A Maharatna Company

CC-SAFETY-STD/COMMON/MMH/R0

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STANDARD FOR MECHANISED MATERIAL HANDLING

Corporate Safety Department

NTPC Limited
Engineering Office Complex
A-8A, Sector- 24, Noida

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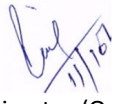
Approved for implementation by	Signature  Director (Operations)
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ISSUED BY : CORPORATE SAFETY DEPARTMENT	**ISSUED TO : ALL NTPC projects , stations, JVs and Subsidiaries**

CONTENT

1. SCOPE

This standard gives guidance for the safe use of all types of cranes, wire rope slings, chain slings and chain pulley block. Subjects covered include safe system of work, management, planning, general recommendations for selection, installation, testing, operation and maintenance of cranes & and for the selection of drivers, slingers and signallers.
Reference is also made to relevant legislation and attention is drawn to statutory requirements for the testing and examination of cranes.

2. DEFINITIONS

2.0 For the purposes of this standard, the following definitions shall apply.

2.1 Appointed Person
The person appointed by the management or organization requiring the lifting operation to be undertaken who will be responsible for all aspects of the lifting operation.

2.2 Automatic Safe Load Indicator
A device fitted to a crane, or incorporated in its design, that automatically gives visual indication to the driver when the load being lifted or carried by the crane approaches the safe working load. And that gives a continuous audible warning to the driver and other persons in the vicinity when the load being lifted or carried exceeds the safe working load. Under certain statutory regulations, the automatic safe load indicator should be of a type approved, by the Chief Inspector of Factories.

2.3 Competent Person
A person who is deemed to be competent and has such practical and theoretical knowledge and such experience of the crane and the equipment used in the lifting operation as is necessary-to- carry out the function to which the term relates in each particular context.

2.4 Driver
The person who is operating the crane for the purpose of positioning loads. Driver does not include any person who is operating a crane for erection of the crane itself. The driver must possess a valid 'transport vehicle' license under any of the following category depending upon the vehicle he drives -

- medium goods vehicle
- heavy goods vehicle

"light motor vehicle" means a transport vehicle or omnibus the gross vehicle weight of either of which or a motor car or tractor or road-roller the unladen weight of any of which, does not exceed [7500] kilograms ;

"medium goods vehicle" means any goods carriage other than a light motor vehicle or a heavy goods vehicle ;

"heavy goods vehicle" means any goods carriage the gross vehicle weight of which, or a tractor or a road-roller the unladen weight of either of which, exceeds 12,000 kilograms;

2.5 Load Radius Indicator
A device fitted on a crane that shows the radius of the hook and the corresponding safe working load.

2.6 Radius
The horizontal distance between the point at which the centre of rotation of the crane meets the ground, and the vertical centreline through the hook.

2.7 Safe Working Load
The maximum load that can be safely handled by a crane at a specified position and under specified conditions.

2.8 Service Conditions

a) In-Service - With the crane handling loads up to the safe working loads in permissible wind pressures specified in the appropriate Indian Standard.
b) Out-of-Service - With the crane either not required for use, or out of use when wind pressures exceed those permitted for in service conditions, and without load on the hook.

3. MANAGEMENT OF THE LIFIING OPERATION

3.1 Safe System of Work

- A safe system of work should be established and followed for every lifting operation. This should include the planning of the operation, the provision, selection, maintenance and examination of the correct equipment and the provision of properly trained, competent personnel with adequate supervision.
- The lifting operation should be taken to include any necessary preparation of a site and erection and dismantling of the crane or cranes. The same principles should be applied when a series of lifting operations are being carried out at one site or the crane is a permanent fixture, for example, in a factory
- Always lift loads gently and operate crane motions smoothly to avoid load swinging. (A swinging load will increase the overturning moment of the cranes.) Use steady lines where necessary and where the load presents a wind catching area. Always travel with the load near to ground level so load swinging can be controlled.

3.2 Appointed Person
The management of the organization requiring the lifting operation to be undertaken should appoint a person with appropriate training and experience who should be competent. This person should be known as the appointed person. The appointed person need not be an employee of the organisation and will not normally undertake the duties of crane driver, slinger or signaller.

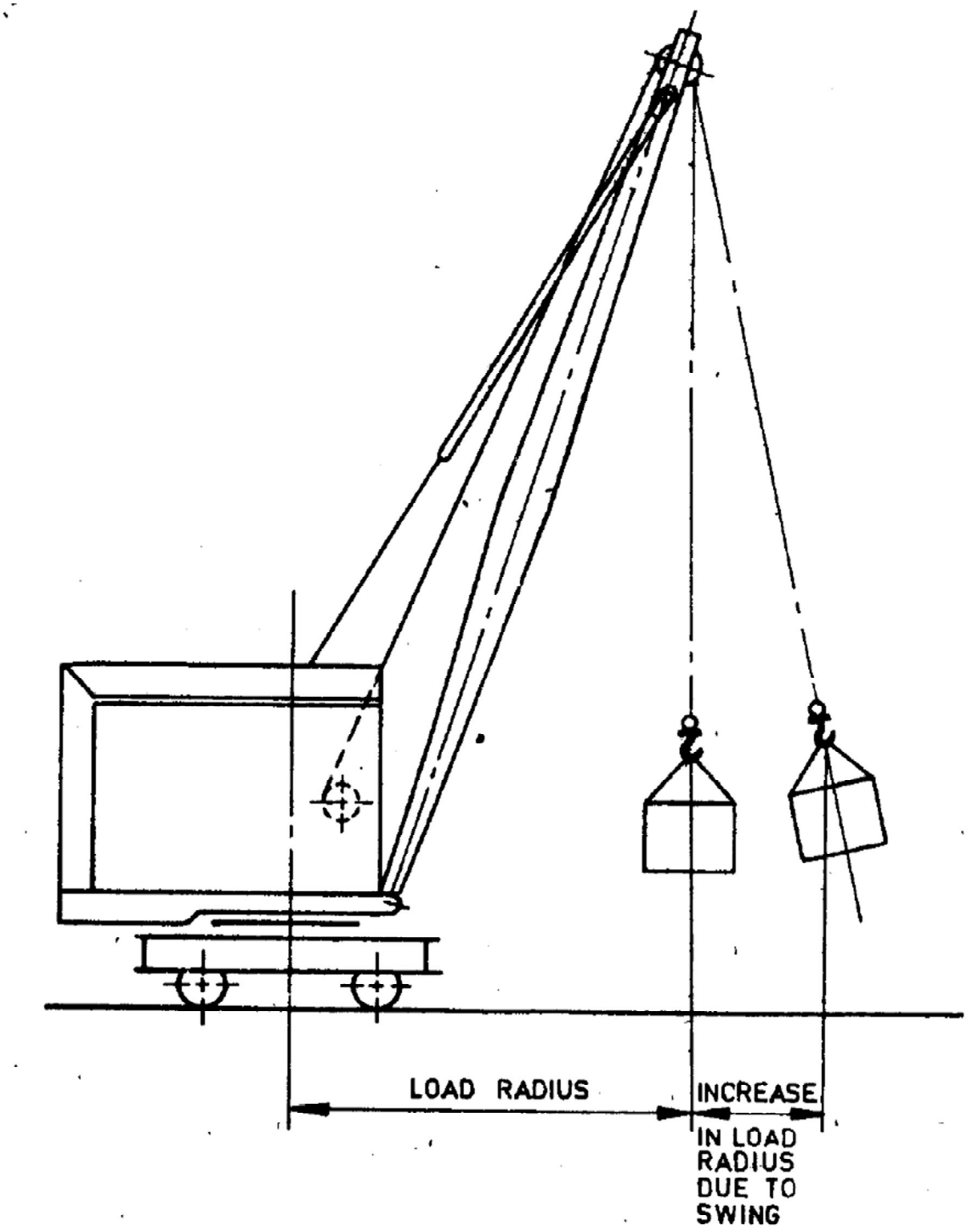


FIG. 1. EFFECT OF A SWINGING LOAD ON LOAD RADIUS

3.3 Duties of the Appointed Person

The management of the organization requiring the lifting operation to be undertaken should specify the duties of the appointed person which should include:

a) The assessment of the lifting operation to provide such planning, selection of crane(s) lifting gear and equipment, instruction and supervision as is necessary for the task to be undertaken

safely. This should include consultation with other responsible bodies, if necessary, and ensuring that where different organizations are involved they collaborate as necessary.

b) Ensuring that there is an effective procedure for reporting defects and incidents (see 10.3) and that adequate maintenance of the equipment is carried out.
c) Responsibility for the organization of the team involved in the lifting operation.
d) The nomination of persons to undertake the duties required for the operation including those listed in 4 or ensuring that this responsibility is delegated to an appropriate person or organization.
e) Responsibility for control of the lifting operation. This duty may be delegated to another person where considered appropriate by the appointed person. It is undesirable that this duty should be undertaken by the crane driver because of the need for the crane driver to be at the crane controls throughout the operation.

The appointed person should be given the necessary authority for the performance of all these duties and in particular, authority to stop the operation whenever he considers that danger is likely to arise should the operation continue.

4. PLANNING OF THE LIFTING OPERATION

4.1 General

Every lifting operation including crane erection and dismantling should be planned to ensure that it is - carried out in a safe manner. The extent of detailed planning will depend on the complexity of the overall operation but no operation should be considered so simple that the planning can be ignored. The plan should never permit exceeding the safe working load of the crane or equipment.

4.2 **Planning**

For a lifting operation where there are obstructions and hazards, or where ground conditions are suspect, or the load being handled is in any way unusual, a high degree of detailed planning, including determination of the load and its characteristics (including centre of gravity), the investigation of the ground conditions, the nature of any obstructions and hazards and the method of slinging and of controlling the movement of the load throughout the lifting operation should be carried out. An essential feature of this planning should be the production-of plans and elevations of the lifting operation at all critical phases from the initial siting of the crane to the final landing of the load. A written statement outlining the duties of, and action required from, each member of the team should be produced and all members of the team should be fully aware of the contents of this statement.

If the crane(s) called for by the planning, has to be erected before commencing work and dismantled after completion then these phases form part of the overall operation and the appointed person should ensure that all relevant factors including space, suitability of ground and access are given due consideration. In any case, safe access to the site of lifting operations is always an important consideration.

Lifting operations involving the simultaneous use of more than one crane carry a higher risk factor than those using only one crane so that additional care should be taken in their planning (see 11.4). It is also essential that the drivers, slingers and the person in charge are thoroughly briefed with particular emphasis on the effect that the operation of one crane has on the other(s). Three

dimensional scale models should be considered a useful aid to the team briefing for particularly complicated lifts.

4.3 Planning for the Permanently Installed Crane

Where a crane installed to carry out a number of operations or installed as a permanent fixture, the planning should be carried out prior to the selection and installation of the crane. Account should be taken of the continuing lifting requirements and the loads that are likely to be lifted. The operations should be reviewed periodically to check that the size and nature of the loads have not altered significantly and that the crane and equipment are still suitable for the duty
required of them.

4.4 Minimum Planning

Lifting operations whose consideration shows that there are no hidden difficulties with access, erection and dismantling, obstructions, hazards or other complications should only require minimum planning. Following the selection of a suitable crane and range of lifting gear and equipment for the loads to be lifted, such operations may be delegated to the team of slinger(s) and crane driver after they have been fully briefed on their task.

