SLOVENSKI STANDARD
SIST EN 13480-3:2002/A4:2010

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Kovinski industrijski cevovodi - 3. del: Konstruiranje in izračun

Metallic industrial piping - Part 3: Design and calculation

Metallische industrielle Rohreitlungen - Teil 3: Konstruktion und Berechnung

Tuyauteries industrielles métalliques - Partie 3: Conception et calcul

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77.140.75	Jeklene cevi in cevni profili za posebne namene	Steel pipes and tubes for specific use

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English Version

Metallic industrial piping - Part 3: Design and calculation

Tuyauteries industrielles métalliques - Partie 3: Conception et calcul

Metallische industrielle Rohreitlungen - Teil 3: Konstruktion und Berechnung

This amendment A4 modifies the European Standard EN 13480-3:2002; it was approved by CEN on 10 October 2009.

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Foreword

This document (EN 13480-3:2002/A4:2010) has been prepared by Technical Committee CEN/TC 267 “Industrial piping and pipelines”, the secretariat of which is held by AFNOR.

This Amendment to the European Standard EN 13480-3:2002 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2010, and conflicting national standards shall be withdrawn at the latest by November 2010.

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 document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

This document includes the text of the amendment itself. The corrected pages of EN 13480-3 will be delivered as issue 12 of the standard.

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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Addition of Annex Q

Add the following new Annex Q: "

Annex Q
(informative)

Simplified pipe stress analysis

Q.1 General

The pressure design of all piping components shall be carried out in accordance with the rules of EN 13480-3. Stresses due to sustained loads, occasional and exceptional loads, thermal expansion and alternating loads have to be taken into account to meet the code stress requirements for their particular load case.

Q.2 Simplified procedure

Q.2.1 General

As a deviation from Q.1, the stresses from gravitational forces and temperature fluctuations can be simply determined (see EN 13480-3:2002, 12.2.10) in accordance with Q.2.2 and Q.2.3 independent of the other stresses in each case.

This procedure shall be applied by experienced personal only. It does not yield information about the loads at anchor points and shall not be applied to piping, operating in the creep range.

This method only applies to piping which is not buried. For buried piping, additional considerations, for example with regard to vertical soil loads, restrained expansion due to soil resistance, or mining subsidence are necessary. These are not covered by the simplified method.

Q.2.2 Specification of allowable spacing of supports

The specification of the allowable spacing of supports, limits the effect of the dead weight of the piping on the deflections and the stresses. Thus it is possible to consider the internal pressure and the dead weight of the piping separate from each other. Proof of the permissibility of the support spacing is provided if, for steel pipes, the support distances given in Table Q.1 are not exceeded and the explanatory notes regarding the specification of support distances are considered. For other parameters, e.g. other materials, the Table Q.1 can be converted in accordance with the information in the explanatory notes of Table Q.1.

Q.2.3 Check of elasticity

To meet the stress limitations in the load case thermal expansion the piping need to have a sufficient elasticity. This is normally achieved by a routing that allows for bending and torsional deflection due to compensating measures. A design calculation for elasticity is not required if the leg lengths comply with the conditions of Figure Q.2. It is assumed that torsional stresses are less significant due to the routing.

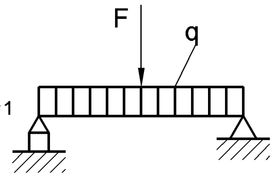
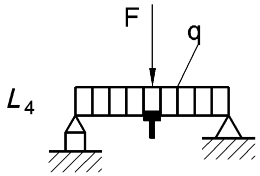
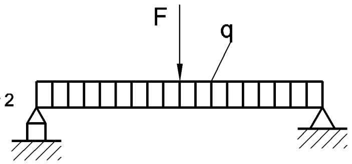
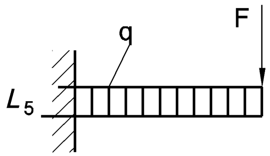
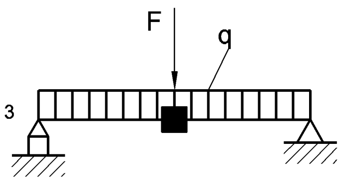
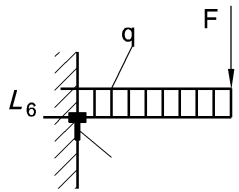
Examples of application of Figure Q.2 and explanatory notes are given in Q.9

