

---

# Knowledge that carries

---

**Rope-friendly operations with  
mobile and crawler cranes –  
focus on wind power**

**LIEBHERR**

**Mobile and Crawler Cranes**



# Introduction

---

As a crane operator in the wind power industry, you face the daily challenge of moving heavy loads safely and efficiently. Often under challenging conditions and with complex crane configurations. The service life and reliability of the hoist ropes and adjustment ropes are crucial for ensuring that operations run smoothly and cost-effectively over the long term.

Using practical examples and specific tips, this document explains how you can significantly extend the service life of your ropes and prevent common types of damage by working carefully and implementing targeted maintenance measures. From the technical fundamentals to the detection of wear and tear, and on to proven measures such as maintenance intervals, proper lubrication, and the

shortening and repositioning of ropes. All content is designed to support you in your day-to-day work. Particular attention is paid to the challenges facing the wind power industry: Heavy loads are lifted to great heights, which increases the risk of premature rope wear. This document shows you how to extend the service life of your ropes by adopting appropriate work practices, conducting regular inspections, and following our Ten Commandments.

The goal is to provide you with the necessary knowledge and the right tools to work safely, efficiently, and cost-effectively – while minimizing wear on your steel ropes and maximizing their service life.





# Contents

|           |                                                                   |           |
|-----------|-------------------------------------------------------------------|-----------|
| <b>1.</b> | <b>Basics</b>                                                     | <b>6</b>  |
| 1.1       | The wire rope                                                     | 6         |
| 1.1.1     | Construction of wire ropes                                        | 6         |
| 1.1.2     | Properties of wire ropes                                          | 6         |
| 1.2       | Rope end connections/pocket lock                                  | 8         |
| 1.3       | Comparison of hoisting ropes and adjustment ropes                 | 9         |
| 1.3.1     | Comprehension questions                                           | 10        |
| 1.4       | The rope drive                                                    | 10        |
| 1.4.1     | Rope drums                                                        | 10        |
| 1.4.2     | Pulleys                                                           | 11        |
| 1.4.3     | Comprehension questions                                           | 11        |
| <b>2.</b> | <b>Quick guide for crane operators</b>                            | <b>12</b> |
| 2.1       | What should you look for? Common problems with the rope drive     | 12        |
| 2.1.1     | Regular inspections in accordance with ISO 4309                   | 12        |
| 2.1.2     | Avoiding twist – What are the reasons?                            | 12        |
| 2.1.3     | Wear on the pulleys                                               | 13        |
| 2.1.4     | Lubrication                                                       | 14        |
| 2.1.5     | Conclusion                                                        | 14        |
| 2.1.6     | Comprehension questions                                           | 15        |
| 2.2       | What can you do? Measures to ensure a long service life for ropes | 15        |
| 2.2.1     | Remove the twist                                                  | 15        |
| 2.2.2     | Replace rope pretension                                           | 16        |
| 2.2.3     | Shorten and reposition the rope                                   | 17        |
| 2.2.4     | Comprehension questions                                           | 17        |
| <b>3.</b> | <b>Hoisting ropes in wind power</b>                               | <b>18</b> |
| 3.1       | Assembly and disassembly of wind turbines                         | 19        |
| 3.1.1     | The issues                                                        | 19        |
| 3.1.2     | Types of damage                                                   | 20        |
| 3.1.3     | Measures                                                          | 21        |
| 3.2       | Luffing jib assembly: Pick up the luffing pulley block at LTM     | 23        |
| 3.2.1     | LTM 1750-9.1: Procedure using winch 1                             | 23        |
| 3.2.2     | LTM 1750-9.1: Procedure using a winch 2                           | 23        |
| 3.2.3     | Other LTM: Pressure indication during assembly                    | 24        |
| 3.2.4     | Comprehension questions                                           | 24        |
| <b>4.</b> | <b>Adjustment ropes in Wind Power</b>                             | <b>25</b> |
| 4.1       | Problem statement: Erecting/take-down as a critical point         | 25        |
| 4.2       | Types of damage                                                   | 25        |
| 4.3       | Measures                                                          | 26        |
| 4.4       | Flat spots on winch 4 (W IV)                                      | 26        |
| 4.5       | Comprehension questions                                           | 27        |
| <b>5.</b> | <b>The 10 commandments of rope-friendly work</b>                  | <b>28</b> |
| <b>6.</b> | <b>Appendix</b>                                                   | <b>29</b> |
| 6.1       | Calculation of minimum hook block weight                          | 29        |
| 6.1.1     | LR 11000: SL10DF2BV                                               | 29        |
| 6.1.2     | LTM 1650-8.1: T3YV2EN                                             | 35        |
| 6.2       | Comparison table: Documentation – Current and new formats         | 38        |
| <b>7.</b> | <b>Solutions</b>                                                  | <b>39</b> |

# List of abbreviations

| Abbreviation | Description                                                        |
|--------------|--------------------------------------------------------------------|
| AAT          | erecting and take down charts                                      |
| BAL          | users manual                                                       |
| BV           | ballast adjustment frame/BV Frame                                  |
| D            | Derrick boom                                                       |
| F2           | fixed jib, Variation 2                                             |
| F1           | force on the load cell: between the SA-frame and the boom          |
| F3           | force on the load cell: between the Derrick boom and the main boom |
| G            | weight of the hook block                                           |
| HA           | main boom                                                          |
| L            | overall boom length                                                |
| LICCON       | Liebherr Computed CONTrolling                                      |
| LML          | Load Moment Limitation                                             |
| LR           | Liebherr Crawler Crane                                             |
| LWE          | Liebherr Company in Ehingen                                        |
| M            | rope weight per meter                                              |
| N            | jib (luffable lattice jib on a mobile crane)                       |
| n            | reeving                                                            |
| SA           | main boom support bracket                                          |
| TLT          | load table                                                         |
| W1, W2,...   | winch 1, winch 2, ...                                              |
| WKA          | wind turbine                                                       |
| WUP          | maintenance and inspection instructions                            |
| Y/Z          | target values for jib assembly                                     |

## How to use this document



Indicates a dangerous situation related to the current topic



Important notice/information regarding the current topic



Reference to the operating instructions



Shows a comparison with a car



Note on photographic documentation



Comprehension questions

First, read through the text of a chapter carefully. Repeat the content. Answer the questions at the end of the chapter (without looking anything up, if possible). You'll find the answers to each question at the end of the document. If you are not yet able to answer the questions without referring to the text, go over the chapter again if necessary.

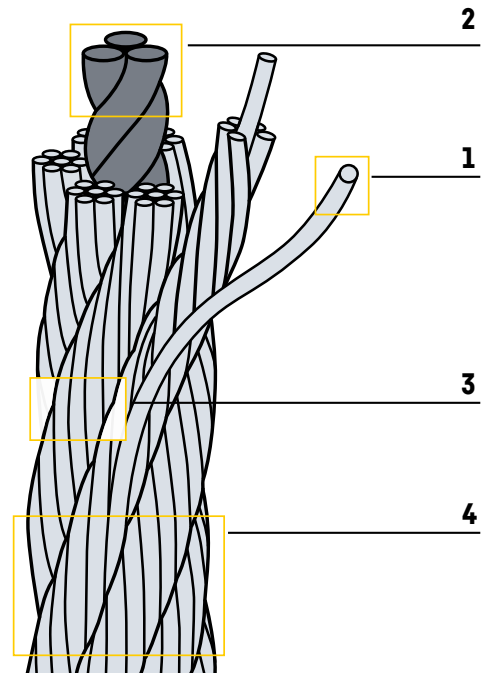
# 1. Basics

## 1.1 The wire rope

### 1.1.1 Construction of wire ropes

A wire rope is a technically sophisticated structure consisting of many individual wires. The multi-step manufacturing process begins with the stranding of individual **wires (1)** into so-called **strands**. In the second manufacturing step, the **core rope (2)** is formed. In the third step, the **outer strands (3)** are stranded around the core rope, resulting in the finished **rope (4)** is formed. Depending on the design, different strands and wires are used. The helical stranding significantly influences the properties of the finished wire rope.

Another important element comes into play at every stage of production. The **lubrication**: The rope is lubricated with grease to reduce wear caused by friction and corrosion.



### 1.1.2 Properties of wire ropes

Wire ropes have properties that significantly affect their service life. A basic understanding is important for avoiding mistakes. You must pay attention to the following features:

- Diameter Reduction
- Transverse compressive strength
- Alternating bending strength
- Corrosion/Lubrication
- Rotational behavior

#### 1.1.2.1 Diameter reduction

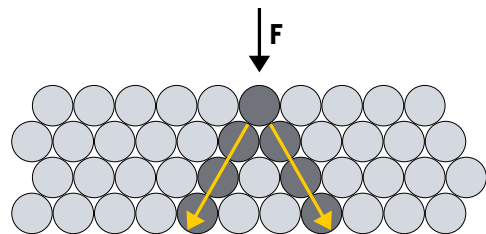
Wire ropes wear out during operation. Among other things, the diameter decreases. This is a normal process, which is why regular inspections are necessary. The reasons for reducing the wire rope diameter are: External abrasion caused by the rope running over sheaves or spooling in a multi-strand configuration.

***The more often your rope is spooled up and down or runs through the pulleys, the faster its diameter decreases.***

#### 1.1.2.2 Transverse compressive strength

Transverse compressive stability describes the resistance against deformation of a rope perpendicular to the rope's axis.

Transverse compressive stability is an important property of wire ropes with a multi-layered construction.



***As a general rule:***

***The tighter the rope is wound onto the winch, the more resistant it is to deformation under lateral pressure.***

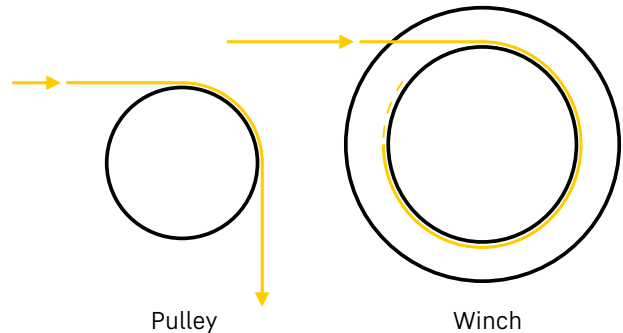
This is especially important for rope sections in the lower windings.

### 1.1.2.3 Bending cycles

The bending cycle describes the change in the curvature of a steel rope.

Bending cycles occur, for example, when ropes are guided over pulleys. Spooling up and spooling down the rope on the winch also cause cyclic bending.

***The more often your rope is subjected to alternating bending, the faster the wires will break.***



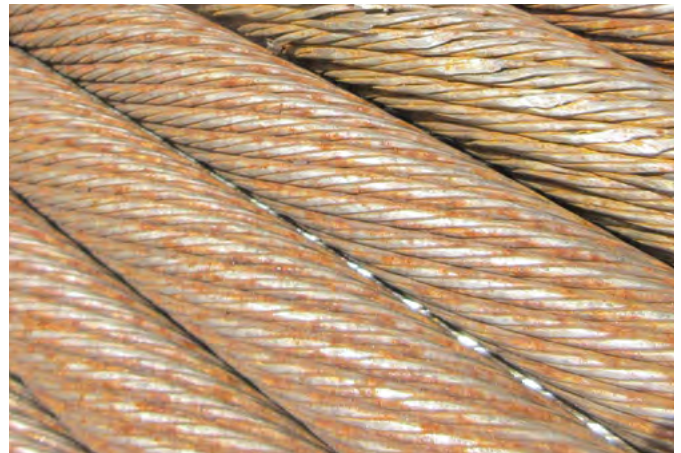
### 1.1.2.4 Lubrication

Rope lubrication is crucial for two things: **Corrosion protection** and **reduction** of friction

**Corrosion:** Severe rust reduces the ropes's cross-sectional area and is therefore a factor considered during regular inspections to determine when the rope is ready for replacement.

The **friction** between the wires sliding against each other in a wire rope and the friction in the rope drive is lower in a well-maintained rope.

When bent, the strands shift relative to one another. With sufficient lubrication, this movement experiences less wear, which can extend the service life of your ropes.



If there is a lack of lubrication, wear increases. This results in increased wear and wire breaks.

However, too much lubrication causes problems: It makes visual inspections more difficult, promotes the buildup of dirt, and can even have an impact on the function of the pulleys. Therefore: **Lubrication – yes, but don't overdo it!**

Liebherr offers you optimal rope lubrication systems, which our Customer Service team will be happy to explain upon request.

***The better the rope is lubricated, the lower the friction and wear.***

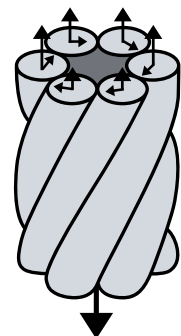


### 1.1.2.5 Rotational behavior

The stranding of wire ropes described above causes them to generate torque around their own axis when under tension. The magnitude of the torque depends largely on the wire rope construction. We distinguish between two categories of wire rope:

1. **rotation resistant** (hoist rope)
2. **Not rotation-free** (adjustment rope)

***The more rotation resistant a rope is designed, the less it twists under tensile load.***



## 1.2 Rope end connections/pocket lock

Wire ropes can be fitted with various end connections. Many wire ropes are connected to the crane or the hook block using the proven Liebherr pocket lock system. The appropriate rope end connector, which is secured to the rope, is designed according to the type of rope (hoisting rope or adjustment rope).

Due to their different properties, it is important that **adjustment ropes are connected using a twist-proof connection**. Oval end connections or end connections with a “nose” are used for this purpose.

|                                                                                                        |    |     |
|--------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <br>adjustment rope  |  |  |
| <br>adjustment rope |  |  |
| <br>hoisting rope   |  |  |



Yes



No



Only after consultation LWE

When discussing pocket locks, terms such as **twist compensator** or **swivel** are often used.

We make the following distinction:

1. Pocket Lock (included as standard with all devices)
2. Pocket Lock with swivel/twist compensator (available only upon request from customer service)

A hoist rope secured by a pocket lock with swivel properties allows only the first rope strand to rotate freely. With multiple-reeved hook blocks, the entire hoisting rope can therefore never completely untwist.

When lifting a load, there is always some twist in the rope. Once the take-down is complete, this twist is removed again.

However, if the load is lifted using a swivel or a twist compensator, the twist cannot be removed and becomes "stuck" on the winch. This results in incorrect twist, which builds up with each lift – the problem gets worse instead of better. **Conclusion:** A pocket lock with a swivel is usually not a solution for twisting problems in the hoist rope and may even intensify them under certain circumstances. **That's why we at LWE generally advise against using pocket locks with swivels!**

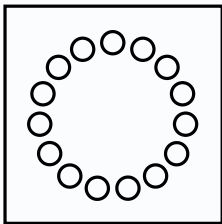
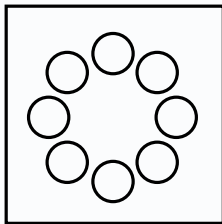
**When using Liebherr telescopic and lattice boom cranes, under no circumstances should a twist compensator be used in connection with an adjustment rope. This can lead to dangerous situations and accidents.**

**Therefore: Signs on all pocket locks.**



### 1.3 Comparison of hoisting ropes and adjustment ropes

Lifting ropes and adjustment ropes serve different purposes and are therefore designed differently. The following table explains key characteristics and highlights differences:

|                                 | hoisting rope                                                                       | adjustment rope                                                                         |
|---------------------------------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| <b>function</b>                 | lifting a load                                                                      | adjusting the position of the boom                                                      |
| <b>rotational behavior</b>      | rotation resistant;<br>less twisting under load                                     | not rotation free;<br>average rotational behavior under load                            |
| <b>symbol</b>                   |  |    |
| <b>number of outer strands</b>  | 15–18 thinner outer strands, resulting in higher resistance to repeated bending     | 6–10 thicker outer strands, resulting in increased resistance to transverse compression |
| <b>rope end connection</b>      | circular rope end connection                                                        | oval rope end connection, rope end connection with a "nose" *                           |
| <b>use</b>                      | winches 1, 2, 6                                                                     | winch 3, 4, 5                                                                           |
| <b>twist compensator/swivel</b> | <b><u>Not</u> recommended</b>                                                       | <b>Prohibited!</b>                                                                      |

\* Winch 4 only on the LR 12500-1.0 and LR 13000 models



### 1.3.1 Comprehension questions

#### 1. What is the basic structure of a steel rope?

- ☐ Made from a single solid steel core.
- ☐ Wires are twisted into strands, which are then twisted together.
- ☐ Only outer strands, no core.
- ☐ Made of a plastic core with a steel jacket.

#### 3. When is it advisable or necessary to use a twist compensator (swivel)?

- ☐ This applies to every steel rope.
- ☐ Not recommended, but permitted for rotation resistant ropes.
- ☐ On the adjustment rope.
- ☐ If possible, work without a twist compensator.

