Checking regime for permanent building works

Part 1: Categories of checking

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This first part of the series on checking and monitoring of building structures focuses on categories of checking, with particular emphasis on risk and proportionality. The second part addresses what to check and when.

Introduction

Regulation 11 J(2) of the Building Regulation 2010 states:

"Any person carrying out any design work must take all reasonable steps to ensure the design work carried out by them (and by any workers under their control) is planned, managed and monitored so that the design is such that if the building work to which the design relates were built in accordance with that design the building work would be in compliance with all relevant requirements."

Designers (or design organisations) must ensure that they have considered the general principles of prevention to adequately manage health and safety risks as required by Regulation 9 of CDM 2015. This includes recognizing that the design itself can also present a risk to projects.

Implementing such a regime is not only fundamental to risk management but also crucial for ensuring compliance with regulatory standards such as BS EN 1990, which is discussed further in this article.

What is a checking regime?

A checking regime refers to the systematic process and procedures used to verify and validate the accuracy, safety, and compliance of design deliverables.

In the context of this article, it is considered as part of an internal quality-assurance process of a design organisation and is distinct from any checking or approval activities undertaken by warranty providers or building control bodies for regulatory compliance.

This includes various levels of reviews, validation and verification activities to identify and correct errors, ensuring compliance with standards and confirming that deliverables are complete and accurate.

Understanding the distinction between validation and verification is crucial to implementing an effective checking regime.

- Validation is the process of confirming that the design methodology, tools, and assumptions are appropriate for their intended purposes. This includes assessing the competence of designers, the suitability of software and hardware, and whether an analysis model is suitable for its intended purpose.
- Verification is the process of ensuring that the design procedures have been correctly implemented and executed without errors. It focuses on confirming that calculations, assumptions, and outputs comply with relevant standards, specifications, and contractual requirements.

Key components of a checking regime

ISO 9001 provides a framework for establishing a quality management system (QMS) that applies to all aspects of an organisation, including design activities. A well-defined checking regime is a fundamental part of this system, ensuring that design processes are structured, traceable, and consistently applied.

The key components of a checking regime can be summarised as follows:

1. **Defined roles and responsibilities:** Clearly outlining the responsibilities of designers, checkers, and approvers is essential to establish accountability at each stage of the process. It should be emphasised that designers are responsible for self-checking their work before handing it over to be checked by others.
2. **Categories of checking**: The category of checking determines the level of scrutiny required, ensuring it is proportional to the risks involved and the potential consequences of errors.
3. **Staged reviews/checks:** Multiple review stages help to identify different types of errors, enabling timely corrections that minimise the impact on subsequent design stages and/or deliverables which are related but outside the scope of the check.
4. **Documentation and records:** A document control system should maintain records of all checks, comments, and approvals, providing traceability to ensure the checking process is completed appropriately by competent staff.
5. **Audit and continuous development:** Regular audits ensure the checking regime is consistently applied across projects and identify areas for improvement.

High-level overview of the checking process:

1. **Designer's self-check:** Before submitting, the designer/originator checks their own work for accuracy and completeness.
2. **Checker's review:** The checker checks the deliverable for accuracy, correctness, appropriateness, adherence to standards and contractual requirements.
3. **Approver's certification:** The approver confirms that the design and check has been undertaken by suitably qualified and experienced engineers and that the design and checking process has been followed appropriately.

Reliability class, consequence class and design supervision level

An effective checking regime should be adaptable to suit the complexity of the structure, the reliability of design inputs, and the design methods employed ensuring that the level of scrutiny is proportional to the risks involved and consequences of errors. These aspects may best be captured within the "reliability classes" of a structure as defined in BS EN 1990:2002, which is linked to the "consequence classes" where reliability requirements are greater for structures with higher consequences of failure.

1. **RC3 (reliability class 3):** This class is for structures where the consequences of failure are significant, such as those that could endanger lives or cause substantial economic loss. The design and supervision requirements are the most stringent in this category.

