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Cranes — Requirements for mechanisms —

Part 1: General

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

Partie 1: Généralités

Reference number
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Foreword

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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.

International Standard ISO 10972-1 was prepared by Technical Committee ISO/TC 96, *Cranes*, Subcommittee SC 9, *Bridge and gantry cranes.*

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

— *Part 1: General*

— *Part 2: Mobile cranes*

— *Part 3: Tower cranes*

— *Part 4: Jib cranes*

— *Part 5: Overhead travelling and portal bridge cranes*

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Introduction

This part of ISO 10972 establishes requirements and gives guidance and design rules that reflect the present state of the art in the field of crane machine design. The rules given represent good design practice that provides guidance for the fulfilment of essential safety requirements and adequate service of components. Deviation from these rules normally may lead to increased risks or reduction of service life, but it is acknowledged that new technical innovations, materials, etc., may enable new solutions that result in equal or improved safety and durability.

Cranes — Requirements for mechanisms —

Part 1:
General

1 Scope

This part of ISO 10972 establishes requirements which apply generally to mechanisms and related components of cranes and lifting appliances as described in ISO 4306-1, ISO 4306-2 and ISO 4306-3.

Requirements concern:

a) general layout and design of mechanisms;

b) selection and/or design requirements of components;

c) instructions for manufacture, mounting, installation and testing.

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

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 10972. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 10972 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1328-1:1995, *Cylindrical gears — ISO system of accuracy — Part 1: Definitions and allowable values of deviations relevant to corresponding flanks of gear teeth.*

ISO 2408:1985, *Steel wire ropes for general purposes — Characteristics.*

ISO 3077:—[1)], *Short link chain for lifting purposes — Grade T (8), calibrated, for chain hoists and other lifting appliances.*

ISO 4301-1:1986, *Cranes and lifting appliances — Classification — Part 1: General.*

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1) To be published. (Revision of ISO 3077:1984)

ISO 4306-1;1990, *Cranes — Vocabulary — Part 1: General.*

ISO 4306-2:1994, *Cranes — Vocabulary — Part 2: Mobile cranes.*

ISO 4306-3; 1991, *Cranes — Vocabulary — Part 3: Tower cranes.*

ISO 4308-1;1986, *Cranes and lifting appliances — Selection of wire ropes — Part 1: General.*

ISO 4309:1990, *Cranes — Wire ropes — Code of practice for examination and discard.*

ISO 4310:1981, *Cranes — Test code and procedures.*

ISO 4347:1992, *Leaf chains, clevises and sheaves.*

ISO 4413:—[2], *Hydraulic fluid power — General rules for the application of equipment to transmission and control systems.*

ISO 4414:—[3], *Hydraulic fluid power — Recommendations for the application of equipment to transmission and control systems.*

ISO 4779:1986, *Forged steel lifting hooks with point and eye for use with steel chains of grade M(4).*

ISO 6336-1:1996, *Calculation of load capacity of spur and helical gears — Part 1: Basic principles, introduction and general influence factors.*

ISO 6336-2:1996, *Calculation of load capacity of spur and helical gears — Part 2: Calculation of surface durability (pitting).*

ISO 6336-3:1996, *Calculation of load capacity of spur and helical gears — Part 3: Calculation of tooth bending strength.*

ISO 6336-5:1996, *Calculation of load capacity of spur and helical gears — Part 5: Strength and quality of materials.*

ISO 7752-1:1983, *Lifting appliances — Controls — Layout and characteristics — Part 1: General principles.*

ISO 7597:1987, *Forged steel lifting hooks with point and eye for use with steel chains of grade T(8).*

ISO 10300-1:—[4], *Calculation of load capacity of bevel gears — Part 1: Introduction and general influencing factors.*

ISO 11660-1:—[4], *Cranes— Access, guards and restraints — Part 1: General.*

3 Definitions

For the purposes of this part of ISO 10972, the definitions given in ISO 4306-1, ISO 4306-2 and ISO 4306-3 and the following definitions apply.

3.1 in-service braking: Stopping or slowing the crane motion with the motor disconnected, through an immediate and easy control by the operator from the normal working position.

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2) To be published. (Revision of ISO 4413:1979)

3) To be published. (Revision of ISO 4414:1982)

4) To be published.

3.2 out-of-service braking: Avoiding unwanted starts for indefinite periods of time.

NOTE — Actuation may be automatic or manual.

3.3 emergency braking: Stopping the crane motion or motions in the case of loss of power or pressure supply through engagement with a limiting device or the activation of an emergency stop switch.

3.4 control braking: Maintaining a desired speed, automatically or by the operator, with the motor engaged.

