Mobile Harbour Crane
G HMK 6407 B

GOTTWALD port technology

Technical Description

Table of Contents **Page**

1 Mobile Harbour Cranes

Gottwald Mobile Harbour Cranes are slewing boom cranes. They were introduced to the market in 1956 and have been developed continually since then. With maximum lifting capacities of up to 200 tonnes and working radii of up to 56 metres, Mobile Harbour Cranes are used to serve ships of all types and sizes.

Because their lifting gear can be changed quickly, Mobile Harbour Cranes are suitable for flexible handling of all types of cargo, including containers, general cargo, bulk materials and project cargo.

Gottwald Mobile Harbour Cranes are equipped with rubber-tyred chassis and are highly mobile. They travel to the ships that are to be loaded and unloaded, and they can be used throughout virtually the entire terminal.

With its low diesel fuel consumption and low noise emissions, the high-efficiency diesel-electric drive concept of the Gottwald Mobile Harbour Cranes ensures that environmental impacts are kept to a minimum.

A Mobile Harbour Crane comprises four main assembly groups:

- chassis
- superstructure
- tower
- boom

With its rubber-tyred chassis, the fully rigged Gottwald Mobile Harbour Crane can travel quickly and comfortably to its place of operation. The superstructure serves as a protective housing for the drives, control system and power generation equipment. The closed tower transmits forces between boom and superstructure and provides the crane operator with comfortable, weather-protected access to the tower cab. The boom is constructed as a torsionally stiff tubular-lattice structure.

The tower cab is the crane operator's ergonomically designed workplace and affords an excellent view of the work area. All the crane functions can be controlled from the tower cab.

Gottwald Mobile Harbour Cranes are designed and manufactured to international standards and guidelines and in accordance with the state of the art. This, together with Gottwald's long experience of crane manufacture, provides the basis for many years of reliable, high-performance crane operation.

2 Chassis

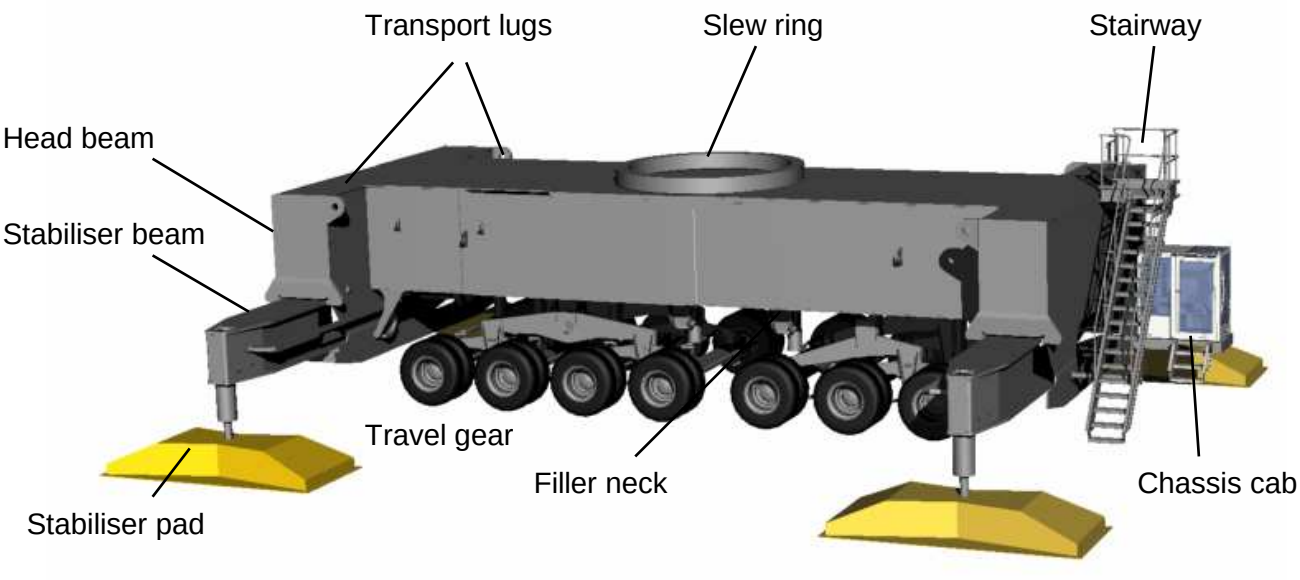

Figure 1: Schematic representation of the chassis

2.1 Steel Structure

The chassis is constructed as a welded steel structure in a torsionally stiff box design. The structure is designed to carry the forces and moments occurring in crane and travel operation.

2.1.1 Transport Lugs

Four fixed lifting points for lifting the fully mounted crane are integrated in the steel structure of the chassis.

