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## PAS 8812:2016

# Temporary works – Application of European Standards in design – Guide



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# Foreword

This PAS was sponsored by High Speed Two (HS2) Limited and the Temporary Works Forum (TWf). Its development was facilitated by BSI Standards Limited and it was published under licence from The British Standards Institution. It came into effect on 31 January 2016.

Acknowledgement is given to Tony Harris and Mariapia Angelino, WSP | Parsons Brinckerhoff, as the technical authors, and the following organizations that were involved in the development of this PAS as members of the steering group:

- AECOM
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Acknowledgement is also given to the members of a wider review panel who were consulted in the development of this PAS.

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This PAS is not to be regarded as a British Standard. It will be withdrawn upon publication of its content in, or as, a British Standard.

The PAS process enables a guide to be rapidly developed in order to fulfil an immediate need in industry. A PAS can be considered for further development as a British Standard, or constitute part of the UK input into the development of a European or International Standard.

## Relationship with other publications

BSI and HS2 engaged with a number of construction industry stakeholders to identify areas in which it was felt that the industry could benefit from further standardization. This engagement resulted in the development of two BSI PAS publications sponsored by HS2 and the Temporary Works Forum, including this PAS and PAS 8811, *Temporary works – Client procedures – Code of practice* (in preparation), which gives recommendations for UK infrastructure client procedures with respect to temporary works construction projects, from planning through to removal.

A number of other areas were identified as benefitting from standardization. A wider programme of work is underway to develop a further two PASs:

- PAS 8810, *Tunnel design – Design of concrete segmental tunnel linings – Code of practice*, which makes recommendations for the design of concrete segmental tunnel linings. It covers design considerations from project inception through to the end of the service life of the tunnel.
- PAS 8820, *Alkali-activated cementitious material and concrete – Specification*, which specifies requirements for alkali activated cementitious binders for suppliers of alkali-activated binders, ready mixed concrete, engineers and architects, contractors, asset owners and end users.

Where Eurocodes are referenced in this PAS, it is assumed that they will be used in conjunction with the relevant UK national annexes.

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## Use of this document

During the preparation of this PAS, the steering group has been mindful of the significant improvements in industry practice made as a result of the experience gained following a series of significant temporary works failures in the 1970s that lead to the publication of the Bragg Report [1] and subsequently the development of BS 5975, *Code of practice for temporary works procedures and the permissible stress design of falsework*. Accordingly, the steering group has endeavoured to provide high-level guidance to aid designers who are familiar with previous permissible stress-based codes and the use of equipment and materials rated with a safe working load to make the transition to the current suite of limit state design standards, focusing particularly on the development of guidance on appropriate approaches to partial factors on actions and materials and aspects associated with structural stability.

As a guide, this PAS takes the form of guidance and recommendations. It should not be quoted as if it were a specification or a code of practice and claims of compliance cannot be made to it.

It has been assumed in the preparation of this PAS that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

## Presentational conventions

The guidance in this PAS is presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

*Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.*

Spelling conforms to *The Shorter Oxford English Dictionary*. If a word has more than one spelling, the first spelling in the dictionary is used.

## Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

**Compliance with a PAS cannot confer immunity from legal obligations.**

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# 0 Introduction

## 0.1 Definition of temporary works

Within the UK construction industry, temporary works are widely understood to comprise: "parts of the works that allow or enable construction of, protect, support or provide access to, the permanent works and which might or might not remain in place at the completion of the works", as defined in BS 5975. This also corresponds to a large degree with the definition of "auxiliary construction works" as defined in BS EN 1991-1-6, *Eurocode 1 – Actions on structures – General actions – Actions during execution*.

## 0.2 Categories of temporary works

A broad range of structures can be categorized as temporary works. Table 1 sets out the six groups of temporary works identified for the purpose of this PAS. The examples given in Table 1 are intended to be illustrative rather than exhaustive.