5. SELECTION OF PERSONS

5.1 General

Safe lifting depends on the selection of suitable persons who are competent to carry out the required duties. The appointed person should ensure that persons involved in the operation are efficiently oganized to ensure good, team work in the working situation and that no member of the team has his efficiency impaired because of alcohol or other drugs. All persons in the team should beware of their duties which should be as listed in 5.2.1 to 5.2.5. Responsibility should only be delegated to an extent that is appropriate, taking into account the ability, competence and authority of the person concerned.

The appointed person should choose persons who are fit and either competent or who are under appropriate training and supervision. The recommended attributes for persons involved in lifting operations are given in 6.1 to 6.5.

5.2 Duties of Persons

5.2.1 Crane Driver

The crane driver should be responsible for the correct operation of the crane in accordance with the manufacturers instruction book and the plan. In some cases, the. crane driver may be responsible for erection and dismantling of the crane. The crane driver should at any one time only respond to the signals from one slinger/signaller who should be clearly identified.

5.2.2 Slinger

The slinger is responsible for attaching and detaching the load to and from the crane hook and for the use of the correct lifting gear and equipment in accordance with planning of the operation.

The slinger is responsible for initiating and directing the safe movement of the crane [see 6.2(h)]. At any one time, dependent upon the physical position of the slinger or slingers, only one slinger should have this responsibility.

Where this slinger is not visible to the crane driver, another slinger or a signaller should be employed to relay the signals to the crane driver. Alternatively, other audio or visual methods should be used such as telephone, radio or closed-circuit television.

To cover the possibility of failure of the audio or visual method, a separate system should be available to enable movement of the crane(s) or load(s) to be safely halted. There should be no further movement of the crane(s) or load(s) until means of signalling have been restored.

If responsibility for directing the crane and load is to be transferred to another person, the slinger should retain responsibility until such time as the slinger considers it necessary to transfer the responsibility. At this time:

a) the slinger should clearly indicate to the crane driver that this responsibility is being transferred and to whom;
b) the slinger should clearly indicate to the new slinger or signaller that this transfer is taking place;
c) the driver and new slinger or signaller should clearly indicate that they accept the transfer of responsibility.

5.2.3 Signaller

The signaller should be responsible for relaying the signal from the slinger to the crane driver. The signaller may be given the responsibility for directing movement of the crane and load instead of the slinger, provided that only one person has the responsibility.

5.2.4 Crane Erector

The crane erector is responsible for the erection of the crane in accordance with the manufacturers instructions (see 9).
Where two or more crane erectors are required, one should be nominated as ‘erector-in-charge’ to control the operation.

5.2.5 Maintenance Personnel

The maintenace personnel should be responsible for maintaining **the** crane to ensure its safe and satisfactory operation. They should carry out all necessary maintenance in accordance with the safe system of work and permit to work (see 7.3 and 7.4).

6. RECOMMENDED MINIMUM ATTRIBUTES

6.1 Crane Driver

The crane driver should:

a) be competent;
b) be more than 18 years of age except when under the direct supervision of a competent person for the purpose of training;

c) be fit, particularly with regard to eyesight, hearing, reflexes, the stature to operate the crane safely, ability to judge distances, heights and clearances;

NOTE- Evidence that the driver is medically fit to drive a crane should be obtained at not more than 5 yearly intervals and should be made available to the appointed person.

d) have been adequately trained in the type of crane being driven and have sufficient knowledge of the crane and its safety devices;
e) understand fully the duties of the slinger and signaller and be familiar with the signal and any alternative methods of relaying the signals which are to be used for the operation being undertaken in order to implement safely the instruction of the slinger or signaller;
f) be familiar with the fire appliances on the crane and be trained in their use;
g) have been authorized to operate the crane. The appointed person in giving this authorization should take competence, training, recent experience and fitness into account.

NOTE- It is also recommended that a record of the drivers training and experience is maintained. Such records should be made available to the appointed person.

6.2 Slinger

The slinger should:

a) be competent;
b) be more than 18 years of age except when under the direct supervision of a competent person for the purpose of training;
c) be medically fit, with particular regard to eyesight, hearing, reflexes, agility, having the physique to handle lifting gear and equipment and be able to establish weights, balance loads and judge distances, heights and clearances;
d) have been trained in the techniques of slinging;
e) be capable of selecting lifting gear and equipment from that provided, suitable for the load to be lifted;
f) be able to understand the signal code for the crane being operated and be able to give clear and precise signals;
g) be capable of giving precise and clear verbal instructions where audio equipment (e.g.radio) is employed and be capable of operating the equipment;
h) be capable of directing the safe movement of the crane and and
i) have been nominated by the appointed person to carry out slinging duties.

6.3 Signaller

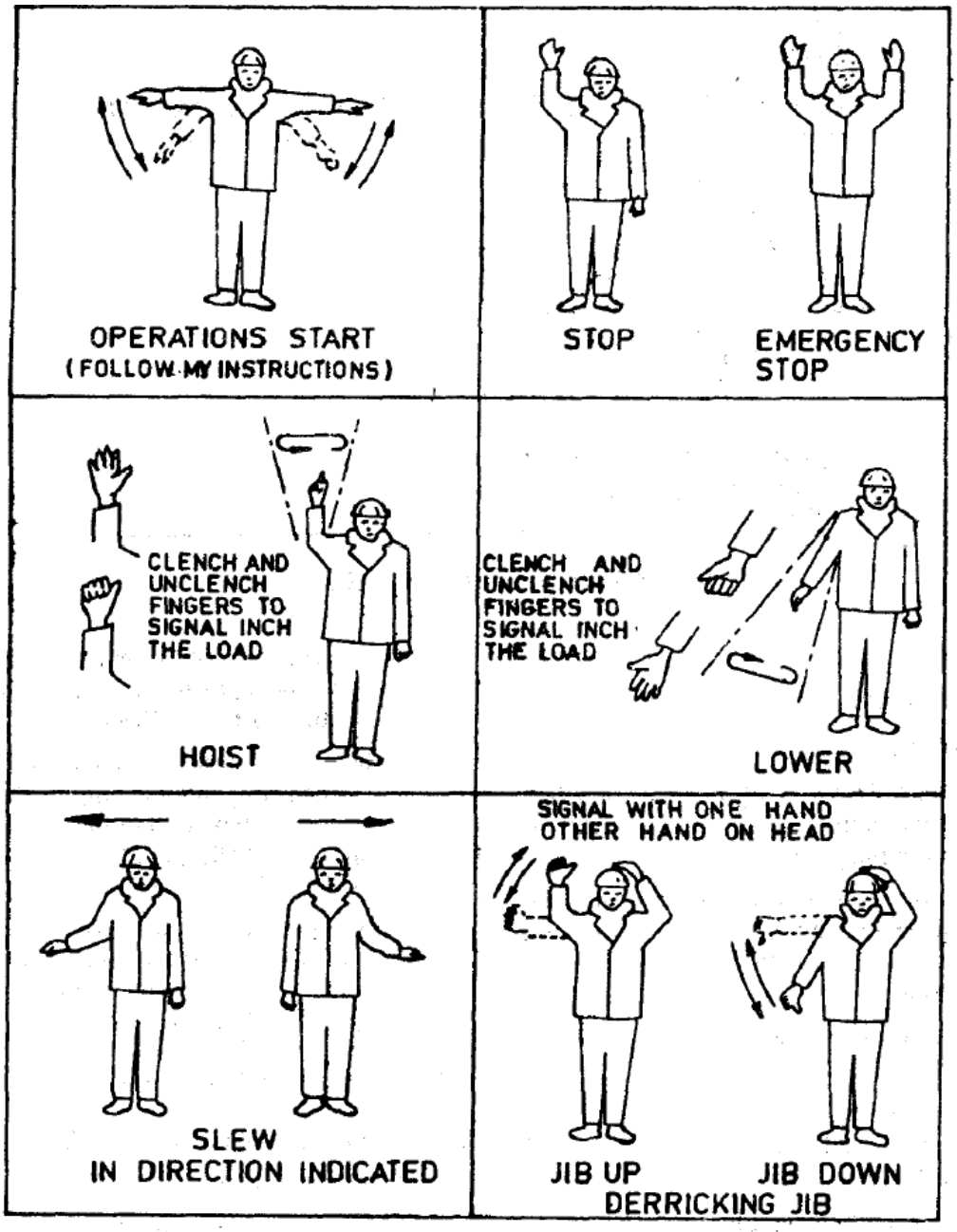
The signaller should:

a) be competent;
b) be more than 18 years of age, except when under the direct supervision of a competent person for the purpose of training;
c) be fit with particular regard to eyesight, hearing, reflexes, mobility, ability to judge distances, heights and clearances;
d) understand the signal code for the crane being operated and be able to give clear and precise signals;
e) be capable of giving precise and clear verbal instructions where audio equipment (e.g. radio) is used and be capable of operating the equipment;
f) be capable of initiating and directing the safe movement of the crane and load; and

g) have been nominated by the appointed person to carry out signalling duties; and
h) be aware of the responsibilities allocated by the appointed person to the crane driver and slinger.

NOTE: - The signaller should stand in a secure position where HE CAN SEE THE LOAD AND CAN BE SEEN CLEARLY by the driver. Facing towards the driver is possible. Each signal should be distinct and clear.

Fig. 2 Recommended Crane Signals – Contd.



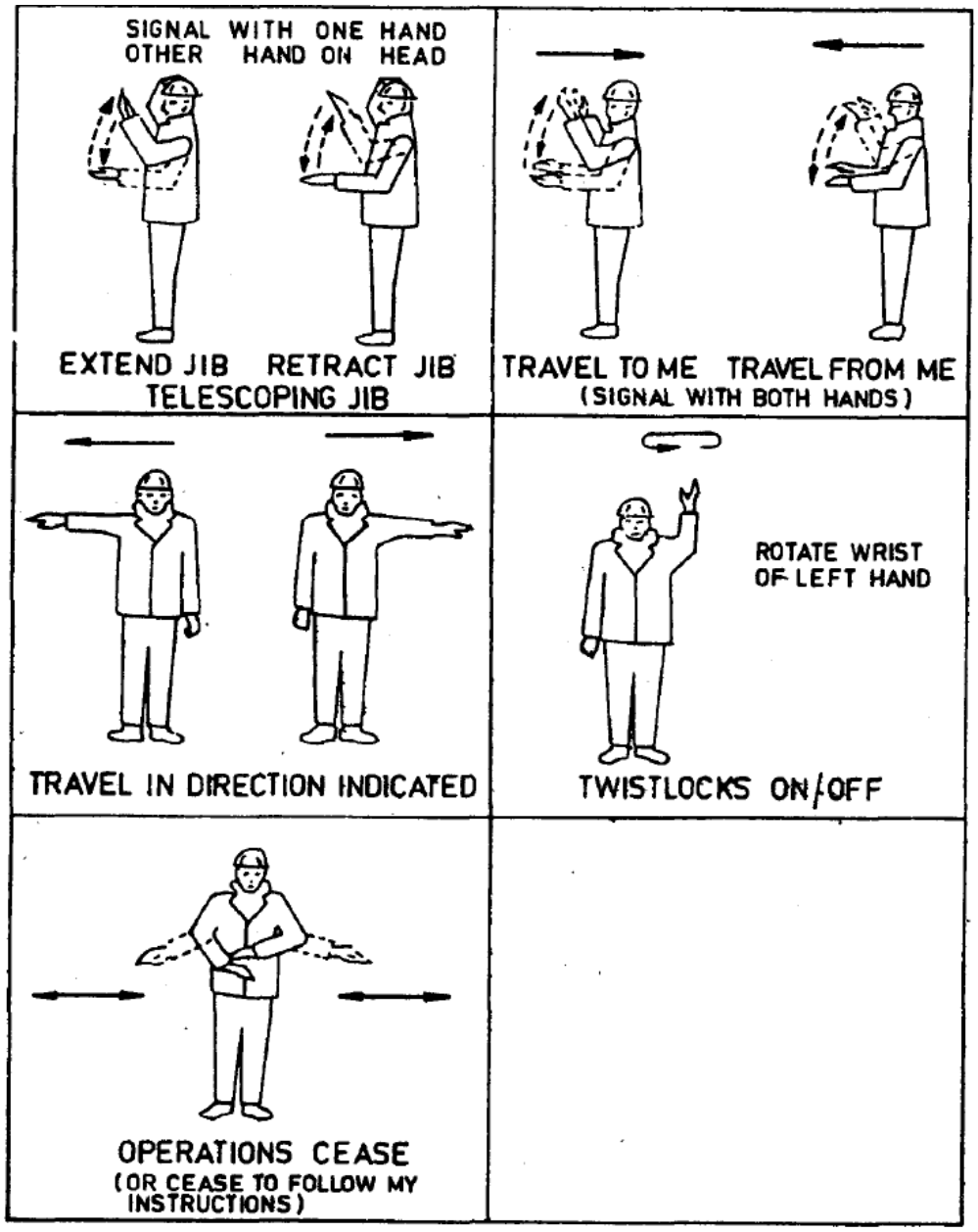


Fig. 2 Recommended Crane Signals

6.4 Crane Erector

The crane erector should:

a) be competent
b) be more than 21 years of age except when under direct supervision of a competent person for the purpose of training;
c) be fit with particular regard to eyesight, hearing, reflexes and have the stature and agility to safely handle the loads involved in crane erection;
d) be able to work confidently and safely at heights;
e) be aware of personal responsibilities under the law (civil and criminal), for personal safety and that of others;
f) be able to establish weights, balance loads and judge distances, heights and clearances;

g) have been trained in the techniques of slinging;
h) be capable of selecting lifting gear and equipment from the that provided; suitable for the load to be lifted;
i) be adequately trained in the erection, dismantling and working of the type of crane being erected, also in the safe use and setting up of any lifting appliance used in the course of these duties; and
j) be adequately trained in the setting and testing of the safety devices fitted to the crane being erected and those on any lifting appliance being used for the erection.

6.5 Maintenance Personnel

The maintenance personnel should:

a) be competent
b) have adequate knowledge of the machinery they are required to maintain
c) have access to manufacturer's relevant literature; and
d) be properly instructed and trained. Where special machinery is involved this should include attending appropriate courses given by the supplier of the equipment.

7. SAFETY

7.1 General

Both the person or organization having overall control of the site and the employers of people involved in the lifting operation have responsibility for safety. In order that this responsibility may be effectively discharged the appointed person (see 3.2) should be given the necessary authority to ensure that adequate systems to achieve safety are in operation. For safety matters relating to lifting operations this will include the use, maintenance, repair and renewal of safety equipment and the instruction and responsibilities of various personnel in relation to the equipment.

7.2 Identification of Person Directing Crane Movements

The person directing crane movements (slinger or signaller) should be easily identifiable to the crane driver by wearing high visibility clothing or by other means.

7.3 Safe System of Work

For every lifting operation and before any maintenance, repairs or adjustments or any inspections are carried out on a crane, a safe system of work should be established to ensure the safety of all personnel. The system should prevent any inadvertent restoration of the power or movement of the crane. The safe system of work should be clearly documented as reliance on verbal instructions alone is not enough to ensure safety.

7.4 Permit to Work

The system should ensure effective communication between all parties concerned. Where it is required to carry out work on a crane at its place of work, a permit to work system may be necessary to achieve a safe system of work. This requires a specially designed form or certificate to be issued only when the requirements of the safe system of work have been implemented. Upon completion of the work the person(s) who have carried out the work should sign the form or certificate to certify that all tools have been removed from the crane, that all guards have been replaced, that all safety devices are operating and that all persons working on the crane have been advised that it is no longer safe to do so.

The work, permits shall be given and received back after completion by only one authorised person. The crane shall be declared safe for operation only by that authorised person. Following the signing of the-certificate, the crane can be restored to service.

The essential details of a permit to work system are:

a) the crane is clearly identified;
b) the degree of power isolation is adequate for the work being undertaken;
c) isolation remains secure against unauthorized restoration of power whilst the permit to work is in force;
d) no work other than that for which the permit specifies should be carried out unless the permit is endorsed for the extra work and all persons involved are notified;
e) where more than one group of people work, each person shall be given the work permits for repairs crane shall be declared safe for operation only after all work permits are returned to the person authorised to issue work permits for repairs;
f) all special precautions are stated;
g) the safe working area around the crane is clearly defined;
h) the safe working load is clearly identified; and
i) that the system be monitored.

7.5 Personal Safety Equipment

The appointed person should ensure that:

a) personal safety equipment such as safety gloves, helmets, safety spectacles, safety harness, safety boots, ear defenders, etc. appropriate for the conditions of the location is available;
b) the equipment is inspected before and after use and maintained in good working order; and
c) a record of inspection and repairs is maintained.

7.6 Use of Personal Safety Equipment

Personal safety equipment appropriate to the conditions pertaining to the location of the crane should be provided to all personnel working on, or visiting the location of the crane.

All personnel working on, visiting or the vicinity of the crane, should be made aware of the requirements relating to their personal safety and to the use of personal safety equipment provided. Persons should be instructed in the correct use of the personal safety equipment provided and be required to use it.

7.7 Access and Emergency Escape

7.7.1 Safe Means of Access and Emergency Escape

Safe means of access and emergency escape should be provided and maintained in good condition:

a) for the driving position(s) of the crane;
b) for inspection, maintenance, repair, erection and dismantling of the crane; and
c) suitable rope, wherever necessary may be provided for emergency escape.

7.7.2. Boarding the Crane

No person(s) should be permitted to board' a crane without first obtaining the driver's agreement. The driver should be aware of what precautions the driver should take whilst the person(s) is/are boarding and should carry these out. Where the point of access is out of sight of the driver a system should be provided to ensure that the driver is aware of the other person's whereabouts. In the case of a crane with pendant control, a second person should be made responsible for ensuring that the pendant is not operated whilst the person(s) is on the crane.

When only one person has to board a radio controlled crane, this person should switch the radio transmitter off, remove the key from its key lock switch and retain possession of the transmitter while the person is on the crane. Where more than one person is to board a radio controlled crane, a driver should be placed in charge of the radio transmitter to ensure that the crane is only moved with the agreement of all persons on the crane. Such movements should only be permitted for maintenance and/or inspection of the crane and
persons on the crane should only give permission to the driver for movements to be made, after they have ensured that they are in a safe position.

7.7.3 Instruction of Personnel
Personnel should be instructed to use (and should use) only the proper means of access and emergency escape.

7.8 Fire Extinguishers
These shall be provided in all the cabins on crane installations. Any fire extinguishers at the location including any mounted on the crane should be scheduled for periodic inspection and renewed as necessary.

7.9 Crane Safety Equipment

7.9.1 Automatic Safe Load Indicator
An automatic safe load indicator is required on certain jib cranes to give warning of an approach to the safe working load and a further warning when an overload occurs.

7.9.2 Load Radius Indicator
A load radius indicator is required on certain jib cranes. It should be clearly visible to the driver and indicate the appropriate safe working load and radius for whatever configuration of the crane is used.

7.9.3 Motion Limit Devices
Where motion limit devices are fitted to limit hoisting, travelling, slewing, traversing, climbing or any other crane motion, they should be regularly inspected and maintained in good working order.

7.9.4 Overload Cut Out Devices
Switches, or other devices, may be fitted to cut out any selected crane motion when the crane is in an overload situation. The devices should be maintained in good working order.

7.9.5 Level Indicator
Where fitted, level indicators should be used in accordance with the instruction manual and maintained in good working order.

7.9.6 Anemometer
Anemometers, or other wind speed measuring devices, should have their indicators mounted in clear view of the crane driver or where appropriate, the person controlling the lift being undertaken. The correct operation of these devices should be regularly verified and they should be maintained in satisfactory condition.

7.9.7 Machinery Guarding
All guarding should be properly fitted whenever the crane is in use and maintained in good condition.

7.10 Documentation

7.10.1 Safe Working Load Charts
Safe working load charts applicable to the various specified operating conditions of the crane, with appropriate de-rating for special applications such as magnet or grabbing duties, should be prominently displayed to the driver. Operation of the crane outside these parameters even in an unloaded situation may give rise to danger.

7.10.2 Instruction Manuals
Instruction manuals (OEM) containing adequate information on the erection, use and dismantling of the crane should be kept regularly available at the location of the crane.

7.10.3 Test Certificate
Current test certificate of thorough examination by a competent person for cranes and lifting gear should be kept readily available.
(See Schedule – I: Register of periodic test & examination of lifting appliances and gears)

7.10.4 Records

a) Records should be maintained for each crane that are sufficient to enable the condition of the crane to & determined and its fitness for further operation to be properly assessed.
b) The records should include:
c) technical information including maintenance instructions and performance data provided by the manufacturer;
d) test certificates, records of thorough examinations and inspection including ropes and brakes (see 14.7.1) (whether statutory or not) carried out on the crane;
e) records of significant repairs and modifications to the crane including renewal of major parts; details of occurrences which are of more than short term relevance [see10.3 (c), 10.3 (d) and 10.3 (e)].

c) Except where specific forms are required by legislation, the format in which records are kept is not important. Whatever method is used should be adequate to ensure that the records allow a relevant and coherent history of the crane to be retrieved. The records should be clearly identifiable with the crane to which they refer.

8. SITING OF CRANES

8.1 General
During the planning operation the appointed person should give careful consideration to the siting of the crane. This should take account of all the factors that may effect its safe operation particularly:

i. the crane standing and support conditions;
ii. the presence of proximity and other hazards;
iii. the effect of wind during in and out of service conditions;
iv. the adequacy of access to allow the placing or erection of the crane in its working position and for dismantling and removal of the crane following completion of lifting operations.

8.2 Crane Standing or Support Conditions

The appointed person should ensure that the loads, imposed by the crane can be sustained by the ground or any means of support and that these are assessed by a competent person. The loads imposed by the crane should be obtained from the crane manufacturer or other authority on crane design and construction. The loadings shall include the combined effects of:

a) the dead weight of the crane (including any counterweight and/or ballasting);
b) the dead weight of the load(s) and any lifting attachment(s);
c) dynamic forces caused by movements of the crane; and
d) wind loadings, resulting from wind speeds up to the maximum permitted (taking into account the degree of exposure of the site).

It is likely that in-service conditions will produce the greater imposed loading but out-of-service and erection/ dismantling conditions should be taken into consideration. It should be appreciated that the vertical and horizontal forces are unlikely to be uniformly distributed and an allowance should therefore be made for these and for any other unpredictable effects.

The appointed person should ensure that the ground or any means of support is such that the crane can operate within the levels and other parameters specified by the manufacturer.

8.3 Proximity Hazards

8.3.1 General

Consideration should be given to the presence of proximity hazards such as overhead electric lines or conductors, oil/gas, 'steam, etc, pipelines nearby structures, cranes, vehicles being loaded, unloaded, stacked goods, public access areas including highways, railways, rivers, etc.

Where any part of the crane or its load cannot be kept clear of such hazards the appropriate authority should be consulted.

The danger to or from underground services, such as gas mains or electric cables, should not be overlooked. Precautions should be taken to ensure that the crane foundation is clear of any underground services or, where this is not possible, that the services are adequately protected to safeguard against damage being caused.