With these lugs, the crane can be transported, e.g. by means of a floating crane, in fully rigged condition, which minimises time-consuming disassembly and assembly work.

2.1.2 Access to the Superstructure

Access from quay to chassis is provided by the stairway mounted at one end of the chassis. The bottom step of the stairway is flexibly mounted to prevent it from being damaged, e.g. if it comes into contact with the ground.

The superstructure platform is accessed via various safety doors. These doors afford safe access from chassis to superstructure for every position of the superstructure.

2.1.3 Main Fuel Tank

The main fuel tank is integrated in the steel structure. Its capacity is sufficient for intensive multi-shift crane operation. Fuel is supplied from the main fuel tank to the intermediate tank in the superstructure.

The filler neck for filling the main fuel tank is located in the chassis. To save time, the main fuel tank can be refilled during crane operation. It is important that the relevant provisions applicable in the country of operation be observed.

2.2 Propping System

The steel structure of the chassis is fitted with two head beams. Each head beam accommodates two stabiliser beams. The stabiliser beams are extended and retracted by means of hydraulic cylinders that are also located in the head beams. The position of the stabiliser beams is constantly monitored by proximity sensors. By means of hydraulic cylinders located in the stabiliser beams, the stabiliser pads are lowered, to prop the crane, and raised. The stabilisers can be operated in automatic or manual modes. All the extension cylinders and jack cylinders are retracted or extended simultaneously.

In automatic mode, the stabiliser system levels the crane fully automatically. Manual fine adjustment is not necessary.

In manual mode, the stabilisers are operated from the tower cab by means of pushbutton switches on the monitor of the Visumatic® (crane management system) near the crane operator seat. The stabilisers are operated by means of a switch on the control panel in the chassis driver cab or via the optional radio remote control (RRC). A level is provided in the chassis cab for monitoring whether the crane is in a horizontal position. In the tower cab, the horizontal position is indicated by an electronic level in the Visumatic®.

2.2.1 Stabiliser Pads

The stabiliser pads are pivotably mounted on the jack cylinders. The stabiliser pads can be removed easily when the crane is to travel through narrow passages.

2.3 Travel Gear

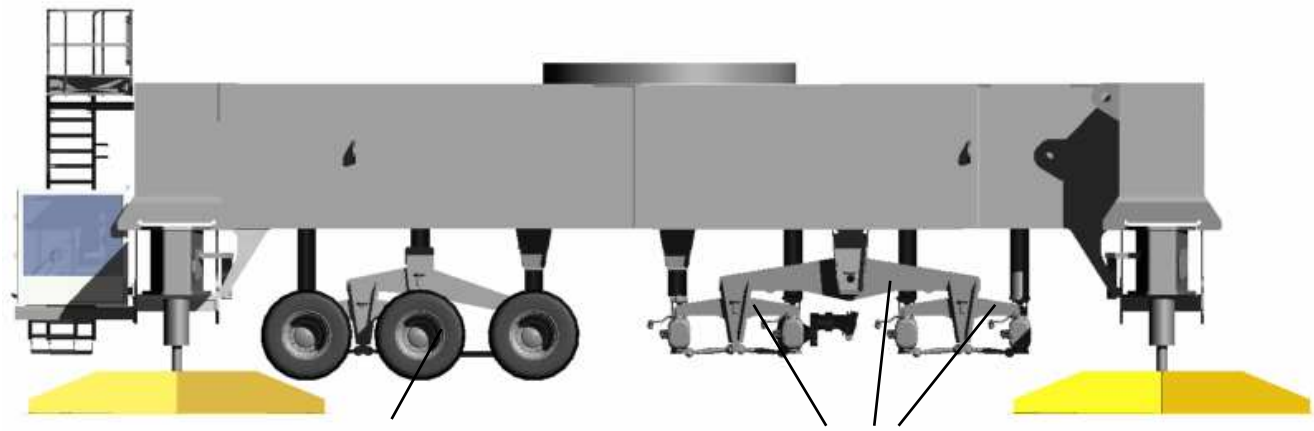

Figure 2: Schematic representation of the travel gear

2.3.1 Travel Drive

In travel operation, the crane is driven by one hydraulic motor per driven axle. The hydraulically controlled torque distribution over the axles ensures uniform torque delivery. The same maximum speed is attained in both travel directions.

2.3.2 Axles

Only two axle types are used; both have twin tyres. The driven axles are additionally braked and steered. They each have a differential in the middle of the axle and planetary gears in the wheel hubs. The other axles are steered axles.

The small number of axle types reduces the number of spare parts that need to be stocked and simplifies maintenance and repair work.

