

Temporary Works Toolkit

Part 15: Designing temporary works to European standards – an introduction to PAS 8812

The Temporary Works Toolkit is a series of articles aimed primarily at assisting the permanent works designer with temporary works issues. Buildability – sometimes referred to now as ‘construction method engineering’ – is not a new concept and one always recognised as vital to the realisation of one’s ideas; it ought to be at the forefront of an engineer’s mind.

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 **Tony Harris** and **Mariapia Angelino** of WSP explain some of the key technical issues around PAS 8812 – the new guide to temporary works design to European standards. This article aims to promote a shared understanding between designers of both permanent and temporary works.

Introduction

Historically, temporary works in the UK have been designed to British Standards and have relied on permissible stress design approaches, with a key standard being BS 5975¹. The full implementation of the Eurocodes in 2010 was accompanied by the withdrawal of conflicting British Standards. Structural design to the Eurocodes, including for temporary works, requires a limit state design approach to be used. This resulted in a degree of apprehension within parts of the industry as to how temporary works solutions should be designed in the context of European standards.

Issues in the application of European standards to temporary works design

The Eurocodes give principles and requirements for structural safety, serviceability and durability which are relevant to both permanent and temporary works. However, it is important to recognise that the challenges and risks faced during the design of temporary works (Box 1) can be substantially different from those for permanent works. These features require

careful consideration and application of Eurocodes to the design of temporary works. This will help ensure that the levels of reliability and safety previously considered appropriate to the design of temporary works in the UK are not compromised.

Moreover, European product and execution standards, written specifically for temporary works and supplementing the Eurocodes, generally provide simplified approaches that are likely to result in designs that are more conservative than those based on the use of Eurocodes alone.

Although these simplified approaches are likely to be valid for the majority of straightforward applications, they may not be appropriate for more complex applications, particularly those where there is an interaction with permanent works or geotechnical design.

Additional information on issues which affect the application of European standards to temporary works design can be found in guidance published by the Temporary Works Forum (TWf)².

Need for a guidance document

BS 5975 contains explicit design guidance specifically aimed at establishing a clear set of procedures to control risks associated with the design, execution and dismantling of temporary works systems. This guidance remains fully valid during the application of European limit state-based design standards.

In the UK, High Speed Two (HS2) recognised the need for a consistent approach to the design and procurement of temporary works to the new suite of European standards. It therefore made funding available to the British Standards Institution (BSI) to facilitate the development of two Publicly Available Specifications (PAS) specific to temporary works (each of which was co-sponsored by HS2 and the TWf):

- *PAS 8811 Temporary works. Major infrastructure client procedures. Code of practice*³ to give recommendations for UK infrastructure client procedures with respect to temporary works within construction projects
- *PAS 8812 Temporary works. Application of European Standards in design. Guide*⁴ to provide complementary guidance on the application of European standards to the design of temporary works in the UK. WSP was appointed to draft PAS 8812.

This article provides an overview of PAS 8812.

Overview of PAS 8812

Introduction

During the preparation of PAS 8812, the steering group was mindful of the significant improvements in industry practice made following a series of significant temporary works failures in the 1970s, which led to the production of the Bragg Report⁵ and the development of BS 5975.

Accordingly, the group endeavoured to provide high-level guidance to aid designers familiar with previous permissible stress-based codes and the use of equipment and materials rated with a safe working load, and help them make the transition to the current suite of limit state design standards.

Purpose and scope

The purpose of PAS 8812 is to promote consistency in the design approach to temporary works by providing:

- high-level guidance on the application of European standards to the design of a broad range of temporary works in the UK. Relevant guidance includes recommendations on suitable partial factors on actions and materials, combinations of actions and analysis approaches, considerations on structural stability and on reuse of equipment, as in the case of proprietary systems and components
- clarification of the relationship between the Eurocodes and other European standards specifically associated with temporary works
- clarification of design requirements for identified groups of temporary works.

PAS 8812 is for use by appropriately qualified and experienced practitioners in the field of structural and geotechnical design of temporary works.

