BRITISH STANDARD

BS EN
13331-1:2002

Trench lining systems

Part 1: Product specifications

The European Standard EN 13331-1:2002 has the status of a British Standard

ICS 93.020

BSI
British Standards

National foreword

This British Standard is the official English language version of EN 13331-1:2002.

The UK participation in its preparation was entrusted by Technical Committee B/514, Access and support equipment, to Subcommittee B/514/WG29, Trench support systems, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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

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Grabenverbaugeräte - Teil 1: Produktfestlegungen

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

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Contents

page

Foreword 3

Introduction 4

1 **Scope** 4

2 **Normative references** 4

3 **Terms and definitions** 5

4 **Symbols** 15

5 **Designation** 16

6 **Materials** 17
6.1 **General** 17
6.2 **Fasteners** 17
6.3 **Minimum fracture elongation of cast iron** 17

7 **Requirements** 17
7.1 **General** 17
7.2 **Minimum characteristic system resistance** 18
7.3 **Deflection** 18
7.4 **Attachment points for extracting, handling, pulling and connecting** 20
7.5 **Struts** 21
7.6 **Strut to panel or slide rail connection** 23
7.7 **Panels** 23

8 **Assessment** 24

9 **Instruction manual** 24
9.1 **General** 24
9.2 **Principle contents** 24

10 **Marking** 25

11 **Conformity** 25
11.1 **Declaration of conformity** 25
11.2 **Evaluation of conformity** 26

Annex A (normative) **Partial safety factors** 27

Annex B (informative) **Relationship between loads and resistance** 28

Annex C (informative) **Assessment nomogram for a trench lining system** 29

Annex D (informative) **Explanation of 'cut and lower' techniques** 31

Bibliography 32

Foreword

This document (EN 13331-1:2002) 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 February 2003, and conflicting national standards shall be withdrawn at the latest by February 2003.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

EN 13331, *Trench lining systems* consists of the following parts:

Part 1: Product specifications.

Part 2: Assessment by calculation or test.

These standards are to be read in conjunction with prEN 12811-2 and prEN 12811-3 *Temporary works equipment-Scaffolds*.

Introduction

Trench lining systems are intended to ensure the stability of vertical trench walls and to protect workers from the effects of collapse of the trenches.

Part 1 of the series deals with materials and specifications for the manufacture of trench lining systems.

Part 2 of the series deals with the evaluation methods using both calculations and tests for trench lining systems.

A trench lining system comprises a variety of components, which, when assembled, create trench support. The instruction manual provides all the necessary information on the designation and safe use of trench lining systems.

1 Scope

This European Standard specifies requirements for metallic trench lining systems assembled completely from purpose made prefabricated components. It includes material, constructional and structural requirements.

Partial safety factors for design refer to annex A.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 10002-1, *Metallic materials - Tensile testing - Part 1: Method of test at ambient temperature.*

prEN 12811-2, *Temporary works equipment - Scaffolds - Part 2: Information on materials.*

EN ISO 898-1:1999, *Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs (ISO 898-1:1999)*

EN 13331-2, *Trench lining systems – Part 2: Assessment by calculation or test*.

ENV 1090-1, *Execution of steel structures – Part 1: General rules and rules for buildings*.

ENV 1999-1-1, *Eurocode 9: Design of aluminium structures – Part 1-1: General rules – General rules and rules for buildings.*

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply.

3.1
trench lining system
assembly of prefabricated components intended for the support of the vertical faces of trenches

NOTE Main load-bearing components are panels, slide rails and supporting components.

3.2
types of trench lining system

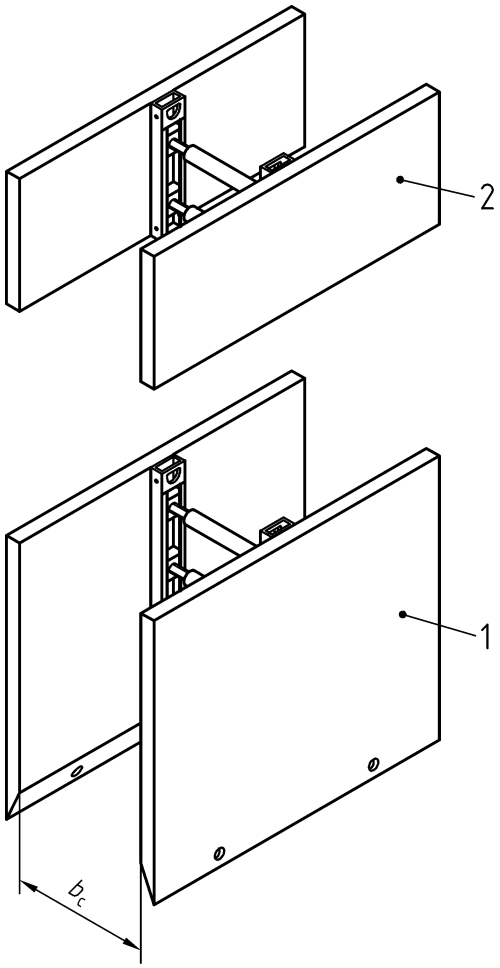
3.2.1
centre-supported trench lining system (CS type)
system in which pairs or panels are held apart by struts attached at the vertical centre line of the panels (see Figure 1)

3.2.2
edge-supported trench lining system (ES type)
system in which pairs of panels are held apart by struts attached at the vertical edges of the panels (see Figures 2 and 3)

3.2.3
slide rail trench lining system (R type), single (RS), double (RD) or triple (RT)
system in which panels can be moved up and down in single or multiple grooves of pairs of slide rails held apart by struts or supporting frames (see Figure 4)

3.2.4
drag box (DB type)
edge-supported trench lining system, intended to be dragged horizontally (see Figure 5)

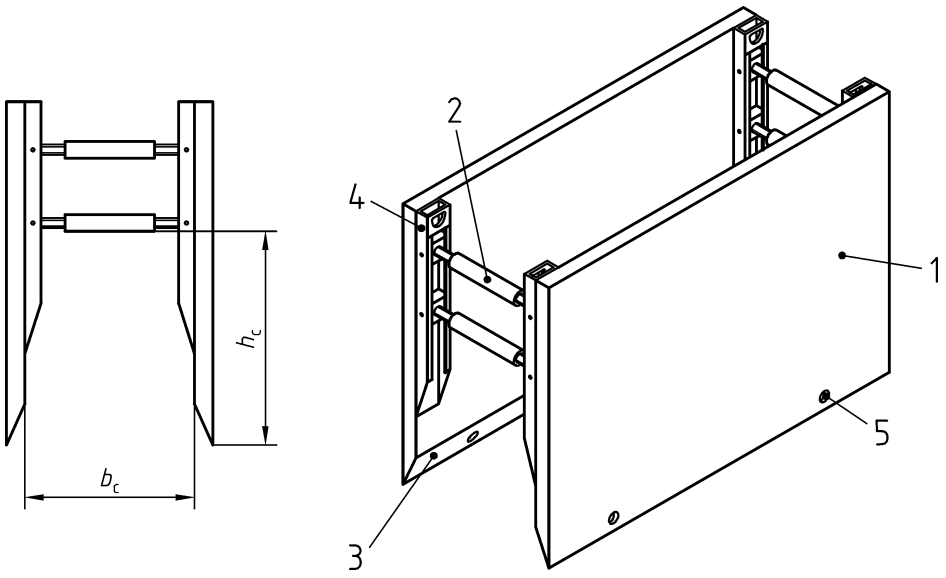
NOTE The leading end has attachment points for pulling and can have cutting edges at the leading end and at the bottom. The clearance under the leading end struts can be different to that under the rear strut.