3.5 chain drive: Device for supporting and moving loads via chain and roller arrangement.

3.6 rope drive: Device for supporting and moving loads via rope, sheave and drum arrangement.

4 General

4.1 Design criteria

4.1.1 General design and layout

General design and layout of a crane mechanism shall take into consideration:

— requirements of the user;

— specific function of the mechanism and its use;

— reliability of the mechanism, considering the consequences of failure;

— displacement of the structure supporting the mechanism;

— avoidance of uncontrolled motions considering the limits of transmission of force or moments, when provided for example by motors, clutches, brakes;

— avoidance of undesirable or excessive vibrations;

— avoidance of excessive noise emissions;

— ease of use and controls of the mechanism with adequate space and motion limiters and indicators;

— recommendations of the component supplier for the selection and installations of component parts;

— serviceability, i.e. easy accessibility for maintenance of components (see ISO 11660-1);

— interchangeability of components;

— availability of lifting lugs or lifting points for handling;

— access for operator or maintenance personnel, see ISO 11660-1;

— environmental conditions and hazards.

4.1.2 Criteria for strength of components

When selecting the components of the mechanisms, it shall be verified that the applicable loading conditions in terms of maximum loading, load spectrum and number of load cycles comply with the corresponding rated characteristics of the components.

— an emergency stopping brake on the rope drum in conjunction with a redundant rope drive, or

— up to a gross load capacity of 16 t, designing the hoist at least two classification groups higher than required for actual operating conditions, and taking M5 as the minimum group.

4.4.2 Travel and slewing brake

Travel and slewing braking shall be capable of arresting the motion of a crane in the most unfavourable loading condition.

4.5 Out-of-service devices

When the mechanism is not in use, its position shall be retained by means of a brake or locking device. The locking device shall be arranged to avoid inadvertent engagement and disengagement. Engagement of the locking device shall prevent inadvertent operation of the motion.

When a crane is required to “weather-vane” in the out-of-service mode, the means of controlling this feature shall be operable from the control station. The device should operate automatically when

— the power supply to the crane is removed;

— the crane is taken out of service.

4.6 Hydraulic and pneumatic systems

The general requirements presented in ISO 4413 and ISO 4414 for hydraulic and pneumatic systems shall be applied for cranes.

The hydraulic system and the control arrangement shall be such that no combination of control selections can initiate any movement not intended by the operator, unless this is essential for the operation of a safety device or interlock.

The circuits shall incorporate the following safety features:

— relief valves shall be provided in pressurized hydraulic and pneumatic circuits in order to limit the maximum pressure in the circuit;

— safety devices to protect against the effects of failure of a hose, pipe or fittings in any load-carrying circuit on the crane.

All components and controls shall be capable of handling the design loads and shall provide safe function of the crane under regular, occasional and exceptional conditions, considering the failure of power source and the testing of the system.

All components and fluids (in a hydraulic system) shall be compatible with the application and the operational environment.

For diagnostic trouble-shooting, pressure test points shall be provided at the appropriate places in the system and be indicated on the circuit diagrams.

Where appropriate, means shall be provided to purge entrapped gas from the hydraulic system.

Back-pressure which may damage or inadvertently control brake components within the system shall be prevented.

Selection or design of hydraulic cylinders shall be made on the basis of maximum compressive and tensile loads at effective length during the characteristic working cycles. Consideration shall be made for the available hydraulic pressure and flow, type of fluid, type and material of seals and wipers and bearing size.

The cross-sectional area of the bore of the tubes, hoses, fittings, valves and fluid passages shall be consistent with fluid pressure and flowrates to minimize starvation and undue temperature rise.

The boom-hoisting mechanism shall be provided with an auxiliary ratchet and pawl or other positive locking device to prevent the drum from rotating in the lowering direction, hold the rated loads indefinitely, and be controllable from the operator's station.

4.6.1 Hydraulic reservoir

The hydraulic reservoir shall maintain the fluid level with a safe margin on the working height during operation and should be capable of containing all the fluid that may flow back from the system with cylinders in the closed position and hold a sufficient reserve of fluid to assist in cooling the hydraulic oil temperature within the limits specified by the supplier.

4.6.2 Filters

The system shall incorporate filters for continuous removal of contaminants from the hydraulic fluid or the air supply.

Filters should be selected and installed so that the filter medium may be changed without disturbing the piping arrangement and draining the fluid from the reservoir. Where brakes are held off hydraulically, filters shall not be placed in the brake return circuit, as they may block and cause sufficient back-pressure to hold off a brake.

Filters should be selected and installed so that the filter medium may be changed without disturbing the pneumatic tubing.

