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# Checking regime for permanent building works

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## Part 2: What to check and when

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The first part of this article series addressed the ‘Categories of checking’ for building structures, with particular emphasis on risk and proportionality.

This second article in the series proposes a structured framework describing what the checkers should focus on during each stage of a project’s design process.

### Introduction

SI 2023 911 (England and Wales) requires that anyone doing design work take all reasonable steps to ensure the final design will comply with building regulations. Complementing this, BS EN 1990 and CDM 2015 implicitly require continuous verification throughout design development with appropriate levels of scrutiny at every project stage to ensure safety and manage design risks effectively. Timely and systematic checks can reveal fundamental issues such as incorrect load paths, missing load cases, conflicting interfaces, or inappropriate assumptions.

This article proposes a structured checking framework that broadly follows the stages defined by the *IStructE Structural Plan of Work* and the *RIBA Plan of Work*.

The primary objective is to provide checkers with guidance on what to look for during each design stage to enable the identification and resolution of design errors at the right time before they impact the follow-on design activities.

Although the article primarily focuses on building structures, the principles discussed would generally be applicable to other types of structures. It should be noted that infrastructure projects, or projects which have interfaces with existing infrastructure assets, must comply with the asset owner’s established design-check regimes (for example, Network Rail or National Highways).

Designers should also be alert to whether the design scope involves higher-risk buildings (HRB) as defined under the Building Safety Act. These are defined as buildings containing at least two residential units, care homes or hospitals of at least 18m or seven storeys in height. Any works, except those by certified tradesman and emergency repairs, are subject to the ‘gateway’ approval regime. Designers should refer to Ref [9] for guidance on their duties and responsibilities when working on HRBs.

## What to check during early design phase

The early design phase aligns with **Stage 0 (Strategic Definition)** and **Stage 1 (Preparation and Brief)** of the Structural Plan of Work.

Given the broad and strategic nature of this early phase, structural engineers involved should typically possess comprehensive multidisciplinary experience, along with a thorough understanding of relevant regulations, liabilities, and construction technologies.

Checks during Stage 0 and Stage 1 should cover the following:

- ▶ Validating key strategic assumptions and documenting potential risks and constraints identified during the checks.
- ▶ Confirming the completeness of the initial project brief which should include site surveys, structural constraints, geotechnical information, performance criteria, sustainability objectives (embodied carbon, future adaptability, resilience, etc.), and all other information that will be required for structural design in subsequent stages.
- ▶ Confirming that regulatory and statutory requirements (building regulations, CDM, and local codes) are identified and integrated into the project brief. If there are any unusual criteria or potential departures from regulations or standard practices, confirm that these are clearly identified and justified.
- ▶ Identifying requirements for any additional site investigations proactively to avoid overly conservative assumptions in subsequent design stages.
- ▶ Confirming project viability and structural feasibility through high-level structural assessments.
- ▶ Scrutinising the strategic choices made by the project team which impact structural feasibility and favours one approach over another.
- ▶ In cases of refurbishment or adaptive use, the structural checks should include feasibility of reuse of the existing foundations, potential impact on adjacent structures, existing utilities and other assets during partial demolition and construction activities.
- ▶ Evaluating key construction logistics for viability of using precast, modular or other modern methods of construction (MMC) which may have specific manufacturing, transportation, and lifting requirements.
- ▶ Reviewing the sustainability objectives and verifying that embodied-carbon targets, resilience, and adaptability criteria are clearly defined in the brief.
- ▶ Checking the completeness of the responsibility matrix to confirm that the structural engineer's responsibilities, interfaces with other disciplines, and third-party approvals are defined clearly.
- ▶ Reviewing the risk and opportunity matrix - if it exists - communicating any risks and opportunities that may not have been identified.

## What to check during the concept design stage

This design phase aligns with **Stage 2 (Concept Design)** and **Stage 3 (Spatial Coordination)** of the Structural Plan of Work.

