Sandvik
rock drill steel
Sandvik drill steel — a strong link in the chain

Drill rods take a great deal of punishment during their working life and only a drill steel of consistently high quality will provide maximum operational dependability and a long service life. We know from our experience that there is only one route for this: carefully selected raw materials for producing the steel and the utmost care and control at every stage of production.

Sandvik Materials Technology is the world’s leading manufacturer of drill steel, with more than a century of experience. Fully integrated production – from steel melt to the finished product – gives us total control of the entire chain of manufacturing processes. Large-scale production enables us to operate a plant which is designed for and dedicated to the manufacture of drill steels. Only Sandvik Materials Technology can make this claim.

All processes are carried out in accordance with a well established quality assurance programme, which meets ISO 9001 requirements. The Sandvik philosophy for product development is based on listening to our customers. We have a long-established tradition of co-operation with leading rock drill manufacturers. This co-operation, together with the Sandvik Group’s expertise in materials and processes results in drill steels which meet the most exacting end user requirements and are well suited to the efficient and economical production methods of our customers.

Recommendations are for guidance only, and the suitability of a material for a specific application can be confirmed only when the actual service conditions are known. Continuous development may necessitate changes in technical data without notice.
Sandvik drill steels for efficient, economical production and longer service life!

Sandvik drill steel has

- high fatigue strength and toughness
- high resistance to wear and permanent distortion
- properties that enable efficient and economic production
- close tolerances for automated manufacturing processes
- a uniform response to heat treatment
- uniform straightness, eliminating the need for straightening

Use our technical service!

Close contact with customers has always been an important part of the total Sandvik service. Technical support and advice are available to our customers from our rock drill steel specialists.

If you have questions concerning material selection or processing, do not hesitate to contact us. Contact can be made through the Sandvik website.

www.smt.sandvik.com/rockdrill
**Manufacturing**
The Sandvik rock drill steel mill is the most up-to-date in the world. It is fully automated and designed specifically for the manufacture of rock drill steel.

**Product quality**
Product quality begins at the very start of the process, where raw material is carefully selected for melting in our 75 tonnes electric arc furnace. At the next stage, the continuous, three stand bloom caster gives us several quality advantages, compared to ingot casting, in terms of the control of non-metallic inclusions, purity, material structure and surface finish.

Ongoing manufacturing processes continue to ensure high quality. Long-hole drilling and the insertion of a core in the drill steel blank, prior to rolling, produce straight centre holes with close dimensional tolerances. After rolling, the core is withdrawn.

In order to eliminate decarburisation and other defects, the surface is turned before the final rolling process.

After rolling, a carefully controlled cooling process guarantees the final and uniform mechanical properties throughout the bar.

**Distribution**
We aim to match our product quality with the highest possible level of customer service. A fully computerised order handling and distribution system ensures fast and on-time deliveries.

**Research and Development**
For more than a century, Sandvik has invested in research and development into the properties and performance of steel. Our efforts have resulted in improved production processes, new grades and sizes of rock drill steel, capable of meeting the ever increasing demands of customers, new applications and new working environments.
Sandvik Group
The Sandvik Group is a global high technology enterprise with around 300 subsidiary companies, 37,000 employees and activities in more than 130 countries.

Sandvik’s operations are concentrated on its three core businesses of Tooling, Mining and Construction, and Materials Technology – areas in which the group holds leading global positions in selected niches.

Sandvik Materials Technology
Sandvik Materials Technology is a world-leading supplier of products with extensive added value in advanced stainless steels, special alloys, metallic and ceramic resistance materials as well as process plants based on steel conveyor belts, and sorting systems.

Quality assurance
Sandvik Materials Technology has a quality management system approved by internationally recognised organisations. We hold for example: ASME Quality System Certificate as a Materials Organisation, approval to ISO 9001 as well as approvals from LRQA, JIS and other organisations as a materials manufacturer.

