regulations

In my opinion, the current building regulations will not slow the rate of building defects because of the following shortcomings:

- Concentration on registration of building consultants which will only weed out poor consultants after defects are detected and if de-registration occurs
- Reliance on certification of design compliance
- Builders controlling certification of construction compliance with the approved design.

3.1 Registration of building consultants

In my experience registered consultants can make mistakes OR act in an un-professional manner as readily as un-registered consultants.

While registration may ensure a minimum standard of education and experience, it does not provide a means of weeding out the poor consultants until multiple breaches have occurred. Each breach is most likely associated with significant building defects which cost the community millions of dollars and potentially lives.

Use of a consultants' professional indemnity insurance policy and de-registration of consultants is a post-disaster response. It does nothing to reduce the potential for building defects to occur.

3.2 Reliance on certification of design

Certification of a design is only useful if the consultant acts in a professional manner and does the checking required to back the statements made.

At best it is a record of what was done. At worst it is a fraudulent statement issued to satisfy a hold point and made under pressure from the party paying the consultants fees and providing on-going work.

Once again, reliance on certification of design is simply a means to access a consultants' professional indemnity insurance policy and is a post-disaster response. It does nothing to reduce the potential for building defects to occur.

3.3 Builders controlling certification of construction compliance with approved design

The use of builders as the primary means of certifying construction compliance with the approved design (refer below for an extract from the NSW Design and Building Practitioners Act 2020 No. 7) involves a blatant conflict of interest and will, in my opinion do nothing to reduce the potential for building defects to occur.

> **17 Compliance declarations by registered building practitioners**
>
> (1) A registered building practitioner must provide a building compliance declaration for building work, contractor document and other required documents to a person for whom the practitioner does the building work before an application is made for an occupation certificate for the building to which the work relates.

The traditional method of the Client employing a Clerk of Works who looked after their interests by ensuring the construction complied with the approved design was the most successful process. The Clerk of Works was paid for by the Client and did not have a conflict of interest with the Builder. Unfortunately, this is not generally possible in today's environment and certainly not for most individual private home owners.

6.0 Recommended improvements to building regulations

I recommend the following improvements to the current building regulations to assist with reducing the frequency and severity of building defects. The focus needs to be shifted from punitive reaction to defects and legal action / insurance rectification of defects to **PREVENTION** of defects.

1. Maintain the existing consultant registration system with clarified (currently no clear guidance is provided) and reduced requirements for Professional Indemnity Insurance plus increase individual background checks on actual past project involvement and performance verified by respected senior consultants.

2. Document clear guidelines for discipline and de-registration of consultants, such as:
    - Significant defects on a project resulting in a 'first strike' warning;
    - Second project with significant defects within a period of 5 years, resulting in a 'second strike' warning and monitoring of performance
    - Continued projects with significant defects resulting in a 'third strike' notification and de-registration

3. Ensure that Principal Certifying Authorities (PCA) are NOT employed (and paid for) by Developers nor Builders nor any party that has a conflict of interest in the project.

4. Establish a Building Checking Group funded by a percentage fee (say 1-2% of actual project cost) paid at Construction Certificate (CC) application stage and used for:
    - Independent CC documentation review by a panel of consultants paid at a fixed % rate of the actual project cost to review CC documentation, provide comments back to the applicant and work through resolution of issues raised.
    - Independent construction surveillance by a panel of consultants paid at a fixed % rate of the actual project cost to review the number and quality of site inspections conducted by the developer's team and to undertake additional site inspections as deemed necessary. If the performance of the developer's construction compliance team is deemed inadequate then the developer will need to pay additional fees for further monitoring and site inspections to achieve reasonable compliance with the approved design intent.

    Members of the panel of consultants used by the Building Checking Group will need to be monitored for outcomes of the building projects they undertake and must be truly independent of Developers, Builders and any party that has an interest in the project.

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