endurance® extreme

HIGH-STRENGTH AND ULTRA-HIGH-STRENGTH HOLLOW SECTIONS FOR EXTREME REQUIREMENTS

To meet the highest demands, strong performance is required. endurance extreme hollow sections made of high-strength and ultra high-strength steels have a high level of strength, which enables a drastic reduction in wall thickness and therefore a significant weight saving. The robust tube solutions can withstand the toughest everyday conditions and static loads.

STEEL GRADES

The steel grades shown in the table form the basis for the endurance extreme brand. In addition, endurance extreme is also available in steel grades in accordance with EN10305, EN10338, EN10346 or VDA239-100 with a minimum yield strength of 500MPa.

Steel grade	Minimum yield point ReH [MPa]	Tensile strength Rm [MPa]	Elongation at break A [%] (from 3mm) [a]	Notched bar impact energy [J] at test temperature -20°C
S500MH	500	580 bis 760	11	40
S550MH	550	600 bis 760	10	27
S600MH	600	650 bis 820	9	27
S650MH	650	700 bis 880	8	27
S700MH	700	750 bis 950	7	27
S900MH	900	930 bis 1200	5	27
S960MH	960	980 bis 1250	4	27

[a] For thicknesses ≥ 3 mm and (W+H)/2T ≤ 10 (square and rectangular), the minimum elongation value must be reduced by 4 and the maximum tensile strength increased by 50 MPa. For profile ratios (W+H)/2T > 10 to < 15 (square and rectangular), the minimum elongation value must be reduced by 2 and the maximum tensile strength increased by 50 MPa.

QUALITY

An increased quality standard is ensured by our internal voestalpine Krems factory standard. For example, the height, width or weld seam centerline of endurance are thus improved. In addition, our endurance hollow profiles are manufactured according to customer requirements in accordance with component drawings. endurance extreme also fulfills the EN 10219-3 standard requirement if required.

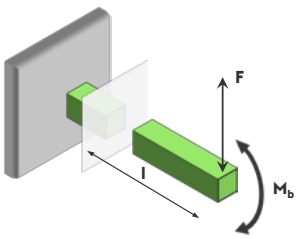
LIGHTWEIGHT CONSTRUCTION

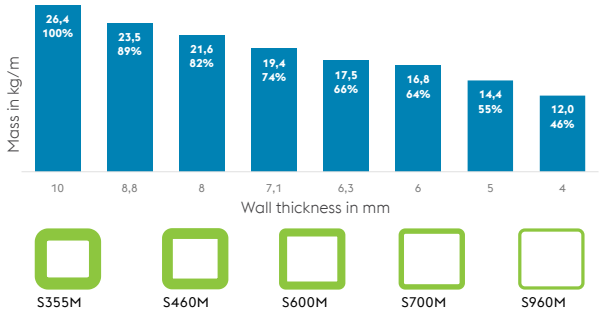
By using high-strength and ultra-high-strength steel grades, weight savings can be achieved while maintaining the load-bearing capacity. The mass can be reduced by up to 54%.

By using lower wall thicknesses with higher strength, the following formula can be applied:

$$T_{HSS} = T \times \sqrt{\frac{R_{eH}}{R_{eH-HSS}}}$$

Legend:
T Wall thickness of low-strength steel
T_{HSS} Wall thickness High Strength Steel
R_{eH} Yield strength low strength steel
$R_{eH\text{-}HSS}$ Yield strength High Strength Steel





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ONE STEP AHEAD.

WELDABILITY AND WELDING RECOMMENDATIONS

To ensure that hollow profile constructions are not prone to significant faults during manufacturing and use, it is necessary to plan appropriately from the design stage through the choice of material to the welding process. The subsequent recommendations help to avoid potential quality issues and flaws.

