Società delle Fucine (SdF) was founded in 1884 and since 1999 it has been a member of ThyssenKrupp Group. The company is located in Terni, Italy and produces large forgings for rolling mills, energy and heavy industry applications.

The production of forged rolls is mainly focused on the back-up rolls for steel industry (Plate Mill, Hot Strip Mill and Cold Mill) and the aluminium industry.
FORGED BACK UP ROLLS

Steel Quality

The selection of carbon and alloy elements aims to achieve the best compromise among different properties such as hardenability, hardness, toughness and fatigue, and thermal cracking resistance. Selected steels and modern roll refining processes allow the results to be obtained thanks to a minimum sulphur and phosphorus content and low hydrogen. Ingots are top poured under vacuum.

Hardening process

In order to obtain a good combination of toughness, hardness and high hardness on the working layer, the back up rolls are inserted one on the other, with a special differential hardening equipment. The heat treatment is then performed by austenitizing the working layer in a high–power heating furnace and then by cooling with blown air and water spray. The uniformity of the treatment is guaranteed by keeping the roll in rotation during the process.

Hardness penetration for back up rolls

The hardness penetration is measured by a Vickers hardness penumeter. The results show the hardness of the working layer as a consequence both at the surface and in the cross-section.

Wear test comparison between BUR with 3% Cr and 5% Cr

The results show a significant improvement in the fatigue resistance of the back up rolls and prevents the failure of necks from arising. The most significant improvements of back up rolls are the following:

- High wear resistance of the working layer as a consequence both at the surface and in the cross-section.
- High thermal cracking resistance
- High spalling resistance of the working layer (tapering is often observed; with work hardening and the proper combination of metallurgical processes, it can be eliminated).
- Good material toughness to bear possible cracks caused by thermal cracking notches from taking place.
- Good micro-cleanliness that prevents local fatigue and inclusions and other discontinuities from arising.

Roll Manufacturing Cycle (flow chart)

Mechanical properties of SdF forged rolls

<table>
<thead>
<tr>
<th>Properties</th>
<th>Unit</th>
<th>BUR-3% Cr</th>
<th>BUR-5% Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultimate tensile strength</td>
<td>Max</td>
<td>1300 - 1800</td>
<td>700 - 1400</td>
</tr>
<tr>
<td>Yield strength</td>
<td>Max</td>
<td>1000 - 1300</td>
<td>600 - 1000</td>
</tr>
<tr>
<td>Elongation</td>
<td>%</td>
<td>15 -</td>
<td>10 -</td>
</tr>
<tr>
<td>Fatigue strength</td>
<td>Max</td>
<td>-</td>
<td>300 - 350</td>
</tr>
</tbody>
</table>

Typical properties of SdF forged BU Rolls

In comparison with cast rolls, forged rolls with an equal chemical composition show a better combination of metallurgical and physical properties, such as a compact porous-free microstructure, good ductility and toughness values and high thermal cracking resistance. The high flowability of the steel during forging, ensures a perfect adapted fibrousity between the body and necks, resulting from soundness in the working layer, improves for fatigue resistance of the rolls and prevents the failure of necks from arising. The most significant improvements of back up rolls are the following:

- Fatigue resistance of necks obtained with a minimum forging induction of 3% on the outer zone, low hardness (HSC 45-46), high tempering temperature and low residual stresses.
- High wear resistance of the working layer as a consequence both at the surface and in the cross-section in high-temperature and low-stress conditions.
- High thermal cracking resistance
- High spalling resistance of the working layer (tapering is often observed with work hardening and a proper combination of metallurgical processes, it can be eliminated).
- Good material toughness to bear possible cracks caused by thermal cracking notches from taking place.
- Good micro-cleanliness that prevents local fatigue and inclusions and other discontinuities from arising.
- Favorable compressive stresses on the working surface of forged rolls.