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Adjustable telescopic aluminium props — Product specifications, design and assessment by calculation and tests

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National foreword

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Adjustable telescopic aluminium props - Product specifications, design and assessment by calculation and tests

Etais télescopiques réglables en aluminium - Spécifications du produit, conception et évaluation par calculs et essais

Baustützen aus Aluminium mit Ausziehvorrichtung - Produktfestlegungen, Bemessung und Nachweis durch Berechnung und Versuche

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Foreword

This document (EN 16031:2012) has been prepared by Technical Committee CEN/TC 053 “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of an identical text or by endorsement, at the latest by November 2012, and conflicting national standards shall be withdrawn at the latest by November 2012.

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Introduction

This European Standard deals with the more common types of adjustable telescopic aluminium props in current use. It is not intended to prevent development of other types of props. For example, props may have hinged ends or other length adjustment devices or be made of other materials. Whilst such props cannot comply with this European Standard, it is nevertheless recommended that the principals of this European Standard be considered in the design and assessment of such props.

This European Standard is a product standard primarily for use in the field of falsework and formwork standardized in EN 12812.

The specified values for load bearing capacity listed in this European Standard are figures for classification. For site use, γ_F and γ_M can be found in EN 12812.

1 Scope

This European Standard specifies materials, design requirements and designation together with assessment methods using both calculations and testing for adjustable telescopic aluminium props which are intended for use on construction sites.

It outlines eleven classes of nominal specified values for strengths for adjustable telescopic aluminium props, each having a series of maximum extended lengths.

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 74-1, *Couplers, spigot pins and baseplates for use in falsework and scaffolds — Part 1: Couplers for tubes – Requirements and test procedures*

EN 74-2, *Couplers, spigot pins and baseplates for use in falsework and scaffolds — Part 2: Special couplers — Requirements and test procedures*

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

EN 1065:1998, *Adjustable telescopic steel props — Product specifications, design and assessment by calculation and tests*

EN 1090-3:2008, *Execution of steel structures and aluminium structures — Part 3: Technical requirements for aluminium structures*

EN 10204:2004, *Metallic materials — Types of inspection documents*

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

EN 12811-2:2004, *Temporary works equipment — Part 2: Information on materials*

EN 12811-3:2002, *Temporary works equipment — Part 3: Load testing*

EN 12812*, Falsework — Performance requirements and general design*

3 Terms and definitions

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

3.1
adjustable telescopic aluminium prop
compression member consisting of two tubes circular or profiled which are telescopically displaceable within each other with a length adjustment device with threaded inner tube (see Figure 1) or with a pin inserted into holes in the inner tube and a mean of fine adjustment using a threaded collar (see Figure 2)

Note 1 to entry: Such props are normally used as a temporary vertical support in construction works.

3.2
endplate
plate which is fixed at right angles to one end of inner and outer tube

3.3
collar nut
nut internally threaded to provide fine length adjustment to the prop to transfer the force from the inner to the outer tube either to a threaded inner tube or through a pin

3.4
inner tube
smaller tube that may be profiled or provided with thread or holes for the coarse adjustment of the prop

3.5
outer tube
larger tube that may be profiled, one end of which could be threaded externally (see Figure 1 and 2)

3.6
length at maximum extension
nominal distance measured between the outside faces of the endplates when the prop is in the fully extended position (fully opened)

3.7
length at minimum extension
nominal distance between the outside faces of endplates when the prop is in the fully closed position

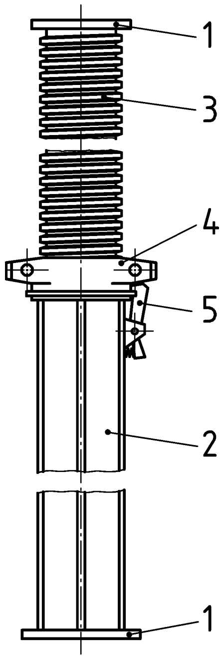
3.8
minimum working length
nominal distance between the outside faces of the endplates necessary to allow safely the dismounting and removal of prop

3.9
safety devices
devices to prevent unintentional disengagement of the inner and outer tube and/or devices to guarantee the minimum overlapping length

3.10
pin
part of the length adjustment device which is inserted through the inner tube holes and is secured to the prop

3.11
working load
nominal characteristic strength of the prop for different classes divided by at least the safety factors given in EN 12812

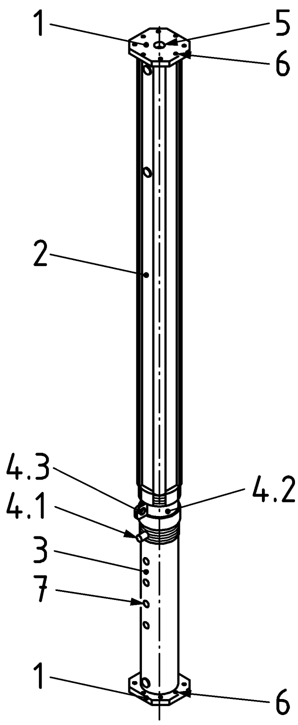
Note 1 to entry: Safety factors can be greater in national regulations.



Key

1 endplates
2 outer tube
3 inner tube
4 length adjustment device (collar)
5 locking (security) device

Figure 1 — Example of adjustable telescopic aluminium prop (type 1)



Key

1 endplate
2 outer tube
3 inner tube
4.1 attached pin
4.2 collar nut
4.3 handle
5 central hole
6 connection holes
7 pin hole

Figure 2 — Example of adjustable telescopic aluminium prop (type 2)

4 Symbols

Symbol	Designation	Unit
D_i	outer diameter of the inner tube	mm
D_m	collar nut major thread diameter	mm
D_p	diameter of the pin	mm
$e_{b,core}$	eccentricity at the base at which the spring becomes effective	mm
$e(N)$	limiting eccentricity of the axial forces	mm
c_b	spring stiffness	N · mm/rad
$e_{b,limit}$	unit eccentricity at the base	mm
$e_{b,0}$	initial eccentricity at the base	mm
e_t	eccentricity at the top	mm
f_y	yield strength	N/mm^2
$f\,y_{act}$	actual yield strength	N/mm^2
$f\,y_{nom}$	nominal yield strength	N/mm^2
f_0	characteristic value of proof strength at the transitions point between prop and base plate	N/mm^2
$f_{0,HAZ}$	characteristic value of proof strength at the transitions point between prop and base plate determined by taking the heat effected zone into account	N/mm^2
l	actual extension length of the prop	m
l_{max}	length of a prop at maximum extension	m
l_0	overlapping length	mm
M_{pl}	plastic moment resistance of the cross section	kN · m
$M_{pl,N}$	reduced plastic moment resistance of the cross section	kN · m
N	normal (axial) force	kN
$N_{R,k}$	characteristic compression resistance	kN
$N_{C,i}$	ideal buckling force	kN
N_{pl}	nominal plastic compression resistance of the cross section	kN
R	strength of a prop	kN
$R_{b,t}$	bearing resistance of the tube	kN
R_p	shear resistance of the pin	kN
R_u	failure load of a test	kN

Symbol	Designation	Unit
$R_{y,act}$	actual characteristic strength of the prop class y where y corresponds to classes from A to W	kN
$R_{y,k}$	nominal characteristic strength of the prop class y where y corresponds to classes from A to W	kN
$R_{y,t}$	lowest evaluated test result in the global test	kN
$R_{y,a}$	average value test result in the global test	kN
$R_{ad,k}$	characteristic strength in compression	kN
V	vertical load	kN
$\Delta\varphi_0$	angle of inclination between the inner and outer tube	rad
γ_M	partial safety factor for the resistance	1
γ_{M1}, γ_{M2}	splitted partial safety factors for the material	1
γ_F	partial safety factor for the action	1

5 Classification

Adjustable telescopic aluminium props shall be classified according to its specified value for nominal characteristic strength $R_{y,k}$ given in Table 1 (load classes) and its maximal extension length l_{max} given in Table 2 (length classes).