#### 2. When does an uneven diameter reduction occur?

- ☐ During normal operation on rollers.
- ☐ Only in cases of corrosion.
- ☐ Due to localized friction, for example, against the side walls or other ropes.
- ☐ When working without a load.

#### 4. What is the purpose of rope lubrication?

- ☐ Increasing in rope weight
- ☐ Reduction of wear and corrosion
- ☐ Improving the color of the rope
- ☐ Preventing the winding from getting spooled on the winch-drum

#### 5. Which properties of a steel rope correspond to which definition?

|                                 |                                                                                        |
|---------------------------------|----------------------------------------------------------------------------------------|
| Rotational behavior             | Describes how to protect the rope from abrasion and rust through adequate lubrication. |
| Transverse compressive strength | Describes how strongly a rope tends to twist when under tensile load.                  |
| Alternating bending strength    | The rope's resistance to wear caused by repeated deflection and bending.               |
| Corrosion/Lubrication           | The rope's ability to withstand lateral compressive forces without deforming.          |

## 1.4 The rope drive

To maximize the service life of your steel wire rope, you must take into account the entire rope drive system on the crane. These include the rope drum, carrier rollers and rope sheaves.

### 1.4.1 Rope drums

Multi-layer rope drums are used wherever long lengths of rope need to be accommodated in a limited space – such as in our telescopic and lattice boom cranes. Compared to single-layer rope drums, multi-layer winding has a greater impact on rope wear. To enable low-wear multi-layer winding, Liebherr rope drums are equipped with a **special grooving**.

The winch's special groove ensures that the rope runs parallel to the winch side wall – with the exception of **two** defined sections of incline per revolution.

The subsequent layers automatically follow this winding pattern, so that the ropes in the lower and upper layers cross at two predetermined points. These areas are called **intersection areas**.

The remaining rope from the two strands lies parallel to one another; the transverse forces from the upper strands are optimally transferred to the lower strands, distributing the load evenly. This way, wear is limited to two points due to the multi-layer winding.

To ensure that these advantages are maintained, the rope must always be under pre-tension when spooling up or spooling down. At least 10 % of the maximum strand tension is necessary; it is better to use 15% or more. This ensures that the rope is guided tightly and evenly. The intersections are usually offset by 180°, meaning they are directly opposite each other. Since the intersection points

are always in the same location, these areas can be easily monitored, and wear can be limited to specific points.

The following two videos each begin with a visual demonstration of the winding patterns of our ropes on the multi-strand winches. Simply scan the QR code with a mobile device and play it.



Measures to extend the service life for hoisting ropes

<https://go.liebherr.com/hblj3f>



My tip: Cut off your hoist rope!

<https://go.liebherr.com/ydd28g>

### 1.4.2 Pulleys

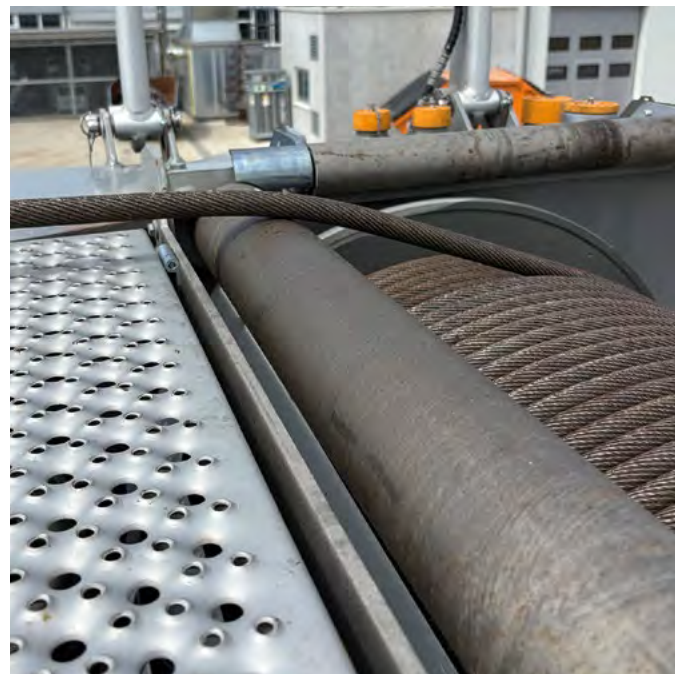
In the rope drive systems of telescopic and lattice boom cranes, **rope sheaves** and **carrying rollers** (see fig.) are used.

Sheaves serve two main purposes:

1. **Rope deflection** in the crane's geometry to transmit the winch's pull force to the desired point.
2. The **pulley block principle** uses the winch's single-strand pull to generate large adjustment and lifting forces.

Liebherr rope sheaves are precisely matched to the diameter of the rope in terms of the diameter of the groove base and its tolerance. In the event of a malfunction, Liebherr sheaves must always be replaced with original spare parts.

Carrying rollers are used to guide the rope around the winches and the boom. Carrying rollers are used where the deflection angles are smaller.



Carrying rollers on winch 1

### 1.4.3 Comprehension questions

1. Why are multi-layer rope drums with special grooves used?

- ☐ To work in a way that is gentle on the rope.
- ☐ To accommodate long rope lengths in a small space.
- ☐ Because it's the most cost-effective solution.
- ☐ To make it easier to install the winches.

2. What is the purpose of the special grooving of the winch?

- ☐ Visual improvement.
- ☐ Parallel winding pattern with defined crossing areas.
- ☐ Allows the rope to be shortened and repositioned, thereby extending its service life.
- ☐ Less force is required when winding.



## 2. Quick guide for crane operators

As a crane operator or rigger, you have the best view of the crane's actual condition. If you notice any abnormalities or defects in the wire rope or the entire rope drive during assembly, you can take immediate action to prevent damage. The prerequisites are knowing what to look out for and which measures are possible or advisable.

### 2.1 What should you look for? Common problems with the rope drive

#### 2.1.1 Regular inspections in accordance with ISO 4309

Ropes are wear parts and must be inspected regularly. Ropes that have reached the end of their service life must be replaced immediately. Improper handling or environmental factors can cause damage to ropes and lead to premature wear.



*All criteria for discarding in accordance with ISO 4309 can be found in the users manual, chapter 8.04, "Inspection of Crane Ropes."*

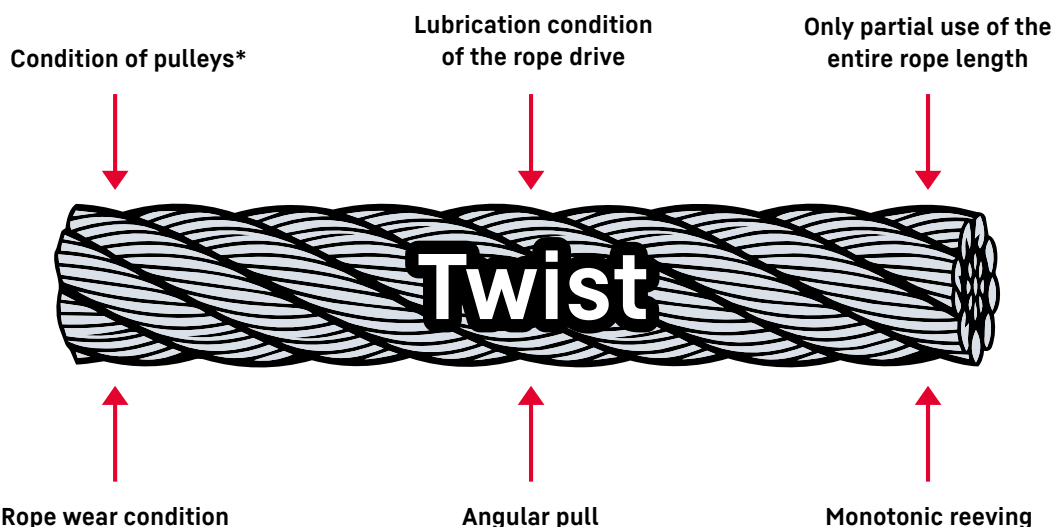
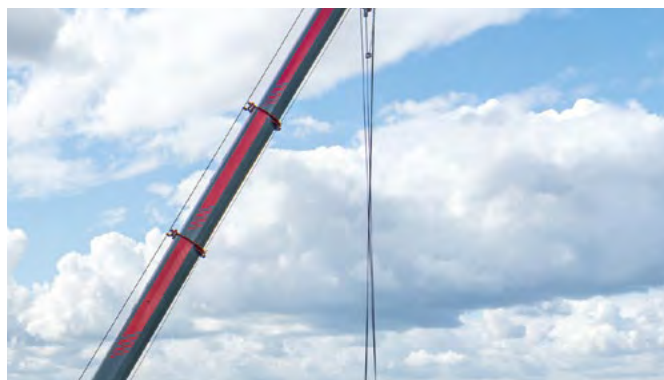
**Note:** If you have any questions about the condition of the rope or any damage, please contact our customer service department for mobile and crawler cranes.

#### 2.1.2 Avoiding twist – What are the reasons?

Twist in hoist and adjustment ropes is caused by daily use. Twist inevitably occurs, especially when working in a monotonous manner (same reeving, same operating mode). This can be seen, for example, when the hook block is twisted or when a luffing sheave block twists (see Figure xy). Equally evident are increased lateral wear on the rope sheaves or severe rope deformations such as **corkscrew** or **basket-shaped deformations**. There can be many reasons for this:

#### Important Information for our Customer Service:

- Description of the Problem
- **Detailed images** of the damaged area and its location
- **Images** of all sheaves (especially the grooved ones) and the sheaves on the hook blocks
- **Image** of the serial number at the end of the rope
- In which position and which winding is the damage located
- LICCON setup code for the driving state
- Operating hours of the OW and the winch



→ affects the twist

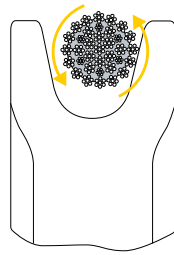
\*Depending on the wear on the sheaves, twisting may occur. Pulley wear is explained in Section 2.1.3.1.

Each of the factors listed (bottom left) contributes to an opening or closing twist in the rope. Over time, these twists accumulate on the rope and become noticeable as a twist. The twists are not equally pronounced at every point. However, if they become too high at a certain point, they can lead to the deformations and damage already mentioned. During operation, as a crane operator, you can influence whether and how much twist develops in the system by following the points listed above.

Note on the deflection angle:

If the rope does not run exactly straight in the groove of the sheave, a deflection angle is created. This causes friction against the side of the sheave, resulting in the rope twisting (twist) – regardless of the rope's construction. If the rope hits the side of the groove first, it “screws” itself into the ground in a helical pattern and twists.

**The following applies: The larger the deflection angle  $\beta$ , the greater the twist.**



**Here's a comparison: If the car wheel alignment is set incorrectly, the tires won't roll properly; instead, they'll be pushed sideways across the asphalt. This leads to increased wear and tear.**



Incorrect reeving can cause twists to form, which accumulate in the winch rope. This applies in particular to adjustment ropes.

Twist in the adjustment rope – for example, on winch 3 – can also be detected by a twisting adjustment pulley set during assembly. Because the crane's configuration remains constant, the same rope sections of a winch are always spooled up and down. Because there is a deflection angle  $\beta$  between the sheaves, the rope inevitably becomes twisted, and this twist can become locked into the lower strands of the rope.

**Note on twist:**

***A wire rope is a complex mechanical structure whose behavior is affected even by the slightest factors. Even if all the points described above are taken into account, twist may still develop in the system.***

**We expressly note that the Reeving plans provided must be strictly followed.**

## 2.1.3 Wear on the pulleys

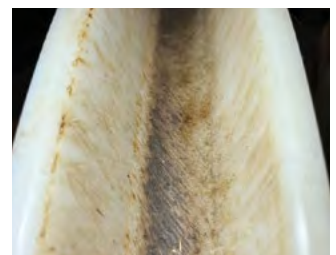
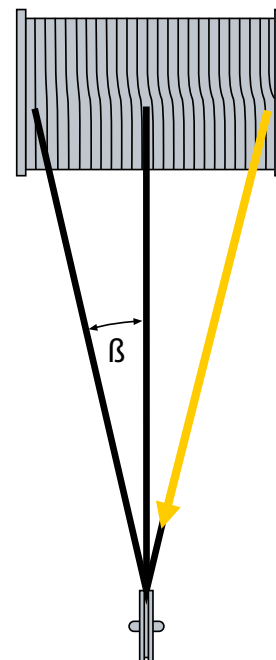
### 2.1.3.1 Negative profiles/worn groove flanks

Negative marks on sheaves are caused by normal wear and tear. Reasons for this include constant rope tension, consistent reeving, insufficient lubrication, luffing under load, or a consistently poor deflection angle. Rope strands entering at an angle can also cause negative profiles, **usually caused by an excessively large deflection angle  $\beta$** . Other reasons for an excessively large deflection angle “beta” include rotational movements of the crane, rope fluttering caused by wind, or vibrations

These pressure marks can lead to wire breaks and premature wear of the rope, and new ropes can be damaged quickly. Therefore, we recommend mechanical reworking using a groove milling machine, a repair drive\*, or, as a last resort, replacing sheaves with negative indentations when spooling up a new hoisting rope.

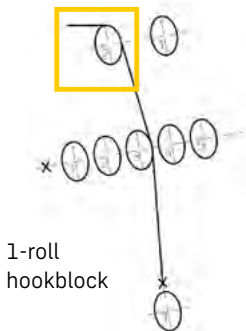
To reduce pressure marks and skewing, the deflection angle  $\beta$  must be kept as small as possible.

\* With a new sheave, a negative impression may form immediately in the groove under high rope tension. A repair run, during which the rope sheave is passed over multiple times using various rope strands, serves to reduce this indentation and restore the groove profile.

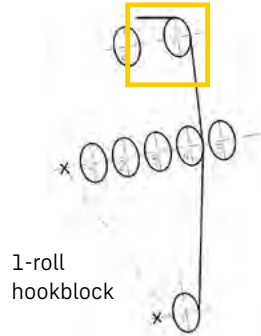


That is why, first of all, the **distance H** between the load hook and the roller head, as well as the **reeving plans** must be strictly observed. The distance H describes the minimum distance between the center of the pulley set and the hook and is explained in detail in chapter 40.35.40 of the TLT. Reeving plans ensure optimal deflection angles and even distribution of the load during the lift. In the example shown here, the system therefore switches to the outer neck roll when the fabric is reeved twice (see figure on the left).

Reeving single-fold



Reeving double



### 2.1.3.2 Grooved inlet

Over time, a wire rope gets thinner due to abrasion and aging. At the same time, rope sheaves also undergo a wear-and-tear process in which the groove diameter narrows due to the thinner rope. If you replace the wire rope with a new one now, it will no longer sit properly in the drum. The constricted sheave crushes the rope and destroys it within a short time. The same applies to carrying rollers.

Result:

Increased **wire breaks and basket formation** on the rope.

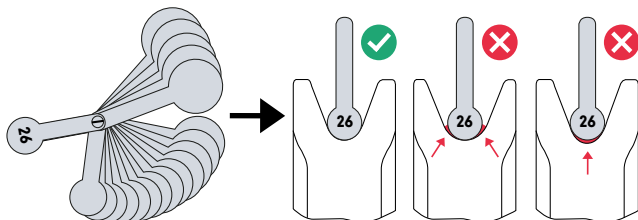
**As a general rule:**

**Groove diameter < rope diameter = poor combination**

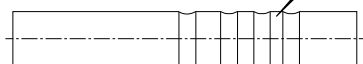
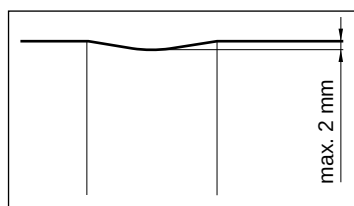
The groove diameter of the rope sheaves must be checked no later than when the rope is replaced.



**Tip:** Document the results with photos.



The depth of the run-in marks on carrying rollers must not exceed 2 mm.



### 2.1.3.3 Fixed pulley Bearings

Fixed pulley bearings mean: The sheave does not turn as the rope passes over it. The rope is literally cutting the sheave in half. This greatly accelerates rope wear and tear, and the danger of accident with life-threatening consequences is extremely high.

### 2.1.4 Lubrication

As mentioned in the chapter on fundamentals, optimal lubrication is essential and should be checked regularly.

### 2.1.5 Conclusion

*All procedures for inspecting rope sheaves and carrying rollers, as well as the criteria for removal from service in accordance with ISO 4308, can be found in the users manual in chapter 8.01, "Periodic Inspections," in subsection 9, "Inspection of Rope Sheaves," and in subsection 10, "Inspection of Carrying Rollers."*

**Note: If you have any questions about the condition of the rope or any damage, please contact our customer service department for mobile and crawler cranes.**

All of the points described affect the rope's service life. Even a new rope can become damaged again in no time at all if certain factors are lacking. The entire rope drive must be inspected regularly. At the very latest **after a rope change**.