2.3.3 Axle Suspension

The axle suspension with robust, low-maintenance equaliser beams guarantees uniform distribution of the total weight over all the axles. At the same time, the equaliser beams permit independent vertical motion of the axles.

Obstacles such as rails and dips can be travelled over or through without difficulty.

2.3.4 Steering

All the axles are steered by means of hydraulic cylinders. The steering angles are synchronised with the aid of electronic linear encoders integrated in the steering cylinders.

The steering concept provides precise steering with the minimum possible tyre wear, and it allows crab steering for better manoeuvrability of the crane.

2.3.5 Crab Steering

In crab steering mode, the crane can travel sideways with a translational motion; for this, all axles are steered with the same steering angle. The sideways travel of the crane facilitates manoeuvring in confined harbours and provides a high level of mobility.

2.3.6 Brakes

Crane travel is braked with the hydraulic service brake by means of brake valves. A low-maintenance, oil-immersed multi-disc brake assists the hydraulic service brake and facilitates starting on gradients. The spring-loaded parking brake is applied automatically after crane travel has been brought to a halt. All the brake systems act on the driven axles.

2.3.7 Travel Gear Control

The travel motion of the crane is controlled from the tower cab, the driver cab or with the optional radio remote control (RRC). This control covers driving, steering, braking, lowering of the crane from the propped position onto the wheels, and propping for crane operation. The crane can accelerate smoothly from standstill all the way up to maximum speed in both directions.

2.3.8 Warning Signals During Crane Travel

During crane travel, yellow lights flash on the superstructure and a pulsating audible alarm is sounded.

2.4 Supply of Pressurised Oil to the Chassis

Pressurised oil for the hydraulic stabiliser, steering, travel gear and brake systems is provided by the pressure oil unit in the superstructure.

2.5 Chassis Driver Cab

The crane is equipped at the front with a weatherproof cab that offers the crane operator a very good view during travel. It is equipped with:

- Controls for travelling and propping the crane
- adjustable driver seat
- safety glass
- heater system
- Rooflight
- Wiper system for windscreen and rooflight
- Windscreen wash system
- ventilation system.

The control panel of the chassis driver's cab can also be designed as a radio remote control (RRC) unit.

3 Superstructure

The superstructure is a torsionally stiff welded steel load-bearing structure designed to carry all the forces and moments occurring in crane operation. It has two floors. With a headroom of 2.5 m on each floor, it provides ample room for easy access to all electrical and mechanical components. The superstructure accommodates:

- the diesel-generator system
- hoist(s)
- slewing gear
- the pressure oil unit
- the electrics room
- the counterweights.

The two floors of the superstructure are divided into a number of different rooms:

Lower floor:

- diesel-generator room
- machinery room for the slewing gear

Upper floor:

- machinery room for the hoist(s) and the pressure oil unit
- electrics room

A platform at the front of the superstructure provides safe access from chassis to superstructure. The superstructure is accessed via lockable doors. The integral stairwell provides comfortable access to the rooms of the upper floor and to the stairway leading to the tower cab.

The superstructure is illuminated with fluorescent lamps, half of which serve also as emergency lighting.

