JAPAN P&I CLUB Vol.36 October 2015
P&I Loss Prevention Bulletin
The Japan Ship Owners' Mutual Protection & Indemnity Association Loss Prevention and Ship Inspection Department

CRANES, THEIR OPERATION AND REASONS FOR FAILURES

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Introduction

Cargo handling cranes, commonly pedestal mounted jib cranes, are fitted on board most handy-size bulk carriers, most general cargo ships and some other smaller or larger bulk carriers. These cranes appear to be fairly robust units which will continue to work when only a minimum of maintenance is carried out, but, in fact, they are highly complex pieces of machinery which incorporate numerous components manufactured to very fine tolerances, all of which must function correctly throughout a working period for the crane, as a unit, to be operated as the manufacturers intended. The cranes should be properly maintained, and should be inspected at specified intervals to ensure that they operate correctly and safely. Additionally, all other equipment used in association with a crane should, likewise, be properly maintained and should be inspected as appropriate. If the equipment is not in the appropriate good condition, failures are likely to occur during cargo operations.

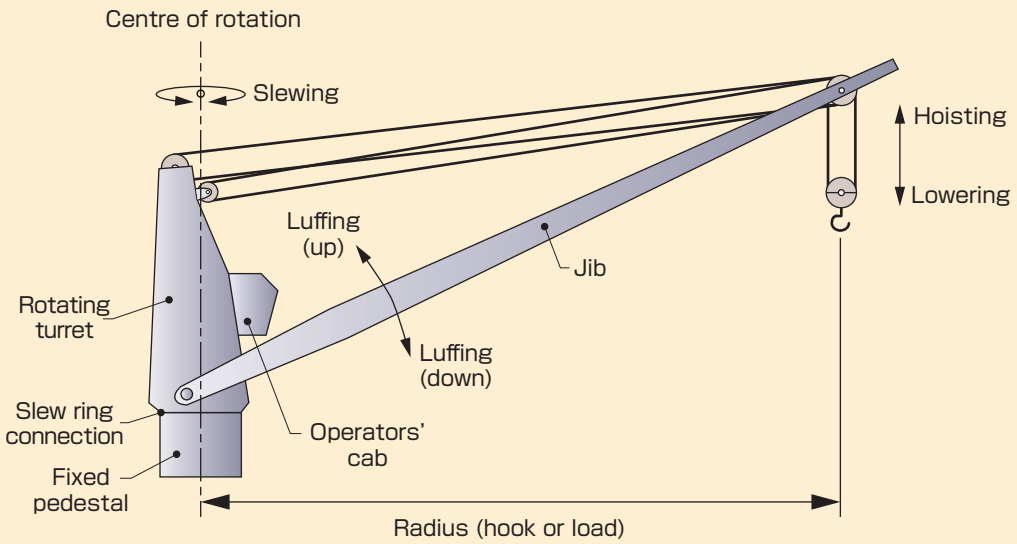


Fig.1 The general movement of a pedestal crane

Each crane will comprise components, as follows:

Wire ropes

Usually a hoist wire and a luffing wire (although on some cranes the luffing of the jib might be by means of one or two hydraulic cylinders) and various ancillary equipment.

Structures

Including a pedestal, a housing and a jib, with associated mountings, bearings and foundations for winches, motors, pumps, etc.

Machinery

Including electrical control equipment and systems, various winches, motors, pumps, etc., limit switches, cut-out switches and other pieces of equipment.

Additionally, some ships are fitted with bulk handling grabs for use with the ships' cranes.

Photo 1 General view of two cranes

Any failure of any part of the crane will lead to delays in the cargo operations, and any such delay is likely to have other consequences. Additionally, the renewal of parts or the carrying out of repairs might be necessary, which is likely to be expensive and cause further delays.

The failure of a cargo handling crane is likely to involve one or more of the following:

1 Failure of a hoist or luffing wire

The result of poor maintenance of the wire leading to weakening of the wire over time or inappropriate operation of the crane and incorrect use of the wire leading to damage being sustained by the wire.

2 Failure of the structures

The result of poor maintenance of the various elements leading to weakening of the structures or incorrect use of the crane leading to damage being sustained by the structures.

3 Failure of the machinery

The result of poor maintenance leading to the failure or incorrect use of the crane leading to overloading of the piece of machinery.

Some general guidance on good practice for the inspection and maintenance of the various parts of ships' cranes is given in the article, together with guidance on the operation of cranes and the maintenance and use of grabs.