**If you replace only the brake pads on your car when the brake discs are worn, the new pads will wear out again within a short time.**





## 2.1.6 Comprehension questions

### 1. Which statement about sheaves is correct?

- ☐ The groove diameter may be smaller than the rope diameter.
- ☐ Worn-out pulleys can quickly lead to wire breaks.
- ☐ Replacement parts do not have to be original.
- ☐ Angles of deflection are irrelevant.

### 2. What typically causes negative profiles on rope sheaves?

- ☐ Magnetic fields that are too strong.
- ☐ The deflection angle at the rope inlet is too large.
- ☐ The temperature in the rope is too high.
- ☐ Heavy use; wear and tear over the years.

### 3. What information is important to include when reporting possible rope damage?

- ☐ Photos of the sheaves.
- ☐ Photos of the damaged area, the location on the rope, and the rope's serial number.
- ☐ Name of the operating personnel.
- ☐ Current operating status of the crane:  
(LICCON crane code)

## 2.2 What can you do? Measures to ensure a long service life for ropes

This chapter explains general measures that extend the service life of ropes. These measures apply to hoist ropes and adjustment ropes and can be used on all Liebherr crane models.

### 2.2.1 Remove the twist

#### 2.2.1.1 Twist in the hoist rope

Two methods for removing twist from the hoist rope are described below. The methods must **be applied** one after the other.

- **Method 1: Un-twisting with single-strand reeving**
- **Method 2: Untwist by turning the hook block**



Both procedures are described in the users manual in *chapter 7.05.50, "Maintenance Instructions- Crane Booms," in subsection 3.10, "Unwinding a Lifting Rope with Extremely Low Twist."* Another method is described as follows.

- **Method 3: Twist compensation by shaking**

The rope is threaded through the hook block, the boom is raised, and, if necessary, extended. The hook block twists in an undesirable direction.

#### The reeved in hoist rope must not be hoisted or lowered during the following steps.

1. Manually turn the load hook to a neutral position (for example, using a Liebherr telehandler).
2. Next, turn the load hook another half turn so that torque is applied to the rope as pre-tension.
3. Now luffer the boom down and set the hook block on the ground. Now, the round rope end connection in the pocket lock comes undone due to the release of tension.
4. Shake out the rope strands several times.
5. Tilt the boom back up to lift the hook block off the ground.

This method can be used with both large and small equipment, including both telescopic and lattice-boom cranes.

### 2.2.2.1 Twist in the adjustment rope

Important for a correct understanding:

**With anti-twist adjustment ropes, twist cannot be removed via a freely rotating end connector. The total twist remains unchanged.**

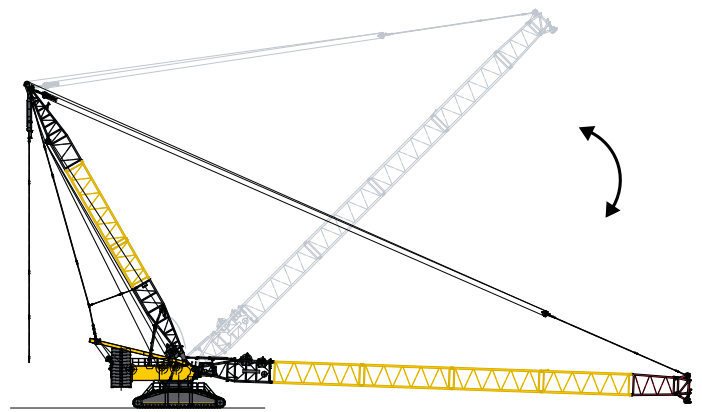
The reason for this is the non-rotating rope end connection on each adjustment rope.

Twist is a phenomenon that occurs locally. That is why it is possible to “distribute” the twist throughout the entire system.

#### Procedure:

1. Short main boom, maximum Derrick radius (no BV frame)
2. Repeatedly luff down and up to about 45°

*If you have any questions about this procedure or about the optimal boom configuration, please contact customer service.*



#### Our recommendation to help you prevent twist:



**The rope should not be operated exclusively in a specific configuration. Different spooling lengths, loads, and deflection points help distribute the stored twist throughout the system.**

**The rope should be completely spooled up and down on a regular basis.**

### 2.2.2 Replace rope pretention

If the rope of a multi-strand winch is not used to its full length due to the winch's configuration, the remaining rope on the drum may become loose within its strands. The main causes are machine vibrations combined with low strand tension. For example, when hoisting and lowering the hook block without a load.

#### Adjustment rope:

For example, in certain configurations, the rope on winch 3 of the crane with lattice mast can be spooled down all the way to its lowest position and then spooled up under load.

#### Procedure:

1. Short main boom, maximum Derrick radius of (no BV frame).
2. The main boom is on the ground, and the rope from winch 3 has been fully spooled down.
3. The Derrick boom is driven forward from the operating position to the assembly position. The Derrick angle is thus reduced by lowering winch 4 and raising winch 3. Be sure to maintain sufficient tension on the rope of winch 3, which is spooled up tightly under tension.

We recommend performing this procedure in conjunction with the configuration described in the previous section, 2.2.1.2.

#### Hoist rope:

To reset the rope tension on the hoisting rope, we recommend that you conduct **regular maintenance lifts**. In the first step, the optimally reeved hook block is spooled down completely, leaving only the four safety windings. The rope is then spooled up tightly onto the winch at a line pull of at least **10 % of the maximum line pull**.

Liebherr recommends the following video to explain the best practices for telescopic cranes and lattice boom cranes.

To do this, simply scan the QR code with a mobile device and play the video.



Measures to extend the service life for hoist ropes

<https://go.liebherr.com/hblj3f>

The two measures described ensure that the rope strands are spooled up tightly. This reduces winding problems and enhances the lateral strength of the lower rope layers.

**This can extend the rope's service life.**

### 2.2.3 Shorten and reposition the rope

Due to the winding method described above for our multi-layer winches, rope wear is concentrated at specific crossing points. From the viewer's perspective, the intersection points run horizontally along the winch. Before the rope in these areas reaches the point where it needs to be replaced, it is possible to **shorten and reposition the rope** the worn section of the rope can be shifted from the crossing points to the parallel section of the winch. The sections of rope that have been subjected to less stress so far are now located at the intersection points. This is possible for both hoist ropes and adjustment ropes.



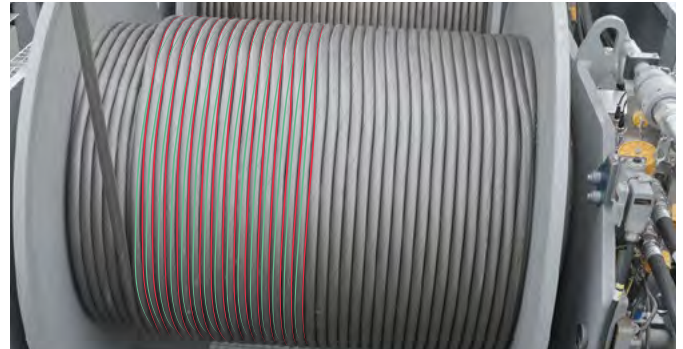
Users manual chapter 7.05.50 Maintenance Instructions for Crane Booms, subsection 3.12: Shortening the Rope.



We also mention this topic on our website. Simply scan the QR code with a mobile device and play it.



<https://go.liebherr.com/ydd28g>



If a crane is operated exclusively in a specific operating mode, the hoist rope can be shortened to a defined target length. This ensures that the rope is spooled down all the way to the lowest position during each job and is always spooled down and up over its entire length.



The bottom layers are protected; there is no need to shift positions for a maintenance lift.



Certain operating modes can only be used to a limited extent with a shortened hoist rope. This option should therefore be examined in detail beforehand.

### 2.2.4 Comprehension questions

#### 1. Why can a rope come loose on a multi-strand winch?

- ☐ Due to vibrations and low single line pull.
- ☐ Because the rope is too tight.
- ☐ Due to excessive load on the hook block.
- ☐ Due to maintenance cycles that are too frequent.

#### 3. What are the important steps to follow when replacing the rope pretetion?

- ☐ Spool down the rope only halfway.
- ☐ Spool down the rope as far as possible, up to the safety windings.
- ☐ Spool up the rope with at least 10% line pull (preferably 15% or more).
- ☐ Turn off the machine.

#### 2. What is the effect of shortening and repositioning a hoist rope?

- ☐ The worn area remains in the same spot.
- ☐ The worn section is moved to the parallel section.
- ☐ The rope's service life can be extended by up to twice as long.
- ☐ The winch can no longer be used.

#### 4. What are some ways to prevent the rope from twisting?

- ☐ Changing crane configurations.
- ☐ Adherence to the Reeving plans.
- ☐ Consistent spool down lengths on the same winch.
- ☐ Use of new sheaves.



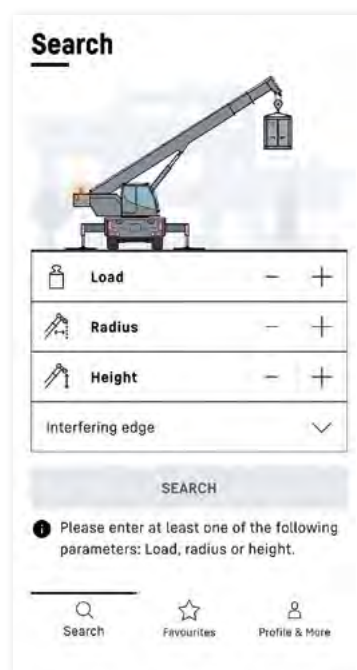
# 3. Hoisting ropes in wind power

The following boundary conditions apply to the assembly or disassembly of a wind turbine. Among other things, the choice of the right crane.

Liebherr offers the Crane Finder as the ideal tool for this purpose.

The **Crane Finder** is a digital planning tool. It was specifically designed to help users quickly, easily, and reliably identify the ideal crane for any lifting task. Whether you're on a construction site, in the office, or on the go using the app version.

With just a few entries (amount to be withdrawn **load**, the desired **height** and **boom radius** ), Crane Finder will shortly provide you with a customised selection of suitable mobile and crawler cranes, including the optimal configuration. Thanks to its intuitive operation, the tool saves time, effort, and resources, and enables you – as a crane operator and planner – to make the right decisions even faster.



Web application  
MyLiebherr



Crane Finder App  
App Store (iOS)



Crane Finder App  
Google Play (Android)

Using this tool, suitable cranes with the appropriate configurations were identified for various wind turbines jobs.

In the first example, a crane is used to perform a lift at a wind turbine with a lifting height of 80 m, which corresponds to a pulley head height of **91 m**, and a weight of **63 t** gross. Based on the two search queries, the following crane is found:

## 1. LTM 1650-8.1

|                             |                 |
|-----------------------------|-----------------|
| Configuration:              | <b>T3YV2EN</b>  |
| Rated load:                 | 68.8 t          |
| Pulley head height:         | 91.2 m          |
| Boom length:                | 92/92/92 (51 m) |
| Adapter length:             | 16 m            |
| Length N:                   | 24.5 m          |
| Rope length W2:             | 800 m           |
| Max. line pull force W1/W2: | 12.7 t          |

In the second example, a crane is used to perform a lift on a wind turbine with a lifting height of 166 m, which corresponds to a pulley head height of **180 m**, and a weight of **140 t** gross. Based on these two pieces of information, the following crane is obtained:

## 2. LR 11000

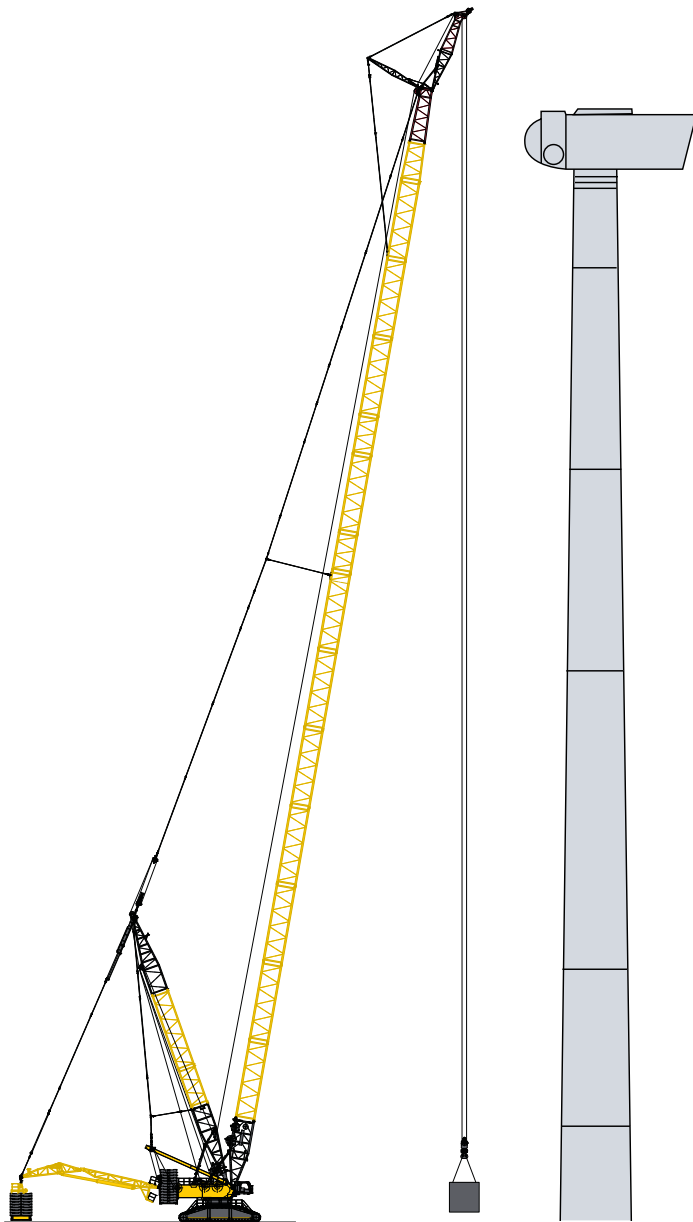
|                             |                  |
|-----------------------------|------------------|
| Configuration:              | <b>SL10DF2BV</b> |
| Rated load:                 | 140.3 t          |
| Pulley head height:         | 184.4 m          |
| Length D:                   | 42 m             |
| Length HA:                  | 168 m            |
| Length F:                   | 12 m             |
| Rope length W1 & W2:        | 1,450 m          |
| Max. line pull force W1/W2: | 23.0 t           |

### 3.1 Assembly and disassembly of wind turbines

During the assembly of wind turbines, the hoisting rope is spooled up under a very heavy load. If basic requirements are not met, this can lead to increased rope wear even during the assembly of the system.

Extreme, adverse load cycles also occur during the disassembly of these systems, which can significantly shorten the service life of the hoist rope

#### 3.1.1 The issues



##### Assembly

Before lifting begins, the crane must be set up with the correct boom configuration, and the load must be properly secured using slingers. The hookblock is usually positioned close to the ground, and most of the hoisting rope has been spooled down. Rope strands that remain on the winch with low or uneven pretension when the load is applied can lead to increased rope wear during the assembly of wind turbines.

→ Insufficient pretension before the first stroke

The lifting of heavy components (e.g., the machine housing) is often followed by the lifting of lighter components (e.g., rotor blades). With the same reeving, these loads are sometimes insufficient to ensure the required 10% pretension in the lower rope layers. If, at the end of the job, the rope is wound up just using the weight of the hook block—for example, when lowering the empty hook block to remove the slings—this can result in serious rope damage during the next lift.

→ Poor pretension after the last stroke

##### Disassembling

During disassembly, light parts are removed first. Example: Rotor blades. After that very heavy components, such as the generator, are lifted.