Filler material and shielding gas

Material (EN10219)	Process	Filler material solid wire (135)	Filler material cored wire (136)	Shielding gas	Preheating [°C]
S500MH S550MH	MAG	z.B. BÖHLER Nimoy 1-IG, UNION MoNi, ... ER90S-G (acc. AWS A5.28)	z.B. BÖHLER HL 53T-MC, BÖHLER Ti 60T-FD, ... E80T15, E81T1 (acc. AWS A5.36)	M21 (e.g. Corgon 18)	___ [1), 2)]
S600MH S650MH	MAG	z.B. BÖHLER NICO 2,5-IG, ER110S-G (acc. AWS A5.28)	z.B. BÖHLER HL 75T-MC, BÖHLER Ti 80T-FD, ... E101T15, E111T1 (acc. AWS A5.36)	M21 (e.g. Corgon 18)	___ [1), 2)]
S700MH	MAG	BÖHLER alform 700-IG, G 79 5 M21 Mn4Ni1, 5CrMo (acc. EN ISO 16834-A)	BÖHLER alform 700 L-MC T 69 6 Mn2NiCrMo M M21 1 H5 (acc. EN ISO 18276-A)	M21 (e.g. Corgon 18, ...) M20 (e.g. Corgon 10, ...)	___ [1), 2)]
S900MH	MAG	BÖHLER alform 900-IG, G 89 6 M21 Mn4Ni2CrMo (acc. EN ISO 16834-A)	BÖHLER alform 900 L-MC T 89 5 ZMn2NiCrMo M M21 1 H5 (acc. EN ISO 18276-A)	M21 (e.g. Corgon 18, ...) M20 (e.g. Corgon 10, ...)	___ [1), 2)]
S960MH	MAG	BÖHLER alform 960-IG, G 89 5 M21 Mn4Ni2,5CrMo (acc. EN ISO 16834-A)	BÖHLER alform 960 L-MC T 89 4 ZMn2NiCrMo M M21 1 H5 (acc. EN ISO 18276-A)	M21 (e.g. Corgon 18, ...) M20 (e.g. Corgon 10, ...)	___ [1), 2)]

[1)] Depending on the climatic conditions (falling below the dew point or condensing humidity), drying of the welding edges at at least 80 °C immediately before welding is recommended.

[2)] For each individual case, an assessment according to EN 1011-2, C.3 - Method B or SEW 088 (CET method) and / or AWS/ANSI D 1.1 recommended.

voestalpine Welding Calculator

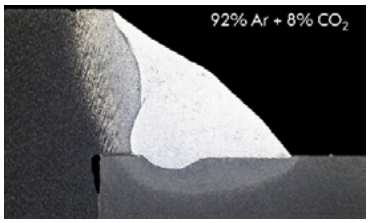
The Welding Calculator app facilitates the calculation and planning of welding tasks, such as cooling times, preheating temperatures and filler material quantities. Developed by voestalpine Steel Division and voestalpine Böhler Welding, it is available for PC, Android and iOS.

Desktop App | Download on the App Store | Google play

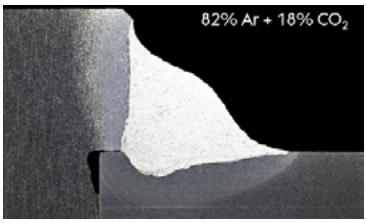
Shielding gas

Shielding gas ISO 14175 M21

Higher active gas content = greater depth and width of penetration, see comparison;



M20

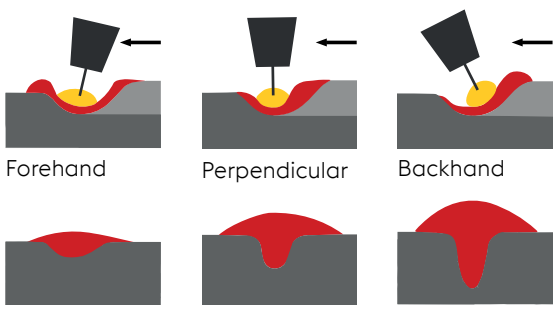


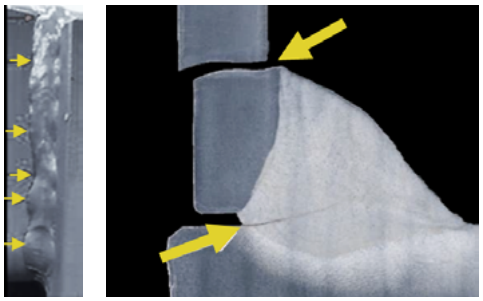
M21

Torch position

Correct torch position for deep penetration and welded root:

- Forehand: flat bead, low penetration
- Perpendicular: normal bead, normal penetration
- Backhand: high bead, deep penetration





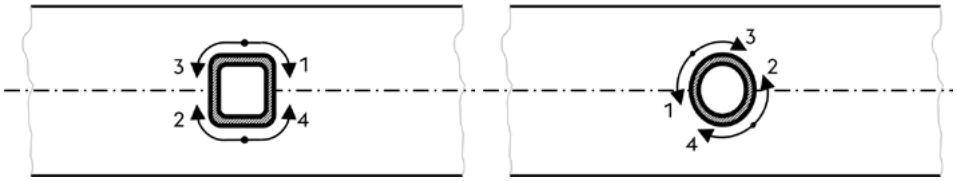
Steady and deep penetration is especially important in the base points of bead transition and the root.