At any place where a crane or its load passes any obstacle, the following points should be observed:

a) Where practicable the crane path should be clearly defined by marking to ensure that it is kept free from obstruction and a clearance of not less than 900 mm should be arranged between the crane and any obstacle. Where it is not reasonably practicable to achieve this clearance, effective precautions should be taken to prevent access to any trapping hazards.
b) Where goods are regularly stacked near a crane, boundary lines for the stacking of goods should be permanently marked on the ground.

8.3.2 Overhead Electric Lines and Cables

Many fatal accidents have occurred due to some part of a crane touching, or even coming near to overhead electric lines or cables, without actually touching. The appointed person should ensure that the local offices of the Electricity Board are consulted if the crane is to be used within 15 m of overhead lines on steel towers, or 9 m of overhead lines on wood, concrete or steel poles. This includes not only

the crane but also the jib at its maximum length. All distances should be measured at ground level from a position estimated by eye to be vertically under the outermost conductor at a tower or pole position.

WARNING NOTE
'TREAT ALL OVERHEAD LINES AND OTHER ELECTRICAL APPARATUS AS LIVE UNLESS DECLARED 'DEAD' AND 'SAFE BY THE LINE OPERATOR OF THE EECIRICITY BOARD. IF IN DOUBT, SEEK ADVICE'.

When a crane must travel underneath an overhead line the crossing route should be plainly marked and 'goal posts' erected each side of the crossing approach to ensure that the jib or moving parts are lowered to a safe position (See Fig. 3).

The dimensions of the goal posts and their distance from the nearest overhead conductor should be decided in consultation with the Engineer of the Electricity Board. Large notices should be posted stating:

'DANGER, OVERHEAD ELECTRIC LINES'

When working parallel to overhead lines, a string of warning markers should be erected at least 6 m measured horizontally along the ground from the outermost conductor at a tower or pole position - where the minimum distance could be encroached by the jib or the crane it should be extended. The actual distance should be agreed upon with the Electricity Board.

Table: For safety clearance for overhead lines

Highest System Voltage (kV)	Safe working clearance (Metres)
12	2.6
36	2.8
72.5	3.1
145	3.7
245	4.3
420	6.4
800	10.3

In addition, a notice should be placed in the cab of all cranes likely to work in the vicinity of overhead electric lines giving the following information:

If machine makes contact with live electric cable, observe following precautions.

a) Remain inside cab.
b) Warn all other personnel to keep away from crane and not to touch any part of the crane, rope or load.
c) Try, unaided, and without anyone approaching the machine, to move the crane until it is clear of power line.
d) If the machine cannot be moved away, remain inside the cab. If possible, get someone to inform the electricity supply authority at once. Take no action until it has been confirmed that conditions are safe.
e) If it is essential to leave the cab because of fire or some other reason, jump clear as far away from the crane as possible. Do not touch the crane and the ground at the same time.
f) Inform the responsible engineer of the works or authority concerned of situation immediately and until assistance is received, someone should remain near the crane to warn of the danger.

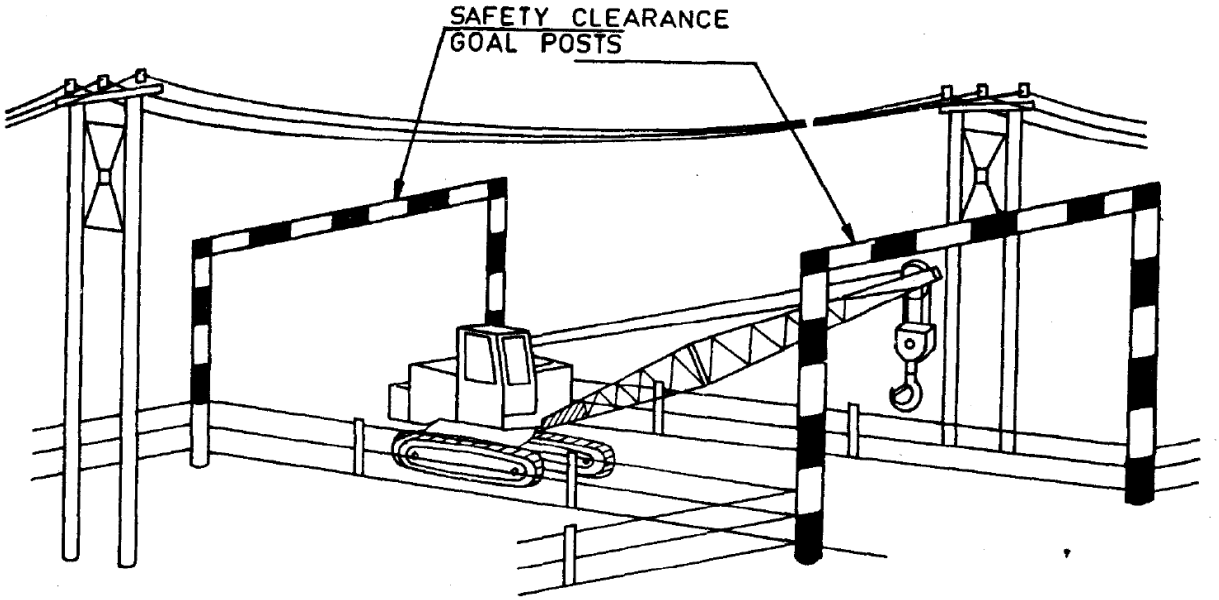


Fig. 3 Travelling Under Overhead Electric Lines and Cables

Devices are available which are designed to be fitted on cranes to give warning when the crane comes within a predetermined distance of the overhead electric line. Such devices have limitations and should not be considered as a substitute for a safe system of work.

9. ERECTION AND DISMANTLING

9.1 Planning

Erection and dismantling of the crane should be thoroughly planned and properly supervised in the same way as the lifting operation (see 4).

A correctly planned erection and dismantling procedure should ensure that:

a) erection of the crane does not commence until an instruction manual clearly understood by erection staff, is available for their use;
b) the erection/dismantling manual is appropriate to the particular crane and bears the crane manufacturer's serial and type number and the owner's identification;
c) the entire erection and dismantling operation is controlled by the erector in charge (see 5.2.4);
d) all personnel involved have a sound knowledge of their part in the operation;
e) any departure from prescribed procedure is approved by the designer or another
f) competent engineer
g) only correct replacement parts and components are used.

9.2 Manufacturer's Erection and Dismantling Instructions

The crane manufacturer's instructions should be closely followed. Any departure from the specified sequential procedure should be verified by the designer or another competent engineer, to ensure stability of the crane and that structural and mechanical parts are not subjected to excessive loading.

9.3 Identification of Components and Materials

9.3.1 Components

All major components that form part of a crane and are dismantled for transportation, particularly those which are load bearing or ensure the stability of the assembled crane, should carry a clear identification mark. Diagrams and drawings in the crane instruction manual, covering erection and dismantling in the crane that show the correct location and orientation of components, should use the same system of marking.

Care should be taken to avoid a mismatch of thread forms of fasteners (nuts and bolts) for example imperil or metric.

9.3.2 Materials

Where components (for example Jib sections) have been manufactured from special materials they should be so marked. This is to enable the correct repair procedures to be used, particularly where control of temperature during the repair is necessary.

Nuts and bolts manufactured from high tensile steel or other special steels should be clearly marked so that they can be distinguished from other nuts and bolts.

9.4 Electrical Supply

The following points should be noted where the crane **is** electrically operated from a source external to the crane.

a) Electrically operated cranes should have an effective earth connection. In the case of cranes mounted on rails, at least one rail track should be electrically bonded at each rail joint and the track should be effectively earthed. Crane wheels should not be used for earthing the crane.
b) The crane structure, motor frames and conducting cases of all electrical equipment, including metal conduit and cable guards, should be effectively and directly connected to earth.
c) The characteristics of the power supply and of the crane equipment should be checked for compatibility before connection.
d) Cables providing power to the crane should be enclosed, positioned or constructed to protect them from mechanical damage:
    a. by running in conduit, or on trays; or
    b. by being clipped to a structure in a position. where they are protected from mechanical damage; or

c. by being of armoured construction.

Where the method of protection is of conducting material, it should be bonded to earth at each end. In no case should the protection be used as an earth conductor.

e) Where practicable, the power supply to a travelling crane should be through a cable winding drum or a properly installed, insulated and protected collector system.

f) Care should be taken to ensure that any trailing cable is not damaged during operational movement or when the crane is travelling. The travel distance should be well within the length of the trailing cable.

g) In addition to any isolator within the crane capable of cutting off the electrical supply to the crane motions, there should be an identified isolation remote from the crane which can be used to cut off the electrical supply to the crane itself.

All isolators should be capable of being locked in the 'off' position and should be identifiable with the crane power supplies they control.

10. PROCEDURES AND PRECAUTIONS

10.1 **Crane Operation**

Whenever a crane is moved anti whether it is lifting a load or not it should only be driven by a competent driver (see 6.1) nominated by the appointed person.

This should not inhibit the appointed person from nominating a trainee driver provided that such a driver is under the direct supervision of a competent driver who has also been nominated for that purpose by the appointed person.

10.2 Periodic Checks

10.2.1 General

The appointed person should ensure that the routine checks given in 10.2.2 and 10.2.3 are carried out.

NOTE - The crane driver may be authorized to carry out periodic checks to the extent that he is considered to be competent.

10.2.2 Daily

At the beginning of each shift or working day, the following routine checks, as appropriate for the type of crane concerned should be carried out:

a) Checks as required by the manufacturers handbook.

b) Checks that all ropes are correctly positioned on their sheaves and have not been displaced.

c) Ensure, by visual inspection, that.no electrical equipment is exposed to contamination by oil, grease, water or dirt.

d) Confirm the operation of all limit switches or cut outs and the dead man's handle **or** lever, using caution in making checks in case of mal-operation.

e) Check proper functioning of all brakes.

f) Check that the automatic safe load indicator is correctly set for the condition of the crane.

g) Check that the load-radius scale is appropriate to the jib combination fitted if this equipment is separate from item (e).

h) By varying the hook radius without load, check the correct movement of 10.2.2 (f) and 10.2.2 (g).

i) Check lubricating oil level(s), hydraulic oil level(s) and engine coolant level(s).

j) Check that there has been no excessive loss of air pressure since the machine was last used.

k) Check build-up time of air pressure for efficiency of system (s).

l) Check that lights, windscreen wiper(s) and washers conform with the requirements of the Road Traffic Act.
m) Check visually the condition of tyres on wheel mounted cranes.
n) Check correct function of all crane controls without load.
o) Check satisfactory operation of audible warning device.
p) Check satisfactory operation of back horn.
q) In the interests of safety and fire prevention, ensure that the crane is in a tidy condition and free from tins of oil, rags, tools, or materials other than those for which storage provision is made.

10.2.3 Weekly

Once a week, in addition to the checks in 10.2.3 the following additional checks as appropriate for the type of crane concerned should be carried out:

a) Check the automatic safe load indicator in, accordance with the operating instructions.
b) Visually inspect the hoist rope(s), trolley travel rope (tower cranes), derricking rope(s) and static suspension ropes for broken wires, flattening, bird caging or other signs of damage, excessive wear and surface corrosion (see 14).
c) Check all rope terminations, swivels, pins and retaining devices. Also check all &eaves for damage, worn bushes or seizure (see 14).
d) Inspect the structure for damage, for example missing and bent bracings on bridges and strut jibs, bulges, indentations and unusual rubbing marks on telescopic jibs, cracked welds, etc.
e) Check hook(s), safety latch(es) and swivel(s) for damage, free movement OK wear. Check the hook shank thread and securing nut for wear or corrosion.
f) Check operation and adjustment of controllers.
g) Check brake and clutch friction linings and drum paths for visible wear and reset, if necessary.
h) Check for creep of hydraulic rams in case of hydraulic machines.
i) On wheel mounted mobile cranes, check tyres for pressure as well as damage and wear on walls and tread. Also check wheel nuts for tightness.
j) On rail mounted cranes, check rails, end stops and also ties where these are fitted. Check existence and condition of guards to remove
k) foreign material from rails.
l) Check slew lock, if fitted.
m) On rubber tyred cranes check, steering, brakes troth foot and parking, lights, indicators, born, windscreen wipers and washers.
n) Generally, inspect the crane to ensure that it is safe for use.
o) Enter results of checks in the records of inspections.

