Tata Steel Technische Richtlijn

R1 10 51 02 ATVK: Mechanical Specification for Production Cranes

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Informatie en wijzigingen

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Inhoudsopgave

1 Introduction

1.1 Objective

This Technical Guideline has been prepared to define the minimal technical requirements that are applicable for production cranes at TATA STEEL in IJmuiden. This guideline does not necessarily comprise all applicable requirements which are relevant in order to comply with the latest relevant European and Dutch national legislation and regulations.

1.2 Structure document

This Technical Guideline has been split into 6 chapters:

1. Introduction
2. Directive's standards and guidelines
3. General requirements
4. Steel structure
5. Design of bridge crane
6. Machinery

1.3 Context and scope

This document should be recognised as a part of the complete design package whereby the functionality, operation, performance and other specific technical requirements are specified in a separate document.
The scope of this guideline applies to the mechanical and electrical design, construction, calculation, manufacturing and delivery ready for use of production cranes.
This guideline also applies to changes such as revamping, upgrades, modifications and modernization.

2 Directives, standards and guidelines

The cranes supplied by CONTRACTOR shall meet all relevant Dutch, European and international rules and regulations, as well as specific TATA STEEL standards and guidelines.

2.1 European Directives

The crane or it's modified parts shall meet all applicable European directives, and in particular the directives as mentioned in table 2.1.

Table 2.1 – European Directives

Number	Description
2006/42/EC	Machinery directive
2014/35/EC	Low voltage directive
2014/30EC	Electromagnetic compatibility directive (EMC)

2.2 European Standards

Compliance with the directives shall be realized by the application of the latest version of the harmonized European standards as mentioned in table 2.2 including the standards that are referred to.

Table 2.2 – European Standards

Number	Description
NEN-EN 15011	Cranes – Bridge and gantry cranes
NEN-EN 14985	Cranes – Slewing jib cranes

2.3 TATA STEEL Standards and Guidelines

The TATA STEEL standards and guidelines as shown in table 2.3 are applicable. The latest version of these documents can be downloaded from: http://www.tatasteel.nl/veiligheid/en/Regulations/

Table 2.3 – TATA STEEL standards and guideline

Number	Discipline	Description
S1 45 04 01	Mechanical – miscellaneous	Execution and inspection of welding work
S1 51 80 01	Mechanical – cranes	Free profile electric overhead travelling cranes
S1 79 00 01	Mechanical – cranes	Crane hooks
S1 79 00 02	Mechanical – cranes	Chain work
S2 17 32 02	Electrical	Main distribution regarding cranes
S2 62 81 01	Electrical	Radio controlled cranes and machines
S3 10 56 01	Civil	Corrosion control by use of protective coatings
S3 37 00 01	Civil	Crane tracks
R1 05 80 01	General	Drawing rules
R1 05 80 02	General	CAD drawing rules
R1 05 80 03	General	Eplan requirements
R1 05 80 04	General	Inventor drawing rules
R1 05 80 05	General	TATA STEEL E3D Model Criteria
R1 60 01 01	Mechanical - other	FEM calculations

In case it is the opinion of the CONTRACTOR that, in order to increase the operational reliability and/or improve the construction, it is useful to deviate from TATA STEEL standards and guidelines, this shall be explicitly mentioned, motivated and submitted for concurrence to TATA STEEL.

3 General requirements

3.1 Tolerances of the crane

3.1.1 General

All measurements on cranes and crane tracks must be made with professional calibrated equipment.

3.1.2 Crane tracks

The crane tracks must comply with the tolerances given in directive R3370001.

3.1.3 Cranes, trolleys etc.

The crane, trolley and the like shall comply with NEN-EN 15011 5.4.6.

3.1.4 Rails

The permissible misalignment of welded connections between rail segments is 1mm/1000 mm.
The welded section of the rail head, top and sides, must be grinded flat.
transition

3.2 Materials

For all applied materials, certifications must be supplied stating the chemical analysis and all mechanical properties. Including the notch impact strength (Charpy V according to EN 10.045), result of lamination check and a chemical analysis. Lamination check shall be performed according to NEN-EN 10160 (In Germany SEL072 is sometimes used but is no longer valid). The nature and extent of tests is to be discussed and agreed upon by TATA STEEL PTC-KDT Inspection Department before orders for materials are placed.
The materials for load carrying components or its welded parts, must be supplied with a material certificate type 3.2 according to NEN-EN 10204. Castings and forgings have to be supplied with certificates according to EN 10204.3.2 unless otherwise agreed. This certificate involves an ultrasonic testing. Furthermore in this case, the buyers authorized representative for inspection or the inspector appointed through official regulations must be established in one of the CEN Member States. If the manufacturer of the material is located in a country that is a member of CEN a material certificate type 3.1 according to EN 10204 (2004) will suffice. All other non-load-carrying materials must be provided with a material certificate type 2.2 according to EN 10204 (2004).

- CONTRACTOR shall specify all materials in order to fulfil the CONTRACT requirements and will advise on materials and its quality criteria;
- Materials of the steel structure that participate in the transfer of forces (including secondary forces) must be made of at least S355J2 in accordance with NEN-EN 10025. Attention must be given to the minimum operating temperatures. If the material thickness exceeds 60 mm, S355J2G3 must be used in accordance with NEN-EN 10025.
- The components of the machinery are to be made of materials that meet the quality standards written at each section. When a tensile strength of >590 N/mm2 is required for design considerations, unalloyed steel is not to be used.
- Bearing housings are made from plate or cast steel with a minimum tensile strength of 500 N/mm2 or nodular cast iron GN42.
- For lifting equipment all supplied carbon materials shall meet the minimum J2 Quality;
- Quenching and tempering steel shall comply with the NEN-EN-ISO 683-2 and -3;
- Open die steel forgings for general engineering purposes shall comply with NEN-EN 10250-2: Non-alloy quality and special steels (e.g. C45, C60, etc.) and the NEN-EN 10250-3: Alloy special steels (e.g. 38Cr2, 42CrMo4, etc.);
- Open die steel forgings shall comply with the NEN-EN 10250-2 and -3;

- For materials used at high temperatures, tensile test at elevated temperature are applicable according to DIN-EN 10002-5 1992;
- Surface conditions of hot-rolled steel plates shall comply with EN 10163-2, Class B, subclass 3;
- Bending of plate materials shall be controlled in the correct radius, no flat run outs allowed at the end of the bended plate material (for bending see EN 12953-4);
- Non pressure-retaining components (including bolting and seats) shall be provided with a 2.2 material certificate according to the NEN-EN 10204:2004;
- All casted parts shall be supplied with a NEN EN 10204:2004 3.2 material certificate (Western European origin), parting the tests sample blocks and test results of the test specimens shall be witnessed by an accredited body or quality department of TATA STEEL;
- All plate material shall comply with EN 10160. The acceptance standard shall be Level S2 Class E3.

3.3 Welded connections

All welded connections of the steel structure, housings and cabins exposed to the open air must be made with continuous welds from both sides of the joint. This also applies to buckling reinforcements.
All parts of the of the steel structure must be welded according to the TATA STEEL standard S1458401 in the following welding category:

3.3.1 Welding category 1

All parts which are exposed to dynamic forces such as: girders, booms, portals, equalizer, hoisting drums, jacking supports, sheave block, wheel bogies, balancers, (temporary / permanent) welded lifting lugs.

3.3.2 Welding category 2

All parts which are exposed to static forces such as: conveyer belt supports, belt drums, frames for motor or gearbox, stiffeners, gearboxes.

3.3.1 Welding category 3

Alle parts which are exposed to light static forces such as: covers, stairs, ladders, platforms, housings, and cabin.

