



## phs-directform®

### Galvanized hot forming steels for the production of press-hardened components using the direct process

phs-directform®, the innovation developed by voestalpine, is directly hot-formed, hot-dip galvanized steel strip to be used in corrosion-resistant light-weight components for the Automotive industry. phs-directform® is a conversion-delayed boron steel with a galvanized coating.

Hot forming can be performed in existing hot-forming lines with a minimum of adaptation.

phs-directform® is the simple and economical solution for press-hardened components that are subject to heavy corrosion. With its excellent properties in joining, paintability and crash performance, phs-directform is recommended for roof frames, cross members, stiffeners, rocker panels, bumpers and B pillars.

#### **Convincing advantages:**

- » Economical manufacturing, even when processing small lots
- » Excellent processability
- » Exceptional cathodic corrosion protection
- » Brilliant paintability
- » Component production in a direct phs processing system (with pre-cooling) possible



Premium quality  
with reduced carbon footprint

**phs-directform®**  
greentec steel

The blanks are heated to roughly 900 °C. The subsequent pre-cooling prevents microcracking during subsequent forming. The blanks are then formed into their final geometry and hardened prior to final cutting. 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 min.    | Cr max. | Ti + Nb max. | B             | Cu max. | N max. | Ni max. |
|----------------------------------|-------------|---------|-----------|--------|--------|------------|---------|--------------|---------------|---------|--------|---------|
| phs-directform 490 <sup>2)</sup> | 0.13        | 0.5     | ≤ 1.50    | 0.03   | 0.025  | 0.015      | -       | 0.15         | -             | 0.2     | -      | -       |
| phs-directform 1500              | 0.17 - 0.23 | 0.5     | 1.7 - 2.5 | 0.02   | 0.005  | 0.02 - 0.3 | 0.05    | *)           | 0.002 - 0.005 | 0.2     | 0.01   | 0.1     |

\*) Ti 0.02 - 0.05 / Nb -

### Mechanical properties in as-delivered condition: Tensile test

Testing transverse to rolling direction

| Steel grade <sup>1)</sup>        | 0.2 % yield strength<br>R <sub>p0.2</sub><br>[MPa] | Tensile strength<br>R <sub>m</sub><br>[MPa] | Fracture elongation<br>A <sub>80</sub><br>[%] min. |
|----------------------------------|--|---|--|
| phs-directform 490 <sup>2)</sup> | 280 - 500  | 380 - 540                                   | 17   |
| phs-directform 1500              | 350 - 600  | 600 - 850                                   | 12   |

### Typical mechanical properties after hot forming: Tensile test and bending test

Testing transverse to rolling direction

| Steel grade                      | Typ. 0.2 % yield strength <sup>3)</sup><br>R <sub>p0.2</sub><br>[MPa] | Typ. tensile strength <sup>3)</sup><br>R <sub>m</sub><br>[MPa] | Typ. total elongation <sup>3)</sup><br>A <sub>50</sub><br>[%] | Typ. bending angle <sup>3) 4)</sup><br>α <sub>1mm</sub><br>[°] |
|----------------------------------|---|--|---|--|
| phs-directform 490 <sup>2)</sup> | 380   | 490  | 18  | 130  |
| phs-directform 1500              | 1050  | 1500   | 6   | 70   |

### Typical mechanical properties after hot forming and cathodic dip coating: Tensile test and bending test

Testing transverse to rolling direction

| Steel grade                      | Typ. 0.2 % yield strength <sup>3)</sup><br>R <sub>p0.2</sub><br>[MPa] | Typ. tensile strength <sup>3)</sup><br>R <sub>m</sub><br>[MPa] | Typ. total elongation <sup>3)</sup><br>A <sub>50</sub><br>[%] | Typ. bending angle <sup>3) 4)</sup><br>α <sub>1mm</sub><br>[°] |
|----------------------------------|---|--|---|--|
| phs-directform 490 <sup>2)</sup> | 380   | 490  | 18  | 130  |
| phs-directform 1500              | 1150  | 1500   | 6   | 70   |

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

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

<sup>3)</sup> Mechanical parameters in hardened condition are standard values achieved in the 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

» Cooling conditions: Pre-cooling rate of > 20 K/s to roughly 500 °C, cooling > 40 K/s to roughly 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 pursuant to VDA 238-100, α<sub>1mm</sub> = α x thickness<sup>0.35</sup>

### Coating in as-delivered condition

| Coating class pursuant to VDA 239-100/EN 10346 | Indication of coating thickness [µm] | Fe content in coating [mass %] | Al content in coating [mass %] max. |
|--|--------------------------------------|--------------------------------|-------------------------------------|
| GA80/80 / ZF 180                               | 11 - 16                              | 8 - 14                         | 0,8                                 |

### Typical values after hot forming

| Coating class pursuant to VDA 239-100/EN 10346 | Layer thickness [µm] | Fe content in coating [Mass %] |
|--|----------------------|--------------------------------|
| GA80/80 / ZF 180                               | 20                   | 55 - 60                        |

### Available dimensions

Maximum width [mm] per thickness, minimum width of 900 mm for wide strip

| Steel grade                      | Thickness [mm] |      |      |      |
|----------------------------------|----------------|------|------|------|
|                                  | 0.8            | 1.0  | 2.0  | 2.2  |
| phs-directform 490 <sup>1)</sup> | 1510           | 1630 | 1630 | 1480 |
| phs-directform 1500              | -              | 1510 | 1510 | -    |

<sup>1)</sup>Indication of preliminary values

Standard end trimming reduces the maximum width by 20 mm.  
Additional dimensions upon request.



Premium quality with reduced carbon footprint



Hot-dip galvanized steel strip – greentec steel Edition

Max. carbon footprint 2.30 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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