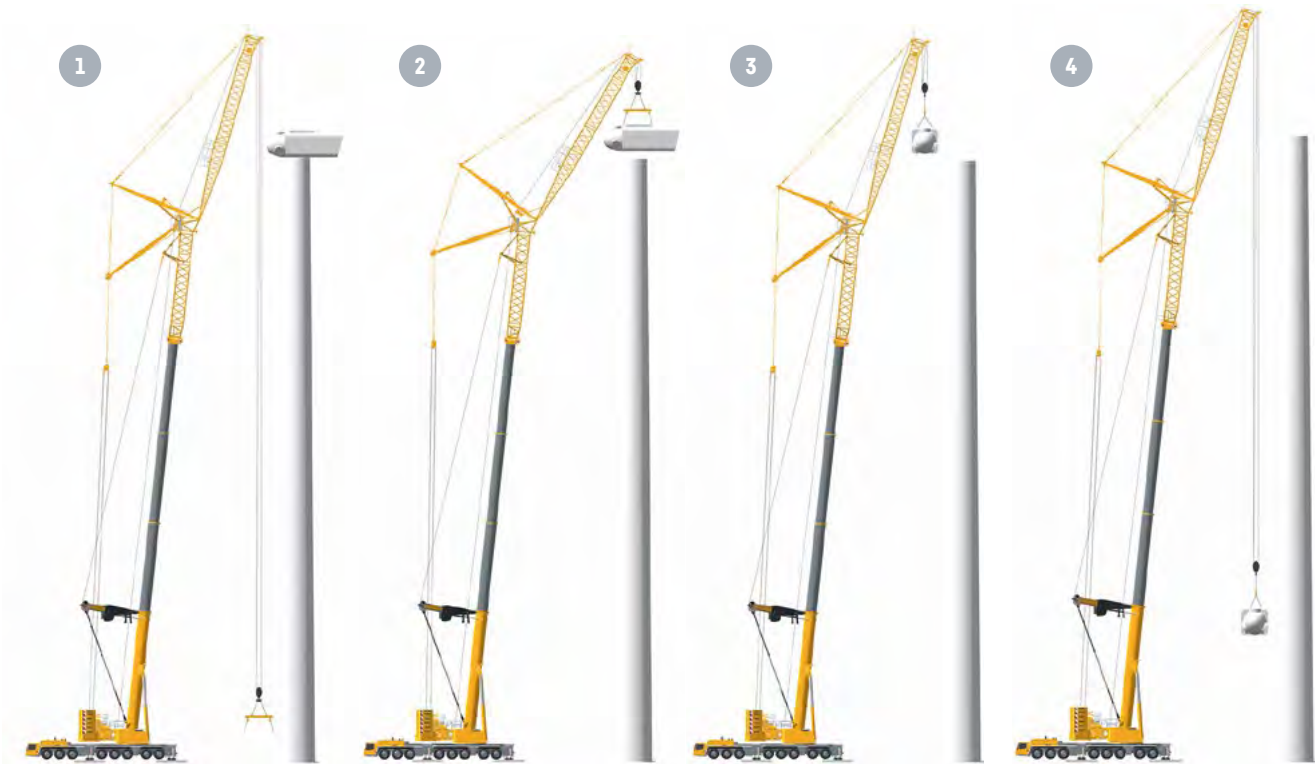
##### This gives rise to the following risks:

- A few light lifts at the start loosen the lower layers of rope on the winch. This happens especially when excess rope remains on the winch and work is done only from the upper layers (vibrations in the system).
- If the rope is wound onto the drum without a load in order to bring the load hook to the anchor point, the necessary pretension is missing. The rope doesn't spool smoothly, and its resistance to lateral pressure decreases significantly.
- If a heavy load is then lifted, the high strand tension during lowering acts directly on the poorly pretensioned lower strands.

### Consequences:

- The rope in the top layer cuts into the lower layers
- Significant rope wear even during the first lowering
- Sudden release of the rope → poor driving quality and vibrations throughout the crane

Here, using the LTM 1650-8.1 as an example, such a suboptimal procedure is illustrated in four steps:



### Result:

The hoist rope may need to be replaced after just a few lifts – resulting in high costs and downtime.

### 3.1.2 Types of damage

Various types of damage can occur to hoist ropes, ranging from deformations and wire breaks to strand breaks. The field photos show typical damage that occurs during operation on the winch of a telescopic crane.

A similar problem can arise even when spooling up a new rope: The rope usually lies on the reel with very little tension. If it is then wound onto the winch with tension, the rope may cut into the reel.

Result: The new hoist rope can be damaged even before its first use and, in the worst case, may be ready for replacement right away.



### 3.1.3 Measures

The following section provides general information that applies to all Liebherr crane models.

#### 3.1.3.1 Over-reeving

We define "over-reeving" as the amount by which the hoist rope is reeved into the hook block exceeding the required amount of reeving. To determine the reeving, a understanding of the process for **calculating the hook block weight** is essential! This is explained in detail in chapter 6.

##### Result at over-reeving:

The single line pull force is reduced. This reduces the lateral pressure on the lower rope layers of the winch and significantly lowers the risk of the rope cutting into the rope.

#### 3.1.3.2 Use of W1, W2, or W1 || W2

Mobile and crawler cranes with higher load-capacity ratings are required for the assembly and disassembly of wind turbines. Most of them are equipped with multiple hoisting winches. The **alternating use** of the hoisting winches ensures that both components **wear evenly** and extend thereby indirectly **the service life of a single hoist winch**.



**It's similar to the tires on a car:**

**If you rotate the front and rear tires on your vehicle, they will wear more evenly and last longer.**

Possible operating modes for the winch are:

#### 3.1.3.3 Hook block auxiliary weights

Additional weights can be mounted on many of the hook blocks on Liebherr telescopic and lattice boom cranes

##### Practical recommendations for use in wind power:

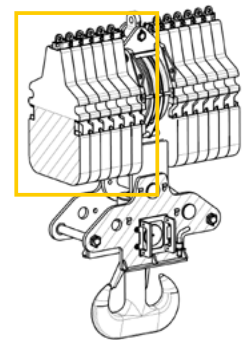
##### Wind turbine assembly:

For the lifting job, over-reeving reduces the strand tension. However, the weight of the hook block must never be less than the minimum weight required by TLT/AAT/BAL.

##### Maximum reeving force and minimum hook block weight!

→ With this combination, the rope is subjected to minimal line pull from the load's pull force.

##### Disassembly of a wind turbine:



##### Max. reeving force and max. hook block weight!

→ The load hook must be raised to the boom head without a load. By using the maximum amount of hook block weights, the line tension can be increased. The hoist rope is spooled up more tightly, improving its resistance to lateral forces. Sample calculations are included in the appendix.

|                             |  |  |  |
|-----------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Individual operation W1     |  |   |  |
| Individual operation W2     |  |   |  |
| Parallel operation W1    W2 |  |   |  |

 Yes

 No

### 3.1.3.4 Replace rope pretension

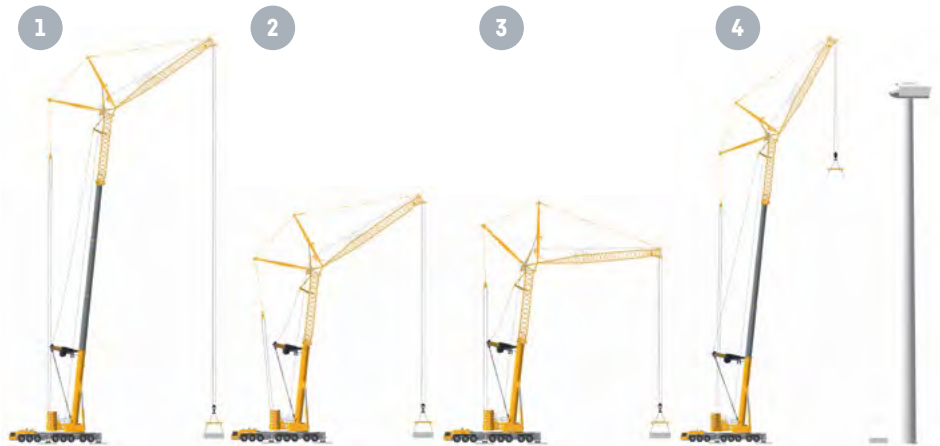
Between two jobs, the rope pretension can be restored either using the load or with additional weights. The hoisting rope can be spooled down all the way down to the lowest rope layers by telescoping, and then neatly rewound under load.

#### Telescopic crane: LTM 1650-8.1 (Configuration T3YV2EN)

When using **W2, n = 7**, and a maximum telescopic load of **12.6 t**, the hoisting rope is **wound onto the winch with a strand tension of approximately 15%**.

This allows **more than 70% of the hoist rope to be spooled up onto the drum** with sufficient pretension.

The figure on the right illustrates the process described.



#### Lattice boom crane:

During the disassembly of wind turbines, a longer boom configuration may be used for the first lift (e.g., rotor blades) than for the second lift (e.g., generator). In the case of lattice boom cranes (e.g., LR 11000), the crane must therefore usually be subjected to a take-down, modification, and re-erection after the rotor blade has been disassembled.

#### Procedure:

1. Before the first lift, you must reeve in the hook block as much as possible so that the hoisting rope can be spooled down all the way to the bottom layers. To achieve maximum reeving, follow the instructions in the chapter "**Minimum Hook Block Weight**".

2. When performing the take-down, perform a maintenance lift → the lower rope strands are tightly wound onto the drum. In the case of single-unit operation W1 or W2 in a 6-fold reeving configuration with the SL10DF2BV configuration, this would look as follows:

- **Step 1:** With 20% line pull (approx. 32 t, including the hook block) Spool up the hoist rope onto the drum and luff down until the 100% cut-off is reached → approx. 350 m of hoist rope are spooled up onto the drum (approx. 3.5 layers).
- **Step 2:** With a 10% line pull (approx. 16 t, including the hook block), continue until the next 100% cut off is reached → approx. 470 m of rope is wound onto the drum (approx. 4.5 layers).

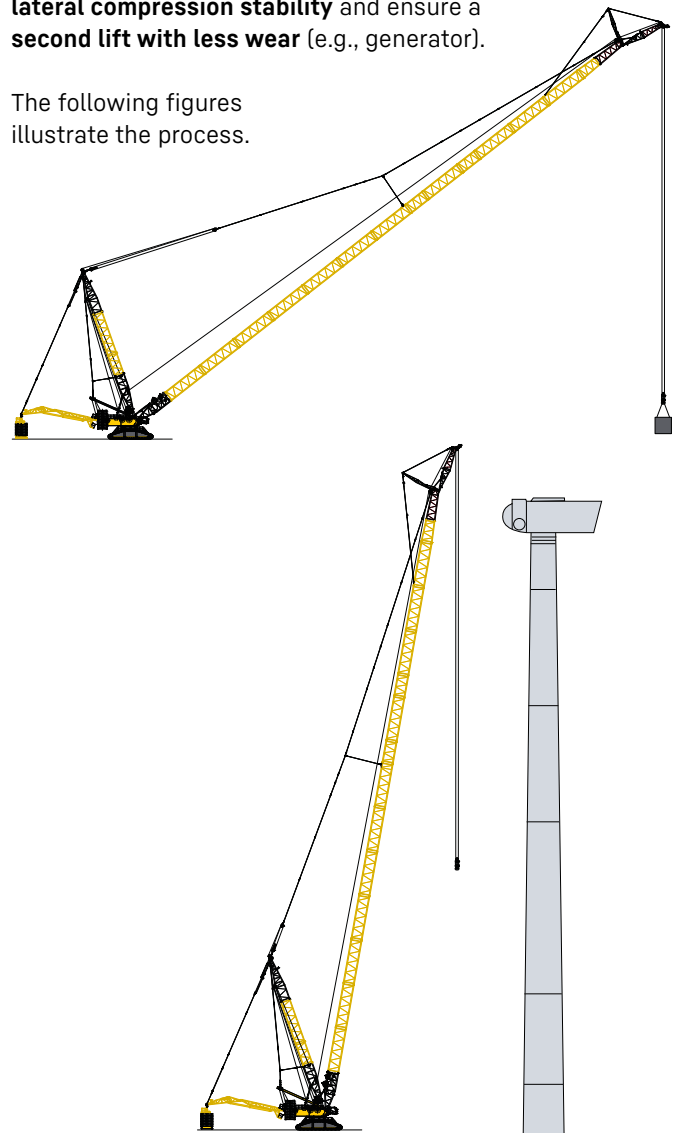
3. You are modifying the crane and setting it up again.

4. When using the hoisting winch, **spool down only as much rope as necessary** so that the lower layers remain taut.

#### Advantage:

The tightly spooled lower rope layers improve **lateral compression stability** and ensure a **second lift with less wear** (e.g., generator).

The following figures illustrate the process.



## 3.2 Luffing jib assembly: Pick up the luffing pulley block at LTM

Further damage to the hoist rope may occur during the assembly of the luffing jib on a Liebherr mobile crane. During assembly of the luffing pulley block, the lifting winch is used as an auxiliary winch to spool down the adjustment rope. This can subject the hoist winch's rope to high pull forces. Due to the design, these forces can cause wear on the hoist rope during certain installation steps. Therefore, depending on the device, certain things must be taken into account **to keep the load as low as possible**.

### 3.2.1 LTM 1750-9.1: Procedure using winch 1



The exact procedure is described in detail in users manual chapter 5.04, "Tiltable Lattice Jib – TN," in subsection 5.8, "Retrieving the Upper Luffing Pulley Block," in a total of four steps.

**The rope on Winch 1 will only be subjected to minimal stress if you follow the steps and distances exactly. In particular, the target values Y.**

The video provides additional information on the topic. To do this, simply scan the QR code with a mobile device and play the video.

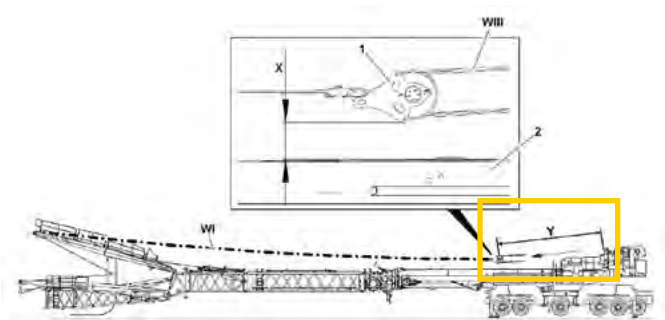
Assembly/disassembly of the luffable lattice jib on the LTM 1750-9.1

<https://go.liebherr.com/qa4427>



| Operating mode: TN; TNH; TYVEN; TYVENH; TYV2EN; TYV2ENH; TYV23EN; TYV23ENH |                               |                |
|----------------------------------------------------------------------------|-------------------------------|----------------|
| Length of the luffing lattice jib                                          | Required minimum rope reeving | Target value Y |
| N 21 m to N 24.5 m                                                         | 4                             | 2 m            |
| N 28 m to N 31.5 m                                                         | 2                             | 4 m            |

Set up target values for NA-frame 2



### 3.2.2 LTM 1750-9.1: Procedure using a winch 2

The N-luffing pulley block can also be assembled using the winch 2.

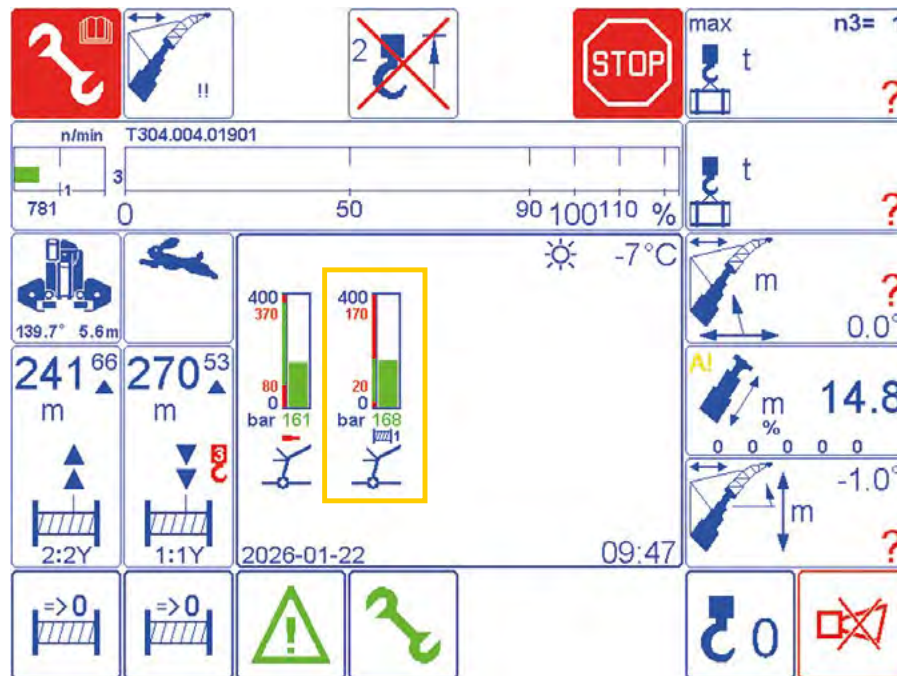
The installation process is similar to that of other LTM: Set NA-frame 2 to 90° and hold NA-frame 1 slightly off the

ground while winch 2 hoists the rope onto the drum and winch 3 lowers the rope at the same time. The target values Z remain the same.



### 3.2.3 Other LTM: Pressure indication during assembly

For the **LTM 1400-6.1**, **LTM 1450-8.1** and **LTM 1650-8.1**, there is another solution for the same winch-related issue . The current load pressure of winch 1 is displayed as a digital value on the LICCON monitor. The pressure should be within the green range. The following points must be taken into account:



### 3.2.4 Comprehension questions

#### 1. What is the purpose of the Liebherr Crane Finder?

- ☐ It automatically calculates the rope's service life.
- ☐ It quickly identifies the right crane, including the optimal configuration.
- ☐ It takes over job planning from the crane operator.
- ☐ It is used exclusively to document completed lifts at.

#### 3. What is the risk if the hoist rope is spooled up using only the weight of the hook block?

- ☐ The single line pull is increasing too rapidly.
- ☐ The lower rope strands are not being pre-tensioned sufficiently.
- ☐ The winding performance is not optimal.
- ☐ The reeving changes automatically.