The guide, together with the companion document PAS 8811, endeavours to provide continuity of good practice during the transition to European standards by recommending:

- the application of appropriate procedural controls, as introduced in BS 5975 and recommended in PAS 8811
- the appropriate transfer of key data and

BOX 1. KEY FEATURES OF TEMPORARY WORKS (REPRODUCED FROM PAS 8812)

- They tend to be in place for a relatively short period of time and then removed and potentially reused
- Elements and components can be reused numerous times within a project or across several projects throughout their service life, potentially making them vulnerable to misuse on site
- They might have interfaces with the permanent works, in terms of the loading that they are subjected to and how they are supported. In some cases, temporary works might be left in place after the completion of construction without necessarily contributing to the resistance or stability of the permanent works, but may influence the residual stiffness and therefore structural behaviour of the permanent system
- They tend to carry a greater proportion of variable actions compared to permanent works
- The structural systems of temporary works often have less redundancy and lower stiffness than permanent works and might therefore be vulnerable to accidental loads associated with site activities
- They can be particularly susceptible to initial imperfections such as lack of fit, eccentricities, corrosion or damage resulting from previous use
- Limited site investigation data might be available when establishing geotechnical parameters
- The party that undertakes the design of temporary works is often not involved in the design of the permanent works that are supported. They might only be involved in a particular aspect of the temporary works and therefore not have a full appreciation of project-wide issues. As such, communication and effective exchange of design data can pose significant challenges and risks unless communication lines and responsibilities are clearly established

information between all parties involved during the lifecycle of temporary works, including design, installation, use and removal

- continuity in the overall levels of safety of temporary works, generally by establishing guidance on appropriate partial factors for actions and material properties
- an appropriate notional lateral destabilising load to ensure stability, as recommended by BS 5975.

Structure

PAS 8812 provides guidance on six groups of temporary works (Box 2). The PAS contains six sections and three annexes. A brief overview of each part is provided in Table 1.

Temporary works design to European standards: key aspects to consider

The design of temporary works to European standards requires particular attention to specific topics in order to guarantee that the level of safety is consistent with past UK practice and is aligned with European practice. A selection of key issues is outlined in the following paragraphs.

Eurocodes terminology and design philosophy

Some of the terms presented in the Eurocodes might represent a change from traditional UK practice and merit clarification to avoid potential misinterpretation when designing to the Eurocodes, and more generally to European standards. Annex B to PAS 8812 helps users better understand the terms defined in the Eurocodes by providing clarity on relevant terms and definitions.

Supported construction

This is defined as elements of the permanent works that are supported by the temporary works. BS EN 1991-1-6⁶ and BS EN 12812⁷ consider supported construction as a variable action. However, the load that supported construction imposes on temporary works will generally remain active and is unlikely to vary significantly once in place, as acknowledged by BS EN 12812. Therefore, it is important that particular attention is paid to the treatment of supported construction for different limit states. PAS 8812 provides guidance to deal with this issue by providing recommended values of ψ factors and partial factors γ_Q .

Safe working load (SWL)

This is defined as the maximum unfactored load that can be safely resisted by an element of proprietary equipment. This term is not used in the Eurocode suite. However, a clear distinction needs to be made between SWL, the characteristic value of an action and the characteristic value of resistance. PAS 8812 provides guidance on this issue. Moreover, when specifying the use of proprietary equipment that has been given an SWL rating

BOX 2. GROUPS OF TEMPORARY WORKS ADDRESSED WITHIN PAS 8812

- Group 1: Falsework, formwork, simple advancing falsework/formwork, access, protection
- Group 2: Geotechnical
- Group 3: Vehicle and pedestrian bridges and related works
- Group 4*: Underground
- Group 5*: Marine temporary works
- Group 6: Other temporary structures (including bridge launching and heavy lift systems)

* Due to the highly specialised nature of Group 4 and Group 5 temporary works, only general guidance is provided in PAS 8812 and reference is made to specific technical publications

by its manufacturer, it should be ensured that the equipment is used as intended by the manufacturer and an appropriate level of safety is maintained.