Key
1 Base assembly
2 Top assembly
b_c Internal trench lining width

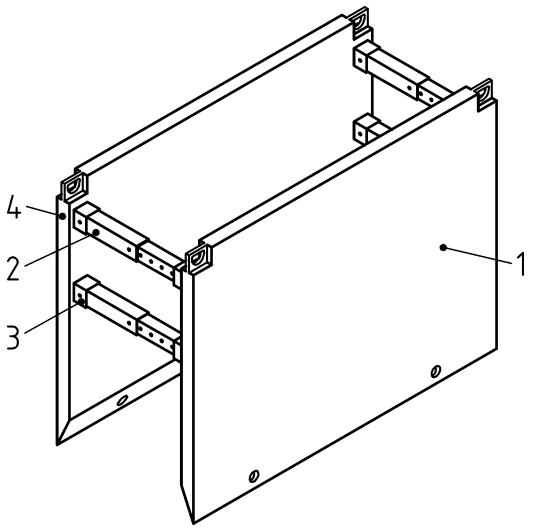
Figure 1 — Example of a centre supported trench lining system (CS type) with struts with variable length adjustment (SV)

For the use of this equipment refer to 7.1.9.



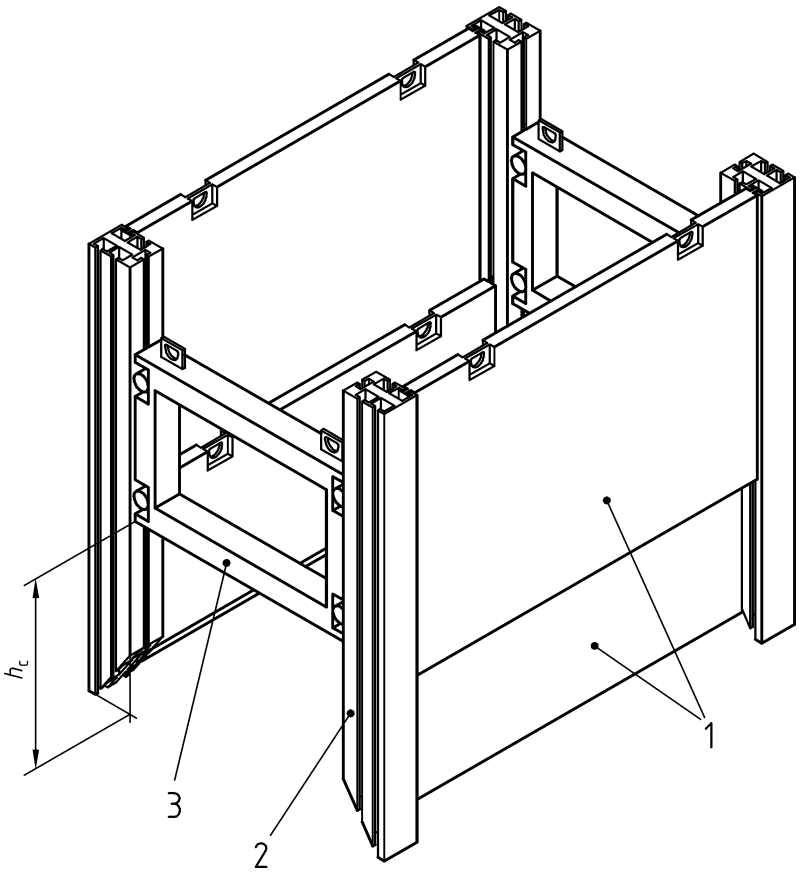
Keys
1 Panel
2 Strut with variable length adjustment
3 Cutting edge
4 Panel soldier
5 Handling point
b_c Internal trench lining width
h_c Bottom strut clearance

Figure 2 — Example of an edge-supported trench lining system (ES type) with struts with variable length adjustment (SV)



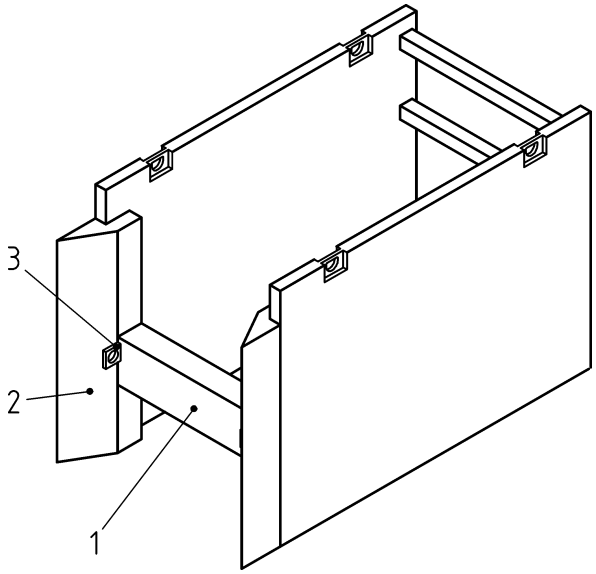
Key
1 Panel
2 Strut with incremental length adjustment
3 Clearance only connection
4 Integral panel soldier

Figure 3 — Example of an edge-supported trench lining system (ES type) with incremental struts and clearance only strut connections



Key
1 Panel
2 Slide rail
3 Supporting frame
h_c Bottom strut clearance

Figure 4 — Example of a slide rail trench lining system, double type (RD), with supporting frames



Key
1 Leading end strut
2 Cutting edge
3 Pulling point

Figure 5 — Example of a drag box (DB type)

3.3
supporting components

3.3.1
strut (S)
component that resists compressive and tensile forces and may resist moments at the end connections

3.3.2
strut with variable length adjustment (SV)
strut comprising threaded spindles, nuts and extension bars for which rough length adjustment is carried out by adding or removing extension bars, while fine length adjustment is achieved by means of the threaded spindles

3.3.3
strut with incremental length adjustment (SI)
strut comprising telescopic tubes with fixing holes and pins and/or extension bars for which only incremental adjustment is possible

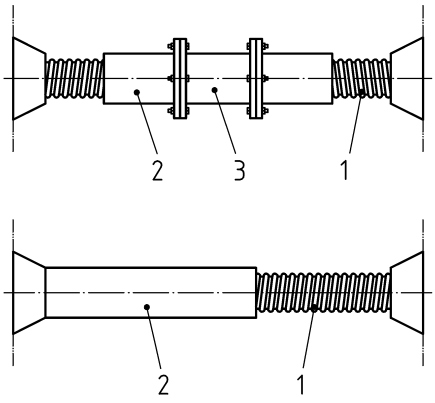
3.3.4
non adjustable strut (SN)
strut with no facility for adjustment

3.3.5
extension bar
component used for axial insertion in a strut to increase its length

NOTE Two basic types of extension bar exist:

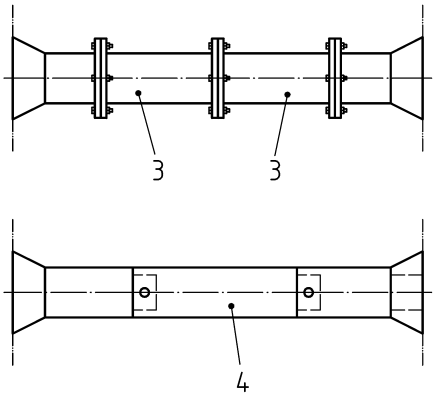
- with flanges at both ends (see Figures 6a and 6b);
- with a pinned spigot and socket connection (see Figure 6b).

3.3.6
supporting frame (FR)
component of a slide rail trench lining system that can be installed at any height above the bottom of the trench to resist compressive and tensile forces and bending moments (see Figure 4)



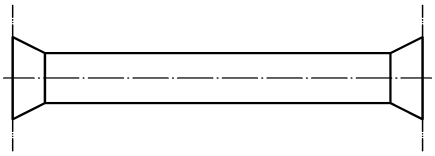
a)

a) Strut with variable length adjustment (SV)



b)

b) Strut with incremental length adjustment (SI)



c)

c) Non adjustable strut (SN)

Key

1 Threaded spindle
2 Nut
3 Extension
4 Extension bar with a pinned spigot and socket connection
5 Telescopic tubes

Figure 6 — Example for strut types

3.4
panel soldier
component for distributing load between panels and struts

NOTE Panel soldiers are installed in a vertical position and can either be attached to the panels (see Figure 2), or form an integral part of them (see Figure 3).

