Toward Regularising Regulatory Compliance Reviews

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ABSTRACT

Regulatory compliance reviews have been the topic of several recent SESOC presentations. These presentations have focused on the challenges faced by reviewers and the reviewed. In this paper, we wish to present a possibly utopian counterpoint to outline how reviews could become a predictable and ordinary part of the design cycle.

We will briefly recap the regulatory environment and the constraints under which regulatory reviews are carried out before moving on to a proposed structure for navigating these constraints. The paper will comprise four main sections.

Section 1 - Provides an outline of key qualities found in good building consent submissions. This is intended to provide a level playing field, where basic presentation and documentation standards are present to enable efficient review.

Section 2 - Proposes a specific review methodology and framework. We focus on working within the feasible scope for regulatory compliance reviews. This also includes some commentary on the level of expertise, resourcing, and time required to satisfactorily complete the reviews.

Section 3 - Focuses on strategies for reviewing efficiently, asking the right questions, and how to answer those questions.

Section 4 – Provides commentary on common areas of concern and a selection of examples of frequently recurring questions from the last 2 years of structural reviews at WCC.

INTRODUCTION

In December 2022 MBIE released the document ‘Review of the Building Consent System’. This report was based on six-week long public consultation occurring between July 2022 to September 2022. This report summarizes key issues within the building consent system, which are broadly categorized as:

1. Roles and Responsibilities poorly defined and understood,
2. Capability and Capacity constraints within building consent authorities,
3. System Agility not present,
4. Performance Monitoring and System Oversight not being effectively carried out,
5. Fragmented Implementation across the sector,

The MBIE report does not mention any next steps in resolving these issues. The MBIE website states that further ‘Public consultation on options for a new or amended building system’ is to be carried out in 2023. The authors of this paper are not aware that this consultation has been undertaken at the time of submitting this paper.

These issues are not new and have been discussed by representatives from the Building Consent Authority (BCA) and the industry at several occasions over time. The SESOC published ‘Design Review Guide’ in 2019, captures the history of these issues and refers to the ‘Report of the IPENZ Structural Engineering Taskforce Enquiring into the State of Practice in Structural Engineering in New Zealand’, released in 2003, which was a response to concerns raised in the Scarry Open Letter. These documents show that for twenty years the industry has been haunted by the same issues. This does not mean that efforts have not been made to counteract them; instead highlights their complexity and evolving nature. These issues continue to transform and intensify alongside the building industry.

As structural engineers, we are most likely to face these identified issues while navigating our structural designs through the building consent process. These issues are understood best by those submitting consent and those processing it. Hence, it is only natural that the solutions to these issues are developed in close collaboration amongst members of the industry and building consent authorities. In an environment that includes engineers from several backgrounds, tightening commercial demands, challenging architectural features and ever-increasing complexity of tools and procedures, it is of the utter most importance that good ‘filters’ are implemented within the system to catch errors. The Building Consent functions of the BCA provide this filter and is in every engineer’s interest that it functions properly.

The SESOC Design Guide 2019 refers to the EngNZ ‘Peer Review – Practice Note 2’ released in 2018. This document sets the definition for structural reviews conducted by the BCA as ‘Compliance Review’. This document states that ‘*A compliance review does not include a peer review of the design and does not require an engineer with equivalent expertise to the originating engineer’,* and ‘*We recommend that regulatory bodies make it clear what type of review is required when engaging engineers*.’ To the authors’ best knowledge, none of the BCAs around the country has formally published further guidance on compliance reviews, i.e., what do they entail and who is able to conduct them? This accords with the core issue from MBIE’s investigation that there is a ‘lack of coherent and well-defined building consent compliance review framework’: A framework that captures the scope of review and competency of personnel conducting them.

These issues have been tackled by the SESOC Design Guide 2019, which appears to incorporate some consultation with Auckland Council structural engineer. The authors of this paper are largely in agreement with this guide. However, this guide leaves one key aspect of the review open to discussion, that is the scope of review. It states that ‘*Using this Guideline the reviewer should define, and agree with their client the appropriate review scope for their particular project’*. In practice the scope of compliance reviews is seldom explicitly defined before the consent is submitted. Commercial constraints of projects also do not allow much time for these discussions to take place between the client/engineer/reviewer, let alone reach an agreement. The scope of review is then most often at the BCA’s discretion. This creates an unknown in the cost of review, often becoming the sticking point for all parties. The authors of this paper are advocating that the scope of compliance reviews should be standardized to the extent possible. The SESOC guide also implies that such reviews are conducted by a third party, rather than the council themselves. In practice, this is not the case since most consents are for low-risk buildings where reviews for are conducted by the council itself.

This paper builds upon the SESOC design review guide and sets a pre-defined scope of review. It largely achieves this by adapting a methodology similar to a 'qualitative' ISA assessment of existing buildings. It provides a pragmatic means of checking analysis and design through visual means. It relies on the premise that establishing compliance on 'reasonable grounds' does not require knowledge of quantitative compliance on every design component. Such a review makes sense where a PS2 is not supplied and the building consent process functions as a screening tool to look for gross design errors. The basis of this information is shared experience of many consent engineers and reference to various existing guidance documents in the industry, i.e., NZSEE Technical Assessment Guidelines – Part B Initial Seismic Assessment, SESOC Body of Knowledge and Skills, EngNZ Structural Tips and Tricks, MBIE Practice Advisory 6 – Achieve Best Practice Every Step of the Way, and jointly published by NZSEE/SESOC/NZGS Earthquake Design for Uncertainty.

This paper also builds further on the 'standard of documentation to be submitted by the designer'. The standard of documentation is key in order to efficiently and accurately conduct a 'qualitative' review. Focus is provided to content of Design Features Report and Calculations that describe the design. This has also been developed through shared experience of several consent review engineers and by referencing various existing guidance documents in the industry, i.e., SESOC Commercial Design Features Report Template, EngNZ Better Design Documentation and NZCIC Design Document guidelines etc.

While the above paragraphs discuss technical aspects of the compliance review framework, it should also be recognized that the procedural aspects also need attention in order to address all of the issues identified by the MBIE report. The technical requirements of a compliance review require that personnel conducting the review are of high competence level and can qualitatively identify design errors in a fast-paced environment. The councils face several challenges in recruiting such experts and maintaining their mark of quality. This resourcing issue affects MBIE's concerns around System Agility, Performance and Fragmented Implementation. There are various other procedural aspects that also require attention but are not discussed in this paper, such as the timeframes necessary for review, cost of review, funding for review, limiting liability of contracted engineers, streamlining administrative and communication process, etc.

