Tower Crane Selection and Safety

Habib Mikati – Managing Director (MEA)
Over 160 Years of Experience

1854 Friedrich August Wolff establishes an iron foundry in Heilbronn
1885 Production of lifting equipment begins
1913 Presentation of the first modern tower crane at the Leipzig Exhibition
1928 Design and manufacture of the first trolley jib crane
1955 Launch of the original WOLFF pin connection
1977 MAN WOLFFKRAN GmbH
2005 WOLFFKRAN GmbH
Crane Selection

WOLFFKERN  The leader of the pack
Upper Structure

- Saddle Jib / Trolley Jib Cranes
- Luffing Jib Cranes
- Clear Series
- Cross Series
- Luffing Cranes
**Cross Series**

- Classic saddle jib crane with tower top
- Work-horse for a wide variety of projects
- Lifts heavier loads than clear series cranes (up to 50 t)
- Long Jib lengths
- Faster Hook
- Less capital Investment
Clear Series

- Construction without Tower Top.
- Less Components to Transport.
- Reduced Assembly and Dis-assembly time.
- Cost and Time saving solution.
- Suitable for Multi-Layer overlapping
Luffing Jib Cranes

- **Luffing jib cranes are specially suited for:**
  - Construction of very high structures
  - Cramped construction site
  - Special projects
Hydraulic luffing Cranes

- Closed hydraulic circuit
- Less components
- Less out of service radius
- Jib fixed by the hydraulic cylinder
- Not widely used
Base / Foundation

Cross Frame / Under Carriage

Fixed

Under Carriage
Cross Frame

Mobile

Under Carriage
Cross Frame

Foundation Anchors

Sacrificial
Re-Usable
System Components

- Tower elements
- Foundation anchors
- Cross Frames
- Centre Ballast
- Climbing gears
- Tower ties
Crane Configuration

**Slewing Frame**
- Slewing Part – Basic jib lengths (typical 30 m)
  * Alternatives:*
    - Tower connection
    - Winch sizes
    - 2- or 2/4-fall trolleys
- Jib extensions incl. counter weights
- Main power supply cable & hoist rope

**System Components**
- Tower section’s
- Spigots
- Cross frame (or foundation anchor/undercarriage)
- Base ballast & centre ballast
System – Components / Crane basic parts

Overview

- Stationary layout
  - Foundation anchor
  - Conventional Undercarriage
  - Cross frame
  - City portal

- Travelling layout:
  - Undercarriage
  - Cross frame

Habib Mikati
System – Components / Foundation anchors
System – Components / Foundation anchors

Fixed Foundation Anchors

Re-Usable Foundation Anchors
System – Components / Under carriages

Fixed

Mobile
System – Components / Cross frame KR
System – Components / Cross frame

Stationary Cross Frame

Travelling cross frame

City Portal
System – Components / **External climbing gear**

- Proven climbing system since the sixties
- One tower element will be climbed in one time
  - Fast and safe climbing procedure
- Monitoring of climbing procedure
System – Components/
Internal climbing gear

Basic equipment:
1 pcs. climbing section KSH20H1
1 pcs. climbing section KSH20H2
3 pcs. climbing frame with ladder suspension KML
10 pcs. climbing ladders KL
(1 climbing ladder = 6 m long, 5 ladders on each side)

- No need for additional sections
- Extra high free standing heights
- Ladder system
- Standard tower elements can be used
System – Components / **Internal climbing gear**

- Standard design with collars
- Space saving design for narrow shafts
System – Components / Tower ties

- **Tie frames**
- **Tie rod elements**
  - *Spindles, rod segments, support brackets*
System – Components / Tower ties

- Spindles
- Segments
- Support brackets (at building)
System – Components / Tower ties
WOLFF Hoist winches

- Normally Tower Crane manufacturers offer more than one option for the Hoist Winch.
- This effects the Hoist Speed, not Maximum lifting capacity of the Crane.
- Bigger winches consume more power.
SAFETY

Cranes is a “safety” business !!!!

With modern technology 2 factors influence normal safety of Cranes:

- Manufacturer
- End User / Operator
Accidents Causes

- **Erection/ Dismantling/ Extending**, 37%
- **Extreme Weather**, 18.50%
- **Foundation Issues**, 13%
- **Mechanical Issues**, 11%
- **Misuse**, 5.50%
- **Cause Unidentified**, 15%
Manufacturer: Safety Features required per EN 14439
New wind calculation required per EN 14439
New wind calculation required per EN 14439 old vs. new

DIN 1055-4:1986

EN 13001 / FEM 1.005

Wind speed $v$ [km/h] vs. Height $z$ [m]

