

BS EN 12811-4:2013



BSI Standards Publication

Temporary works equipment

Part 4: Protection fans for scaffolds —
Performance requirements and product
design

National foreword

This British Standard is the UK implementation of EN 12811-4:2013.

The UK participation in its preparation was entrusted to Technical Committee B/514/42, Access and working platforms.

A list of organizations represented on this committee can be obtained on request to its secretary.

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ISBN 978 0 580 75729 7

ICS 91.220

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 December 2013.

Amendments issued since publication

Date	Text affected
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EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 12811-4

November 2013

ICS 91.220

English Version

**Temporary works equipment - Part 4: Protection fans for
scaffolds - Performance requirements and product design**

Équipements temporaires de chantiers - Partie 4: Pare-
gravats pour échafaudages - Exigences de performance et
conception du produit

Temporäre Konstruktionen für Bauwerke - Teil 4:
Schutzdächer für Arbeitsgerüste - Leistungsanforderungen,
Entwurf, Konstruktion und Bemessung des Produkts

This European Standard was approved by CEN on 28 September 2013.

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Foreword

This document (EN 12811-4:2013) has been prepared by Technical Committee CEN/TC 53 “Temporary works equipment”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2014, and conflicting national standards shall be withdrawn at the latest by May 2014.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This European Standard is part of a series of standards EN 12811, *Temporary works equipment*, which consists of the following parts:

- *Part 1: Scaffolds — Performance requirements and general design;*
- *Part 2: Information on materials;*
- *Part 3: Load testing;*
- *Part 4: Protection fans for scaffolds — Performance requirements and product design.*

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Each year, many objects fall from a height and strike people. Often, this leads to serious injury, because the impact is on the head. This statistic does not take into account the many near misses.

The dangers associated with falling objects has been recognized by the European Commission, which dealt with the matter by writing an amendment to the Work Equipment Directive (89/655/EEC) that deals exclusively with work at height (2001/45/EEC) and requires the prevention of objects falling off scaffolds.

Usually the provision for preventing such dangerous occurrences takes the form of a “toe-board” attached to the edge of the platform. However, toe-boards according to EN 12811-1 should be at least 150 mm high and statistics indicate that they are not always effective. Therefore, additional protection is often specified, by local by-laws, especially for scaffolds erected above areas where members of the public cannot be prevented from entering, for example in city and town centres.

One way of satisfying these local regulations is to provide a protection fan attached to the main scaffold at some distance below the working platform.

Because these protection fans are required to arrest the fall of substantial objects such as bricks, blocks, scaffold boards and the like, they could be considered as a necessary safety-critical accessory for scaffolds. This, coupled with the fact that they have to arrest the fall of significant objects, i.e. subjected to significant dynamic loads, puts them in the category of complex structures. Yet, in many European countries, there are no rules to govern the design and installation of protection fans.

Across much of Europe, protection fans are:

- erected in configurations that are not verified; and
- attached arbitrarily to scaffolds.

That is to say, the information related to protection fans, such as it is, is very basic. Under the suite of standards drawn up by CEN TC 53, Temporary works equipment has had its design formalized across Europe. The current situation is that un-designed and unverified components are being attached to scaffolds. Therefore, it is necessary to formalize the design and erection of protection fans.

1 Scope

This European Standard specifies product requirements, methods of structural and general design and tests for protection fans for scaffolds to protect workers as well as members of public from objects that may fall off the outside edge of scaffolds being used close to where they are working or passing by.

This European Standard only applies to protection fans while the scaffold is being used as a working place.

Protection fans attached to structures other than scaffolds as defined in EN 12811-1 are outside the scope of this European Standard.

This European Standard applies only to protection fan systems on to which construction debris may fall from 24 m or less.

This European Standard ensures resistance of protection fans for most blunt falling objects representing an impacting energy not exceeding 720 J.

NOTE This energy corresponds to a 3 kg object falling from 24 m.