Table 1 — Load classes of adjustable telescopic aluminium props

Load class	Specified value for nominal characteristic strength $R_{y,k}$
A	$51{,}0 \cdot \frac{\ell_{max}}{\ell^2} \leq 44{,}0$ kN
B	$68{,}0 \cdot \frac{\ell_{max}}{\ell^2} \leq 51{,}0$ kN
C	$102{,}0 \cdot \frac{\ell_{max}}{\ell^2} \leq 59{,}5$ kN
D	34,0 kN
E	51,0 kN
R	66,0 kN
S	82,5 kN
T	99,0 kN
U	115,5 kN
V	132,0 kN
W	148,5 kN

Where

l_{max} is the length at the maximum extension in metres;

l is the actual extension length in metres.

Table 2 — Length classes of adjustable telescopic aluminium props

Length class	Length at maximum extension l_{max}
10	1,00 m ≤ l_{max} ≤ 1,49 m
15	1,50 m ≤ l_{max} ≤ 1,99 m
20	2,00 m ≤ l_{max} ≤ 2,49 m
25	2,50 m ≤ l_{max} ≤ 2,99 m
30	3,00 m ≤ l_{max} ≤ 3,49 m
35	3,50 m ≤ l_{max} ≤ 3,99 m
40	4,00 m ≤ l_{max} ≤ 4,49 m
45	4,50 m ≤ l_{max} ≤ 4,99 m
50	5,00 m ≤ l_{max} ≤ 5,49 m
55	5,50 m ≤ l_{max} ≤ 5,99 m
60	6,00 m ≤ l_{max} ≤ 6,49 m
65	6,50 m ≤ l_{max} ≤ 6,99 m
70	7,00 m ≤ l_{max} ≤ 7,50 m

6 Designations

EXAMPLE EN 16031 R65/49 T1 M

Designation of a prop in accordance with EN 16031, class: “R65”, with a minimum extended length: “49” dm, “T1” type 1 with threaded inner tube, “M” with an ongoing production inspection level M:

EN 16031 R65/49 T1 M

European Standard number block — EN 16031

Load class, length class/minimum extended length — R65/49

Prop type 1 with threaded inner tube — T1

With an ongoing production inspection level — M

7 Materials

Materials shall have a good resistance and be protected against atmospheric corrosion. They shall be free of any impurities and defects which might affect their satisfactory use. Steels of deoxidation type FU (rimming steels) are not permitted.

Materials should be selected from the relevant existing European and International Standards and, whenever applicable, should be in accordance with the following standards: EN 12811-2:2004 (in particular Clause 6) and EN 1999-1-1 for aluminium.

8 Requirements

8.1 Tubes

For the purposes of assessment, the method of making holes shall be stated on the relevant drawings.

NOTE The preferred method of forming holes is by drilling.

For aluminium profiled tubes, the minimum nominal wall thickness shall be at least 2 mm.

For tubes for which it is possible to attach EN 74-1 and EN 74-2 couplers see EN 12811-1.

8.2 Welding

The welding shall be carried out in accordance with execution class 2 (EXC 2) of EN 1090-3:2008.

8.3 Length adjustment device

A prop shall be provided with a length adjustment device to modify the length from the minimum to the maximum extension.

The adjustment device shall be one of two types:

1) a threaded collar connected to the outer tube with a threaded inner tube (type 1) (see Figure 1); or

2) a pin inserted into holes in the inner tube and a threaded collar connected to the thread in the outer tube (type 2) (see Figure 2).

8.4 Permanent prevention against unintentional disengagement

The inner and outer parts of a prop shall be prevented from being permanently separated except by intentional action. One of the following methods shall by applied:

— safety method 1: permanent locking connection (see Figure 3a);

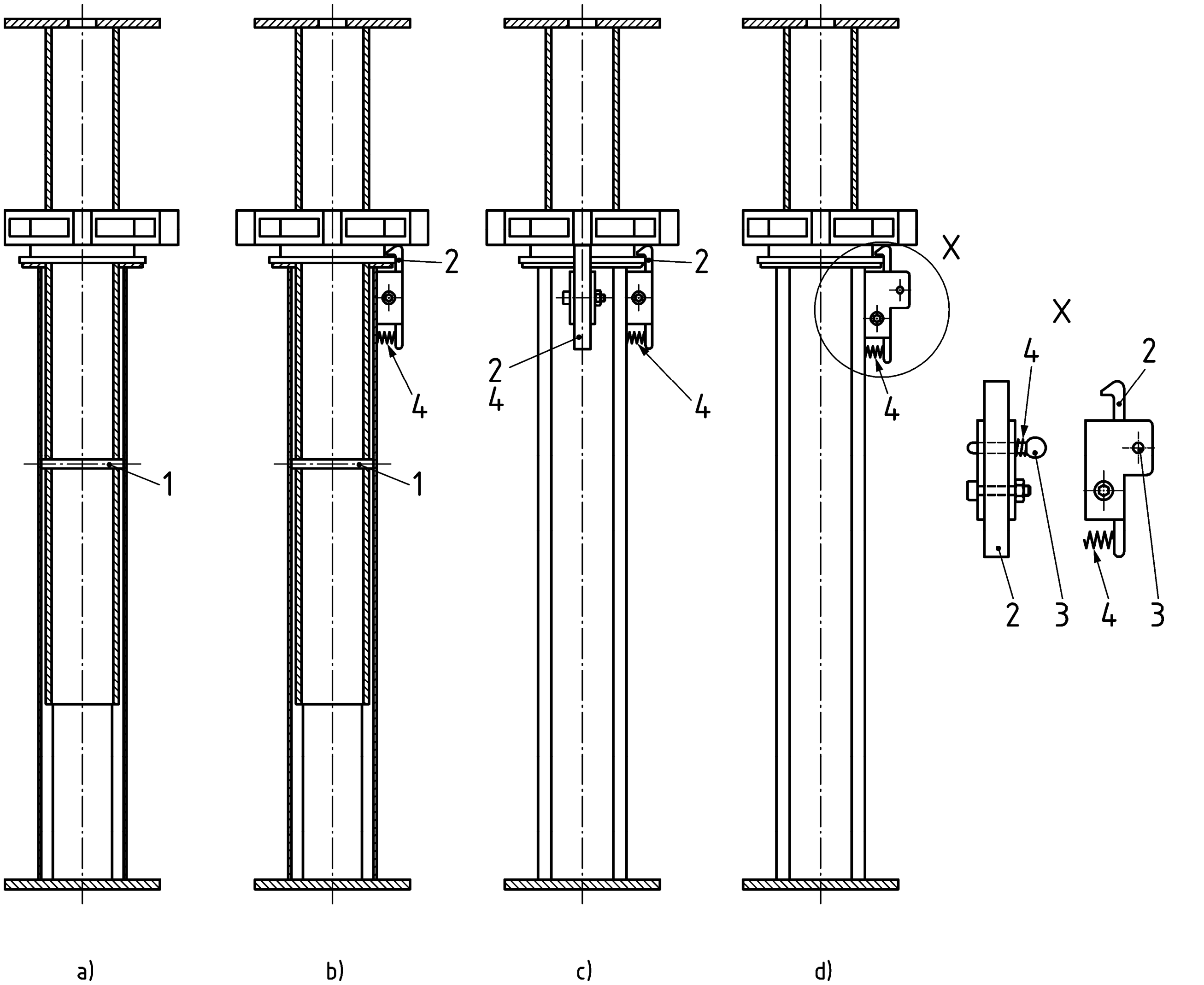
NOTE Safety method 1 is usually used for prop type 2.

— safety method 2: an automatic safety device and an additional permanent locking connection (see Figure 3b);

— safety method 3: two independent automatic safety devices arranged on the circumference not opposed each other (see Figure 3c);

— safety method 4: an automatic safety device locked by an additional automatic permanent safety device (see Figure 3d).

