CROSS Safety Alert
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The management of design related risks: structural civil and fire engineers

CROSS UK

CROSS-UK Safety Alert

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Who should read this alert?

This Alert is aimed at structural and civil engineers and fire engineers and those who engage with them in design and checking. It applies to risk management in all sectors of building and construction work.

Significant, and tragic, failures involving structures continue to occur: fires in apartment blocks in Milan, London and Taiwan, and structural collapses in Florida and Nigeria being recent examples. This paper gives emphasis to the need for engineers to consider risk management at a fundamental level.

Introduction

Structural and Fire Engineers have worked with the management of safety risk for many years and particularly so since 1995 when the CDM Regulations appeared in the UK for the first time. Structural engineering design (including the consideration of fire) leads to hazardous situations and it is clearly important that the consideration of the associated risks is adequate (and legally compliant). It is unfortunate perhaps that, although our work is recognised as high-risk, it is not considered sufficiently high to warrant the additional regulation applicable to, for example, North Sea operations, or the Major Hazard industries; these are obliged to utilise formalised systems[1].

The reality is that despite the importance, and the length of time since CDM first appeared, there is no accepted industry-wide methodology, and no available suite of fully worked examples.

We could split safety risk into a number of Types:

	Type	Example
A	**Occupational safety hazard and risk**	
	These are the hazards, and resultant risks, which stem from the 'CDM approach' and generally highlighted on the HSE website, in 'CDM' books and courses. They concern safety or health issues arising from the work activity on site (during construction or thereafter). Generally speaking a competent contractor will have standard, industry accepted means of dealing with these providing there are no significant issues relating for example, to access, location or environment.	Work at height, use of site vehicles, electrical/gas works, trench work, noisy activities or those involving vibration, dust.

[1] This will change shortly with the proposed Building Safety Act, however, initially at least, this will only apply to a minority of structures.

B	**Codified hazard and risk**	
	These are the risks dealt with in design codes of practice (British Standards and the like) and which, for structural engineers considering safety, generally centre on the avoidance of collapse. There is a longer list of considerations for fire engineers, including collapse, containment, and spread of fire. Generally speaking, for most structures, compliance with the design code (usually the Eurocodes) will lead to a safe result i.e. the risk is managed to accepted standards, which, for buildings, are also set out in the Building Regulations. Notwithstanding, the designer needs to be on the lookout for exceptions.	Collapse, disproportionate collapse, overturning, fire resistance (of materials and in construction detailing), fire spread, means of escape.
C	**Non-codified hazard and risk**	
	These are generally 'soft hazards' (1, and below) and are rarely, if ever, mentioned in any CDM advice or guidance, nor are they detailed in conventional structural engineering books in any comprehensive manner. There is no industry accepted approach.	Ironically it is these which historically have caused the most problems in terms of structural failures (1).

Soft hazards are defined (1) as:

Originating from the design, but whilst leading to a risk to others, do not lead to a work task on site (or later on the completed structure) e.g. calculation or design concept error, analysis error or lack of adequate specified/achieved supervision on site.

These, unlike many Type A hazards, are within the direct control of the designer.

Nonetheless, with Type A hazards, if the designer inadvertently creates a difficult construction situation, there is always another intervention opportunity to pick this up. This intervention arises from the obligation on the contractor to have a safe system of work- regardless of any contractual situation. However, with Type B or C hazards, if there is an error (leading to a concerning risk) it is very unlikely that the contractor will realise this (and is under no obligation to do so). This lack of a second chance (or, as in John Reason's Swiss Cheese model, another 'slice'), provides no defence in depth.

Note that although Types B and C are also covered by the CDM Regulations, they rarely feature as part of any explicit elimination or mitigation action, nor feature in any CDM related publication. This is a major historical shortcoming.

This Alert concentrates on the last of these (Type C-Soft Hazards). It is written to remind engineers of the essential need to manage risk arising from their design, but also to understand that the breadth and depth of this risk management may be more extensive than often thought.

Causes of failure: the 3Ps

SCOSS established the concept of the '3Ps' almost 20 years ago. It is a simple, but effective way, of reminding ourselves of the fundamental causes of failure, viz:

3Ps	Example failure aspect: inadequate-
People	competency and resource
Process	consideration of analysis methodology, concept, checking, site supervision, information provision, and other factors
Product	specification of sources and performance requirements or checks on certification.