All welds of the main steel structure must be NDT examined before further assembly.
Trolley rails must be connected by full root fusion, according to TATA STEEL standard S1458401.
The use of weld quality B* according to ISO5817 during engineering is not allowed.

3.4 Bolted connections

The following applies concerning bolt connections:

- Bolt connections for steel structures shall be made using hexagonal bolts galvanized according to EN 15048 and EN 14399.
- For all other bolt connections ISO-898-1 is applicable. For nuts the ISO-898-2 applies.
- All bolts, nuts and washers shall be hot dip galvanized and ISO-fit, the hot dip galvanized coatings according to the ISO 10684.
- The Bolts, nuts and washers packaging shall be provided with a CE-marking.
- Both under the head and under the nut a hot dip galvanized washer shall be provided.
- Material bolts 8.8 minimum quality.
- Material nuts 8 minimum quality.
- For stainless steel bolts and nuts: use minimum the A4 quality.
- Fitted bolts must comply with DIN 609 and 610. Quality 8.8 has to be used except for fastening the slewing bearings.
- Material of prestressed bolts must be quality 10.9
- The tightening moment of prestressed bolts has to be shown on the drawing.
- The bolt length between head and nut of all prestressed bolts must be at least 5xd.
- Locking nuts or washers has to be used, but is not allowed to place under tensile stress
- Washers shall be made according to ISO 7089 and ISO 7090. Remark: all the used washers shall be fit for purpose (dimensions, surface hardness, used material, etc.);
- For slotted holes, use suitable washers to distribute de torque load (bigger and thicker washers).
- The quality marking of bolts and nuts shall be visible during construction for traceability.
- Bolts, nuts, and washer shall be of identical make.
- Bolts for flange connections shall extend two times the pitch of the thread outside the nut.
- The application of stud bolts and tap bolts is not allowed.
- The transfer of lateral forces on anchor bolts is allowed. Apply in that case a pin, key or retaining block for that purpose.
- All bolts, studs, and nuts larger than 40 mm nominal diameter shall be ultrasonically examined over an entire end surface before threading.
- Wear parts and exchange parts shall use bolts and nut connections.
- When eyebolts are used, they shall meet the TATA STEEL standard S1790002 (release 3.1), see paragraph 4.2. for info of One-off use eyebolts and Repeated use eyebolts.

3.5 Electrical installation.

The electrical installation at the crane must be according ETVK (technical directive R2 10 51 03)

3.6 Preferred suppliers.

A preferred supplier list is given in Attachment A. Deviations from this list are acceptable when better alternatives are available.

3.7 Corrosion prevention and Conservation

All products indicated shall be coated in accordance with TATA STEEL standard S3105601
The used colours comply with TATA STEEL QHSE 3.30.

Item	Color
Cabin	Yellow RAL 1003
Wheel bogies	Yellow RAL 1003
Girders	Yellow RAL 1003
Portal (gantry crane)	Grey RAL 7036
Machine room (gantry crane)	Blue RAL 5010
Handrails	Yellow RAL 1003
Access hatches	Yellow (RAL 1003) and black (RAL 9004) diagonally striped
Interior paint work:	White RAL 7034.
Electrical equipment such as switch boxes, rackets etc.	White RAL 7034.

3.8 Platforms, stairs and ladders

Areas that are to be regularly accessible such as operator cabs, housings for electrical installations, winch housings, box girders with accessories, cable garlands, lubricating points, etc. must be made accessible by platforms and stairways in accordance with NEN-EN 15011 section 5.6.2. Ladders in accordance with NEN-EN 15011 section 5.6.2. are permitted for the other inspection points.
All cranes must be accessible by stairways on both sides of the crane.
All platforms and stairways are to be provided with high edge grids of 30 x 3 mm.
The platform grids should be installed in such a way that the grids cannot shift even in the absence of fasteners. The use of sheet metal with a non-slip profile is subject to our permission, and should generally be avoided.
Turning gates are to be provided with heavy hinges and closing action must rely on gravity.
Stairs must be provided with anti-slip steps.
Platforms must be designed in such a way that oil or grease leaking from the crane is prevented.
Butt connections for pipe guards must be welded with the aid of an inserted pin.
Girders must have a second handrail on the trolley side.

3.9 Operator's cabin

The cabin must be designed for 24/7use in a production environment. Alternative requirements will be stated in the tender. Compliance to ergonomic design is essential. The design and choice of supplier requires TATA STEEL approval.

The cabin design must comply with the following requirements:

- According to NEN-EN 15011:
  - Section 5.6 and ETVK (technical directive R2 10 51 03)
  - ISO 8566, Cabins and control stations.
  - ISO-7752: Control layout and characteristics.
  - NEN- EN 614-1, Safety of machinery - Ergonomic design principles
  - NEN-EN 13557: Cranes - Controls and control stations
- The suspension should be such that:
  - The crane driver's safety is ensured.
  - Mechanical vibration and shock evaluation of human exposure the whole body vibration according to ISO 2631-1, with the limit of 0,25m/s^2 for 6 hours.
- A movable cabin has its own drive.
- A energy chain is preferred at a movable cabin.
- A 3D simulation study must be made with all possible views the operator can make. The simulation study is for approval of a TATA STEEL PTC-KBT engineer.
- The slew bearing of a rotating cabin must have as little movement as possible.
- The rotating cabin must have a safety system if the slew bearing fails.

3.9.1 Accessibility

The design shall be in according with NEN-EN 15011 section 5.6.2 and TATA STEEL standard S1 51 80 01(Free profile on and around electric overhead travelling cranes).

The accessibility of the cabin, crane in park position, shall be ensured along the shortest/easiest and safest possible way, using normal stairways and platforms. It must be possible for the operator to exit the cabin in any position.

All motors, brakes etc. shall be accessible in a convenient and safe way. It must be possible to easily replace or repair components.

3.9.2 Noise level

Noise level inside the cabin, according to EN ISO 11688-1 and EN ISO 11688-2, must be lower than LAeq<65 dB(A), preferable 55dB(A).

3.9.3 Windows

The windows of the cabin must be according to NEN-EN 13557 section 5.2.2.2 shall be tempered (toughened) and/or laminated glass.

The windows in the cabin must be laminated safety glass breakage type B (see image 1)
Breakage type A and C are not allowed.
The windows must be coded so it is recognisable as safety glass, see image 2 for a example. Or a certificate must be delivered.

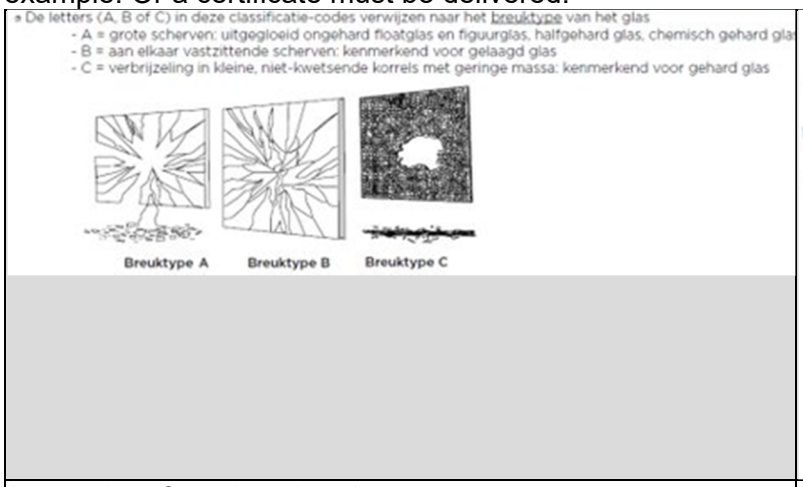


Image 1: safety glass breakage types

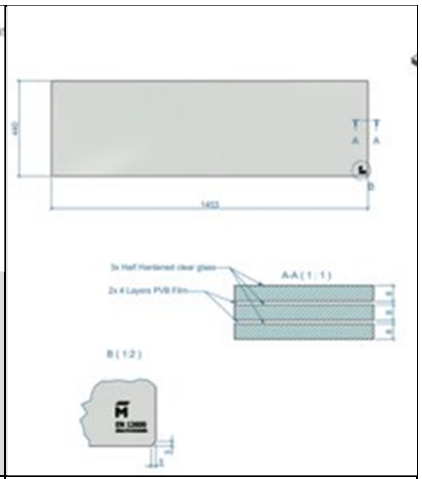


Image 2: example coding

Windows of liquid steel cranes or cranes in possible explosion environment must be equipped with special glass according to “hoogovens” standard, see image 3 for an example.