Design of the welded joint

Avoiding start and stop positions in radii

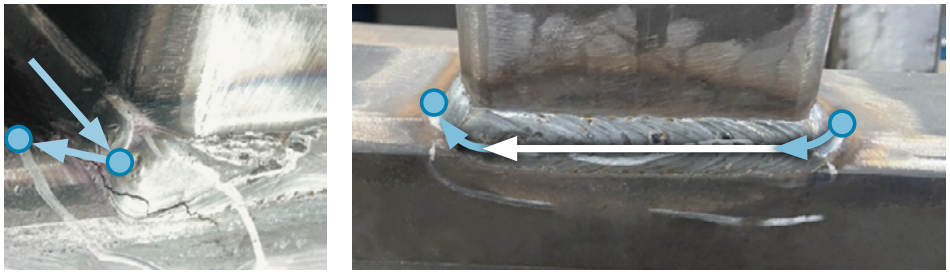
Recommendation from EN 1090-2:2018 Annex E - Welded joints in hollow section

- Stop and start positions of welds for in-line splice joints in chords should be chosen to avoid these positions coming directly under the location of a subsequent weld between a brace and the chord.
- Stop and start positions should not be located at or close to the corner position of a joint between two circular, square or rectangular hollow sections.
- Welding between hollow sections should be completed all round, even if this total length of weld is not necessary for strength reasons.



Overlap welding where possible

If, for design reasons, the start and stop positions must be within the radius, the start and end positions must be extended beyond the radius to ensure an overlap, which considerably reduces the notch effect.



Weld preparation

Observe the general recommendations for weld seam preparation e.g.:

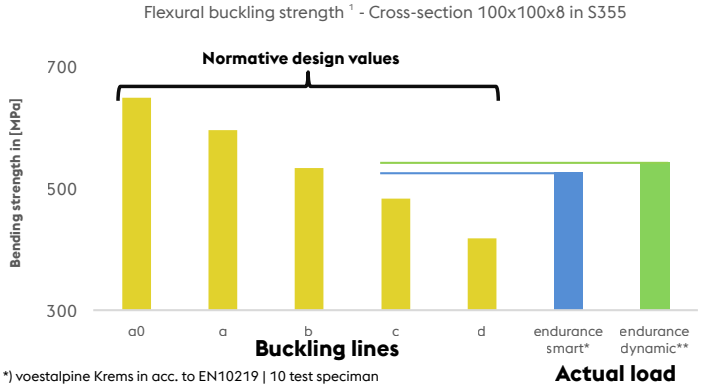
- descale surfaces to be joined
- surfaces dry, free from grease

Buckling stiffness

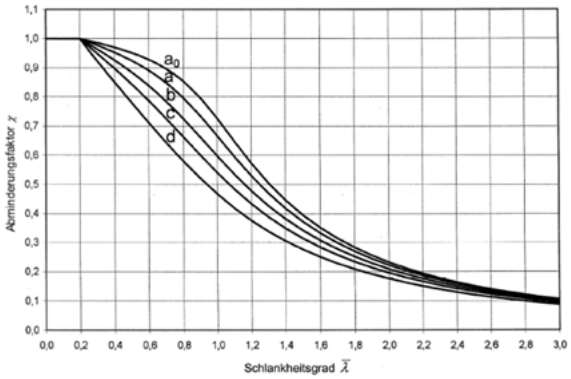
According to valid standards (Eurocode 3: DIN EN 1993-1-1:2010-12), a design value of the flexural buckling resistance must be verified for compression members subjected to centric loading.