**Table 1** – Groups of temporary works relevant to this PAS

Group	Sub-group	Examples
<b>Group 1</b>	<b>Falsework</b>	Support to a partially completed structure (e.g. in situ and precast concrete, steelwork during assembly) Propping Façade retention Needling Flying shores Gantries/cantilever Service bridges Structures providing stability during construction, alteration or demolition
	<b>Formwork</b>	Vertical (wall and column) Soffits Sloping Arches Cantilever soffits Permanent formwork
	<b>Simple advancing falsework/ formwork</b>	Formwork travellers (horizontal) Climbing formwork (vertical) Advancing/launching formwork
	<b>Access</b>	Tied scaffolds Freestanding scaffolds Gantries Special scaffolds (e.g. underslung scaffolds)
	<b>Protection</b>	Hoardings Protection fans Temporary roofs

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**Table 1** – Groups of temporary works relevant to this PAS (*continued*)

Group	Sub-group	Examples
<b>Group 2</b>	<b>Geotechnical</b>	Trench and excavation support Tower crane bases Piling/crane mats Retaining walls Earthworks Foundations Cofferdams Horizontal and inclined propping Underpinning Ground anchors Haul/site roads
<b>Group 3</b>	<b>Vehicle and pedestrian bridges and related works</b>	Temporary bridges Propping trafficked bridges
<b>Group 4</b>	<b>Underground</b>	Tunnels/headings Shafts Chambers Tunnelling thrust pits
<b>Group 5</b>	<b>Marine temporary works</b>	Temporary quay walls Dolphins Access jetties Floating plant
<b>Group 6</b>	<b>Other temporary structures</b>	Bridge launching Heavy lift systems Moving of structures Protection decks Structural support to cranes or other lifting devices Erection gantries Hydraulic equipment Jacking

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### 0.3 Typical features of temporary works and associated risks

The following typical features of temporary works and their conditions of service mean that they tend to be subjected to risks that might not apply to permanent works.

- a) They tend to be in place for a relatively short period of time and then removed and potentially reused.
- b) 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. As such, their inspection and maintenance history, particularly when there is a risk of fatigue damage, needs to be managed.
- c) They might have interfaces with the permanent works, both 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 the permanent works without necessarily contributing to the resistance or stability of the permanent works.
- d) They tend to carry a greater proportion of variable actions than permanent works.
- e) Structural systems often have less redundancy and lower stiffness than permanent works and might therefore be vulnerable to accidental loads associated with site activities.
- f) They can be particularly susceptible to initial imperfections such as lack of fit, eccentricities, corrosion or damage resulting from previous use.
- g) Commonly a relatively short timescale is allocated for their design and procurement.
- h) Limited site investigation data might be available when establishing geotechnical parameters.
- i) The dominant variable action is typically expected to be encountered at its characteristic value during normal service, whereas in permanent works it would be expected to occur only rarely over the structure's design life.
- j) The party that undertakes the design of temporary works is often not involved in the design of the permanent works that they support and 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.

- k) The nature of the procurement process for temporary works might bring risks associated with:
  - 1) assumptions regarding construction sequence;
  - 2) design interfaces and communication of design assumptions; and
  - 3) competence of the organization(s) responsible for the safe design, erection, use and removal of the temporary works.

### 0.4 Continuity in best practice

This PAS recognizes the developments in the field of design and management of temporary works in the UK in the last forty years, in particular those that stemmed from the Bragg Report [1] and subsequently BS 5975, *Code of practice for temporary works procedures and the permissible stress design of falsework*, which has been and remains the reference standard for design of falsework in the UK over the last 30 years.

This PAS together with the companion document PAS 8811 (in preparation) therefore endeavours to provide continuity of good practice during the transition to European Standards through the following approaches.