According to IStructE's Structural Plan of Work, the outputs of the Concept Design Stage are as follows:

- ▶ Basis of Structural Design

- ▶ Deliverables List
- ▶ Initial Structural Drawings / Model

Checks during the Concept Design Stage should cover the following:

- ▶ Checking that the Basis of Structural Design explicitly refers to and justifies use of applicable codes and standards, and clearly defines the performance criteria (loading, durability, fire, serviceability, disproportionate collapse, etc.). On more complex projects, the Basis of Structural Design should be reviewed at the earliest stage with the checker and the approver to avoid potentially abortive time.
- ▶ Verifying that structural drawings are compatible with general arrangement plans, architectural layouts, MEP, and other design disciplines.
- ▶ Verifying that the geotechnical assumptions are appropriately derived and based on adequate site-specific investigations.
- ▶ Confirming that any departures from industry standards are described with justification. The checks should also include an understanding of how the technical and approval risks will be managed and confirming that such risks have been clearly communicated with the stakeholders.
- ▶ Confirming that the assumed construction methodology, sequencing, and their implications on structural design are adequately described.
- ▶ Verifying the vertical and lateral load paths and that they are clearly shown on initial sketches/ drawings/ models.
- ▶ Verifying the feasibility of safety critical key details and checking that they are described clearly with emphasis on load transfer mechanism and redundancy.
- ▶ Confirming that the Deliverables List aligns with the scope and design programme.
- ▶ Reviewing of information provided to support Party Wall Agreements, and other relevant Approval in Principle (AIP) and statutory requirements and agreements.
- ▶ Confirming that structural design meets the requirements of the brief and clearly meets performance criteria defined in the Basis of Structural Design.
- ▶ Cross-checking the analysis models/calculations to confirm that the outputs are correct and they capture the level of detail that is appropriate for planning and pricing purposes.
- ▶ Undertaking simplified, independent calculations and analyses to confirm that the structural concepts presented in Initial Structural Drawings/Models is viable.
- ▶ Confirming that major temporary works are clearly described and consistent with permanent works assumptions. There should be sufficient information for the contractor to proceed with planning and initiating discussions with temporary works designers to start developing the design of temporary works and construction methods.
- ▶ Verifying that the performance criteria for contractor-designed elements are correct and clearly defined. These include but are not limited to design loads, tolerances, stiffness, and durability requirements.
- ▶ Verifying that initial structural drawings/models are complete, coordinated, and appropriate for the level of development expected for this stage.

The scope of the checks may be extended to cover resourcing and commercial aspects. For example, the checker may be requested to estimate the engineering resource requirements alongside the design programme and deliverables list to help identify potential problems with planning for design delivery.

### What to check during the detail design stage

This design phase broadly aligns with Stage 4 (Technical Design) and Stage 4.5 (Production Information) of the Structural Plan of Work.

According to IStructE's Structural Plan of Work, the outputs of the Technical Design and Product Information Stages are as follows:

- ▶ Structural Drawings / Information Model suitable for manufacture and construction
- ▶ Structural Specifications
- ▶ Structural Sustainability Report

The checks during the detail design stage should verify that design outputs are coordinated, fully compliant with project requirements and applicable standards, and suitable for manufacturing and construction.

The checks during this stage are generally more detailed and thorough compared to previous design stages. It may also involve third party checking. Some of the specific checks to be carried out during this stage may be grouped as follows:

#### Structural calculations and analysis models:

- ▶ Independently verifying structural analysis models. This involves checking inputs (geometry, loads, boundary conditions, load combinations) and comparing outputs against - generally - simplified analysis models / calculations.
- ▶ Confirming the structural stability under all relevant load combinations with due consideration of the beneficial variable loads, accidental cases and robustness requirements.
- ▶ Verifying that the resistance of structural members is adequate and the member sizes are appropriate to allow for design of robust and practicable connection details. For example, the steel member sizes should not inadvertently lead to disproportionate levels of fabrication and/or impractical connections which may require redesign of structural framing in subsequent design stages.
- ▶ Verifying that the assumptions of analysis models are consistent where structural analysis relies on inputs from other disciplines (for example, geotechnical discipline where soil-structure interaction is prominent). Cross-checking alignment of assumptions in communication with designers and checkers of the other disciplines.
- ▶ Validating all the spreadsheets or calculation tools and confirming that they are appropriate for their intended applications in the project.

