



## phs-scalefree®

### The first hot forming steel up to 2000 MPa with a thin zinc coating

The high-quality grade phs-scalefree 2000 is an outstanding development in the field of lightweight automotive design and opens up new perspectives for the economical production of ultra-high-strength components.

The single-phase zinc ferrite coating ensures unique scale protection with excellent hot forming properties and provides corrosion protection. All phs scalefree® grades can be processed in both direct and indirect hot forming processes.

Manganese-boron steels with thin zinc layers enable complex component geometries and are recommended for large components.

#### Typical applications

- » Large components, e.g. door rings
- » B pillars
- » Internal structural components

#### Convincing advantages

- » Excellent workability up to 2000 MPa with a thin zinc coating
- » Increased tool life and longer cleaning intervals based on clean processes
- » No hydrogen uptake in the press hardening process
- » Complex component geometries
- » Large components
- » Very good welding and adhesive bonding properties
- » Both direct and indirect hot forming processes possible



Premium quality  
with reduced carbon footprint

**phs-scalefree®**  
greentec steel

In the direct process, the blanks are heated to roughly 900 °C. They are then formed to their final geometry and hardened prior to final cutting.

In the indirect process, the blanks are first formed to their final geometry by shape cutting and conventional cold forming processes. The material is subsequently form-hardened in hot condition. This adjusts the mechanical properties and finalizes the component geometries.

The entire process chain can be simulated down to the detailed component properties.

Depending on customer requirements, surface conditioning and/or transport corrosion protection is applied by the component manufacturer.

### Chemical composition in mass %

Steel grade <sup>1)</sup>	C	Si max.	Mn	P max.	S max.	Al	Cr max.	Ti + Nb max.	B	Cu max.	N max.	Ni max.
phs-scalefree 490	≤ 0.13	0.5	≤ 1.5	0.03	0.025	≥ 0.015	-	0.15	-	0.2	-	-
phs-scalefree 1500	0.20 – 0.25	0.5	1.1 – 1.5	0.02	0.005	0.02 – 0.08	0.35	*)	0.002 – 0.005	0.2	0.01	0.1
phs-scalefree 2000 <sup>2)</sup>	0.30 – 0.38	0.5	≤ 2.0	0.02	0.005	0.02 – 0.08	0.5	0.20	0.002 – 0.005	0.2	0.01	0.5

\*) Ti 0.02 – 0.05 / Nb -

### Mechanical properties in as-delivered condition

Testing transverse to rolling direction

Steel grade <sup>1)</sup>	0.2 % yield strength R <sub>p0.2</sub> [MPa]	Tensile strength R <sub>m</sub> [MPa]	Total elongation A <sub>80</sub> [%] min.
phs-scalefree 490	280 – 500	380 – 540	21
phs-scalefree 1500	350 – 480	470 – 700	18
phs-scalefree 2000 <sup>2)</sup>	400 – 650	550 – 800	15

### Mechanical properties after hot forming and hardening (Typical values)

Testing transverse to rolling direction

Steel grade	0.2 % yield strength <sup>3)</sup> R <sub>p0.2</sub> [MPa]	Tensile strength <sup>3)</sup> R <sub>m</sub> [MPa]	Total elongation <sup>3)</sup> A <sub>50</sub> [%]	Bending angle <sup>3) 4)</sup> α <sub>1 mm</sub> [°]
phs-scalefree 490	400	490	16	130
phs-scalefree 1500	1050	1500	6	70
phs-scalefree 2000 <sup>2)</sup>	1200	1900	5	45

### Mechanical properties after hot forming, hardening and cathodic dip coating (Typical values)

Testing transverse to rolling direction

Steel grade	0.2 % yield strength <sup>3)</sup> R <sub>p0.2</sub> [MPa]	Tensile strength <sup>3)</sup> R <sub>m</sub> [MPa]	Total elongation <sup>3)</sup> A <sub>50</sub> [%]	Bending angle <sup>3) 4)</sup> α <sub>1 mm</sub> [°]
phs-scalefree 490	400	490	16	130
phs-scalefree 1500	1150	1500	6	70
phs-scalefree 2000 <sup>2)</sup>	1400	1850	5	50

<sup>1)</sup> The voestalpine steel grades meet the specifications of VDA 239-500.

<sup>2)</sup> Indication of preliminary values

<sup>3)</sup> Mechanical parameters in hardened condition are standard values achieved in professional processing of flat sheets.

The indicated values are not guaranteed by voestalpine Stahl GmbH.

» Austenitization conditions: Furnace chamber temperature of 910 °C, 45 s annealing time after achieving a blank temperature of 870 °C

» Transfer time approx. 10 seconds (transfer time = time between furnace opening and complete pressure buildup in the press)

» Cooling conditions: Cooling rate > 40 K/s up to roughly 200 °C, during cooling between water-cooled plates

» Temperature at which blanks are removed < 200 °C

» Conditions of heat treatment during bake-hardening simulation: 170 °C/20 min, oil

<sup>4)</sup> Instrument measurement of bending angle during bending test according to VDA 238-100, α<sub>1 mm</sub> = α x thickness <sup>0.35</sup>

Coating in as-delivered condition

Coating class <sup>1)</sup> pursuant to VDA 239-100 and VDA 239-500	Layer thickness per side [g/m <sup>2</sup> ]	Indication of coating thickness [µm]	Fe content in coating [mass %] max.	Al content in coating [mass %] max.
GI35/35	35 - 55	4.9 - 7.7	≤ 1	1.0
GA35/35			8 - 15	

<sup>1)</sup> Other layer thicknesses upon request

Coating after hot forming (Typical values)

Coating class	Layer thickness [µm]	Fe content in coating [mass %]
GI35/35	10	> 65
GA35/35		

Available dimensions

Steel grade	Thickness range [mm]	Width range [mm]
phs-scalefree 490	0.5 - 2.0	900 - 1700
phs-scalefree 1500	1.0 - 2.0	900 - 1490
phs-scalefree 2000 <sup>2)</sup>	1.0 - 2.0	900 - 1380

<sup>2)</sup> Indication of provisional values

The available combinations of widths and thicknesses vary depending on the steel grade. Additional dimensions upon request.



Premium quality with reduced carbon footprint



Hot-dip galvanized steel strip – greentec steel Edition

Max. carbon footprint 2.13 kg CO<sub>2</sub>e per kg of steel <sup>1)</sup>

<sup>1)</sup> per EN 15804+A2 (EPD methodology) cradle to gate

All products, dimensions and steel grades listed in each voestalpine supply range are available as greentec steel Edition.

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voestalpine Stahl GmbH  
voestalpine-Straße 3  
4020 Linz, Austria  
productmanagement@voestalpine.com  
www.voestalpine.com/steel

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