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Cranes — Requirements for mechanisms —

Part 3: Tower cranes

Appareils de levage à charge suspendue — Prescriptions pour les mécanismes —

Partie 3: Grues à tour

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10972-3 was prepared by Technical Committee ISO/TC 96, *Cranes*, Subcommittee SC 7, *Tower cranes*.

ISO 10972 consists of the following parts, under the general title *Cranes — Requirements for mechanisms*:

— *Part 1: General*

— *Part 3: Tower cranes*

Introduction

This part of ISO 10972 applies the principles given in ISO 10972-1 to tower cranes, and establishes minimum requirements of good practice for mechanisms in order to enhance safety. It is acknowledged that innovations and new materials may enable new mechanisms that are not addressed here. This part of ISO 10972 is not intended to prohibit such innovations provided they furnish equivalent safety.

Cranes — Requirements for mechanisms —

Part 3: Tower cranes

1 Scope

This part of ISO 10972 establishes requirements which apply specifically to the mechanisms and related components of tower cranes, in addition to the general requirements given in ISO 10972-1.

These additional requirements concern

a) the arrangement, features and characteristics of the crane mechanisms, and

b) the minimum requirements for certain mechanism components.

Rules for the proof of competence calculation regarding different limit states (yield strength, fatigue, wear) are excluded from this part of ISO 10972.

This part of ISO 10972 is not applicable to the climbing mechanisms and related components used on tower cranes, nor to the climbing frame.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4301-3, *Cranes — Classification — Part 3: Tower cranes*

ISO 4302, *Cranes — Wind load assessment*

ISO 4306-1, *Cranes — Vocabulary — Part 1: General*

ISO 4306-3, *Cranes — Vocabulary — Part 3: Tower cranes*

ISO 4413, *Hydraulic fluid power — General rules relating to systems*

ISO 9374-3, *Cranes — Information to be provided for enquiries, orders, offers and supply — Part 3: Tower cranes*

ISO 10972-1, *Cranes — Requirements for mechanisms — Part 1: General*

IEC 60204-32, *Safety of machinery — Electrical equipment of machines — Part 32: Requirements for hoisting machines*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4306-1 and ISO 4306-3 and the following apply.

3.1
coupling
device that connects two components and transmits torque between them

3.2
maximum working pressure
maximum pressure in any hydraulic circuit or individual component during normal operation

4 Specific provisions for tower cranes

4.1 Design criteria

4.1.1 Hoist winches

Powered hoist winches are used for lifting and lowering loads at controlled speeds. Movements due to gravity alone are not allowed.

The group classification of the hoisting winch mechanism shall be in accordance with ISO 4301-3.

4.1.2 Luffing mechanisms

Powered luffing mechanisms shall derrick the jib with the load at controlled speed. Movements due to gravity alone are not allowed.

The group classification of the luffing mechanism shall be in accordance with ISO 4301-3.

4.1.3 Hydraulic systems

The characteristics of the hydraulic systems and relative components shall be designed to comply with ISO 4413.

4.1.4 Trolley-travelling mechanisms

The mechanisms shall allow horizontal or inclined motion of the trolley along the jib with the load applied.

If the mechanism provides hoisting of the load, it shall also comply with the standards relative to lifting mechanisms.

The system shall ensure the controlled motion of the trolley with load in both directions, in accordance with the geometric configuration of the crane jib (whatever the inclination).

Movements determined by gravity alone are not permitted.

The group classification of the trolley travelling mechanism shall be in accordance with ISO 4301-3.

4.1.5 Crane-travelling mechanisms

If a travelling mechanism is fitted, tower cranes can travel on

a) straight rails,

b) rails featuring curves.

The travelling mechanisms shall provide driving mechanisms at least at two corners, consisting of an electric motor, a coupling, a brake, a speed reducer and wheels for running on the rails.

Provision shall be made to allow greasing.

The diameter and number of wheels shall be assessed in accordance with the load per corner.

The crane shall be equipped with means for anchoring against dragging, when it is out-of-service.

This resistance shall be assessed in relation to the dragging force of the wind, in out-of-service conditions, in accordance with ISO 4302.

The group classification of the crane-travelling mechanism shall be in accordance with ISO 4301-3.

4.1.6 Slewing mechanisms

The slewing mechanisms shall enable the positioning of the hook and the load in the desired position.

The power should be supplied by means of a slip ring. When no slip ring is used, the jib rotation shall be limited, in both directions. The cable shall be arranged in such a manner that it cannot be damaged.