This European Standard does not cover the requirements for the total area to be protected against falling items.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 74 (all parts), *Couplers, spigots and baseplates for use in falsework and scaffolds*

EN 338, *Structural timber — Strength classes*

EN 1990, *Eurocode — Basis of structural design*

EN 1993-1-1, *Eurocode 3: Design of steel structures — Part 1-1: General rules and rules for buildings*

EN 1995-1-1, *Eurocode 5: Design of timber structures — Part 1-1: General rules and rules for buildings*

EN 1999-1-1, *Eurocode 9: Design of aluminium structures — Part 1-1: General structural rules*

EN 12810-1:2003, *Façade scaffolds made of prefabricated components — Part 1: Products specifications*

EN 12811-1:2003, *Temporary works equipment — Part 1: Scaffolds — Performance requirements and general design*

EN 12811-2, *Temporary works equipment — Part 2: Information on materials*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12811-1:2003 and the following apply (see also Figure 1).

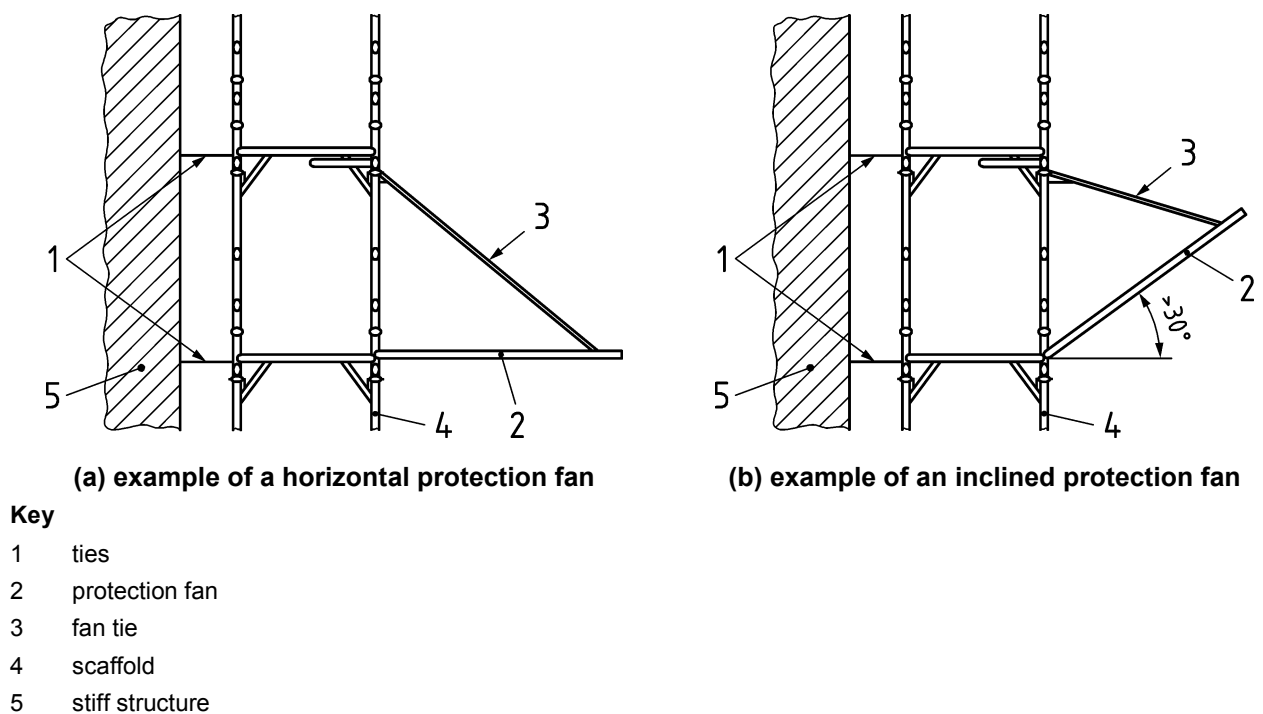


Figure 1 — Examples of protection fan systems

3.1

protection fan system

set of interconnected components used for the purpose of arresting falling objects, which includes (a) an assessed set of configurations and (b) the product manual

3.2

component

part of a protection fan system which cannot be dismantled further

Note 1 to entry: For example a support or a vertical frame.

3.3

element

integral part of a component

Note 1 to entry: For example a welded connection.

3.4

connection device

device for the connection of components

3.5

configuration

particular arrangement of connected components

3.6

protection fan configuration

configuration of the protection fan system comprising a complete scaffold or a representative section from it

3.7

arresting surface

surface on which falling object is interrupted and prevented from falling any further

3.8

protection fan

complete assembly of the arresting surface and its immediate structural support members

3.9

scaffold bay

length of scaffold defined by two consecutive standards

Note 1 to entry: For example, two bays are defined by three consecutive standards.