The additional permanent safety device shall be so designed that the safety device can only be detached or attached by at least two consecutive deliberate manual actions.



Key

1 permanent locking connection
2 automatic safety device
3 additional automatic safety device
4 spring

Figure 3 — Examples of methods of locking safety devices

8.5 Anti hand trap

For prop type 2, when the prop is fully closed without the pin inserted, there shall remain at least 100 mm clearance between the endmost part of the outer tube and the inside of the endplate.

8.6 Overlapping length

There shall be an overlapping length between the outer and inner tube, l_0, of at least 300 mm when the prop is fully open.

8.7 Endplates

Props with endplates of classes A, B, C, D and E shall be in accordance with 7.5 of EN 1065:1998. For classes R, S, T, U, V and W endplates shall be square or rectangular.

Endplates shall have at least two holes for connection purposes. If a central hole is required in the endplates, it shall have a minimum diameter of 28 mm.

Plain aluminium endplates shall be made from material having a minimum proof stress of 195 N/mm^2. They shall have a minimum nominal thickness of 10 mm.

Profiled endplates shall have a spring stiffness and a bending resistance at least equal to that of plain endplates.

At corners which would otherwise be sharp, the radius shall be at least 5 mm.

9 Verification

9.1 General

The properties of a prop shall be verified following the steps in Table 3.

The actual characteristic strength $R_{y,act}$ of a prop shall be verified both with the outer tube at the bottom and with the inner tube at the bottom.

The actual characteristic strength of a prop $R_{y,act}$ shall be verified at maximum extension for the classes A, B or C in the fully closed extension and also in the most unfavourable extension in between. The most unfavourable extension is the length with the smallest quotient $R_{y,act} / R_{y,k}$.

For all extended lengths, the actual characteristic strength $R_{y,act}$ of a prop shall be at least equal to the nominal characteristic strength $R_{y,k}$ specified in Table 1.

Table 3 — Verification steps

Step	Property	Verification method
1	Actual characteristic strength $R_{y,act}$	Determined by calculation supported by detail tests in accordance to 10.2 and confirmed by tests in accordance with 10.4
2	Characteristic strength of length adjustment device	Determined by tests in accordance with 9.3
3	Prevention against unintentional disengagement	Tests in accordance with 10.3

The global analysis to determine the internal forces and moments shall use elastic analysis design principles, assuming that the behaviour of the material is linear at all stress levels. The resistances of cross sections may be calculated by using plastic stress distributions. For the global analysis, the second order theory shall be used, taking into account the influence of the deformations of the structure on the internal forces and moments.

The values for resistance in compression, bending moment, stiffness and eccentricities at the base shall be defined or calculated or determined by tests in accordance with 10.2 to support the analysis model chosen.

9.2 Calculation of prop strength

9.2.1 General

Characteristic strength calculations shall be carried out using the structural model given in Figure 4.

The deformation of the inner tube in the overlap zone shall be taken into account.

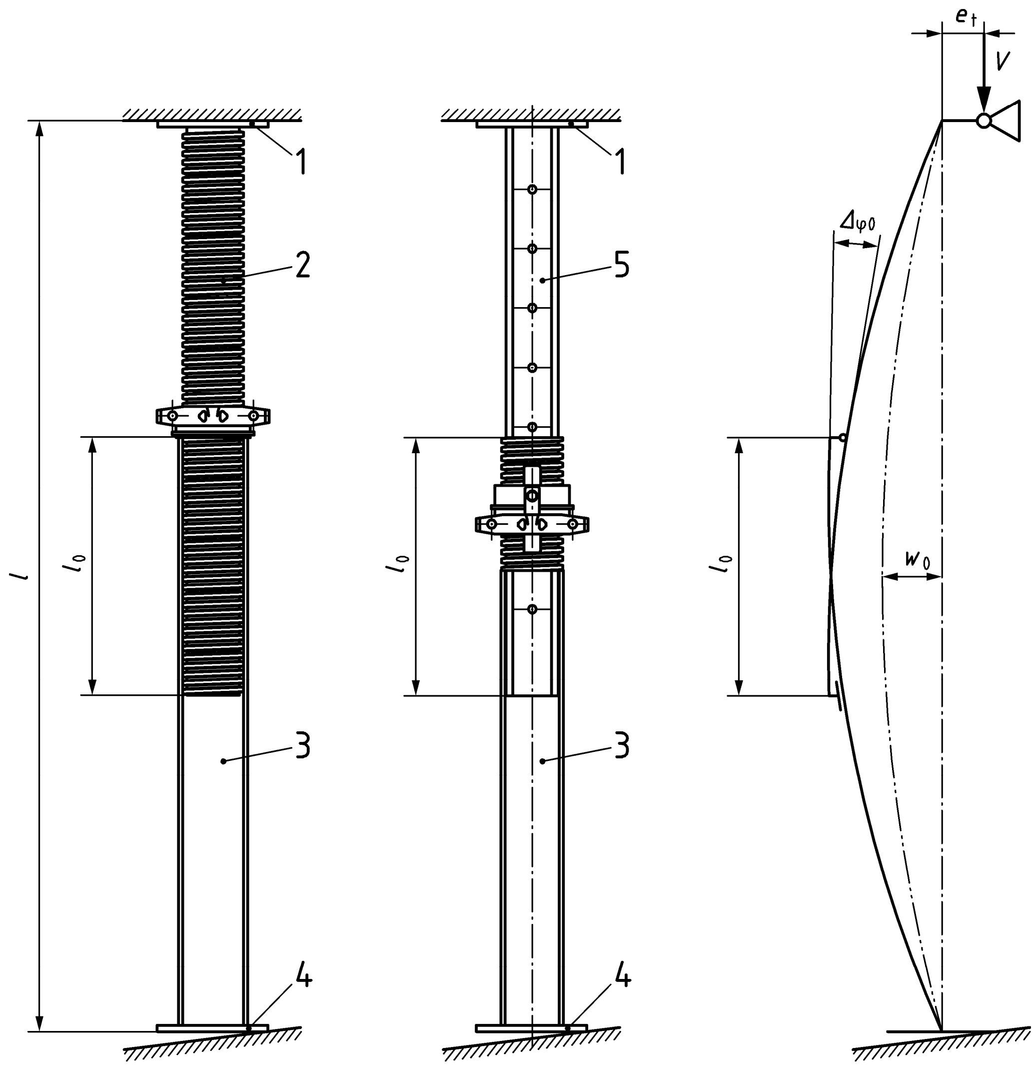
Additional contact points which occur when the looseness between the inner and outer tube have been taken up may also be allowed for.

9.2.2 Imperfections

9.2.2.1 Angle of inclination $\Delta\varphi_0$

The angle of inclination $\Delta\varphi_0$ (see Figure 4) caused by the clearance between the tubes in the overlap zone shall be determined from the nominal dimensions of the components.

For detail X see Figure 5 or Figure 8.



a) Prop type 1 b) Prop type 2 c) Structural model

Key

1 end plate on top
2 threaded inner tube
3 outer tube
4 end plate on the base
5 inner tube with holes

e_t eccentricity at the top
w_0 preflexure
$\Delta\varphi_0$ angle of inclination
V vertical load ($R_{y,k}$ or $R_{y,act}$)

Figure 4 — Structural model for the verification of the actual characteristic strength of different prop types

9.2.2.2 Preflexure

In addition to the angle of inclination, a sine-shaped preflexure of the prop as a whole with a maximum offset w_0 in accordance with the verification procedure shall be assumed:

— verification procedure elastic-elastic: $w_0 = \ell/375$

— verification procedure elastic-plastic: $w_0 = \ell/250$

9.2.3 Behaviours of inner and outer tube

9.2.3.1 Rigidity

The axial compression stiffness and the bending stiffness of the tubes shall be calculated or determined by detailed tests in accordance with 10.2.

