Overview

- Braiding technology and production calculation
- Advantages against plastic tubes and tape winding
- KBB 1/24-100
- KBB 1/32-100
- KBB 1/48-100
- Special machines
- Accessories braiding machines
- Engineered Yarns
- Wire braiding
- Winding technology

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Discover the possibilities

Braids are textile constructions which yarns cross each other in diagonal direction. We distinguish between round braids and flat braids.

Round braids: Round braids have a round or oval cross section. The products made are cords (technique), laces (for clothes), cables (electro technique) or ropes (heavy braids).

Flat braids: Flat braids are called laces or just flat braids. Braids have special characteristic features. Standard braids have only a low lateral stability. Due to this property they can be sewn to other textiles without problems. On the other hand they can be made rigid and stiff with inserts and after treatments.

The load-bearing capacity of braided products is much higher than products made with other techniques. Because of the special properties, braids can be found (often hidden) in many different applications. Some examples: Clothes and shoes, candle wicks, sash cords, water ski ropes, mountaineering ropes, yachting ropes, parachute lines, fishing nets, mooring lines, medical applications such as catheters or dental floss, overbraided high-pressure tubes, ground cables or harnesses.
Production calculation

Main specifications of the braid

a) Cable diameter
b) Lay length or pitch (Density in Inch)
c) Used material (yarn type und yarn thickness)
Production calculation

The density can be defined differently:

a) Picks per engl. Inch (Inch = 25.4 mm)
b) Picks per french Inch (Inch = 27 mm)
c) Lay length in mm.

The calculation is as follows:

Example: 24 carrier braid, diameter: 10 mm

Lay length = 31.4 mm
12 Picks = 1 carrier revolution on braiding machine
31.4 mm : 12 carriers = 2.6 mm per pick
25.4 mm : 2.6 mm per Pick = 9.76 picks/ engl. Inch
Production calculation

Main formula for endless braids:

Braid in metres per hour = \( \text{Lay length} \times \text{horn gear speed} \times 4 \times 0.06 \)

numbers of carriers

Example: Harness diameter 10 mm, lay length 31.4 mm; used machine KBB 1/24-100; (horn gear speed 250 rpm)

Braid in metres per hour = \( 31.4 \text{ mm} \times 250 \text{ rpm} \times 4 \times 0.06 \)

24 carriers

Braid in metres per hour = 78.5
(without joints and set-up time)
Production calculation

Example harness production:

Harness tree: main arm 3 m length, diameter 15 mm, side arms 6 x 0,5 m, diameter 8 mm.

Production (main arm) = 15 mm x Pi x 250 rpm x 4 x 0,06 / 24 carriers
Production (main arm) = 117,8 m/h -> 3 m = 1,5 mins

Production (side arm) = 8 mm x Pi x 250 rpm x 4 x 0,06 / 24 carriers
Production (side arm) = 62,83 m/h -> (6 x 0,5 m) = 3,2 mins

Estimated handling time (side arm/ each): 30 sec. per arm
Estimated handling time (side arm/total) = 6 arms x 30 sec. = 3,0 mins

Production time = 1,5 mins (main arm) + 3,2 mins (side arms) + 3 mins handling
= 7,7 = 8 mins plus set-up time
Production calculation

Product length in relation to yarn length
Product length = yarn length on bobbin x sin braiding angle

Example: Shortage factor for the following angles

Product length (35°) = Yarn length x 0.5735 (sin 35°)
Product length (45°) = Yarn length x 0.7071 (sin 45°)
Product length (55°) = Yarn length x 0.8191 (sin 55°)
Product length (65°) = Yarn length x 0.9063 (sin 65°)
Production calculation

Working time with one set of bobbins:

Working time = Yarn length in metres \times \text{shortage factor} \times \text{production speed per hour}

Example with bobbin with 265 ccm = 237 m yarns 1-ply:

\[ \text{Standzeit} = 237 \text{ Meter} \times 0.7071 \]
117 metres per hour

Working time = 1.4 hours

Shortage factor 35° = 0.5735
Shortage factor 45° = 0.7071
Shortage factor 55° = 0.8191
Shortage factor 65° = 0.9063
Example: A = 78 mm² harness cable

Surface = Diameter² x Pi / 4
78 mm² = Diameter² x 3,14 / 4
78 mm² x 4 = Diameter²
3,14
99,36 mm² = Diameter²
9,96 mm = Diameter