4 Classification

4.1 Rules for classification

Protection fans shall be classified in accordance with the requirements of Table 1.

Table 1 — Classification of protection fans

Classification criteria	Classes
Snow Load	SL0 or SL1 in accordance with Table 2
Shape	V0 or V1 in accordance with Table 3
Width	B1 to B7 in accordance with Table 4

4.2 Snow loading classification

The standard specifies two snow loading classes as shown in Table 2.

Table 2 — Snow loading classes of protection fans

Classification	Snow load
Class SL0	No snow load
Class SL1	With snow load

4.3 Shape classification

The standard specifies two shape classes as shown in Table 3.

Table 3 — Shape classes

Classification of protection fan	Shape characteristic
Class V0	With horizontal (or partial horizontal) surface or inclination $\leq 30^\circ$ – see Figure 1(a)
Class V1	With (uniform) inclined surface ($>30^\circ$) – see 7.2.2 – see Figure 1(b)

Class V0 shall only be chosen if the access onto the protection fan is prevented in the standard set of system configurations.

Class V0 shall have a vertical or inclined upstand at the edge which shall have a vertical height of not less than 50 cm.

4.4 Width classification

This European Standard specifies seven width classes as follows:

Table 4 — Width classes

Width classification	B1	B2	B3	B4	B5	B6	B7
Minimum width m	0,6	0,9	1,2	1,5	1,8	2,1	≥ 2,4

The width class chosen shall depend on a risk assessment, which demonstrates that it is adequate.

NOTE 1 In some EU member states national regulations or other requirements do not allow some of the width classes.

NOTE 2 B is defined in Figure 2.

5 Designation

The designation of a scaffold system shall consist of the following parts:

Protection fan EN 12811-4	<div>Shape Class</div>	<div>Load Class</div>	<div>Width Class</div>
	V0 Horizontal surface	SL0 No snow load	BX ($1 \leq X \leq 7$)
	V1 Inclined surface	SL1 With snow load	

For example: EN 12811-4 V0 B5 means a protection fan system with a horizontal or partial horizontal surface designed for snow load and with a width corresponding to B5 taken from Table 4.

6 Materials

6.1 General

Materials shall be selected from European or international standards.

Materials shall fulfil the requirements given in the appropriate European Standards where design data is provided.

Materials shall be free from any impurities and defects which may affect their satisfactory use.

Materials used shall be sufficiently robust and durable to withstand normal working (and storage) conditions.

Information about the most commonly used materials is given in EN 12811-2.

6.2 Specific material requirements

6.2.1 Steel

Steels of de-oxidation type FU (rimming steels) shall not be used.

Information on common types of corrosion protection is given in EN 12811-2.

6.2.2 Timber

Timber shall be stress graded in accordance with EN 338.

If a protective coating is used, it shall not prevent the discovery of defects in the material.

Plywood shall have at least 5 plies and shall have a minimum thickness of 9 mm. In addition, it shall have good durability with regard to climatic conditions (see 8.2.2 for service class requirements).

7 General requirements

7.1 General

A protection fan system shall be effective in arresting the fall of any objects that fall from height.

Attention shall be paid to ergonomic considerations. This means that components used in the construction of protection fans shall:

- be of a size that is easy to grasp;
- be of a cross-section and weight that allows safe manual handling; and
- not incorporate any sharp edges.

Where components are meant to be lifted by crane, it shall have attached or it shall be possible to attach components that allow them to be attached safely to a lifting device.

Protection fans shall not replace safety-critical components, e.g. edge protection, toe-board. The materials used in protection fans shall not require special measures for their disposal.

It shall be possible to arrange the arresting surface of the protection fan so that there is no gap between adjacent units.

NOTE 1 This can be achieved by filling the gap with purpose-made components.

When in place, the arresting surface shall be designed to ensure that any construction debris that is arrested is retained within the plan area of the arresting surface.