General guidance on inspections and maintenance

There should be on board every ship fitted with cranes a manual produced by the manufacturers of the cranes giving recommendations and guidance with regard to the operation of the cranes and details of inspections and maintenance which should be carried out, as a minimum. There should also be a planned maintenance regime which should include the recommendations set out in the manufacturers' manual. Additionally, there should be a regime for the inspection of each crane and its machinery and structures within the Safety Management System procedures. All the required maintenance, the appropriate inspections, and the testing of each crane and all its various parts, should be carried out at appropriate intervals. Records should be kept of all maintenance, all inspections, and the renewal of any parts, and those records should be held for future reference. More detailed comments, with regard to the various parts of a crane, are dealt with below.

More detailed comments with regard to the various parts of a crane.

1

Cranes, and other lifting appliances and their loose gear, are required to be thoroughly inspected annually, with a further thorough inspection and a proof load test every five years. Those inspections and testing are in accordance with the ship's Flag State requirements, although it is common procedure for the classification society surveyor to carry out the required inspections and tests. Details of the surveys should be recorded in the ship's Register of Lifting Appliances and Cargo Handling Gear. Also, there should be on board an appropriate test certificate for all wire ropes on board; that is, for all of those in use and for all spare wire ropes. The certificates should give the date of manufacture, the material strength, the construction of the rope and the breaking load test of a sample. There should be an inventory of all wire ropes on board and records of the dates of renewal of the wires in use on all cranes.

2

Wire ropes, motors, electrical control systems and other pieces of machinery and equipment wear out or might be damaged during the operation of a crane. It is therefore necessary for a number of spare parts to be maintained on board at all times. The trading pattern of the ship will, to an extent, dictate what type and what number of spares will be required. If the ship is trading in very hot or very cold areas, or if the cranes are frequently used for cargo handling, the hoist wires and winch motors might not last as long as if the ship is trading in less harsh environments. For example, even ignoring misuse, the hoist wire might be heavily worn with broken wires after only two years in use if self-loading and self-discharge is a routine procedure, whereas the hoist wire of a crane on a ship which is trading between terminals with on-shore loading and off-loading facilities might require renewal at only five year intervals.

Maintenance and inspections of the cranes, their wire ropes and their various pieces of machinery and equipment are essential to ensure that the operation of the crane is reliable and that there is a minimum of wear and damage.

Wire ropes and their ancillary equipment

Steel wire rope is constructed in a number of different arrangements, each arrangement of the outer strands and the core having different characteristics. Those characteristics will provide resistance to one or more of the following:

1 Rotation

The torque or turning motion generated when a load is applied or is removed.

2 Fatigue

Deterioration as a result of working, bending and straightening around sheaves or a barrel when it is under load.

3 Abrasive wear

Which takes place between a wire rope and the sheaves it passes over, and between a rope and the barrel, or adjacent ropes on the barrel, as it is paid out or hauled in.

4 Crushing

Crushing of a wire rope will occur when there are multi layers of a rope on the barrel.

5 Corrosion

A galvanised coating of the wires is normal for wires fitted to ships' cranes to minimise the effects of corrosion due to contact with sea water.