The compliance review framework is far from being fully defined; however, this paper is intended to provide a more specific framework for compliance regulatory reviews in order to steer progress in the right direction.

CONSENT DOCUMENTATION STANDARDS

BCA's receive consent applications from a vast number of engineers with varying backgrounds and design office practices. The direct consequence is varying quality and completeness of documentation. According to the Building Act, the legal requirement is to provide sufficient documentation in order to demonstrate compliance with B1. Over time, the industry has expanded on this requirement and developed a standard for itself through the production of a Design Features Report, logically set out Calculations, comprehensive set of Drawings and Work Specifications.

There is no set standard for these documents, nor a legal requirement for them to be submitted for consent. MBIE document 'Standard order of documents checklist' does provide a list of consent documentation to be submitted and its general intent but it is tailored towards NZS3604-type residential projects and lacks detail on documents that form part of specifically engineered structural solutions. A design submitted with poor quality documentation leads to a higher number of RFIs, processing time, and additional cost to the applicant. Different BCAs have dealt with this underlying problem of variety in different ways, including curating their own lists of approved engineers or requiring widespread use of PS2 reviews to act as a first filter. Engineering New Zealand and SESOC have tried to ameliorate these problems by providing better guidance on the expected documentation standard to the applicants; so that documentation submitted for consent is easy to understand, review and approve. Ultimately, there is a causative link between poor design practices that are inadequately screened by these practices and MBIE's recent reviews of occupational regulation for those working in high-risk areas.

WCC has come up with the following list of requirements that they will interrogate during the initial vetting of the consent. The following list is intended to be as comprehensive as practical, but obviously not all projects will require exactly the same subset of these requirements. The intent is for consenting officers to interrogate whether the intent of the guidance has been applied, with the ultimate goal of clear and easy to review materials submitted for Building Consent. Once this system is established, the aspiration is for those to provide the basis for a conversation between the BCA and the applicant to convey an expectation that projects with poor-quality materials will need to accept longer consent processing time, closer scrutiny of the design, and concomitantly higher fees.

The list below has been developed by reviewing submitted documentation and conducting a study on which projects had a higher number of RFI. The list focuses on calculations, rather than drawings and specifications, because calculations are the basis for producing drawings and are what generate most RFI. Typically, once calculations are correct it is relatively likely that the drawings will also be correct. A good industry standard for drawings is the NZCIC documentation guidelines published in 2008 and 2016. These include plans, elevations, sections and details, with in-depth information on the level of information required. If sufficient construction information is not found on the drawings, then this will be queried by the reviewer. Specifications are not reviewed in detail but are checked in overall completeness for critical aspects to the design (see documentation checklist under compliance review methodology). It is recommended that the designers utilise tools such as Masterspec to submit accurate and consistent specifications.

Design Features Report

- Definition of structural system and form (structural elements and their purpose), i.e., clear explanation of intended gravity and lateral systems.
- Design approach, i.e., analysis type used (linear, response spectrum, non-linear pushover, etc.) with detailed description of modelling parameters.
- For a staged consent, a section outlining scope of various stages. Similarly for an amendment application, a revised report outlining scope of amended works.
- All Specific Engineering Design elements captured,
- Underlying design assumptions, i.e., flexible vs. stiff retaining wall, ductility chosen vs available,
- List of items to be confirmed during construction for retrofit projects, and
- The proposed methodology and sequence of construction,
- Loading and load cases considered (see Part 2 document table)
- Design tools used (e.g., Spacegass, Microstran, Etabs, Ruamoko, etc.)
- Material properties used,
- Summary of geotech parameters adopted (Loading and capacity related, i.e., subsoil class, unit weights, friction angle, bearing strengths, spring stiffnesses etc.)

- Reference to geotechnical report and all other geotechnical guides used, i.e., MBIE Modules.
- Design standards referenced,
- Serviceability criteria set,
- Approach to durability, maintenance, and fire resistance,
- Discussion on seismic gaps, effects on neighbouring properties and underground civil infrastructure, i.e., public drains.
- Proprietary systems utilized and their manufacture design & construction requirements,
- Reference to supporting documentation, i.e., BRANZ research, peer reviewed papers, ASCE or other standards etc.
- Evidence of the verification and validation process used,

We recommend templates by SESOC, EngNZ utilized or other custom template that covers the list of items above.

Calculations

- Readable if handwritten
- Legible computer model snippets, with no overlapping content and explanation notes
- Simple diagrams at the start of main calc section to highlight what is being checked and for what loading
- Consistently marked north-south/longitudinal-transverse axis on all plans within calcs
- Consolidated calculations into sections and sub-sections, i.e., loading (dead, live, wind etc.), lateral design (columns, beams, braces, connections etc.), gravity design (beams, columns, connections etc.)
- All calculation pages uniquely and logically numbered
- Calculations have a summary column on the left or right, clearly stating design outcomes. Summary sketches of all outcomes at the end of each section.
- References to employed standards and other technical literature
- Superseded calculations have been clearly marked and/or omitted from final design package
- Alternate options of design that are not exercised are separated out and the option selected is clearly identified
- Calculations and analysis match the design presented in structural drawings
- Checked all ULS cases and the appropriate combination of loads, i.e. vehicle impact alongside active soil pressure on barriers supported on retaining walls
- Evidence for quality control (independent technical review and verification checks) on calculations and details.

Geotechnical Report

- A site plan and sufficient description indicating location, nature, and extent of all soil/rock/ground water testing being carried out.
- Provides sufficient geotechnical information relative to scope of works being undertaken, i.e., as suggested within Module 2 NZGS/MBIE.
- Provides an inferred subsurface profile interpreting the results from all ground investigations undertaken.
- Provides an assessment of global site stability for natural hazards (as per section 71 of building act), incorporating items such as slope stability, lateral spread and liquefaction.