3.5
slide rail
discrete vertical member which has a groove or grooves at two sides to engage with and guide panels

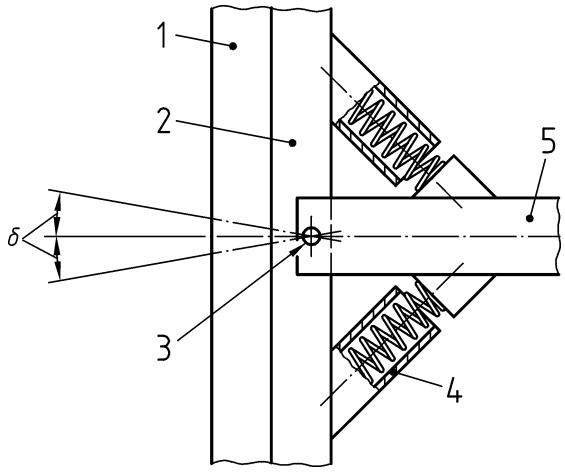
NOTE Opposite rails are connected by struts or supporting frames (see Figure 4)

3.6
strut to panel or slide rail connection

3.6.1
articulated strut to panel connection (A)
strut connection with mechanical devices to limit the rotation of the strut, at the point where it meets the panel or slide rail (see Figure 7)

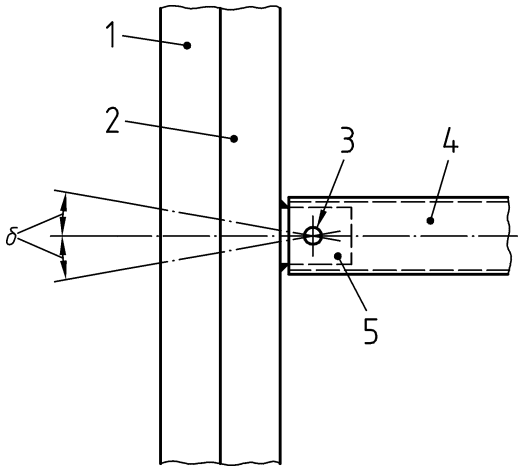
3.6.2
clearance only strut to panel connection (C)
strut connection in which the rotation of the strut, at the point where it meets the panel or slide rail, is limited to that movement permitted by gaps intentionally provided (see Figure 8)

3.6.3
fixed strut to panel connection (F)
fully restrained strut to panel or slide rail connection, permitting no free rotation (see Figure 9)



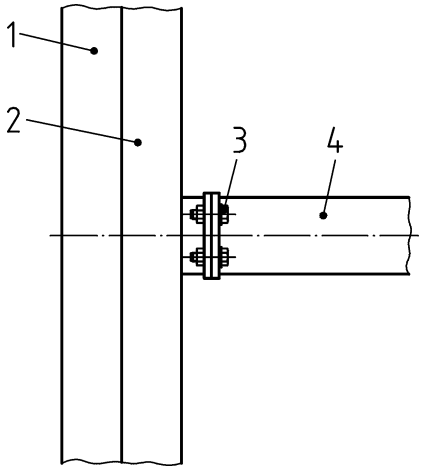
Key
1 Panel
2 Panel soldier
3 Pin
4 Rotation limitation device
5 Strut
δ Possible rotation angle

Figure 7 — Example of an articulated strut to panel connection (A)



Key
1 Panel
2 Panel soldier
3 Pin
4 Strut
5 Strut to panel connector
δ Possible rotation angle

Figure 8 — Example of a clearance only strut to panel connection (C)



Key
1 Panel
2 Panel soldier
3 Bolts
4 Strut

Figure 9 — Example of a fixed strut to panel connection (F)

3.7
internal trench lining width, b_c
clear horizontal distance between the panels of a trench lining system (see Figure 2)

3.8
bottom strut clearance h_c
vertical distance between the lowest edge of a panel or slide rail and the lowest point of the bottom supporting component (see Figures 2 and 4)

3.9
trench width b
distance between the soil faces

3.10
base assembly (B)
assembly of components of a centre- or edge-supported trench lining system that are placed in the trench before all other assemblies

NOTE The bottom edges of the panels normally have cutting edges. The clear space, h_c b_c at the bottom is intended for placing pipes (see Figures 1 and 2).

3.11
top assembly (T)
assembly of components of a centre- or edge-supported trench lining system intended for use above a base module or another top module to support deeper trenches (see Figure 1)

3.12
characteristic system resistance R_k
resistance to an external load of a specific assembly of components of a trench lining system (see annex B)

NOTE Multiple configurations, where possible, can produce a variety of characteristic system resistance values for a given assembly.

3.13
extracting, handling, pulling and connecting points

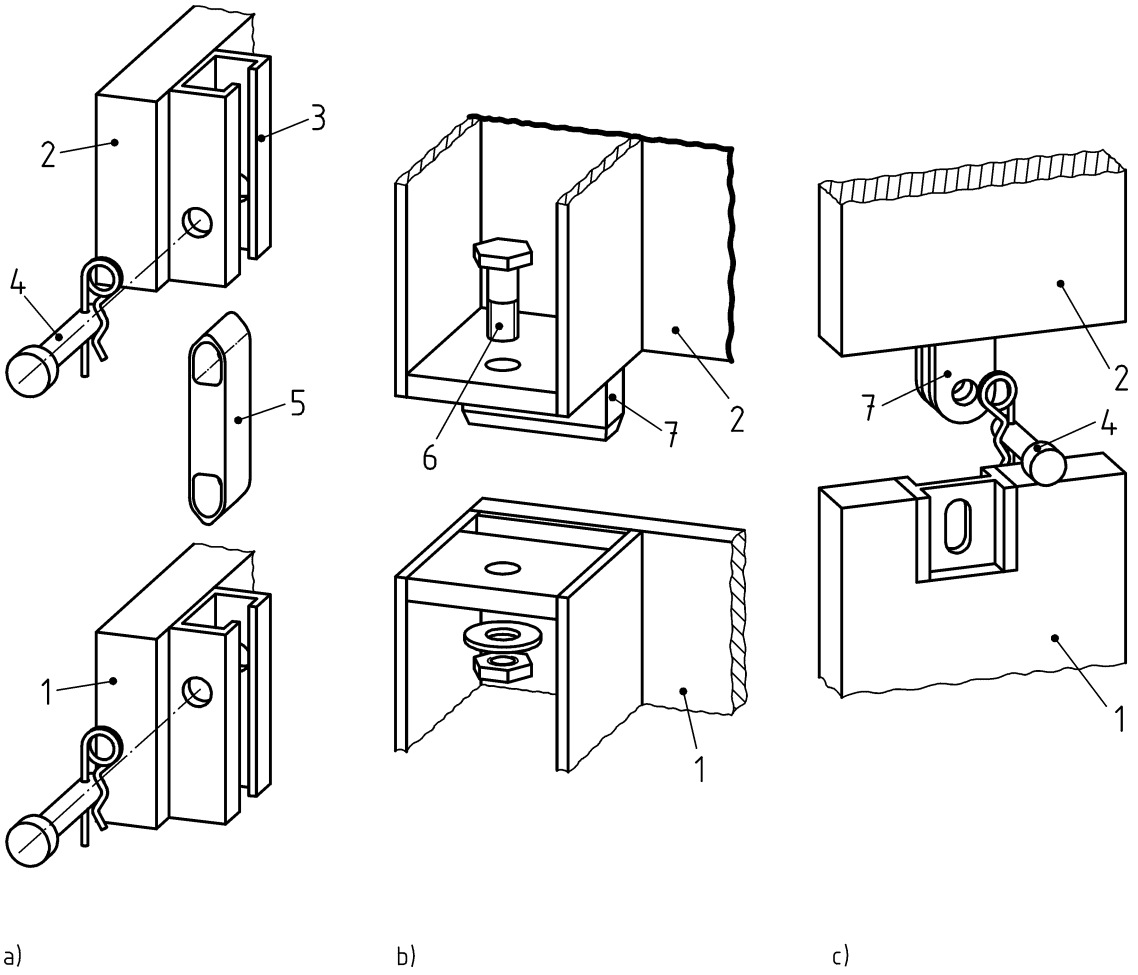
3.13.1
extracting point
point to attach lifting gear to enable extraction of trench lining systems