DIN
C 25
C 50
D 25
D 50
E 25
E 50
Safety Overview
Crane Safety

- Manufacturer’s obligation
  - Machinery Directive 2006/42/EC
  - Electromagnetic Compatibility 2004/108/EC
  - Noise Emission Directive 2000/14/EC
  - Low Voltage Directive 2006/95/EC

Crane manufacturer provides the customer with

- Crane Manual
- CE Declaration of Conformity
- Warning of residual risks
- Log book and recommended periodical inspections
Crane Safety

Operating companies obligations

- Ensure the tower cranes are safely erected and dismantled
- Operate the tower crane according to the manufacturer’s instructions
- Training of Personnel: Operators, riggers, servicemen, etc…
- Maintain the crane in good working condition
- Conduct routine inspections at regular intervals
- Abide and follow National regulations of each country
- Inspect and Test the Crane after every erection
Slewing tower crane utilization

- Technical drawings
- Safety clearance
- Personnel
- Documentation and Operation instructions
- Load test
- Safe load handling
- Hand signals
- Safety precautions

Planning
Assembly
Operation

The leader of the pack
Planning – Technical drawings from manufacturer

Technical drawings from manufacturer showing the:

- **Foundation loads / corner loads**
- **Tower sections combination**
- **Theoretical tower deflections**
Planning - Danger zones and workplaces

I. Safety clearance between several slewing tower cranes

The following safety clearances must be observed if several slewing tower cranes are being operated simultaneously on the construction site.

- Tower and jib: min. 2 m
- Crane top and max. hook height: min. 2 m
The following safety clearances must be observed when operating a luffing crane in combination with a slewing tower crane:

- Clearance between the tower and jib: min. 2 m
- Clearance between the tower and center of rotation: min. 2 m
- Or between the tower top and bottom edge of the load: min. 2 m
Assembly - Personnel

- **General requirements**
  - Be trained and instructed in accordance with manufacturer & contractor rules
  - Personnel must read and understood the "Safety manual"

- **Operating personnel requirements**
  - Crane operators must have comprehensive knowledge of national regulations
  - Use the device as intended and wear the personnel safety tackle
  - Take the tower crane out of service immediately after faults, abnormal operating states and report immediately

- **Service personnel requirements**
  - Carry out assembly/ disassembly, maintenance and repairs in accordance with the documentation
  - Ensure that all safety and danger signs are clearly stated on the crane
Assembly – Documentation and instructions

The maximum permitted wind speed for assembly is 12.5 m/s (45 Km/h)

- Strictly adhere to valid safety measures and accident prevention regulations
- All parts of the crane must be inspected by an expert prior to installation
- Safeguard the assembly area
- “Carefully” Read the assembly instructions in the manual
- Always use tackle such as belts / slings and shackles of sufficient carrying capacity
- Get information about the wind conditions
- Inform the manufacturer of any non-compliance with regulations
Assembly – EN 14439 / 125 % overload test

- According to EN 14439, each tower crane must be tested at 125% load before initial startup.
- The maximum allowable wind speed during the special test is 8 m/s (28 km/h). This value corresponds to wind force 4 as per Beaufort scale.
- The overload test must be accomplished by qualified personnel, 3rd Party or technicians from WOLFFKRAP.
- WOLFFKRAP requires a confirmation with the results of the 125% load test.
**Operation - Safety Equipment**

To rescue injured personnel from heights, you will find a backpack with a rescue system and instructions in the operator’s cabin. In case of injured or unconscious personnel on the slewing tower crane, this rescue system can be used for rappel.

<table>
<thead>
<tr>
<th>Hard hat</th>
<th>Safety goggles</th>
<th>Hearing protection</th>
<th>Safety gloves</th>
<th>Safety shoes</th>
<th>Safety harness</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Hard hat" /></td>
<td><img src="image" alt="Safety goggles" /></td>
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<td><img src="image" alt="Safety shoes" /></td>
<td><img src="image" alt="Safety harness" /></td>
</tr>
</tbody>
</table>
**Operation - Hand signals in acc. with DIN 33409**

<table>
<thead>
<tr>
<th>Caution</th>
<th>Stop</th>
<th>Stop - Danger</th>
<th>Slow</th>
<th>Marking destination</th>
<th>Indicating distance stop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arm extended vertically, palm facing forward.</td>
<td>Both arms extended horizontally to the side.</td>
<td>Both arms extended, palms down, move arms back and forth horizontally.</td>
<td>Both arms extended forward, palms facing down, move your arms slowly up and down.</td>
<td>Point at the destination with both hands.</td>
<td>Hold both palms in parallel according to the distance to go.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hoist</th>
<th>Lower</th>
<th>Hoist slowly</th>
<th>Lower load slowly</th>
<th>Start moving</th>
<th>Travel to /away from me</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forearm vertical, finger pointing up, move hand in small horizontal circles.</td>
<td>Arm extended downward, finger pointing down, move your hand in small horizontal circles.</td>
<td>Forearm horizontal, palm facing up, move the forearm slowly up and down.</td>
<td>Forearm horizontal, palm facing down, move the hand slowly up and down.</td>
<td>Arm raised, palm facing forward, move your arm back and forth to the side.</td>
<td>Forearms angled horizontally, palms towards / away from the body, wave with both arms.</td>
</tr>
</tbody>
</table>
Operation - Safe handling of loads