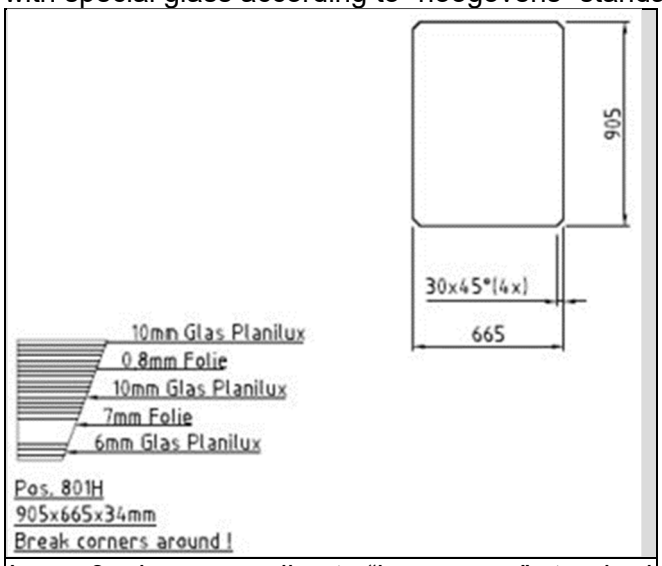


Image3: glass according to “hoogovens” standard

3.10 Cooling, heating and ventilation

The cooling equipment must be equipped with provisions to ensure that no vapour water will leak off the crane. The cooling, heating and ventilation system(s) need the approval of the TATA STEEL climate specialist.

3.10.1 Electrical accommodation

When electronic equipment is installed in a girder, room or cabinet the inside temperature may not exceed +30°C. If necessary a cooling installation is required.
In case of a malfunction during operation or planned maintenance it must be possible to reduce the room temperature within fifteen minutes to maximally 28 °C.

A heating system is required if the environment temperature can drop below +10°C. The system must keep the inside temperature at a minimum of +10°C. It must be possible to connect the heating system to a socket at mainland.

3.10.2 Operator's cab

The inner temperature must be adjustable between the +15°C and +25°C. The ventilation system shall be designed considering at least 10 air changes per hour and shall maintain the cabin pressure slightly above atmospheric pressure to prevent ingress of dust from outside and keep the temperature constant at set value.

4 STEEL STRUCTURE

4.1 General

The design of the main steel construction of a crane must comply with following requirements:

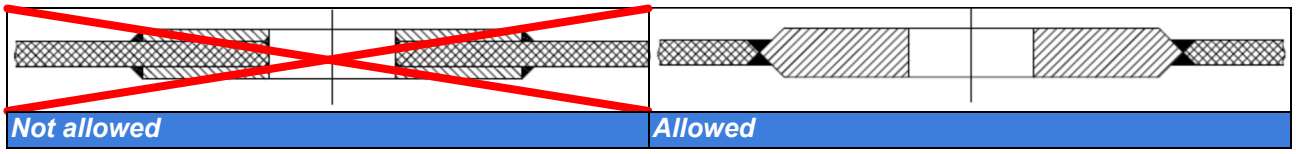
- Sufficiently stiff and robust for use in the steel industry.
- The design is as simple and smooth as possible. Accumulation of dirt and fluid must be prevented. When necessary drain holes must be provided.
- Maximize plates to minimize welding.
- Subassembly parts of the main steel structure must be as large as possible.
- The parts of the main steel structure, girders, platforms, wheel girders and portal must be designed with bolt connections
- ISO 22986, check toevoegen?

4.1.1 Box girders

Box girders must be provided with reinforcing internal against buckling. All main girders must be provided with hatches for inspection and repair, the number and size shall depend on the construction, or 100% closed and vacuum.
Box girders with a trolley track on top must be designed with a fully welded hot rolled T-bar under the rail support. The rail must be secured by adjustable rail clamps witch are welded onto the T-bar. The type and make of the rail clamp requires approval of TATA STEEL.
The trolley rail must be supported by a reinforced wear strip of at least 6 mm thickness and 10 mm narrower than the base of the rail. The wear strip must be in one piece.
Trolley rails must be secured at the end by welded-on stops, taking expansion into account.
Externally box girders must have a 1° slope.
If box girders are used for housing of the electrical equipment, provisions must be taken to meet the safety rules as stated in the ETVK (technical directive R2 10 51 03).

4.1.2 Material thickness and reinforcement

Reinforcements in the structure must be provided in all places for example supporting pivots, shafts, wheels, bogies, and hatches. Sheet metal parts must be added locally by welding and must be installed symmetrically into the joint.



4.1.3 Connections of main joints

For the main joints of the main structure bolt connections or pins are required. The connection must be dimensionally fixed.

4.2 Engineering calculations for the steel structure

4.2.1 General

Depending on the kind of operation and the loads handled, cranes are classified according to NEN-EN15011.

4.2.2 Basic calculation rules for steel structure

The maximum permissible deflection in girders supported by two points as a result of mobile loading (trolley and maximum load) in crane class, according to NEN-EN15011, from U3 with load spectrum Q4 or Q5 is 1/1,000 of the distance between the supports. In crane class U1, U2, U3 and beneath load spectrum Q4 , the permissible deflection is respectively 1/700, 1/800 and 1/900,of the distance between the supports.
In the case of booms, the permissible deflection in relation to the boom length is twice as large as with girders on two supporting points.
Horizontal loads caused by angled forces have to be taken into account with 15% of the workload and added to load combination A, table 12a of NEN-EN 13001-2.

In case of gantry, bridge or overhead cranes, the steel structure must, under the circumstances mentioned below be able to transfer forces from one track to the other. It is assumed that the wheels are blocked on one of the tracks and that wheel slip of the driven wheels occurs on the other track, or that a longitudinal force occurs as a result of the breakdown torque in the drive motors. The position of the crane and crane parts in this case must be such that maximum stress occurs.
The coefficient of friction during slipping is assumed to be 0.25. This load should be added to load combination B, table 12a of NEN-EN 13001-2.
Loads caused by tipping of a trolley with a guided load should also be included in combination B, table 12a of NEN-EN 13001-2.
High risk parts for example the cabin car must be checked for fatigue. The principles of the calculation must be traceable.

4.3 Materials of the steel structure

Materials of the steel structure that participate in the transfer of forces (including secondary forces) must be made of at least S355J2 in accordance with NEN-EN 10025 and the conditions mentioned in NEN-EN 13001-3-1.
Attention must be given to the minimum operating temperatures stated in the crane specification. The minimum requirements can be found in NEN-EN 13001-3-1,Table 4.
If the material thickness exceeds 60 mm, S355J2G3 must be used in accordance with NEN-EN 10025.

Parts that do not participate in the transfer of forces and are not welded to parts that do transfer forces can be made of S235 J2. This applies for example to stairways, platforms, guards, etc.
The trolley rail material must have a tensile strength of 700-800 N/mm2 minimum and a factory certificate must be supplied.