#### 2. Why is it especially important to ensure that the rope is sufficiently tensioned before the first lift?

- ☐ To increase the hoisting speed.
- ☐ To prevent excessive rope wear right from the start of assembly.
- ☐ To be able to drive the boom in a shorter configuration.
- ☐ To increase the crane's load capacity.

#### 4. What are the potential consequences of insufficient rope pre-tension when lowering heavy loads?

- ☐ Wire breaks caused by friction.
- ☐ Sudden release of the rope and vibrations in the crane.
- ☐ Rope damage caused by poor lateral pressure stability.
- ☐ Overtime for service staff.



## 4. Adjustment ropes in wind power

It is not only hoisting ropes that are subjected to high loads during certain operations. Adjustment ropes are also subject to heavy wear if handled improperly. Particularly in the field of lattice boom cranes.

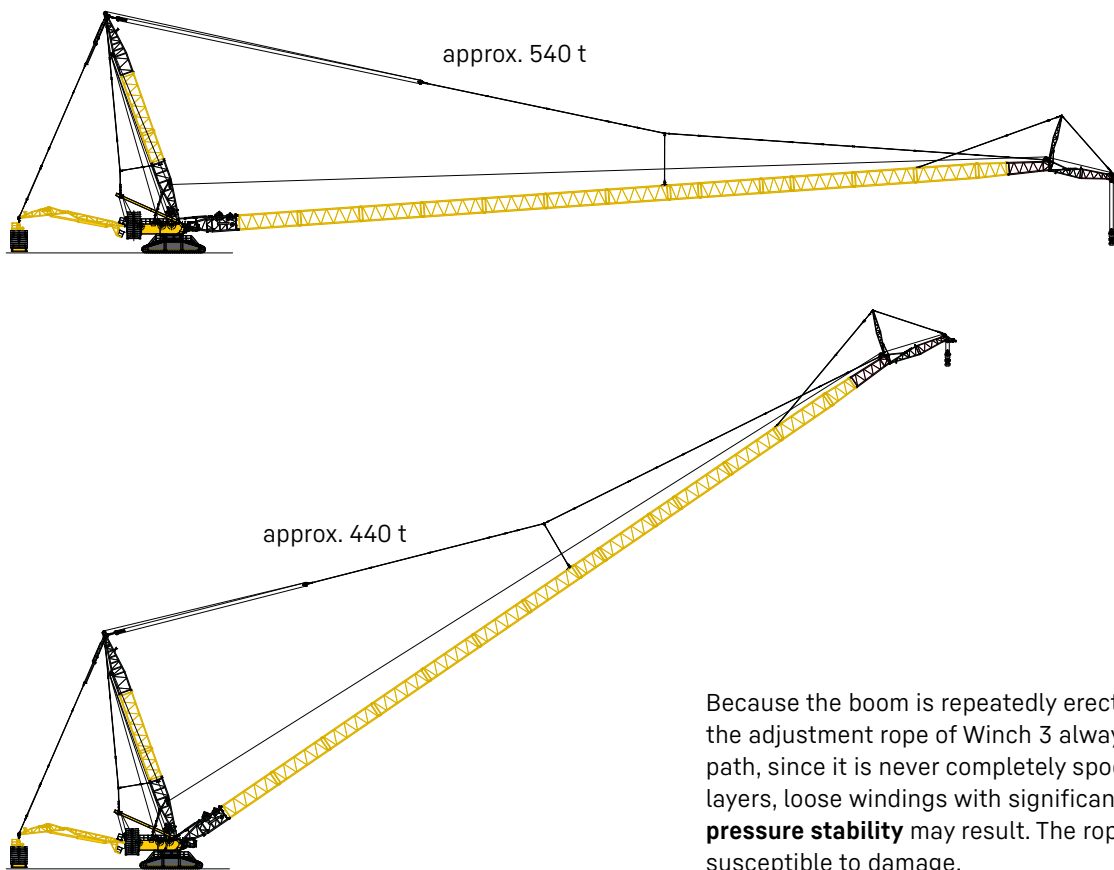
### 4.1 Problem statement: Erecting/take-down as a critical point

Using the LR 11000 as an example in the configuration **SL10DF2BV**, we assume that the crane is primarily operated in the wind power sector with a constant boom length. The greatest pull forces on the main boom adjustment rope (winch 3) occur **when the crane is being erected and performed during the take-down**. The more horizontal the main boom is during these phases, the greater the forces acting on it. This is clearly evident displaying **F1** and **F3** in combination with the suspended ballast.

#### Example:

If the main boom angle changes from  $4^\circ$  to  $34.4^\circ$ , the force **F3** decreases from approximately 540 t to approximately 440 t – a reduction of over 100 t.

At the same time, the adjustment rope is wound onto the drum by approximately 226 meters, that is, **from layer 4, winding 8, to layer 6 winding 2**. Consequently, the 3rd and 4th layer are subjected to the greatest lateral forces.



Because the boom is repeatedly erected and taken down, the adjustment rope of Winch 3 always runs along the same path, since it is never completely spooled out. In the lower layers, loose windings with significantly poorer **transverse pressure stability** may result. The rope becomes more susceptible to damage.

### 4.2 Types of damage

The loss of transverse pressure stability is evident from **deformations** of the rope at the intersections of the multi-layer winding. Depending on the severity, this can cause the rope to become ready to be discarded. Typically, the same turns on the same layers are always affected.



### 4.3 Measures

The service life of the adjustment rope can be extended by taking specific measures:

- With its extensive range of equipment, a lattice boom crane is designed for a wide variety of applications. This makes it a highly flexible machine. Because the device is used in as many different ways as possible, the rope is also used at various lengths and is subjected to different loads. This reduces one-sided stress and thus premature failure. For example, instead of using only the SL10DF2BV configuration length for the LR 11000, different lengths of this configuration can be used for different lifts. Here components (including the rope) are subjected to different loads and do not wear out exclusively in the same spot:



**If you always drive a car taking only right turns, the left wheel bearing will be the first to fail.**

- One important factor is the increase in transverse pressure stability. By replacing the **rope tension**, it can be maintained. Chapter 2.2.2 describes the procedure for the adjustment rope.

- If the adjustment rope shows signs of wear or flattening at the intersections of the multi-layer winding, this can be corrected by **shortening the rope**, the worn section can be moved to the less stressed parallel sections of the winding. This procedure is described in detail in Section 2.2.3.

- By using **shorter rods in the S-adjustment** the **LR 11000 in the SL10DF2BV configuration** allows an extension in the service life of the adjustment rope of winch 3. In particular, with regard to **transverse pressure stability and twist**.

When constructing modern wind turbines today, **significantly more turbines are installed in a shorter amount of time** using the same crane. As a result, the ropes are used more intensively and wear out more quickly over time. Even though the rope used to last longer, it now reaches the same or even a higher number of operating hours in a shorter period of time.

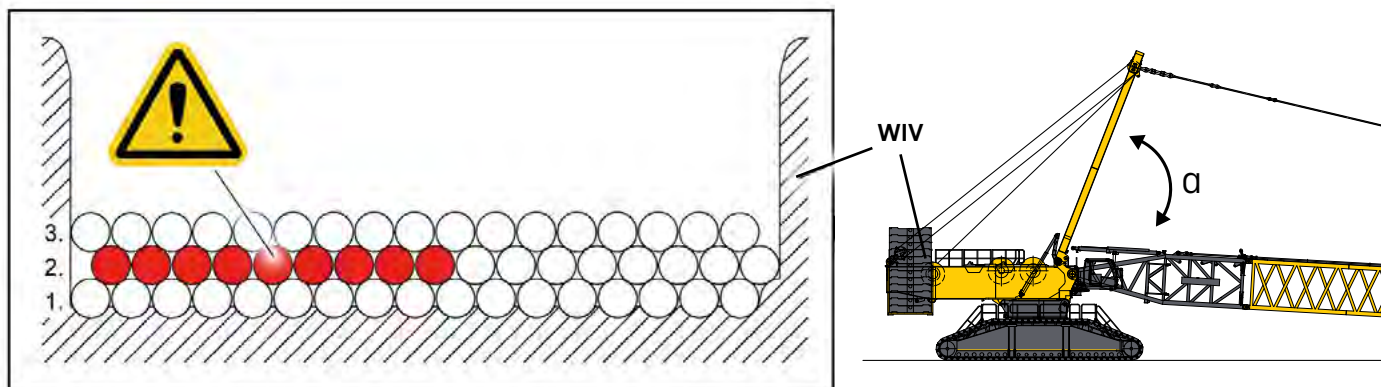
**If you drive your car at a constant speed of 150 mph on the highway, you risk premature engine failure.**



### 4.4 Flat spots on winch 4 (W IV)

On winch 4, operational factors may cause flattening in the second layer during high single line pull. For example, by frequently performing erecting and take-downs on long main booms.

This flattening is normal at first, as long as there are no wire breaks – or only a few.



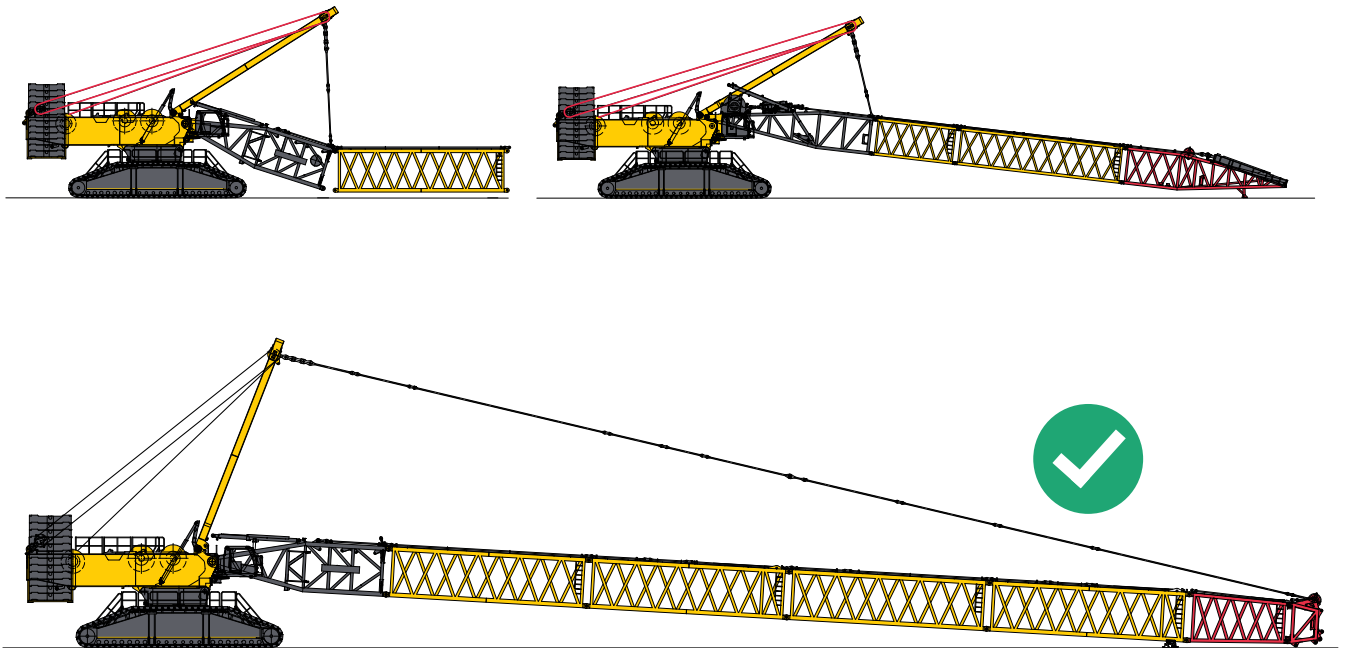
Flat spots exceeding **20%** do not automatically result in the rope being ready for discard if the affected section of the rope is inspected by a qualified person during each straightening operation.

It is also important that, during high single line pulls, the flattened section of rope remains completely on the winch drum and that the specified minimum **angle  $\alpha$**  is not exceeded. Provided these criteria are met, the rope on

winch 4 may continue to be used with the flattened sections.

*Permitted only in accordance with users manual chapter 8.04/subsection 27.4 and only under the conditions specified therein. No evaluation by operating personnel.*





## 4.5 Comprehension questions

**1. Why is erecting and taking-down the main boom on lattice boom cranes particularly taxing on the adjustment rope?**

- ☐ The rope length increases significantly in the process.
- ☐ During these phases, the highest pull forces act on the adjustment rope.
- ☐ The lower strands of the rope are subjected to enormous lateral forces.
- ☐ The suspended ballast is relieved.

**2. What are the consequences of a loss of lateral tension stability in the adjustment rope?**

- ☐ Increase in load capacity.
- ☐ Deformations of the rope at the intersections of the multi-layered winding.
- ☐ Automatic reduction of the single line pull.
- ☐ Even rope wear along the entire rope length.

**3. Under what conditions may flattening on the winch 4 (WIV) continue to be accepted?**

- ☐ When there is no longer any lubrication.
- ☐ The flattening is greater than 20 % and is not tested.
- ☐ Regular inspections are conducted, and the minimum angle  $\alpha$  is maintained.
- ☐ The rope is operated exclusively in idle mode.



# 5. The 10 commandments of rope-friendly work



To maximize the service life of hoist ropes or adjustment ropes, there are a few basic principles to keep in mind. If these guidelines are followed consistently and properly, the rope's service life can be significantly extended:

**1. Wind up the rope onto the winch with at least 10% tension**

This prevents the rope from cutting into itself, improves its resistance to lateral pressure, and reduces spooling problems. The rope lays perfectly in every layer on the winch. Wear occurs almost exclusively at the junctions, provided the rest of the rope drive is in good condition.

**2. Perform regular maintenance cycles on the rope**

A maintenance cycle involves completely spooling down the rope on the winch and then spooling it up while applying a pre-tension of at least 10% of the rope's tensile strength. Maintenance lifts can be performed in various configurations, depending on the crane and the length of the rope.

**3. Use as much of the rope length as possible on the winch**

If possible, the load should be lifted with the lowest possible amount of rope remaining on the winch. This can be achieved by using a longer main boom or by overreeving the hook block, as well as by cutting the rope to a specific length.

**4. Use different configurations/reevings**

That is why the crane should be used as flexibly as possible. For example, by changing the reeving, using winch 2 instead of winch 1 or W1 || W2, or by altering the crane configuration (longer or shorter boom).

**5. Use auxiliary weights on the hook block to increase the single line pull**

If the rated load allows it, adding auxiliary weights to the hook block results in better spooling and increased lateral force stability when lifting with an empty hook block.

**6. Shorten the rope in a timely manner and reposition it**

If the crossover areas between the layers – which are subject to heavy wear – are offset, the rope may, under certain circumstances, experience a significant extension of its service life.

**7. Maintain and inspect the entire rope drive system regularly**

The rope drive extends from the winch, along the rope, through the rope sheaves and carrying roller of the crane through the hook block, to the rope end connection. All components must therefore be regularly maintained and inspected.

**8. Maximum reeving and minimum hook block weight during assembly of a wind turbine**

Ideally, the boom can be taken-down without further spooling the hoist winch, so that the hoist rope remains spooled up with high single line pull.

**9. Use maximum reeving and maximum hook block weight during disassembly of a wind turbine**

The hook block must be hoisted to the boom head without any load. To increase the line pull, the remaining load capacity should be utilized by adding auxiliary weights to the hook block.

**10. Never use a twist compensator in connection with an adjustment rope**

This can lead to dangerous situations and accidents.

**These guidelines are essential for maximizing the rope's service life and preventing financial losses.**



# 6. Appendix

## 6.1 Calculation of minimum hook block weight

The following weights and heights are relevant for the crane configurations determined using CraneFinder:

|                | Telescopic Mobile Crane | Lattice Boom Crane |
|----------------|-------------------------|--------------------|
| Hub height WKA | 80 m                    | 166 m              |
| Net load       | 60t                     | 125t               |

Before each lift, the required hoist rope reeving configuration and the optimal weight for the hook block must be determined. Since there are various weight combinations possible for hook blocks, which in turn affect the winding behavior and service life of hoisting ropes, the basic procedure must be clear.

The following section provides step-by-step instructions on how to determine the hoist rope reeving and the hook block weight.



The following description is intended only as a general overview and guide. It is mandatory to follow the users manual when performing the work!

1

The following must be given in the beginning:  
→ the total boom length **L**  
→ the total weight

*See load chart manual chapter 40.90*

2

Determination of the **minimum reeving  $n_{min}$  and minimum weights for the hook block** based on criteria/specifications:  
1. to lift the **load**:  
→ maximum strand tension  
2. because of **statical reasons**:  
→ to prevent uncontrolled backward movement of the boom system in steep boom positions  
3. for **reliable load weighing**:  
→ to ensure accurate load weighing by the LML  
4. for **parallel operation**  
→ Proper operation of the parallel operation mode

*See load chart manual chapter 40.90*

3

Maximum reeving for the boom system  
→  $n_{max}$   
ensure that the **hook block reaches the bottom**.