For the inner tube of type 2 props, the reduction of the flexural rigidity due to the holes shall be calculated; for circular tubes in accordance with Annex A of EN 1065:1998. If the holes are not produced by drilling, the resultant deformations of the tube shall be measured and the sectional properties of the deformed tube calculated.

9.2.3.2 Resistances of tubes

The characteristic moment resistance $M_{\text{pl,k}}$ and the characteristic compression resistance $N_{\text{pl,k}}$ of the tubes shall be calculated or determined by detail tests in accordance with 10.2.

The moment capacity $M_{\text{R,k}}(N)$ shall be determined, taking into account the effects of axial forces.

This capacity $M_{\text{R,k}}(N)$ may be calculated for circular and profiled tubes using Formula (1):

$$M_{\text{R,k}}(N) = M_{\text{pl,k}} \cdot \cos\left(\frac{\pi}{2} \cdot \frac{N}{N_{\text{pl,k}}}\right) \quad (1)$$

where

$M_{\text{R,k}}(N)$ is the reduced plastic resistance moment allowing for axial force;

$M_{\text{pl,k}}$ is the characteristic moment resistance of the gross cross-section ($\alpha_{\text{pl}} \leq 1{,}25$);

N is the axial force ($R_{\text{y,k}}$, (see Table 1 or $R_{\text{y,act}}$));

$N_{\text{pl,k}}$ is the characteristic compression resistance of the gross cross section.

Local buckling effects should be evaluated according to EN 1999-1-1 or taken into consideration according to 10.2.1.

NOTE 1 In case of verification procedure elastic-elastic, the resistance of the tubes needs to be calculated using the linear stress distribution.

NOTE 2 Equations for determining the structural properties of a perforated circular tube, are to be taken into account in accordance with Annex A of EN 1065:1998.

9.2.4 Boundary conditions

9.2.4.1 Eccentricities at the ends

9.2.4.1.1 Eccentricity at the top

At the top of the prop an eccentricity $e_{\text{t}} = 10$ mm (see Figure 4) shall be assumed.

9.2.4.1.2 Eccentricity at the base

At the base of the prop, one of two structural models, a) or b), for the calculation of the eccentricities shall be used.

Structural model a)

The following eccentricities shall be assumed (see Figure 5):

$e_{b,0} = 0.40 \cdot D_1$;

$e_{b,core} = -0.25 \cdot D_1$;

$e_{b,limit} = -\min\{0.50 \cdot D_1; e(N)\}$.

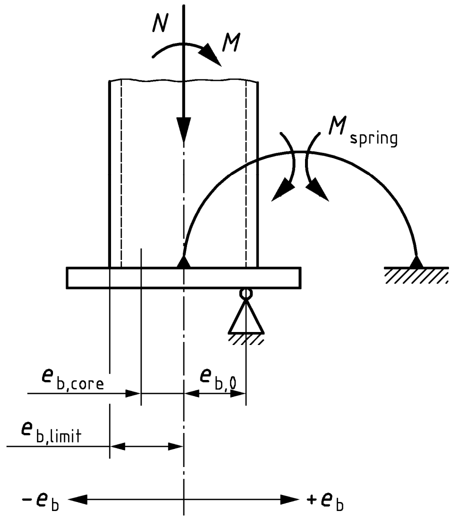


Figure 5 — Eccentricities at the base plate — structural model a)

where

D_1 effective diameter at the base in millimetres (see Figure 6).

The effective diameter D_1 shall be calculated by taking both the outer diameter of the profile and, if welded to the profile, the thickness of the endplate, into account. The following calculations and Figure 6 are examples:

— welded endplate: $D_1 = D + 2 \cdot t$

— non welded endplate: $D_1 = D$

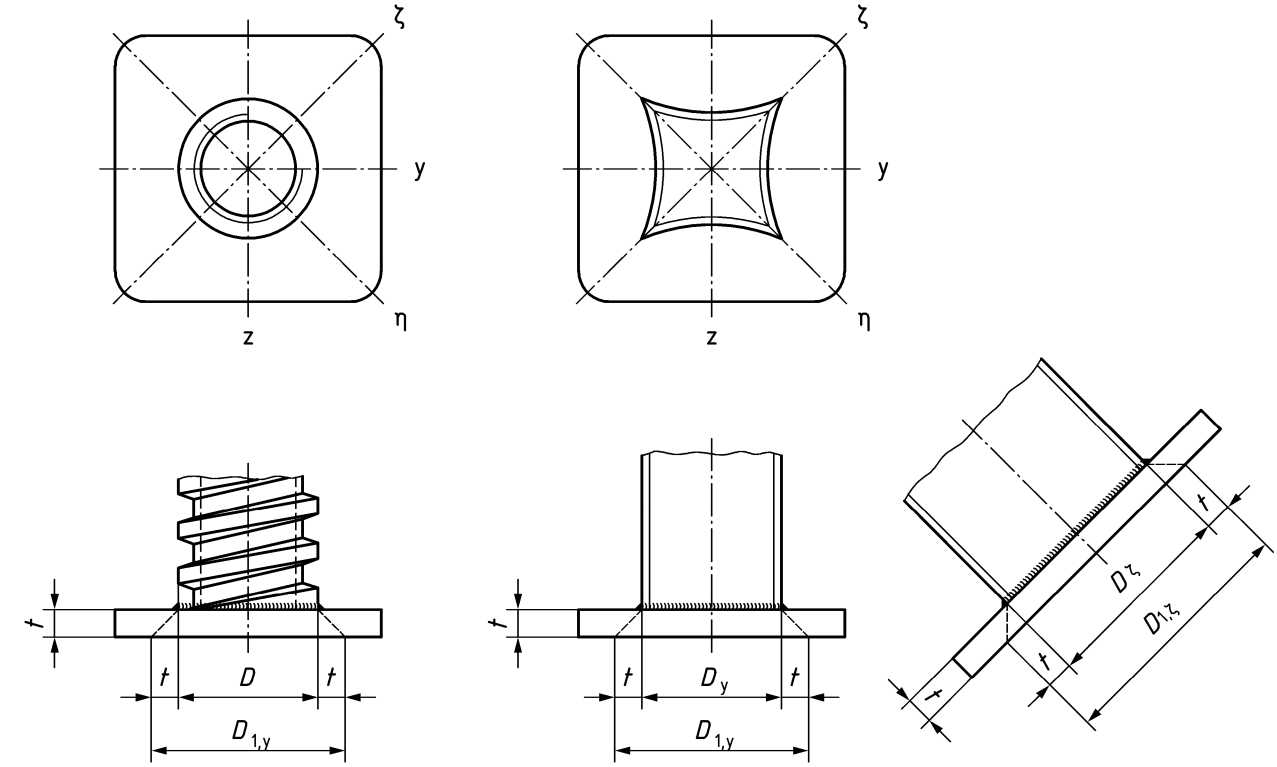


Figure 6 — Effective diameter D_1

NOTE The minimum elastic bending resistance of the profile may correspond with the maximum effective diameter D_1. A simplified analysis may use the minimum of bending resistance and minimum effective diameter. Otherwise, calculations should be performed for both directions using corresponding parameters.

$e(N)$ limiting eccentricity of the axial forces N may be determined either

— by detail tests according 10.2.4, or

— by the following simplified calculation when assuming a load-path via a partial area solely under compression (see Figure 7).

For the calculation $e(N)$ is the distance between the centre of gravity C and the centre of gravity $S(A(N))$ of an ideal necessary net-cross-section area $A(N)$ in section 1-1 (see Figure 7).

$$A(N) = \frac{N}{f_0} \tag{2}$$

where

N axial force ($R_{y,k}$ or $_{Ry,act}$);

f_0 characteristic value of proof strength at the transitions point between prop and base plate (section 1-1, see Figure 7). If the connection is welded, f_0 is to be determined by taking the heat effected zone into account $f_{0,HAZ}$.