10.2.4 Crane Out of Use for a Considerable Period

If a crane is not to be used for a period exceeding three or four weeks, precautions may have to be taken to prevent deterioration or damage. In cases where a crane has been out of use for more than three or four weeks, it may he necessary to carry out a programme of checks in addition to those specified in 10.2.2 and 10.2.3.

The extent and thoroughness of this programme will depend not only on the length of the period of out-of-use, but also on the location of the crane during this period. A crane standing under cover, or inside a workshop, may require very little in addition to the checks detailed in 10.2.2 and 10.2.3, but a crane which has been out-of-use in the open, exposed to the action of weather and atmospheric pollution, etc, will require an extensive appraisal to ensure its fitness for work.

In general terms the following points should be covered as a minimum:

a) All crane ropes should be examined for signs of corrosion and damage and thoroughly lubricated.
b) All control linkages should be examined for evidence of seizure or partial seizure and correct lubrication undertaken.
c) Every crane motion should be tested for several minutes without load, each motion individually at first then by combination of two or more motions simultaneously as appropriate.
d) The test of all crane motions should he repeated under load.
e) The correct functioning of all the crane safety limits should he checked, in particular the automatic safe load indicator should be tested
f) by lifting a known weight.

The result of all the tests in the programme should he documented in the crane records (see 7.10.4) along with details of any corrective action taken to overcome any defects prior to the crane being returned to service.

10.3 Reporting of Defects and Incidents

The appointed person should ensure that there is an effective procedure for reporting defects and incidents. This procedure should include notification to the appointed person, the recording of action taken to rectify any defects and clearance of the crane for further service.

This procedure shall include the immediate notification of:

a) any defects found during daily or weekly periodic checks;
b) defects found at any other time;
c) incidents or accidents however slight;
d) shock loads in whatever manner they occur; and
e) dangerous occurrences or accidents (see 13).

The procedure should include provision for an examination by a competent person after any incident, whether a repair is necessary or not, to ensure that the crane is fit for further service.

10.4 Leaving the Crane Unattended

In no case should a crane be left unattended even for short periods, unless all loads have been removed from the hook which should be left in a safe position, the power supplies to all motions switched off or the engine stopped, and appropriate motion brakes and locks applied to put the machine in a safe condition. The ignition key and any other keys should be removed from the crane whenever the driver is absent from the machine.

For longer periods and for out-of-service conditions, isolation should be more permanent, that is, switches locked of, fuel supplies cut off and any doors giving access to machinery or control cabs locked to prevent unauthorized access. machinery should be left in the out-of-service condition as described in the operating instructions.

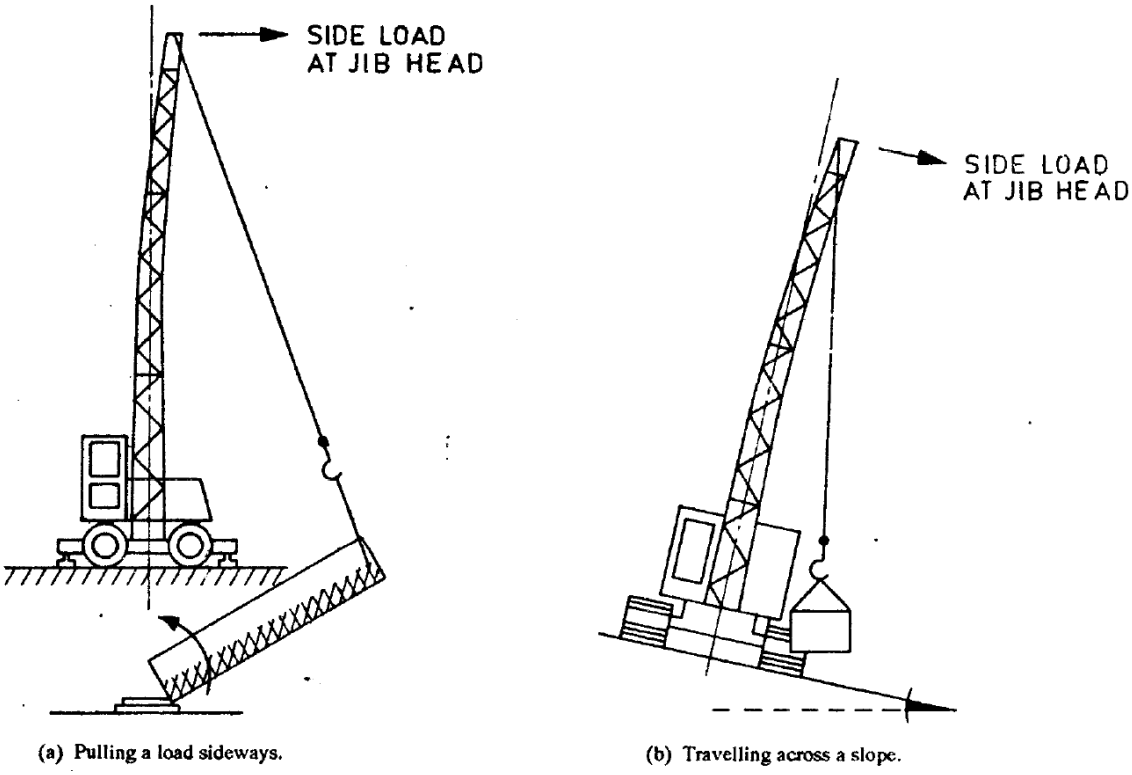
For details of methods to safeguard particular types of cranes, reference should be made to the appropriate section of this Code.

11. OPERATING CONDITIONS

11.1 Safe Working Load

The safe working load of the crane should not be exceeded other than for the express purpose of a test of the crane under the supervision of a competent person. The safe working load of any item used to attach the load to the crane should not be exceeded other than for the express purpose of a test of the item under the supervision of a competent person. Care should be taken to prevent pendulum swinging of the load, by careful control of the operating motions to match the swing of the load and to keep it under control at all times.

Safe working loads apply only to freely suspended loads. The crane hoisting, slewing, traversing, luffing or travelling motions of a crane should not be used to drag any load along the ground with the hoist rope out of the vertical position. Before lifting a load, the hoist line should be plumb (See Fig. 4). Failure to observe these points may hazard the stability of the crane or introduce loadings (stresses) into the crane for which it has not been designed, and, even with an automatic safe load indicator fitted, a structural failure may result without any warning being given.



(a) Pulling a load sideways.

(b) Travelling across a slope.

AVOID SIDE LOADING THE JIB

Fig. 4 Side Loading on Jib

Figures show typical operational conditions imposing a side loading on the jib of a crane. Jibs are not designed for high side loads in crane service. Do not pull or drag loads sideways using &her the &wing motion or hoist line. The hoist line should always be in the plane of the jib and hanging plumb.

11.2 Mode of Operation and Control

11.2.1 Identification of Controls and, Direction of Movement

To ensure safe use of the crane, each control should be marked to identify the motion controlled and the direction of movement.

On no account should the driver tamper with any controls, mechanisms or equipment either to enable the crane to function outside the operational range or loads specified by the crane manufacturer or other competent person, or to attempt to correct any suspected defect.

Before starting any lifting operation with a crane, the following should be observed:

a) The driver should be familiar with the controls and their layout.
b) The driver should have a clear and unrestricted view of the load and operational area. If not, the driver should act under the directions of the slinger or an authorized signaller who is positioned to have a clear and uninterrupted view; in some circumstances this may be a legal requirement. It is particularly important that the driver should ensure that lifts can be carried out without causing damage. The driver should therefore ensure that loads and crane hoist-ropes are well clear of obstructions.
c) Where telephone, radio or closed-circuit television communications are being used, the driver should ensure that the calling signal is functioning satisfactorily and that verbal messages can be clearly heard.
d) Where air or hydraulic systems are used the driver should ensure that the gauges are functioning.
e) Where air or hydraulic systems are used the driver should ensure that the system(s) is/are at the correct operating pressure(s).

The hoist rope, or if applicable, the hoist chain should be vertical at the commencement of, and throughout, the hoisting operation. The load should initially be lifted just clear of the supporting surface and be brought to rest while the slings, balance of the load etc, are checked, before proceeding. Proper care should be exercised by the driver at all times to avoid shock or side loading on the jib or structure. Care should also be taken to avoid the hook coming into contact with the structure.

If it is necessary during normal operations to hold a load suspended for any period of time, the driver should remain at the controls so that the crane is fully operational to meet any emergency.

It is undesirable, where motion motors are to be reversed, to put the controller over the reverse position before the motor has come to rest unless the control gear is specifically designed to allow this to be done. It is undesirable, for safety reasons, to subject the crane motion safety devices to continual operation. Care should therefore be taken when approaching the motion limits to avoid their frequent operation.

In areas which are not adequately illuminated, all travelling cranes which move close to where personnel have to pass or work should be distinguished at the leading end of the crave by a suitable warning lamp.

Before any crane is moved along its track, a warning should be given by the person in charge of the lifting operation to all personnel whose safety is likely to be endangered. A warning bell on may be fitted for this purpose.

11.2.2 Radio-Controlled Cranes

To prevent unauthorized use, the driver of a radio-controlled crane should:

a) retain the transmitter in his physical possession;
b) remove the key from its keylock switch and, for short periods, retain the key in his possession; and for longer periods, or when the crane ne is not in use, deposit the transmitter in safe storage.

NOTE - Provision should be made for the security of the transmitter when the crane is out in use.

When the radio transmitter is fitted with a belt or harness, the driver should be wearing the harness before switching on the transmitter so that accidental operation of the crane is prevented.

The transmitter should only be switched on when operating the crane and should be switched off before removing the harness.
The controlled range feature, where provided on a radio controlled crane, should be tested at suitable intervals and it is necessary that at the beginning of each shift, or where there is a change in driver, the controlled range should be checked to ensure that it is in accordance with the limits specified for its operation.

11.3 Handling of Loads nNear Persons

When loads have to be handled in the vicinity of persons, extreme care should be exercised and adequate clearances allowed. Drivers and signallers should pay particular attention to possible dangers of persons working out of sight.
All persons should stand clear of the load being lifted. When lifting from a heap, all persons should stand away from the heap in case other adjacent material or objects are displaced.
Lifting of loads over highways, railways, rivers or other places to which the public have access should be avoided. If this is not possible, permission should be obtained from the appropriate authority and the area kept clear of traffic and persons.

11.4 Multiple Lifting

11.4.1 General

Lifting a load with two or more cranes requires greater attention to planning and supervision because the effects of the relative motion between the cranes may induce additional loadings on the cranes, the load and the lifting gear in use.
Because of this and the difficulty in monitoring these additional loads, multiple lifting should only be used when the physical dimensions, characteristics, weight or required movement of the load prevent the operation being carried out by a single crane.
Multiple lifting should be planned with extreme care (see 4) and should include an accurate assessment of the portion of the load to be carried by each crane. It is essential that the reason for and the extent to which the hoist rope(s) may come out of plumb should be evaluated. Additional forces may overload the cranes causing thein to overturn or fail either immediately or in the longer term. The cranes should not be subjected to forces in excess of those which would
occur were they handling their safe working loads as single lifts.