Environment
Environmental awareness is an integral part of our business and is at the fore-front of all activities within our operation. We hold approval to ISO 14001.
Grades and applications

Sandvik rock drill steel is available in four standard grades, which are described on pages 6-11. Other grades can be supplied by agreement.

Sanbar 20
(19HS20)

Type of steel
Sanbar 20 is a high strength chromium-molybdenum steel with high fatigue strength and excellent wear resistance in the as-rolled condition.

Application
Integral drill steels primarily (pilot rods and tapered rods).

Mechanical properties
As-delivered condition, typical values
\( \sigma_{0.2} \ldots \ldots \ldots 850 \text{ MPa (123 ksi)} \)
\( \sigma_m \ldots \ldots \ldots 1300 \text{ MPa (189 ksi)} \)
Hardness \ldots \ldots 37-43 HRC

Decarburisation
The maximum permissible decarburisation depth is 0.20 mm (0.008 inches) on the outer surface and 0.10 mm (0.004 inches) on the inner surface.

Sanbar 61
(8HSL61)

Type of steel
Sanbar 61 is a high strength silicon steel with good toughness and impact resistance in the as-rolled condition.

Application
Tapered rods primarily (pilot rods and integral drill steels).

Mechanical properties
As-delivered condition, typical values
\( \sigma_{0.2} \ldots \ldots \ldots 820 \text{ MPa (119 ksi)} \)
\( \sigma_m \ldots \ldots \ldots 1350 \text{ MPa (196 ksi)} \)
Hardness \ldots \ldots 38–44 HRC

Decarburisation
The maximum permissible decarburisation depth is 0.30 mm (0.012 inches) on the outer surface and 0.20 mm (0.008 inches) on the inner surface.

Sanbar 64
(4HS64)

Type of steel
Sanbar 64 is an air-hardening, high nickel alloy steel with good response to carburising. It has excellent fatigue strength and wear resistance in the case hardened condition.

Application
Extension rods, shank rods, (tapered rods).

Mechanical properties
As-delivered condition, typical values
\( \sigma_{0.2} \ldots \ldots \ldots 900 \text{ MPa (131 ksi)} \)
\( \sigma_m \ldots \ldots \ldots 1250 \text{ MPa (181 ksi)} \)
Hardness \ldots \ldots 37–43 HRC

Decarburisation
The maximum permissible decarburisation depth is 0.30 mm (0.012 inches) on the outer surface and 0.20 mm (0.008 inches) on the inner surface.

Sanbar 23
(5HS23)

Type of steel
Sanbar 23 is an air-hardening, high chromium, molybdenum alloy steel with good response to surface induction hardening and suitable for carburising. It has high fatigue strength and wear resistance in the case hardened condition.

Application
Extension rods, shank rods, (tapered rods)

Mechanical properties
As-delivered condition, typical values
\( \sigma_{0.2} \ldots \ldots \ldots 1000 \text{ MPa (145 ksi)} \)
\( \sigma_m \ldots \ldots \ldots 1350 \text{ MPa (196 ksi)} \)
Hardness \ldots \ldots 38–44 HRC

Decarburisation
The maximum permissible decarburisation depth is 0.30 mm (0.012 inches) on the outer surface and 0.20 mm (0.008 inches) on the inner surface.