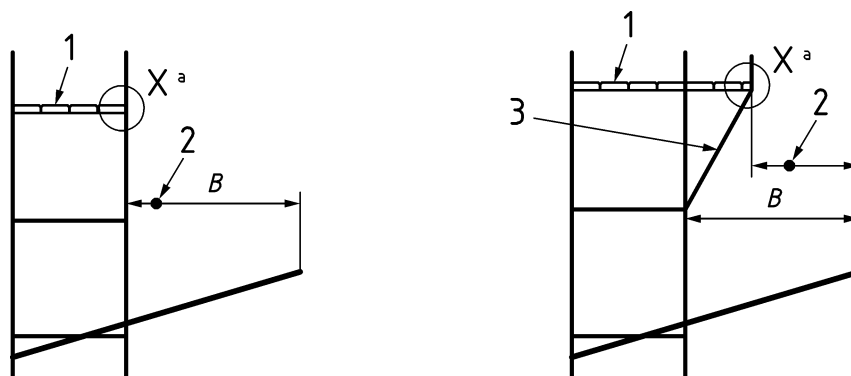
The arresting surface of a protection fan shall resist the forces from uplift applied by maximum wind. Such resistance shall be mechanical means.

NOTE 2 Mechanical means includes nailing down.

7.2 Dimensions

7.2.1 Width

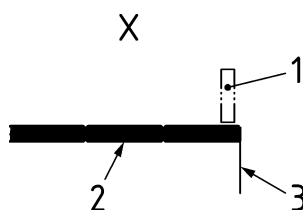
The width of the protection fan, B, as shown in Figure 2, is measured from the outer edge of the working platform, as shown in Figure 3, below.



Key

- 1 working platform
- 2 protected area B (width of protection fan)
- 3 fan tie
- B width of protection fan
- X for detail see Figure 3
- ^a The outer edge of the working platform is as defined in EN 12811-1.

Figure 2 — Width of protection fan (B)



Key

- 1 toe board
- 2 working platform
- 3 measurement point of width (B)

Figure 3 — Detail of measurement of width of protection fan (B)

7.2.2 Minimum inclination of protection fan

The minimum inclination to the horizontal of the protection fan for class V1 is 30°.

7.3 Components and elements

7.3.1 Couplers

Couplers for connecting the protection fan to the main scaffold structure shall comply with EN 74-1 or EN 74-2 or EN 74-3, whichever is appropriate.

7.3.2 Steel scaffold tubes (circular)

Steel tubes shall be in accordance with the specification in EN 12811-1:2003, 4.2.1, and EN 12810-1:2003, 6.2.2.

7.3.3 Aluminium scaffold tubes (circular)

Aluminium tubes with an outer diameter of 48,3 mm shall conform to the specification of EN 12810-1:2003, 6.2.3.

8 Requirements for design

8.1 Basic requirements

8.1.1 General

Each protection fan shall be designed to ensure that it does not collapse or move unintentionally at all stages, including erection, modification and until fully dismantled.

8.1.2 Arresting surface

The arresting surface shall be capable of resisting the impact from falling construction debris.

This ability to arrest falling objects shall be verified by testing in accordance with Clause 9.

8.1.3 External support

A protection fan shall have a support capable of resisting the design loads and limiting movement.

8.1.4 Fixings for protection fans

Fixings for protection fans shall be capable of supporting the loads that protection fans will be subjected to in service.

8.2 Structural design

8.2.1 Method of design

The design of any protection fan shall be carried out following the limit state method.

All loads specified in this European Standard shall be treated as characteristic loads.

The protection fan system, including its elements shall satisfy the load requirements.

Design shall be carried out in accordance with the Eurocode design standards for structural engineering. The current standards include:

- for steel: EN 1993-1-1;
- for aluminium: EN 1999-1-1;
- for timber: EN 1995-1-1;
- for design: EN 1990.

If there are conflicts between provisions in this European Standard and other standards, e.g. Eurocodes, then the provisions in this European Standard shall have precedence.

8.2.2 Special requirements for timber

When using EN 1995-1-1 the following characteristics shall be used:

- a) for load duration: short term duration for all loads;
- b) service class: shall be Class 3;
- c) modulus of elasticity: $E_{0,05}$ for ultimate limit state.

8.2.3 Partial safety factor

8.2.3.1 Ultimate limit state

For the ultimate limit state, partial safety factors shall be:

- a) Partial factors for load:

$Y_F = 1,5$ for all permanent loads;

$Y_F = 1,5$ for all variable imposed loads, e.g. working wind.