Choose the perfect reeving  
→ **The more you reeve in, the better!**

4

Calculate the **hook block weight** using the selected reeving angle  
→  **$G = L \times M \times n \times F$**

*See load chart manual chapter 40.35*

The four points mentioned are described in detail on the following pages for both the telescopic mobile crane and the lattice boom crane.

### 6.1.1 LR 11000: SL10DF2BV

The LR 11000, with the SL10DF2BV configuration (168 m main boom + 12 m F2 jip), is used as an example crane. The load to be lifted weighs approximately 125 t and will be raised to a height of 166 meters.

Detailed procedures are explained in the included load chart under Section 40.35, "hook blocks and load Hooks," and in Section 40.45, "Determining hoist rope reeving and hook block selection."

### 6.1.1.1 Boom length and gross weight

1

The boom length should be determined by the lifting height of the load.

The gross weight is calculated as follows:

- Weight of the load to be lifted
- Weight of the load handling equipment (load hooks)
- Weight of the fastening equipment

The total weight is estimated at 135 t to 140 t.

### 6.1.1.2 Minimum hoist rope reevings and system-specific minimum hook block weight

2

When a hoisting rope is reeved into a hook block, the pulley principle is applied. That's the principle of the distribution of force across multiple rope strands. The rope is guided alternately over sheaves at the boom head and at the load hook. Each strand of rope that supports the load hook bears a portion of the load. This reduces the required pull force of the winch accordingly.

If, for example, the rope is reeved in four times into the hook block, the winch only has to exert about a quarter of the actual force. To compensate this, the winch must pull four times the length of the rope to lift the load. The more often it is reeved in, the heavier a load can be lifted by the winch. At the beginning of the load chart, the maximum loads are listed in a table according to the amount of reevings. The respective load charts indicate the recommended **hoist rope reeving**.

EST1, F = 230.0 kN, d = 32.0 mm

|     | EN 13000 | ASME B30.5 |
|-----|----------|------------|
| 1x  | 23.2     | 21.1       |
| 2x  | 46.2     | 42.2       |
| 3x  | 68.9     | 63.3       |
| 4x  | 91.5     | 84.4       |
| 5x  | 113.8    | 105.5      |
| 6x  | 135.8    | 126.6      |
| 7x  | 157.7    | 147.7      |
| 8x  | 179.3    | 168.8      |
| 9x  | 200.7    | 189.9      |
| 10x | 221.9    | 211.0      |
| 11x | 242.9    | 232.1      |
| 12x | 263.7    | 253.2      |
| 13x | 284.3    | 274.3      |
| 14x | 304.7    | 295.4      |
| 15x | 324.8    | 316.5      |
| 16x | 344.8    | 337.6      |
| 17x | 364.5    | 358.7      |
| 18x | 384.1    | 379.8      |
| 19x | 403.5    | 400.9      |
| 20x | 422.7    | 422.0      |
| 21x | 441.6    | 443.1      |
| 22x | 460.4    | 464.2      |
| 23x | 479.0    | 485.3      |
| 24x | 497.5    | 506.4      |
| 25x | 515.7    | 527.5      |

LR 11000 T235.056.00317 EN 13000  
SL10DF2BV: SL10-168m D-42m F2-12m 10°BV



501

| m     | 13.0  | 15.0  | 16.0  | 18.0  | 22.0  | 26.0  | 30.0  |
|-------|-------|-------|-------|-------|-------|-------|-------|
| 24.0  | 140.0 | 140.0 | 140.0 | 140.0 | 140.1 | 140.1 | 140.1 |
| 26.0  | 139.2 | 139.2 | 139.2 | 139.3 | 139.3 | 139.3 | 139.3 |
| 28.0  | 138.5 | 138.6 | 138.6 | 138.6 | 138.6 | 138.7 | 138.7 |
| 30.0  | 137.8 | 137.9 | 137.9 | 137.9 | 137.9 | 138.0 | 138.0 |
| 32.0  | 137.0 | 137.1 | 137.1 | 137.1 | 137.1 | 137.1 | 137.2 |
| 34.0  | 136.2 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 | 136.5 |
| 36.0  | 135.4 | 135.5 | 135.6 | 135.6 | 135.6 | 135.6 | 135.7 |
| 38.0  | 134.7 | 134.8 | 134.9 | 134.9 | 134.9 | 134.9 | 135.1 |
| 40.0  | 133.9 | 134.0 | 134.1 | 134.1 | 134.1 | 134.2 | 134.3 |
| 44.0  | 131.5 | 132.6 | 132.5 | 132.6 | 132.6 | 132.7 | 132.8 |
| 48.0  | 129.4 | 131.2 | 131.2 | 131.1 | 131.2 | 131.2 | 131.4 |
| 52.0  | 107.6 | 122.4 | 124.9 | 129.4 | 129.7 | 129.8 | 130.0 |
| 56.0  | 94.8  | 109.2 | 115.4 | 126.6 | 128.1 | 128.1 | 128.4 |
| 60.0  | 83.4  | 97.0  | 103.9 | 116.5 | 125.0 | 125.0 | 125.2 |
| 64.0  | 73.4  | 86.3  | 92.9  | 104.9 | 121.9 | 121.8 | 122.0 |
| 68.0  | 64.2  | 76.5  | 82.7  | 94.1  | 114.0 | 118.8 | 119.0 |
| 72.0  | 56.1  | 67.8  | 73.8  | 84.7  | 105.2 | 116.1 | 116.3 |
| 76.0  | 48.5  | 59.7  | 65.4  | 75.8  | 96.1  | 110.3 | 113.4 |
| 80.0  | 41.6  | 52.3  | 57.8  | 67.7  | 87.3  | 103.3 | 110.3 |
| 84.0  | 35.3  | 45.6  | 50.8  | 60.3  | 79.3  | 95.7  | 106.5 |
| 88.0  | 29.3  | 39.2  | 44.2  | 53.2  | 71.5  | 87.4  | 101.4 |
| 92.0  | 24.2  | 33.7  | 38.4  | 47.2  | 64.8  | 80.1  | 95.4  |
| 96.0  | 19.3  | 28.3  | 32.8  | 41.3  | 58.2  | 73.2  | 87.8  |
| 100.0 | 15.9  | 24.1  | 28.3  | 36.3  | 52.6  | 67.1  | 81.3  |
| 104.0 | 12.6  | 20.1  | 23.9  | 31.4  | 47.2  | 61.4  | 75.1  |
| 108.0 | 9.2   | 16.1  | 19.6  | 26.6  | 41.8  | 55.6  | 68.9  |
| 112.0 | 6.2   | 12.7  | 15.9  | 22.5  | 36.8  | 50.4  | 63.1  |
| 116.0 |       | 9.8   | 13.0  | 19.1  | 32.5  | 45.8  | 58.1  |
| 120.0 |       |       | 9.9   | 15.6  | 28.1  | 41.1  | 53.0  |
| 124.0 |       |       | 7.2   | 12.7  | 24.5  | 37.0  | 48.4  |
| 128.0 |       |       |       | 10.0  | 21.2  | 33.2  | 44.1  |
| 132.0 |       |       |       | 7.3   | 18.0  | 29.5  | 39.3  |
| 136.0 |       |       |       |       | 15.0  | 26.0  | 33.2  |
| 140.0 |       |       |       |       | 12.3  | 22.7  | 28.2  |
| 144.0 |       |       |       |       | 9.7   | 19.4  | 20.1  |
| 146.0 |       |       |       |       | 8.4   | 17.4  | 17.8  |

The specified hoist rope reeving n=7x is required to ensure that the maximum possible load specified in this table can be lifted.

140.1 t in this case.



The maximum possible single line pull must not be exceeded. Accordingly, the minimum number of reevings ( $n_{\min}$ ) for the hoist rope must be selected from the "Hoist Rope Reeving Table" (EST) based on the load to be lifted (see Load Chart Manual, chapter 40.90). In the example, for single-rope operation, the hoist rope would need to be reeved in at least **7 times** to lift a maximum load of **157.7 t**.

In parallel operation, a 3x2 reeving might be sufficient. This value must be verified mathematically in the following steps. The load chart lists this hoist rope reeving as appropriate for the maximum load capacity of the boom configuration. In this case, n = 7x is required for 140.1 t.

The additional limit criteria for the minimum reeving of the hoist rope and the minimum weights of the hook block must be strictly observed. They ensure that the crane operates stably and with high levels of safety under all operating conditions. For structural reasons, a certain minimum number of rope strands and sufficient hook block weight are required to ensure that the boom system is pulled sufficiently in the direction of the load and remains stable. This is especially important for steep angles of the main boom.

The following criteria apply to the LR 11000 with the selected configuration:

| SL10 boom<br>hub height | with F2-jib                |                                         | angle range of the main boom |       |
|-------------------------|----------------------------|-----------------------------------------|------------------------------|-------|
|                         | minimum hoist rope reeving | minimum hook block weight<br>hook block | from                         | up to |
| 168 m                   | 6                          | 4.7 t                                   | 30°                          | 87°   |

Another criterion is the **reliable load weighing of the LICCON overload protection system**. To ensure that the LML load weighing system operates accurately and can unambiguously determine the actual load, minimum reevings have been specified. Both when operating a single winch and when using two winches. The tables do not specify any default values for our configuration. Therefore, we will proceed to the next step.

The **parallel operation** plays a central role. When winch 1 and winch 2 are operating simultaneously, they must run smoothly in parallel. If the reeving is too less, it would result in imprecise control and, consequently, cause the hook block to become misaligned. Therefore, in parallel operation, there are generally **2×5 rope strands** are required – only at the fixed lattice jib F2 are **2×3 strands** sufficient. These minimum values prevent the bottle from becoming misaligned and guarantees safety by ensuring that the load is distributed evenly across both winches.

In summary, the following values apply:  $n_{\min} = 2 \times 3$  and  $G_{\min} = 4.7 \text{ t}$

### 6.1.1.3 Maximum reeving ( $n_{\max}$ )

To determine the maximum reeving, the crane design must be taken into account.

**The key question is:**

**How much rope can you reeve into the hook block so that the hook block can still reach the bottom even when the boom is in its steepest position?**

This formula applies to all telescopic and lattice boom cranes. The rope length can be found in the data sheet. Due to the rope path of the hoist winch, special attention must be paid to the length of the Derrick boom on a lattice boom crane. The SL10DF2BV configuration is used here as an example.

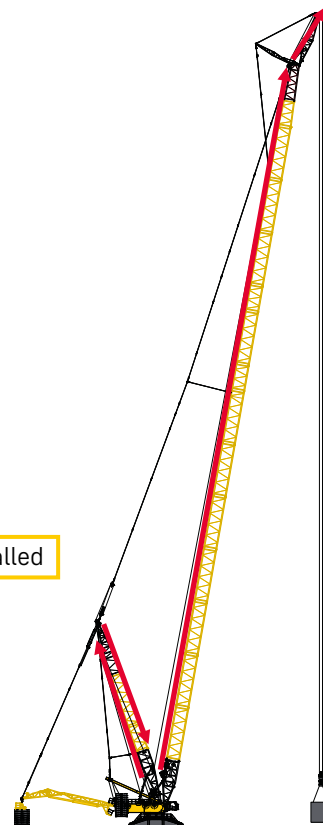
The maximum reeving is calculated using the following formula:

$$n_{\max} = \frac{\text{rope length} - \text{total boom length} - (2 \times \text{Derrick length})}{\text{Pulley head height}}$$

$$n_{\max} = \frac{1,450 \text{ m} - 180 \text{ m} - (2 \times 42 \text{ m})}{184.4 \text{ m}}$$

$$n_{\max} = 6,432 = 6$$

When Derrick is installed



3

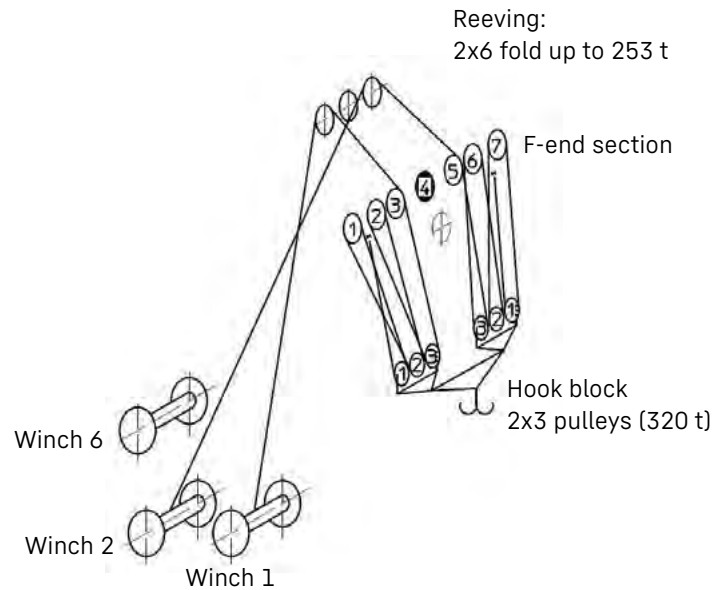
In single-hook block mode, the rope from winch 1 or 2 with a maximum of 6 reeving is long enough to reach the bottom with the hook block.

In double-hook operation, a maximum of 2x6 reeving is used. The hook block is designed for this purpose, so this configuration is allowed.

This information is included in the reeving plans (provided documentation).

In summary:  $n_{\max} = 2 \times 6$

The result calculated here gives the so-called maximum **over reeving**. A rope-friendly operating method involves deliberately reducing the single line pull on the rope during the lift. This is achieved through over-reeving. The lower the single line pull, the longer the rope will last.



**When driving uphill with a car and a heavy trailer, the load on the clutch increases significantly compared to a car without a trailer.**

#### Example:

For the LR 11000 with a lifting capacity of approximately 135 t – 140 t (including hook block and lifting slings), a configuration of  $n_{\min} = 2 \times 3$  would theoretically be sufficient for reeving in the SL10DF2BV configuration with dual-hook operation (W1 || W2). The single line pull is then nearly 100 % of the maximum single line pull.

By applying maximum over-reeving, the single line pull can be reduced to about half of the maximum.

The result: less lateral pressure on the multi-layer winch, reducing the possibility of the thread cutting into the lower layers.

| Reeving | Maximum load (EN 13000) | Percentage single line pull at 137.5 t load |
|---------|-------------------------|---------------------------------------------|
| 2x3     | 137.9 t                 | 99.7%                                       |
| 2x4     | 182.9 t                 | 75.2%                                       |
| 2x5     | 227.5 t                 | 60.4%                                       |
| 2x6     | 271.7 t                 | 50.6%                                       |

For our configuration, we'll choose the **2x4 reeving** (reducing the strand tension to 75%). Thus, the total weight of the hook block, including the load, remains safely within the load chart. This is verified in the following calculation step.

#### 6.1.1.4 Calculate the minimum weight of a hook block

4

In TLT Chapter 40.35, "Hooks blocks and Load Hooks," the calculation is performed step by step using the following formula:

| Formula |
|---------|
|---------|

$$G = L \times M \times n \times F$$

Formula for calculating the minimum required hook block weight for a functional rope drive with the selected reeving.

| Abbreviation | Designation                        | Unit |
|--------------|------------------------------------|------|
| G            | Minimum required hook block weight | kg   |
| L            | Overall boom length                | m    |
| M            | Rope weight                        | kg/m |
| n            | Reeving                            | -    |
| F            | Factor                             | -    |

Explanation of the variables used to calculate the minimum required weight of the hook block.

The total boom length **L** and reeving **n** are known. The weight of the rope **M** is taken from the table in this chapter. By applying a factor of 1.1, Liebherr takes into account an additional 10% safety margin for the hook block weight.

Substituting these values into the formula gives us the following calculation:

$$G = 180 \text{ m} \times 5.09 \frac{\text{kg}}{\text{m}} \times 2 \times 4 \times 1.39 \times 1.1$$

$$G = 11,207 \text{ kg}$$

### Double-hook block, 320/160 DM (SWL 320 t)

For a lattice boom crane, the maximum allowable hook block weight is limited by the erection and take down criteria (see AAT).

In the example given, the LR 11000 is already at the limit of these charts. **Increasing the weight of the hook block before erecting the boom is therefore not permitted.**

We suggest the following options:

**1. Lifting the hook block with auxiliary tools:** During the erecting process, the hook block is guided by auxiliary devices so that the boom supports only the maximum allowable hook block load of 5.8 t. As soon as the load chart applies, the full hook block weight can be applied (see the operating instructions and AAT on the following page).

**2. Install the auxiliary weights later:** The boom is first erected without any auxiliary weights on the hook block. Once the maximum load capacity has been reached, the auxiliary weights are installed.