- Make sure that the hands of slingers remain out of the dangerous area when the rope is tensioned.
- If necessary, a guide rope must be used to control the load.
- The load must be free before being hoisted.
- Note that the load hook must be located vertically above the load’s center of gravity.
- The hoisting ropes must not be twisted.
- Do not lift any loads with large surface if these are exposed to strong or gusty wind force.
**Operation - Safe handling of loads**

- It is forbidden to drag the load or pull it at an angle:
- Personnel must retreat to a safe place while the load is being hoisted or lowered.
- The load should be lowered for realignment if wrongly suspended.

- Lift the load slowly until full tension is applied to the hoisting rope.
- Never allow the load to swing or oscillate. Swinging loads are a source of risk to man and machine.

- Do not hoist a load with excess ropes or tackle hanging down at its side. Remove loose tackle or attach it to a higher position.
- Place loads properly onto supports or bucks to prevent damage to the lifting tackle.
Operation – Safety Precautions

The maximum permitted wind speed for operation is 20 m/s (72 Km/h).

- Do not allow the hook to touch the ground, to prevent unwinding the hoist rope.
- Check the windings of the hoisting rope on the drum
- Check the proper seating of all wire ropes on the pulleys
- Make sure that movement of the tower crane on the rail carrier is not obstructed
- The main power cable of the tower crane can be safely unwound
- Do not deploy any methods of operation which pose a risk to safety
- Do not switch off the tower cane while slewing
- Ensure that all risks to individuals is excluded before the crane is put into operation
- Warn personnel to stay well clear off the load
Crane Safety Details

- Sensors & Limit Switches
- Working Area Control System
- Extra Censoring
- Secondary brakes
- Safety details EN 14439
- Crane monitoring / WOLFFLink
Safety Features – Sensors & Limit Switches

1 - Hoist height limit switch (at the drum)
2 - Control cabinet (with crane control & inverters)
3 - Slewing angle sensor (at the slip-ring system)
4 - Inclination sensor (at jib hinge point)
5 - Load measuring shaft (at shaft in rope sheave)
6 - Display in cabin
9 - Luffing gear sensor (at luffing drum)
Safety Features – Sensors & Limit Switches

Working Area Controls System

- The crane can be programmed to prevent its operation in certain areas (above Metro tracks, roads, buildings etc.)
- Closed areas can be A or B see below
- On the display in cabin warning symbols must show
Safety Features – Sensors & Limit Switches

**Extra “Censoring”**

**Wind startup function**
The crane control ensures that the crane turns in the desired direction. Without this function, the wind might push the crane in another direction, risking collision of crane with an obstacle/building.

**Voltage monitoring**
The crane control monitors the existing electric network and switches off automatically when the safe operation of the crane is no longer ensured. By means of automatic load reduction, the crane control tries to compensate for voltage dips in customer’s network. In extreme cases, this may lead to crane switch-off to ensure safe operation.
Safety Features – Sensors & Limit Switches

Extra "Censoring"

Slack rope protection for luffing cranes
The system checks whether the jib really luffs out. This prevents the jib from falling abruptly into the luffing ropes when the wind fades.

Wind gauge
All European Tower cranes must be equipped with wind gauges.

Monitoring of automatic central lubrication of slew ring
The filling of the automatic central lubrication system is monitored. When the signal ‘Grease tank empty’ is received, an error message is indicated to the crane operator. This prevents consequential damage to the slew ring.
Secondary Brakes on Hoist Drive and Luffing Drum

Secondary brakes on the hoist drive and luffing drum are an option to further increase safety.
Safety Features required per EN 14439

- Rest platforms min. every 6 m
- Ladders positioned at an angle incl. safeguards against falling backward
Safety Features required per EN 14439

Hand and knee rails, toe-boards (rec. 10 cm high), no gaps in walkways wider than 20 cm
Safety Features required per EN 14439

Anemometer for all top-slewing tower cranes

Outside light indicators showing the crane condition
Safety Features required per EN 14439

**Continuous light:**
- **Green light on:** Crane is switched on
  - Crane is used with remote control
- **Yellow light on:** Load capacity has reached app.95 %
- **Red light on:** 100 % Load capacity is reached