11.4.2 Factors to be Considered in Planning the Multiple Lifting Operation

If all the factors governing the distribution of the load between the cranes can be accurately determined it should be possible to use each crane up to its safe working load. In practice it may be difficult to evaluate all the factors accurately and their effect on the distribution of load between the cranes so it may be necessary to make a reduction in the load that each crane is permitted to take.
The principle factors to be considered are as follows:

a) **Weight of the load -** The total weight and its distribution should be either known or calculated. Where the information is taken from a drawing, due allowances should be made for casting and rolling margins and manufacturing tolerances.
b) **Position of the centre of gravity -** Owing to the variable effect of manufacturing tolerances and rolling margins, quantity of weld metal, etc, the position of the centre of gravity may not be known accurately and the proportion of the load being carried by each crane may therefore be uncertain.
c) **Weight of the lifting gear - The** weight of the lifting gear should be part of the calculated load on the cranes. When handling heavy or awkwardly shaped loads, the deduction from the safe

working load(s) of the cranes to allow for the weight of the lifting gear may well be significant. The weight of the lifting gear and its distribution should therefore be accurately known.

d) In cases where the crane ropes are reeved round pulleys that are part of a specially designed piece of lifting gear, for example a lifting beam, it is acceptable to take the weight of the removed hook block and hook into consideration when determining the net weight of the lifting gear.

e) **Capacity of the lifting gear -The** distribution within the lifting gear of the forces which will arise during the lifting operation should be established. The lifting gear used should, unless specially designed for the particular lifting operation, have a capacity margin in excess of that needed for its proportioned load. Special lifting gear may be necessary to suit the maximum variation in distribution and direction of application of loads or forces which can occur during multiple lifting.

f) **Synchronization of crane motions -** If the variation in the direction and magnitude of the forces acting on the crane during the multiple lift are to be kept to a minimum, it is essential that the crane motions are synchronous in their effect. Thus, whenever possible, cranes of equal capacity and similar characteristics should be used. In practice there will always be some variation due to differences in response to the activation of the motion controller and the setting and efficiency of the braking system.

The safe working load of a crane is based on the premise that the load will be raised and lowered in a vertical plane. The crane structure will have been designed to withstand any lateral loads imposed by accelerations in the various crane motions, but it is unsafe to rely on this lateral strength to withstand horizontal components of out-of-plumb lifts. Since it is unlikely, particularly if the cranes have dissimilar characteristics, that the motions of the two cranes will be accurately synchronized, an assessment should be made of the effect of variation in plumb of the hoist ropes, which may arise from inequalities of speed, together with a determination of the means for keeping such inequalities to a minimum.

Instruments are available to monitor the angle of inclination and load in each hoist rope constantly throughout the lifting operation. The use of such instruments and the restriction of the motion speeds together with the strict use of one motion at any one time can assist in the control of the loads on the cranes within the planned values.

11.4.3 Recommended Safe Working Load During Multiple Lifting

If the person planning the multiple lift is satisfied that all the factors identified in 11.4.2 (a) to 11.4.2 (e) have been accurately identified or are being monitored, the cranes may be used up to their safe working loads.

If the person planning the lift cannot accurately evaluate all the factors, then an appropriate down rating should be applied to all the cranes involved. The down rating may be 10 percent of the crane's safe working load but where stability of the crane(s) is likely to be affected the down rating may have to be 25 percent or more.

11.5 Weather Conditions

11.5.1 General

For cranes operating in situations where they are likely to be affected by the weather careful attention should be given to this aspect. Certain weather conditions such as strong wind, heavy rain, ice or snow can impose loads on a crane and adversely affect the safety or crane operations.

11.5.2 The crane should not be operated in wind speeds that are in excess of those specified in the operating instructions for the crane. Gusting wind conditions may have an additional adverse effect

on the safe handling **of** the lead and the safety of a crane. Even in relatively light wind conditions, extra care should be taken when handling loads presenting
large wind catching areas.
The limitations on wind speed for erection, testing and dismantling the crane may be lower than the limitation for normal operation and in cases of doubt the designers' or another competent engineer's advice should be obtained. The testing of a crane should not be carried out in an area which is known to be subject to freak weather conditions.
Instructions issued by the crane manufacturer advising of the conditions under which a crane should be taken out of service and recommending the conditions in which it should be secured, should be strictly followed.

11.5.3 Wind Speed Indication
In the case of high cranes, an anemometer should be mounted at a suitable high point of the crane structure or at a similar height and exposed position on the site.

11.5.4 Visibility
In poor visibility, suitable means of communication should be provided to ensure the safe operation of the crane. In extreme conditions crane operations should be stopped until there is sufficient improvement in visibility to enable operations to be safely resumed.

11.5.5 Rain, Snow or Ice
During adverse weather conditions, the appointed person should ensure that adequate precautions are taken to avoid danger when the crane or the load are affected by rain, snow or ice.

12. TESTING AND EXAMINATION

12.1 General

12.1.1 Testing and Examination
Various tests and a thorough examination by a competent person are required to ensure that a crane is safe for use. Item 13 gives the legal requirements for the testing and thorough examination of cranes. Additional tests and thorough examinations are usually necessary following any substantial alteration or repair to the crane. Any lifting gear to be used
with-the crane in normal duties or for the purpose of testing the crane, should already have been tested separately from the crane.

12.1.2 Test Certificates and Documentation
Cranes are used under a wide variety of conditions but the following minimum requirements generally apply:

a) A crane should not be used unless it has the appropriate current test certificates. Tests will be required following substantial repairs or alteration, and/or periodically as prescribed by legislation.
b) Periodic examination and inspections, systematic maintenance, repairs, renewals and any necessary heat treatment (as applicable) should be carried out and recorded.
c) The safe working load should be clearly marked on the crane or the charts affixed to it.
d) Any lifting attachments should be clearly marked with their safe working loads.
e) A copy of the operating instructions should be with the crane.
f) All test certificates and records related to the above should be available for inspection. (see 7.10.4)

12.1.3 Thorough Examination

A thorough examination should be understood to mean the following:

a) A detailed examination sufficient to ensure that the crane is safe for use.
b) Whenever considered necessary by the competent person, visual examination can be supplemented by methods of non-destructive testing that determine the condition of any part of the crane without causing any detrimental change to the material;
c) Where considered necessary, parts of the crane should be dismantled by a skilled person to the extent -required by the competent person.
d) The examination should be carried out with the crane in operation and at rest.

12.1.4 Test Site

Careful consideration should be given to the conditions of the site where the tests are to be conducted. It should be remembered that the recommendations provided in the operating instructions for the crane relate to operations within the safe working load and that more stringent requirements apply when loads are being applied for the purpose of testing.

The following general requirements apply to all types of cranes. Further guidance is given in other parts of this standard covering specific crane types:

a) The ground should be well consolidated and capable of withstanding the loads that will be applied to it. Care should be taken to ensure that there are no hidden dangers such as cable ducts, drains, pipes, back-filled areas, cellars or other subterranean weaknesses.
b) The ground should be level to within the limits appropriate for testing the particular crane.
c) The site should be of sufficient area and have unrestricted overhead clearance to allow the unobstructed movement of the crane and load throughout all its appropriate test movements, for example, slewing, derricking travelling etc.
d) A test is designed to prove a crane and it must be borne in mind that the crane might for some hidden reason not withstand the loading. It is therefore necessary to ensure that all personnel not essential to the test are kept away from the area. Test personnel should be so positioned that they are unlikely to be injured should there be any mishap. It is recommended that the test area be roped off and notices posted prohibiting unauthorized entry. The test site should be well clear of places where the public has access such as roads, railways etc. For similar reasons the site should be clear of plant and property which, as well as inhibiting the test, could also be damaged.

12.1.5 Weather Conditions

Apart from the obvious danger to personnel it should be recognized that weather conditions such as wind, ice and snow can impose loads on the crane. For this reason test sites should preferably not be in areas which are known to be subject to freak weather conditions. The limitations on wind speed for testing of the crane may be lower **than** the limitation for
normal operation and in cases of doubt, the designer's or another competent engineer's advice should be sought.

The competent person in charge of the test should ensure that adequate precautions are taken when the wind speed exceeds the limit or the crane or load are heavily coated with ice or snow.

Tests should never be undertaken when the crane or load cannot be clearly seen because of a limitation on visibility caused by rain, snow, mist or fog, etc.

12.2 Test Requirements for the Crane

12.2.1. Conduct of the Test

The tests should be carried out under the control of the competent person appointed for this purpose who should clearly indicate when the tests start and when they have been completed. The driver, signaller and/or slinger should for the duration of the tests accept instructions only from the competent person.
Immediately prior to the tests, the competent person should ensure, by thorough examination (see 12.2.2) that the condition of the crane is satisfactory for the tests and that the site and weather conditions are suitable (see 12.1.4 and 12.1.5).
During the tests the load should be kept close to the ground. Shock loading which may be caused by rapid acceleration of crane motions, sudden braking, erratic or sudden steering movements or movement of the crane controls should be avoided. At all times care should be exercised to avoid danger to personnel and damage to plant and surrounding property.
Precaution - Where safety devices have been over-ridden or disconnected their correct functioning should be restored and checked.

12.2.2 Overload Testing
The testing of the crane requires the application of loads in excess of the safe working load. Prior to the application of overloads, it should be established by reference to an authority on the design and construction of the crane, for example the manufacturer, that the design of the crane will permit the imposition of the overloads at the appropriate positions at which they will be applied. This is necessary because the overloads may be limited by the structural strength and not the stability of the crane. Under such circumstances, the structure might buckle or collapse without warning before the crane gives any sign of tipping.
Before commencing the overload test, the crane should be thoroughly examined by a competent person for any significant defects or limiting condition of the crane, for example, insufficient falls of rope for the load under consideration, which require to be rectified before application of the overload.
The crane should be operated through the motions for which it is designed to carry load. These motions will include:

a. hoisting and lowering;
b. derricking in and derricking out;
c. slewing in both directions through the maximum angle for which load carrying is permitted;
d. telescoping through the permitted range of movement; and
e. travelling and traversing in both directions.

NOTE - Precautions should be taken to limit swinging of the load. The crane should show itself capable of sustaining full control of the load throughout these tests. There should be an adequate supply of known weights with means of handling them.

12.2.3 Testing of Automatic Safe Load Indicator
Automatic safe load indicators should be tested at the time of testing the crane and in some circumstances it should be noted that this is a statutory requirement.
The Construction (Lifting Operations) Regulations 1961 require automatic safe load indicators to be of a type approved by the Health and Safety Executive and for them to be inspected once a week.

NOTE - It should be noted that the test button provided on certain indicators only confirms that the electrical circuit and power supply are satisfactory. Such test buttons cannot confirm the correct functioning of the indicator mechanism which can only be effectively checked by lifting a known load at the appropriate radius.

12.3 Thorough Examination After Test

A thorough examination (see 12.1.3) should be carried out by a competent person to ensure that the crane has satisfactorily withstood the test loadings without signs of structural damage that will effect the safety of the crane, such as:

a) cracking;
b) permanent deformation,
c) paint flaking, and
d) loosening of or damage to structural connections.

The examination should confirm that all mechanisms function correctly and are free from defect.

12.4 Certification

After any test or examination, the results should, be recorded. Where a machine is used temporarily under a different set of regulations then the certificates issued for the prime use of the machine should be considered as acceptable.