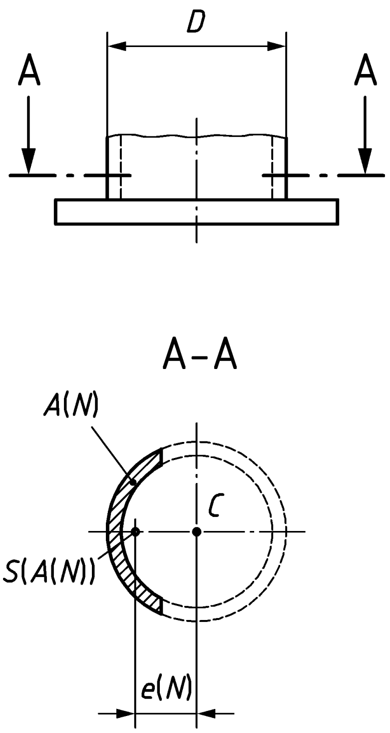


Figure 7 — Simplified calculation scheme for distance $e(N)$

Structural model b)

The following eccentricity shall be assumed (see Figure 8):

$e_{b,0} = 5$ mm

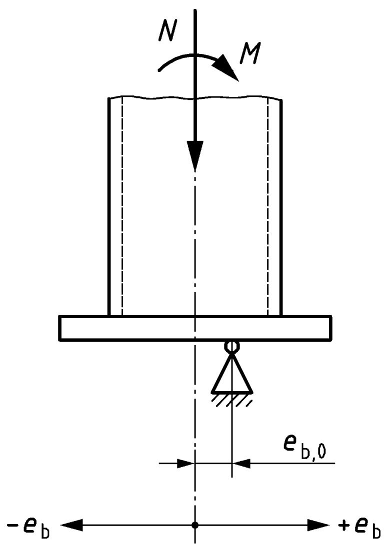


Figure 8 — Eccentricities at the base plate — structural model b)

9.2.4.2 Rigidity at the ends

9.2.4.2.1 Rigidity at the top

A hinge shall be assumed at the top (see Figure 4).

9.2.4.2.2 Rigidity at the base

Structural model a)

In structural model a) (see 9.2.4.1.2) the relation between the moment of the spring M_{spring} (see Figure 5) and rotation at the base of the prop shall be taken as that described in Figure 9.

For higher values of the quotient M_{Spring}/N than $|e_{\mathrm{b,0}}| + |e_{\mathrm{b,limit}}|$, the load carrying capacity of the prop is assumed to be exhausted.

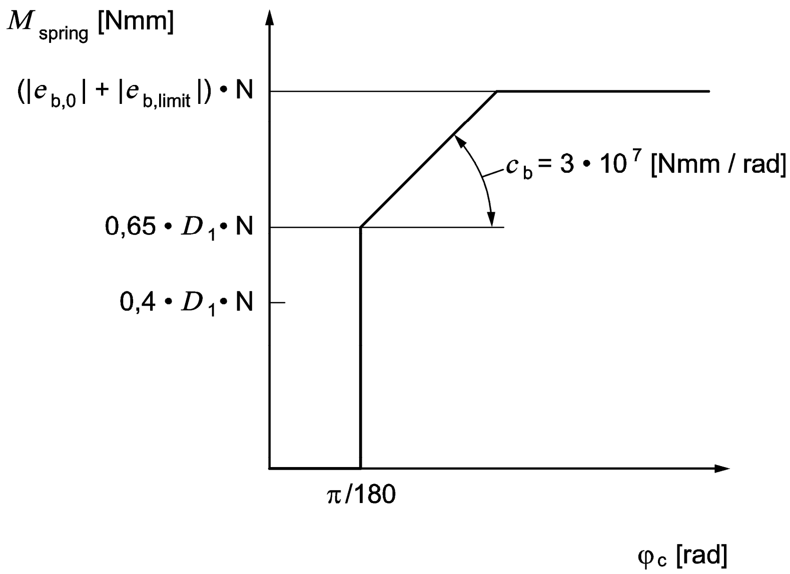


Figure 9 — Relation between the moment of the spring and the rotation at the base of the prop

NOTE For the base of the prop, a structural model with load-dependant mechanical properties should be analysed (see Figure 9). First, a hinged support with an initial eccentricity $e_{\mathrm{b,0}}$ is assumed. When the rotation reaches $\varphi_{\mathrm{b}} = \pi/180$ rad ($\triangleq$ 1°) any additional rotation will be prevented until the quotient M_{Spring}/N reaches the eccentricity $|e_{\mathrm{b,0}}| + |e_{\mathrm{b,core}}| = 0.65\,D_1$. For higher values of the quotient M_{Spring}/N, a spring stiffness $c_{\mathrm{b}} = 3 \cdot 10^7$ N · mm/rad is assumed until the value of the quotient reaches the limit eccentricity $|e_{\mathrm{b,0}}| + |e_{\mathrm{b,limit}}|$.

Structural model b)

In structural model b) (see 9.2.4.1.2) a hinge shall be assumed at the base.

9.2.5 Verification of prop strength

The calculated actual characteristic strength $R_{\mathrm{y,act}}$ shall be compared with the nominal characteristic strength $R_{\mathrm{y,k}}$ specified in Table 1, for a prop with the same class and extension. $R_{\mathrm{y,act}}$ shall not be less than $R_{\mathrm{y,k}}$.

9.3 Verification of the strength of length adjustment device

The strength of the length adjustment device shall be determined by compression tests in accordance to 10.3. The characteristic strength $R_{ad,k}$ shall not be less than $R_{y,act}$.

9.4 Verification of the prevention against unintentional disengagement

The inner and outer tubes of props shall remain attached to each other when tested in accordance with 10.3.

9.5 Confirmation of the calculation results by testing

To confirm the calculation results, confirmation tests in accordance to 10.4 shall be carried out. The test strength $R_{y,t}$ shall be not less than 0,95 $R_{y,act}$ and $R_{y,a}$ not less than $R_{y,act}$.

10 Tests

10.1 General

If not specified in this European Standard, tests shall be carried out and evaluated in accordance with EN 12811-3.

All test equipment used shall have sufficient accuracy so that the resulting measurement uncertainty is less than 1 %.

The specimens required for testing shall be randomly selected from a batch of at least 50 props. The batch shall either be taken from current production, or from a stock.

New props shall be used for all tests.

10.2 Detail tests

10.2.1 Compression tests on unthreaded tubes

10.2.1.1 General

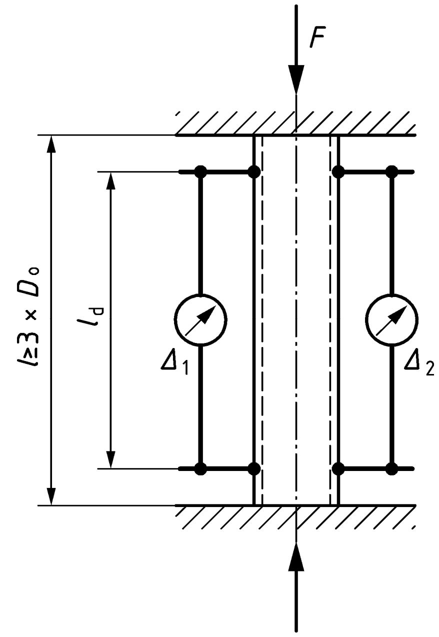
When plastic design methods are applied and when the structural analysis does not evaluate local buckling effects of the outer tube and unthreaded inner tube, tests shall be carried out to establish the resistance in compression. The proof strength achieved in stub-column-tests shall correspond with the proof strength from tension tests. This means that the average of the proof strength achieved shall not differ more than 5 %. If the difference is more than 5 %, the elastic design method shall be used; if the resistance in compression is less than the elastic properties in tension, the profiled tube shall be modified.

10.2.1.2 Purpose of test

To establish the characteristic compression resistance $N_{R,k}$.

10.2.1.3 Test arrangement

A test arrangement is shown in Figure 10. Deformation measurements shall eliminate effects from the testing machine and the specimen's ends. At least $n = 5$ tests shall be carried out.



