The European Union

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EN 1993-1-12 (2007) (English): Eurocode 3: Design of steel structures - Part 1-12: General - High strength steels [Authority: The European Union Per Regulation 305/2011, Directive 98/34/EC, Directive 2004/18/EC]

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English Version

Eurocode 3 - Design of steel structures - Part 1-12: Additional rules for the extension of EN 1993 up to steel grades S 700

Eurocode 3 - Calcul des structures en acier - Partie 1-12 : Règles additionnelles pour l'utilisation de l'EN 1993 jusqu'à la nuance d'acier S 700

Eurocode 3: Bemessung und Konstruktion von Stahlbauten - Teil 1-12: Zusätzliche Regeln zur Erweiterung von EN 1993 auf Stahlsorten bis S 700

This European Standard was approved by CEN on 6 July 2006.

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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 CEN Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Foreword

This European Standard EN 1993-1-12, "Eurocode 3: Design of steel structures: Part 1-12: Additional rules for the extension of EN 1993 up to steel grades S 700", has been prepared by Technical Committee CEN/TC250 « Structural Eurocodes », the Secretariat of which is held by BSI. CEN/TC250 is responsible for all Structural Eurocodes.

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of an identical text or by endorsement, at the latest by August 2007, and conflicting National Standards shall be withdrawn at latest by March 2010.

According to the CEN-CENELEC Internal Regulations, the National Standard Organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, 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.

National annex for EN 1993-1-12

This standard gives alternative procedures, values and recommendations with notes indicating where national choices may have to be made. Therefore the National Standard implementing EN 1993-1-12 should have a National annex containing all Nationally Determined Parameters to be used for the design of steel structures to be constructed in the relevant country.

National choice is allowed in EN 1993-1-12 through:

- **2.1** (3.1(2))
- **2.1** (3.2.2(1))
- **2.1** (5.4.3(1))
- **2.1** (6.2.3(2))
- **2.8** (4.2(2))
- **3** (1)

1 General

1.1 Scope

(1) This EN 1993-1-12 gives rules that can be used in conjunction with parts

- EN1993-1-1
- EN 1993-1-2
- EN 1993-1-3
- EN 1993-1-4
- EN 1993-1-5
- EN 1993-1-6
- EN 1993-1-7
- EN 1993-1-8

- EN 1993-1-9
- EN 1993-1-10
- EN 1993-1-11
- EN 1993-2
- EN 1993-3-1
- EN 1993-3-2
- EN 1993-4-1
- EN 1993-4-2
- EN 1993-4-3
- EN 1993-5
- EN 1993-6

to enable steel structures to be designed with steel of grades greater than S460 up to S700.

(2) Where it is necessary to alter a rule in other parts to enable up to S700 to be used, it is stated what needs to be done, either by noting that a rule is not to be used with steel grades greater than S460, then giving the one that is required, or by giving an additional rule or rules.

1.2 Normative references

(1) 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.

EN 499 *Welding consumables – Covered electrodes for manual metal arc welding of non alloy and fine grain steels – Classification*

EN 10025-6 *Hot rolled products of structural steels - Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition*

EN 10149-1 *Hot-rolled flat products made of high yield strength steels for cold forming – Part 1: General delivery conditions*

EN 10149-2 *Hot-rolled flat products made of high yield strength steels for cold forming – Part 2: Delivery conditions for thermomechanically rolled steels*

EN 12534 *Welding consumables – Wire electrodes, wires, rods and deposits for gas shielded metal arc welding of high strength steels – Classification*

EN 12535 *Welding consumables – Tubular cored electrodes for gas shielded metal arc welding of high strength steels – Classification*

1.3 Symbols

(1) Symbols used in this standard are defined in the standards referred to.

2 Additional rules to EN 1993-1-1 to EN 1993-1-11

2.1 Additional rules to EN 1993-1-1

3.1(2) Additional note:

NOTE The National Annex may specify steel grades greater than S460 up to S700 for general use or for use in specific applications. The grades in Tables 1 and 2 and the nominal values that may be used for their yield strengths and [AC1] ultimate tensile strength [AC1] are recommended for use, provided that the rules in this Part 1.12 are followed.