2. **RC2 (reliability class 2):** Involves structures where failure has moderate consequences, demanding more rigorous design and supervision as compared to RC1.
3. **RC1 (reliability class 1):** Applies to structures with low consequences of failure. Design and supervision requirements are relatively less stringent.

Table B1 of BS EN 1990 defines **consequences classes (CC)** to differentiate the required level of reliability for structures based on the potential consequences of their failure or malfunction. This classification system is also adopted by **CG 300**, which specifies the technical approval (TA) procedures and requirements for highway structures. The reproduced table below provides a reference for these classifications.

Consequences classes	Description	Examples of buildings and civil engineering works
CC3	**High** consequence for loss of human life, *or* economic, social or environmental consequences **very great**	Grandstands public buildings where consequences of failure are high (e.g. a concert hall)
CC2	**Medium** consequences for loss of human life, economic, social or environmental consequences **considerable**	Residential and office buildings, public buildings where consequences of failure are medium (e.g. an office building)
CC1	**Low** consequence for loss of human life, *and* economic, social or environmental consequences **small or negligible**	Agricultural buildings where people do not normally enter (e.g. storage buildings, greenhouses)

Depending on the structural form and decisions made during design, particular members of the structure may be designated in the same, higher or lower consequences class than for the entire structure.

In addition to Table B1 of BS EN 1990, reference should be made to **Building Regulations A3 – Table 11**, which defines consequence classes specifically for buildings within the context of reducing the sensitivity of the buildings to disproportionate collapse in the event of an accident.

Continuing from the discussion on consequences classes (CC) in Table B1 of BS EN 1990, the standard also defines design supervision levels (DSL) in **Table B4**. The design supervision level is linked to the reliability class and determines the minimum recommended requirements for checking of design calculations, drawings, and specifications. The Table B4 is reproduced below provides a reference to these design supervision levels.

Design Supervision Levels	Characteristics	Minimum recommended requirements for checking of calculations, drawings and specifications
DSL3 relating to RC3	Extended supervision	Third party checking: Checking performed by an organisation different from that which has prepared the design
DSL2 relating to RC2	Normal supervision	Checking by different persons than those originally responsible and in accordance with the procedure of the organisation

Design Supervision Levels	Characteristics	Minimum recommended requirements for checking of calculations, drawings and specifications
DSL1 relating to RC1	Normal supervision	Self-checking: Checking performed by the person who has prepared the design

Categories of checking

The level of checking required for a design deliverable should not be determined solely by the consequences of failure. In line with risk practice, both the likelihood of design errors and their consequences should guide the decision on the level of checking required.

To align with the design supervision levels defined in BS EN 1990, the following checking categories are suggested to establish a proportionate approach, ensuring that each deliverable undergoes an appropriate level of scrutiny.

These categories recognise that design outputs frequently serve as inputs for other engineering decisions. Small, seemingly low-risk errors can accumulate throughout the design process, potentially leading to significant consequences if not detected in a timely manner. The second part of this article series (“*What to check and when?*”) will provide further guidance on this aspect of the checking regime.

The following sections define **checking categories 1, 2, and 3**, outlining when each category is applicable and the required level of checking and verification.

It should also be noted that a structure may incorporate elements requiring different categories of checking. For example, a structure classified as CC2 may require category 2 checking for overall stability, while routine design of individual elements where consequences of errors are low (design of blockwork lintels for example) may only require category 1 checks.

Checking category 3 - appropriate for CC3 and CC2 with high risk profile

Category 3 applies to deliverables which require third-party checking, typically characterised by high complexity, significant risk, or regulatory requirements. Additionally, contractual obligations often mandate an independent review to ensure impartiality and to provide an unbiased evaluation, reducing the likelihood of design errors in critical infrastructure.

Characteristics of these deliverables include:

- High complexity: Often involves multiple disciplines, unusual designs, considerable exercise of engineering judgement, significant departures from standards, novel methods of analysis, any of which increases the likelihood of errors or miscommunication among team members.
- CC2 buildings where the likelihood of errors is higher: Applies to novel/complex structures, types/forms of structures that are new to the practice.
- Significant risk: Poses substantial risks to public safety, the environment, or financial investment.
- Regulatory requirements: Mandates independent review for compliance with stringent performance standards, legal and safety requirements.
- Large scale: Applies to major infrastructure or large-scale engineering projects.