5 Design of Bridge crane

5.1 Crane body

In order to reduce skewing forces, the wheelbase must be at least one sixth of the span width. For cranes with bogies, this ratio must be maintained with reference to the main pivots on each corner.
To make sure that the loads are distributed properly over the running wheels, an articulated connection must be fitted to one of the head joints in such a way that one girder can ascend and descend in relation to the other girder at the side of the articulation, unless the vendor can demonstrate that the pressures exerted by the wheels during operation vary by no more than 10%. However, the maximum rated wheel load must under no circumstances be exceeded by more than 5%.
The other head joint must be able to twist to accommodate the above-mentioned difference in height of crane rails.
The permissible stress is not to be exceeded when parallel differences exceed 1:500 between both tracks.
The maximum difference in height between the main pivots of the crane on the same track is 1:1000 of the wheelbase.

The head joints must be fully capable of transferring the skewing forces in a horizontal direction in accordance with NEN-EN15011.
The vertical movement between the crane girders must be taken into account in designing the support for the trolley rail.

5.2 Design trolley

The distribution of the loads at the corners is to be checked for the maximum movement of the girders.

The trolley frame should be designed mainly with a view to rigidity, so that the operation of the machine parts placed on it are not compromised due to deflection of the trolley frame. The permissible deflection in girders on which machinery is placed is 1 : 2,500.
The hoisting ropes must stay free of the trolley frame and the rest of the crane, when the load swings at maximum 15° from the perpendicular unless specified otherwise in the specification.

5.3 Access

The trolley must be equipped with a fully closed floor with sufficient guards around drums, brakes, couplings and other rotating machinery.
A walkway for easy access to both girders.

5.4 Maintenance

The trolley frame must be equipped with hoisting eyes for hoisting and positioning the trolley.
In order to replace the wheels the trolley needs to be provided with jacking points to lift the trolley with hydraulic jacks.
If rope sheaves and other machinery are located under the trolley frame, an inspection and maintenance platform is required. The trolley needs to be equipped with tools to replace components, for example the wire ropes, sheaves, gearboxes, motors etc.

6 Machinery

6.1 General

6.1.1 Engineering calculation

For the purpose of safe use, cranes must be calculated according to specific standards.
Depending on the kind of operation and the load spectrum, the crane is classified, into several crane classes according to NEN-EN15011.
The specification indicates into which mechanism class a mechanism shall be classified.

6.1.2 Materials

The components of the machinery are to be made of materials that meet the quality standards written at each section.
When a tensile strength of >590 N/mm2 is required for design considerations, unalloyed steel is not to be used.
Bearing housings are made from plate or cast steel with a minimum tensile strength of 500 N/mm2 or nodular cast iron GN42.

6.1.3 Fits and tolerances

All machinery to be finished in accordance with the NEN-EN-ISO 286-1.

6.1.4 Assembly of machinery

All machinery must be executed and assembled in such a way that each part can be replaced easily without first having to remove other parts. All parts have to be maintenance friendly.

Motors are to be installed on planed or milled faces of sufficient length for the motors to be slid back along them to release the coupling bolts.

Adjustable padding, min. thickness 3 mm, is to be placed beneath the motors, to be adjusted in case the shaft height does not correspond to the spare motors. The motor has to be adjustable in X and Y direction with adjusting bolts which can be fixed.

All bearings, brackets, gear boxes etc. are to be mounted on planed or milled faces and fastened by at least two adjusting bolts.

Where plates on beams have to be reinforced at shaft openings to achieve the permissible surface pressure, such reinforcement is not to be achieved by welding on thickening plates. This must be done by welding in one plate of sufficient thickness, fitted symmetrically, so that no moment occurs in the beam plate. See paragraph 4.1.2.

Bearing housings that have to transfer fluctuating axial loads must be locked up with secured wedge-shaped keys. Single key plates may be used for non-jolting or non-fluctuating axial loads.

6.2 Mechanism

6.2.1 Engineering calculation of travel mechanisms

The travel mechanisms must be calculated for the nominal torque that may occur.
The permissible stresses in the shafts are to be based on the conditions referred to NEN-EN 15011.
Long drive shafts, e.g. for crane travel, may not twist beyond 1/4° per metre under maximum load and in case of shafts more than 10 m long, not more than 2.5° in total.
In order to determine the number of driven wheels necessary, a maximum friction coefficient of 0.14 between rail and wheel when accelerating has to be taken into account. For outside cranes the friction coefficient to be taken into account when braking and with the wind behind is 0.1.
Calculation of drive mechanisms, where buffers limit the end positions, is to be based on forces caused by buffer impact as well as on the kinetic energy of the drive mechanism.
The effects caused by buffering of the crane must be calculated for the drive mechanisms, the steel structure and the cabin suspension.
In this case the minimum deceleration factor shall be a=5m/s² with a buffer factor of 1.25 times the load, unless stated otherwise or calculated precisely.
In drive mechanisms where the drive torque is transmitted via the running wheels, the running wheels may be expected to slip during buffering with a coefficient of friction between wheel and rail of 0.25. The speed at the time of buffering should be the nominal speed. The maximum stress during a buffer impact must not exceed 0.8 x tensile strength.
Finally, drives where applicable, must be calculated taking in to account the wind force.
If not specified wind and/or gale forces must be calculated in accordance with
NEN-EN 13001-2 table 5 désignation Normal.

According to ISO 4301-1: Mechanism; mechanism group	≤ Ac3	Ac4	Ac5/Ac6	Ac7	Ac8
Lifetime of ball and roller bearings at nominal motor speed	20.000 hrs	25.000 hrs	31.500 hrs	40.000 hrs	50.000 hrs
Mechanism Group	**≤ Ac3**	**Ac4**	**Ac5/Ac6**	**Ac7**	**Ac8**
Main hoisting gear	4s	4s	3,5s	3,0s	2,5s
Trolley travelling gear, excl. wind. However a_{max} = 0,25 m/s²	6s	6s	5s	4,5 s	4s
Crane travelling gear, excl. wind. However a_{max} = 0,35 m/s²	9s	9s	8s	7s	6,3s
Luffing gear, excl. wind	8s	7s	6,3s	5,6s	5s
Slewing gear, excl. wind	8 s	8s	7s	6,3 s	5,6s
Cabin travelling gear general: a = 0,20 m/s²					

TABLE 1 – Basic design and calculation data different from NEN-EN 15011 A4.

6.2.2 Engineering calculation of hoisting mechanism

Hoisting winches for cranes carrying liquid steel must be designed in such a way that any part of the machinery or a hoisting rope may break, or fail without any risk of the load falling from the crane. In this case the crane must be able to end the cycle.
In case of hoisting winches for grab service with uncontrolled drives, each winch is to be calculated for full load.

Hoisting winches are to be checked for the brake torque that appears at simultaneous electrical and mechanical braking. The mechanical brake must be sufficient in case of an emergency stop.

6.2.3 Design of hoisting winch

The main hoisting winch shall in principle consist of an electrical motor, electrical brake with flexible coupling, closed gear transmission, gear coupling and rope drum with one layer.
The hook block suspended on at least 2 steel ropes and a beam type equalizer.
A grab winch, if required, should, in principle, consist of two identical winches standard. Auxiliary hoists available as commercial products, to be agreed upon by TATA STEEL.

Each hoisting winch is to be provided with a rotating limit switch that switches off the winch at top and bottom positions. In case of grab winches, each switch must switch off both winches. Each winch is to be equipped with a lever switch for the top position, operated by the multi-sheave block, hoisting trestle or grab.

An additional 0.5 m hoisting height is to be left before the rotary switch is engaged, after the highest operating position mentioned in the specification has been reached. When an unloaded winch cut out by this switch has come to rest, at least 200 mm is to be left before the lever switch is operated. When the lever switch has cut out the hoisting winch, an additional 200 mm free run is to remain beyond the running-out distance of the unloaded winch. The rotary limit switch must be coupled direct to one of the winch operating shafts via a gear coupling.
The two limit switches are to be installed in such a way that the cable connections and switch elements are easily accessible.