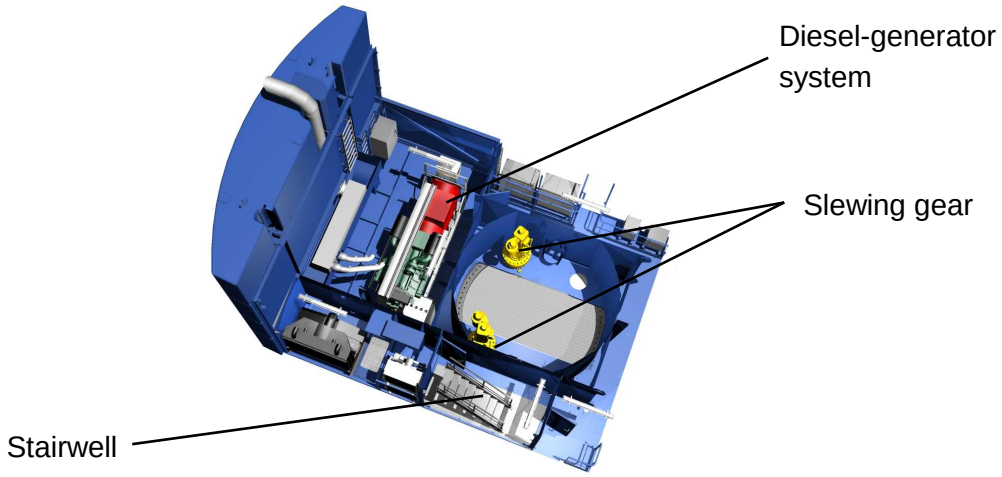

Figure 3: Schematic representation of the superstructure – lower floor

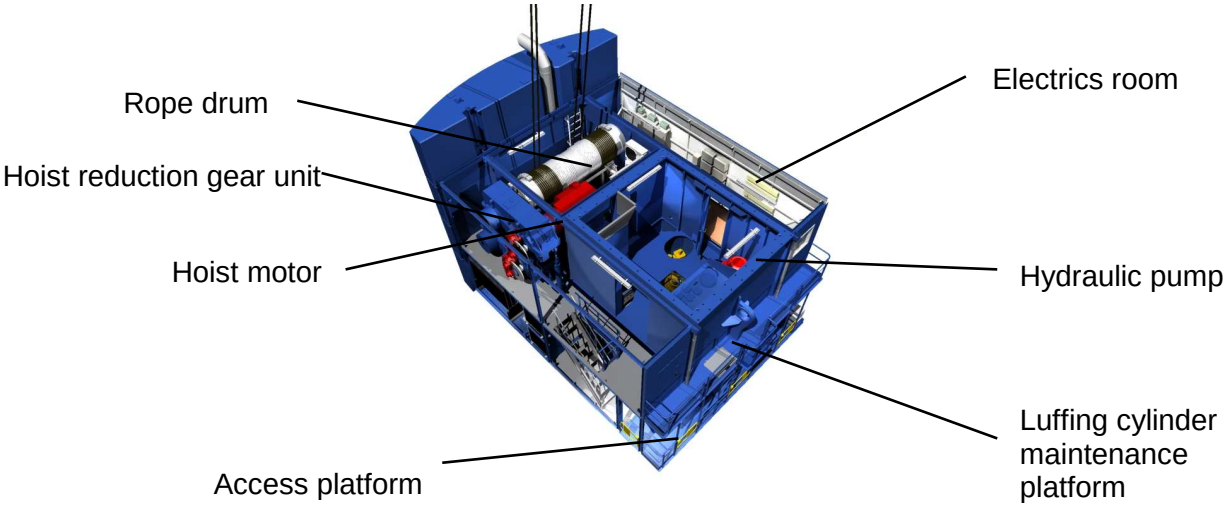

Figure 4: Schematic representation of the superstructure – upper floor

3.1 Protective Housing

The protective housing protects all components from environmental influences; it also protects the environment from noise emissions. The protective housing is made up of the steel structure of the superstructure together with side panelling made of coated composite plates and a roof made of aluminium plates. The rope outlet on the roof of the superstructure is protected against ingress of rain and dust by means of rubber seals. Water ducts are provided for rainwater removal.

The side walls can be removed easily for replacement of individual drive units.

3.1.1 Communication System

The Mobile Harbour Crane is equipped with a communication system having headphones and microphones, which can be connected in:

- the diesel-generator room
- the machinery room for the hoist(s) and pressure oil unit
- the machinery room for the slewing gear
- the electrics room
- the chassis driver cab
- the tower cab

The system is supplemented with external loudspeakers and an amplifier with microphone in the tower cab.

3.1.2 Ventilation System

The superstructure is provided with forced ventilation. In the lower part of the tower fresh ambient air is sucked in and introduced into the superstructure. In the superstructure, the air is distributed to the two machinery rooms and to the diesel-generator room. The fresh air serves to cool the machine units and as combustion air for the diesel engine. The heated exhaust air is

removed in an upward flow through the closed tower and escapes via air outlet openings. The exhaust air from the diesel-generator room escapes via air outlet openings in the diesel-generator room.

The slight positive pressure in the superstructure minimises the dust load on the drive units.

3.2 Diesel-Generator System

The electric power for the crane drives is generated by a diesel-generator system. The diesel generator unit is adequately dimensioned so that all crane functions can be carried out simultaneously and independently of each other.

The diesel engine is connected to a three-phase generator. For quick replacement, the diesel-generator unit is mounted on a sliding frame, which can be removed sideways from the superstructure using standard port equipment.

The control unit for the diesel engine is installed on the engine and equipped with start and stop buttons, key-operated ignition and a digital display for:

- engine oil pressure
- coolant temperature
- rev counter
- operating hours counter
- battery voltmeter

The starter batteries with the main switch are also located in the diesel-generator room.

3.2.1 Intermediate tank

The diesel engine is operated with fuel from the intermediate tank, which is also located in the diesel-generator room. The intermediate tank is automatically filled with fuel from the main fuel tank in the chassis.

3.3 Four-Rope-Grab Hoist

The hoist assembly comprises two hoists, each having a modular design. One hoists serves as holding gear, the other opens and closes the four-rope grab. Each hoist comprises:

- DC motor
- spring-loaded disc brake
- completely enclosed reduction gear unit
- milled rope drum.