- a) **Application of appropriate procedural controls.** Safe implementation of temporary works is reliant on the application of appropriate procedural controls as introduced in BS 5975 and recommended in PAS 8811. These procedural controls cover the full process, including the selection of appropriate design standards, the development of the initial concept, and the management of operations through the erection and operation phase to final decommissioning.
- b) **Appropriate transfer of key data and information.** A key theme identified within the Bragg Report [1] was the need for the appropriate transfer of key data and information across all phases of the design cycle through effective communication between all involved parties, including coordination between the designers of permanent and temporary works.
- c) **Continuity in the overall levels of safety.** The overall levels of safety for falsework design embedded in BS 5975 have proved to be necessary and largely successful. This PAS has endeavoured to establish guidance on appropriate partial factors for actions and material properties that do not erode this position.

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d) **Design for stability.** The introduction in BS 5975 of the requirement for falsework systems to be designed to resist a notional lateral destabilizing load when considering global and nodal stability has resulted in a significant improvement in the safety of such systems within the UK. The guidance provided in this PAS aims to maintain that legacy and, where relevant, suggests extending its application to other temporary works systems.

These European Standards are intended to supplement the Eurocodes and provide additional guidance for those engaged in the design of these categories of temporary works. Generally, they provide simplified approaches that are likely to produce more conservative designs than those resulting from the use of the Eurocodes alone. Although these simplified approaches are likely to be valid for the majority of straightforward applications, they might not be appropriate for complex applications or where there is an interaction with permanent works or geotechnical design.

## 0.5 European Standards for temporary works design

The Eurocodes (i.e. BS EN 1990 to BS EN 1999) provide common structural design rules for construction works. Although they focus on the design of permanent works, they give principles and requirements for structural safety, serviceability and durability, which are also relevant to temporary works. However, because of the different features of permanent and temporary works, the application of the Eurocodes to the design of temporary works needs to be considered carefully in order to ensure that levels of reliability and safety that have previously been considered appropriate to the design of temporary works are not compromised.

A great deal of published guidance on the application of the Eurocodes exists in the form of non-contradictory complementary information (NCCI), most of which is equally valid to both permanent and temporary works. However, only a limited amount is available that is specific to the development of temporary works solutions and in particular how to apply a limit state design approach to temporary works.

European product and execution standards written specifically for temporary works have been published alongside the Eurocodes, for example:

- a) BS EN 1004, *Mobile access and working towers made of prefabricated elements – Materials, dimensions, design loads, safety and performance requirements;*
- b) BS EN 1065, *Adjustable telescopic steel props – Product specifications, design and assessment by calculation and tests;*
- c) BS EN 12063, *Execution of special geotechnical work – Sheet pile walls;*
- d) BS EN 12810 (all parts), *Façade scaffolds made of prefabricated components;*
- e) BS EN 12811 (all parts), *Temporary works equipment;* and
- f) BS EN 12812, *Falsework – Performance requirements and general design.*

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## 1 Scope

This PAS gives guidance on the application of European Standards to the design of temporary works in the UK when adopted voluntarily, required by the Public Procurement Directive [2] or stipulated by the client.

**NOTE** See also *PAS 8811, Temporary works – Client procedures – Code of practice (in preparation)*.

It covers:

- a) interpretation of key design approaches applicable to all temporary works including:
  - 1) recommendations on suitable partial factors and combinations of actions;
  - 2) recommendations on appropriate analysis approaches;
  - 3) stability considerations;
  - 4) considerations on reuse of equipment, as in the case of proprietary equipment;
- b) relationship between the Eurocodes and other European Standards specifically associated with temporary works; and
- c) clarification of design requirements for identified groups of temporary works.

The aim of this PAS is to promote consistency in the design approach to temporary works and remove uncertainties for temporary works designers.

It does not cover issues relating to either the procedural control of temporary works covered in BS 5975 or specific requirements related to client procedures, which are covered in PAS 8811 (in preparation).

This PAS highlights issues to be taken into account by the temporary works designer when selecting the most appropriate standards to adopt, in relation to the transfer of key design data and information across all phases of the design cycle. This PAS is for use by practitioners in the field of structural and geotechnical design of temporary works.

This PAS provides non-contradictory complementary information (NCCI) with respect to existing standards and other relevant guidance documents.