A calculation example for a square hollow section with a side length of 120 mm and a wall thickness of 8 mm results in the following normative design values at a nominal yield strength of 355 MPa. This was compared with tubes from voestalpine Krems endurance smart and endurance dynamic, which were tested on the buckling stability test rig at the University of Munich.

endurance hollow sections clearly exceed the reference for square and rectangular tubes - buckling line C for EN10219:



*) voestalpine Krems in acc. to EN10219 | 10 test speciman
**) voestalpine Krems | 8 test specimen
The reference for square and rectangular tubes acc. to EN10219 is buckling line c
1) The loads shown must not be used as a basis for dimensioning

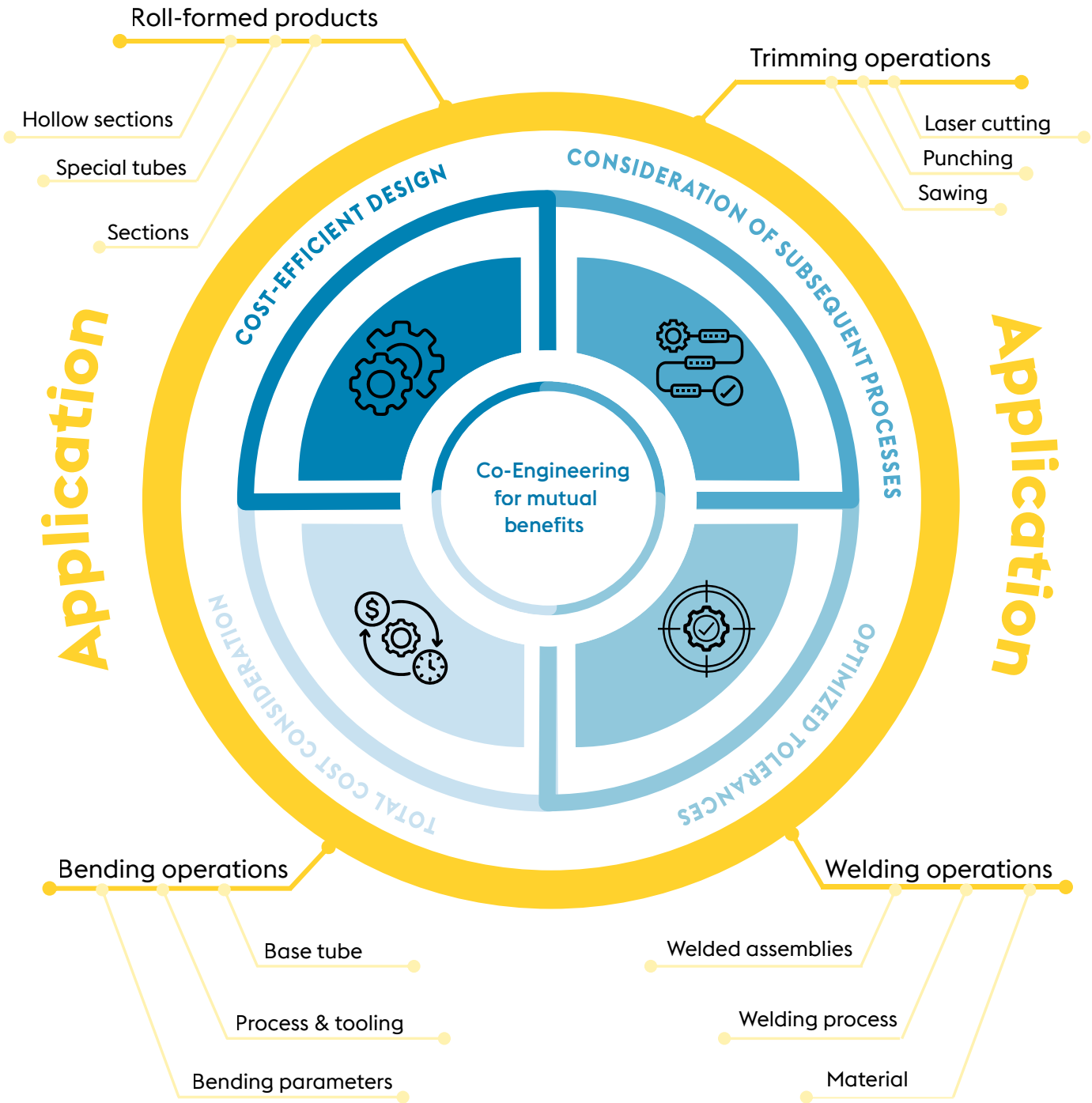


Source: Eurocode 3: DIN EN 1993-1-1:2010-12

a_0 Buckling line for hot-finished hollow sections from S460
a Buckling line for hot-finished hollow sections up to S420
c Buckling line for cold-finished hollow sections (independent of strength)

Co-Engineering and application

According to the motto „From development to application“ , we try to support our customers with technical know-how at an early stage.



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