The rope drums, reduction gear units and hoist motors are arranged in such a manner that all the maintenance points are easily accessible. The ropes are coiled in one layer on the rope drums in order to keep wear low. Two ropes are coiled on each drum.

The rope ends are connected directly to the grab or to the hook rotator, i.e. the hoisting speed of the grab or hook equals the rope speed.

A horizontal load path during luffing is achieved by triple reeving of the ropes between tower and boom head.

3.3.1 Hoist Lubrication

The hoist reduction gear units are oil immersed. The oil level is monitored.

3.3.2 Hoist Brake

The hoists are braked electrically by the hoist motors. When the hoisting speed is near zero, the spring-loaded hydraulically released disc brakes are applied automatically. These brakes also act as emergency brakes in the event of a power supply failure.

3.3.3 Hoist Control

The electric motor is a separately excited DC shunt motor. The hoist motor is controlled by means of thyristors connected in an inverse-parallel arrangement. The DC drive system provides smooth acceleration and deceleration of the hoisting motion. It thus protects the mechanical components and the steel structure from fatigue. The maximum possible hoisting speed is automatically increased with reduced load.

In crane operation with the hook rotator, both hoists are electronically synchronised.

3.4 Slewing Gear

With the slewing gear, the superstructure can be slewed infinitely. The slewing gear has a modular design and comprises:

- DC motor
- elastic coupling
- disc brake
- three-row roller bearing slew ring
- fully enclosed planetary reduction gear unit.

The drive pinion of the planetary gear unit engages with the internal toothing of the slew ring.

3.4.1 Slewing Gear Lubrication

The slewing reduction gear unit is oil-immersed. The roller bearing slew ring and the toothing are lubricated by means of a central lubrication system.

3.4.2 Slewing Gear Brake

The slewing motion is braked electrically. When the slewing gear has been brought to a standstill, the spring-loaded hydraulically released disc brake is applied automatically. This brake also acts as an emergency brake in the event of a power supply failure.

3.4.3 Slewing Gear Control

The electric motor is a separately excited DC shunt motor. The slewing gear motor is controlled by means of thyristors connected in an inverse-parallel arrangement. The DC drive system provides smooth acceleration and deceleration of the slewing motion. The maximum slewing speed depends on the boom position and is controlled automatically.

3.5 Luffing Gear

The boom is luffed in and out by means of a hydraulic differential luffing cylinder that holds the boom in position. The cylinder is mounted below the boom. Brake valves control the cylinder movement. For safety reasons, pipe-break valves are fitted.

The boom head can be lowered to a convenient working height for maintenance purposes.

For maintenance work, the valve block on the luffing cylinder can be accessed easily from a platform on the superstructure.

3.5.1 Luffing Gear Drive

The pressure oil unit in the superstructure supplies the luffing cylinder with pressurised oil for its operation.

3.5.2 Luffing Gear Control

Acceleration and deceleration of the luffing motion are controlled smoothly and in an infinitely variable fashion by means of valves and by alteration of the volumetric flow rate of the oil.

3.6 Pressure Oil Unit

The pressure oil unit supplies pressurised oil to the luffing gear on the superstructure and to the propping, steering, travel gear and brake systems on the chassis. It comprises:

- a three-phase squirrel-cage motor
- an elastic coupling
- an axial piston pump.

The axial piston pump has an adjustable oil displacement. The displacement is adapted as necessary during crane operation.

3.7 Counterweight

The counterweight is mounted in a positive-fitting manner in T-rails at the rear of the superstructure.

4 Tower/Boom System

The high boom pivot point on the tower allows the crane to be positioned very close to the ship without risk to ship freight, ship superstructure or crane components.

The elevated position of the tower cab offers an excellent view of the entire work area and into the ship's hold.