Where, for any reason, the competent person considers it necessary to restrict the use of a machine (for example site limitations prevent the testing of the full range of duties of the machine) then the restrictions should be noted on the certificate and the use of the
crane should be subject to these restrictions. The markings/tables of safe working loads on the machine should be amended to reflect these restrictions.

13. LEGAL REQUIREMENTS

13.1 General

Employers and the self-employed shall ensure, so far as is reasonably practicable, the health and safety at work of all their employees and that undertaking are conducted in such a way as to ensure, so far as is reasonably practicable, that persons not in their employment who may be affected are not thereby exposed to risks to their health and safety.

This duty not only includes the provision and maintenance of plant which is, so far as is reasonably practicable, safe and without risks to health but also the provision and maintenance of systems of work, information, instruction, training and supervision as are necessary to ensure, so far as is reasonably practicable, the health and safety at work of employees.

Employees have a duty to take reasonable care for the health and safety of themselves and of other persons who may be affected by their acts or omissions at work. They also have the duty to co-operate with their employers so far as is necessary, to enable the employers to comply with their legal duties.

Note: Section 29 of The Factories Act, 1948:

[**Lifting machines, chains, ropes and lifting tackles:**

(1) In any factory the following provisions shall be complied with in respect of every lifting machine (other than a hoist and lift) and every chain, rope and lifting tackle for the purpose of raising or lowering persons, goods or materials:—

(a) all parts, including the working gear, whether fixed or movable, of every lifting machine and every chain, rope or lifting tackle shall be—

(i) of good construction, sound material and adequate strength and free from defects;

(ii) properly maintained; and

(iii) thoroughly examined by a competent person at least once in every period of twelve months, or at such intervals as the Chief Inspector may specify in writing; and a register shall be kept containing the prescribed particulars of every such examination;

(b) no lifting machine and no chain, rope or lifting tackle shall, except for the purpose of test be loaded beyond the safe working load which shall be plainly marked thereon together with an identification mark and duly entered in the prescribed register; and where this is not practicable, a table showing the safe working loads of every kind and size of lifting machine or chain, rope or lifting tackle in use shall be displayed in prominent positions on the premises;

(c) while any person is employed or working on or near the wheel track of a travelling crane in any place where he would be liable to be struck by the crane, effective measures shall be taken to ensure that the crane does not approach within six metres of that place.

(2) The State Government may make rules in respect of any lifting machine or any chain, rope or lifting tackle used in factories—

(a) prescribing further requirements to be complied with in addition to those set out in this section;

(b) providing for exemption from compliance with all or any of the requirements of this section, where in its opinion, such compliance is unnecessary or impracticable.

(3) For the purposes of this section a lifting machine or a chain, rope or lifting tackle shall be deemed to have been thoroughly examined if a visual examination supplemented, if necessary, by other means and by the dismantling of parts of the gear, has been carried out as carefully as the conditions permit in order to arrive at a reliable conclusion as to the safely of the parts examined.

Explanation—In this section—

(a) "lifting machine" means a crane, crab, winch, pulley block, gin wheel, transporter or runway;

2[(b) "lifting tackle" means any chain sling, rope sling, hook, shackle, swivel, coupling, socket, clamp, tray or similar appliance, whether fixed or movable, used in connection with the raising or lowering of persons, or loads by use of lifting machines.]

14. ROPES

14.1 Rope Replacement

Only ropes of the correct size, type, strength and construction as specified in the crane manufacturers' handbook should be fitted to the crane unless an alternative rope has the prior approval of the crane designer, rope manufacturer or other competent engineer.

14.2 Rope Length

The length of the rope used should be sufficient for the particular application for which the crane is to be used but in no circumstances should it be such that in the extreme positions:

a) there is less than two turns of rope left on the drum, and

b) the drum flanges project less than two rope diameters or 50 mm whichever is less, beyond the outer layer of the rope in all circumstances

14.3 Handling, Storage and Installation

14.3.1 Offloading

To avoid physical damage, ropes should be offloaded with care. The reels or coils should not be dropped. A steel bar should be placed through the centre hole of the reel and lifted by means of a suitable sling. Coils of wire rope should not be lifted by their securing bands, unless it is known that the bands are especially designed for this purpose.

14.3.2 Storage

Ropes should be stored in a cool, dry building and should not be in contact with the floor. Ropes should never be stored where they are liable lo be affected by chemical fumes, steam or other corrosive agents. Ropes in store should be examined periodically and a rope dressing applied, if necessary.
Ropes that have been removed from a machine for future use should be thoroughly cleaned and a dressing applied before being stored. Ropes having a length in excess of 30 m should be stored on a drum.

14.3.3 Uncoiling and Handling

14.3.3.1 General

To prevent the possibility of kinking or disturbance of the lay, ropes should be paid out without slack and in a straight line. Coils of rope should preferably be paid out from a turntable. Alternatively, where the coil is short, one end can be made free and the remainder rolled along the ground. For ease of handling the inside end should first be secured to an adjacent turn. A rope should never be unwound by throwing off turns with the coil or reel flat on the ground (See Fig. 5). The rope should be kept as clean as possible during this operation.
Before any rope is cut it should be tightly served or secured on either side of the intended cut. Fig. 6 shows a common method.

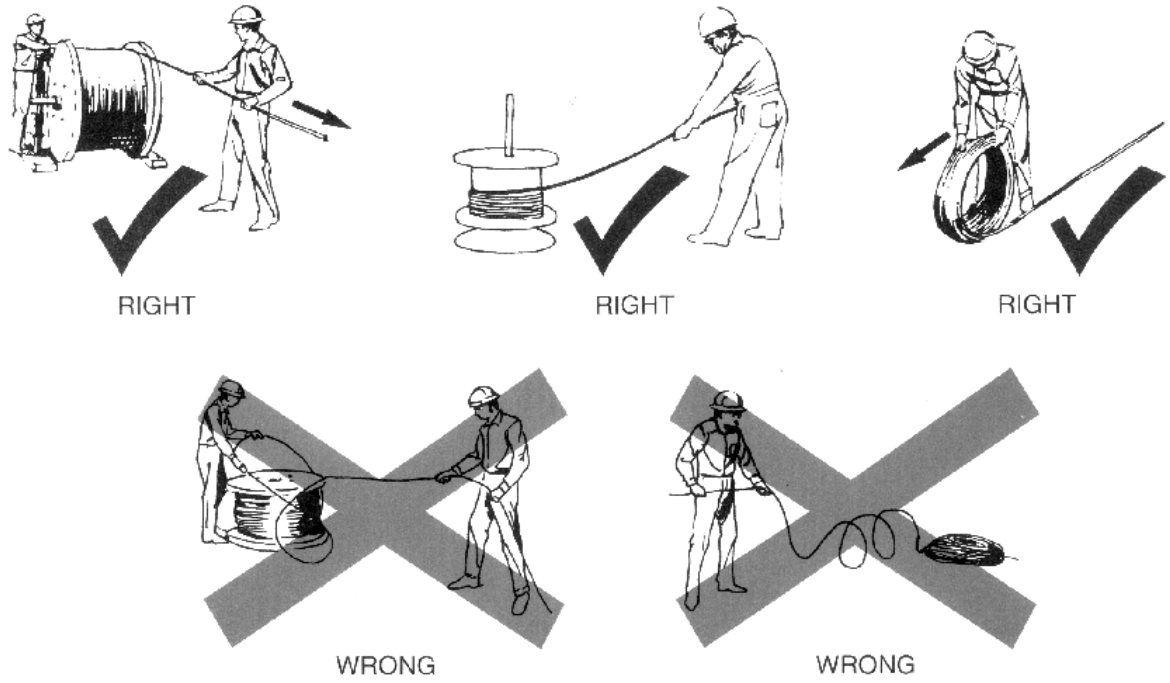


Fig. 5 Correct Method of Paying Out Rope

14.3.3.2 Multi-strand rope

Great care should be taken with multi-strand ropes to ensure that they are installed without imparting any rotation to the rope. A free end will, have no pronounced tendency to rotate but caution should be exercised to ensure that the lay of the rope is not disturbed, either by turns in or turns out. If the strands are disturbed, malformation of the rope may develop during subsequent use.

14.3.4 Installation

The lay of the rope should not be disturbed during installation, that is, turn should not be put in nor taken out of the rope. Ordinary lay ropes are usually stable but special care should be taken with

Lang's lay and multi-strand ropes. When winding a rope from a reel to a drum, it should be bent in the same direction. Re-reel from the top of the reel to the top of the drum. A tensioning load should also be applied to the rope to achieve good coiling. A simple brake such as a plank rigged to bear against the reel flanges, may provide ample rope tension. The reel and the drum should be spaced well apart to facilitate even coiling (see Fig. 7).

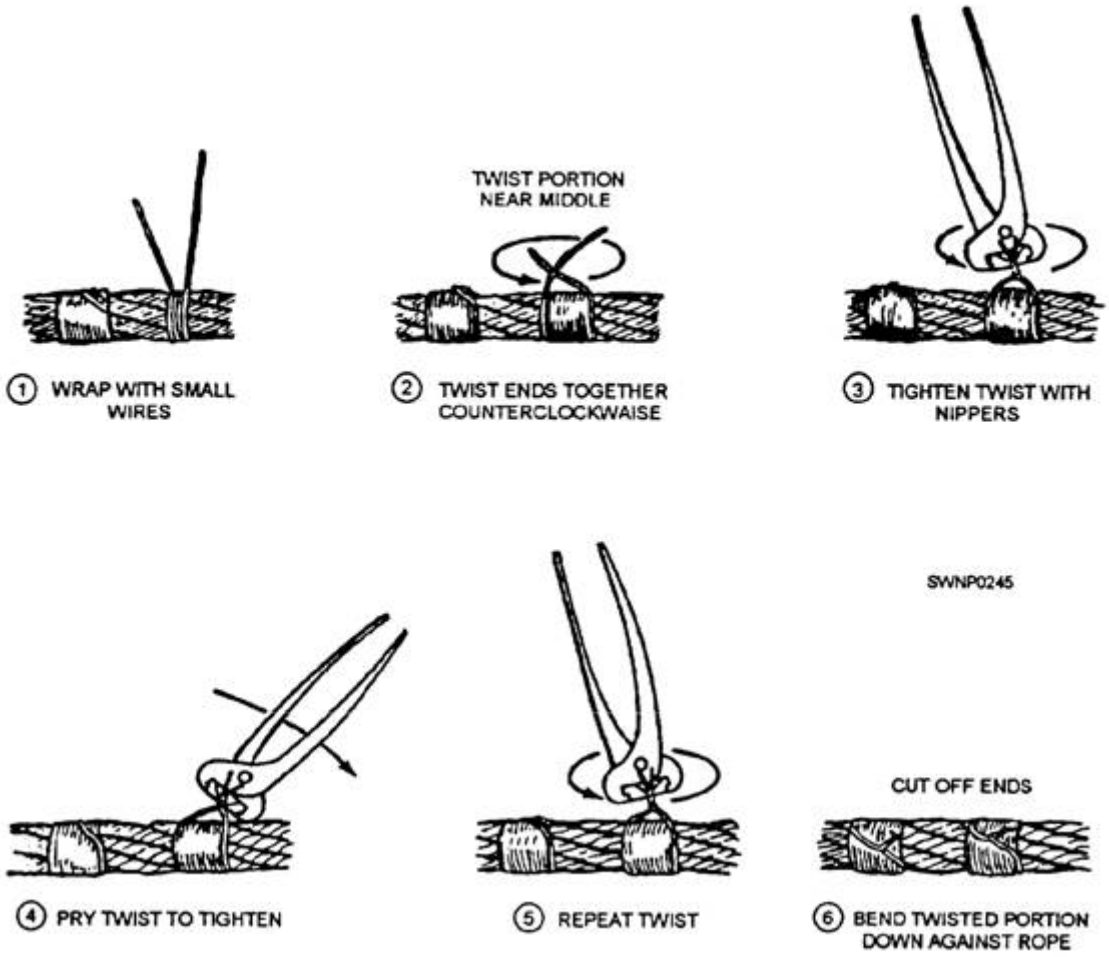
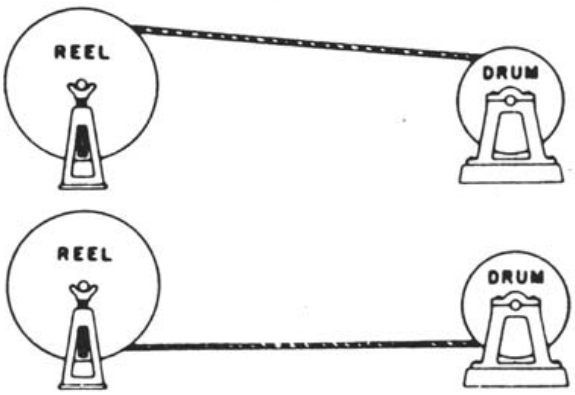


Fig. 6 Seizing of Ropes (Before Cutting)



Always reel from top to top or bottom to bottom

Fig. 7 Transferring Rope from Reel to Drum

14.3.5 Running-in

After fitting a new running rope, it is advisable to run through its operating cycle for a number of operations at reduced speeds and loads to permit the new rope to adjust to the working conditions. This is particularly important for multi-strand ropes.