3.13.2
handling point
point for handling components to aid the assembly of the system and for use in transportation

3.13.3
pulling point
point for horizontally pulling drag boxes

3.13.4
vertical connecting point
point for connecting base panels to top panels, top panels to top panels and slide rails in a vertical direction (see Figure 10)

3.13.5
panel connector
component used to connect two vertically adjacent panels or slide rails (see Figure 10a))



Key
1 Base panel
2 Top panel
3 Panel Soldier
4 Pin
5 Panel connector
6 Bolt
7 Integral panel connector

a) Separate panel connector with pin b) Integral panel connector with bolt c) Integral panel connector with pin

Figure 10 — Examples for vertical connecting

4 Symbols

For the purpose of this European Standard, the symbols given in Table 1 apply:

Table 1 — Main symbols

	Symbol	Explanation	Units
1	A_p	Area of the panel	m^2
2	b	Trench width	m
3	b_c	Internal trench lining width	m
4	B_k	Characteristic slide rail bending resistance	kNm
5	D_o	External diameter of the outer tube	mm
6	D_i	External diameter of the inner tube	mm
7	F_{tk}	Characteristic supporting component's tensile resistance	kN
8	F_{ck}	Characteristic supporting component's compression resistance	kN
9	h_b	Distance between axis of the bottom strut and the lower edge of the panel	m
10	h_c	Bottom strut clearance	m
11	h_m	Distance between the upper strut and the bottom strut	m
12	h_t	Distance between axis of the upper strut and the top edge of the panel	m
13	P_k	Characteristic panel resistance	kN/m^2
14	$R_{E,k}$	Characteristic resistance of extracting, connecting and pulling points (vertical direction)	kN
15	R_k	Characteristic system resistance	kN/m^2
16	S	Thread depth	mm
17	S_r	Radial engagement of the thread	mm
18	S_a	Axial engagement of the thread	mm
19	t	Wall thickness of the tube	mm
20	$_F$	Partial safety factor for action	-
21	$_M$	Partial safety factor for resistance	-
22		Coefficient of friction	-

5 Designation

For each trench lining system a designation shall be established following the model given in Table 2.

Table 2 — Model for designation of a trench lining system conforming to this European Standard

Item	Possible designation
Type of trench lining system (see 3.2)	Centre-supported: CS Edge-supported: ES Supported by single slide rails: RS Supported by double slide rail: RD Supported by triple slide rail: RT Drag box: DB
Module (see 3.10 and 3.11)	Base module: B Top module: T Not relevant for slide rail system: X
Supporting component (see 3.3)	Strut with variable length adjustment: SV Strut with incremental length adjustment: SI Non-adjustable strut: SN Supporting frame: FR
Strut to panel/slide rail connection (see 3.6)	Articulated: A Clearance only: C Fixed: F
Length of slide rail in m	For slide rail systems: For all other systems: XX
Panel length height thickness in m	., ..X., ..X.,..
Internal trench lining width range $b_{c,\,min}$ / $b_{c,\,max}$ in m (see 3.7)	.,../.,..
Bottom strut clearance range $h_{c,\,min}$ / $h_{c,\,max}$ in m (see 3.8)	.,../.,..
Characteristic system resistance range in kN/m^2 (see 3.12)	../..
Mass (min/max) in t	../..

EXAMPLE An example of a designation for an edge supported base module with struts with incremental length adjustment, clearance only strut to panel connections, (3,50 2,40 0,10) m panels, (1,00/2,80) m internal trench lining width range (1,20/1,50) m bottom strut clearance range, a characteristic system resistance range of 60/30 kN/m^2 and a mass range of 2,20/2,30 t is as follows:

Trench Lining System EN 13331-1:
ES – B – SI – C – XX – 3,50 2,40 0,10 – 1,00/2,80 – 1,20/1,50 – 60/30 – 2,20/2,30

6 Materials

6.1 General

Materials shall be chosen in accordance with prEN 12811-2.

6.2 Fasteners

Bolts and screws shall be of maximum strength grade 8.8 conforming to EN ISO 898-1:1999.

6.3 Minimum fracture elongation of cast iron

Cast iron shall have a minimum fracture elongation A = 7 % determined by tensile testing to EN 10002-1.

7 Requirements

7.1 General

7.1.1 The manufacturer shall declare the characteristic resistance of each specific assembly of the trench lining system R_k in kilonewtons per square metre (kN/m^2) and of the components as follows:

a) panels P_k in kilonewtons per square metre (kN/m^2)

b) slide rails B_k in kilonewtons metres (kN m)

c) supporting components in compression F_{ck}, and in tension F_{tk}, in kilonewtons (kN)

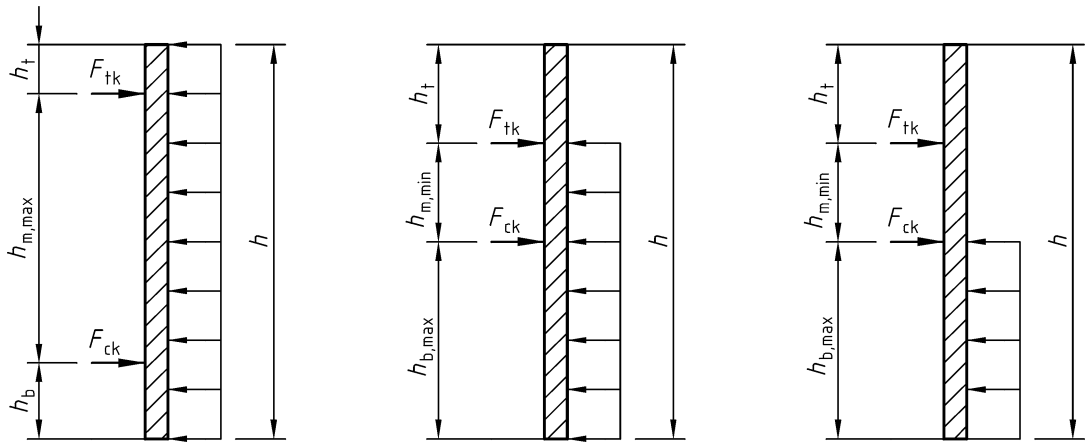
The characteristic resistance shall be declared for the configuration in which the components are assembled in the most onerous position.

Examples of the most onerous position are:

a) with the lowest strut in a base assembly at the highest declared position (h_b)

b) with the longest strut declared for the system.

The characteristic system resistance and the characteristic resistance of the components shall be determined by a uniformly load in accordance with the three cases given in Figure 11.



Key

h_t Distance between the upper strut and the top edge of the panel

h_m Distance between the upper strut and the bottom strut

h_b Distance between the bottom strut and the lower edge of the panel

Figure 11 — Cases 1, 2 and 3 for the calculation of the characteristic resistances

7.1.2 The construction of steelwork shall be carried out in accordance with ENV 1090-1.

The construction of aluminium structures shall be carried out in accordance with ENV 1999-1-1.