The drive of hoisting winches for cranes carrying liquid steel must consist of at least 2 motors and 2 brakes, a working brake and a holding brake, operating separately and independently, per motor.
Each brake must be designed to stop the winch at full load.
The fixed ends of the ropes are to be fastened to an equalizer with a buffer device so that, should one of the ropes break, the load will be gradually transferred to the other rope, while a switch is activated to stop the movement.

If power has to be supplied to the multi-sheave block or to the hoisting trestle, this must be done at a hoisting speed of < 16 m/min, by a spring cable reel. In case the hoisting speed exceeds 16 m/min, a motor cable reel is to be installed that can effectively follow the acceleration, speeds and deceleration of the hoisting gear. The make and type of such a reel requires TATA STEEL' approval.

6.2.4 Design of trolley travel drive

The trolley travel gear, in principle, consists of an electrical motor, electrical brake with flexible coupling, closed gear transmission, couplings between drive shaft and the wheels.

The use of standard shaft mounted gear reducers which are exchangeable as one unit is also permitted (SEW/Flender).
Motors shall be easily exchangeable (IEC type).
The drive shaft for the running wheels must be equipped with couplings to enable easy replacement. For checking the alignment of the wheels in bogie and trolley structure inspection provisions are required. Trolley travel must be provided with an electrical brake. Jack points are to be located near the crane wheels in such a way that wheels or bogies can be easily replaced. The jacks do not form part of the supply; the auxiliary constructions required for jacking, however, are part of the supply.

6.2.5 Design crane travel drive.

The travel gear, in principle, consist of an electrical motor, (possibly a shaft mounted reducer) electrical brake with flexible coupling, closed gear transmission, couplings between drive shaft and wheel(s). Brakes must be only holding brakes. Bridge and gantry cranes must be equipped with drive units per girder or corner.
The drive shaft for the crane wheels are to be equipped with couplings to enable easy replacement. For checking the alignments of the wheels in bogie and crane structure inspection provisions are required.

Rail clamps are to be installed as a safety device in the event of gale, and must be released electrically or electro-hydraulically; the design or manufacture is to be approved by TATA STEEL. The required coefficient of friction is 0.25, the swing being so large that rail tolerances and rail wear do not affect proper operation.

The crane is to be provided with jack point at each corner, designed in such a way that the unloaded crane can be jacked up, whatever the position of its parts. If there are more than two wheels at each corner, jack points must be located so that any 2-wheel bogie or any wheel can be disconnected without first having to disconnect other bogies or wheels.
It should also be possible to jack up any corner of the crane, possibly after installing an auxiliary device. The jacking facility and jacking method are to be clearly shown in the drawing, and any auxiliary devices should be included in the crane manufacturer's delivery.

If the crane is used for the transport of bulk goods such as ore or coal, and there is any possibility of the goods being spilled onto the crane track, entirely sealed drive units must be installed. These drive units must be effectively shielded so that proper operation will not be affected by dirt, either raised by the wind or settling naturally under operating conditions, and/or humidity. The clearance between the bottom of gear box and the top of the rail head should amount to at least 100 mm.

These cranes must also be provided with rail clearing devices so that the rail remains unobstructed even if there is a particularly large quantity of bulk material on the track. For this purpose, a fender is to be installed by means of which a width of 500 mm can be cleared on either side of the track. The rail cleaning device must be placed behind these fenders in order to sweep the top and sides of the rail head.
These guards are to be installed both behind and in front of each set of bogies.

Simple guards should also be installed on cranes that do not transport bulk goods but travel on a ground track.

6.2.6 Design of boom hoisting drive

The hoisting winch, in principle, consists of an electric motor, an electrical service brake with flexible coupling, a closed gear transmission, a gear coupling and a single layer rope drum.
The fixed end of the rope is to be fastened to a beam type equalizer with buffers.
Boom hoisting should take place with two separate sets of hoisting ropes of such secure dimensioning that, should one of the ropes fracture, the other rope still has 4-fold overcapacity.

In the highest position, the boom is to be held by hooks. For this purpose, when the boom is in highest position, first a buffer must be compressed up to the stage where the holding hooks operate. The boom must then be run out until the holding hooks hold the boom and the steel wire ropes have no load. The buffer pressure must then be sufficient to prevent the boom from moving as a result of wind or storm forces. It must be possible to release the holding hooks by means of electric jacks or similar devices.

The boom movement must be operable from the level at which the operating controller is located, in such a way that all movements of boom and holding hooks are readily visible.

The entire structure must be calculated that the boom remains hanging in one set of ropes. In that case a switch is activated to stop the movement.

For safety reasons, preference is given to two complete hoisting winches, mechanically coupled to each other. Should at any particular point of one of the winches fail, the other winch should be able to move the boom with one set of ropes.

When using one winch, the drum shaft is to be secured against fracture by e.g. extending the hubs into the bearing blocks.
Furthermore the drum is to be equipped with an emergency brake system that comes into action to arrest the winch in case the normal speed of rotation is exceeded. For this purpose the brake thread must meet the specifications the brake supplier will issue for this particular condition of operation.

All pivots of the boom are to be equipped with bushings or spherical bearings. The boom hoisting motor must be capable of sufficiently compressing the buffers, as described above. The entire boom hoisting movement is to be calculated while taking into account the motor's breakdown torque.

The gears are to be housed in a fully sealed gearbox with splash lubrication. Each winch is to be provided with a rotary limit switch for the highest and lowest positions and for switching to low speed. In addition, a maximum load switch and a slack rope switch are to be installed. The boom, when used, is to be held by suspension bars designed in such a way that wind forces and/or mass forces cannot cause considerable vibrations.

The pivots of the suspension bars must be provided with automatic grease lubrication or designed in such a way that they do not need maintenance.

6.2.7 Luffing drive unit

This should preferably be a system where the load line is as close as possible to a straight horizontal line and where, particularly for the grab operation, as few deflecting sheaves as possible are necessary. For other solutions, draft specifications must first be submitted and in principle approval obtained before details are worked out.

A drive is optional, and may be either by sectors fitted with teeth, a rack and pinion, or a screw spindle. If sectors with teeth are installed, these must be fitted with precision milled teeth and

installed against suitably finished mating surfaces. In case both sectors with teeth and a rack and pinion are used, these should be installed in such a way that the forces on the two pinions are equal. The teeth must be grease lubricated automatically, which is to be facilitated by fitting a lubricating guide to each drive pinion. Screw spindles must be adequately enclosed. The entire luffing gear must be of such design that the play between teeth is kept to a minimum.
The main dimensions are to be calculated in such a way that the rotary limit switch operates at the minimum and maximum radius stated in the specification and that a clearance is left against the buffers once braking is complete.
Springy buffers that can absorb the full kinetic energy of all moving parts, i.e. of apron, ballast and top winch, must limit the end positions. The luffing gear is to be provided with lever limit switches for maximum and minimum radius. A rotary limit switch, if any, indicates interim stages.
All pivots of jib and luffing gear are to be equipped with spherical bearings.

6.2.8 Slewing drive unit for jib cranes.

The slewing drive consists in principle of an electric motor, an electrical service brake and concomitant flexible coupling, a closed gear transmission, a pinion and a slewing bearing.

Slewing bearings
The slewing assembly is to be fitted with a ball or roller slewing bearing. This slewing bearing must be of a type with teeth on the inside.

Diameter, type, type of teeth and support for the slewing bearings to be determined in consultation with the manufacturer, and subject to approval; a written guarantee of the specifications must be submitted.
In any case the useful life as specified in Table I is to be taken into account.

