Temporary Works

Temporary Works

Principles of design and construction

Second edition

Edited by
Peter F Pallett and Ray Filip

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Foreword

The first edition of this useful and timely book was published in 2012, and in the six years since then, the work has become a standard reference in the field. During that time, the level of attention given to temporary works in general has increased along with the degree of scrutiny of the competence of those practising in the field. This is to be applauded, although the level of awareness of non- specialist engineers is still too low.

This second edition contains new chapters and extensive rewrites of some of the original chapters. The scope of the work is wide, and the new chapters cover areas where there have recently been problems. It is good to see that these are being addressed.

The management of temporary works is critical to the safe execution of the majority of building and engineering schemes and the widening of the scope of the book can only help in providing guidance for this. What is notable is that the depth of knowledge in a number of fields is still relatively superficial and hopefully some research of these fundamentals can be prompted by a wider exposure to the engineering community.

There is still too much delegation of the responsibility for temporary works to the contractor, with drawings and specifications that do not identify what the thinking or performance requirements for that temporary works is. The designers of permanent works have responsibilities to consider how their creations can be constructed. This may be through early contractor engagement or by clear statement of what the performance requirements are for the temporary condition. There are initiatives to make permanent schemes more material efficient, without considering the implications for the construction and demolition phases.

We are seeing greater levels of awareness and control in temporary works and this is a key part of the management of major works. However, the implementation of the processes required in BS 5975 is still low at the smaller end of the market and we need to be encouraging best practice in this area. Whilst the levels of complexity may be lower and standard solutions may be applicable for some situations, there needs to be appropriate care for any level of temporary works. One of the hurdles for this is the lack of perceived value of engineering from smaller scale clients. It is hard to see how this can be overcome without a more rigorous

prosecution of the Construction Design and Management Regulations.

This book is an integral part of the development of the body of knowledge in temporary works. The authors and editors are to be commended on their efforts which have led to an improvement to an already fine volume. It is my hope that through work such as this we can enable all engineers to consider and design for the temporary condition. My thanks go to those who are enabling that process through their efforts.

Tim Lohmann CEng FICE FStructE
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He is a founder member of the BSI committee for falsework (BS 5975), co-author of the National Access and Scaffolding Confederation's TG20:08 on scaffolding and principally known for the Concrete Society publication *Formwork – A Guide to Good Practice*. He is an accredited CUBS 'Expert Witness – Civil Procedures', with expertise in above-ground temporary works.

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Ray has advised many organisations on temporary works procedures, temporary works design and risk management. He carries out site audits and inspections, and is regularly consulted by the Health and Safety Executive on temporary works issues. He has also provided training courses for many organisations in the UK and Europe.

Ray has been involved in producing a number of technical publications and papers for CIRIA, the Concrete Society, the Contractors Plant Hire Association, the Deep Foundations Institute and *The Structural Engineer* magazine. He is a member of the committee responsible for the British Standard on temporary works (BS 5975).

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Introduction

Temporary Works has been produced for practitioners or would-be practitioners to enable them to apply and enhance their practical skills and knowledge, usually developed in the larger area of permanent works, in this specialism. It will also be of interest to all technicians, undergraduates and graduates wishing to broaden their professional development to have a basic understanding of temporary works. It therefore does not go into considerable detail of design, or the minutiae of construction, but instead shows the reader the unique philosophy and applications by reference to current methods that will enable this specialisation to be applied. You will not find complete worked examples, as an assumption has been made that the reader will either be competent in general engineering principles or will wish to develop those skills not yet possessed.

Where appropriate, each chapter has six main headings of introduction, description of topic (how and why it works), any alternatives worth considering, common methods of construction and principles of design, concluding with references.

Our primary target readership could be considered to be engineers working for a contractor or builder, or for a design consultant, or those intending to gain the technical elements of skill needed to perform efficiently in these roles. We would hope that we have also provided something of value to students and their teachers on the more practical engineering courses.

The most economical temporary works can be 'no temporary works'. Often designing out the temporary works is impossible. Where required, it is rarely considered during the planning and preliminary design stages of a project and rarely specified in the pricing for the permanent works – yet the temporary works have a significant impact on the overall cost of a project. This impacts the industry in several ways. Firstly, it has for many years been given minimum coverage in education at colleges and universities, although fortunately that has improved. How many readers had lectures on temporary works while at college? Secondly, it has until recently been considered a contractor's issue and left to the construction phase of a project, with Permanent Works Designers often not even being involved. The result is that the subject of temporary works has expanded into many specialised fields, each having its own experts and, in many cases, being delivered by specialist suppliers.

ICE Publishing realised that to obtain authoritative guidance a single author would not suffice. Murray Grant and Peter Pallett, well-known and respected engineers with detailed knowledge in temporary works were appointed as managing editors for the first edition published in 2012. This second edition is edited by Peter Pallett and Ray Filip, replacing Murray Grant (retired), to manage, coordinate and proof (and, in some cases, write) the detailed chapters. This edition not only brings up to date the topics inherent in temporary works in the original 27 chapters, but introduces a further seven chapters, to expand on the topics covered and introduces several subjects of a technical nature, more often associated with building construction. The result is that several separate authors have contributed, each being arguably the most knowledgeable engineer and practitioner in their field, writing on their own specialised subject. The result is an authoritative work, informed by the latest UK regulations and use of European codes in the UK.