7.1.3 Welding of steel shall be carried out in accordance with prEN 12811-2.

7.1.4 Assessment of the trench lining system by calculation or test shall be carried out in accordance with EN 13331-2.

7.1.5 Calculations based on partial safety factors shall be in accordance with annex A.

7.1.6 Pins shall be retained in such a way that they cannot be disengaged accidentally. An example with the use of retaining pins is shown in Figure 10.

7.1.7 The internal trench lining width b_c for systems in which access for personnel is required shall be at least 600 mm.

7.1.8 All parts of the trench lining system that are handled when the system is in use in the ground shall be accessible from the inside of the system.

7.1.9 A centre-supported trench lining system shall consist of at least two units. The vertical edges between the units shall be connected. A centre-supported trench lining system shall not have more than one top module. This top module shall have at least two struts on one panel soldier.

7.2 Minimum characteristic system resistance

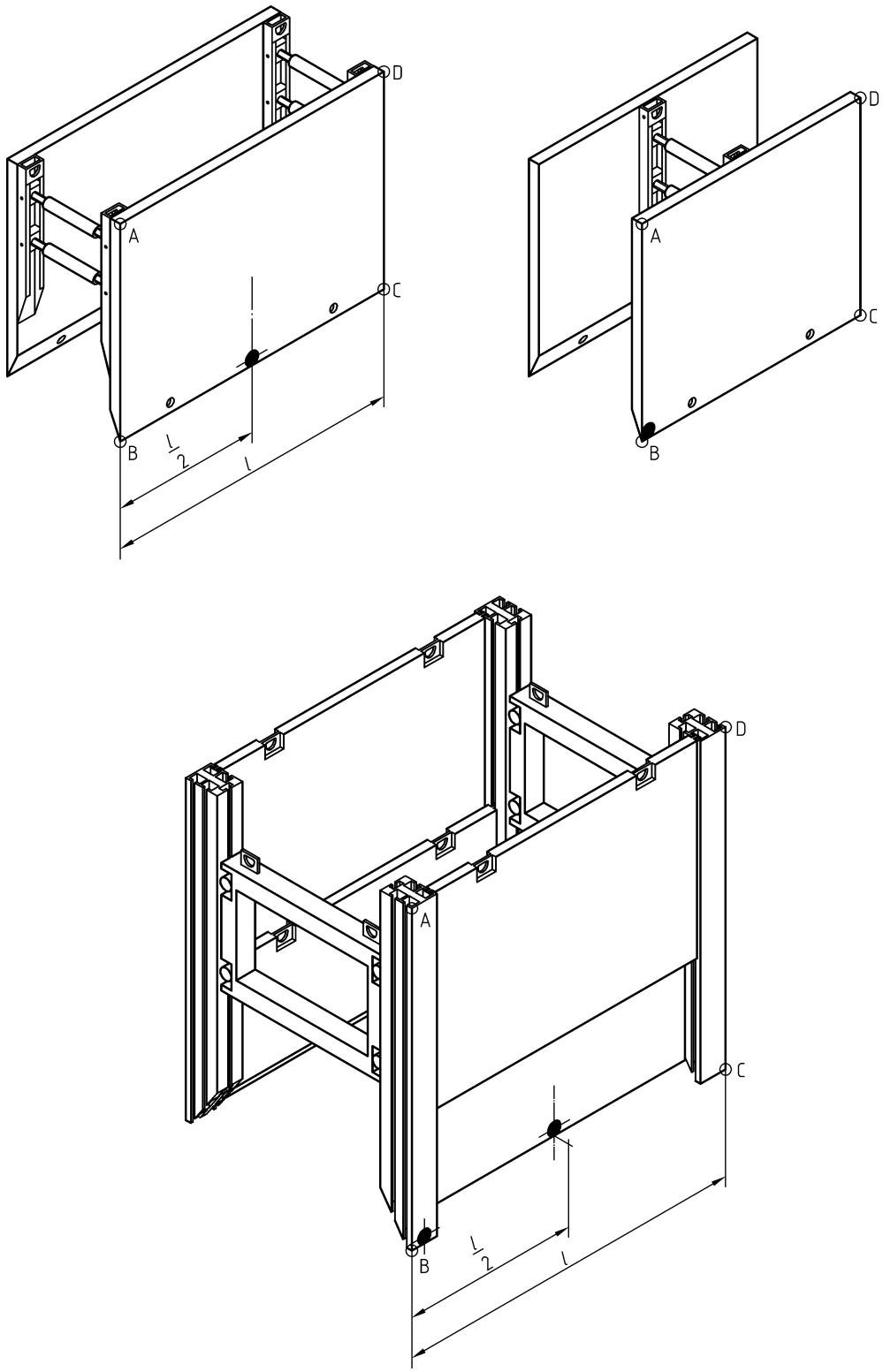
The minimum characteristic system resistance shall be

$$R_{k,\,min} = 30\ kN/m^2$$

7.3 Deflection

The maximum deflection of the panels and slide rails shall be declared for the load value equal to the characteristic resistance divided by $_F x\ _M$.

The deflection shall be expressed relative to the plane ABCD shown in Figure 12 which also gives the positions where the maximum deflections are expected.



a) Edge supported trench lining system

b) Centre-supported trench lining system

c) Slide rail trench lining system

Black spots indicate the positions where the maximum deflections are expected.

Figure 12 — Reference planes and positions where the maximum deflection is expected

7.4 Attachment points for extracting, handling, pulling and connecting

7.4.1 A panel for a base assembly for an edge-supported trench lining system shall be provided with at least two extracting points. Where a panel for a base module can be inverted four extracting points shall be provided – two at the top edge and two at the lower edge.

7.4.2 A panel for a base assembly for an edge-supported trench lining system, shall be provided with at least four handling points.

NOTE Extracting points can be used as handling points.

7.4.3 A panel for a base assembly for an edge-supported trench lining system shall be provided with at least two vertical connecting points at the top edge.

NOTE Extracting points can be used as connecting points.

7.4.4 A panel for a base assembly for a centre-supported trench lining system shall be provided with at least one extracting point. Where base panels can be inverted two extracting points shall be provided, one at the top and one at the lower edge.

7.4.5 A panel for a base assembly for a centre-supported trench lining system shall be provided with at least three handling points.

7.4.6 A panel for a base assembly for centre-supported trench lining systems shall be provided with at least one connecting point.

NOTE Extracting points can be used as connecting points.

7.4.7 A panel for a top assembly for an edge-supported trench lining system, shall be provided with at least two extracting points, four connecting points and four handling points. Where top panels can be inverted four extracting points shall be provided.

NOTE Extracting points can be used as connecting points or handling points.

7.4.8 A panel for a top assembly for a centre-supported trench lining system shall be provided with at least two extracting points, two connecting points and three handling points.

NOTE Extracting points can be used as connecting points or handling points.

7.4.9 Slide rails shall be provided with at least one extracting point, two handling points and if necessary one connecting point.

7.4.10 In addition to the requirements for extracting, handling and connecting points, a drag box shall be provided with pulling points enabling attachment to the leading edge of each panel.

7.4.11 All extracting and handling points shall permit lifting devices to be connected at any angle between vertical and 60 ° from vertical.

7.4.12 Handling points shall be provided for struts exceeding 50 kg.

7.4.13 Supporting frames shall be provided with at least four handling points and two extracting points.

NOTE Extracting points can be used as handling points.

7.4.14 Points intended only for handling shall be positioned and configured so that they cannot be used for extracting, unless they have the same load-bearing capacity as the extracting points.