4.6.3 Installation

The installation of the system shall be such that as far as possible the effects of external influences (such as atmospheric conditions, unauthorized interference and mechanical impact) shall not be detrimental to the system. In addition, installation-induced stresses in tubes shall be avoided and flexibility of the support members shall be allowed for on all rigid tubes.

All practical care shall be taken to prevent the inclusion of contaminants during assembly and installation of components, and the system should be thoroughly cleaned prior to testing.

The specific type of hydraulic fluid in the system shall be either permanently and legibly marked at the point of filling of the reservoir or included in the instruction manuals. Other hydraulic fluids shall not be used, either alone or mixed with the specified fluid.

On each accumulator, the pre-charge pressure and charging medium shall be permanently and legibly marked.

4.7 Gear drives

4.7.1 Strength requirements

Stresses occurring in any operating condition shall not exceed the permissible values. The following requirements shall be met:

— non-permissible stresses from elastic and/or thermal deformations shall be avoided;

— statically determined configurations and components shall be preferred so that the stresses occurring are known and their effects on other components can be determined.

4.7.2 Gears

Gears shall be in accordance with ISO 6336 (all parts) for spur and helical gears and ISO 10300-1 for straight-bevel and spiral-bevel gears, taking into account ISO 1328-1 for accuracy.

Gear wheels shall be made from material that has proven properties for the intended application and life of the gear.

The dimensions of the gears shall be derived from the rated torque, material strength, and the driving gear groups.

The type of connection shall not produce any non-permissible stresses on the gears.

Irreversibility shall be avoided where the moment of inertia of the moved parts is greater than the moment of inertia of the moving parts.

4.7.3 Gear enclosures

Gearing shall be guarded when it constitutes a hazard during normal operation or maintenance.

Where gears are fully enclosed in a gear case, the gear case shall be oil-tight and sealed with a gasket or an appropriate sealing compound.

The gear case supporting structure shall firmly secure the case in position and prevent it from coming loose during operation.

The gear case construction shall be rigid to ensure that the gear shaft alignments and centre distances are maintained under all working conditions.

Drain plugs, breathers and oil-level indicators should be readily accessible.

Gear cases should be provided with lifting lugs.

For all gear cases, particular attention shall be paid to ensure proper lubrication of all gears and bearings.

4.7.4 Bearings and supports

A component supported on a bearing, the bearing itself and its support structure shall be so designed that failure of a bearing shall not lead to the dropping of any major part of the crane or the load.

4.8 Rope and chain drive requirements

4.8.1 Rope drives

Rope drives shall be classified into driving-gear groups in accordance with the operating requirements and conditions of use of the hoisting gear as specified in ISO 4301-1.

Calculations for rope drives shall be made in accordance with ISO 4308-1.

Design of rope drives shall take into account possible uneven distribution of load between the ropes, if these are not eliminated by design.

Rope equalizers shall be arranged to permit movement of the rope at the rope equalizer without sliding movement between the rope and equalizer.

4.8.1.1 Drums

Drums shall be made from material that has proven properties for the intended application and life of the drum.

The pitch diameter of the drum shall be in accordance with ISO 4308-1.

Where it is not practicable to accommodate all the rope in a single layer, special provision shall be made to ensure correct coiling of the rope from each layer to the next (guiding, where necessary) under any condition of operation.

The grooved drum shall be designed such that at the outer limit position a length of rope equivalent to two drum revolutions remains attached. At the inner limit position of a single layer drum, a length of groove equivalent to at least one complete revolution of the drum shall remain unoccupied.

The thickness of the drum shell shall be determined by proof of competence calculation or by tests. If not covered by calculation or tests, a wear allowance shall be added to the drum thickness. The wear allowance shall take into account factors such as material hardness, environment and intended service conditions.

Rope drums shall be designed so that the ropes cannot run off the end of the drum.

Suitable measures for single-layer drums are flanges, rope guides with end limiters or other end limitations that prevent the rope jamming.

The multilayered drums shall be provided with a flange at least at each point where the rope enter the next layer.

The flanges and other side limitations shall be flat and extend not less than 1,5 times the rope diameter beyond the outmost rope layer.

The groove shall have an arc of radius not less than 0,525 times the nominal diameter of the rope. The rope diameter tolerance shall be considered when fixing the groove arc radius. The groove shall have a depth of not less than 0,33 times the nominal rope diameter. For optimal rope life conditions, see annex C of ISO 4308-1:1986.

Grooving shall be smooth and free from surface defects liable to damage the rope. The edges shall be rounded.

Rope anchorage on the drum, together with two frictional revolutions of the rope, shall be capable of withstanding not less than 2,5 times the nominal force on the rope. In the verification calculation, the coefficient of the friction between the rope and the drum shall not be assumed greater than 0,1.