Table Q.1 — Allowable spacing of supports for steel pipes (for boundary conditions refer to Explanatory Notes for Table Q.1)

			Empty pipe, without insulation							Water-filled pipe, without insulation							Water-filled pipe, insulation thickness 40 mm							Water-filled pipe, insulation thickness 80 mm						
DN	d_a	s	q	L_1	L_2	L_3	L_4	L_5	L_6	q	L_1	L_2	L_3	L_4	L_5	L_6	q	L_1	L_2	L_3	L_4	L_5	L_6	q	L_1	L_2	L_3	L_4	L_5	L_6
mm			kg/m	m						kg/m	m						kg/m	m						kg/m	m					
25	33,7	2,0	1,6	2,9	5,6	4,8	2,9	2,8	1,5	2,3	2,7	4,6	4,0	2,5	2,3	1,2	7,0	2,0	2,7	2,3	1,4	1,3	0,7	11,8	1,8	2,0	1,8	1,1	1,0	0,5
25	33,7	4,0	2,9	2,9	5,2	5,2	3,6	2,6	1,8	3,5	2,8	4,8	4,8	3,3	2,4	1,7	8,1	2,2	3,2	3,2	2,2	1,6	1,1	13,0	2,0	2,5	2,5	1,7	1,3	0,9
40	48,3	2,0	2,3	3,6	6,8	5,2	3,2	3,4	1,6	3,9	3,1	5,2	4,0	2,4	2,6	1,2	9,2	2,5	3,4	2,6	1,6	1,7	0,8	14,3	2,3	2,7	2,1	1,3	1,4	0,6
40	48,3	4,0	4,4	3,5	6,5	6,4	3,9	3,3	1,9	5,7	3,3	5,7	5,6	3,4	2,9	1,7	11,0	2,8	4,1	4,0	2,5	2,1	1,2	16,1	2,5	3,4	3,3	2,0	1,7	1,0
50	60,3	2,0	2,9	4,0	7,6	5,4	3,3	3,8	1,7	5,4	3,4	5,6	4,0	2,4	2,8	1,2	11,3	2,9	3,9	2,7	1,7	1,9	0,8	16,6	2,6	3,2	2,3	1,4	1,6	0,7
50	60,3	4,5	6,2	3,9	7,3	6,9	4,2	3,7	2,1	8,3	3,6	6,4	6,0	3,6	3,2	1,8	14,2	3,2	4,9	4,6	2,8	2,4	1,4	19,4	2,9	4,2	3,9	2,4	2,1	1,2
80	88,9	2,3	5,0	5,5	9,3	6,1	3,7	4,7	1,9	10,6	4,6	6,4	4,2	2,5	3,2	1,3	17,8	4,0	4,9	3,2	2,0	2,5	1,0	23,5	3,7	4,3	2,8	1,7	2,1	0,9
80	88,9	5,6	11,5	5,4	9,0	8,0	4,9	4,5	2,4	16,3	5,0	7,6	6,7	4,1	3,8	2,1	23,5	4,5	6,3	5,6	3,4	3,2	1,7	29,2	4,3	5,7	5,0	3,1	2,8	1,5
100	114,3	2,6	7,3	6,3	10,6	6,6	4,0	5,3	2,0	16,6	5,1	7,0	4,4	2,7	3,5	1,3	25,0	4,6	5,7	3,5	2,2	2,9	1,1	31,1	4,4	5,1	3,2	1,9	2,6	1,0
100	114,3	6,3	16,8	6,2	10,3	8,7	5,3	5,1	2,7	24,9	5,6	8,5	7,1	4,4	4,2	2,2	33,3	5,2	7,3	6,2	3,8	3,7	1,9	39,4	5,0	6,7	5,7	3,5	3,4	1,7
150	168,3	2,6	10,8	7,6	13,0	7,1	4,3	6,5	2,2	31,7	5,8	7,6	4,1	2,5	3,8	1,3	42,6	5,4	6,5	3,6	2,2	3,3	1,1	49,5	5,2	6,0	3,3	2,0	3,0	1,0