- Confirms 'good ground' as defined by NZS3604, or establishes bearing capacities for structural design.
- Confirms site subsoil class (as defined by NZS1170.5) for the purposes of earthquake loading.
- Confirms soil expansiveness class (as defined by AS2870).
- Lists geotechnical parameters for the design of retaining walls, rock/soil anchors and foundation design.
- Provides Geotech analysis input and output parameters as appendix to the report.
- Incorporates requirement for review of final structural plans by geotechnical engineer and inspections during construction.
- Incorporates other key aspects noted in geotech report template produced by NZGS (TBC)

Producer Statement – Design (PS1)

- Check fully filled out and credentials of engineer on CPEng register, i.e., right practice area
- VM4 noted, if design includes retaining walls and foundations
- Appropriate level of construction monitoring recorded for the project
- All lists and schedules referenced, are attached
- Schedule of inspections is attached
- B2 statement is attached
- Highlights any specific exclusions from design

Producer Statement – Design Review (PS2)

- Peer review scope provided with coverage and exclusions
- Peer review comments register provided for review
- Peer review letter provided highlighting any outstanding actions by the designer and any matters of varying engineering judgement between designer and reviewer.
- Review of B2 statement and its application within the design documents
- Signed DFR, Specification and Drawings, or a list of schedule clarifying, which documents (and their revisions) have been peer reviewed.

REGULATORY COMPLIANCE REVIEW METHODOLOGY

Building Consent Authority (BCA) processing of structural engineering design has evolved over the last 10 years, predominantly following the 2010-2011 Canterbury Earthquake Sequence. In the past, it was a simple exercise of review by administrative staff for completeness of documentation and correct filling of producer statements. This has changed to high-level specific engineering design review by BCA-engaged chartered structural engineers. This has created additional challenges for the consent processing, namely the extent/depth of review to be carried out; and the time to be spent on the review. BCA's carry liability for the consents they approve; and are thus practicing within their rights to modify the 'depth of review' necessary to minimize their own risk.

The objective of a BCA 'Regulatory Compliance Review' is to be satisfied on *reasonable grounds* that the design is compliant with B1. It is a compliance assessment using a 'qualitative' rather than a 'quantitative' approach. The rate at which BCA is tasked to process consents is much faster than that to design the building. Under this framework, the BCAs role is to conduct a 'concept to preliminary' level review of the structure and raise potential concerns with the design engineer. It is then the responsibility of the design engineer to address those concerns with their design rationale and substantiate their claims with quantitative (calculations, analysis) evidence. Once the BCA is satisfied with the design rationale and the quality of quantitative evidence supplied, then that particular concern can be closed out. If left unresolved, BCA retains the right to reject that consent application. If a peer reviewer is involved in the process, the BCA will also require that the design rationales and any additional quantitative work conducted be reviewed by the peer reviewer. The peer reviewer must have oversight on the job, until the end of the consenting process. This is required, as BCA-appointed engineers do not have the time availability to dig deep into quantitative aspects of the design themselves.

Reviewing at a 'qualitative level' can vary between engineers. This is contributed by several factors ranging from; defined scope of review; process and methodology adopted; time and funding constraints, competence level of reviewer; differences in engineering judgement; communication/administrative procedures adopted etc. Furthermore, no known guidelines have been published by any engineering society on the BCA 'Regulatory Compliance Review' process; which leaves all the above factors open to personal interpretation. The industry belief that such reviews are simply 'administrative' is no longer applicable. BCAs are engaging chartered professional engineers for consent reviews, in order to meet their desired outcome of limiting risk and liability. Yet, there appears to be no framework set in place for such reviews to be conducted consistently and efficiently. WCC is taking steps to ensure that engineering reviews are consistent and that requirements are clearly communicated to the industry. WCC BCA is committed to put measures in place to ensure engineering compliance is being established with high standard.

Hence, it is recognized that urgent attention is needed to develop consistent procedures for BCA 'Regulatory Compliance Review' of structural engineering designs. This starts by recognizing, that such reviews can only be carried out by experienced chartered professional engineers or under their supervision. The process that has to be applied is akin to 'IEP' assessment of earthquake vulnerable structures and requires high level of good engineering judgement (see NZSEE Assessment Guidelines, section B3.3 - experience required). The process aim should be to establish if there is sufficient 'evidence of compliance', i.e., have all the relevant steps of design and documentation been conducted; AND that the design looks visually sound via 'qualitative screening' of load paths, detailing and resilience. It is not required for the consent processing engineer to be definitive of compliance on every building component, i.e., does every nut and bolt capacity exceed its demand.

WCC BCA has developed the following qualitative review procedure, which encompasses being robust and efficient; while reducing the risk of non-compliant designs. There are five criteria considered important to be checked on every project. These being:

1. Loading
2. Load Paths
3. Sizing (Design)
4. Detailing
5. Documentation (Specification, Geotechnical, Architectural)

Within each of these criteria, several items that can be visually screened relatively quickly. A comprehensive checklist of such items is tabulated below. All the items may not be applicable to every project, but they provide good general guidance on how a review should be approached.

It should be noted that BCA review does not remove the need for a robust internal quality assurance and verification procedures by designers. In fact, the application of such in-house procedures forms part of the BCA review checklist.

Documentation

- Works specification contains material/workmanship quality control requirements for the trades being utilized
- Specification or DFR provides method of compliance to B2 for all structural materials and a maintenance schedule is provided
- Procurement and quality control of steel sourced internationally, SCNZ system has been documented
- Geotech report is up to date and relevant to the proposed structural development
- Geotech report is complete and addresses soil slope failure, lateral spread and associated loading on foundations, liquefaction, displacements, soil stiffness, active and passive pressure parameters etc.
- Structural engineer has applied all loading and design requirement of the Geotech report
- Calculation pack is complete for all elements
- Adequate CM level of monitoring is specified.
- Proprietary design elements, their design performance specifications and supplier construction specifications.
- Layout of the structure and loads match those shown in the architectural drawings.

Loading

- Detailed DFR provided, with all load requirements
- Dead, superimposed, live distributed and point loads (plant, storage, plantation, vehicle etc)
- Vehicle barrier impact loads and application point, pedestrian balustrade loads
- Retaining wall soil strength parameters and horizontal loading pressure coefficients
- Base site wind loads
- Earthquake ductility, period, base shear coefficient, seismic weight, site class
- Parts acceleration and factors

Load Paths & Structural System

- Direct/non-convoluted vertical and horizontal load paths all the way to the ground. If load paths are difficult to hand analyse intuitively, recommend full peer review at an early stage
- No missing load paths
- No accidental brittle failure links in the load path chain, i.e., premature flexural buckling of portal frame rafters when mu>1.25 is adopted.
- Ductility adopted matches the detailing utilized
- Mixed stiffness/ductility systems with transfer diaphragms
- Appropriate diaphragms load paths for inertia and transfer loads
- Correct use of ‘flexible’, ‘semi-rigid’ and ‘rigid’ diaphragm, relative to stiffness of lateral load resisting system.
- Possible failure mechanisms and their resilience for higher loads/displacements for mu>1.25 design, i.e., resilience present (see document ‘Design for Uncertainty’, jointly produced by NZSEE, SESOC and NZGS.