Chemical compositions, nominal, %

<table>
<thead>
<tr>
<th>Sandvik grade</th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>P max</th>
<th>S max</th>
<th>Cr</th>
<th>Ni</th>
<th>Mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanbar 20</td>
<td>0.97</td>
<td>0.2</td>
<td>0.3</td>
<td>0.025</td>
<td>0.020</td>
<td>1.0</td>
<td>-</td>
<td>0.2</td>
</tr>
<tr>
<td>Sanbar 61</td>
<td>0.41</td>
<td>1.5</td>
<td>0.9</td>
<td>0.025</td>
<td>0.020</td>
<td>0.7</td>
<td>0.5</td>
<td>0.2</td>
</tr>
<tr>
<td>Sanbar 64</td>
<td>0.22</td>
<td>0.3</td>
<td>0.7</td>
<td>0.020</td>
<td>0.025</td>
<td>1.3</td>
<td>2.9</td>
<td>0.2</td>
</tr>
<tr>
<td>Sanbar 23</td>
<td>0.24</td>
<td>0.3</td>
<td>0.5</td>
<td>0.020</td>
<td>0.025</td>
<td>3.1</td>
<td>-</td>
<td>0.5</td>
</tr>
</tbody>
</table>
Sandvik rock drill steel is supplied as hollow, hot-rolled, round or hexagon bar. The ends are trimmed square to within 0.15 mm (0.006 inches) maximum. The outer surface can be supplied dry, or oiled for protection against corrosion during transport. The flushing holes are normally sealed with plastic caps.

Bars are supplied in standard bundles containing max 1500 kg (3300 lbs).

**Surface condition**
Both the outer and inner surfaces are free from harmful slag marks, cracks and scratches. The maximum depth of defects is 0.20 mm (0.008 inches) on the outer surface and 0.15 mm (0.006 inches) on the inner surface.

**Straightness**
Maximum deviation is 1 mm per 1000 mm (0.04 inch in 39.4 inches).

**Fixed lengths**
Fixed lengths can be supplied upon request. The length tolerances for fixed lengths are:

<table>
<thead>
<tr>
<th>Length, mm</th>
<th>Tolerance, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 3375</td>
<td>± 2</td>
</tr>
<tr>
<td>3376–5750</td>
<td>± 3</td>
</tr>
<tr>
<td>&gt; 5750</td>
<td>± 4</td>
</tr>
</tbody>
</table>

**How to order**
To ensure fast and accurate delivery of Sandvik rock drill steel, we recommend that your order contains the following information:
- Quantity
- Grade
- Denomination
- Hole size

Also, any special requirements regarding tolerances, lengths, max. bundle weight, or corrosion protection should be stated.
Sanbar 20

Integral drill rods

Machinability
Machining may require prior annealing.

Forging

Heat treatment
Annealing (induction heating) 850–900°C (1560–1650°F), cooling in air.

Normalising (induction heating)
950–1050°C (1740–1920°F), cooling in air. Hardening of shank end (through hardening).

Hardening
Induction heating to 1000–1100°C (1830–2010°F). Forced cooling in air or oil.

Tempering
Recommended hardness 50 HRC, temperature appr. 500°C (930°F)/0.5 hrs. Tempering within 1 hr after hardening.

Fabrication of Sanbar 20
Forging
This material requires rapid heating to the forging temperature and, above all, the soaking time at full temperature should be as short as possible. This will minimise grain growth and decarburisation, both of which drastically impair the fatigue strength. The design of the shank and the forging of the collar are very important to the properties and performance of the drill rod. Abrupt changes in cross-section and forging defects cause stress concentrations that can severely diminish the performance of the rod and give rise to fracture. It is therefore vital that the radius between the collar and the rod is generous and defects such as laps, folds and cracks are avoided. Heat the rod end locally to the correct forging temperature. Forge within the temperature range specified for Sanbar 20, and terminate at the lower end of the temperature range. This will restrict grain growth. Forge the collar using a mandrel in the flushing hole, so that the flushing tube will not close up during forging.

Shank end hardening
The shank must be hardened after forging and machining to obtain the strength necessary for robust service. Local hardening always gives rise to a soft zone at the transition between the heated and the unheated part of the rod. This results in a lower hardness in this zone, which becomes the weakest part of the rod. Hardness in the transition zone should, therefore, be maintained at as high a level as possible. The use of induction heating to produce a high transition zone hardness level, is recommended.

Tempering
Recommended hardness 50 HRC, temperature appr. 500°C (930°F)/0.5 hrs. Tempering within 1 hr after hardening.