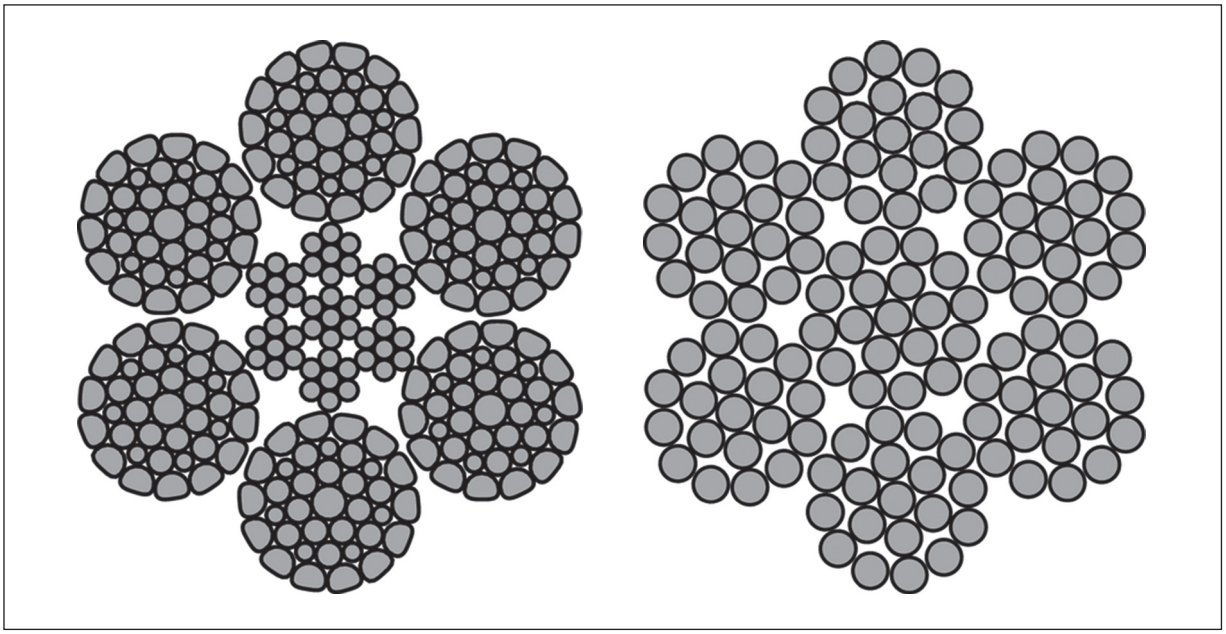


Fig.2 Compacted outer strands compared with strands of a normal wire rope (by courtesy of Certex (UK)).

Wire ropes fitted to deck cranes should be designed for the purpose and should incorporate resistance to rotation, fatigue, corrosion and abrasive wear. Resistance to abrasive wear is achieved by the construction incorporating compacted outer strands. That is, the strands are made up with wires of a particular cross section, not circular, so as to produce a smooth outer surface to the strands which might look as if the wire is worn overall. There should be on board an appropriate test certificate for all wire ropes and there should be an inventory showing the date of fitting of all wires in use on all the cranes and the status of all spare ropes. The master and the chief officer, and appropriate crew members, should have full knowledge of the status of crane wires and of the construction of wires fitted to the deck cranes. The wire ropes in use should be of the correct diameter and construction, as specified by the crane manufacturer, because only the correct wires will run smoothly and correctly over sheaves and on the winch barrels. Wire ropes of incorrect diameter and/or construction will deteriorate rapidly when in use and may cause damage to other parts of the crane.

The period of safe use of a wire rope will depend to a large extent upon the manner in which it is maintained and cared for while it is in use. If the wire is regularly inspected and lubricated, and if the other parts of the crane are properly maintained, the wire will suffer less damage than if proper maintenance is not carried out.

The planned maintenance regime is likely to require that inspections of the wire ropes are carried out at set intervals and that the ropes are lubricated with an appropriate grease at the same or at a different interval. During routine inspections and maintenance of the wire ropes they should be inspected over their full length and their fittings should also be inspected. Inspections and maintenance should be carried out in respect of the following:

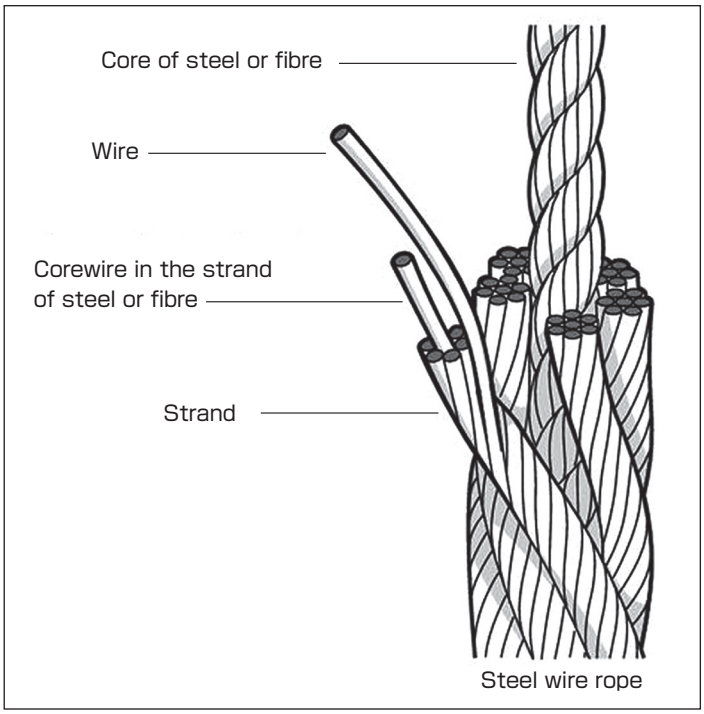


Fig.3 Wire construction (by courtesy of Certex (UK))

1 The wire rope over its full length

Inspections should be carried out to identify defects (as set out below) and the rope should be lubricated overall with particular attention to parts of the rope in way of sheaves when the crane is stowed for sea, end ferrules and end terminations.

2 Swivels

These should be in sound condition without defects and should turn easily by hand, if not they should be dismantled, cleaned, re-built and greased.

3 Ancillary equipment

Including hooks, cargo blocks, shackles and other loose gear - should be in sound condition without defects and all moving parts should be free and appropriately greased.