Power supply
If the specification indicates that pivot contacts should be avoided, the viable slewing angle must be 2 x 270°.

For the drive of the slewing gear, preference is given to at least two drive units; this number should be increased if the load on the teeth is likely to be excessive.

If the brakes are unable to hold slewing part of the crane during a gale, when the crane is stationary, a locking device should be installed by means of which the slewing part can be locked in two positions.

The teeth of the ball or roller slewing bearing must be greased automatically, which must be facilitated by fitting a lubricating guide to each drive pinion.

The ball or roller races of the slewing bearing must also be greased automatically.
A tray is to be placed under the slewing bearing teeth to catch grease spillage.

6.3 Gear transmissions.

6.3.1 Engineering

If a load to be hoisted is suspended on free-hanging ropes, calculations must be based on a horizontal force of 0,15 x the load.
Greased transmissions, must have a hardened pinion. However, a calculation is to be based on unhardened materials.

Teeth accuracy after processing must at least meet the following DIN 3961 requirements:
quality 6: first transmission
quality 7: second transmission
quality 8: all other transmissions.

The quality of the tooth finish must be determined according to the radial speed limits:
Radial speed above 6 m/s = DIN class 5-8
Radial speed from 3 to 6 m/s = DIN class 8-10
Radial speed to 3 m/s = DIN class 10-12.

6.3.2 Gearboxes (also standard gearboxes)

Gearboxes for travel mechanism are preferred to be of parallel-shaft gear unit type with the support near the input shaft.
Gearbox with a division must be equipped with two shoulder bolts or dowel pins. It is not allowed to use spring washers in gearboxes.
The gearbox must have an oil level indicator and a big oil tap (d=40m or bigger), which is easy to use. Oil tap and indicator must be sufficiently robust to withstand becoming defective.
A plate must be attached to the gearbox clearly showing the following information:

Manufacturer	
Model	
Oil filling	…Liter
Oil type	
Transmission	i=

If the peripheral velocity of the gears dipped in oil is less than 1.0 m/s, whereby the lubrication of other gear wheels is insufficient, an oil pump has to be installed with an 80 mm filter, driven by an extension of the motor shaft and distributing the oil to the necessary points.
Any piping required for this purpose must be of seamless steel pipe with a minimum passage of Ø 12 mm. Hoses are not to be used.

The covers of gearboxes are to be designed in such a way that no oil leakage can occur. The use of retaining rings, etc. for the shaft seal should preferably be avoided. Gearboxes must be designed in such a way that the bores for the bearings can be re-machined. Covers of gearboxes must be provided with at least two push-off holes.

6.3.3 Material and welding

Gear transmissions in oil baths gearbox
Standard gearboxes are acceptable if the selected brand or manufacturer is approved by TATA STEEL.

Open gear transmissions
If hardening is needed it is to be achieved through the foot of the tooth. After hardening, surface hardness should be at least 50 HRC.

Shaft couplings
Forged or cast steel.

Gearbox housing
Welded gearbox housings according TATA STEEL standard S1 45 04 01 category 2. After welding the gearbox must be stress relieved.

6.4 Bearings, shafts, pivot pins couplings

6.4.1 Bearings

All rotating shafts must be carried on ball or roller bearings. Conical roller bearings are not allowed. All bearings have to be of SKF or FAG –type or equivalent, approval by TATA STEEL.

Self-aligning roller bearings fitted on a separate bushing must be used for the rope sheaves.
Bearings that may be idle under stress for a considerable time, e.g. running wheel bearings on a level-luffing crane and pivots for jib and luffing machinery, must be checked for false brinelling.
The bearings in gearboxes are to be lubricated by splash or mist lubrication.
Bearings with grease lubrication are to be housed in bearing housings with large grease chambers with re-lubrication facility. The covers for these bearing housings must have at least three grooves for the grease to seal off the dirt from outside.
If outer rings of ball or roller bearings are carried in parts that cannot or are difficult to be disconnected, separate bushings are to be installed around them. Such bushings are to be properly secured.

6.4.2 Shafts

Shafts with diameter differences of more than 100 mm are to be preforged. All shafts, particularly those with fluctuating loads, must be fitted with large radius (equal to or larger than 0.1 d) or stress-relieving grooves at the transfer of diameters. The roughness value to be equal to that of shrunk connections.

The bottom side of keyways in shafts must be fillet. The distance between the end of the keyway and a transfer of diameter should be at least equal to the width of the keyway.

6.4.3 Pivot points

All pivot points with a limited turn (less than 360°), are to be provided with bushes, spherical bearings or with roller bearings. In the case of pivot points where two bushes are installed for each point, the bushes must be pressed in against a stop, so that they cannot be displaced inwards.

For pivot points a surface pressure calculation is required and must be approved by TATA STEEL PTC -KBT engineer.

All pivot points must be provided with a lubricating facility consisting of a nipple and ducting. Each lubricating point is to have its own duct and nipple. Lubricating nipples at shaft ends to be countersunk. For disassembly purposes the pins must be equipped with a screw thread on one side.

6.4.4 Couplings

An elastic coupling must be installed between motor and gear case on all drives where the coupling part on the gear case shaft also serves as brake disc or drum.

When three support points are designed, a gear coupling must be installed.

6.5 Rope drums

6.5.1 Engineering

The calculation of the wall thickness of the drum is to be based on the formula of “Kurt and Pajer Scheffler. The calculated min. permissible wall thickness of the drum must be increased for wear and on roundness of the basic material by 10% of the rope diameter in order to have sufficient thickness after machining and wear.
The influence of changing loads in the rope must be calculated to determine the permissible fatigue stresses. The flanges to support the shaft and gear coupling shall be calculated on a horizontal load of 10% of the maximum rope force. Load factors shall be in compliance with the specified crane class.
The welded connections in the drum structure are to be calculated and checked according to NEN-EN13001-3-1.

6.5.2 Design of welded rope drum

The diameter and groove must be designed accordance NEN 3508. The number of grooves on the drum must be such that at least three permanent windings are left on the drum in the lowest indicated position and one groove is left in the highest position. The wall thickness of the rope drum must be selected in such a way that the design life is longer than the design life of the crane for wear and fatigue. This must be demonstrated with a calculation.
The rope drum to be designed with flanges at both sides with a height of three times the rope diameter. The rope ends are to be fastened with two clamps per rope. Each clamp must have at least two bolts.
With the use of a bolted connection between the drum flange and drum gear-unit coupling the load must not pass through the bolt connection.

6.5.3 Material and welding

Welded rope drum must be made with material S355J2G3 and must be welded according TATA STEEL standard S1 45 04 01 category 1.

6.6 Rope sheaves.

6.6.1 Engineering

For all types of sheaves a calculation is required.
The rim must be designed for a horizontal load of 10% of the maximum rope force.
The diameter and groove have to be in accordance with NEN 3508.
The thickness of the rim in the groove must be calculated for a maximum wear of 10 mm in the bottom of the groove.
The groove need to be hardened according to the tensile strength of the used wire rope. See table 6.6.1. The hardened groove bottom needs to have a thickness for wear of 6 mm. The rope sheave must be replaced on wear and not on fatigue. A calculation need to show that wear occurs sooner than fatigue.

6.6.2 Design of rope sheaves

Diameter and groove of the rope sheaves must be in accordance with EN 13001-3-2 unless otherwise specified.
All the rope sheaves has to be made with the roller bearings on bushes and protection covers.
The covers for these bearing housings must have at least three grooves for the grease to seal off the dirt from outside.
In any event, the rope must be prevented from leaving the sheave.