Key

D_0	outer diameter of the unthreaded tube
l	specimen's length
l_d	length of measuring bridge
Δ_1, Δ_2	shortening

Figure 10 — Principle test arrangement for compression test

10.2.1.4 Evaluation of test results

The shortening Δ shall be calculated from Formula (3).

$$\Delta = (\Delta_1 + \Delta_2)/2 \tag{3}$$

The characteristic compression resistance $N_{R,k}$ shall be determined in according with Clause 10 of EN 12811-3:2002. Adjustment of the achieved ultimate compression strengths shall be carried out using the nominal proof strength of the material and the actual proof strength of tube material used.

The results using the mean value shall be analysed.

10.2.2 Compression tests on threaded tube

10.2.2.1 General

Tests on threaded tubes shall be carried out to establish the axial compression stiffness $E \cdot A$ and the characteristic compression resistance $N_{R,k}$.

Tests are dispensable if the mentioned data are calculated using the core diameter of the thread and the average internal diameter.

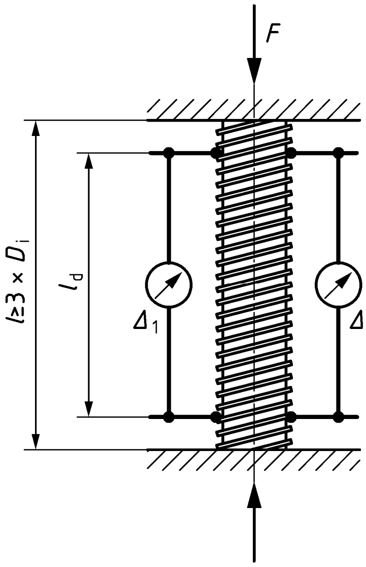
Adjustment of the achieved ultimate compression strengths shall be carried out using the nominal proof strength of the material and the actual proof strength of tube material used.

10.2.2.2 Purpose of test

To determine the axial compression stiffness $E \cdot A$ and characteristic compression resistance $N_{R,k}$ of threaded tubes.

10.2.2.3 Test arrangement

A test arrangement is shown in Figure 11. Deformation measurements shall eliminate effects from the testing machine and the specimen's ends. At least $n = 5$ tests shall be carried out.



Key

D_i outer diameter of the threaded tube
l specimen's length
l_d length of measuring bridge
Δ_1, Δ_2 shortening

Figure 11 — Test arrangement for axial compression stiffness $E \cdot A$ and characteristic compression resistance $N_{R,k}$ of threaded tubes

10.2.2.4 Evaluation of test results

Structural analysis shall use the average of test results according to Formulae (3), (4) and (5).

$$E \cdot A_i = F \cdot \frac{l_d}{\Delta_i} \tag{4}$$

$$E \cdot A = \frac{n}{\sum \frac{1}{(E \cdot A_i)}} \tag{5}$$

The characteristic compression resistance $N_{R,k}$ shall be determined according to Clause 10 of EN 12811-3:2002 and adjustment of the achieved ultimate compression strengths shall be carried out using the nominal proof strength of the material and the actual proof strength of tube material used.

NOTE An increased strength due to cold forming of the thread may be considered; the increase factor should be evaluated from proofs taken from the core of the thread and from the tube material.

10.2.3 Bending tests on threaded tube

10.2.3.1 General

Tests on threaded tubes shall be carried out to establish the bending stiffness $E \cdot I$ and the capacity of bending moment $M_{B,R,k}$ as well as the characteristic moment resistance $M_{pl,k}$. Tests are dispensable if the mentioned data are calculated using the core diameter of the thread and the average internal diameter.

Adjustment of the achieved ultimate bending moments shall be carried out using the nominal proof strength of the material and the actual proof strength of tube material used in accordance with EN 12811-3.

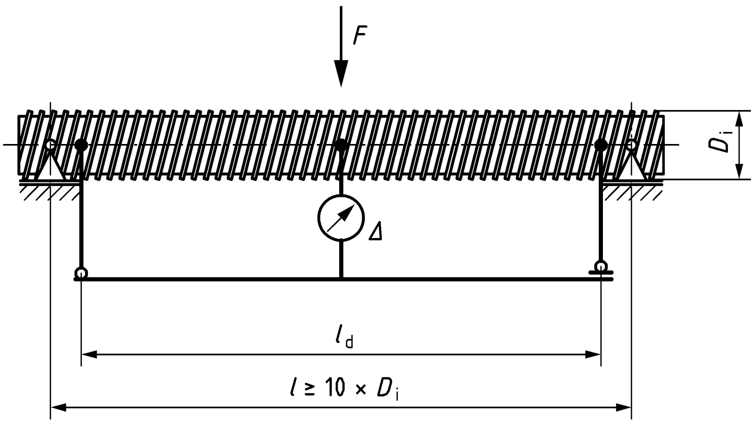
10.2.3.2 Purpose of test

To determine the bending stiffness $E \cdot I$ and capacity of bending moment $M_{B,R,k}$ of threaded tube.

10.2.3.3 Test arrangement

A test arrangement is shown in Figure 12. At least $n = 5$ tests shall be carried out. Other suitable test arrangements such as 4-point bending test may also be used.

NOTE Special attention should be paid to the deflections normal to the axis (ovalization).



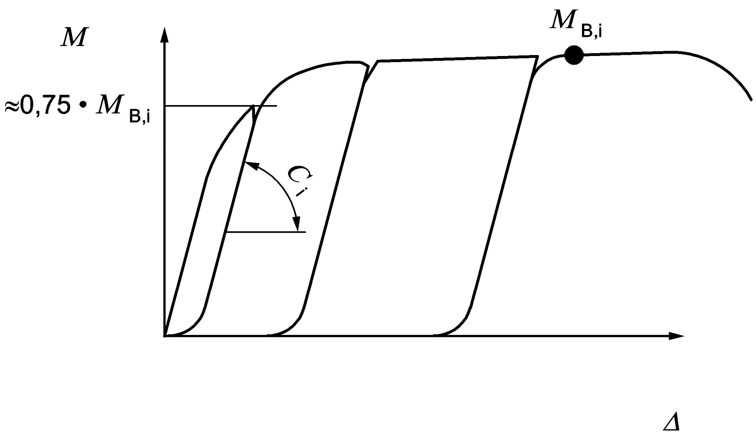
Key

D_i outer diameter of the threaded tube
l span
l_d length of measuring bridge
Δ deflection

Figure 12 — Test arrangement for bending stiffness $E \cdot I$ and capacity $M_{B,R,k}$ of threaded tubes

10.2.3.4 Evaluation of test results

Each bending stiffness $E \cdot I_i$ shall be determined using c_i from the unloading curve (see Figure 13).



Key

$M_{B,I}$ capacity of bending moment

Figure 13 — Example of load-deflection curve of bending test

In the case of a symmetrical test set up with one central test, force bending stiffness is calculated using Formulae (6) and (7):

$$E \cdot I_i = c_i \frac{l^2}{24} \cdot \left[2 - 3 \cdot \frac{l - l_d}{l} + \left(\frac{l - l_d}{l} \right)^3 \right] \quad (6)$$

$$E \cdot I = \frac{n}{\sum \frac{1}{(E \cdot I_i)}} \quad (7)$$

Structural analysis shall use the results of bending stiffness according to Formula (7).

The capacity of bending moment $M_{B,R,k}$ shall be determined according to Clause 10 of EN 12811-3:2002. Adjustment of the achieved ultimate bending moments shall be carried out using the nominal proof strength or increased strength of the material and the actual proof strength of tube material used.

The characteristic moment resistance $M_{pl,k}$ shall be determined according to Formula (8).

$$M_{pl,k} = M_{B,R,k} \cdot \frac{1,25}{\alpha_{pl}}$$

$$\frac{1,25}{\alpha_{pl}} \leq 1,0 \quad (8)$$

where

$\alpha_{pl} = W_{pl}/W_{el}$ is calculated using the core diameter of the thread and the average internal diameter.