Table 1 — Nominal values of yield strength f_y and ultimate tensile strength f_u for hot rolled structural steel

EN10025-6 Steel grade and qualities	Nominal thickness of the element t mm					
	$t \leq 50$ mm		50 mm$<t\leq$100 mm		100 mm$<t\leq$150 mm	
	f_y [N/mm^2]	f_u [N/mm^2]	f_y [N/mm^2]	f_u [N/mm^2]	f_y [N/mm^2]	f_u [N/mm^2]
S 500Q/QL/QL1	500	590	480	590	440	540
S 550Q/QL/QL1	550	640	530	640	490	590
S 620Q/QL/QL1	620	700	580	700	560	650
S 690Q/QL/QL1	690	770	650	760	630	710

Table 2 — Nominal values of yield strength f_y and ultimate tensile strength f_u for hot rolled flat products.

EN 10149-2[a]	1,5 mm $\leq t \leq$ 8 mm		8 mm $< t \leq$ 16 mm	
	f_y [N/mm^2]	f_u [N/mm^2]	f_y [N/mm^2]	f_u [N/mm^2]
S 500MC	500	550	500	550
S 550MC	550	600	550	600
S 600MC	600	650	600	650
S 650MC	650	700	630	700
S 700MC	700	750	680	750
a) Verification of the impact energy in accordance with EN 10149-1 Clause 11, Option 5 should be specified.				

3.2.2(1) Additional note:

NOTE The limiting values of the ratio f_u/f_y, the elongation at failure and the ultimate strain ε_u for steels greater than S460 up to S700 may be defined in the National Annex. The following values are recommended:

- $f_u/f_y \geq 1{,}05$;
- elongation at failure not less than 10 %;
- $\varepsilon_u \geq 15 f_y/E$.

3.2.2(2) Additional notes:

NOTE 1 Steels with grades greater than S460 up to S700 conforming to one of the steel grades listed in Tables 1 and 2 should be accepted as satisfying these requirements.

NOTE 2 The ability of a steel structure to absorb deformation is related to both the elongation and the toughness properties of its constituent steel products. The global performance required depends on the anticipated deformations. The local performance required depends on the details used. Due to higher stress levels, structures of steels according to Tables 1 and 2 require special care in both the control of deformations

and in detailing to avoid notches and other stress concentrations. The global analysis should consider imposed deformations where relevant.

5.4.1 (3) Additional rule:

Not applicable to steels with grades greater than S460 up to S700.

5.4.1 (4)B Additional rule:

Not applicable to steels with grades greater than S460 up to S700.

5.4.3(1) Additional rule:

For steels of grades greater than S460 up to S700, the global analysis using non-linear plastic analysis considering partial plastification of members in plastic zones only, applies.

NOTE: The National Annex may specify additional rules for steels according to Tables 1 and 2. Rules for design with FEM are given in Informative Annex C of EN 1993-1-5.

6.2.3(2) Additional rule:

For steels with grades greater than S460 up to S700 the design resistance of a net section should be taken as

$$N_{t,Rd} = \frac{0{,}9 A_{net} f_u}{\gamma_{M12}} \qquad (6.7a)$$

where γ_{M12} is the partial factor for net section resistance for steels with grades greater than S460 up to S700.

NOTE: The National Annex may specify the value of γ_{M12}. The value $\gamma_{M12} = \gamma_{M2} = 1{,}25$ is recommended.

6.2.3(3) Additional rules:

Steels with grades greater than S460 up to S700 should not be used for applications where capacity design is required.

Table 6.2 Additional rule:

The rules for S 460 also apply for steels with grades greater than S460 up to S700.

2.2 Additional rules to EN 1993-1-2

The standard is applicable to steels with grades greater than S460 up to S700 without further additional rules.

2.3 Additional rules to EN 1993-1-3

The standard is applicable to steels with grades greater than S460 up to S700 without further additional rules.

2.4 Additional rules to EN 1993-1-4

EN 1993-1-4 is not applicable.

2.5 Additional rules to EN 1993-1-5

The standard is applicable to steels with grades greater than S460 up to S700 without further additional rules.

2.6 Additional rules to EN 1993-1-6

Annex B is not applicable to steels with grades greater than S460 up to S700.

2.7 Additional rules to EN 1993-1-7

The standard is applicable to steels with grades greater than S460 up to S700 without further additional rules.

2.8 Additional rules to EN 1993-1-8

1.1(1) Additional rules:

EN 1993-1-8 may be applied also to steels with grades greater than S460 up to S700 if the following additional rules are applied.