6.6.3 Material and welding

Cast steel or welded steel. The tensile strength should be at least 590 N/mm2.
For grab unloaders casted rope sheaves must be used.
Selection of supplier and type requires approval of TATA STEEL.
Welded rope sheaves according to TATA STEEL standard S1 45 04 01 category 1.
The groove must be free of paint and provided with an anti-rust coating.

Rope grade	***Tensile strength (N/mm²)***		***Hardness***	
	Min.	*Max.*	*HB(Brinell)*	*HRC (Rockwell)*
1770	*1570*	*1960*	*445/470*	*49*
1960	*1770*	*2160*	*470/480*	*51*
Table 6.6.1				

6.7 Steel wire ropes, rope suspensions and equalizers

6.7.1 Engineering

The safety factor for all ropes for normal hoisting purposes must comply with the conditions mentioned in NEN 3508.
The safety factor for ropes hoisting liquid steel must be based on a braking force of at least 8 times the normal working stress including the efficiency of the hoist and dynamic effects.

6.7.2 Design steel wire ropes, rope suspensions and equalizers

Steel wire ropes to be selected by the supplier and to be approved by TATA STEEL.

Single hoisting ropes to be of the right-hand type.
Right-hand and left-hand types in case more hoisting ropes are used.
In normal service the fleet angle of the rope angle to the drum will not be more than 2° in both directions.

The fixed rope section to be fitted with solid thimbles. These thimbles are to be fastened with Talurit clamps. The equalizer must be of the beam type, equipped with a swivel to enable free swinging without bending of the fixed rope end.
Rope sheaves as an alternative to equalizer are not accepted.

Ropes for apron hoisting operations have to be of the galvanized type.

If the grab ropes on a grab winch are to be connected to the crane ropes by connecting links, Nemag Quick release links are to be used only.
The quality of pear links and cup sheaves must be high.

6.7.3 Welding

The equalizer must be welded according TATA STEEL standard S1 45 04 01 category 1.

6.8 Lifting force limiter

The device must be able to function within 5° swinging of the load without stopping the service of the crane. The device must be adjustable for smooth operation under normal load.
Preferably a load pin is to be placed in the equalizer centre point.
Adjustment is to be made during dynamic hoisting. Maximum setting: 10 % over operating load. Calculation and design according NEN EN 15011 section 5.5. on strength and fatigue.

6.9 Multi-sheave blocks and hoisting trestles

Hoisting trestles and spreaders for cranes carrying liquids are to be provided with laminated hooks. These hooks must be fastened to the trestle universally jointed with forged steel or laminated forks in such a way that they can move 90° from the vertical within the trolley traversing direction.

This movement is necessary for replacement of the hooks. The hooks must be able to swing 15° to either side in the crane traversing direction.
The length of the hooks must be such that the steel ladle can turn 360° around the axle journals. The inside support area of the hooks must be provided with a lining to protect from wear. The underside and sides of the trestle must be protected with 8 mm sheeting in case of heat radiation. The distance from the sheeting to hook and trestle must be 100 mm and the sheets are to be fastened with serviceable clips.

Multi sheave block for harbour cranes must be designed in such a way that it's impossible to catch the ships hatch or gangway.

6.9.1 Welding

Must be welded according TATA STEEL standard S1 45 04 01 category 1.

6.10 Laminated hooks and forged hooks

Crane hooks and laminated hooks shall be designed and calculated according TATA STEEL directive S1790001.

6.11 Brakes.

6.11.1 Engineering

For Hoisting, the required maximum braking time is 2 seconds.

Where in the case of malfunction a locking brake may accidentally act as a retarding brake the torque of the brake must be calculated as follows:
Mbrake ≥ 1.1 x MSWL + Minertia with a braking time of 2 sec.

A check shall be made to ensure that the heat developed by braking in no way damages the brake disc or drum, while the brake linings must be assured of a service life of 100,000 times braking.

6.11.2 Material brake

The make and type of the brake requires approval of TATA STEEL.

6.11.3 Material brake drums

Perlitic cast iron GG 30 in accordance with DIN 1691, where P must be 0.2%.

6.11.4 Material brake discs.

Forged steel or cast steel

6.12 Wheels

6.12.1 Engineering

For crane and trolley travel the maximum wheel-load in operation has to be used for the calculation of the diameter.
The design of the wheels must be according to NEN-EN 13135 annex B.
Bearings must be calculated for maximum wheel pressure in operation and thereof an amount of 10% horizontal force, acting at the point of contact between rail and wheel and perpendicular to the rail. With due regard to the nominal speed.

6.12.2 Crane wheels

The selection of the wheel diameter and/or tread is to be governed by TATA STEEL.
The wheels to be designed for the normal crane rail type according to DIN 536, type A.
Wheels with ring gear are not permitted.
All wheel/axle connection are shrunk fit according to SKF design.
Because of the vertical movement of the driven wheels and for standardisation purposes a coupling between the drive gear and the wheel axle has to be installed to enable easily wheel change.

6.12.3 Material

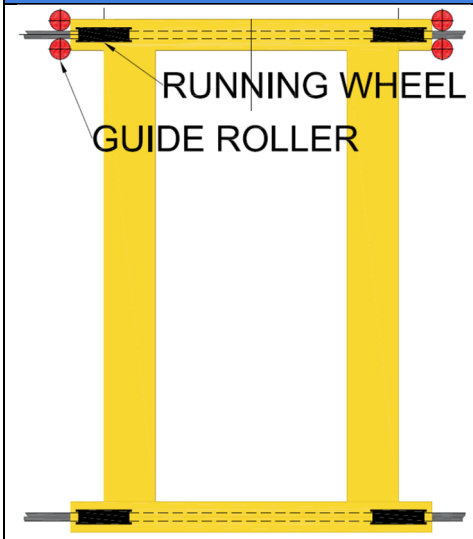
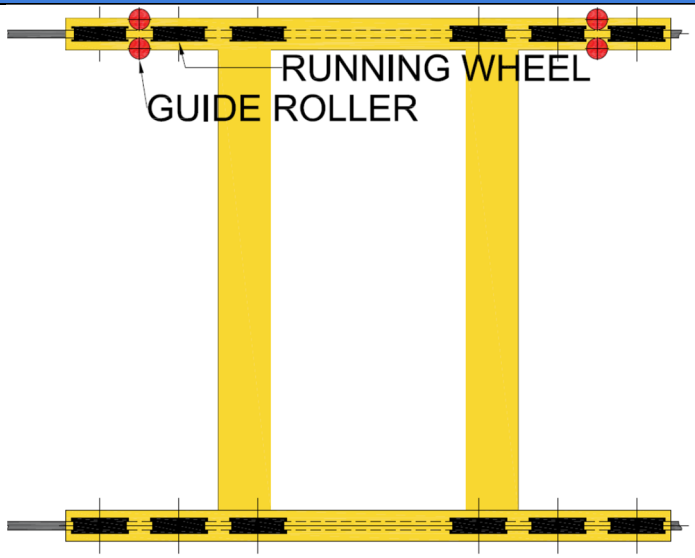
Preferable material 42CrMo5-04 or equivalent
The hardness of the contact surface must be at least 500 HB
The hardness 15 mm under the contact surface 480 HB
The use of surface hardened wheels shall not lead to an increase of the admissible pressure or to a reduction of the diameter.
Inside bearings FAG or SKF, alternatives to be approved by TATA STEEL.
The design and choice of supplier requires approval of TATA STEEL.

6.13 Guide rollers

Unless technically impossible, guide rollers are to be used to improve alignment of the crane on the rails.