Shot peening
Shot peening of an adequate intensity and coverage is recommended. It improves fatigue strength due to:

- Introduced compressive stresses
- Increased hardness
- Smoother surface defects

Corrosion protection
Corrosion of a material subjected to fluctuating loads accelerates the fatigue process. In under ground applications, particularly, products should be protected in order to avoid premature fatigue breakages starting from the hole surface.

Sizes and tolerances, metric units – Sanbar 20 and Sanbar 61
The table lists Sandvik standard sizes. Other sizes are available on request. H = hexagon

<table>
<thead>
<tr>
<th>Denomination</th>
<th>Nominal bar size mm</th>
<th>tolerance</th>
<th>Hole dia. incl. ovality mm</th>
<th>Eccentricity1) max mm</th>
<th>Random1) length m (±10%)</th>
<th>Weight kg/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>H 19</td>
<td>19.03</td>
<td>±0.18</td>
<td>6.0±0.4</td>
<td>0.55</td>
<td>5–6</td>
<td>2.23</td>
</tr>
<tr>
<td>H 22</td>
<td>22.20</td>
<td>+0.20/-0.15</td>
<td>6.7±0.4</td>
<td>0.6</td>
<td>7.5–8.5</td>
<td>3.06</td>
</tr>
<tr>
<td>H 25</td>
<td>25.35</td>
<td>+0.20/-0.23</td>
<td>7.6±0.5</td>
<td>0.7</td>
<td>5.5–6.5</td>
<td>4.00</td>
</tr>
</tbody>
</table>

1) Eccentricity = the distance between the centre of the bar and the centre of the hole
2) Fixed cut lengths are available on request.
**Sanbar 61**

**Tapered rods**

**Machinability**
Machining may require prior annealing.

**Forging**

**Heat treatment**
Annealing (Induction heating).
730–780°C (1350–1440°F), cooling in air.

**Normalising (induction heating)**
1000–1050°C, (1830–1920°F), cooling in air:
Shank end hardening (case hardening) Hardening: Induction heating to 900–1000°C, (1650–1830°F), 2–5 sec. quenching in water or oil.

**Tempering**
Recommended surface hardness 55–60 HRC, temperature appr. 150–250°C (300–480°F).

**Fabrication of Sanbar 61**

**Forging**
This material requires rapid heating to the forging temperature and, above all, the soaking time at full temperature should be as short as possible. This will minimise grain growth and decarburisation, both of which drastically impair the fatigue strength. The design of the shank and the forging of the collar are very important to the properties and performance of the drill rod. Abrupt changes in cross-section and forging defects cause stress concentrations that can severely diminish the performance of the rod and give rise to fracture. It is therefore vital that the radius between the collar and the rod is generous and defects such as laps, folds and cracks are to be avoided. Heat the rod end locally to the correct forging temperature. Forge within the temperature range specified for Sanbar 61, and terminate at the lower end of the temperature range. This will restrict grain growth. Forge the collar using a mandrel in the fluting hole, so that the fluting tube will not close up during forging.

**Shank end hardening**
The shank must be hardened after forging and machining to obtain the strength necessary for robust service. This steel has been developed primarily for surface induction hardening. A normalising process is recommended in order to eliminate prior transition zones and create optimum mechanical properties. This process will decrease the grain size and result in a microstructure with high strength and good toughness. Normalise within the temperature range specified for Sanbar 61. Recommended hardness range: 38–44 HRC. The heated zone should overlap the previously heated zone by about 25 mm.

After the above treatment, surface induction harden the shank by heating and quenching according to the recommendations above. Temper for 0.5 hour in the range of 150–250°C (300–480°F) to obtain a hardness of 55–60 HRC.

**Brazing**
The minimum hardness value in the transition zone resulting from the brazing operation should be as high as possible. It is very important to avoid interaction between transition zones and geometrical notches.

**Shot peening**
Shot peening of an adequate intensity and coverage is recommended. It improves fatigue strength due to:
- Introduced compressive stresses
- Increased hardness
- Smoother surface defects

**Corrosion protection**
Corrosion of a material subjected to fluctuating loads accelerates the fatigue process. In underground applications particularly, products should be protected in order to avoid premature fatigue breakages starting from the hole surface.