**Important:** Because the hook block is lightweight, it is essential to watch for slack rope at W1/W2 during the erecting process!

The maximum lifting capacity of the boom is 140.1 t. Thus, a load of 125 t plus a hook block weighing 12 t for a total of 137 t is already close to the lifting capacity limit.

With higher reeving settings of  $n = 2 \times 6$ , the hook block weight would increase to 17.4 t, and the crane would be overloaded. Therefore, the number of reevings remains at  $n = 2 \times 4$ .

The final step is to select a hook block. Available double-hook blocks are described in the TLT in chapter 40.35.30, "Hook Blocks for Parallel Operation." The 320 DM double-hook block seems ideal for this purpose, with a maximum load capacity of 315.4 t and a weight of 4.7 t. To reach the minimum required weight of 11.2 t, several **Auxiliary weights** of 1 t each can be mounted on the 320 DM:

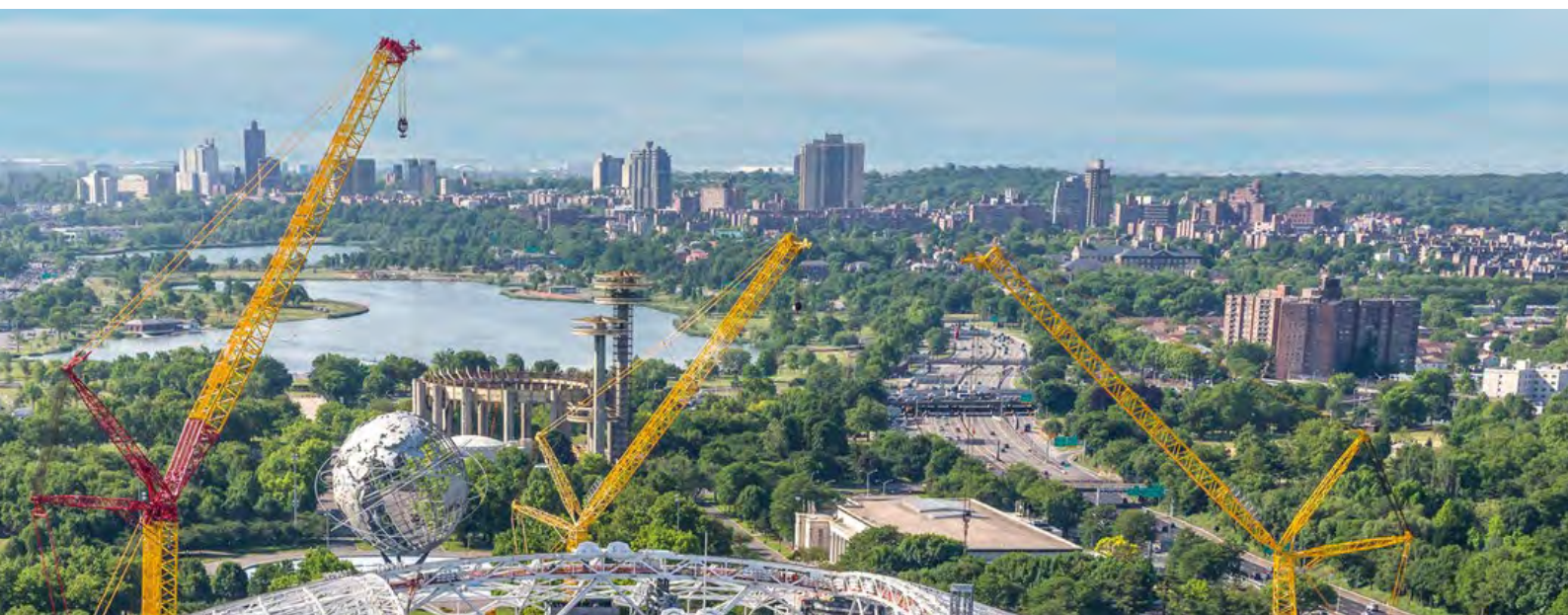
| Load    | Rope sheaves | Max. reeving | Net weight without auxiliary weight |
|---------|--------------|--------------|-------------------------------------|
| 315.4 t | 2 x 3        | 2 x 7        | 4.7 t                               |

| Hook block with installed auxiliary weights | Net weight           |
|---------------------------------------------|----------------------|
| 2 auxiliary weights                         | 6.7 t                |
| 4 auxiliary weights                         | 8.7 t                |
| 6 auxiliary weights                         | 10.7 t               |
| 8 auxiliary weights                         | 12.7 t               |
| 10 auxiliary weights                        | 14.7 t               |
| 12 auxiliary weights                        | 16.7 t <sup>1)</sup> |

1) Maximum allowable weight of the hook block

Finally, here is a table comparing all the values

|                 | Reeving n | Hook block weight G |
|-----------------|-----------|---------------------|
| Chapter 6.1.1.2 | 2 x 3     | 4.7 t               |
| Chapter 6.1.1.3 | 2 x 4     |                     |
| Chapter 6.1.1.4 |           | 11.2 t              |
| Final values:   | 2 x 4     | 12.7 t              |



**SL10DF2BV – Operation, Superstructure Ballast 210 t / Central Ballast 90 t**  
**SL10F25: F-connector head**

aat\_235\_056\_00001\_00\_002  
Page: 42 of 42

On tracks: 9.6 m x 9.2 m x 2.0 m  
Ground inclination: maximum 0.3°  
without auxiliary mechanical support

**System: S 3228.50/40/25/20/15**  
**D 2825.25/20**  
**F 2318.10**

**Wind speeds:**

**Max. 9.0 m/s:** for all boom lengths and wind directions (360°).

**Max. 12.8 m/s:** for boom lengths under 140 m and wind directions of 360°. For total boom lengths of 140 m or more (high-lighted in gray in the table), raising or taking-down the boom is permitted only when the wind is blowing toward or away from the boom. The permissible flow angle range is ±25°.

| <b>SL10DF2BV</b><br><b>DR 13 m</b><br><b>DBR 30 m</b> |          |        |     | Maximum weight of the hook block (t) on the F2 jib                        |    |     |     |     |     |     |     |     |     |
|-------------------------------------------------------|----------|--------|-----|---------------------------------------------------------------------------|----|-----|-----|-----|-----|-----|-----|-----|-----|
|                                                       |          |        |     | For Derrick ballast (t)                                                   |    |     |     |     |     |     |     |     |     |
|                                                       |          |        |     | with a Derrick radius (DR) of 13 m / Derrick ballast radius (DBR) of 30 m |    |     |     |     |     |     |     |     |     |
|                                                       |          |        |     | 0                                                                         | 50 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 450 |
| Main boom length (m)                                  | SL10-162 | F2 (m) | 12  | -                                                                         | -  | -   | -   | -   | -   | -   | -   | 8.1 | 13  |
|                                                       |          |        | 15  | -                                                                         | -  | -   | -   | -   | -   | -   | -   | 6.9 | 11  |
|                                                       |          |        | 18  | -                                                                         | -  | -   | -   | -   | -   | -   | -   | 6.3 | 11  |
|                                                       |          |        | 21  | -                                                                         | -  | -   | -   | -   | -   | -   | -   | 5.1 | 10  |
|                                                       |          |        | 24  | -                                                                         | -  | -   | -   | -   | -   | -   | -   | 4.3 | 9.6 |
|                                                       |          |        | 27  | -                                                                         | -  | -   | -   | -   | -   | -   | -   | 3.2 | 8.4 |
|                                                       |          |        | 30  | -                                                                         | -  | -   | -   | -   | -   | -   | -   | 2.8 | 8.1 |
|                                                       |          |        | 33  | -                                                                         | -  | -   | -   | -   | -   | -   | -   | -   | 6.9 |
|                                                       |          |        | 36  | -                                                                         | -  | -   | -   | -   | -   | -   | -   | -   | 6   |
|                                                       |          |        | 39  | -                                                                         | -  | -   | -   | -   | -   | -   | -   | -   | 5   |
| Main boom length (m)                                  | SL10-168 | F2 (m) | 12  | -                                                                         | -  | -   | -   | -   | -   | -   | -   | -   | 5.8 |
|                                                       |          |        | 15  | -                                                                         | -  | -   | -   | -   | -   | -   | -   | -   | 5.1 |
|                                                       |          |        | 18  | -                                                                         | -  | -   | -   | -   | -   | -   | -   | -   | 4.5 |
|                                                       |          |        | 21  | -                                                                         | -  | -   | -   | -   | -   | -   | -   | -   | 3.3 |
|                                                       |          |        | 24  | -                                                                         | -  | -   | -   | -   | -   | -   | -   | -   | 2.8 |
|                                                       |          |        | 127 | -                                                                         | -  | -   | -   | -   | -   | -   | -   | -   | -   |
|                                                       |          |        | 30  | -                                                                         | -  | -   | -   | -   | -   | -   | -   | -   | -   |
|                                                       |          |        | 33  | -                                                                         | -  | -   | -   | -   | -   | -   | -   | -   | -   |
|                                                       |          |        | 36  | -                                                                         | -  | -   | -   | -   | -   | -   | -   | -   | -   |
|                                                       |          |        | 39  | -                                                                         | -  | -   | -   | -   | -   | -   | -   | -   | -   |

- Hook block weight up to 20 t permitted
- Erecting is not permitted

## 6.1.2 LTM 1650-8.1: T3YV2EN

### 6.1.2.1 Boom length and total weight

1

The example crane is the **LTM 1650-8.1** with the configuration **T3YV2EN** with 92/92/92 and N=24.5 m. The net load to be lifted is 60 t at a hub height of **80 m**.

We estimate a gross load of approximately **63 t**.

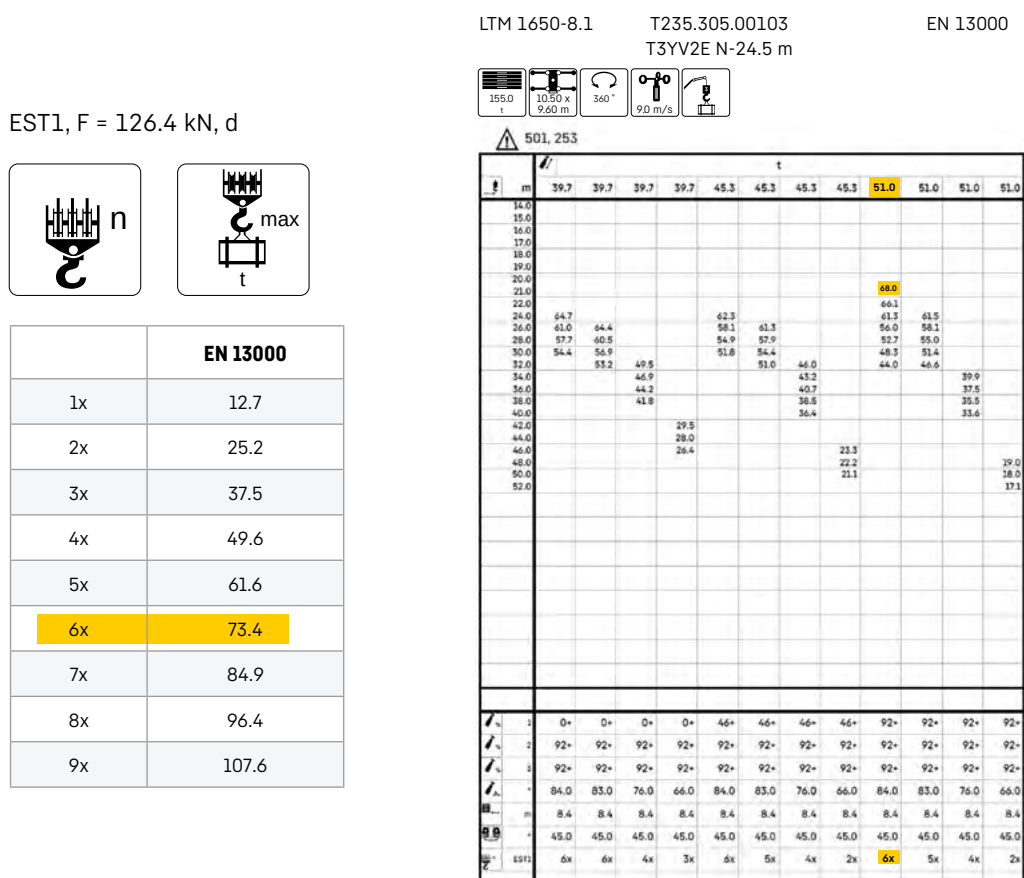
The load chart provided includes detailed instructions in Section 40.35, "Hook Blocks and Load Hooks."



The following description is intended only as a general overview and guide. It is mandatory to follow the users manual when performing the work!

### 6.1.2.2 Minimum hoist rope reeving and system-specific minimum hook block weight

2



The number of hoist rope reeving is specified here as  $n = 6$ . In theory,  $n = 5$  would be sufficient for the load; however, the weight of the hook block and the lifting slings must be included in the total weight. This would exceed the load capacity at  $n = 5$ .

Minimum requirements must also be met for telescopic cranes.



TLT chapter 40.40 contains tables for the corresponding operating modes. Since we are using a jib size of N-24.5m, none of the tables apply to us. Therefore, there are no guidelines for selecting hooks.

| Boom   | Length of the luffing lattice jib | Hoist rope minimum reeving | Hook block minimum weight |
|--------|-----------------------------------|----------------------------|---------------------------|
| T3     | N- 21.0 m                         | 2                          | 1.0 t                     |
| T3YVE  | N- 21.0 m                         | 2                          | 2.0 t                     |
| T3YV2E | N- 21.0 m                         | 2                          | 2.0 t                     |

### 6.1.2.3 Maximum reeving ( $n_{\max}$ )

The maximum possible hook block reeving is set so that the hook block reaches the bottom even when the boom is in its steepest position.

Refer to the operating manual for the required rope length. Since the rope on winch 1 is likely too short, you should use the longer rope on winch 2.

$$n_{\max} = \frac{\text{rope length} - \text{total boom length}}{\text{pulley head height}}$$

$$n_{\max} = \frac{800 \text{ m} - (51 \text{ m} + 16 \text{ m} + 24.5 \text{ m})}{91.2 \text{ m}}$$

$$n_{\max} = 7.77$$

For this lift,  $n_{\max} = 7$ .

This means that the remaining boundary conditions in the TLT still need to be clarified. These are described in chapter 40.35, "Hook Blocks and Load Hooks," of the TLT.

#### ATTENTION

Rope damage due to insufficient weight of the hook block!

If system-related a minimum reeving of the hoist rope is not required for the operating mode:

► Take minimum reevings at the hook block depending on the weight of the load to be lifted.

If loads are picked up at great heights:

► If possible, make a over reeving.

If the reeving was increased:

► Increase the weight of the hook block.

When the hook block weight is too low:

► Choose a heavier hook block or increase the hook block's weight using Auxiliary weights or conversion kits.



#### Note

Observe the following notes:

For wear reduction of the hoist rope:

► If the available rope length and the maximum allowable hook block weight permit it, use a higher amount of reevings. This is especially true when lifting heavy loads.

Since the hoist rope weight in the load charts is based on minimum reeving and minimum radius is only taken into account up to the crane's contact area:

► When reeving occurs or when the hook block is lowered below the crane's contact surface  
The additional weight of the hoisting rope must be subtracted from the maximum load capacity.



#### Note

Observe the permissible hook block weights for erection and take-down of the boom system.

If an increase in the hook block's own weight causes the permissible hook block weight for erecting  
If the limit for the erection and take-down of the boom system is exceeded, the boom system cannot be erected and taken-down with this hook block weight.

► Observe the permissible hook block weights for erecting and take-down as listed in the erecting and take-down charts.

If the permissible hook block weight for erection and take-down is exceeded:

► Remove the auxiliary weights used for erecting and take-down of the boom system.



### 6.1.2.4 Calculate the minimum weight of the hook block

Chapter 40.35 of the TLT, "Hook blocks and Load Hooks," also contains the formula for calculating the minimum hook block weight.

#### Formula

$$G = L \times M \times n \times F$$

The total length  $L = 91.5 \text{ m}$  and reeving  $n = 7$  are given. Rope Weight  $M$  and factor  $F$  can be found in the corresponding tables in this chapter.

The 10% safety margin must be observed. This results in the following calculation:

$$G = 91.5 \text{ m} \times 3.09 \frac{\text{kg}}{\text{m}} \times 7 \times 1.46 \times 1.1$$

$$G = 3,180 \text{ kg}$$

Next, select the hook block from the TLT, chapter 40.35.10, "Hook Block for Single Operation" (see next page).

## Hook Block 100 DM (SWL 100.0 t)

| Load   | Rope sheaves | Max. reeving | Net weight with auxiliary weight |
|--------|--------------|--------------|----------------------------------|
| 84.9 t | 3            | 7            | 3.000 t                          |

As mentioned in the previous chapter, auxiliary weights can be attached to any Liebherr hook block. Several t in total. These are important not only for achieving the calculated minimum weight of the hook block, but also for improving the winding performance of the hoisting rope due to the increased strand tension.