150	168,3	7,1	28,2	7,5	12,6	9,7	5,9	6,3	3,0	46,9	6,6	9,8	7,6	4,6	4,9	2,3	57,8	6,3	8,8	6,8	4,2	4,4	2,1	64,7	6,1	8,4	6,4	3,9	4,2	2,0
200	219,1	2,9	15,7	8,7	14,8	7,7	4,7	7,4	2,3	51,4	6,5	8,2	4,2	2,6	4,1	1,3	64,7	6,1	7,3	3,8	2,3	3,6	1,2	72,3	5,9	6,9	3,6	2,2	3,4	1,1
200	219,1	7,1	37,1	8,6	14,6	10,2	6,2	7,3	3,1	70,1	7,4	10,6	7,4	4,5	5,3	2,3	83,4	7,1	9,7	6,8	4,2	4,9	2,1	91,0	6,9	9,3	6,5	4,0	4,7	2,0
250	273,0	2,9	19,6	9,8	16,6	8,0	4,9	8,3	2,4	75,6	6,9	8,4	4,1	2,5	4,2	1,2	91,5	6,6	7,7	3,7	2,3	3,8	1,1	99,9	6,5	7,3	3,5	2,2	3,7	1,1
250	273,0	7,1	46,6	9,7	16,4	10,6	6,5	8,2	3,3	99,2	8,0	11,2	7,3	4,5	5,6	2,2	115,0	7,7	10,4	6,8	4,1	5,2	2,1	123,4	7,6	10,1	6,6	4,0	5,0	2,0
300	323,9	2,9	23,3	10,6	18,1	8,2	5,0	9,1	2,5	102,7	7,3	8,6	3,9	2,4	4,3	1,2	120,9	7,0	7,9	3,6	2,2	4,0	1,1	130,1	6,9	7,6	3,5	2,1	3,8	1,1
300	323,9	8,0	62,3	10,6	17,8	11,4	7,0	8,9	3,5	136,8	8,7	12,1	7,7	4,7	6,0	2,4	155,0	8,4	11,3	7,2	4,4	5,7	2,2	164,2	8,3	11,0	7,0	4,3	5,5	2,2
350	355,6	3,2	28,2	11,1	19,0	8,6	5,3	9,5	2,6	123,9	7,7	9,0	4,1	2,5	4,5	1,3	143,6	7,4	8,4	3,8	2,3	4,2	1,2	153,3	7,3	8,1	3,7	2,3	4,1	1,1
350	355,6	8,8	75,3	11,1	18,7	12,0	7,3	9,4	3,7	165,0	9,1	12,7	8,1	4,9	6,3	2,5	184,7	8,8	12,0	7,7	4,7	6,0	2,3	194,3	8,7	11,7	7,5	4,6	5,8	2,3
400	406,4	3,2	32,2	11,9	20,3	8,8	5,4	10,2	2,7	157,9	8,0	9,2	4,0	2,4	4,6	1,2	179,9	7,7	8,6	3,7	2,3	4,3	1,1	190,4	7,6	8,3	3,6	2,2	4,2	1,1
400	406,4	10,0	97,8	11,8	20,0	12,8	7,8	10,0	3,9	215,0	9,7	13,5	8,6	5,3	6,8	2,6	237,0	9,5	12,9	8,2	5,0	6,4	2,5	247,5	9,4	12,6	8,0	4,9	6,3	2,5
500	508,0	4,0	50,4	13,3	22,7	9,9	6,0	11,4	3,0	246,7	8,9	10,2	4,4	2,7	5,1	1,4	273,4	8,7	9,7	4,2	2,6	4,9	1,3	285,4	8,6	9,5	4,1	2,5	4,8	1,3
500	508,0	11,0	134,8	13,2	22,4	13,7	8,4	11,2	4,2	320,3	10,7	14,6	8,9	5,4	7,3	2,7	347,1	10,5	14,0	8,6	5,2	7,0	2,6	359,1	10,4	13,8	8,4	5,1	6,9	2,6

