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The Ropeblock view & approach on hook standard EN 13001:3-5

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ROPEBLOCK

Components for hoisting and lifting industry
- Smart engineering
- Efficient manufacturing

100 EMPLOYEES

5,000 BLOCKS PRODUCED EVERY YEAR

TENS OF THOUSANDS SOCKETS & SHEAVES PRODUCED EVERY YEAR
State of the art?

Design of hook blocks and hook should be state-of-the-art; according latest standards.

For Ramshorn hooks: DIN 15402.
- Established 40—50 years ago.
Reasons to change

Problem with the old DIN standard and hook choice; fatigue
- Hook size was chosen typically based on Mechanism class (operation hours), not based on actual stress cycles.
Reasons to change

Old standard DIN 15402

Problem with the old DIN hook; the shape
- Sharp edge
  - Damage to the hook and hardware
  - Based on the radius a de-rating of sling capacity is required (IMCA 179)
- Shape of the hook was ‘fixed’ in the standard. Difficult to deviate.
Creation of a new standard

Old crane standards (± 40-50 years ago)
- FEM and national standards (DIN, BS, NEN, NBN, etc.)

CEN TC 147; EN 13001 (± 10 years ago)

CEN TC 147; EN 13001:3-5 (2016)
- Pull back of DIN 15400 and implementation of new hook standard *(However: DIN 15402 as a informative annex)*

- Based on actual ‘picks’
- Design approach for hooks in new standard relatively free
  → possibility to optimize the hook shape.
Optimization

Improvement of hook shape:
- Take the sharp edge off
- How much?
  - Grommets, slings
  - Wire rope, fiber
  - Existing hardware
  - Theory

A combination of inputs lead to the optimized curvature and size.

The Ropeblock version of the EN 13001:3-5 hook → bending radius double in size.
Optimization

De-rating formula IMCA 179 \( E = 1 - 0,5/\sqrt{D/d} \)

\( d = \) rope diameter
\( D = 2 \times r \)

Hook No. 16 (typically around 50 ton)

DIN 15401 \( R = 14 \)  
\( \rightarrow \) Red. 59%

Ropeblock EN 13001:3-5 \( R = 28 \)  
\( \rightarrow \) Red. 42%
Validation by testing

Scope:

- Wire rope grommet
- Polyester round sling (WLL 20t; MBL 140t)
- Endless (rope) sling
- Endless (round) sling

300t testbed
Hook size 16
(Typ. SWL 40-63t, MBL 320t)
Results

Wire rope grommet (1960 grade, ø39mm, 6x36WS IWRC round sling)

- **WLL 25,5 x 2 = 51t* (@ f:1)**
- **CGBL (Imca) → 122,7x2 = 245t*E**

**IMCA 179 → E = 1 - 0,5/V((2*r)/d) →**

- Hook radius $R = 14$ mm/wire rope ø 39 mm → 41%
  (59% red.) → $2r < d$
- Hook radius $R = 28$ mm/wire rope ø 39 mm → 58%
  (42% red.) → $2r > d$

<table>
<thead>
<tr>
<th>DIN 15402 / new EN 13001:3-5</th>
<th>Ropeblock optimized EN 13001:3-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1836kN</td>
<td>2168kN</td>
</tr>
</tbody>
</table>

18% improvement
Results

• Polyester round sling (with jacket)
  WLL 20t x 2 = 40t*
  FoS 7:1 → MBL 140t x 2 = 280t*
  (*theoretical)

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<tbody>
<tr>
<td>1679kN</td>
<td>2070kN**</td>
</tr>
</tbody>
</table>

- 23% improvement
** Broke in basket

*E = ?
Results

Dyneema®

Endless (round) sling construction made with Dyneema® (SK78)

Smaller slings, MBL 742kN & 1037kN

Basket hitch (2x): MBL 151t & 211t (theoretical)

<table>
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<th>DIN 15402 / new EN 13001:3-5</th>
<th>Ropeblock optimized EN 13001:3-5</th>
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</thead>
<tbody>
<tr>
<td>1207kN (123 t)</td>
<td>1507kN (154t)</td>
</tr>
<tr>
<td>1834kN (187 t)</td>
<td>2372kN (242t)</td>
</tr>
</tbody>
</table>

- 30% improvement
- No reduction required on Ropeblock hook design
Results

Dyneema®

Wire Rope Bending Radius

Standard Shape

Optimized Shape
Results

Endless (rope) sling construction made with 12x1 braided rope made with Dyneema® (SK78)

<table>
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<tr>
<th>Rope size (MBL/MBF)</th>
<th>DIN 15402 / new EN 13001:3-5</th>
<th>Ropeblock optimized EN 13001:3-5</th>
<th>Improvement rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>21mm (1122kN)</td>
<td>890kN</td>
<td>1058kN</td>
<td>19%</td>
</tr>
<tr>
<td>24mm (1599kN)</td>
<td>1133kN</td>
<td>1286kN</td>
<td>14%</td>
</tr>
<tr>
<td>28mm (2103kN)</td>
<td>1184kN</td>
<td>1403kN</td>
<td>18%</td>
</tr>
<tr>
<td>32mm (2661kN)</td>
<td>1106kN</td>
<td>1427kN</td>
<td>29%</td>
</tr>
<tr>
<td>40mm (3942kN)</td>
<td>1627kN</td>
<td>2387kN</td>
<td>47%</td>
</tr>
</tbody>
</table>

*) Calc MBL = Rope MBL * 1,5 * 2 for basket hitch (theoretical, for D/d > 3)
For D/d < 3 → E to be taken into account:
- For e.g.: Hook No. 16 – rope ø 40 mm
DIN 15402 / EN 13001:3-5 → E = 0,51
Ropeblock EN 13001:3-5 → E = 0,73

E : ISO 18264 → 1 < D/d < 3
E = 1 – (0.5 / √(D/d)) * 1.27
• Endless (rope) sling construction made with 12x1 braided rope made with Dyneema® (SK78)

% improvement DIN 15402/EN 13001:3-5 versus Ropeblock design EN13001:3-5

DIN/EN : $D < d$
Results

Safe lifting is more than the gear only!

• The current IMCA 179 efficiency model may be considered conservative for wire rope slings
• ISO 18264 seems to be too optimistic for HMPE rope.
• Amend the ISO derating formula?
Results

Ropeblock hook: According EN 13001:3-5, but with improved shape.

- returns better efficiency
- allows smaller slings (check hardware curvature)
- increases wear performance & durability of slings
- saves costs
- increases safety

A number of gain.....: typ. 20-30%

Answered a long time market desire.
THANK YOU FOR YOUR ATTENTION

Special thanks to DSM Dyneema for their support and testing materials.

Disclaimer

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