3.6.1(1) For steels with grades greater than S460 up to S700 and bolts loaded in shear in oversize and slotted holes should only be used for category C connections.

3.10.3(2) Not applicable to steels with grades greater than S460 up to S700.

3.10.4 Not applicable to steels with grades greater than S460 up to S700.

3.12(2) This clause also applies to connections in steels with grades greater than S460 up to S700.

4.2(2) Additional rule:

For steels with grades greater than S460 up to S700 the filler metal may have lower strength than the base material.

NOTE The National Annex may give restrictions for the use of such undermatched electrodes.

4.5.3.2(6) Additional rule:

For under matched electrodes that are used for steels with grades greater than S460 up to S700 〚AC1〛 f_u should be substituted with the ultimate strength of the filler metal f_{eu} according to Table 3 for electrodes according to EN 499, EN 12534 and EN 12535. β_w 〚AC1〛 should be taken as 1,0.

Table 3 — Ultimate strength f_{eu} of electrodes

Strength class	35	42	55	62	69
Ultimate strength $f$eu N/mm^2	440	500	640	700	770

4.7.1(1) Additional rule:

The resistance of welded connections with undermatched electrodes with steel grades greater than S460 up to S700 should be based on the strength of the filler metal.

4.11 Additional rule:

For steel grades greater than S460 up to S700 longitudinal fillet welds in lap joints with steel grades greater than S460 up to S700 should not be longer than $50a$ unless the non-uniform stress distribution is taken into account in the design.

5.1.3 Not applicable to steels with grades greater than S460 up to S700.

5.1.4 Not applicable to steels with grades greater than S460 up to S700.

5.2.2.4 Not applicable to steels with grades greater than S460 up to S700.

6 Additional rules:

The rules for semi-rigid joints are not applicable for steels with grades greater than S460 up to S700. If non-linear plastic global analysis considering the partial plastification of members in plastic zones is used, connections between members [AC1⟩ should only be on the basis of full-strength joints. If elastic global analysis is used, connection with partial-strength joints may be used, provided that the resistance of joints exceeds the design values of the internal forces and moments ⟨AC1] in the connected elements. In both cases the resistance of joints should be determined based on elastic distribution of forces over the components of a joint.

6.2.6.9 to 6.2.6.12 Additional rules:

The rules for column bases may only be used for steel grades greater than S460 up to S700, provided that the bolt failure mode is decisive for verification of base plates in bending on the tension side of connections and an elastic distribution of forces in anchor bolts is used.

7.1.1(4) Additional rule:

For steels with grades greater than S460 up to S700 the reduction factor is 0,8.

2.9 Additional rules to EN 1993-1-9

8(1) Additional rule:

[AC1⟩ For hybrid girders made of steel with flange grades greater than S460 up to S700 the limitation $\Delta\sigma \leq 1{,}5 f_{yf}$ should be applied, where f_{yf} is the yield strength of the flange. ⟨AC1]

2.10 Additional rules to EN 1993-1-10

2.3.2(1) Additional rule:

Table 4 may also be used to determine the maximum permissible element thickness for steel grades greater than S460 up to S700.

NOTE 1 Linear interpolation can be used in applying Table 4. Most applications require σ_{Ed} values between $\sigma_{Ed} = 0{,}75 f_y(t)$ and $\sigma_{Ed} = 0{,}50 f_y(t)$. $\sigma_{Ed} = 0{,}25 f_y(t)$ is given for interpolation purposes. Extrapolations beyond the extreme values are not valid.

NOTE 2 For ordering products made of steels according to Table 4 the T_J – values should be specified.

NOTE 3 [AC1⟩ Table 4 ⟨AC1] has been derived for the guaranteed Charpy energy values CVN in the direction of the rolling of the product.