If any defects or damages are found, repairs should be carried out if appropriate, or the item should be removed from the crane and a new item should be fitted.

Wire ropes should be examined for defects and if those defects are excessive advice should be obtained and/or the rope should be discarded, as follows:

1 Number of broken wires

When broken wires are found, the number of broken wires within a part of the wire rope, for example, within a length equal to six diameters, should be assessed. If an excessive number of wires within that length are broken, the wire rope should be discarded (see ISO 4309 and below).

2 Fractured strands

If a complete strand is fractured, the wire rope should be discarded.

3 External and internal wear

If there is excessive wear, either internally or externally, the strength of the wire will be adversely affected and it may be appropriate to discard the wire rope; specialist advice should be sought

4 External and internal corrosion

If there is excessive corrosion, either internally or externally, the strength of the wire will be adversely affected and it may be appropriate to discard the wire rope; specialist advice should be sought.

5 Decrease in elasticity

Although this is difficult to defect by ship's staff, if the wire rope is found to have a reduced diameter or if there is elongation of the lay or the wire rope is found to be more stiff than expected, specialist advice should be sought.

6 Kinks and other mechanical damages

If any kinks, distortions or other damages are found, their severity should be assessed and it might be appropriate to discard the wire rope; specialist advice should be sought.

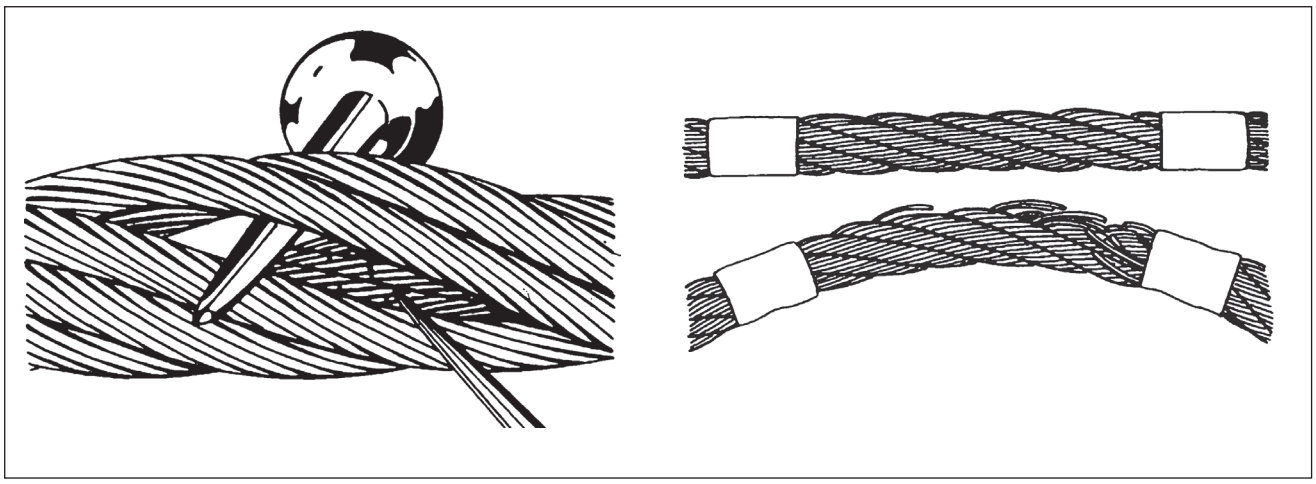
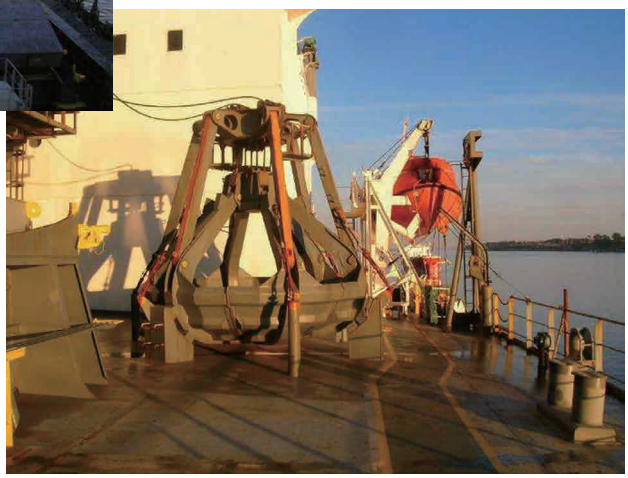


Fig.4 Inspections of rope for internal and external damage (by courtesy of Certex (UK))

The international standard ISO 4309, "Cranes - Wire ropes - Care, maintenance, installation, examination and discard", sets out a comprehensive list, with photographs, of defects that affect wire ropes. Guidance with regard to how inspections should be carried out is shown, and what should be looked for is given, for example how to carry out an internal examination of a wire using specialised tools. Also, the discard criteria for wire ropes of different types are given, for example, the number of broken wires in a specified length of the wire rope which would warrant discard.