10.2.4 Tests for the limit eccentricities of prop ends

10.2.4.1 General

Structural model a) according to 9.2.4.1.2 uses a spring at the base with load-dependant properties representing the behaviour of the prop end. The limit eccentricity $e(N)$ shall be evaluated for two different axial forces *F* by suitable tests.

Tests are dispensable if the structural model uses a simplified calculation scheme in accordance with Figure 7.

10.2.4.2 Purpose of test

To determine the limit eccentricity $e(N)$ at the ends of props made of aluminium tubes and endplates.

10.2.4.3 Test arrangement

A test arrangement is shown in Figure 14. At least $n = 5$ tests shall be carried out each with test force F_1 and F_2.

The lower axial test force F_1 shall be in the range calculated according to Formula (9).

$$F_1 = \frac{f_y}{\left(\frac{1}{A} + \frac{0{,}5 \cdot D_1}{W}\right)} \quad (9)$$

where

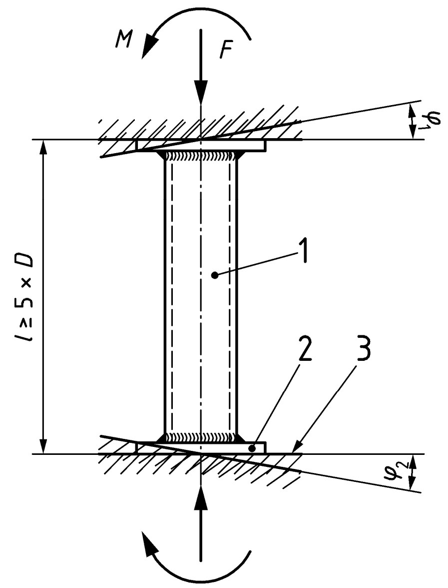
F_1 is the axial test force;

A is the cross sectional area;

W is the elastic section modulus;

D_1 is the effective diameter at the base $D_1 = D + 2 \cdot t$, if the endplate is welded to the tube; otherwise use diameter $D = D_i$ or D_0;

f_y is the characteristic proof strength $f_{0,HAZ}$ of heat affected zone if the endplate is welded to the tube (otherwise use the proof strength $f_{0.}$);

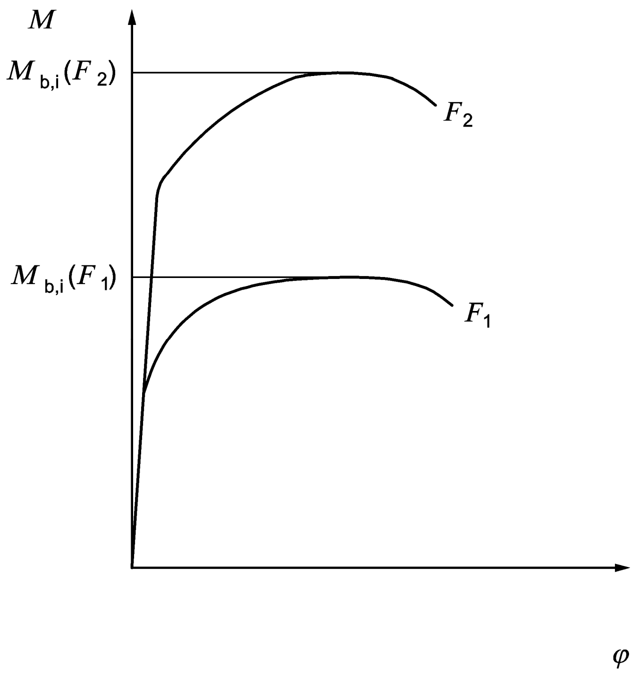


Key

D outer diameter of the tube
φ rotation between the specimens ends and the crossheads
1 inner or outer tube
2 endplate
3 cross head

Figure 14 — Test arrangement for the limit eccentricity at the base

The higher axial test force shall be at least $F_2 = 2 \cdot F_1$ and should refer to the expected range of props load application. The axial compression force is constant during the test while the bending moments applied to the specimen are increased until failure. Moment-rotation-curves for two different axial compression forces F_1 and F_2 are shown in Figure 15.



Key

F_1, F_2 axial compression forces
$M_{b,i}(F_1)$ maximum bending moment in test i with F_1
$M_{b,i}(F_2)$ maximum bending moment in test i with F_2

Figure 15 — Example of moment-rotation curves

10.2.4.4 Evaluation of test results

Ultimate moments $M_{b,limit}(F_1)$ and $M_{b,limit}(F_2)$ shall be evaluated according to 10.8 of EN 12811-3:2002 with $M_{b,i}(F_1)$ and $M_{b,i}(F_2)$. An adjustment of ultimate moments depending on material properties is not required.

Spring resistance $M_{b,limit}(R_{y,act})$ to be used in the structural analysis is shown in Figure 16.

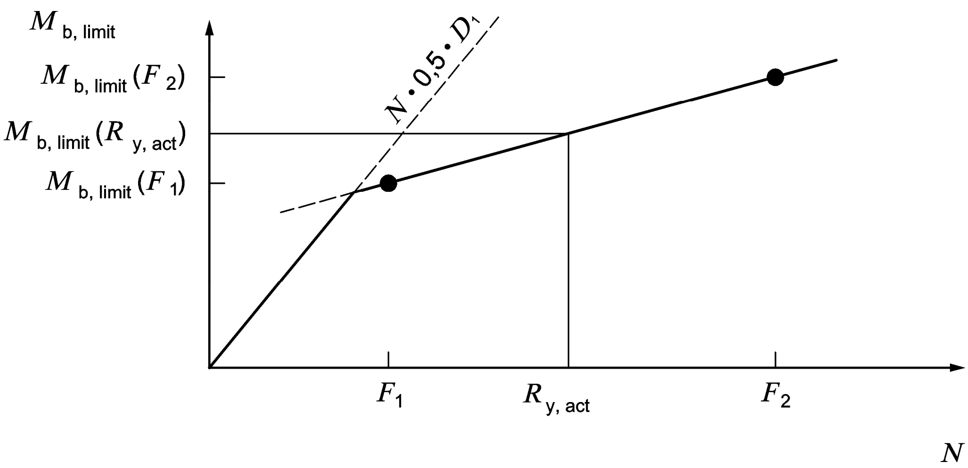


Figure 16 — Spring resistance $M_{b,limit}(R_{y,act})$

$$e(N) = M_{b,limit}(R_{y,act}) / R_{y,act} \quad (10)$$

10.2.5 Compression tests on length adjustment device

10.2.5.1 General

Tests on the length adjustment device shall be carried out to establish the characteristic strength in compression $R_{ad,k}$.

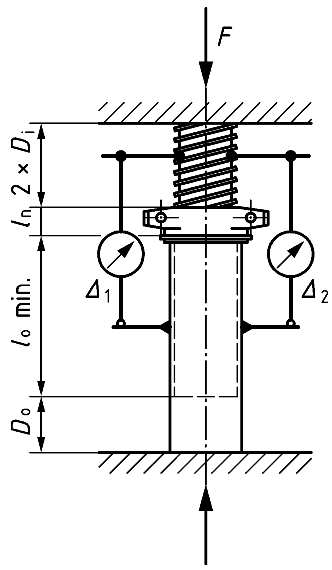
10.2.5.2 Purpose of test

To determine the characteristic strength of the length adjustment device $R_{ad,k}$ for prop type 1 and type 2.

10.2.5.3 Test arrangement

A test arrangement for prop type 1 is shown in Figure 17. For a test arrangement for prop type 2, see 10.3 of EN 1065:1998

At least $n = 5$ tests shall be carried out.



Key

D_i outer diameter of the threaded tube

D_0 outer diameter of the outer tube

l_0 minimum overlapping length

l_n length of nut

Δ_1, Δ_2 shortening

Figure 17 — Test arrangement for characteristic strength of length adjustment device

10.2.5.4 Evaluation of test results

The results shall be evaluated in accordance with EN 12811-3 to obtain $R_{ad,k}$.