Table 4 — Maximum permissible values of element thickness t in mm

Steel grade	Subgrade	Charpy energy CVN		Reference temperature T_{Ed} [°C]																						
				10	0	-10	-20	-30	-40	-50	10	0	-10	-20	-30	-40	-50	10	0	-10	-20	-30	-40	-50
		at T [°C]	J_{min}	$\sigma_{Ed} = 0{,}75\, f_y(t)$							$\sigma_{Ed} = 0{,}50\, f_y(t)$							$\sigma_{Ed} = 0{,}25\, f_y(t)$						
EN 10025-6																										
S500	Q	0	40	55	45	35	30	20	15	15	85	70	60	50	40	35	25	145	125	105	90	80	65	55
	Q	-20	30	65	55	45	35	30	20	15	105	85	70	60	50	40	35	170	145	125	105	90	80	65
	QL	-20	40	80	65	55	45	35	30	20	125	105	85	70	60	50	40	195	170	145	125	105	90	80
	QL	-40	30	100	80	65	55	45	35	30	145	125	105	85	70	60	50	200	195	170	145	125	105	90
	QL1	-40	40	120	100	80	65	55	45	35	170	145	125	105	85	70	60	200	200	195	170	145	125	105
	QL1	-60	30	140	120	100	80	65	55	45	200	170	145	125	105	85	70	205	200	200	195	170	145	125
S550	Q	0	40	50	40	30	25	20	15	10	80	65	55	45	35	30	25	140	120	100	85	75	60	50
	Q	-20	30	60	50	40	30	25	20	15	95	80	65	55	45	35	30	160	140	120	100	85	75	60
	QL	-20	40	75	60	50	40	30	25	20	115	95	80	65	55	45	35	185	160	140	120	100	85	75
	QL	-40	30	90	75	60	50	40	30	25	135	115	95	80	65	55	45	200	185	160	140	120	100	85
	QL1	-40	40	110	90	75	60	50	40	30	160	135	115	95	80	65	55	200	200	185	160	140	120	100
	QL1	-60	30	130	110	90	75	60	50	40	185	160	135	115	95	80	65	200	200	200	185	160	140	120
S620	Q	0	40	45	35	25	20	15	15	10	70	60	50	40	30	25	20	130	110	95	80	65	55	45
	Q	-20	30	55	45	35	25	20	15	15	85	70	60	50	40	30	25	150	130	110	95	80	65	55
	QL	-20	40	65	55	45	35	25	20	15	105	85	70	60	50	40	30	175	150	130	110	95	80	65
	QL	-40	30	80	65	55	45	35	25	20	125	105	85	70	60	50	40	200	175	150	130	110	95	80
	QL1	-40	40	100	80	65	55	45	35	25	145	125	105	85	70	60	50	200	200	175	150	130	110	95
	QL1	-60	30	120	100	80	65	55	45	35	170	145	125	105	85	70	60	200	200	200	175	150	130	110
S690	Q	0	40	40	30	25	20	15	10	10	65	55	45	35	30	20	20	120	100	85	75	60	50	45
	Q	-20	30	50	40	30	25	20	15	10	80	65	55	45	35	30	20	140	120	100	85	75	60	50
	QL	-20	40	60	50	40	30	25	20	15	95	80	65	55	45	35	30	165	140	120	100	85	75	60
	QL	-40	30	75	60	50	40	30	25	20	115	95	80	65	55	45	35	190	165	140	120	100	85	75
	QL1	-40	40	90	75	60	50	40	30	25	135	115	95	80	65	55	45	200	190	165	140	120	100	85
	QL1	-60	30	110	90	75	60	50	40	30	160	135	115	95	80	65	55	200	200	190	165	140	120	100
EN 10149-2																										
S500	MC	-20	40	80	65	55	45	35	30	20	125	105	85	70	60	50	40	195	170	145	125	105	90	80
S550	MC	-20	40	75	60	50	40	30	25	20	115	95	80	65	55	45	35	185	160	140	120	100	85	75
S600	MC	-20	40	70	55	45	35	30	20	15	105	90	75	60	50	40	35	180	155	130	110	95	80	70
S650	MC	-20	40	65	50	40	30	25	20	15	100	85	70	55	45	35	30	170	145	125	105	90	75	65
S700	MC	-20	40	60	45	35	30	25	20	15	95	80	65	50	45	35	30	165	140	120	100	85	70	60

2.11 Additional rules to EN 1993-1-11

The standard is applicable to steels with grades greater than S460 up to S700 without further additional rules.

3 Additional rules to application parts EN 1993-2 to EN 1993-6

(1) The design rules in the application parts EN 1993-2 to EN 1993-6 can also be applied to steels with grades greater than S460 up to S700.

NOTE The National Annex to this Part may limit the range of applicable grades of steel for EN 1993-2 to EN1993-6.