**Sizes and tolerances, imperial units – Sanbar 20 and Sanbar 61**
The table lists Sandvik standard sizes. Other sizes are available on request. H = hexagon.

<table>
<thead>
<tr>
<th>Denomination</th>
<th>Nominal bar size inch</th>
<th>tolerance inch</th>
<th>Hole dia. incl. ovality max inch</th>
<th>Eccentricity1) max inch</th>
<th>Random2) length ft</th>
<th>Weight lb/ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>H 3/4</td>
<td>0.749</td>
<td>±0.007</td>
<td>0.236±0.015</td>
<td>0.021</td>
<td>16.4–19.7</td>
<td>1.50</td>
</tr>
<tr>
<td>H 7/8</td>
<td>0.874</td>
<td>+0.007/-0.005</td>
<td>0.263±0.015</td>
<td>0.023</td>
<td>24.6–27.8</td>
<td>2.05</td>
</tr>
<tr>
<td>H 1</td>
<td>0.998</td>
<td>+0.007/-0.009</td>
<td>0.299±0.019</td>
<td>0.027</td>
<td>18.0–21.3</td>
<td>2.68</td>
</tr>
</tbody>
</table>

1) Eccentricity = the distance between the centre of the bar and the centre of the hole
2) Fixed cut lengths are available on request
Machinability
Sanbar 64 can be machined in the hot rolled condition.

Forging

Heat treatment
Annealing (induction heating) 680–720°C (1260–1330°F), cooling in air.

Gas carburising and direct quenching

Tempering

Surface induction hardening
Hardening: Induction heating to 900–1000°C (1650–1830°F), 3-6 seconds, quenching in water or in oil.

Sanbar 64
Extension rods, Shank rods

Tempering
Recommended surface hardness 50–55 HRC, temperature, 150 to 250°C (300–480°F). Tempering may not be needed.

Fabrication of Sanbar 64
Forging
This material requires rapid heating to the forging temperature and, above all, the soaking time at full temperature should be as short as possible. This will minimise grain growth and decarburisation, both of which drastically impair the fatigue strength. Heat the rod end locally to the correct forging temperature. Forge within the temperature range specified for Sanbar 64.

Heat treatment
Overall gas carburising gives Sanbar 64 excellent fatigue strength and wear resistant properties. It is very important to control the atmosphere in the furnace by having a stable gas flow and an even temperature. The recommended surface carbon content is 0.5 to 0.7%. To increase the toughness, tempering needs to be carried out immediately after carburising, according to the recommendations above. The required case depth must be a function of the thread dimension but is in the area of 0.6 to 1.2 mm (0.020 to 0.057 inches). It is essential to ensure that rods are carburised internally in order to obtain maximum service life. The absence of internal carburising can be extremely detrimental, especially in corrosive environments.

In some applications, e.g. surface drilling in poor conditions, surface induction hardening, carried out according to the recommendations above, can be an alternative to overall carburising.

The required case depth must be a function of the thread dimension but is in the area of 1.5 to 3 mm (0.06 to 0.12 inches).

Shot peening
Shot peening of an adequate intensity and coverage is recommended. It improves fatigue strength due to:
- Introduced compressive stresses
- Increased hardness
- Smoother surface defects

Corrosion protection
Corrosion of a material subjected to fluctuating loads accelerates the fatigue process. In under ground applications particularly, products should be protected in order to avoid premature fatigue breakages starting from the hole surface.