**Flashing light:**
- **Green light on:** Jib weather waving position
- **Yellow light on:** Wind speed exceeding 12 m/s
- **Red light on:** Wind speed more than 15 m/s
Safety Features required per EN 14439

- Windscreen wipers
- Monitor with operating data for operator’s support
- Minimum standards regarding heating and ergonomic layout of seat/control panels
Safety Features - Cab

- Single pane side windows, tinted glass & quality blinds for best vision
- Seat adjustable to all body heights, ample length adjustment for perfect seating
- Effective heating with air vents along the side and front windows
- Radio with SD/USB port and Bluetooth hands-free equip.
- Additional storage space, six sockets, beverage cooler
Manufacturer Safety

When you buy a crane make sure it complies with

**EN 14439**

This means it is safe for your employees, personnel around you and to your investment.
Real time view of:
current operating conditions and warning signals

Auto-Call:
per e-mail or sms when crane failure occurs

Storage of crane data
for a defined period of time as basis for further evaluation

Administration of entire crane fleet

Web Link

WOLFFKran
The leader of the pack

Habib Mikati
## Real Time View of Operating Conditions

### Load
- **Load [t]**: 0.9
- **Load/load moment [%]**: 4
- **Derating [%]**: 100
- **Reeving**: 2

### Signal lamps
- **Crane On**
- **Load warning 85%**
- **Overload protection 102-110%**
- **Jib may windvane**

### Positions
- **Radius [m]**: 24.1
- **Hook position [m]**: 4
- **Slewing angle [°]**: 94

### Miscellaneous
- **Wind speed [Km/h]**: 3.9
- **Fault display**: 0

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## Web Link – Management of Operating & Crane Data

**Summary of past operating data as basis for analysis with respect to:**

- Life cycle evaluation
- Crane utilization

### Hours of operation [h]

<table>
<thead>
<tr>
<th>Component</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoist drive</td>
<td>43</td>
</tr>
<tr>
<td>Hoist 2-falls</td>
<td>43</td>
</tr>
<tr>
<td>Trolley drive/Luffing drive</td>
<td>33</td>
</tr>
<tr>
<td>Slewing drive</td>
<td>31</td>
</tr>
</tbody>
</table>

### Load movements [h]

<table>
<thead>
<tr>
<th>Load Percentage</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>5..20%</td>
<td>91</td>
</tr>
<tr>
<td>20..40%</td>
<td>19</td>
</tr>
<tr>
<td>40..60%</td>
<td>2</td>
</tr>
<tr>
<td>60..80%</td>
<td>0</td>
</tr>
<tr>
<td>80..108%</td>
<td>0</td>
</tr>
</tbody>
</table>

### Switch cycles

<table>
<thead>
<tr>
<th>Component</th>
<th>Switch Cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoist drive</td>
<td>17935</td>
</tr>
<tr>
<td>Trolley drive/Luffing drive</td>
<td>19099</td>
</tr>
<tr>
<td>Slewing drive</td>
<td>42768</td>
</tr>
<tr>
<td>Load moment &gt; 95%</td>
<td>3</td>
</tr>
<tr>
<td>Lubrication cycles</td>
<td>220</td>
</tr>
<tr>
<td>Faulty lubrication cycles</td>
<td>5</td>
</tr>
</tbody>
</table>

### Load moment cycles

<table>
<thead>
<tr>
<th>Load Percentage</th>
<th>Switch Cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>5..20%</td>
<td>1335</td>
</tr>
<tr>
<td>20..40%</td>
<td>345</td>
</tr>
<tr>
<td>40..60%</td>
<td>39</td>
</tr>
<tr>
<td>60..80%</td>
<td>5</td>
</tr>
<tr>
<td>80..108%</td>
<td>3</td>
</tr>
</tbody>
</table>
Data Storage and Extracion

DATA STORED FOR THE ENTIRE LIFE-CYCLE:

- Total working hours of the crane and every drive
- Total time that loads were lifted (5 phases)
- Total number of times that the load limitation was reached
- Total switching operations of each drive
- Date and time of last setting of the menu

DATA STORED FOR 40 WEEKS: Compiled per week

- Switching operations and times that drives were in operation
- Time that loads were lifted (5 phases)
- Number of times that load limitation were reached

DATA STORED FOR 30 DAYS: Compiled per day

- Times when the crane was put into operation and switched off, total duration in operation
- Switching operations of the hoist winch
- Maximum wind speed at specified hour
- List of errors

DATA STORED FOR 2 WEEKS: Compiled per week

- Date and time of every crane failure and warning message
- Total number of crane failures per week
Cranes in Makkah
Thank you for your attention