Following completion of an inspection of a crane wire, the wire should be lubricated by the application of an appropriate grease or dressing. It might be necessary, if required by the age of the previous dressing or by the procedures of the lubricant manufacturer, for the wire to be cleaned to remove any old and de-natured dressing, in which case an appropriate cleaning product should be used. The lubricant should cover all parts of the rope and it might be necessary to work the dressing into the core of the rope in order to ensure the proper working of the lubricant.

Records of all inspections, maintenance and renewals of crane wires should be kept for future reference.



Crane structures

The structures of a crane include: (a) the pedestal upon which the crane is mounted; (b) the housing of the crane including all strength structures within the housing and all sheaves, and their mountings, at the top and at any other location on the crane; (c) the slewing ring at the base of the housing and its associated mechanisms; and (d) the crane jib including the heel bearings, the strength structures of the jib itself and the sheaves, and their mountings, at the jib head and at any other location. Additionally, the foundation structures of the winches, motors, pumps, etc., also form part of the structures of a crane.

Routine maintenance of the various parts of the structures, and of the fittings and support structures, is essential for the continuing correct operation of the crane. In accordance with the planned maintenance regime, inspections and testing of the various parts should be carried out and the repair and any renewal of parts should be undertaken as follows:

1. The main structures of the crane should be inspected to establish if any damage has been sustained or if there are any defects in the form of fractures or corrosion of the steelwork. Repairs and/or renewals should be carried out as appropriate.
2. All sheaves, bearings and other moving parts should be inspected to determine whether or not any wear or deformation of the parts is present. If parts are defective they should be removed and new spare parts should be fitted and then tested for correct operation. Those moving parts should be lubricated using the appropriate grease in the correct manner.
3. All foundation structures and mountings should be inspected to determine whether or not any defects or damages are present and, if any such defects/damages are present, appropriate repairs should be carried out.

Records of all inspections, maintenance, repairs and renewals should be kept for future reference.

Photo 2 Maintenance on-going at the top of a crane

Crane machinery

The machinery of a crane includes all electrical control equipment and systems, all motors, hydraulic oil pumps, filters and coolers, and winches, together with winch brakes and control gear, all limit switches, cut-out switches and other pieces of equipment.

Routine maintenance of these various pieces of machinery is essential for their continuing correct operation. In accordance with the planned maintenance regime, inspections and testing of the various parts should be carried out, with renewal of items, etc., as necessary, as follows:

1. Items such as filters should be cleaned/renewed at designated intervals and when indicated by increasing differential pressure.
2. Gearbox oil and any hydraulic oil should be changed and kept to the required level in accordance with the manufacturers' specification. Additionally, when appropriate, the oil should be changed subject to shore-based analysis of samples, to include particle count to assess the internal wear of the machinery. This sampling/testing should be done at about three-monthly intervals, subject to the on-going use of the cranes.
3. All limit switches and cut-out switches should be inspected and tested at appropriate intervals to ensure their correct operation and any defective parts should be renewed.
4. Electrical control equipment and systems should be inspected and tested at appropriate intervals and any defective parts should be renewed.
5. All motors, pumps and winches, and their brake mechanisms, should be inspected and tested at appropriate intervals and renewal of any complete units or parts of those units should be carried out as required when defects are found. Defects and developing problems might be identified by way of shore-based analysis of samples of oil, to include particle count, to assess the internal wear of the machinery.

Records of all inspections, maintenance, repairs and renewals should be kept for future reference.