- Displacement incompatibility between other structural elements or external restraints
- No substantial horizontal and vertical irregularity, see NZSEE Assessment Guidelines Part B, Table BA.4.
- Staged construction temporary load cases considered (Erection methodology, sequence, temporary propping and bracing of structure & soil considered at a performance specification level. These items should be covered in detail by a separate temporary works consent as well)
- Assumed external restraint locations are appropriate and adequate

Element Design

- Strength hierarchy (weak beam/strong column)
- Protected members are sized to overstrength of yielding members.
- Member sizes matches the ductility chosen
- Member sizes match those on other similar projects, cross-check
- Soft storey or torsional potential post-yielding not present
- Serviceability performance in deflections and vibrations (optional)
- Maximum deflections, P-Delta/delta effects, pounding potential (i.e., neighbouring building response is considered)
- Sizing and detailing of critical elements that have high load concentrations. Recommended to perform 'back of the envelope' type calculations or review designer detailed calculations
- Adequate layout and reinforcing of diaphragms, with attention to vertical system displacement incompatibility
- All new products and systems are tested and formally approved. Use risk based to level of interrogations necessary, i.e. scale modelling, peer review, proof testing, published research etc.

Detailing

- Redundancy and ductility in connections
- Minimum actions for steel connections
- Minimum edge distances for bolts and concrete anchors
- No welding of G8.8 bolts
- Maximum and minimum reinforcement quantities for concrete
- Reinforcement for shrinkage, thermal and flexural cracking (optional)
- Adequate confinement of concrete and anti-buckling restraint to longitudinal bars, especially cranked bars
- Anchorage lengths on longitudinal bar hooks and laps. Anchorage of stirrups and spiral ends.
- Curtailment of reinforcement in tension zones, i.e., $d+L_d$, 1.3d requirements
- Bar size and bond in high shear zones, i.e., beam-column joints
- Concrete strength & covers for durability and fire
- Buildability to achieve performance as designed, i.e., flow of concrete, feasibility of butt welds etc
- Safety in design for aspects of construction and maintenance.
- Connection details match the calc assumptions i.e., pin or fixed
- Dis-similar materials, i.e., aluminium in concrete, SS steel with mild steel not utilized
- Typical details and location of control joints in masonry walls and slabs, with adequate dowelling (optional)

- Adequate seating and displacement compatibility design for deep precast flooring systems. No sawcuts in suspended slabs.
- Lateral restraint of beams and columns from premature flexural or axial buckling, with adequate fixity at their ends and through the length
- Missing primary structure details
- Penetrations through beams and floors are adequately located and reinforced
- High level comparison of details to other similar projects and SCNZ tabulated connections
- Eccentricity in connections has been designed for
- Inter-storey displacement allowances in stairs, precast floor seating and façade elements
- Adequate fixings to diaphragms, with consideration to high damage areas.
- Adequate factor of safety for potential severe structural weaknesses, i.e., punching shear (axial + flexural induced) in suspended slabs, shear and buckling of columns.

REQUESTING ADDITIONAL INFORMATION

Once the engineers appointed by the Building Consent Authority (BCA) have carried out their review of the submitted material, they will likely have questions about either the documentation or the design. Part 3 of the guidelines is intended to address how to request additional information, how to provide additional information, and collates a list of commonly-asked questions.

How to request information

Information can be requested only where there are questions around compliance with the Building Code. Designs must comply with all aspects of the Building Code unless a waiver is sought, so questions can arise on life safety, durability, safety during construction, or anything else covered by any section of the Building Code. However, questions must confine themselves to ensuring compliance with the normative standards cited, or with equivalent performance-requirements for alternative solutions. Each request for information follows a pattern in order to convey the key requirements efficiently and clearly:

1. Cite the relevant section of the Building Code.
2. Cite any relevant standards or design guides for the question. Be as specific as possible.
3. Identify the document and provide page/section/ drawing number where this question has arisen within the set, if possible.
4. Explain the effect of the potential non-compliance, if this is not obvious.
5. Identify what additional evidence (see key terms and phrases below) is required to determine that, on reasonable grounds, the design complies with the Building Act.

Restrict yourself to one topic per question. There is no penalty for lodging multiple requests, and this will make it easier for the consultant to clearly identify your requirements and ensure they provide the required information.

When forming your question, use key terms and phrases in a consistent way to request the type of additional information required:

- Clarify – Provide an explanation within the RFI response that helps understand the documentation already provided.

- Demonstrate – Provide additional calculations, diagrams, or explanation that provides additional evidence showing the design complies.
- Confirm – Typically used to indicate that there is a difference between two or more documents, with the expectation that one or more documents will be adjusted so that all match.
- Consider – Indicates a suggestion from the reviewer to the designer that indicates an area of the design which may be technically compliant with the Building Code, but which could fall short of informative performance standards. This is especially applicable for service limit states but can also pertain to detailing and robustness.
- Validate – Supply a second source of information that corroborates the design, such as a strut-and-tie analysis to confirm the results from a floor grillage model or a research paper to support an adopted design parameter.
- Provide – Add new information that appears to be missing from the consent application. This seeks information about apparent gaps in the design.

When writing the questions, avoid declarative statements about compliance or non-compliance. It is up to the submitting engineer to prove compliance, but their lack of evidence or evidence which contains errors does not form proof that the design is non-compliant.

Good Examples

- B1 [1] - Calculations p. B3 [3] - The point load has been split between two joists, but there is nothing physical preventing a single joist from being loaded, such as by enforcing deflection compatibility via blocking. Please **demonstrate** that a single joist is adequate. If the joist is intended to have two-span continuity, you must note this requirement on the drawings, since S5 is not specific about any requirements for continuity [5].
- B1 [1] - Calculations p. 91 - While estimating seismic demand, the elastic seismic force has been divided by KR=3. KR cannot be applied to estimating design seismic force. Further, KR = 3 can be applied only if the performance of URM wall/pier is dominated by rocking/ bed joint sliding failure modes (C8.10.2.2) [2]. Please **validate** the assumed loading or revise the loads.