The literature demonstrates that most failures occur through a shortcoming in 'People' or 'Process' (usually both). In the UK at least, it is rare to get a 'Product' failure.

Background and Designer's obligations

The hazards and associated risks described below are significant if not carefully considered. They fall under statutory obligations[2]. The expectation is that Designers will follow related authoritative published guidance, unless there is a good reason not to do so (in which case the explanation should be documented). A failure to give these hazards adequate attention is also likely to breach the Code of Conduct of professional institutions.

Reminders through recent failures

Events such as those listed in the opening paragraph tend to be caused through the failure to manage 'soft hazards'. Information on soft hazards has been publicised (1,2,3) and emphasises the essential need to have regard to key issues at the appropriate stage of the project: any project of any size. None of these hazards relates specifically to Higher Risk Buildings which are currently the focus of much attention. They apply universally, are not new, are well documented, and have previously led to failures.

They are of relevance to all structural and civil and fire engineers whatever the type or scale of project.

Key 'soft hazards and risks'

3Ps	Issue:	Risk/comment
People	Competency and resource	Amended brief, staff absence, altered timescales, unexpected complexities, programme pressures.
Process	Assumptions	Need for assumptions to be understood, validated and communicated. This is important for the record, for review, for follow-on, or for partner designers
	Constructability	The designer must always be satisfied that a safe (and economic) method exists. If not obvious this must be illustrated.
	Follow through	Where other designers follow, the initiating designer must ensure adequate information on the assumptions, extent of design, codes used and the like are communicated.
	Review process	All bar the simplest designs require a 'check'. Checks come in various formats and an assessment is required as to the appropriate format in each case. The consideration may include the extent of check, inclusion of concept review, whether it is numerical, and degree of independence.
	Responsibility for design	Absolute clarity is essential. This is particularly critical where design is to be followed through by others as is often the case. It is important that small items e.g. fixings, do not escape clarification.
	Single point of responsibility	Where a design may be affected by subsequent design, assumptions yet to be proven, or actions by others, a single point of responsibility should exist so as to provide the overview. This is not explicitly stated in the Eurocodes but is a logical requirement of a risk managed approach.
	Change control	At any point in the project there needs to be an agreed protocol to authorise any design change. This should preferably involve the original designer, but if not possible, another designer, fully briefed, and of adequate competence should be involved.

[2] Both s3 of the Health and Safety at Work etc Act, and also Reg 9 of the Construction (Design and Management) Regulations. NI has separate legislation but equivalent obligations.

	Lack of independent site supervision	Site supervision is often mistakenly thought of, or presented, as a Client prerogative, whereas in fact the level of site supervision should be determined by the in-built assumptions of the design code, supplemented by the designer's own judgement as to the necessary coverage and time period. The outcome should be conveyed to the Client as a necessary part of the design. Site supervision is a risk mitigation measure.

Summary

Structural and civil and fire engineers work in a high risk environment; most of the time all is well, but when a problem occurs it can be very serious both in terms of life, commercial cost and reputation. It is easy to slip into complacency; however, a quick review of the CROSS database, and the literature, demonstrates the need for constant vigilance.

Managing safety risk is not an optional exercise. It is a statutory obligation, will be a contractual requirement, and is an obligation under Institution Codes of Practice. It requires a disciplined approach by the designer, on all projects (risk does not respect project size). In addition, it may involve advice to Clients and others which on occasions may be perceived as unwarranted: from a quality control or cost perspective. Competent risk assessment and experience may say otherwise.

This Alert is written to remind us of the above, and to give emphasis to risks perhaps not always given due attention.

References

1 Designing for a safer built environment: a complete guide to the management of design risk. Carpenter J. ICE Publishing, London, UK at **Designing a Safer Built Environment: A complete guide to the management of design risk | ICE Bookshop>**

2 ICE Civil Engineering Journal ,Vol 174, Issue 3, **Civil engineers need to act now on the wider lessons from the Grenfell tower fire tragedy>**

at **Proceedings of the Institution of Civil Engineers - Civil Engineering | Vol 174, No 3 (icevirtuallibrary.com)>**

3 Griffiths & Armour 2020 'A brave new world: the claims context' at **Brave New World: A Claims Context - 2 Part release - Griffiths and Armour>**

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