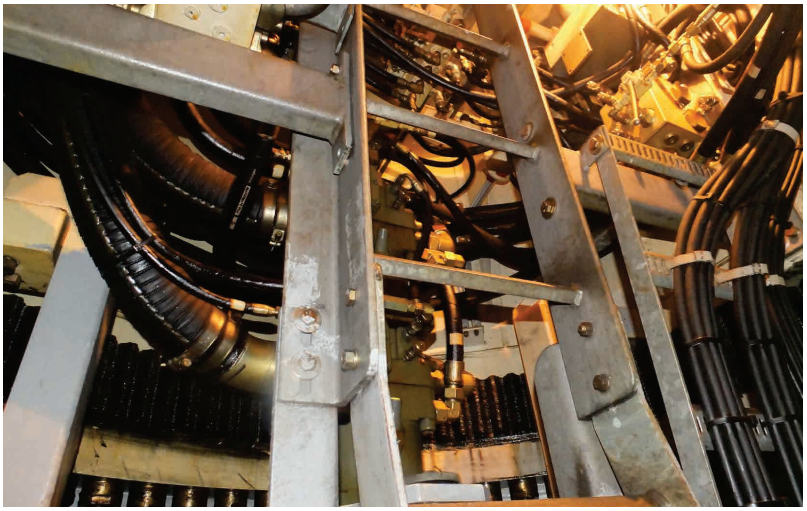


Photo 3 Part of the machinery and hydraulic systems of a crane

Normal operation of cranes

When ships' cranes are used for cargo operations, it is likely that they will be used over an extended period and also that stevedores' crane drivers will operate the cranes; it is sometimes the case that members of the crew will operate the cranes during such operations. It is essential that the cranes are in good order and operating satisfactorily at the beginning of any cargo operations and that the crane drivers are experienced in order that incidents are avoided. If any incidents do occur, an investigation should be carried out and any appropriate inspections should be completed as discussed in a separate section below. The general procedures for the normal operation of cranes are set out below.

As discussed above, there should be on board a planned maintenance regime for the inspection and care of the cranes; the requirements of that regime should be strictly followed. If all the required inspections and necessary maintenance of the cranes, that is of their machinery, their structures, and their wire ropes and other equipment, are completed, the cranes will be ready for use during cargo operations, or for other tasks, at any time. However, during an extended period of cargo operations the cranes, and their various components, will be subjected to loads and stresses which might lead to damages being sustained by some of the parts even though all the required inspections, maintenance, renewals, etc. have been carried out. For this reason, inspections of the cranes should be carried out before a period of cargo operations, on-going inspections should be carried out during those operations and a thorough examination of each crane should be carried out after the cargo work has been finished.

Before cargo operations

Before arrival at a cargo operations berth, where the cranes are to be used, or perhaps while the vessel is at anchor waiting to go alongside if it is safe to do so, a thorough examination should be carried out. Things to look for are as follows:

Photo 4 The control panel in the cab

1. All controls and the various limit switches and cut-outs are functioning correctly.
2. All electrical components and gear are dry and operating correctly.
3. All machinery and machinery housings are dry and operating correctly.
4. All wire ropes are satisfactorily lubricated and all swivels move freely.
5. All sheaves are satisfactorily greased and move freely.

If any defects or problems are identified during the inspections, corrective action should be taken without delay. For example, if it is found that the cargo hook swivel is somewhat stiff it should be greased or, if necessary, dismantled, cleaned, re-built and greased to ensure that it is completely free. Also, parts of any of the wire ropes which appear to be dry, for example in way of the sheaves when the crane is stowed for the voyage, should additionally lubricated as necessary.

During cargo operations

During all cargo operations the duty deck officers and duty crew members should continually observe the operation of the cranes and the working of all their parts. If any part appears to be malfunctioning the crane should be stopped and corrective action should be taken. For example, if the machinery is not functioning correctly and smoothly the chief engineer should be notified and tests and examinations of the machinery should be carried out, following which any necessary repairs should be completed. Also, if any of the sheaves or any of the bearings are not functioning correctly or are making unusual noises, investigations should be carried out and any appropriate repairs or greasing should be carried out.

Throughout cargo operations all limit switches must be operable and they must not be over-ridden. The over-riding or by-passing of a limit control must only be carried out in special circumstances and under the direct supervision of senior ship's staff and not during normal cargo operations. An example of when over-riding is acceptable is when the jib is being lowered onto its cradle in the rest position.

Photo 5　The controls in the cab

If it is found that the driver of a crane is not operating the crane correctly in any way, the cargo operations should be suspended and an investigation should be conducted.

a　If the driver is a crew member, an internal, onboard assessment of that crew member should be conducted and either that crane driver should receive further instructions with regard to the operation of the crane or an alternative, fully and properly trained crew member should be directed to drive the crane during the cargo operations.

b　If the driver of the crane is a stevedores' employee, the master should prepare a letter of complaint directed to the stevedores and other appropriate parties and should request details of the driver's experience and copies of any appropriate certificates of instruction. An investigation should then be conducted together with representatives of the stevedores to establish why the crane driver was mis-handling the ship's crane. If appropriate, an alternative, sufficiently trained, crane driver should be directed to drive the crane before cargo operations are resumed. Records should be kept of all discussions held, to include the details of all parties taking part, of the discussions and of all decisions taken.