Bad Examples

When requesting information it is relatively easy to be unclear on one or more of the points above, and this will make it unlikely that the engineer can successfully answer the question.

- Please ensure all parts of the PS1 and CoDW (Certificate of Design Work) are filled out correctly.

This is a bad example because the engineer has likely filled out this information to the best of their ability already. If a mistake has been made, they are unlikely to find it when reviewing their documentation. This question does not follow Rule 3, specificity. This question could be phrased differently:

- In the PS1 the nominated level of construction monitoring has been selected as CM2.

Edge Cases

It is well understood that structural design often requires judgment, since it is neither practical nor necessary to produce comprehensive calculations for each design element. The level of experience of both the designer and the reviewer can affect what calculations are deemed necessary to determine compliance “on reasonable grounds” with the performance requirements of the Building Act. The standard for whether a question is appropriate hinges on the question of what constitutes “reasonable”.

The interpretation of reasonable grounds usually relates to an inferred benchmark of typical industry practice. The general guideline is that if a design is ‘atypical’ for a theoretical ordinary engineer, then it may be useful to seek clarification on the design to ensure it complies. Design in this context means any aspect of the building or design process, including unusual geometry, materials, analytic approach, etc. Not all design problems can be intutivelysolved , hence a good design should always be intelligible to a reasonable engineer. Where designs can’t be successfully understood by an average practicing engineer, i.e., use of non-linear modelling, time-history analysis, historic structures, high-rise and complex buildings etc., then a peer review is likely to be necessary to confirm on reasonable grounds that the design complies with the building code.

Engineers with high levels of specialist expertise in the building type or design approach can therefore sometimes feel that questions are not warranted because the design is within typical parameters, but those parameters aren’t understood by the reviewer. This can arise at all project scales, for example, an engineer with only large-scale infrastructure design experience may not be familiar with typical design approaches in domestic-scale house construction. Such engineers should also consider the fact that reviewing engineers are likely to have seen a cross-section of general practice and will be well placed from this experience to understand what typical design looks like.

Below is a possible set of criteria for deciding whether to ask a question in a case where the design approach is unclear:

1. Does the design consider a complete load path from application to ground? Inadequate designs very often consider only a limited portion of the load path. An obvious example would be a design for a bolted connection between steel and concrete that considers only the capacity of the bolt itself not the capacity of the concrete member for the concentrated applied loads.
2. Does it seem likely that additional calculation or consideration of additional cases change the design? Often experienced designers will omit checks from their calculations because a particular load combination isn’t likely to govern. For example, the design of a medium-rise concrete wall building is unlikely to be governed by wind loading, so the engineer may not have checked this case.
3. Does the design rely upon a single load path? Single-system buildings are vulnerable to poor performance of that single mechanism, and therefore the design is comparatively high risk, whereas buildings with multiple alternate load paths will not suffer a disproportionate failure if one part of the design performs below expectations. A common example of a single-system building is a pinned-base portal frame building, where any defects in the knee joint could lead to a sudden failure.
4. Does the design allow for robustness, or is it likely to experience disproportionate failures if the design loads are exceeded? It is especially the case that for seismic loads, the loads experienced by the building may be substantially larger than those required in the design case. This is especially the case for retrofitted buildings, where a nominal

seismic performance point might already less than code requirements for a new building.

5. Does the design use atypical calculation or detailing approaches? Often ambitious engineers will use approaches such as displacement-based design that have a strong theoretical basis but may not have been tested by real-world applications, and which are not used by the “reasonable” professional engineer. The experience and judgment of the reviewing engineer may not be adequate for comparing this specific design to typical cases.

If any of these points are identified as posing a risk, then additional information should probably be sought. It cannot be more emphasized that open and direct communication between the designer and the reviewers is key to quickly establishing consensus on variable engineering judgments.

It is important to understand that asking questions does not restrict design solutions/methods to acceptable solutions/published guidance. Questions seek additional evaluation to ensure the design is acceptable based on performance requirement (basis of the building code).

Limitations

You should note that Producer Statements are often used to form reasonable grounds for accepting a consent but are not a requirement within the Building Act. This means that while questions on the details of a Producer Statement can be asked, it may not form adequate grounds to reject a consent if they are not. Most building consent authorities will have additional procedures and requirements for review if the design is unsupported by a producer statement.

There is no inherent requirement in the Building Act for the provision of a Detailed Seismic Assessment (DSA) to support the application for Building Consent for remedial design. However, if the calculations for the strengthening show apparent reliance upon the conclusions of the DSA, then it is permissible to ask for that supporting information. The information could be provided either by supplying the DSA, or by transplanting all relevant calculations from the assessment into the design. If the calculations undertaken for the DSA are integral to the design of the strengthening, they need to be subject to the same level of scrutiny as any other calculations. The DSA may also raise issues that are unrelated to compliance with the Building Act, and these are not legitimate targets for further inquiry. For example, if a building consent is submitted for retrofit of a building’s stairs, any calculations pertaining to drifts or accelerations would be relevant, but not questions relating to the assessment of the floor diaphragm.

It is also worth noting that Section 112 of the Building Act does not generically require strengthening to a specific targeted level, so it is not necessary to nominate a %NBS in the building consent documentation, and nor does the BCA endorse any nominated performance level.

For Earthquake Prone buildings, or buildings where the use is changing, a specific strengthening level should be agreed with the BCA as “practicable” early in the design. In those cases, all aspects of the seismic performance would be legitimate topics for inquiry whether strengthening is proposed or not, since the legislation governing that kind of modification to the building has different requirements from the Building Act.

Contractor and Proprietary Design Items

It is common for parts of the structure to be designed by other parties than the structural engineer. This may be “secondary” elements, such as the cladding and its immediate supports, or primary structure where the supplier will design the detailed product. Contractor design often includes all temporary works and enabling works. In all cases where structural design will be carried out by someone other than the structural engineer, it is necessary for the structural engineer to convey their understanding of the requirements to that designer. In international practice, this is often termed “Outlined Design” or “Performance Specified Design”, or similar terms.

These subsequent design items are still subject to the performance requirements of the Building Act, and so it is legitimate to ask questions where there is ambiguity on that question. As a minimum, even accepting that a proprietary component or package of enabling works can be assumed to be carried out competently, it is often still necessary for the structural engineer to provide an outline of the loading and performance requirements.