The group classification of the slewing mechanism shall be in accordance with ISO 4301-3.

4.2 Power (motors)

4.2.1 Hoist winches and luffing winches

The selection of electric motors shall be in accordance with IEC 60204-32.

The position of the motor shall allow sufficient ventilation.

4.2.2 Trolley-travelling mechanisms

The power and torque of the motor shall be sufficient to allow the movement of the trolley in all operating and test conditions, taking into account the following:

a) the influence of the jib's angle of inclination (the jib is never perfectly horizontal);

b) resistance to rolling;

c) any friction on the rims of the wheels;

d) the friction caused by the load-hoisting ropes;

e) the lifting of the load (inclined-jib cranes without systems for horizontal load trajectory);

f) the influence of the wind;

g) the inertia and the performance of the mechanism.

4.2.3 Crane-travelling mechanisms

The motors shall provide the power required, assessed on the basis of

a) maximum friction and mass,

b) lateral friction between rail and wheel,

c) minimum gradient tolerated by the rails,

d) number of starts in the unit of time,

e) force of the wind when the structure is in service.

4.2.4 Slewing mechanisms

The motors shall supply the total required power for

a) the mass to be moved

b) in the case of electric motors, the number of starts in the unit of time.

The motors shall provide a total torque sufficient to withstand the force due to

— in-service wind on the jib,

— in-service wind on other rotating structures,

— in-service wind on the load,

— friction.

4.3 Coupling

4.3.1 Hoist winches and luffing winches

Failure of elastic elements in a coupling between motor and gear box shall not cause hazardous movements.

Selection of the coupling in the kinematic chain shall be made based on the general design of the mechanism and on its use and performance, in order to

a) avoid vibrations,

b) damp unwanted peak values of torque,

c) compensate possible misalignments.

Non-homogeneous rotating parts shall be dynamically balanced.

4.3.2 Crane-travelling mechanisms

In the case of hydraulic couplings or equivalent devices connected to short-circuit starting motors, the brakes, or slowing-down systems, shall be located downstream from the couplings.

For other couplings, see 4.3.1.

4.3.3 Slewing mechanisms

In the case of hydraulic couplings or equivalent devices connected to short-circuit motors, the brakes, or slowing-down systems, shall be located downstream from the couplings.

For other couplings see 4.3.1.

4.4 Brakes

4.4.1 General requirements

In case of cut-off of the hoisting force, the brake shall be applied automatically. The brake shall have a thermal capacity suited to the number of hourly manœuvres, ambient temperature and permitted temperature.

The brakes shall be so designed that, in emergencies, the braking force can be regulated to guarantee a controlled load-descent speed. The design of the brake shall take into account the thermal energy to be dissipated when allowing the maximum load to descend from the maximum height.

The electrical circuit of the motor and brake shall be so designed that the electromotive force, if any, produced by the motor cannot affect any required braking.

The reliability of the springs shall be suited to the effective life of the brakes and the number of expected brakings. The system shall be designed so as to ensure that pre-stressing of the springs does not affect the elastic constant of the spring.

The brakes shall be protected against infiltration of oil, rainwater or other contaminants.

4.4.2 Hoist winches

The dynamic braking moment shall be at least 1,5 times the moment generated by the rated loads.

The friction-lining surfaces shall fit to the brake drum or disk so as to prevent any undue wear, and shall not be made of hazardous material (e.g. asbestos).

4.4.3 Luffing mechanisms

An additional brake may be installed directly on the drum flange to permit braking to be directly controlled by the operator in case of failure in the main brake or in the driving mechanisms.

This provides the possibility for replacement and maintenance of the motor and main brake.

Means shall be provided to automatically control the operating time sequences of the two brakes, to avoid any undue dynamic load on the kinematic chain.

The dynamic braking moment shall be at least 1,5 times the moment generated by the rated loads.

In case of a cut-off of the hoisting force, the main brake shall be applied automatically, and the additional brake applied after a delay time.

The instruction handbook shall provide at least the time intervals and the recommended procedure for controlling the brake wear.

The friction-lining surfaces shall fit to the brake drum or disk so as to prevent any undue wear, and shall not be made of hazardous material (e.g. asbestos).

4.4.4 Trolley-travelling mechanisms

The brakes shall be able to stop and hold the trolley in the desired position, in the worst-case operating and test conditions.

For cranes with a capacity of less than 1 000 kg and whose overturning moment is less than 40 000 N · m, and only with regard to the horizontal movement of the loads, the trolley may be stopped and held in position by means of systems based on the self-locking properties of the gear box in use.