#### Manufacturing and construction information – drawings and specifications:

- ▶ Verifying that the structural drawings and specifications clearly convey all details required for manufacturing and construction.
- ▶ Verifying that structural drawings are compatible with general arrangement plans, architectural layouts, MEP, and other design disciplines.

- ▶ Verifying that all drawings and specifications explicitly reference applicable codes, standards, statutory requirements, and contractual obligations.
- ▶ Verifying that all structural materials are clearly specified and consistent across calculations, drawings, and specifications.
- ▶ Checking that the drawings clearly communicate any special construction-stage considerations influencing structural stability (limits on imposed loads during construction, propping requirements, etc.)

#### **Contractor-designed items:**

- ▶ Checking that the contractor's design briefs are up-to-date and in-line with any changes which may have been introduced during the development of detail design.
- ▶ Verifying that contractor-designed items meet the performance specifications and are compatible with the final design.
- ▶ Checking that clash detection activities have been completed by engineers and technicians as may be required (when verifying complex setting out information). Verifying this independently by spot checks where possible.

#### **Temporary works and constructability:**

- ▶ Verifying that the potential impact of construction sequence and methodology on the permanent structure are adequately addressed.
- ▶ Verifying that the temporary works concepts, construction methodologies, sequencing, and temporary stability measures are consistent with the assumptions made in the design of permanent works.
- ▶ Where temporary structures rely on a partially completed permanent structure for stability, verifying that the performance criteria (loads, stiffness, movement limits, etc.) are provided by the temporary works designer and the partially erected permanent works are adequate to accommodate such loads, stiffness and movement limits.

#### **Sustainability and embodied carbon:**

- ▶ Checking that the design documentation demonstrates compliance with sustainability targets, including embodied carbon limits, future adaptability and resilience.

#### **Quality assurance and approval:**

- ▶ It is good practice for the structural engineers to list the architect's and MEP engineer's applicable drawings and their versions in their deliverables. These can change during design development, so it is important to ensure that the final design matches and is properly coordinated.
- ▶ Reviewing the final submission with the understanding that:
  - Approval of a design means that the design is complete, that the design complies with the required standards, specifications and legislation in terms of structural strength, stability and serviceability. Ref [7]
  - Approval of a design drawing means that the drawing is complete, that the drawing conforms to the design and that the structural content of the drawing is correct. Ref [7]

- ▶ Confirming that all checking activities and outputs are formally recorded in line with the project's checking regime. Checking that records are kept demonstrating that checks have been thoroughly completed.

### Preservation and record of design

All design drawings, calculations, computer printouts, test results, test certificates, etc. should be retained in a form easily retrievable for a certain period. In the UK, this period is generally 12 years post-completion or 15 years for residential buildings over 11m or 5 storeys. However, it may differ depending on contractual obligations, client requirements and insurance companies.

At completion, a final check is done to ensure that any design development during construction has been recorded and included in the H&S file along with all CDPs, certifications, etc.

#### Key points summary:

This article proposes a framework outlining what the checkers should focus on during each Stage of the IStructE Structural Plan of Work to effectively manage design risks.

- ▶ At the early design stages (Stages 0 and 1), checks focus on validating strategic assumptions, ensuring the project brief is complete, and identifying potential risks, constraints, and sustainability goals.
- ▶ During the Concept Design and Spatial Coordination Stages (Stages 2 and 3), the checker should verify that the initial structural drawings/models are suitable for costing and planning purposes.
- ▶ During detailed design stage (Stage 4 and 4.5), the checker should verify that the design is code compliant, satisfies the Project Brief and all details required for manufacturing and construction are clearly conveyed on drawings and specifications.
- ▶ Comprehensive and clearly documented records of all checking activities are essential for quality assurance and demonstrating regulatory compliance.

#### References

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9. The Structural Engineer Magazine Article: *What does the Building Safety Act mean for small projects?*, August 2024

Reference can also be made to [Structural Engineers Registration Ltd.](https://www.istructe.org/registration) for further guidance on how to approach the management of risk with regards to the checking of structural designs.