Yarn length (per lay length) = Numbers of carriers x Diameter braid x 3,14

Cos braiding angle

Yarn length (per lay length) = 24 carriers x 9,96 mm x 3,14
0,7071

Yarn length (per lay length) = 1.061 mm
Calculation (per meter harness cable) = 1.061 mm x 1000 mm

9,96 mm x Pi

Calculation (per meter harness cable) = 33.908 mm yarn

Calculation (per meter harness cable) = 34 metres yarn
Numbers of carriers recommendation when using Engineered Yarns

<table>
<thead>
<tr>
<th>Numbers of carriers:</th>
<th>24</th>
<th>32</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineered Yarns:</td>
<td>6 - 13 mm</td>
<td>16 - 19 mm</td>
<td>19 - 40 mm</td>
</tr>
<tr>
<td>Herzog:</td>
<td>8 - 20 mm</td>
<td>16 - 28 mm</td>
<td>25 - 40 mm</td>
</tr>
</tbody>
</table>
Advantages against Plastic tubes and tape winding

- Compact machine footprint
- No cable vibrations
- Small storage
- Less storage costs
- Easy parameter changes possible
Advantages against Plastic tubes and tape winding

- Little wire to wire movement
- Smaller harness diameter
- No fittings required
- Easier installation
- Tamperproof
- 100 % occupied
- Flame retardant (MVSS 302, SAE J369 und UL 94)
Advantages against Plastic tubes and tape winding

High assembly costs
Pre cut raw materials necessary
approx. 30 % space loss
Vibrations of cables in plastic hoses
water trap
Advantages against Plastic tubes and tape winding

Will not trap particule matter

Seeds, Stones Dwellings

Rodents, Insects
Advantages against Plastic tubes and tape winding

- Abrasion resistant
- Weatherproof
- Colour/ Tracer
- Temperature tolerant
- Chemical exposure
- No tape/ fittings required
- Easy installation
- Tamperproof
- 100 % occupied
- Appearance
Calculation Wire harness braid (per US foot; as per Engineered Yarns brochure)

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Description</th>
<th>Unit Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monofilament:</td>
<td>0.5”(12.7 mm) to 1.0”(25.4 mm)</td>
<td></td>
</tr>
<tr>
<td>Polyester hose</td>
<td></td>
<td>$0.015</td>
</tr>
<tr>
<td>Shrink tube (0.020):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polyolefin</td>
<td></td>
<td>$0.24</td>
</tr>
<tr>
<td>PVC</td>
<td></td>
<td>$0.27</td>
</tr>
<tr>
<td>PVDF</td>
<td></td>
<td>$3.85</td>
</tr>
<tr>
<td>EY overbraided harness:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VN-4000, 40 mm PVC</td>
<td></td>
<td>$0.14</td>
</tr>
<tr>
<td>VN-4400, 28 mm PVC</td>
<td></td>
<td>$0.08</td>
</tr>
<tr>
<td>EY-1877, 28 mm TPE</td>
<td></td>
<td>$0.21</td>
</tr>
<tr>
<td>EY-3023, 28 mm PVDF</td>
<td></td>
<td>$0.36</td>
</tr>
<tr>
<td>Convoluted tube:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PE</td>
<td></td>
<td>$0.09</td>
</tr>
<tr>
<td>FR-PE</td>
<td></td>
<td>$0.13</td>
</tr>
<tr>
<td>FR-Nylon (+fittings)</td>
<td></td>
<td>$0.15</td>
</tr>
</tbody>
</table>
According to customers‘ experiences there are no price difference between braided harnesses and harnesses with plastic hose covers.

All technical descriptions of yarns, yarn properties and wire harness manufacturing are from Engineered Yarn brochures. All calculations are made according to our best knowledge and must be proven by experimental harness production.
For wire harnesses between dia. 8 – 20 mm

User friendly design

Operator panel for left and right handed operators

High efficiency, low maintenance required

Suitable for EY cardboard tubes or Herzog flange bobbin 55 x 130 mm
For wire harnesses between dia. 16 – 28 mm
User friendly design
Operator panel for left and right handed operators
High efficiency, low maintenance required
Suitable for EY cardboard tubes or Herzog flange bobbin 55 x 130 mm
For wire harnesses between dia. 25 – 40 mm