The trolley shall be fitted with end stops so that it cannot leave the jib.

Wheels shall be guided by flanges or pulleys so that they cannot leave the jib.

When the trolleying ropes transmit eccentric pulls to the trolley, the application of horizontal guiding rollers and rimless wheels are required.

4.4.5 Crane-travelling mechanisms

The brakes shall be able to stop the crane gradually. The deceleration rate shall be taken into account by the manufacturer.

The total dynamic braking torque shall be capable of opposing the total force applied to the structure by in-service wind, in accordance with ISO 4302.

4.4.6 Slewing mechanisms

The static braking torque shall permit the slewing part of the crane to be held in position against in-service wind.

4.5 Out-of-service devices for slewing mechanisms

It shall be possible to release the brakes manually or by means of remote control, to put the crane out of service.

In the latter case, the remote control shall be provided with safety contacts and indicators to ensure the actual disengagement.

4.6 Hydraulic and pneumatic systems

4.6.1 General

The characteristics of the hydraulic systems and relative components shall be designed so as to comply with ISO 4413.

4.6.2 Hydraulic fluid

The physical and chemical properties of the hydraulic fluid shall be suited to the use and expected number of cycles.

The viscosity of the fluid shall guarantee the correct working of the system, within the operating temperature range of the crane.

4.6.3 Reservoirs

The maximum and minimum levels of the fluid shall be indicated.

The size and position of the drainhole shall be chosen to limit the flowrate of the fluid, thus avoiding the formation of turbulence.

4.6.4 Filters

The filtering power shall be adequate for the hydraulic components served.

The size of the filter shall permit rated flow in all operating conditions, within the expected viscosity range, taking into account the allowed temperature excursions.

The filters installed on the machines intended for only a few assembly cycles may be without a clogging indicator, if the instructions provide for their scheduled cleaning or replacement. In this case, disassembly of the filter may entail disassembly of parts of the system and emptying of the tank. If no clogging indicator is provided, it is recommended to install a bypass to allow the fluid to bypass the filter if it is becoming blocked.

4.6.5 Hydraulic circuit

This circuit shall be designed and manufactured so as to minimize any risks in case of failure, breakdown or malfunctioning of one or more of the components.

The design characteristics of the hydraulic circuit shall be such as to permit controlled movement of the cylinders and of the remaining actuating devices, if any, in normal operating conditions.

Pressure measurement shall be foreseen at the main points of the circuit.

Means to prevent any cavitation shall be arranged, taking into consideration a long period of inactivity of the actuator.

4.6.6 Pumps

The pumps shall be capable of producing the desired flowrate within the designed working range.

The pressure limit of the pump shall be at least equal to the setting of the overpressure valve. Reverse movement of the engines shall be prevented or limited, especially if this can damage the pumps or the other components. If the risk of damage is negligible, then instructions or warnings for the prompt checking of the direction of movement are sufficient.

4.6.7 Pipes and joints

The pipes and joints shall have a limit state not less than 4 times their respective maximum pressures.

The stop valves shall be connected to the cylinders by rigid pipes, or preferably directly installed on the cylinders.

Those pipes and joints with safety functions shall be readily accessible.

4.6.8 Cylinders

The maximum force that could be developed by the cylinders, considering any foreseeable overpressure due to for example temperature variations, shall be such as to prevent any damage to the structure under normal operating conditions.

When single-effect cylinders are used, the safety of withdrawal of the rod shall be guaranteed.

The circuit shall be designed so as to prevent the partial or total emptying of the cylinder chambers. Instructions shall be provided to check and remedy the possible emptying of the system before each cycle of use.

The rods shall be protected from corrosion, taking into account the working environment of the machine and the periods of inactivity.

The cylinders shall be provided with a stop valve, to stop operation in case of lack of power or failure of the supply pipe. The stop valve shall also be capable of relieving any dangerous overpressure.

A device shall be provided to maintain a uniform speed of the rod, when this component moves due to the effect of the applied load, in order to prevent any oscillations to the structures.

The cylinders shall be installed so as to facilitate maintenance operations of the crane and related components, as well as disassembly of the components.

4.6.9 Valves

Valves that require regulation by the user shall be installed in locations which are readily accessible.

4.7 Gear drives

4.7.1 Hoist winches

The design of the gear drives shall be based on the stresses determined by the applied loads, the driving and braking torques.