7.4.15 Extracting and pulling points shall be clearly differentiated by colour and shape from handling points.

7.4.16 Extracting and connecting points shall have the following characteristics resistance $R_{E,\,K}$ (vertical direction) as given by the following:

$$R_{E,\,k} = R_k \times A_p \quad /n \quad \text{in kilonewtons (kN)}$$

where

R_k is the highest specified characteristic system resistance, in kilonewtons per square metre (kN/m^2);

A_p is the area of the panel in square metres (m^2);

NOTE Where the panel can be used with one or more panels above it, the area includes those panels;

is the coefficient of friction, taken as 0,5;

n is the number of extracting, connecting and pulling points up to a maximum of two.

7.4.17 The characteristic resistance in the horizontal direction of pulling points of drag boxes shall be calculated using the equation in 7.4.16.

7.4.18 The characteristic resistance of handling points shall be at least six times the load suspended from that point in any direction within 60 ° from the vertical.

7.5 Struts

7.5.1 Struts shall be capable of resisting compressive and tensile forces induced by the loading cases specified in Figure 11.

7.5.2 The external diameter of outer tubes shall be D_0 60 mm (see Figure 13)

Dimensions in millimetres

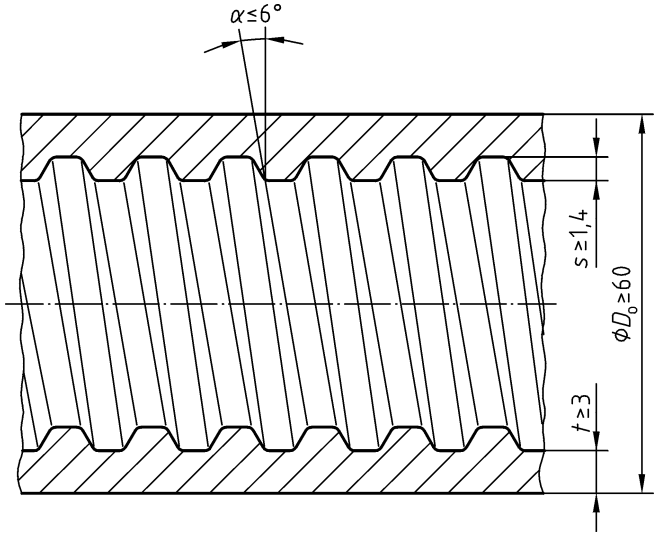


Figure 13 — Dimensions of an outer tube with thread

7.5.3 The external diameter of inner tubes shall be D_i 45 mm (see Figure 14).

7.5.4 The wall thickness of tubes at any point including the point at which a thread has been cut shall be t 3 mm (see Figure 13 and Figure 14).

7.5.5 The helix angle of the thread shall be 6 °.

7.5.6 The thread depth shall be s 1,4 mm (see Figure 13 and Figure 15).

7.5.7 The radial engagement of the thread shall be s_r 0,4 s at maximum eccentricity (see Figure 15).

7.5.8 The axial engagement of the thread shall be s_a 0,7 D_0 and s_a 50 mm (see Figure 16).

7.5.9 The minimum engagement for a variable strut shall be maintained by mechanical stops.

7.5.10 For variable or incremental struts the extent of angular misalignment shall not exceed = 1,5 ° at full extension (see Figure 16).

Dimensions in millimetres

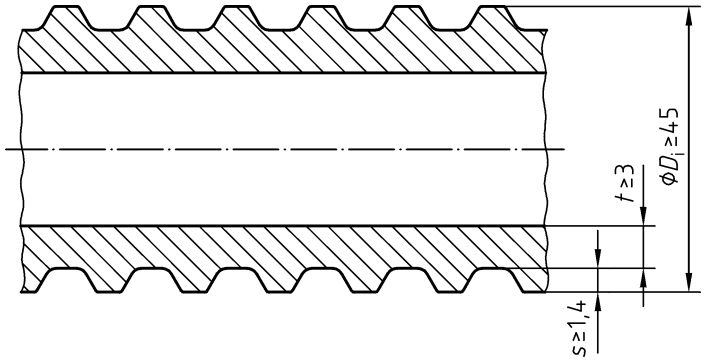


Figure 14 — Dimensions of an inner tube with thread

Dimensions in millimetres

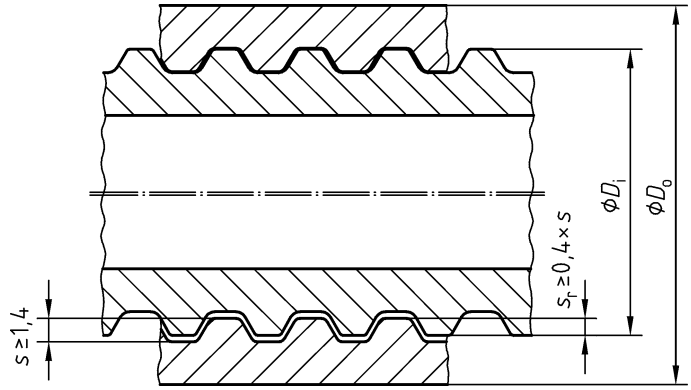
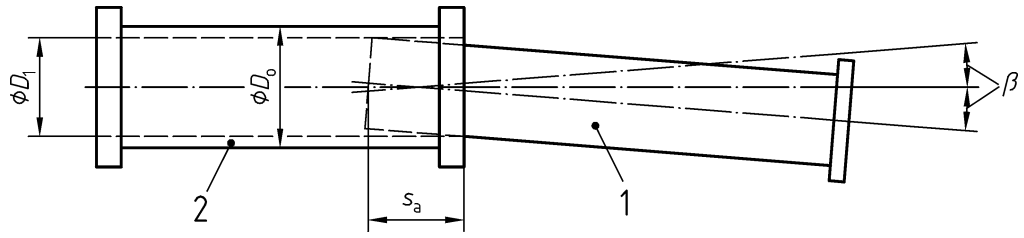


Figure 15 — Thread depth and radial engagement for a variable strut - between threaded bar and outer tube



Key
1 Threaded bar
2 Outer tube
s_a Axial engagement

Figure 16 — Maximum angular misalignment

7.5.11 All strut components shall be connected in such a way that they cannot be disengaged accidentally.

7.5.12 Flanges connecting extension components shall be provided with at least four holes for bolts.

7.5.13 When the pulling force (see 7.4.17) is applied to the leading end strut of a drag box, the leading end strut shall be capable of transferring this force to the panels (see Figure 5).

NOTE This force can be applied from the bucket of an excavator or through chains that are attached to the leading edge strut and connected to the bucket of the excavator.

7.6 Strut to panel or slide rail connection

7.6.1 The possible rotation angle in a vertical plane between articulated or clearance only strut connection and panel or slide rail shall not exceed = 8° (see Figures 7 and 8).

7.6.2 The possible rotation angle in a horizontal plane between articulated or clearance only strut connection and panel or slide rail shall not exceed = 3,5°.

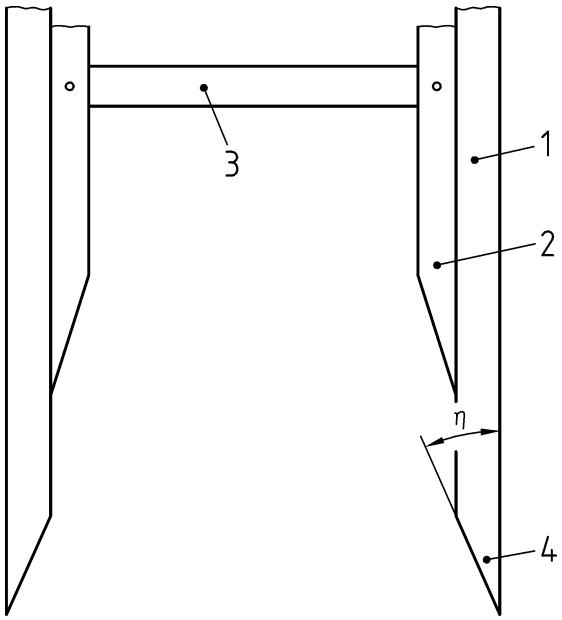
7.6.3 The connections between drag box panels and leading end struts shall have a connection where movement in any direction is reduced to the minimum.