- Outline construction methodologies are often necessary to explain an assumed construction sequence and identify risks in line with the Health and Safety requirements for primary designers.
- Loading diagrams must be provided when load cases are anything atypical, such as transfer forces on a rib-and-infill floor, or specific wind design pressures where the wind speed is assessed above the limits of NZS3604.

Providing Additional Information

When responding to an RFI, it is important to read the question and be specific in the response.

As a baseline, you should assume:

1. That the materials you provided have been reviewed, so if they have asked a question already considered by your materials then you can simply assist by specifically citing the location and explaining the interpretation.
2. The BCA reviewer will have no ability to undertake many common peer review strategies such as parallel modelling, so if they ask for more information it is incumbent upon you to provide it.

Responses need to demonstrate in detail how the questions raised by the council engineer are addressed within the documentation. The responses are not simply 'yes we know, peer reviewer has looked it and it is not a problem'. The aim is to provide confidence to the reviewer that he/she should approve the design. The reviewer is looking for evidence that the designer has robust documentation in place, have considered critical aspects of the design and are able to respond with robust engineering rationales.

When responding to RFI’s, it is not only the wording of the response; but also the material provided for review that needs to be easily identified and followed. Some of the actions that can be taken to fast-track the review of responses is:

1. When revising pages of drawings, calculations and reports submit them as part of a revised complete set of documents. Additional fragmentary calculations are difficult to reconcile with the remainder of the package and can create contradictions very easily.

2. In your response, be specific and cite where in the document package the information can be found, and specifically explain how this information answers the request for information. Often architects will respond on the engineer's behalf without any additional context which can result in delays while the reviewer searches for the information.
3. Ensure that the updated documentation is clearly revised and clouded to indicate the changes that have occurred since the original submission.
4. When providing additional information and documents, include in your response the additional documents' title, or alternatively incorporate the RFI number in the document title. The document must still be sufficiently complete to be reviewed in isolation from the RFI, because typically only the completed and consolidated document that form the application will be available to subsequent users (such as future owners).

It should also be noted that if there is significant delay in the time taken to reply to council RFI queries, the reviewer may require additional time to process the responses as they have to re-familiarize themselves with the consent documentation.

When responding, use respectful language in formulating your responses and avoid condescending comments, i.e., 'this is a waste of time, you need to stop being picky'. If the design is adequate, then it should be possible to provide the additional information requested to demonstrate that. Where designers prevaricate or deflect it can often be because the design is inadequate. If you have genuine concern with the content of the RFI's, then raise a formal complaint that can be thoroughly investigated.

A sample structure for a suitable RFI response is shown below:

- Per [RFI] please find attached [additional or revised] documentation, refer to [page / drawing].

Requesting Clarification from Reviewer

The online administrate portals that many councils' utilize can sometime make it difficult to engage in an open discussion over technical concepts. In such instances, where you feel that the message is not being clearly interpreted and/or will require too much effort to resolve through the online processes, then request a video conference/meeting with the reviewer early. All council engineers now have access to software such as MS Teams and are more than happy to engage in a positive discussion.

FREQUENTLY REQUESTED INFORMATION

WCC BCA has collated a sample of well-known and frequently repeated RFIs as shown below (*list under development*). The list of queries is not comprehensive, however provides a good indication of commonly reoccurring issues that lead to longer processing times for consents.

Note that generally code references have not been included in the sample questions below to ensure that these questions do not introduce inaccuracies and errors as codes are revised. For example, at the time of writing, NZS3603 is being phased out and being replaced by AS/NZS 1720.1.

Documentation

Producer Statements and Certificates of Design Work

- The method used for design is not cited within the B1 verification methods: it is an alternative solution. Revise the producer statement noting the alternative solution used.
- International design standards have been used (e.g., BS8081, FHWA, BS EN 1997-1), in lieu of verification methods available under B1. This is an alternative solution. Demonstrate that the solution meets the performance standards of the Building Act.

Unclear Documentation

- Provide calculations and design criteria report for the structural portion of the building consent submission. This documentation must demonstrate compliance with the relevant parts of the NZ Building Code, (refer to tabulated items under standard documentation).
- When submitting any revised documents in response to the RFI, provide new consolidated bundles of documents (i.e., a complete revised calculation set that incorporates additional checks, rather than additional pages of calculations attached to the RFI response). Provide name of the document and page/ section/ drawing reference numbers, for those related to your RFI response.
- Cloud and up-rev all drawings in which changes have been made.
- Your design refers to “factors of safety”, “safe working loads” and/or “allowable stresses”. Clarify how these terms correspond to ultimate limit state forces and stresses compatible with LFRD as outlined in NZS1170.0.

Design Features Report

The DFR is not technically required either for compliance or to demonstrate the means of compliance with the Building Act or its performance requirements. The purpose of the DFR is to enable reviewers to understand the design because if a design can’t be easily understood, it will be very expensive to review.

- Provide include a Design Features Report (DFR). The DFR should clearly state the structural form and intended structural system, including importance level and ductility assumptions.
  - It should nominate the analysis and design methodologies and approaches, and specifically note where solutions are within the Acceptable Solutions and Vertification methods, or whether they are alternative solutions. You should cite any design guidance used to undertake any parts of the analysis or design (e.g. BRANZ research papers, NZSEE papers, ASCE standards, etc).
  - It should outline your underlying assumptions, load cases, design approach, and references to any supporting documentation that you have relied upon. You should cite any third-party documents used to form the basis of the design, including the architectural drawings, fire report, geotechnical interpretive report, etc
  - It should include the results of geotechnical investigation and note how compliance with the geotechnical recommendations has been achieved.
  - It should outline your compliance approach to Durability, B2, requirements of NZBC would be met. You may find it beneficial to use the template published by SESOC.

B1 Structure

Investigation

Consent applications are frequently silent on the condition and geometry of existing buildings. Designs are often presented focusing solely on the new alterations without enough information to evaluate whether those alterations will affect the existing structure. For example, if a new internal stair is proposed, the consent package should consider whether the floor diaphragm remains adequate. This can only be evaluated by understanding the existing construction, but consents will often only provide calculations for the new construction.