- b) Partial factors for material:

$Y_M = 1,1$ for ductile metallic materials (definition of ductility see EN 12811-2);

$Y_M = 1,5$ for brittle metallic materials;

$Y_M = 1,3$ for timber.

8.2.3.2 Serviceability limit state

For serviceability limit state, partial safety factors shall be:

$Y_F = 1,0$ for all loads;

$Y_M = 1,0$ for all materials.

8.2.3.3 Uplift checks

Y_F (for self-weight) = 0,9.

8.3 Actions

8.3.1 General

Four main types of loading need to be considered:

- a) permanent loads;
- b) variable imposed loads;
- c) wind loads, and
- d) snow loads.

8.3.2 Permanent and variable imposed loads

8.3.2.1 Class V0

Permanent loads shall include the self-weight of the fan structure, including all components, such as platforms and fittings and shall be evaluated using published data.

Protection fan systems of the class V0 shall be designed in accordance with EN 12811-1, load class 2.

NOTE The service load in Class 2 is intended to cover most snow loads. However, for snow loads in excess of this, see EN 12811-1:2003, 6.2.6.

8.3.2.2 Class V1

Permanent loads shall include the self-weight of the fan structure, including all components, such as platforms and fittings and shall be evaluated using published data.

NOTE For snow loads in excess of $1,5 \text{ kN/m}^2$ see EN 12811-1:2003, 6.2.6.

8.3.3 Variable Imposed loads: Class V1

8.3.3.1 Working wind and maximum wind

Wind loads shall be evaluated in accordance with EN 12811-1 and EN 12810-1. Two wind conditions shall be investigated:

- working wind (in-service wind) in accordance with EN 12811-1, 6.2.7, and
- maximum wind (out of service wind) with the value in accordance with EN 12810-1, 8.3.

8.3.3.2 Aerodynamic force coefficient c_f

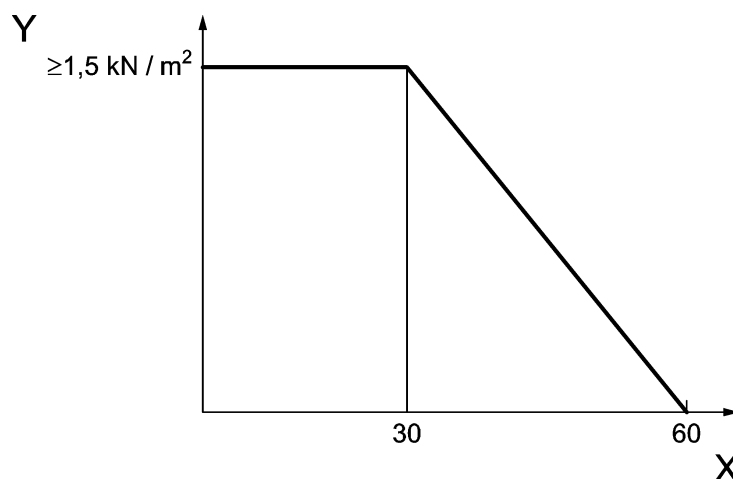
- a) $c_{f\perp}$ The value of the aerodynamic force coefficient $c_{f\perp}$ shall be taken as $\pm 1,3$.
- b) $c_{f\parallel}$ The value of the aerodynamic force coefficient $c_{f\parallel}$ shall be $\pm 0,3$.

8.3.3.3 Erection loads – operatives (EL)

Where erection of the protection fan requires persons to work on the incomplete protection fan system, a minimum erection load shall be applied to the protection fan structure to account for the loads of persons who will erect the protection fan. This erection load shall be a load of $1,0 \text{ kN}$ spread over an area $200 \text{ mm} \times 200 \text{ mm}$ for each person located at the worst point evaluated by calculation.

8.3.3.4 Snow Loads

The intensity of the snow loads shall be applied over the full width B in accordance with Figure 4, below:



Key

X inclination of protection fan
Y snow load intensity

Figure 4 — Intensity of snow load

For inclinations between 30° and 60° the load shall be interpolated.