7.6.4 Strut to panel or slide rail connections shall be capable of resisting compressive and tensile forces. They shall also be designed so that they are capable of resisting moments without plastic deformations of the metallic components.

7.7 Panels

7.7.1 The lower edges of a base module designed to be installed by the cut and lower method described in annex D shall be fitted with cutting edges with a cutting angle of 45° (see Figure 17).

7.7.2 Panels for centre-supported trench lining systems shall not exceed 3,0 m in length.



Key
1 Panel of a base module
2 Panel soldier
3 Supporting component
4 Cutting edge
Cutting angle

Figure 17 — Panel cutting edge

8 Assessment

The equipment shall be assessed in accordance with EN 13331-2 to verify its conformity with this standard and with the information declared.

Assessment shall be carried out under the most onerous conditions permitted in the instruction manual, typically at the maximum extension of all strut components and related to the deflection points specified in Figure 12.

Consideration shall be given to all critical combinations.

EN 13331-2 sets out the requirements for the testing of components and assemblies.

9 Instruction manual

9.1 General

An instruction manual shall be provided with each trench lining system.

The instruction manual shall be available in the language of the country in which the trench lining system is to be used.

9.2 Principle contents

The instruction manual shall contain the following main elements:

a) The designation of the trench lining system conforming to Clause 5.

b) Instructions for the sequence of assembling and dismantling the components and instructions on the handling of components.

c) Full information on lifting, handling, extracting and pulling and the appropriate equipment to be used for these actions.

d) Detailed information on installation and extracting.

e) Any limitations on the assembly of components and use of the trench lining system.

f) Measures to minimize hazards from e.g.:

- ¾ possible instability due to wind loading when an assembly is stored at ground level;
- ¾ sloping or uneven ground;
- ¾ soft ground;
- ¾ accidental collisions.

g) All possible configurations together with their dimensions and the characteristic system resistances when the components are assembled in the most onerous position.

h) Guidance on relating the characteristic system resistance to loading conditions after installation by means of diagrams or equivalent methods (see annex C).

i) Forces which may be imposed on attachment points for extracting and pulling.

j) Criteria for rejecting components which are worn or damaged.

k) Instructions for storage, transport, maintenance and repair.

l) The data on deflection specified in 7.3.

m) The moment of the strut to panel or slide rail connection specified in 7.6.4.

n) Specification of the strength grade (see 6.2) and of the tightening torque for bolts and screws.

o) An indication of the maximum number of top assemblies for which the system is designed.

10 Marking

Panels, supporting components, panel soldiers (except integral panel soldiers) and slide rails shall be marked with the following information:

a) The number of this European Standard, i.e. EN 13331-1;

b) A symbol or letter to identify the manufacturer;

c) A symbol or letter to identify the trench lining component;

d) The year and the month of manufacture, using the last two figures for the year and two figures for the month.

A durable marking shall be used, e.g. cold stamping.

11 Conformity

11.1 Declaration of conformity

The manufacturer or supplier shall declare that the trench lining system conforms to EN 13331-1 and EN 13331-2.

11.2 Evaluation of conformity

For evaluation of conformity purposes, the manufacturer or supplier shall provide, in addition to the instruction manual, the technical and material specification and calculation of each component accompanied by the manufacturing drawings.

Annex A
(normative)

Partial safety factors

Calculations for the trench lining system shall be based on the following partial safety factors

$_F$ 1,50 (for actions)

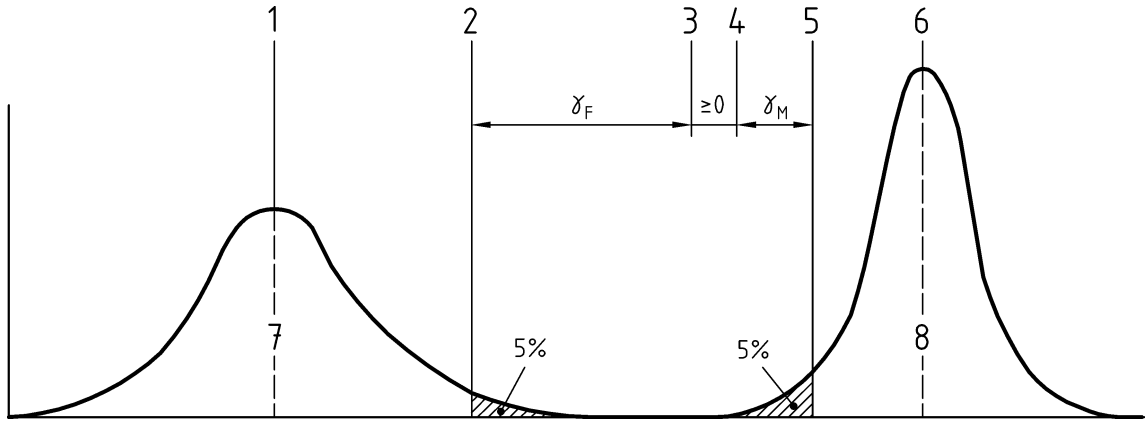
$_M$ = 1,10 (for resistances)

If reference standard (e.g. ENV 1993-1-1) indicate higher partial safety factors $_M$ for special components, these higher factors shall be used.

Annex B
(informative)

Relationship between loads and resistance

Figure B.1 shows the relationship between load and resistance.



Key

F Partial safety factor for action
M Partial safety factor for resistance

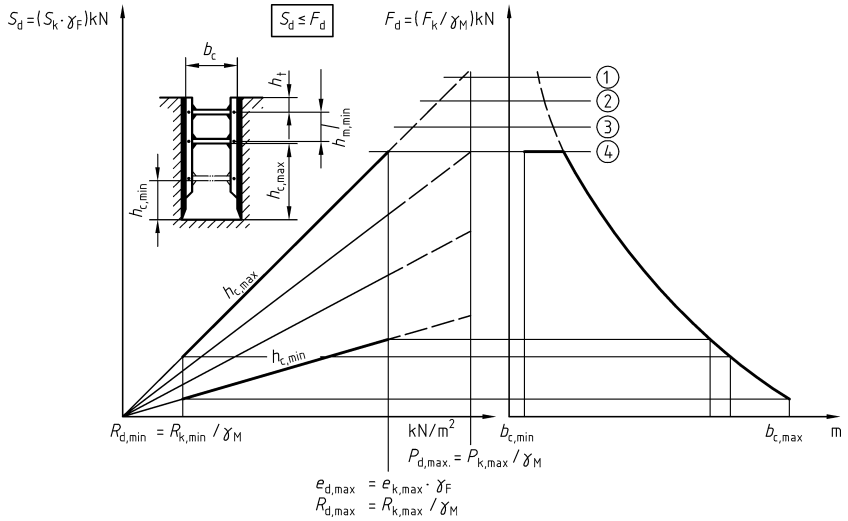
1 Mean load
2 Characteristic load e_k
3 Limit state design load e_d
4 Limit state resistance R_d
5 Characteristic resistance R_k
6 Mean strength
7 Load
8 Material

Figure B.1 — Relation of load and resistance

Annex C
(informative)

Assessment nomogram for a trench lining system

Figure C.1 provides an example of the principle of an assessment nomogram for a trench lining system.