When the anchorage relies on a clamping action, it shall comprise two or more clamps. The anchorage of the rope to the drum shall not decrease the required breaking strength of the rope by more than 20 %.

Rope anchorage shall be secure and readily accessible. If two or more ropes lead off a drum, provision shall be made for adjustment of the rope length at an anchored end.

4.8.1.2 Sheaves

Sheaves shall be made from material that has proven properties which are known for the intended application and life of the sheave.

The pitch diameter of the sheaves shall be in accordance with ISO 4308-1.

The cross-sectional radius at the bottom of the sheave groove should be such as to form a close-fitting saddle for the size of rope used. The groove shall have an arc of radius between 0,525 and 0,63 times the nominal diameter of the rope. The groove shall be tangential with the sides which form an included angle between 30 ℃ and 60 ℃ symmetrical about the centreline of the groove. The maximum fleet angle of the rope shall be considered when selecting the included angle of the sheave. For optimal rope life conditions, see annex C of ISO 4308-1:1986.

The depth of the groove shall be not less than 1,5 times the nominal diameter of the rope.

Grooves shall be finished free from surface defects liable to damage the rope. The edges shall be rounded at the rim to facilitate entrance of the rope in the groove.

4.8.1.3 Ropes

The ropes shall be selected according to ISO 4308-1.

Suitable rope constructions are those that comply with the requirements of ISO 2408.

Discard criteria shall be according to ISO 4309.

4.8.2 Chain drives

Chain drives shall be classified into driving-gear groups in accordance with the operating requirements and conditions of use of the hoisting gear as specified in ISO 4301-1.

Chain-drive wheels and reversing wheels shall be designed so that the chains are not overstressed by bending.

Chain-drive wheels, chain-reversing wheels, chain guides and the chains shall all be matched to each other with regard to dimensions and materials.

Chain-drive wheels shall be of monobloc design.

All parts of the chain drive shall be protected against thermal radiation, if necessary.

4.8.2.1 Chains

Round steel link chains and roller chains shall be manufactured, tested and marked in accordance with ISO 3077 and ISO 4347.

The ratio of the ultimate breaking force to the design force of the chain shall be at least 4 in the case of handpowered hoisting gear and at least 5 in the case of powered hoisting gear.

4.8.2.2 Chain guides

Chain drives shall have a device to ensure the correct running of the chain over the chain-drive wheels and chain-reversing wheels and to prevent the chain from jumping out, twisting and jamming.

In working and traffic zones of chain drives, the engagement points of the chain on the chain wheels shall be safeguarded to prevent personnel from contact.

4.8.2.3 Chain mountings

Chain mountings shall be dimensioned so that 2,5 times the nominal force in the chain can be absorbed without permanent deformation. In addition for hoists, proof shall be provided of the required fatigue strength.

The unloaded chain end shall be secured so that it cannot be pulled through. This protective device shall be capable of reliably absorbing the forces to be expected.

Screwed connections in chain mountings shall be secured against accidentally becoming undone. It shall be possible to check the condition of the fastening.

4.9 Shafts

Shafts shall be designed to resist all stresses due to bending and torsion or a combination of both. Due allowance shall be made for stress reversal and for stress raising elements such as keyways, splines, section changes, etc.

4.10 Load-carrying equipment requirements

Load-carrying equipment shall be dimensioned for the maximum rated load. The design, material and manufacture of load-carrying equipment shall be such that fatigue fractures and brittle fractures are avoided.

Hooks shall comply with ISO 4779 or ISO 7597. Verification shall be made that no permanent deformation of the hook has taken place during testing in accordance with ISO 4310.

Where a hook is provided with a safety latch, the latch shall be self-closing and bridge the throat of the hook for the purpose of retaining slings, chains, etc. under slack conditions.

Hook assemblies shall be weighted to ensure that they descend under all designed operating conditions.

Hook assemblies shall be permanently labelled with the rated capacity.

4.11 Manufacture and maintenance

Mechanisms shall be manufactured using the applicable engineering drawings and adhering to the noted tolerances. Welders shall be qualified for the type of welding specified. High-strength fasteners shall be properly torqued. Proper fixtures shall be utilized during the manufacturing process, as applicable, to assure satisfactory alignment of components as specified by engineering drawings. Repairs shall be carried out in accordance with the recommendation of the manufacturer by a suitably qualified competent person.

Provision shall be made for lubrication of gears, as appropriate, and of all bearings and journals. Lubrication points shall be accessible except for centralized lubrication points.

ICS 53.020.20

Descriptors: handling equipment, lifting equipment, cranes (hoists), machine components, specifications, design, generalities.

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