Wind

Temporary structures are less likely to be exposed to the characteristic wind, which is based on a 50-year return period in BS EN 1991-1-4⁸. The wind action may thus be reduced by using appropriate probability and seasonal factors (see BS EN 1991-1-4) to take account of a temporary structure being in use for a shorter period. However, any reduction to the wind action from its 50-year return period value requires careful consideration. PAS 8812 provides guidance on this issue.

Equivalent horizontal force

The Bragg Report recognises the importance of applying a minimum horizontal force to ensure lateral stability. PAS 8812 acknowledges this issue and recommends the introduction of an equivalent horizontal force (also called a 'notional lateral force' in BS 5975), which is typically given as a percentage of the vertical actions applied to the structure.

Imperfections

Temporary works can be particularly susceptible to initial imperfections such

as lack of fit or eccentricities. The influence of global and local imperfections should be taken into account in the analysis where relevant.

The Eurocodes provide recommendations concerning imperfections in each material-specific part. Supplementary guidance is also provided in other European standards such as BS EN 12810 to 12812^{7,9,10}.

Reuse of proprietary equipment

When proprietary equipment is reused multiple times, a minimum value of the partial material factor should be considered to take account of the increased possibility of bow imperfections, eccentricity and lack of redundancy. PAS 8812 provides guidance on this issue.

Falsework

Falsework is one of the few categories of temporary works that has a specific European standard, i.e. BS EN 12812. This is intended to provide information on structural design that is supplementary to the provisions given in the Eurocodes.

However, the scope of application of BS EN 12812 in relation to the Eurocodes is not clearly defined for different classes of falsework systems. PAS 8812 provides guidance on this issue.

Conclusions

The design of temporary works to European standards requires consideration of the associated features and risks, which may not necessarily apply to permanent works. Currently, there is not a great deal of guidance on the design of temporary works to European standards. Perhaps more importantly, the available standards need to be considered carefully in order to ensure that levels of reliability and safety which have previously been considered appropriate to the design of temporary works are not compromised.

To reduce uncertainty and provide complementary guidance to practitioners, the BSI guide PAS 8812 has been developed. It aims to promote consistency in the design approach to temporary works by providing a means of navigating the diverse landscape of existing standards and guidance documents associated with temporary works design. PAS 8812, together with the companion document PAS 8811, endeavour to support continuity of good practice while providing specific guidance on some key technical issues presented in this article.

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TABLE 1: STRUCTURE OF PAS 8812 AND KEY CONTENTS

Part	Title	Content
Section 0	Introduction	This provides general information to understand the context of the PAS
Section 1	Scope	This defines the scope of the PAS, as well as its limitations
Section 2	Normative references	This contains the normative references to the PAS
Section 3	Terms, definitions and symbols	This provides key terms and definitions relevant to temporary works design (a more extensive discussion is provided in Annex B)
Section 4	Designing temporary works to the Eurocodes	This includes guidance on design situations, actions, limit state design, combination of actions for ULS and SLS, methods of analysis, verifications, stability, use of proprietary equipment
Section 5	Materials	This includes specific considerations for prefabricated equipment in steel and aluminium that may be reused multiple times
Section 6	Specific design requirements for identified groups of temporary works	This comprises six sub-clauses dealing with the six groups of temporary works indicated in Box 2
Annex A (informative)	Reference publications for temporary works	This provides an extensive list of reference publications for temporary works designers
Annex B (informative)	Clarification of key terms and definitions for the design of temporary works to the Eurocodes	This provides clarification on terms and definitions from BS EN 1990 relevant to temporary works design
Annex C (normative)	Combinations of actions and partial factors for the design of temporary works to the Eurocodes	This gives guidance and recommendations on establishing combinations of actions for the design of temporary works to the Eurocodes and gives recommended values of ψ factors and partial factors on actions to be used

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- ▶9) British Standards Institution (2004) *BS EN 12810 Facade scaffolds made of prefabricated components (parts 1 and 2)*, London: BSI
- ▶10) British Standards Institution (2002-13) *BS EN 12811 Temporary works equipment (parts 1-4)*, London: BSI

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