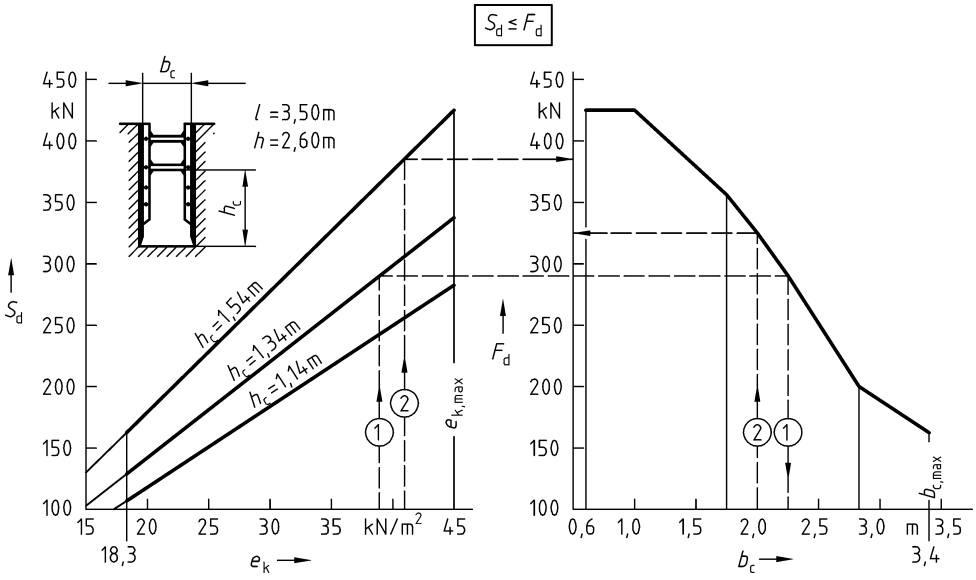


Key

S_d	Force from the design earth pressure e_d in the bottom strut depending on panel length and height in kilonewtons (kN)
S_k	Force from the characteristic earth pressure e_k in the bottom strut depending on panel length and height in kilonewtons (kN)
F_d	Design bottom strut resistance in kilonewtons (kN)
F_k	Characteristic bottom strut resistance in kilonewtons (kN)
$P_{d,\,max}$	Maximum design panel resistance in kilonewtons per square metre (kN/m^2)
$P_{k,\,max}$	Maximum characteristic panel resistance in kilonewtons per square metre (kN/m^2)
$R_{d,\,max}$	Maximum design system resistance in kilonewtons per square metre (kN/m^2)
$R_{k,\,max}$	Maximum characteristic system resistance in kilonewtons per square metre (kN/m^2)
$R_{d,\,min}$	Minimum design system resistance in kilonewtons per square metre (kN/m^2)
$R_{k,\,min}$	Minimum characteristic system resistance in kilonewtons per square metre (kN/m^2)
$_M$	Partial safety factor for resistance
1	Maximum design compressive resistance of the bottom strut
2	Design compressive resistance of the bottom strut related to design tensile resistance of the upper strut
3	Design compressive resistance of the bottom strut related to design bending resistance of the slide rails or soldiers
4	Influence of other components
$e_{d,\,max}$	Maximum design earth pressure at the building site in kilonewtons per square metre (kN/m2)
$e_{k,\,max}$	Maximum characteristic earth pressure at the building site in kilonewtons per square metre (kN/m2)
$_F$	Partial safety factor for action
$n_{m,\,min}$	Minimum distance between the axes of upper and bottom strut in metres (m)
$h_{c,\,max}$	Maximum bottom strut clearance in metres (m)
$h_{c,\,min}$	Minimum bottom strut clearance in metres (m)
b_c	Internal trench lining width in metres (m)
$b_{c,\,min}$	Minimum internal trench lining width in metres (m)
$b_{c,\,max}$	Maximum internal trench lining width in metres (m)

Figure C.1 — Assessment nomogram for a trench lining system (see 9.2, h)

Figure C.2 provides an example of an assessment nomogram for a specific trench lining system.



Key

S_d Design force in the bottom strut in kilonewtons (kN)

F_d Design bottom strut resistance in kilonewtons (kN)

e_k Characteristic earth pressure in kilonewtons per square metre (kN/m^2) (here: uniformly distributed)

$_F$ Partial safety factor for action, here 1,5

l Panel length in metres (m)

h Panel height in metres (m)

h_c Bottom strut clearance in metres (m)

b_c Internal trench lining width in metres (m)

1 EXAMPLE 1

Building site conditions:

- Characteristic earth pressure e_k = 39 kN/m^2,
- external pipe diameter D_e = 1,30 m,

The existing trench lining system admits an internal trench lining width b_c = 2,25 which is sufficient for pipework.

2 EXAMPLE 2

Building site conditions:

- Characteristic earth pressure e_k = 41 kN/m^2,
- external pipe diameter D_e = 1,50 m,
- possible internal trench lining width b_c = 2,00 m.

With b_c = 2,00 m the system's load-bearing capacity is too low, as shown by $S_d > F_d$

Figure C.2 — Example of an assessment nomogram for an edge supported trench lining system with a characteristic system resistance range 74,2/30 kN/m^2 (corresponding to a characteristic earth pressure range 45/18,3 kN/m^2), an internal trench lining width range 0,60/3,40 m and three options for the bottom strut clearance

Annex D
(informative)

Explanation of 'cut and lower' techniques

An example of the 'cut and lower' method for the installation of box systems with cutting edges is given in Figure D.1.

The box is installed during excavation by pushing down each panel with the bucket of the excavator. The panels are pushed down alternatively on each corner post.

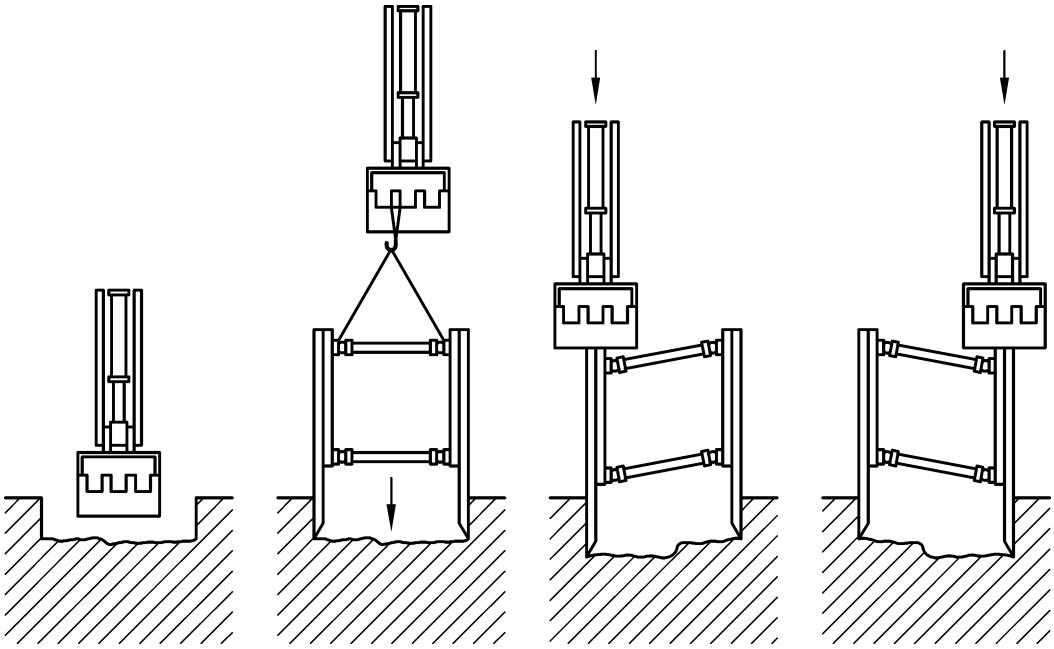


Figure D.1 — An example of the 'cut and lower' method for installing boxes

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prEN 12811-3, *Temporary works equipment – Scaffolds – Part 3: Load testing.*

ENV 1993-1-1, *Eurocode 3: Design of steel structures – Part 1-1: General rules and rules for buildings*.

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