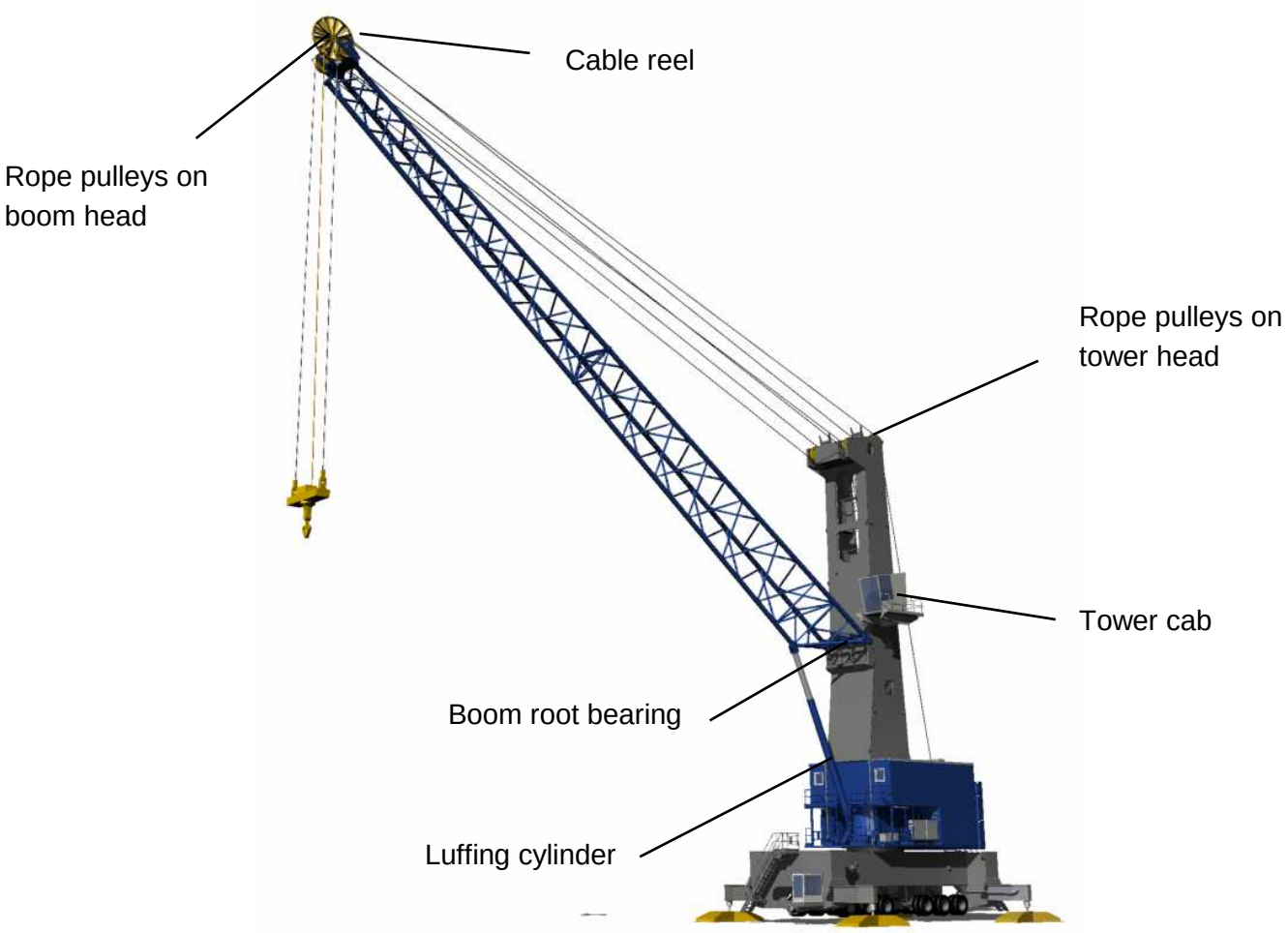

Figure 5: Schematic representation of the tower/boom system

4.1 Tower

The tower is a torsionally stiff, welded steel structure. It has a closed design up to the tower cab. The transmission of forces and moments to the superstructure takes place in a uniformly distributed manner over the entire circumference of the tower.

4.1.1 Rope Pulleys

A rope pulley set is provided on the tower head. Rope guides prevent the hoist ropes jumping out of the pulleys. The rope pulleys run in anti-friction bearings and are of a low-maintenance design. Grease nipples are, however, provided for lubricating the bearings.

The rope pulleys can be accessed easily via ladders and platforms.

4.2 Luffing Boom

The luffing boom is constructed as a torsionally stiff, welded tubular-lattice structure with two upper chords and one lower chord. The boom comprises the boom root and the boom head, which are connected together by a flange connection that remains immovable even in the long term.

4.2.1 Boom Root Bearing

The boom root is mounted in plain bearings on the tower. A maintenance platform provides easy, safe access to the boom root bearing.

4.2.2 Rope Pulleys

A rope pulley set is provided on the boom head. The design of the rope pulley set is the same as that of the rope pulley set on the tower head. The distance between the rope pulleys is selected such that load is stabilised below the boom.

4.2.3 Cable Reel at Boom Head

A motorized cable reel is installed at the boom head in order to coil and uncoil the electrical cable for the remotely controlled hook rotator and lifting gear such as:

- automatic spreaders
- electro-hydraulic grabs
- pneumatic lifting devices etc.

The cable reel is torque-controlled for an automatic slack cable adjustment and the prevention of shock loads on the cable. Thus the cable service life is increased.