After cargo operations

Following completion of a period of cargo operations during which there have been no particular incidents of note, there should be a general, overall inspection of the cranes and their equipment to establish whether or not any damage has been sustained. A record of the inspection should be kept with details of any damages or defects found. If any damages or defects are found remedial work should be put in hand as appropriate. If structural repairs are carried out, or if work associated with load bearing systems is done, the crane should be re-tested with a proof load by a competent authority recognised by the Flag State, or other certifying authority on behalf of the Flag State.

It should be borne in mind that a crane which is fully and properly maintained is less likely to suffer a failure or the development of a defect during its normal operation. If a defect does develop, records of all inspections, maintenance and any work carried out will assist with demonstrating that due diligence has been exercised to ensure, so far as possible, that the crane was apparently in normal working order before the defect was identified.

Incidents involving damage to a crane

When an incident involving one or more of the ship's cranes occurs during cargo operations, be it major or minor in extent, the crane(s) should be immediately stopped and an investigation and inspections of the crane(s) should be started.

Incidents might include failure of electrical or mechanical components, failure of a hoist or luffing wire or failure of any part of the structure of the crane, any bearings or sheaves. The incident might have been brought about by mis-handling of the crane by the crane driver, by contact between the structure of the crane and another object - possibly the cargo being handled or another crane - or may be the result of an unforeseen failure of the maintenance and repair system on board.

Photo 6 The jib of this crane collapsed and suffered extensive damage as a result of a mechanical failure

The investigation should establish facts as follows:

1. The extent of the failure and what parts of the crane(s) are involved.
2. The reasons for the failure.
3. The extent and nature of all repairs which are necessary.

Remedial action should then be started, without delay, and the classification society should be notified. If structural repairs are carried out, or if work associated with load bearing systems is done, the crane should be re-tested with a proof load by a competent authority recognised by the Flag State, or other certifying authority on behalf of the Flag State. All broken or failed parts should be retained for future testing and examination. Records of all incidents should be kept, with details of all findings and remedial action taken. Additionally, a report, including full details, should be issued to the operators' office.

Photo 7 These wires failed when overloaded

Grabs and their use

Bulk cargoes are handled either by some sort of conveyor system with either a spout for delivery or a suction or bucket leg for off-loading, or by grabs. The grabs might be stevedores' equipment fitted to on-shore stevedores' cranes, might be stevedores' grabs fitted to ship's cranes, or might be ship's grabs fitted to ship's cranes.

Although the grabs used by stevedores in conjunction with shore-side cranes might be any one of a number of types and designs, grabs used in conjunction with ship's cranes are usually of the clamshell type, connected to and lifted by the crane hook with the opening and closing mechanisms within the upper part of the grab. Usually, the opening and closing mechanism is by hydraulic cylinders powered by an electric pump, powered either from the ship via an umbilical cable plugged into the ship's electrical supply system or by a power pack incorporated into the machinery of the grab and operated via a radio control system. Occasionally, mechanical grabs with a wire and latch opening and closing system, sometimes known as dump grabs, are used.

Grabs from ashore

If grabs are provided from ashore, before they are taken into use with ship's cranes they should be fully inspected to establish whether or not they display any damages or defects; if any damages or defects are found, details of these should be recorded for future reference. The grabs should then be properly fitted to the crane hook or cargo block, as appropriate, and should then be fully tested to ensure that the grabs function correctly. If a grab fails to function correctly, it should be removed from the crane's hoist wire and returned ashore. Only fully functioning grabs should be put into service.

Ship's grabs

With regard to ship's grabs, they should be the subject of part of the ship's planned maintenance regime and routine inspections and maintenance should be carried out. That routine maintenance and inspection regime should include the thorough inspection of all structures of the grabs and their mechanical parts, and of any associated equipment, including any umbilical cables and control systems to ensure, as follows:

1. All moving parts are free and well greased.
2. All machinery and control systems are functioning correctly.
3. Hydraulic oil reservoirs are filled to the appropriate level.
4. All parts are without defect or damage.

If any defects or damages are found, corrective action should be taken without delay. A record of all inspections carried out and the findings of the inspections, of all maintenance done, and of any repairs or renewals, should be kept for future reference.

Before each ship's grab is taken into use for cargo operations, it should be rigged to the cargo hoist wire of the ship's crane and should be fully tested to demonstrate its fully functioning capability. A record of that testing should be kept.

Grab capacity and safe working load

The technical specification for a clamshell grab will include its capacity in cubic metres, its weight in tonnes, its dimensions in metres and details of its operation. The capacity might be a single figure, or might be two or more figures, if spill plates or moveable panels are fitted to the grab, which can be removed or put in place to alter the capacity of the grab when closed. The capacity of typical grabs used for the loading and discharging of bulk cargoes using ship's cranes ranges from about 4m3 to about 16m3. The weight of the grab might be about 2 tonnes or as much as 12 tonnes. This should be shown on the name plate attached to the grab.