8.4 Load combinations

For class V1 loads shall be combined as specified in Table 5:

Table 5 — Combinations of loads to be used

Load case	Scaffold condition	Self-weight	Variable imposed load (8.3.3)			
			Working wind	Maximum wind	Snow load	EL
1	In-service	1,0	1,0	0	1,0	0
2	Out of service ^a	1,0	0	1,0	0,7	0
3	Erection ^b	1,0	1,0	0	0	1,0
^a This load combination is to check fixings and possible buckling of any intermediate support members.						
^b See 8.3.3.3						

8.5 Falling object impact loads

The performance of the protection fan under these loads shall be verified by testing in accordance with Clause 9.

9 Testing to verify performance

9.1 Purpose of testing

Because dynamic behaviour during impact is difficult to analyse and calculate, tests shall be carried out to:

- a) verify that protection fans will arrest falling objects at initial impact and after any rebound, and

- b) verify that the falling object does not fall outside the protection fan, and
- c) ensure, that the protection fan system has a sufficient robustness.

9.2 General

The protection fan sample shall be erected following the scheme provided by the manufacturer. Drop tests have to be carried out which give the most onerous actions to the protection fan itself and to the supporting structure.

Examples of drops positioning are illustrated in Figure 6.

A minimum of three tests shall be carried out.

Each test shall comprise of one drop in the different positions shown in Figure 6. During each test the material shall not be changed.

The protection fan sample shall satisfy the requirements of 9.1 for each test; permanent deformations and local damage are acceptable.

9.3 General description of test components

9.3.1 Test sample

The samples shall be set up in the most onerous configurations required in the manufacturer's instructions.

9.3.2 Test impactor

The test impactor shall be rigid steel sphere of diameter of not more than 150 mm and with a weight of 12 kg falling from 6 m.

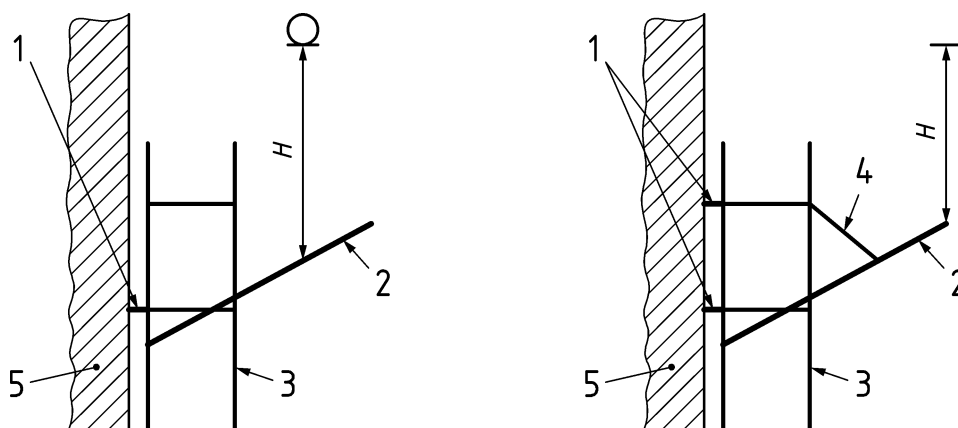
9.4 Test

9.4.1 Principle of the test

A prescribed impactor (see 9.3.2) is allowed to fall vertically under gravity and impact with the protection fan under test, testing its ability to arrest the fall of the impactor and retain it on the protection fan.

9.4.2 Test set up

The protection fan shall be attached to a minimum 2-bay wide scaffold (according to the manufacturer's instructions) which is tied to a stiff structure, A (see Figure 5).



Key

- 1 ties
- 2 protection fan under test
- 3 scaffold – width 2 bays
- 4 fan tie
- 5 stiff structure

NOTE The tie positions shown are examples only.

Figure 5 — Test set up (illustrative only)

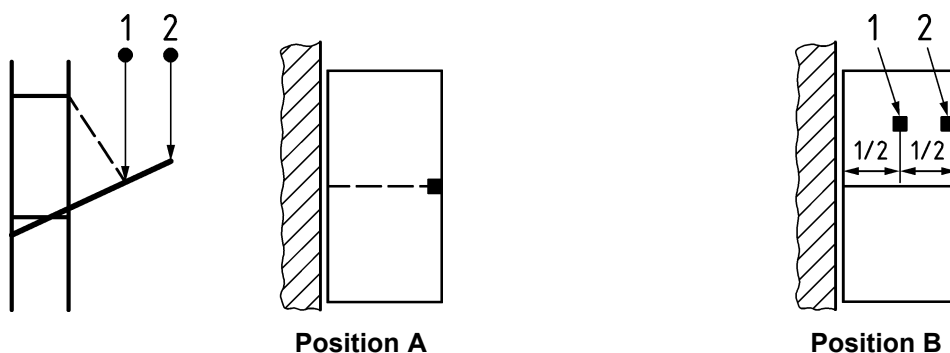
9.4.3 Test procedure

The falling height H shall be measured from point of impact on the fan with the scaffold (see Figure 5). The falling height shall be $H = 6$ m.