- High-risk CC2 structures: Applies to CC2 structures where their failure could impact the immediate vicinity. These may be air-rights buildings, buildings where consequences extend beyond one building e.g. modular/MMC projects, permanent/temporary structures adjacent to critical infrastructure (substations, railways, major gas/water pipes, transmission towers, etc.).
- Stakeholder sensitivity: Involves substantial public or stakeholder interest which may require third-party checking to enhance transparency and build trust among stakeholders.
- Innovative approaches: Use of new or untested design methods, construction technologies, or materials which may require independent verification to assess their viability and safety.
- Previous issues: If similar projects have encountered problems in the past, a third-party check may be warranted to prevent recurrence and ensure that lessons learned are applied.

Required checks:

- Designer self-checks the deliverable for accuracy, completeness, and compliance.
- The designer organisation carries out a category 2 level check internally which may include additional levels of checks such as interdisciplinary reviews, specialist reviews by experts on specific fields, reviews by risk committees formed by individuals with significant experience in similar projects, etc.
- Third-party checks are performed by an external organisation that has not been involved in the design. These checks must ensure coordination of the whole design scope.
  (Note: In some cases, third-party checks may be conducted by another team within the same design organisation, provided there are no conflicts of interest and no objections from client and/or organisations providing regulatory oversight.)

Checking category 2 - appropriate for CC2

This category applies where at least one of the following is applicable:

- The consequences of errors are moderate.
- The design activities are "non-routine" involving complex analysis such as 3D finite element modelling for analysis, determination of site-specific ground parameters, etc.
- Design activities involve a considerable degree of interpretation of input parameters (including but not limited to loading, geotechnical parameters, etc.) and determination of load paths.

Required checks:

- Designer self-checks the deliverable for accuracy, completeness, and compliance.
- A detailed independent check with reference to the drawings and specifications but not the original calculations is undertaken by a person or team who have not been involved with any aspect of the original design.
- The independent checker can be within the same design organisation.

Checking category 1 - appropriate for CC1 and CC1 elements in CC2 buildings

This checking category may be appropriate for deliverables where:

- The consequences of errors are low.
- The design activities can be considered as "**routine**" in the sense that they involve use of simple methods of analysis and are performed using established contemporary practices based on widely adopted design codes and guidance documents.
- Design inputs are readily available, not based on engineering judgement or open to interpretation (e.g. imposed load of an office floor, geometry of the structure).
- The deliverable is holistic and does not serve as input for higher-risk design activities.

Required checks:

- Designer self-checks the deliverable for accuracy, completeness, and compliance.
  (Note: Independent checking by another engineer who is not part of the design team is encouraged. The checker may see and thoroughly review the calculations of the designer, rather than carrying out their own independent calculations.)

Key points summary:

- Implementation of an effective checking regime is a crucial part of risk management while ensuring compliance with regulatory standards.
- Checking categories should align with risk and proportionality, considering both consequences and likelihood of errors.
- Designers must always self-check their work before submitting for independent checking.

References

1. British Standards Institution (2005). *BS EN 1990:2002+A1:2005 Eurocode: Basis of Structural Design*. London: BSI
2. Institution of Civil Engineers (2020). *Guidance for Design Risk Management (Version 2, March 2020)*. London: ICE
3. Health and Safety Executive (2015). *Managing Health and Safety in Construction: Construction (Design and Management) Regulations 2015 (L153)*. London
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6. The Building Regulations 2010: Approved Document A – Structure. London: DCLG.
7. International Organization for Standardization (2015). *ISO 9001:2015 – Quality Management Systems — Requirements*
8. Institution of Structural Engineers (2016). *Essential Knowledge Text No. 14: Principles for Computer Analysis of Structures — Principles for Computer Analysis of Structures*. London: IStructE.

Reference can also be made to Structural Engineers Registration Ltd. for further guidance on how to approach the management of risk with regards to the checking of structural designs and a proposed Building Risk Group Matrix.