BS 5975:2019 is the source document for recommended procedures for all organisations involved in temporary works. It provides the framework for safe management of the subject, from concept, through design and construction to completion. At the time of editing this book the 2019 edition of BS 5975 was under final preparation. The managing editors have been involved with the significant updates in the 2019 edition and this book has been updated accordingly. A BSI decision to split BS 5975 into a Part 1 for procedures and a Part 2 for falsework design will be undertaken in the future. Readers should be aware, however, that this book refers to BS 5975 as a single document published in 2019.

Scope of temporary works

A precise use of the *Oxford Dictionary* would limit our definition of temporary works to any work that is done to enable the creation of a permanent structure or infrastructure element. However, this would preclude the opportunities that often arise to reduce or avoid the work and costs of creating something that will be removed or redundant once the client's needs have been satisfied. To avoid temporary works is often a broader, and more elegant, approach to construction, with less exposure to risk and savings in overall cost. On several occasions in the preparation of this book, the definition of temporary works has been extended to suggest alternative processes, at all times promoting the safety of operations and introducing correct procedures for temporary works.

Before using the detailed information, readers of this book are advised to consider if there may be an alternative process whereby the cost and effort of providing works that serve no permanent purpose could be reduced or even avoided.

Furthermore, readers are advised not to limit their selection of temporary works to those methods chosen for inclusion in this book (simply because they are those most commonly used), but to explore the wide range of engineering for potential solutions to their specific project.

Design of temporary works

Designers will be aware of the three basic methods of design, namely permissible stress, limit state and 'custom and practice'. Each method has its merits, and no one method should be preferred in temporary works. This book is not a design manual, and identifies the principles of the designs, and not the detailed method of analysis of the members involved.

In Europe few, if any, educational establishments still teach permissible stress. However, at the time of writing, the majority of Temporary Works Designers in the UK are still using permissible stress in temporary works designs. There is limited confidence to date in the UK on the use of limit state for temporary works design, particularly as the parameters and boundary conditions for temporary works are not the same as for permanent designs. For readers unfamiliar with the differences a short resume follows.

Permissible stress design

Where a member has a load at which it fails, and by applying a single factor of safety (usually 2.0 on collapse and 1.2 on overturning), a safe working load is established. The design then involves checking that for all foreseeable conditions the applied service loads and self-weight do not exceed the safe working load. It should be pointed out that nearly all site staff and operatives have an understanding of safe working loads. The member is considered to be elastic and deflections and so on are all checked using the elastic properties of the members.

For example, to lift a pallet of bricks weighing 10 kN (plus lifting attachments) the site staff would refer to the crane capacity table for reach and check that 10 kN is acceptable for that radius. The crane supplier has produced the data sheets in safe working load terms.

Limit state design

This was introduced at the end of the 19th century and considers both the variability of the material from which the member is made and the probability of the loads actually occurring, and applies partial factors to both.

A statistical approach is used to establish the material properties. Several tests to failure are carried out which generate slightly different ultimate values. Statistical analysis is carried out to provide the characteristic strength with an associated confidence limit normally set at 5%. This means that, if tested, 95% of the members will fail above that value.

The design considers the probability that the calculated loads will be exceeded and applies partial safety factors to suit (usually 1.35 on self-weight, and 1.50 on imposed loads) to give the design loads. The process is then repeated for the materials, and the design resistance of the member calculated by dividing the characteristic resistance by a partial factor based on the probability that the material is not as strong as expected.

The design then involves checking that for all foreseeable conditions the design loads are less than the design resistance. This is the check for the ultimate limit state. A further design check is needed on the unfactored loads to check that the serviceability condition is not exceeded.

This means that a like-for-like comparison between permissible stress and limit state is not possible. It goes without saying that designers cannot mix limit state and permissible-stress methods in a design. If designers provide loads to sites they should clearly specify which loads they are providing to avoid confusion.

The European standards adopted in the UK all use limit state design concepts. The scaffolding industry as a case in point, uses the European documents but introduces a conservative 'quasi-permissible stress' approach (see Chapter 21), to provide design data for site use in understandable 'permissible stress' terms.

The crane capacity table discussed earlier will, most likely, have been generated by limit state design, but converted into 'safe working loads' for site use. The same concept occurs in highway bridge design – the signpost for a bridge weight limit does not state the characteristic strength in kilonewtons but the 'safe load' (usually in tonnes) because that is what the users, the public,

understand, although European limit state design codes were most probably used in the load verification.

Custom and practice design

There are still examples in temporary works of ‘custom and practice’ design being the norm. It relies on the experience and knowledge of operatives who have used similar systems before and ‘know what works’. In the long distant past someone probably did calculations or tests, but it works. This approach is accepted in the European standard for falsework where support to some in situ concrete building slabs (>300 mm thick and <3.5 m high) are ‘custom and practice’ as there are no European design rules and ‘design’ is left to operative experience and knowledge (see Section 22.1.4 in Chapter 22 for class A falsework). Use of column clamps in formwork is another example.

The management systems used (see Chapter 2) should identify and control such systems – ‘custom and practice’ is probably used more frequently on smaller sites than designers realise – it requires engineering judgement, and organisations should have the relevant procedures to control it.

Peter F Pallett and Ray K Filip