The shafts shall be adapted to the twisting moment, and the bending and shearing forces caused by the rope applied to the drum.

The fastening of the gear drives and their connection to the drum shall take into account any other loads being applied to the shaft due to alignment errors, deformation of the structure, etc.

It shall be possible to inspect and replace the lubricant without disassembling the gear drives.

When the gear drives are designed to drive several drums alternately, means shall be provided to control the movement of each drum.

Devices shall be provided which permit engine start-up only when the kinematic chain is interrupted.

4.7.2 Luffing winches

The design of the luffing winches shall be based on the stresses determined by the lifting of the jib (boom) with its load and accessories, and on the driving and braking torques.

The shafts shall be adapted to the twisting moment, and the bending and shearing forces caused by the rope applied to the drum.

The fastening of the luffing winches and their connection to the drum shall take into account any other load applied to the shaft due to alignment errors, deformation of the structure, etc.

It shall be possible to inspect and replace the lubricant without disassembling the gear drives.

4.7.3 Crane-travelling mechanisms

The travelling mechanism of rail-mounted cranes shall be fitted with devices that prevent tipping over or collapsing in the event of a wheel bearing failure.

4.7.4 Slewing mechanisms

No self-locking mechanism shall be used, in order to permit jib rotation with the wind if necessary.

The drive elements shall be selected in accordance with the maximum torque moment of the motor or the brake.

4.8 Rope and chain requirements

4.8.1 Hoist winches

The surface of the drums shall be smooth, so as to prevent the undue wearing of the rope.

The drums shall be grooved to ensure the correct winding of the rope. No grooved drums may be used when the winding rope forms a single layer and special provisions are given for the correct and compact winding of the rope.

The groove pitch P shall comply with the following relation: 1,04 $d < P <$ 1,15 d, where d is the diameter of the rope.

The groove shall be between 0,25 d and 0,40 d deep. The radius of the groove shall be between 0,525 d and 0,650 d.

Drums shall be flanged at both ends for a radial distance of not less than two rope diameters beyond the wound rope.

4.8.2 Luffing mechanisms

The surface of the drums shall be smooth, so as to prevent undue wear on the rope.

The drum shall be grooved to ensure correct winding of the rope, in order to limit surface wear and any deformation, possible fatigue or damage.

The groove pitch P shall comply with the following relation: 1,04 $d < P <$ 1,15 d, where d is the diameter of the rope.

The groove shall be between 0,25 d and 0,40 d deep. The radius of the groove shall be between 0,525 d and 0,650 d.

Drums shall be flanged at both ends for a radial distance of not less than two rope diameters beyond the wound rope.

4.8.3 Trolley-travelling mechanisms

The ropes enabling movement of the trolley in both directions shall be designed to be independent. The rope drums shall be grooved.

Ropes with multiple-groove friction pulleys shall be designed so as to ensure a torque equal to twice the torque required in the worst-case operating condition.

A drive system with a multiple-groove friction pulley is allowed only for loads carried approximately horizontally.

The drive pulley shall have at least three grooves; the loose pulley shall consist of a single unit. Multiple-groove pulleys may be wedge-shaped.

It shall be possible to pre-stress the rope by means of a device maintaining the tension in accordance with the operating conditions.

A coefficient of friction between the rope and pulley not exceeding 0,10 is recommended for calculation.

The ropes shall be designed taking into account the following:

a) the angle of inclination of the jib (which is never perfectly horizontal),

b) resistance to rolling,

c) any friction on the rims of the wheels,

d) friction caused by the load hoist-ropes,

e) lifting of the load (inclined-jib cranes without systems for horizontal load trajectory),

f) the effects of the stress device,

g) the influence of the wind,

h) the inertia and performance of the mechanism.

Means shall be provided so that, in case of failure of a rope, the trolley position will be maintained.

4.9 Maintenance and instructions

4.9.1 Maintenance

The mechanisms shall be designed to be readily accessible, and replacement of those components subject to wear shall be possible without having to disassemble the entire mechanism.

The mechanism shall be accessible for periodic inspection, in particular of the bolting of the slewing ring and the lubrication of the pinion toothing and slewing ring.

4.9.2 Instructions

Instructions shall be provided for the selection and scheduling of oil changes.

The instruction manual shall provide at least the time intervals and the recommended procedure for controlling the wear. Instructions shall also be provided to assess the maximum wear of the components.

The circuit diagram shall be supplied.

The instruction manual supplied with the machine shall contain all the necessary instructions for its operation and maintenance in accordance with ISO 9374-3.

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