4.3 Access to Tower Cab

Weather-protected access to the tower cab is provided via the closed tower. The tower cab can be reached easily via wide, safe stairways having a stair angle of 50°. Spacious platforms facilitate maintenance work.

5 Tower Cab

The crane operator controls all the functions of the crane from a spacious, ergonomically designed tower cab. Large windows and the cab position high on the tower provide an excellent view of the work area and the ship's holds.

The tower cab is made of steel plates and sections which are protected against corrosion in a salt-laden, marine environment by a tried-and-tested paint finish. The tower cab is fitted with safety glass windows. The windows are arranged in such a manner that they are easy to clean from inside and outside. The near-silent ventilation system with its air outlets on the windscreen and side windows and in the footwell ensure the windows do not mist up.

The non-glased surfaces in the cab are panelled with a material which is heat and sound insulating. The dark, carefully matched colour scheme inside the cab minimises reflections from the windscreen. A number of practical and ergonomic features make the tower cab a pleasant place to work:

- windows of tinted safety glass
- a front window with infinitely variable opening
- sound and heat insulating interior panelling
- upholstered operator seat, which is adjustable in the vertical and horizontal directions
- controls and indicators
- air outlets for the windscreen and side windows and the footwell
- infinitely adjustable sun blinds on the side windows, rooflight and windscreen, and on the door
- air conditioner
- near-silent ventilation system with electric heater
- wiper/washer system for the front and roof windows
- interior lighting
- electric socket
- electric horn
- internal and external communication system
- ashtray
- CD radio.

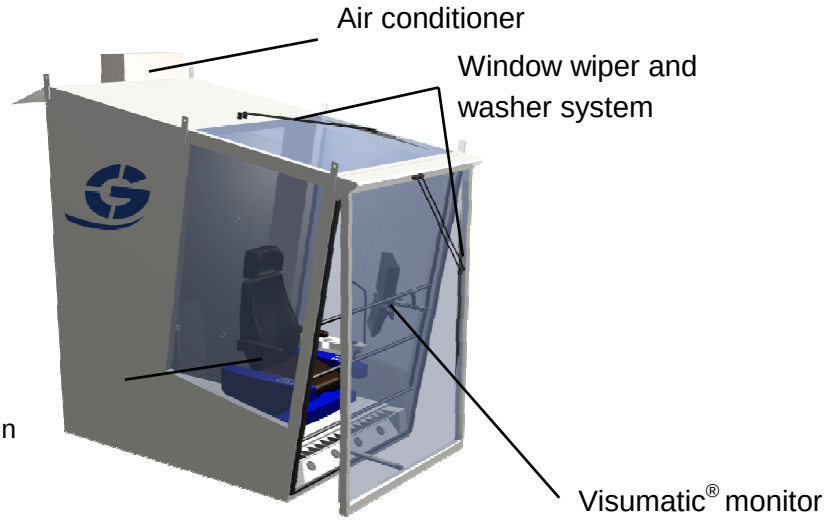

Figure 6: Schematic representation of the tower cab

5.1 Controls and Indicators

The controls and indicators for all crane functions are located in control panels on both sides of the operator seat and on the Visumatic®.

The controls comprise light switches and control levers and switches for all main and auxiliary crane functions.

5.2 Visumatic® – Crane Management System

Visumatic®, Gottwald's crane management system, displays all the crane functions in a structured, easy-to-understand form on a monitor near the crane operator seat. The individual functions are indicated by coloured pictograms and are selected with function keys on the monitor.

All the data required for operating and monitoring the crane are shown on the Visumatic® monitor. These data include:

- check list with status indicator for crane, travel and propping operations
- actual and limit values for load, radius and hoisting height
- wind speed
- fuel level
- operating mode (hook, spreader or grab operation)
- diagnostic messages
- support for fault finding and remedying
- indication of remaining operating hours until end of maintenance interval
- diesel engine diagnostic system
- statistics for diagnostic messages and performance data.

6 Hook Rotator

The crane is equipped with a hook rotator, which rotates the hook so that the load can be turned to any desired position from the tower cab. The hook can rotate freely or be locked in position.

The lifting gear comprises a beam from which a ramshorn hook equipped with safety catches is suspended by means of a universal joint. The hook, which is mounted in roller bearings, is remote-controlled from the tower cab. It is infinitely rotatable.

The electro-hydraulic hook rotator comprises an electric motor, a hydraulic pump, a hydraulic motor and a gear unit. These assemblies plus the slipring assembly are accommodated in a closed rotator beam and protected from environmental effects and jolts or impacts.

The rotator beam and the rotator are equipped with power supply and remote control connections for spreaders, grabs and other lifting gear.