The weight of cargo which can be lifted by a grab depends upon the capacity of the grab and the density, or the stowage factor, of the commodity. When calculating the weight of cargo lifted by a grab, it should be remembered that it is likely the surface of the cargo in the grab will be slightly peaked or crowned, such that a greater weight than the volume of the grab might indicate will be lifted. An allowance for this of 25% should be included in any calculation.

All ships' cranes are designed for particular operations and are certified to have a particular safe working load (SWL), dependent upon the strength of the structures of the crane and the strength of the wires which are fitted. That safe working load will be for hook operation, that is, for the loading and off-loading of cargo lifted by slings attached to the cargo hook. For pedestal cranes the SWL is also only applicable between the maximum and minimum working radii.

If the crane is designed for both hook operation and for grab operation, it is likely to be given two different SWL ratings by the manufacturer, one for hook operations and one for grab operations. It is usual for the grab operation rating to be 20% less than the hook operation rating. For example, a crane having a safe working load of 35 tonnes for hook operation will be down rated by 20%, or by 7.0 tonnes, such that its SWL for grab operation would be 28.0 tonnes. It must be remembered that this SWL includes the mass of the grab. The two SWL ratings should be stated on the plate on the crane jib.

Eg. Total lift taken by the crane wire

For example, for a grab of capacity 10m^3 and weight 4 tonnes, handling a cargo of density about 2.0 tonnes/m^3 or stowage factor 0.5m^3/tonne, the grab would lift 25 tonnes of the cargo (that is 20 tonnes plus the 25% allowance of 5 tonnes), such that the total lift taken by the crane wire would be 29 tonnes.

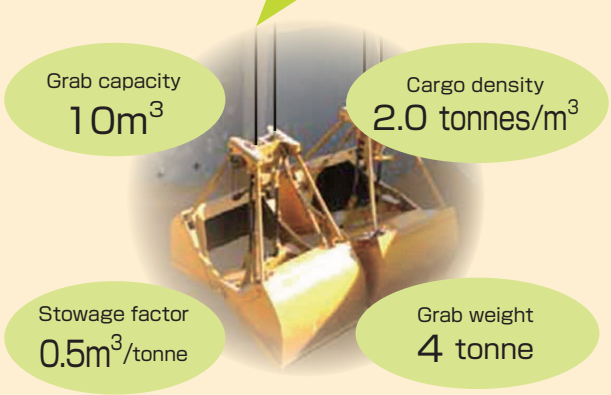


Photo 8 The plate on the side of the jib shows a SWL for hook work of 35 tonnes and a SWL for grab work of 28 tonnes.

The allowance given by the crane manufacturer is for a number of reasons, some of which are technical and some are operational. When a crane is used with a grab fitted to the hoist wire, the crane will lift and transfer a loaded grab in one direction and, after the load is released, it will lift and transfer an empty grab in the other direction, such that the crane will be transferring a load at all times when in operation, whereas in hook operation a load is transferred in only one direction. In order to compensate for those increased loadings on the structures and mechanisms of the crane, a down rating is applied. From the operational point of view, when a grab is closed in order to take a load from the pile alongside or in the hold, the grab will bite into the pile and become partly submerged. When the hoist wire motor is engaged the wire will be tensioned as the weight of the grab and of cargo is taken and that weight will be, effectively, greater than the weight of the grab and the weight of the cargo it can hold, as discussed above. Initially, there is likely to be some cargo on the shoulders of the grab, or in the grab, in addition to the 25% allowance, to increase the weight, and because there will be an amount of suction between the lower part of the grab and the cargo beneath the grab in the pile, there will be a further increase in the weight being lifted. Additionally, there might be a very rapid take-up of weight by the hoist wire as the full grab is lifted or a rapid release of the load when the grab is opened, such that a snatch loading might be applied to the hoist wire, its structures and the mechanisms of the crane itself. These various factors are taken into account by the application of a small down rating of the safe working load of the crane for grab operation.

For grab operation of a crane which is not specifically designed for grab operation and is therefore not given a grab operation safe working load, consideration should be given to applying an allowance whenever grabs are used for the loading or off-loading of bulk commodities.

Safety

The safety management system for the ship should include a manual in which there are all the various procedures to be adopted for safe working practices during cargo operations and during maintenance and repair of the cranes or derricks on board. Those procedures and any other or additional procedures should be followed. Maintenance of cargo handling equipment should be planned and work assessments should be completed, and all appropriate personal safety equipment and appropriate working equipment should be available and in good condition. Where appropriate, a permit to work should be issued. Before cargo operations are begun, discussions should be held to plan the operation and to identify any risks or problems which might arise.

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