Q.3 Explanatory notes for Table Q.1

Table Q.2

L_1		f_{all} = 3 mm DN ≤ 50 f_{all} = 5 mm DN > 50		L_4	 Welded Tee	σ_{max} = MIN(40 N/mm^2 0,4 f_h) i according to Annex F
L_2		σ_{max} = MIN(40 N/mm^2 0,4 f_h)		L_5		σ_{max} = MIN(40 N/mm^2 0,4 f_h)
L_3	 Forged Tee	σ_{max} = MIN(40 N/mm^2 ; 0,4 f_h) i according to Annex F		L_6	 Welded Tee	σ_{max} = MIN(40 N/mm^2 ; 0,4 f_h) i according to Annex F

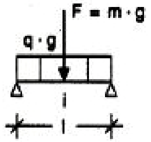
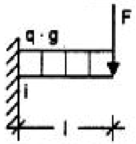
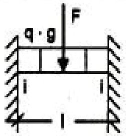
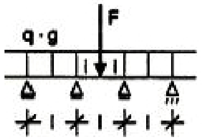
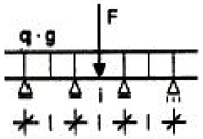
Conditions:

Forged, or welded Tee with horizontal branch

Stress from internal pressure not considered

Tolerances and allowances not considered

Table Q.3

Case	System	Load	Criterion		Remarks	Index of curve in figure 1
			Deflection	Stress		
A		q [kg/m] m [kg]	$f_A = \frac{l_{AF}^3 \cdot 9{,}81 \cdot 5 \cdot 10^6}{384 EI}(q \cdot l_{AF} + 1{,}6\,m)$	$l_{AS} = -\frac{m}{q} + \sqrt{\left(\frac{m}{q}\right)^2 + \frac{8 \cdot W \cdot \sigma_{max}}{9{,}81 \cdot 10^3 \cdot q \cdot i}}$		1
B		q [kg/m] m [kg]	$f_B = \frac{l_{BF}^3 \cdot 9{,}81 \cdot 10^6}{24 EI} \cdot (3q \cdot l_{BF} + 8\,m)$	$l_{BS} = -\frac{m}{q} + \sqrt{\left(\frac{m}{q}\right)^2 + \frac{2 \cdot W \cdot \sigma_{max}}{9{,}81 \cdot 10^3 \cdot q \cdot i}}$		1
C		q + Single load in all fields	$f_C = \frac{l_{CF}^3 \cdot 9{,}81 \cdot 10^6}{384 EI} \cdot (q \cdot l_{CF} + 2\,m)$	$l_{CS} = -\frac{3m}{4q} + \sqrt{\left(\frac{3m}{4q}\right)^2 + \frac{12 \cdot W \cdot \sigma_{max}}{9{,}81 \cdot 10^3 \cdot q \cdot i}}$	Cont. support with equal field length (individual mass in each field)	4
D		q + Single load in particular field only	$f_D = \frac{l_{DF}^3 \cdot 9{,}81 \cdot 10^6}{384 EI} \cdot (q \cdot l_{DF} + 6{,}1\ m)$	$l_{DS} = -\frac{126m}{265q} + \sqrt{\left(\frac{126m}{265q}\right)^2 + \frac{12 \cdot W \cdot \sigma_{max}}{9{,}81 \cdot 10^3 \cdot q \cdot i}}$	$\frac{m}{q} <= 0{,}38\ l^*$ $l^* = \sqrt{\frac{12 \cdot W \cdot \sigma}{9{,}81 \cdot 10^3 \cdot q \cdot i}}$	3
E		q + Single load in particular field only	$f_E = \frac{l_{EF}^3 \cdot 9{,}81 \cdot 10^6}{384 EI} \cdot (q \cdot l_{EF} + 6{,}1\ m)$	$l_{ES} = -\frac{543m}{265q} + \sqrt{\left(\frac{543m}{265q}\right)^2 + \frac{24 \cdot W \cdot \sigma_{max}}{9{,}81 \cdot 10^3 \cdot q \cdot i}}$	$\frac{m}{q} > 0{,}38\ l^*$ $l^* = \sqrt{\frac{12 \cdot W \cdot \sigma}{9{,}81 \cdot 10^3 \cdot q \cdot i}}$	2