7 Safety Equipment

The safety equipment installed complies with the applicable EU directives. Additional safety equipment further enhances operational safety.

7.1 Safe Load Indicator

The crane is equipped with an automatic safe load indicator that ensures its safe operation.

The system indicates the actual load on the hook and the actual radius of the boom. As soon as the permissible load is reached, motions that would increase the load moment are disabled and an audible alarm is sounded in the tower cab.

7.2 Securing for Crane Travel

Before crane travel, the superstructure and chassis must be locked together mechanically and the boom must be in the travel position. When these conditions are satisfied, the slewing gear is switched off and the travel drive enabled.

7.3 Stabiliser Monitoring

The propping status is monitored. If the crane is correctly propped, the superstructure/chassis locking device can be unlocked and the crane drives can be operated.

Before the stabiliser pads can be raised into the travel position, the superstructure and chassis must be locked.

7.4 Limit Switches

The hoisting and lowering motions of the crane are limited by electronic limit switches. In the pre-limit switch range, the speed of the hoisting motion is reduced. When the switch-off point is reached, the hoisting motion is stopped.

For the electronic limit switching of the hoist, the hoisting height is detected by two redundant systems. The values are compared in a computer. As a check, the comparison is also performed in parallel in a second computer.

The limit switching of the luffing gear functions in the same manner as that of the hoist.

7.5 Safety Valves

The jack and luffing cylinders are equipped with pipe-break valves that hold the cylinders in position should a leak occur.

Pressure limiting valves protect the hydraulic circuits from excessive pressure.

7.6 Anemometer

An anemometer is located on the tower head. The wind speed is shown on the Visumatic® monitor. If the allowed wind speed is exceeded, an audible alarm will be sounded in the tower cab.

7.7 Emergency Stop

In case of danger to staff in the work area or to the crane itself, the motions of the crane can be stopped immediately by actuating an emergency stop switch.

Emergency stop switches are mounted in the chassis and tower cabs, in the superstructure and in the electrics room. When one of these switches is actuated, all crane motions are stopped immediately.

Further emergency stop switches are mounted at the front and rear of the chassis. When one of these emergency stop switches is actuated, all crane travel motions are stopped immediately.

8 Electrical Equipment

The main drives of the crane are driven by means of electric motors. This drive concept, which is the most wide-spread and commonly used drive concept in port technology applications, offers the following advantages:

- low operating and maintenance costs
- reliable operation even in continuous, multi-shift operation
- reliable operation under extreme climatic conditions
- long machine-unit service lives with unvarying high efficiency
- easy service and maintenance.

The required electric power is generated independently of external power sources by a diesel-generator system in the crane. As an alternative, with the external power supply option, the crane can be connected to the shore power supply.

Thyristor converter units convert the alternating current generated by the diesel-generator system to direct current for the hoist and slewing gear drives. The DC drive system provides smooth acceleration and deceleration of the crane motions.

8.1 Electrics Room

The closed, lockable electrics room is located in the superstructure. Accommodated in this room are the crane control system and the electric control equipment.

The electric control equipment is arranged by function groups. All cables, plugs and terminal strips are clearly marked so that maintenance work can be performed easily.

An air conditioner and a heater in the electrics room prevent problems due to moisture and make it possible to carry out maintenance work safely and reliably under all weather conditions.

8.2 Central Computer

The programmable logic controller of the crane is installed in the electrics room. It detects and monitors all electric signals and diagnostic messages via a bus system. In addition, data is exchanged between the controller, the crane drives and the tower cab via a high-speed bus system.

8.3 Lighting

The tower cab, all rooms of the superstructure, and the entrances, stairways and platforms are illuminated by fluorescent lamps. Half of these fluorescent lamps serve also as emergency lighting. Thanks to the installed lighting, it is possible to walk safely on and in the crane, and to perform maintenance work without difficulty, when it is dark outside.

Floodlighting is provided for illumination of the work area in night operation of the crane. Lights are mounted on the boom head, below the boom, on the front of the tower and on the rear of the tower cab platform.

8.4 Operating Hours Counter

The operating hours counters record the operating hours of the various crane drives.

8.5 Video Camera Assistance

The crane is equipped with a camera system that assists the crane operator during loading and unloading of cargo. The image captured by a video camera on the boom head is displayed on a monitor in the tower cab. The monitor is mounted in a clearly visible position close to the operator seat.

9 Surface Protection

All load-bearing parts are sandblasted and painted using proven methods. These methods meet the requirements of a salt-laden, marine environment.

10 Additional Equipment

The selected options complement the standard equipment and enable the cranes to be adapted to the special requirements of customers.

Subject to change.