Sizes and tolerances, metric units – Sanbar 64 and Sanbar 23
The table lists Sandvik standard sizes. Other sizes are available on request. H = hexagon, R = round

<table>
<thead>
<tr>
<th>Denomination</th>
<th>Nominal bar size mm</th>
<th>tolerance mm</th>
<th>Hole dia. incl. ovality max mm</th>
<th>Eccentricity1)</th>
<th>Random2)</th>
<th>Weight kg/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>H 22</td>
<td>22.17</td>
<td>+0.18/-0.17</td>
<td>6.7±0.4</td>
<td>0.6</td>
<td>7.5–8.5</td>
<td>3.05</td>
</tr>
<tr>
<td>H 25</td>
<td>25.30</td>
<td>+0.30/-0.15</td>
<td>8.6±0.5</td>
<td>0.7</td>
<td>7.5–8.5</td>
<td>3.88</td>
</tr>
<tr>
<td>H 28</td>
<td>28.60</td>
<td>±0.25</td>
<td>8.8±0.5</td>
<td>0.7</td>
<td>5.5–6.5</td>
<td>5.05</td>
</tr>
<tr>
<td>H 32</td>
<td>32.05</td>
<td>+0.35/-0.25</td>
<td>9.6±0.6</td>
<td>0.8</td>
<td>8–9</td>
<td>6.38</td>
</tr>
<tr>
<td>H 32</td>
<td>32.05</td>
<td>+0.35/-0.25</td>
<td>12.1±0.7</td>
<td>0.8</td>
<td>8.5–9.5</td>
<td>6.05</td>
</tr>
<tr>
<td>H 35</td>
<td>35.30</td>
<td>±0.30</td>
<td>9.5±0.6</td>
<td>1.0</td>
<td>9–10</td>
<td>7.88</td>
</tr>
<tr>
<td>H 38</td>
<td>38.30</td>
<td>±0.35</td>
<td>16.0±0.8</td>
<td>1.0</td>
<td>9–10</td>
<td>8.36</td>
</tr>
<tr>
<td>R 32</td>
<td>32.20</td>
<td>±0.30</td>
<td>9.2±0.5</td>
<td>0.75</td>
<td>9–10</td>
<td>5.87</td>
</tr>
<tr>
<td>R 32</td>
<td>32.20</td>
<td>±0.30</td>
<td>11.7±0.6</td>
<td>0.75</td>
<td>7.5–8.5</td>
<td>5.55</td>
</tr>
<tr>
<td>R 39</td>
<td>39.00</td>
<td>±0.30</td>
<td>10.3±0.6</td>
<td>0.8</td>
<td>6–7</td>
<td>8.72</td>
</tr>
<tr>
<td>R 39</td>
<td>39.00</td>
<td>±0.30</td>
<td>14.5±0.8</td>
<td>1.0</td>
<td>6–7</td>
<td>8.08</td>
</tr>
<tr>
<td>R 46</td>
<td>45.80</td>
<td>±0.40</td>
<td>17.0±0.9</td>
<td>1.2</td>
<td>10–11</td>
<td>11.15</td>
</tr>
<tr>
<td>R 52</td>
<td>52.05</td>
<td>±0.45</td>
<td>21.5±1.0</td>
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<td>7–8</td>
<td>13.85</td>
</tr>
<tr>
<td>R 60</td>
<td>60.00</td>
<td>±0.70</td>
<td>22.6±2.2</td>
<td>1.75</td>
<td>7–8</td>
<td>19.05</td>
</tr>
</tbody>
</table>

1) Eccentricity = the distance between the centre of the bar and the centre of the hole
2) Random = length of ±10%
**Sanbar 23**

**Extension rods, Shank rods**

**Machinability**
Sanbar 23 can be machined in the hot rolled condition.

**Forging**

**Heat treatment**
Annealing (induction heating), 720–770°C (1330–1420°F), cooling in air.

**Gas carburising and direct quenching**

**Tempering**
Recommended surface hardness 57–62 HRC and core hardness 36–44 HRC. Temperature appr. 180 to 250°C (300–450°F) for 1 hour.

**Surface induction hardening**
Hardening
Induction heating to 900–1000°C, (1650–1830°F), 3–6 sec. quenching in water or in oil.

**Tempering**
Recommended surface hardness, 50–55 HRC, temperature appr. 150 to 250°C (2010–2010°F) Tempering may not be needed.