$I = \frac{\pi}{64}\left(d_a^4 - d_i^4\right)\left[mm^4\right]$; $W = I\frac{2}{d_a}\left[mm^3\right]$; $E\left[KN/mm^2\right]$

Q.4 Symbols

d_{Am}	[mm]	mean diameter of branch
d_m	[mm]	mean diameter of pipe
d_a	[mm]	external diameter of pipe
d_i	[mm]	internal diameter of pipe
f	[mm]	deflection
l*	[m] = m/q*	equivalent length
i	[-]	stress concentration factor
l	[m]	support spacing, cantilever length (general)
m	[kg]	additional (single) mass
q	[kg/m]	mass relative to length
s	[mm]	nominal wall thickness
v	[-]	weld efficiency
x	[-] = *l*/L	ratio of length with/without additional mass
y	[-] = *l**/L	ratio of equivalent length/length without additional mass
DN		nominal diameter
E	[kN/mm^2]	modulus of elasticity at calculation temperature
F	[N] = m · g	single load
I	[mm^4]	moment of inertia
f_h	[N/mm^2]	allowable stress at maximum metal temperature according to EN 13480-3:2002, 12.1.3
L	[m]	length without additional mass
W	[mm^3]	section modulus
ρ	[kg/m^3]	density
σ_{max}	[N/mm^2]	maximum allowed bending stress due to weight
g	$\left[\frac{m}{s^2}\right]$	acceleration due to gravity

Q.5 Indices f_L

A, B, C, D, E	reference to cases in Table Q.3
F, S	reference to deflection/stress criterion
*	Parameter deviating from Table Q.1
-	relative to continuous support

Q.6 Explanatory notes to Q.2.2

Q.6.1 Specification of allowable spacing of supports

Q.6.1.1 General

Q.6.1.1.1 Values

The support distances in the Table Q.1 "Allowable spacing of supports of steel pipes" have been determined on the basis of the equations in the Q.3 "Explanatory notes to Table Q.1". The following data have been used for the mass q relative to length:

Medium	ρ_M	= 1 000 kg/m^3
Pipe material	ρ_R	= 7 900 kg/m^3
Thermal insulation	ρ_D	= 120 kg/m^3
Sheet covering	$\rho_S \cdot s_B$	= 10 kg/m^2

Overlaps and fasteners are included. The stiffening effect of the sheet covering has not been taken into account even though under certain circumstances it can be considerable. Additional loads $F = m \cdot g$ are not taken into account in the support distances in Table Q.1.

Q.6.1.1.2 Limitation of deflection, L_1

The support spacing L_1, has been specified in accordance with the "limitation of deflection" criterion. The limit deflection f has therefore been included as follows, from the point of view of avoiding possible "puddle formation":

— where DN ≤ 50 f = 3 mm;

— where DN > 50 f = 5 mm.

The calculation model for L_1 is the single field support, moments-free supported at both ends (case A in the Table Q.3 "Explanatory notes to Table Q.1"). An average value $E \approx$ 200 kN/mm^2 has been assumed for the modulus for elasticity.

$$L_1 = l_{AF}\,(f,\, q,\, m = 0,\, E \cdot I) = L_{AF}\,(f,\, q,\, E \cdot I)$$

Q.6.1.1.3 Limitation of stress, L_2 to L_6

The support distances L_2, to L_6, have been determined in accordance with the "limitation of stress" criterion. By complying the support spacings L_2 to L_6, the stresses σ due to q at L_2 and L_5 in the undisturbed piping (without a tee) and at L_3 and L_6 in piping with a tee (welded or forged) at the point of maximum moment are limited to σ = MIN (40 N/mm^2; 0,4 f_h)

Q.6.1.2 Single field supports (moments free) L_2 to L_4

The support distances in Table Q.1 have been determined using the equation for l_{AS} in Table Q.3. For this, undisturbed piping with a stress concentration factor i = 1 has been assumed for L_2. For L_3, a forged tee with a stress concentration factor $\underline{i} = 0{,}9/(8{,}8 \cdot s/d_m)^{2/3})$ has been assumed in the centre of the field.