Wind Loading

Many engineers place undue reliance upon published maps of wind speeds, or in the crude calculation presented in NZS3604. There can be a significant commercial pressure to produce a wind speed below 55 m/s because this is the upper limit of NZS3604. Where wind speeds exceed NZS3604 they also typically exceed manufacturers' published performance profiles, which can have significant cost implications for design in addition to increased material costs. Where wind speeds are found higher than this a typical approach is to scale NZS3604 spans, bracing demands, fixing loads, etc by the square of the difference. This may result in adequate designs in some situations but could be either conservative or unconservative in most cases, and so this approach should only be accepted with caution.

Wind loading may also affect a building's compliance with E2, refer to the discussion below.

- The site wind speed has been calculated above the limits of NZS3604, requiring Specific Engineering Design. Provide additional calculations for the wind loading. Include:
  - A summary of holistic and local pressures acting on each part of the building envelope,
  - Specifically calculated lateral loading (bracing demand) from the wind,
- The values adopted for the Terrain Category, Hill Shape, or Shielding, are not typical for wind speeds in this vicinity. Validate the adopted parameters.
- A wind speed has been adopted based on the maps provided by the Territorial Authority and/or BRANZ. These maps are provided "for information" and may not be suitable for use in the detailed design of structures. The wind speed you have selected may not be appropriate for your site. Provide a site-specific wind calculation to NZS1170.2.

Seismic Loading

Analysis

Load Path

Often engineering documentation is presented in the form of mathematical equations stating a demand and calculating a capacity. In the absence of load path diagrams the validity of the numerical part of the design can be difficult to interpret. Where diagrams are provided, they are often at a very high level of abstraction and so neglect localised eccentricities.

- The connections between the primary structural frame and the roof cross bracing appear to be eccentric. The calculations check pure axial capacity, neglecting the induced bending and shear forces arising from the eccentricity. Demonstrate the adequacy of the connection for the second-order forces arising from the eccentricity.

- There does not appear to be a positive connection between the proposed and existing structure. Demonstrate the load path for tension and shear forces.
- The building is potentially sensitive to torsional modes of seismic response, which will impose demands on the diaphragm and connections in addition to the calculated direct shear. Clarity how these transfer forces have been considered in the load distribution between lateral elements.

Lateral Structure

Lateral elements are often designed in isolation without considering system effects, especially consideration of system deflection compatibility.

- Provide a summary diagram showing the centre of mass, the centre of rigidity, load application locations, and the shear into each lateral element for each orthogonal load direction.
- Demonstrate that the combined steel portal frames and light timber frame bracing system complies with the recommendations of *BRANZ study report SR337(2015)* with particular regard to displacement compatibility and mixed-ductility systems.
- Demonstrate that the proposed structure can develop the level of ductility indicated in the calculation of the seismic loads.
- New eccentrically braced frames are proposed to supplement the existing structure's lateral capacity. This will induce transfer forces in the existing diaphragm. Confirm the magnitude of these transfer forces and demonstrate the adequacy of the diaphragm to transfer them. We note that you have undertaken a pseudo-static equivalent analysis using a grillage model, please confirm that this has considered the transfer forces since the pESA method primarily addresses diaphragm inertial forces.

Gravity Structure

Gravity design tends to be one of the less fraught aspects of design. Where designs generate RFI it is often because it is difficult to trace how transfer forces have been considered in the design. Calculations are often presented with no accompanying diagram, in which circumstance checking whether one beam's shears have been correctly applied to another in the calculation set is very time consuming.

Design

Load Path

- When designing the retaining walls, you have relied upon the floors to provide lateral support. Demonstrate the adequacy of the floors for the imposed static and seismic soil loads and clarify how these loads have been considered in the design of the superstructure.

Lateral Structure

- With regards to gap between units at the inter tenancy walls, we do not believe the current details shown on the drawings are compliant with NZS1170.5 requirements. NZS1170.5 requires one of two approaches for adjacent structures: (1) Diaphragms are fixed together as required by Clause 5.7.1 "...elements within diaphragms and connections between diaphragms... shall be capable of accommodating both the imposed displacement and force demands" (2) Sufficient seismic separation is provided to ensure that contact does not occur at the Ultimate Limit State, as required by Clause 7.4.1.2 “At any point above the ground, the design horizontal deflection of the structure shall be such that, when combined with the design horizontal deflection of any adjacent structure at the same height, contact does not occur”. Note that in the past we have accepted flexible connections between diaphragms (such as GIB quite ties) as an alternative solution, provided the engineer confirms that the force and displacement capacity of the quiet ties is sufficient to meet the requirements of (1).

- According to Reid design documentation, Reidbrace 25mm and 32mm bars can only be designed as ductility 1.25 and 1 respectively. Provide revised calculations demonstrating compliance to NZS 3404 for a nominally ductile or an elastic system. Provide calculations for the end connection demonstrating it is adequate when checked as a pin, rather than a bolt, in accordance with Section 9.5 of NZS 3404.

Gravity Structure

- The subfloor posts have a very large buckling length. Your calculations have demonstrated their adequacy for these loads, but since there is no requirement for access in this area you could consider adding lateral braces to reduce the buckling length and increase the robustness of the subfloor system.

Element Capacity Checks

Detailing

- Clearly indicate the concrete covers and strength in your drawing notes, or include references on the drawing to where this information can be found.

B1 Geotechnical

- Confirm the selection of safety factors, as they do not match typical partial factors out of the cited standard BS EN 1997.1.
- Provide calculations for site-specific peak ground accelerations used.
- The proposed structural design is not in line with the recommendations made in the provided geotechnical report. Provide a review by the geotechnical engineer confirming that it is consistent with the geotechnical conditions and outlining the changed recommendations.

Investigation

- Provide evidence of the ground conditions, include:
    - A plan showing the locations of testing carried out,
    - The testing logs (i.e. auger logs per NZGS guideline for the field classification and description of soil and rock for engineering purposes, scala test results, CPT logs, or other strength tests, as applicable),
    - A section through the site showing the inferred subsoil strata in relation to the ground surface,
    - Confirms the global stability of the site,
    - A commentary on geotechnical design parameters adopted (drained/undrained, c-phi/S_u, ultimate bearing capacities, site soil class/V_{s30}, parameters for retaining wall design, etc), including citation of any validating publications.

Liquefaction

- The building is in an area which may be subject to liquefaction. Provide an analysis evaluating the liquefaction potential and demonstrate how the building has been designed to mitigate the effects of liquefaction as applicable.