**Fabrication of Sanbar 23**

**Forging**
This material requires rapid heating to the forging temperature and, above all, the soaking time at full temperature should be as short as possible. This will minimise grain growth and decarburisation, both of which drastically impair the fatigue strength. Heat the rod end locally to the correct forging temperature. Forge within the temperature range specified for Sanbar 23.

**Heat treatment**
Surface induction hardening is recommended for Sanbar 23. Hardening and tempering should be carried out according to the recommendations above. The required case depth must be a function of the thread dimension but is in the area of 1.5 to 3 mm (0.06 to 0.12 inches).

**Shot peening**
Shot peening of an adequate intensity and coverage is recommended. It improves fatigue strength due to:
- Introduced compressive stresses
- Increased hardness
- Smoother surface defects

**Corrosion protection**
Corrosion of a material subjected to fluctuating loads accelerates the fatigue process. In underground applications particularly, products should be protected in order to avoid premature fatigue breakages starting from the hole surface.

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### Sizes and tolerances, imperial units – Sanbar 64 and Sanbar 23

The table lists Sandvik standard sizes. Other sizes are available on request. H = hexagon, R = round

<table>
<thead>
<tr>
<th>Denomination</th>
<th>Nominal bar size</th>
<th>tolerance</th>
<th>Hole dia. incl. ovality</th>
<th>Eccentricity¹</th>
<th>Random²</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>(inch)</td>
<td>(inch)</td>
<td>(inch)</td>
<td>(inch)</td>
<td>max inch</td>
<td>length ft (±10%)</td>
<td>lb/ft</td>
</tr>
<tr>
<td>H 7/8</td>
<td>0.872</td>
<td>±0.007/-0.006</td>
<td>0.263±0.015</td>
<td>0.023</td>
<td>24.6–27.8</td>
<td>2.05</td>
</tr>
<tr>
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<td>±0.011/-0.005</td>
<td>0.338±0.019</td>
<td>0.027</td>
<td>24.6–27.8</td>
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<tr>
<td>H 1 1/8</td>
<td>1.125</td>
<td>±0.009</td>
<td>0.346±0.019</td>
<td>0.027</td>
<td>18.0–21.3</td>
<td>3.39</td>
</tr>
<tr>
<td>H 1 1/4</td>
<td>1.261</td>
<td>±0.013/-0.009</td>
<td>0.377±0.023</td>
<td>0.031</td>
<td>26.2–29.5</td>
<td>4.28</td>
</tr>
<tr>
<td>H 1 1/4</td>
<td>1.261</td>
<td>±0.013/-0.009</td>
<td>0.476±0.027</td>
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<td>27.8–31.1</td>
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<td>1.389</td>
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<td>0.374±0.023</td>
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<td>29.5–32.8</td>
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</tr>
<tr>
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<td>±0.013</td>
<td>0.629±0.031</td>
<td>0.039</td>
<td>29.5–32.8</td>
<td>5.61</td>
</tr>
<tr>
<td>R 1 1/4</td>
<td>1.267</td>
<td>±0.011</td>
<td>0.362±0.019</td>
<td>0.029</td>
<td>29.5–32.8</td>
<td>3.94</td>
</tr>
<tr>
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<tr>
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<td>1.535</td>
<td>±0.011</td>
<td>0.570±0.031</td>
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<td>1.803</td>
<td>±0.015</td>
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<td>±0.017</td>
<td>0.846±0.039</td>
<td>0.062</td>
<td>22.9–26.2</td>
<td>9.29</td>
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<td>R 2 23/64</td>
<td>2.362</td>
<td>±0.027</td>
<td>0.889±0.086</td>
<td>0.068</td>
<td>22.9–26.2</td>
<td>12.78</td>
</tr>
</tbody>
</table>

¹) Eccentricity = the distance between the centre of the bar and the centre of the hole
²) Fixed cut lengths are available on request