For the lift just described, the calculation yields a required hook block weight of **3180 kg**. Up to **12 auxiliary weights** can be installed, for a total weight of **6500 kg**. With a maximum load capacity of 68 t according to TLT and a net load of 60 t, approximately 8 t remain for lifting slings and a hook block.

The following table illustrates the positive effect:

| Auxiliary weights        | , hook block weight | Empty load hook on the line | Percentage Improvement of the Strand drawing |
|--------------------------|---------------------|-----------------------------|----------------------------------------------|
| 2 x 500 kg<br>2 x 375 kg | 3,250 t             | 464 kg                      | 0 %                                          |
| 4 x 500 kg               | 3,500 t             | 500 kg                      | 8 %                                          |
| 8 x 500 kg               | 5,500 t             | 786 kg                      | 69 %                                         |
| 10 x 500 kg              | 6,500 t             | 929 kg                      | 101 %                                        |

| aat_275_305_00100_00_000                                                                                                                           |                        |                                                                    |      |      |      |                                                                                                                                                                                                 |      |      |      |      |      |      |
|----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|--------------------------------------------------------------------|------|------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|------|------|
| T3YV2EN - Angled erection<br>Wide support base (100%) 10.5 m x 9.6 m<br>Telescopic boom T-16.7 (0/0/0)<br>Outer radius of the counterweight: 6.4 m |                        |                                                                    |      |      |      | Ground inclination up to -3° (downhill gradients)<br>Observe the minimum reeving hoist rope<br>Observe the minimum weight of the hook block<br>Can be automatically raised starting at N-38.5 m |      |      |      |      |      |      |
| Luffing lattice jib                                                                                                                                |                        | Permissible wind speed in (m/s)                                    |      |      |      |                                                                                                                                                                                                 |      |      |      |      |      |      |
|                                                                                                                                                    |                        | Counterweight on superstructure in (t) with an outer radius in (m) |      |      |      |                                                                                                                                                                                                 |      |      |      |      |      |      |
| N....(m)                                                                                                                                           | HKFL (t) <sup>-1</sup> | 175                                                                | 165  | 155  | 145  | 135                                                                                                                                                                                             | 125  | 115  | 105  | 95   | 85   | 75   |
| 21.0                                                                                                                                               | 4.0                    | 6.4                                                                | 6.4  | 6.4  | 6.4  | 6.4                                                                                                                                                                                             | 6.4  | 6.4  | 6.4  | 6.4  | 6.4  | 6.4  |
| 24.5                                                                                                                                               | 3.5                    | 13.4                                                               | 13.4 | 13.4 | 13.4 | 13.4                                                                                                                                                                                            | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 |
| 28.0                                                                                                                                               | 3.5                    | 13.4                                                               | 13.4 | 13.4 | 13.4 | 13.4                                                                                                                                                                                            | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 |
| 31.5                                                                                                                                               | 3.0                    | 13.4                                                               | 13.4 | 13.4 | 13.4 | 13.4                                                                                                                                                                                            | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 |
| 35.0                                                                                                                                               | 3.0                    | 13.4                                                               | 13.4 | 13.4 | 13.4 | 13.4                                                                                                                                                                                            | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 |
| 38.5                                                                                                                                               | 3.0                    | 13.4                                                               | 13.4 | 13.4 | 13.4 | 13.4                                                                                                                                                                                            | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 |
| 42.0                                                                                                                                               | 3.0                    | 13.4                                                               | 13.4 | 13.4 | 13.4 | 13.4                                                                                                                                                                                            | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 |
| 45.5                                                                                                                                               | 3.0                    | 13.4                                                               | 13.4 | 13.4 | 13.4 | 13.4                                                                                                                                                                                            | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 |
| 49.0                                                                                                                                               | 3.0                    | 13.4                                                               | 13.4 | 13.4 | 13.4 | 13.4                                                                                                                                                                                            | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 |
| 52.5                                                                                                                                               | -                      | 13.4                                                               | 13.4 | 13.4 | 13.4 | 13.4                                                                                                                                                                                            | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 |
| 56.0                                                                                                                                               | -                      | 13.4                                                               | 13.4 | 13.4 | 13.4 | 13.4                                                                                                                                                                                            | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 |
| 59.5                                                                                                                                               | -                      | 13.4                                                               | 13.4 | 13.4 | 13.4 | 13.4                                                                                                                                                                                            | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 |
| 63.0                                                                                                                                               | -                      | 13.4                                                               | 13.4 | 13.4 | 13.4 | 13.4                                                                                                                                                                                            | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 |
| 66.5                                                                                                                                               | -                      | 13.4                                                               | 13.4 | 13.4 | 13.4 | 13.4                                                                                                                                                                                            | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 |
| 70.0                                                                                                                                               | -                      | 13.4                                                               | 13.4 | 13.4 | 13.4 | 13.4                                                                                                                                                                                            | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 |
| 73.5                                                                                                                                               | -                      | 13.4                                                               | 13.4 | 13.4 | 13.4 | 13.4                                                                                                                                                                                            | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 |
| 77.0                                                                                                                                               | -                      | 13.4                                                               | 13.4 | 13.4 | 13.4 | 13.4                                                                                                                                                                                            | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 |
| 80.5                                                                                                                                               | -                      | 13.4                                                               | 13.4 | 13.4 | 13.4 | 13.4                                                                                                                                                                                            | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 |
| 84.0                                                                                                                                               | -                      | 13.4                                                               | 13.4 | 13.4 | 13.4 | 13.4                                                                                                                                                                                            | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 |
| 87.5                                                                                                                                               | -                      | 13.4                                                               | 13.4 | 13.4 | 13.4 | 13.4                                                                                                                                                                                            | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 |
| 91.0                                                                                                                                               | -                      | 13.4                                                               | 13.4 | 13.4 | 13.4 | 13.4                                                                                                                                                                                            | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 |

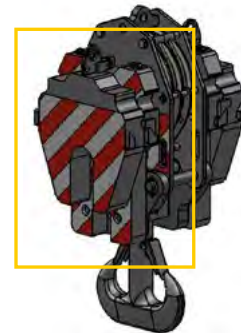
| Hook block net weight                            | 1,500 t               |
|--------------------------------------------------|-----------------------|
| Hook block with installed auxiliary weights      | Net weight            |
| 4 auxiliary weights (4 x 375 kg)                 | 3,000 t               |
| 4 auxiliary weights (2 x 500 kg and 2 x 375 kg)  | 3,250 t               |
| 4 auxiliary weights (4 x 500 kg)                 | 3,500 t               |
| 6 auxiliary weights (6 x 375 kg)                 | 3,750 t               |
| 6 auxiliary weights (2 x 500 kg and 4 x 375 kg)  | 4,000 t               |
| 6 auxiliary weights (4 x 500 kg and 2 x 375 kg)  | 4,250 t               |
| 6 auxiliary weights (6 x 500 kg)                 | 4,500 t               |
| 8 auxiliary weights (2 x 500 kg and 6 x 375 kg)  | 4,750 t               |
| 8 auxiliary weights (4 x 500 kg and 4 x 375 kg)  | 5,000 t               |
| 8 auxiliary weights (6 x 500 kg and 2 x 375 kg)  | 5,250 t               |
| 8 auxiliary weights (8 x 500 kg)                 | 5,500 t               |
| 10 auxiliary weights (4 x 500 kg and 6 x 375 kg) | 5,750 t               |
| 10 auxiliary weights (6 x 500 kg and 4 x 375 kg) | 6,000 t               |
| 10 auxiliary weights (8 x 500 kg and 2 x 375 kg) | 6,250 t               |
| 10 auxiliary weights (10 x 500 kg)               | 6,500 t <sup>1)</sup> |
| 12 auxiliary weights (4 x 500 kg and 8 x 375 kg) | 6,500 t <sup>1)</sup> |

1) Maximum allowable weight of the hook block

As a final step, the threshold criteria for erecting and taking-down listed in the AAT must be observed. When erecting the boom, the hook block weight must **not exceed 3.5 t**.

Only after the erection of the boom the weight can be increased to **6.5 t**.

Before the take-down of the boom, the weight must be reduced to **a maximum of 3.5 t** again.



Finally, here is a table comparing all the values

|                 | Reeving n | Hook block weight G |
|-----------------|-----------|---------------------|
| Chapter 6.1.2.2 | 6         | 2.0 t               |
| Chapter 6.1.2.3 | 7         |                     |
| Chapter 6.1.2.4 |           | 3.18 t              |
| Final values:   | 7         | 6.5 t               |

(\*1 Maximum weight of the hook block that the boom can be erected  
(\*2 luffable lattice jib cannot be raised

## 6.2 Comparison table: Documentation – Current and new formats

As part of a documentation reorganization, all documents provided with certain mobile and crawler cranes may have been restructured and revised. Chapters have been reorganized or moved to other documents.

The following table compares the chapters in the current version that are relevant to the brochure with the corresponding chapters in the new version:

| Chapter in the training document                         | Page  | Crane Documentation: Current Format                                                                                                 | Crane Documentation: New Format                                                                               |
|----------------------------------------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| 2.1.1 Regular inspections in accordance with ISO 4309    | 12    | Book: Crane-users manual<br>Chapter: 8.04 Inspection of Crane Ropes                                                                 | Book: Maintenance and inspection<br>Chapter: Exam; Section: Check the hoist ropes or ropes                    |
| 2.1.3 Roller Wear                                        | 13    | Book: Crane-users manual<br>Chapter: 8.01 Recurring Inspections<br>section: Review of Roles                                         | Book: Maintenance and inspection<br>Chapter: Maintenance, Maintenance Staff<br>section: Rope sheaves          |
| 2.2.1 Removing Twist                                     | 15    | Book: Crane-users manual<br>Chapter: 7.05 or 7.05.50 Maintenance<br>section: Turning an extremely rotation-resistant hoist rope out | Book: Maintenance and inspection<br>Chapter: Maintenance, Maintenance Staff<br>section: Spinning out the rope |
| 2.2.3 Shortening and repositioning the rope              | 17    | Book: Crane-users manual<br>Chapter: 7.05 or 7.05.50 Maintenance<br>section: Shortening the rope                                    | Book: Maintenance and inspection<br>Chapter: Maintenance, Maintenance Staff<br>section: Shortening the rope   |
| 3.2 luffing jib Assembly LTM 1750 – Winch 1              | 23    | Book: Crane-users manual<br>Chapter: 5.04 Luffing Lattice Jib-TN<br>section: Assembling the luffing lattice jib                     | Book: Crane-users manual<br>Chapter: Assembly operation<br>Section: Not yet available                         |
| 4.4 Flattening                                           | 26    | Book: Crane-users manual<br>Chapter: 8.04 Inspection of Crane Ropes<br>section: Operational wear on the ropes of Winch 4            | Book: Maintenance and inspection<br>Chapter: Inspection<br>section: Not available yet                         |
| 6.1 Appendix<br>Calculation of minimum hook block weight | 29–37 | Book: Load Chart Book or Using the Load Charts<br>Chapter: 40.30, 40.35, 40.40, 40.45, 40.90                                        | Book: Use of the load charts<br>Chapters: 7, 8, and 9                                                         |
| 6.1 Appendix<br>Calculation of minimum hook block weight | 29–37 | Book: Erection and take-down charts                                                                                                 | Book: Erection and take-down charts                                                                           |

# 7. Solutions

## 1.3.1

### 1. What is the basic structure of a steel rope?

- ☒ Wires are twisted into strands, which are then twisted together.

### 3. When is it advisable or necessary to use a swivel / twist compensator?

- ☒ Not recommended, but permitted for rotation resistant ropes with.
- ☒ If possible, work without a twist compensator.

### 2. When does an uneven diameter reduction occur?

- ☒ Due to localized friction, for example, against the side walls or other ropes.

### 4. What is the purpose of rope lubrication?

- ☒ Reduction of wear and corrosion

### 5. Which properties of a steel rope correspond to which definition?

**Corrosion/Lubrication =** Describes how to protect the rope from abrasion and rust through adequate lubrication.

**Rotational behavior =** Describes how strongly a rope tends to twist on its own when under tensile load.

**Alternating bending strength =** The rope's resistance to wear caused by repeated deflection and bending.

**Transverse compressive strength =** The rope's ability to withstand vertical compressive forces without deforming.

## 1.4.3

### 1. Why are multi-layer rope drums with special grooves used?

- ☒ To accommodate long rope lengths in a small space.

### 2. What is the purpose of the special grooving of a winch?

- ☒ Parallel winding pattern with defined crossing areas.
- ☒ Allows the rope to be shortened and repositioned, thereby extending its service life.

## 2.1.6

### 1. Which statement about sheaves is correct?

- ☒ Worn-out pulleys can quickly lead to wire breaks.

### 3. What information is important to include when reporting possible rope damage?

- ☒ Photos of the sheaves.
- ☒ Photos of the damaged area, the location on the rope, and the rope's serial number.
- ☒ Current operating status of the crane (LICCON crane code)

### 2. What typically causes negative profiles on rope sheaves?

- ☒ The deflection angle at the rope inlet is too large.
- ☒ Heavy use; wear and tear over the years.

## 2.2.4

### 1. Why can a rope come loose on a multi-strand winch?

- ☒ Due to vibrations and low line tension.

### 3. What are the important steps to follow when replacing the rope pretension?

- ☒ Spool down the rope as far as possible, up to the safety windings.
- ☒ Spool up the rope with at least 10% line pull (preferably 15% or more).

## 3.2.4

### 1. What is the purpose of the Liebherr Crane Finder?

- ☒ IT quickly identifies the right crane, including the optimal configuration.

### 3. What is the risk if the hoist rope is spooled up using only the weight of the hook block?

- ☒ The lower rope strands are not being pre-tensioned sufficiently.
- ☒ The winding performance is not optimal.

## 4.5

### 1. Why is erecting and taking-down the main boom on lattice boom cranes particularly taxing on the adjustment rope?

- ☒ During these phases, the highest pull forces act on the adjustment rope.
- ☒ The lower layers of the rope are subjected to enormous lateral forces.

### 3. Under what conditions may flattening on the winch 4 (WIV) continue to be accepted?

- ☒ Regular inspections are conducted, and the minimum angle  $\alpha$  is maintained.

### 2. What is the effect of shortening and repositioning a hoist rope?

- ☒ The worn section is moved to the parallel section.
- ☒ The rope's service life can be extended by up to twice as long.

### 4. What are some ways to prevent the rope from twisting?

- ☒ Changing crane configurations.
- ☒ Adherence to the Reeving plans.
- ☒ Use of new sheaves.

### 2. Why is it especially important to ensure that the rope is sufficiently tensioned before the first lift?

- ☒ To prevent excessive rope wear right from the start of assembly.

### 4. What are the potential consequences of insufficient rope pre-tension when lowering heavy loads?

- ☒ Wire breaks caused by friction.
- ☒ Sudden release of the rope and vibrations in the crane.
- ☒ Rope damage caused by poor transverse pressure stability.
- ☒ Overtime for service staff.

### 2. What are the consequences of a loss of lateral tension stability in the adjustment rope?

- ☒ Deformations of the rope at the intersections of the multi-layered winding.

[illegible]

[illegible]



# MyLiebherr

**Our MyLiebherr portal provides you with easy access to the digital Liebherr service world.**

**Start taking advantage of our comprehensive service and additional offerings for your mobile and crawler cranes right away.**

Our MyLiebherr portal is the easy way for you to access Liebherr's digital service world.

Take advantage of a wide range of basic and additional services for your mobile and crawler cranes.

With our MyLiebherr portal, you can easily access Liebherr's digital service world.

Take advantage now of comprehensive service and additional offerings for your mobile and crawler cranes.

Our MyLiebherr portal provides you with easy access to the world of Liebherr digital support.

Take advantage right away of the many additional services and features for your mobile and crawler cranes.

Accessing Liebherr's range of digital services is very easy through the MyLiebherr portal.

Enjoy comprehensive service and additional services for your mobile and crawler cranes.

The MyLiebherr portal—easy access to the digital world of Liebherr services. Take advantage of our wide range of maintenance and optional services for mobile and crawler cranes today.



## One portal, all services **MyLiebherr**



Planning

**Crane Finder**



Operations

**Performance**



Planning

**Crane Planner 2.0**



Operations

**Documents**



Maintenance

**Spare Parts Catalogue**



Planning

**LICCON Work Planner**



Training

**Digital Training Courses**



Maintenance

**Parts Shop**

Subject to change • Subject to modification • Sous réserve de modifications • Con riserva di modifiche • Salvo modificaciones • Changes may occur

Liebherr-Werk Ehingen GmbH • P.O. Box 1361 • 89582 Ehingen, Germany  
Phone +49 73 91 5 02-0 • [www.liebherr.com](http://www.liebherr.com)

MyLiebherr



Printed in Germany (1)  
lwe-p465-08-2026