User friendly design

Operator panel for left and right handed operators

High efficiency, low maintenance required

Suitable for EY cardboard tubes or Herzog flange bobbin 55 x 130 mm
Horizontal Braiding machine with Siemens PLC and take-off winch for manufacturing of extra long and heavy harnesses for aviation industry.
Vertical braiding machine with cylindrical take-off disc, Siemens PLC, movable pan, laser-pointer, take-off slides, special carriers with easy carrier exchange system for aviation industry
Hot cutting unit for cutting Polyester fibres.
Enlarged take-off disc for very stiff harness cables.
Easy carrier exchange system to exchange carrier upper parts
- lower down times
- easy carrier change when using different carrier types
Splitted Lexan cover above carriers to avoid harness trees fall into braiding machine
Turnable pan for easy loading and unloading of the harness when braiding
PLC- device for repeatable set-up for aviation industry
Engineered Yarns

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Available yarn types Engineered Yarns

- VN-4400/VN-4000, Standard PVC coated yarn for conventional harness applications.
- VN-4400S/VN-4000S, High performance PVC coated yarns for applications that require improved chemical resistance and temperature tolerance.
- EY-3023, PVDF coated yarn for applications that require improved abrasion resistance with superior heat and chemical resistance.
- EY-1877, TPE coated yarns for applications that require outstanding abrasion resistance with improved heat and chemical resistance.
## Engineered Yarns

<table>
<thead>
<tr>
<th></th>
<th>VN-4400</th>
<th>VN-4400S</th>
<th>VN-4000</th>
<th>VN-4000S</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diameter</strong></td>
<td>0.028” (0.71 mm)</td>
<td>0.28” (0.71 mm)</td>
<td>0.040” (1.02 mm)</td>
<td>0.040” (1.02 mm)</td>
</tr>
<tr>
<td><strong>Tensile Strength</strong></td>
<td>15 lbs (6.80 kg)</td>
<td>15 lbs (6.80 kg)</td>
<td>22 lbs (9.97 kg)</td>
<td>22 lbs (9.97 kg)</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>1000 yds/lbs (2000 m/kg)</td>
<td>1000 yds/lbs (2000 m/kg)</td>
<td>550 yds/lbs (1100 m/kg)</td>
<td>550 yds/lbs (1100 m/kg)</td>
</tr>
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</table>
## Engineered Yarns

### Chemical reaction with typical fluids in construction vehicles

<table>
<thead>
<tr>
<th>Fluid</th>
<th>VN-4400</th>
<th>VN-4000</th>
<th>EY-1877</th>
<th>EY-3023</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC</td>
<td>PVC</td>
<td>TPE55D</td>
<td>PVDF</td>
<td></td>
</tr>
<tr>
<td>Battery Acid</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Gunk</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Motor Oil</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Gasoline</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Anti-Freeze</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Washer Fluid</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Hydraulic Fluid</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Brake Fluid</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Transmission Fluid</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Dry Heat Aging</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

0 = no reaction, 5 = heavy reaction
(Trial 30 days at room temperature)
<table>
<thead>
<tr>
<th>Engineered Yarns</th>
<th>Suggested environmental temperatures</th>
</tr>
</thead>
<tbody>
<tr>
<td>VN-4000/VN-4400:</td>
<td>-40°C to 107°C</td>
</tr>
<tr>
<td></td>
<td>-40°F to 225°F</td>
</tr>
<tr>
<td>VN-4000S/VN-4400S:</td>
<td>-54°C to 138°C</td>
</tr>
<tr>
<td></td>
<td>-65°F to 280°F</td>
</tr>
<tr>
<td>EY-3023:</td>
<td>-54°C to 150°C</td>
</tr>
<tr>
<td></td>
<td>-65°F to 302°F</td>
</tr>
<tr>
<td>EY-1877:</td>
<td>-45°C to 138°C</td>
</tr>
<tr>
<td></td>
<td>-49°F to 280°F</td>
</tr>
</tbody>
</table>
Special equipment when handling wires
Wire braiding

Usage of frequency inverter for smooth start
Wire braiding

Special carrier for coated and uncoated wires
Higher bobbin capacity with flange bobbins than cardboard tubes.

Less bobbin changes on winding machine.

Cheaper bulk yarn prices.
Creel for feeding the winding machine

Yarn package is under constant tension.

Yarn package will be braked by pneumatic brake system when winding machine stops.

Yarn is permanently braked and controlled
Winding technology

Winding machine with 4 spindles

Automatic machine stop due to pre select meter counter.

Automatic stop caused by yarn breakage
EY yarn handling

Cardboard tube EY
141 ccm capacity, cross wound
Advantage: convenient, ready to use product
Disadvantage: more expensive

Flange bobbin Herzog
265 ccm capacity, parallel wound
Advantage: less bobbin changes, higher capacity, cheaper yarn price
Disadvantage: Winding machine necessary