Foundations

- No detailed testing procedure is nominated for the soil nails / piles. Provide your intended testing approach.
- Fill behind walls is to be progressively monitored for compaction to ensure the entire depth of fill meets the bearing requirements for the concrete slab-on-grade and/or shallow piles.
- You have shown a slab-on-grade placed above nominally compacted fill. In the structural specification, no performance points are nominated. The PS1 indicates that the design is valid on the assumption of 300kPa bearing below ground, but the design will only be adequate if the new fill meets the bearing requirements for the slab system.
- Excavations are not shown in areas of fill and so the contractor may place fill over unsuitable deep soil; the requirement for compacted fill to be placed on material that already meets or exceeds the strength requirement for the fill needs to be clear.
- The structural inspections list does not include bearing confirmation at the end of compaction, or any visits during compaction. Amend your document set to make the means and verification of the compaction clearer.

Piling

- Demonstrate the adequacy of the load path from the pile into the primary structure.
- Demonstrate the capacity of the piles.

Retaining Walls

- Provide an outline methodology for how the verticality of retaining walls will be monitored during back-filling.
- It does not appear that the retaining walls have been checked for seismic soil loads. We note that it has become common practice to check retaining walls in Wellington to the requirements of MBIE document 'Module 6: Earthquake resistant retaining wall'. Please review the retaining wall design for seismic loading and revise the design if necessary.
- These walls are very close to the boundary. Please provide a construction methodology and erection sequence for these walls demonstrating a continuous safe working conditions and demonstrating there is no risk posed to the adjacent properties by the excavations.
- Please clarify how the assumed surcharge was determined.

B2 Durability

- Provide specification and maintenance schedule for all structural materials to meet their intended design life. The Engineering New Zealand B2 practice advisory may be utilised; however, design documentation needs to be specific on treatments utilized and maintenance procedures followed. Detail treatments via structural drawings (i.e. timber treatment class, concrete covers etc.) or as performance requirements in structural specifications (i.e. paint or galv. protection, SNZ TS 3404 corrosive categories/zones, suggested products etc.).

- Dissimilar materials on the galvanic chart are being utilized in this exterior connection. Provide additional details showing how separation is created to prevent accelerated corrosion of the anodic material.

E2 External Moisture

B1 does not have any specific requirements for service-level performance of structures. Nonetheless, as the "Leaky Homes" debacle demonstrated over a long period of time, service-level performance can be the determinant factor for a building's lifespan. Theoretically excellent seismic performance is no consolation to a building owner whose timber framing has rotted away due to water ingress.

- The site wind speed has been determined to be higher than the limitations of NZS3604. Provide:
  - Design of cladding materials, or certification from the supplier for the calculated pressures,
  - Design of all secondary and primary elements affected by the wind, including their connections, such as window trimming studs and sills,
  - Confirmation that deflections under wind loading will not compromise the waterproofing system around the openings.

F4 Safety from Falling

- No calculations are included for the vehicle impact barrier. Demonstrate the adequacy of the end and side walls for vehicle impact. A turning circle study might demonstrate that the side walls cannot be impacted directly and so it may be suitable to design them for a "glancing impact".

F5 Construction and demolition hazards

Despite the presence of a "Safety in Design" section in the SESOC templates, structural and geotechnical engineers must still frequently be asked questions around the ability to construct and demolish buildings. In particular, geotechnical engineering recommendations around safe cut heights and slopes are infrequently reflected adequately on structural drawings. Many engineers' first responses to questions around these topics is to note that temporary works are the responsibility of the contractor, but this is not the view of the Building Act, nor of the Health and Safety legislation. While the detailed design of a specific application for temporary works might rest with the contractor, as a bare minimum the structural and geotechnical engineer must establish that there is at least one viable safe method of constructing the building.

CONCLUDING REMARKS

Regulatory compliance reviews are a critical mechanism for the engineering profession to ensure that buildings are safe for the public. The variability of approaches from engineers providing engineering designs combines with a variability of approaches amongst reviewing engineers to create an environment where the results of a regulatory compliance review by a Building Consent Authority can feel like a significant risk. Anecdotally there are several firms operating in Wellington whose fee proposals explicitly ringfence any request for information from the WCC because historically it was too difficult to predict whether a design would be accepted. This is a clearly undesirable situation and in this paper we have proposed a holistic approach to engineering documentation and building consent presentation that we hope will demystify the process. While it is impossible to describe every possible structure, by undertaking a study of recurring questions we have provided an empirical basis for understanding widespread areas where engineers may need to revise their practices and approaches for compliance with the performance requirements of the Building Act.

REFERENCES

Chung, S 2019. Trends and Observations from Regulatory Reviews in Wellington. *SESOC Conference 2019.*

Chung, S & Ashby, C 2021. Trends and Observations from Regulatory Reviews in Wellington. *SESOC Conference 2021.*

Engineering New Zealand, Apr 2018 - Practice Note 2: Peer Review

Engineering New Zealand, 2021. Structural Tips and Tricks

MBIE, Jun 2005. Practice Advisory 6: Achieve best practice every step of the way. https://www.building.govt.nz/building-code-compliance/b-stability/b1-structure/practive-advisory-6/

MBIE, Jun 2010. National Building Consent Authority Competency Assessment System.

MBIE, Jul 2022. Risk, Liability and Insurance in the Building Sector.

MBIE, Dec 2022. Issues Discussion Document – Review of the Building Consent System.

MBIE, Standard order of documents checklist for building consent applications. 2022 https://www.building.govt.nz/projects-and-consents/apply-for-building-consent/support-your-consent-application/standard-order-of-documents-checklist/

NZCIC, 2022, Design documentation guidelines: Structural

NZSEE Technical Assessment Guidelines Part B – Initial Seismic Assessment

NZSEE, SESOC and NZGS, Aug 2022. Earthquake design for uncertainty.

Scarry, J Dec 2002. An Open Letter to IPENZ Regarding the Parlous State of the Structural Engineering Profession and the Construction Industry in New Zealand.

SESOC, March 2011, Domestic Housing Design Features Report Template

SESOC, May 2018. Design review guide.

SESOC, May 2018. Body of Knowledge and Skills.

SESOC, June 2021, Commercial Design Features Report Template

Smith, A, 2007. IPENZ Structural Task Force – SESOC Committee Update, *Journal of the New Zealand Structural Engineering Society*, Vol 20(1) 43-53 Auckland:SESOC