10.3 Test of the prevention against unintentional disengagement

10.3.1 Purpose of test

To verify the capacity of the inner and outer parts of a prop so as to prevent them from being separated by an unintentional action.

10.3.2 Test arrangement

10.3.2.1 Test arrangement for safety method 1

Suspend the prop vertically by its endplate with the outer tube uppermost. Raise the inner tube until the prop is in the fully closed position. Allow the inner tube to fall under gravity three times. At least 3 props shall be tested.

10.3.2.2 Test arrangement for safety method 2

Suspend the prop vertically by its endplate with the outer tube uppermost. Connect only the safety device. Apply an axial tension load of 3 kN. Remove the load of 3 kN and suspend the same prop vertically by its endplate with the outer tube uppermost. Raise the inner tube until the prop is in the fully closed position. Allow the inner tube to fall under gravity one time. At least 3 props shall be tested.

10.3.2.3 Test arrangement safety method 3

Suspend the prop vertically by its endplate with the outer tube uppermost. Connect only one safety device. Apply a vertical axial tension load of 3 kN. Repeat the test with the second safety device to the same prop. At least 3 props shall be tested.

10.3.2.4 Test arrangement safety method 4

Suspend the prop vertically by its endplate with the outer tube uppermost. Connect the safety device with permanent additional safety device inserted. Apply an axial tension load of 3 kN. At least 3 props shall be tested.

10.3.3 Evaluation of test results

10.3.3.1 Evaluation of test results safety method 1

When a prop is tested three times, the inner tube and outer tube shall remain attached to each other.

10.3.3.2 Evaluation of test results safety method 2

The safety device shall be able to resist a load of 3 kN and to connect the inner tube with the outer tube.

When a prop is tested one time, the inner tube and outer tube shall remain attached to each other.

10.3.3.3 Evaluation of test results safety method 3

Each safety device shall be able to resist to a load of 3 kN and to connect the inner tube with the outer tube separately.

10.3.3.4 Evaluation of test results safety method 4

The safety device shall be able to resist to a load of 3 kN and to connect the inner tube with the outer tube. The permanent additional safety device after test shall remain locked.

10.4 Confirmation test for the prop strength

10.4.1 Material properties

The mechanical properties of the tubes from at least three tested props shall be determined by testing according to 10.2.2 of EN 1065:1998.

10.4.2 Global test

10.4.2.1 Purpose of test

To confirm the actual characteristic strength $R_{y,act}$, carry out global tests to determine $R_{y,t}$ and $R_{y,a}$.

10.4.2.2 Test arrangement

The method of loading shall be in accordance to 10.1.2 of EN 1065:1998.

Carry out at least three tests with the maximum extended length in the position of the prop with the lower actual characteristic strength $R_{y,act}$ (outer or inner tube at the bottom).

If calculating the actual characteristic strength $R_{y,act}$ using the structural model given in structural model a) (see 9.2.4.1.2), the test arrangement shall be performed in accordance to 10.2.3 to 10.2.5 of EN 1065:1998.

If calculating the actual characteristic strength $R_{y,act}$ using the structural model given in structural model b) (see 9.2.4.1.2), the test arrangement shall be performed in accordance to 10.2.3 to 10.2.5 of EN 1065:1998, except at the base of the prop shall be a hinge with an eccentricity of 5 mm.

10.4.2.3 Evaluation of test results

Each ultimate test value shall be adjusted in accordance with 10.7 of EN 12811-3:2002 depending on the material properties. For confirmation of calculation, the lowest evaluated tests result $R_{y,t}$ and also the average value $R_{y,a}$ shall be taken.

The spread of the results cannot be greater than ± 12,5 % with respect to the average.

11 Documentation of test results

See Clause 9 of EN 12811- 3:2002.

12 Marking

The marking shall be permanently applied on the prop or based on a metal plate connected to the prop, and shall be legible after the protective coating has been applied. The height of the characters shall be at least 4 mm.

The position of the marking shall not be obscured when the prop is in the upright position with the outer tube at the bottom.

Props shall be marked with the following information, in the sequence given:

- EN 16031;
- name or trademark of the prop manufacturer;
- year of manufacture (at least two digits);
- classification (see Table 1 and Table 2);
- inspection level L or M if Annex A (informative) is applied;
- sign of the independent certification organisation (for inspection level M only) if Annex A is applied; e. g. EN 16031 “PROPS” 09 C/D 50 L.

13 Assessment

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

On completion of a successful assessment, a statement to that effect shall be given by the assessor. This statement shall refer to the assessment report.

The assessment report shall include at least:

- identification of all technical documents required by this European Standard;
- data for components and connections as resistances and stiffnesses evaluated by tests;
- check of content of the user manual.

14 User manual

The user manual provided by the manufacturer shall contain at least:

- designation;
- drawings with general dimensions;
- minimum and maximum extended length and minimum working length;
- working loads for falsework;
- classification;
- weight;
- instructions for mounting, dismantling and use, including the use of couplers if possible;
- instructions for maintenance;
- main criteria of use capability;
- marking details and their position.

Annex A
(informative)

Ongoing production control

The manufacturer of adjustable telescopic aluminium props should be controlled by one of the following inspection methods:

— Inspection level L

The production quality control shall be carried out by a manufacturer approved to either EN ISO 9001 or EN ISO 9002.

— Inspection level M

The production quality control shall be carried out by an independent certification organisation.

The manufacturer should control the inspection documents given in Table A.1 of the components and control if these documents fulfil the content as given in the drawings included in the assessment report.

Minimum ongoing quality control requirements are given in Table A.2.

Table A.1 — Inspection documents

Component	Property to be checked	If supplied to the prop manufacturer		If produced by the prop manufacturer
		Per batch	Additional check	
For all structural components	Material, dimensions, tolerances as given in the drawings included in the assessment report	Inspection certificate 3.1 in accordance with EN 10204:2004	Random checks on receipt of materials	1 ‰ of the components

Table A.2 — Inspection of prop manufacturer

Component	Characteristic to be checked	Limit deviation	Frequency of inspection	
			Internal inspection	M-level third party control
Threaded tube	Increased yield strength (increase factor), tests in accordance with Table 1	No value below as given in the assessment report	With 0,1 ‰ of the tubes or at least 1 per batch	With 3 threaded tubes
Outer and inner tube	Dimensions, tolerances	As given in the drawings included in the assessment report	With 0,1 ‰ of the tubes or at least 1 per batch	Usually two visits per year; during each visit at least three props of each prop class currently being produced
Inspection documents	In accordance with Table 1	Minimum level as given in Table A.1	Per batch	Usually two visits per year; during each visit at least three props of each prop class currently being produced
Length of the prop	Fully open	+ 10 mm/0 mm	Al least 0,1 ‰ of all props and prop components units produced per working day with a minimum of one unit per batch	
	Fully closed	0 mm/– 10 mm		
End plate	Perpendicularity to tube axis	± 1,0°		
	Concentricity to tube axis	± 2 mm		
	Flatness	1 mm		
Inner tube holes	Diameter	± 0,3 mm		
	Concentricity relative to tube axis	± 0,5 mm		
Outer tube thread (if separate)	Concentricity to outer tube	0,5 mm		
Axial clearance between the tubes in the overlap zone	Angle of inclination	+ 20 % as 9.2.2.1		
Anti hand trap	Prop fully closed, clearance as prescribed in 8.5	No minus limit deviation		
Welding	Throat thickness, workmanship	As 8.2 and data drawing		
Unintentional disengagement	Tests of prevention against unintentional disengagement accordance with 10.4	According to the safety method		
Marking	Completeness and legibility	As Clause 12 and data drawing		

Bibliography

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

[2] EN 1090-2, *Execution of steel structures and aluminium structures — Part 2: Technical requirements for steel structures*

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