Allow the impactor to fall under gravity and impact with the protection fan at the points shown below:

- a) position A2: At the outermost point of the frame;
- b) position B1: Centric between the supporting frames and centric between the scaffold face and outermost part of the fan;
- c) position B2: Centric between the supporting frames and at the outermost part of the fan.

The impact points are also shown in Figure 6.



Key

- 1 general impact position 1
- 2 general impact position 2

Figure 6 — Illustration of test drop positions

9.4.4 Results to be recorded

After the test the following shall be recorded:

- a) the protection fan arrangement and the situation of testing points and other important things;
- b) whether the samples had been changed and for what reason;
- c) any damage to the tested sample.

9.4.5 Compliance with the testing requirements

To comply with the testing requirements of this European Standard, the impactor shall be arrested by the protection fan and shall not fall outside the protection fan normal to the facade.

If in any of the tests the impactor is not retained, the protection fan shall not comply with this European Standard.

9.4.6 Test report

The test report shall contain at least the following:

- a) the name of the test organization or institution;
- b) the name of the product being tested;
- c) the name of the manufacturer of the product under test;
- d) clear identifications of the configurations for the test;
- e) a statement that the protection fan under test complies with the testing requirements;
- f) any photographs that support the statement made in e), and
- g) the classification of the test sample.

Any testing organization or institution shall be able to demonstrate competence to carry out the relevant testing requirements of this European Standard.

NOTE Some countries have systems for national accreditation of testing laboratories.

10 Assessment of compliance

An assessment shall be carried out by a person or an organization different from the original designing person and organization.

On completion of a successful assessment, a statement to that effect shall be given by the assessor. This statement shall identify the reference number of all examinations and the test report shall include:

- identification of the particular set of components examined;
- identification of the standard set of system configurations.

11 Manuals

11.1 General

The manufacturer of the protection fan shall produce a set of instructions forming the product manual together with the product manual provided by the scaffold manufacturer. It will be part of the basis of the structural design. The content is given in 11.2.

11.2 Content of a product manual

The product manual shall include the following information subdivided as outlined in EN 12811-1:

- a) list containing each component and a description from which it can be identified, e.g. a drawing;
- b) instructions for the sequence of erection and dismantling the components and for the way to handle them;
- c) the layout of each system configuration of the standard set giving its designation, its anchorage pattern and how to include the ancillary components;
- d) instructions for tying under all these circumstances;
- e) a statement of limitations of use with reference to:
 - 1) wind velocity pressure,
 - 2) ice and snow; and
 - 3) maximum distance below the working platform;
- f) a full specification of the items which are not purpose designed components, for example, loose tubes and couplers;

NOTE This will enable their purchase to be arranged if they are not supplied by the manufacturer.

- g) Loads imposed on the facade to which the scaffold is tied and loads on the foundation from wind and snow loads;
- h) an indication that obviously damaged components shall not be used;
- i) any instructions for storage, maintenance or repair which the manufacturer considers appropriate;
- j) structural data necessary for the design of the scaffold;
- k) how to obtain further information about the product;
- l) a warning that the height of the installation will depend on the risk assessment;
- m) a warning that the width class chosen shall depend on a risk assessment which demonstrates that it is adequate and/or on the legal requirements.

12 Marking

Each prefabricated protection fan's structural component, except items which are not purpose designed for protection fans and couplers complying with EN 74-1 and EN 74-2 shall be marked as follows:

- a) a symbol or letters to identify the structural component and its manufacturer;

- b) markings that allow components to be traced and identified (the year of manufacture, using the last two digits; alternatively a code for tracing the year of manufacture may be used).

Marking shall be so arranged that it will remain legible for the life of the component. The size of the lettering shall take account of the size of the component.

Bibliography

- [1] EN 12811-3, *Temporary works equipment - Part 3: Load testing*

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