6.13.1 Engineering

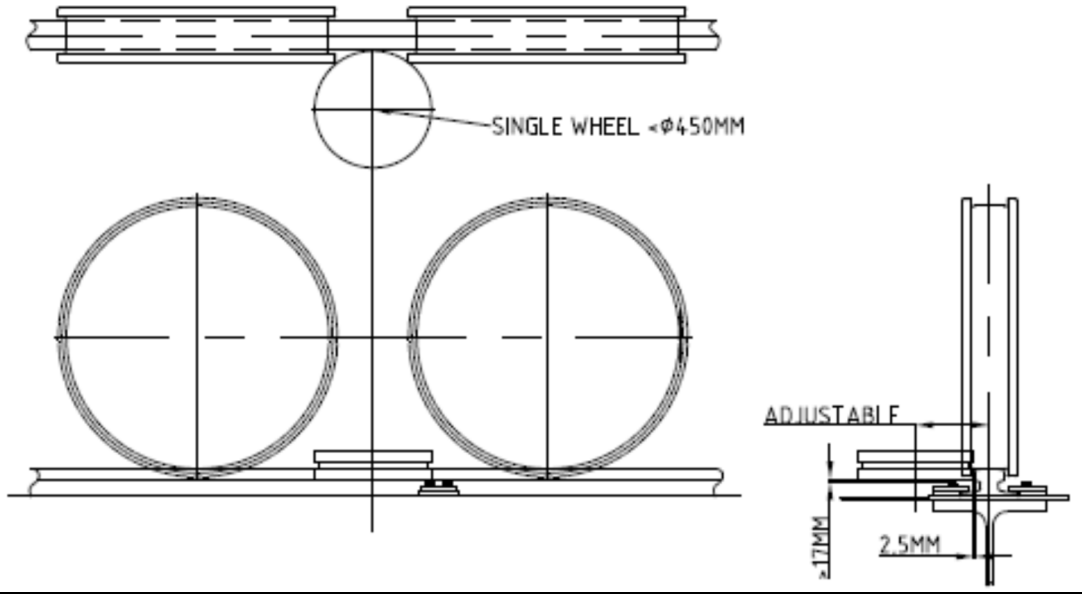
The load caused by skewing must be calculated according NEN-EN 15011 paragraph 5.2.1.4. When skewing forces are minimum, guide rollers are considered unnecessary.
The guide rollers must be designed for the maximum skewing load and the bearing(s) for >50.000 operating hours. The maximum Hertz compressive stress of the guide rollers must be calculated.
The position of the guide rollers depends on the design of the crane and the number of wheels and see example 1 or 2

Example 1	Example 2
	
For cranes with 4 wheels, the guide rollers must be placed on the outside corners.	***A crane designed with wheel bogies the guide rollers must be placed between the two outside wheels.***

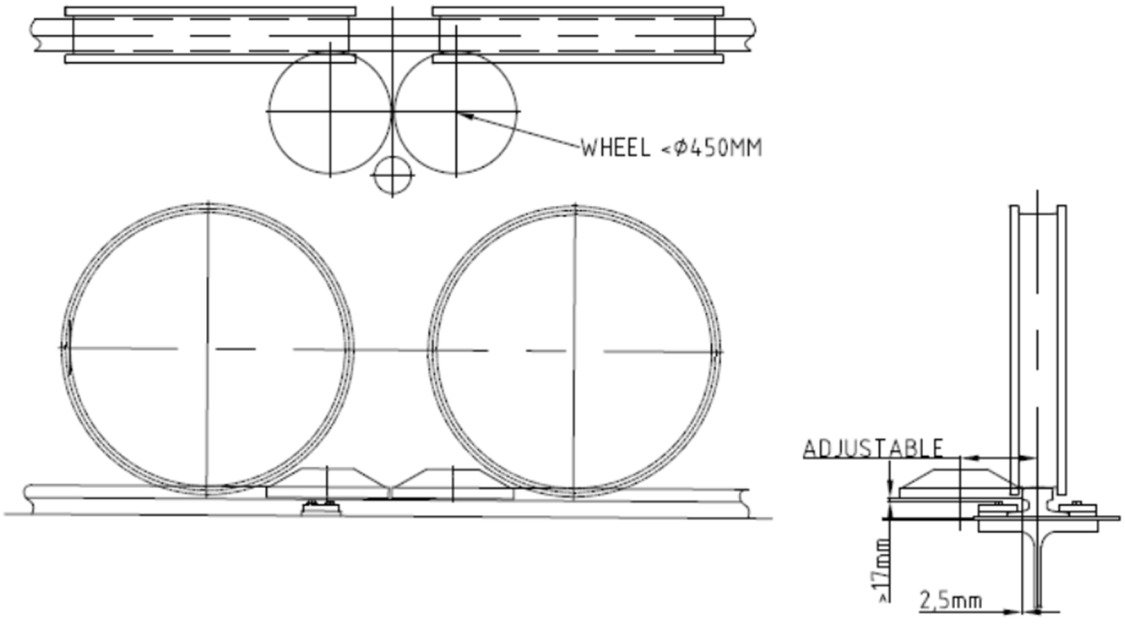
The design of the guide rollers must meet the following requirements:

- Mounting position at the fixed head joint side unless it's technical not feasible.
- Horizontal adjustable up to the maximum wear.
- Easy to replace, hoisting points, tools.
- The guide wheel must be equipped with a protection bracket, which prevents the guide from falling down in case the guide wheel breaks down. This protection bracket must be removable for maintenance.
- Distance between guide roll and rail clips must be greater than the maximum wear of the wheel and the rail together.
- Double wheel guide rolls must be designed with a balancer.
- See also example 3 and 4.

Example 3: single wheel version



Example 4: double wheel version with balancer



6.13.2 Material of guide roller

Materials being used with a tensile strength of at least 1000 Nmm2. If hardened wheels are required, the following applies: tread hardness HV450 with a hardening depth of 12:15 mm. Bearings FAG or SKF, alternatives to be approved by TATA STEEL.

6.14 Bogie for crane wheels

If more wheels are required per corner, the wheels are to be placed in bogies.
In case more than two wheels are required per corner, the bogies are to be coupled with balances.
The pivots of all bogies and balances on cranes operating in the open, are to be protected against humidity and dirt. All pivots are, therefore, to be properly sealed by means of grease chambers and solid covers. The construction of the pivot points must be designed as a form fitting connection.

6.14.1 Welding

Must be welded according TATA STEEL standard S1450401 category 1.

6.15 Buffers

Additional to NEN-EN15011 annex G (NEN-EN13001-2, 4.2.4.4), buffers are to be calculated using maximum travel speed and with the trolley centred on the crane.

All traversing movements, level-luffing movements, slewing and hydraulic movements within a restricted radius must be provided with buffers that can absorb the full kinetic energy. The use of hydraulic buffers is preferred.

Synthetic buffers for travel functions must be made according TATA STEEL direction R1590104.
If necessary, hydraulic and synthetic buffers are protected against heat radiation or weather conditions.

6.16 Lubrication

All technical solutions must meet the requirements of TATA STEEL Directive R1490101

6.17 Hydraulics and Pneumatics requirements

For hydraulic systems TATA STEEL Standard S1420101 and TATA STEEL Technical Guidelines R1420100 – R1420110 are applicable.

For pneumatic systems TATA STEEL Standard S1410101 and TATA STEEL Technical Guidelines R1410100 – R1410110 are applicable.

For hydraulic and pneumatic pipes, the pipe specifications HSS016 and HSS250 are applicable.

Attachment A: Preffered suplier list

Subject	Make	Supplier
Running wheels		Valdunes
Welded rope sheaves		Gosan
Hydraulic buffer	Oleo	
	Enidine	
Synthetic buffer	Eriks	Eriks
	Aclacel	
	Conductix	Conductix
Magnetic type disc brakes	Sibre, Simé, Witton Kramer or Antec.	
Thruster type drum brakes	Siegerland, Römer, Bubenzer or Antec.	
Cabin		Metagro
Grabs		Nemag
Slew bearing		Rothe Erde