All new ropes when first installed will stretch due to the wires and strands bedding in. This will normally be accommodated by the installation. If not it may be necessary to cut and re-terminate.

14.4 Rollers and Guide Sheaves

Rollers or guide sheaves are sometimes fitted on the jib of the crane to ensure that the rope does not rub against the jib structure. A siezed roller, or sheave will cause serious damage to a rope, leading to its premature failure and they should therefore be checked at regular intervals [see 10.2.3 (c)] to ensure that they are free to rotate.

14.5 **Rope Drums and Sheaves**

Where alternative drums and/or lagging can be fitted, it should always be ensured that the drum or lagging is compatible with the size of rope and the duty requirements.

Sheaves are usually manufactured from ferrous materials, but the use of plastics sheaves and sheaves with plastic inserts is increasing. For many uses, plastics sheaves and inserts give an increase in rope life, but there may be a change in the failure mode of the rope. Special attention should be given to the examination of ropes used, with plastics sheaves and inserts (see 14.8.2.3).

14.6 Rope Terminations

14.6.1 General

Only rope termination as specified by the crane and/or rope manufacturer should be used to attach a rope to a drum, hook block or the structure of the crane. Care should be taken to ensure that anchorage points are securely fastened.

Terminations should be examined for mechanical damage, for example elongation of the holes of clevis type fittings? for the presence of broken wires (see14.8.2) and for evidence of the rope pulling through the termination. Consideration should be given to the possibility of internal corrosion: discard after a period specified by the rope/crane manufacturer may be the only solution to this problem.

Rope terminations can be of permanent or non-permanent type and special attention should be given to the assembly and use of the latter which normally take the form of a wedge and socket that can be fitted to the rope at site. Guidance is given in 14.6.2 to the procedures that are necessary to ensure that this type of fitting is safely assembled.

Wire rope grips (U-bolts) as the sole means of terminating a rope can be dangerous and they should not therefore be used for this purpose.

14.6.2 Wedge and Socket Terminations for Ropes

14.6.2.1 Assembly

The following points should be noted when assembling wedge and socket terminations:

a) It is essential that only wedge and socket assemblies of the correct dimensions and strength for the particular rope are used. Failure to do so may result in the rope pulling through the fitting.

b) Wedges and sockets for a particular size of rope should be matched to each other and should not therefore be obtained front different manufacturers. The fit of the wedge (with rope) in the socket should always be checked at the time of assembly. An

oversize wedge, or a wedge of incorrect taper, will not enter the socket sufficiently to give a secure termination; too small a wedge will protrude too far through **the** socket and the high localised loading may cause the socket to crack and open out, allowing the wedge to pull through.

c) The rope should be fitted so that the live or loaded part of the rope is not kinked where it leaves the socket, but pulls directly in line with the point of attachment of the socket. Incorrect fitting will result in premature failure of the rope.

d) When the termination is made up, the tail-end length of rope left protruding from the socket should be long enough for the securing method used [see 14.6.2.(h)].

e) Multi-strand ropes tend to show distortion when they are bent around small radii and may require temporary serving, for example with electricians' tape during the fitting of the socket. The serving should be subsequently removed as far as possible to allow for rope inspection.

f) After a wedge and socket termination has been made or remade, it is essential that the wedge and rope are properly seated in the socket before the equipment is put into service. Failure to do so may allow the rope to pull through the fitting or particularly when the rope is new, the wedge to be sprung out of the socket.

g) Initially the wedge should be hammered home using a wooden packer to protect the fitting and rope against' **damage** and simultaneously a second person should pull on the ends of the rope. A substantial load should then be raised and left suspended (but not unattended) to seat the wedge and rope firmly into the socket before the assembly is put into service.

h) There are two ways of securing the dead-end lengths of rope protruding from the socket depending on the circumstances of use:

   i. The tail-end may be looped back on, itself and secured by a wire rope grip or clamp to form a loop. The loop should be lashed to the live part of the rope by suitable means, such as soft binding wire, to prevent flexing of the rope in service. If this method is used, the tail-end length of the rope should be about 15 times the diameter of the rope for example 195 mm tail-end length for a13 mm diameter rope. The clamp or wire rope grip should not be allowed to encroach on the fused end of the rope.

   ii. Where there is a possibility of the loop interfering with an obstruction, such as the working structure, which might cause the wedge to loosen and the rope to pull free, the tail-end length of the rope should not be looped back but should be fitted with a simple clamp or wire rope grip and laid parallel to the live rope. If a wire rope grip is used a distance piece, or a short length of rope of the same diameter, will be necessary to ensure that the rope, is adequately gripped. If necessary, the tail-end may be lashed to the live part with soft binding wire.

   NOTE- In both (i) and(ii) the clamp is used to ensure that the rope **cannot slip through the anchorage before the wedge has seated properly.**

i) Special care should be taken when tension may be completely removed from the rope, for example when a load is set down where there is a possibility that the wedge may become loosened.

14.6.2.2 Inspection

When inspecting wedge and socket rope anchorages particular attention should be paid to;

a) rope damage, for example broken wires or deformation of the rope where it emerges from the socket;
b) the condition of the socket, for example cracks, particularly if the wedge is seen to protrude excessively. The socket lugs should be examined for possible deformation, cracks, or other defects;
c) the security and tightness of the wedge fitting.

The wedge and socket and the part of the rope lying inside the fitting should be examined each time the termination is dismantled for any reason.
A wedge and socket termination found to be damaged should be replaced. **A** length of rope that has previously been fitted with a wedge and socket termination should not be straightened and use for load-bearing purposes.

14.7 Maintenance, Examination and Discard Criteria

14.7.1 General

The continued safe operation of wire ropes depends on the regular assessment of the condition of the ropes and the equipment with which they are used.
Some cranes operate in conditions where the ropes and equipment are particularly liable to damage. In such circumstances, the assessment of the condition of the rope and the equipment should be carefully carried out, and the rope removed from service when the intervals and before the rope is showing signs damage is such as to affect its safe operation.
Good maintenance will, in general, increase the rope life. Regular cleaning and service dressing is a necessary part of good maintenance.
Guidance regarding rope maintenance, inspections and examinations and discard criteria are given in 14.7.2 to. 14.8.6. If the person inspecting the rope has any doubts about its safe operation, the rope should not be used until it has been examined and declared fit for further service by the competent person.
Records should be kept of the maintenance, examination and discard of wire ropes (see 7.10.4).

14.7.2 Rope Maintenance

The maintenance of wire ropes is normally confined to cleaning and application of dressings. The dressings are usually of mineral oil origin and are used to provide lubrication of the wires and strands and to provide protection against corrosion.
Corrosion is a common cause of deterioration of ropes, especially those working out of doors. Internal as well as external corrosion can occur. The former is more dangerous because it can. lead to an appreciable reduction in the strength of the rope before the deterioration becomes apparent.

The dressings used for these ropes should therefore:

a) penetrate easily into rope,
b) displace moisture from metal surfaces,
c) give good corrosion protection,
d) be resistant to wash off by water,
e) be reasonably resistant to emulsification, and
f) not cause build up on surface so as to cause displacement of the rope.

In certain environmental conditions, the application of a dressing might aggravate the wear, for example by retaining abrasive materials and in these situations the application of dressings should be avoided unless it is required to protect the rope against corrosion.
The dressing should be compatible with the type of lubricant applied during the manufacture of the rope and in this respect the rope maker's advice should be sought.

14.7.3 Frequency of Dressing

This depends very much on the installation and environment in which the rope is working. There are, however, certain general principles to be followed in order to obtain the best rope life. These are:

a) wherever practical a dressing should be applied when the rope is fitted to the crane;
b) The dressing should be re-applied at regular intervals and before the rope is showing signs of corrosion or dryness

16.7.4 Application of Dressing

There are several methods of applying dressings and the most suitable for any particular rope depends upon the viscosity of the dressing and the length of rope involved. The methods of application include brushing, spraying dripfeed or by automatic applicators.

For maximum effect the lubricant should be applied if possible to the rope where it 'opens up' as it travels over a sheave or winds onto drum.

If the existing dressing on the rope is heavily loaded with dirt, sand, grit, etc, or if loose corrosion products are present, these should be removed with a wire brush or other suitable means.

14.8 Assessment of **Rope Condition and Discard Criteria**

14.8.1 General

When carrying out inspections and examinations to assess the fitness of the rope for further service, it is necessary to consider both general deterioration and localized deterioration or damage. It is' therefore necessary to examine the whole length of the rope, paying particular attention to the hope adjacent to the terminations, lengths which have been running or, stationary over drums, sheaves and deflection pulleys, and any other areas likely to sustain damage (See Fig. 8).

The criteria in 14.8.2 to 14.8.6 should be considered and are likely to occur in combination. The competent person should assess for each, the severity of deterioration between the per-feet condition and the discard condition and the cumulative effect on the rope. A combination of two or more criteria should be viewed more seriously than one occurring on its own.

14.8.2 Broken Wires

14.8.2.1 Generally distributed broken wires

Unless specified, the number of generally distributed broken wires permissible before the rope is discarded if in any length of ten diameters the total number of visible broken wires exceeds five per cent of the total number of wires.

Breaks that occur on the crown of the rope are typical of deterioration by abrasive wear and bend fatigue, breaks that occur in the valley area between the strands are typical of deterioration of the core by wear, fatigue or corrosion.

In the case of multi strands ropes wire breaks will frequently occur in the valley area between strands and may become visible if the rope is flexed, or opened for internal inspection.

14.8.2.2 Localized broken wires in the vicinity of terminations

The rope should be discarded when there are three or more visible wire breaks in the immediate vicinity of termination. Detachable terminations such as a wedge and socket should be examined for broken wires within and under the terminations.

If the rope is shortened so that the broken wires are removed, then it may be considered for re-termination and reuse. Wire breaks at or adjacent to the termination, even if low in number, are indicative of high stresses at this point and may be caused by incorrect fitting of the termination. The causes should be investigated before the rope is re-terminated.

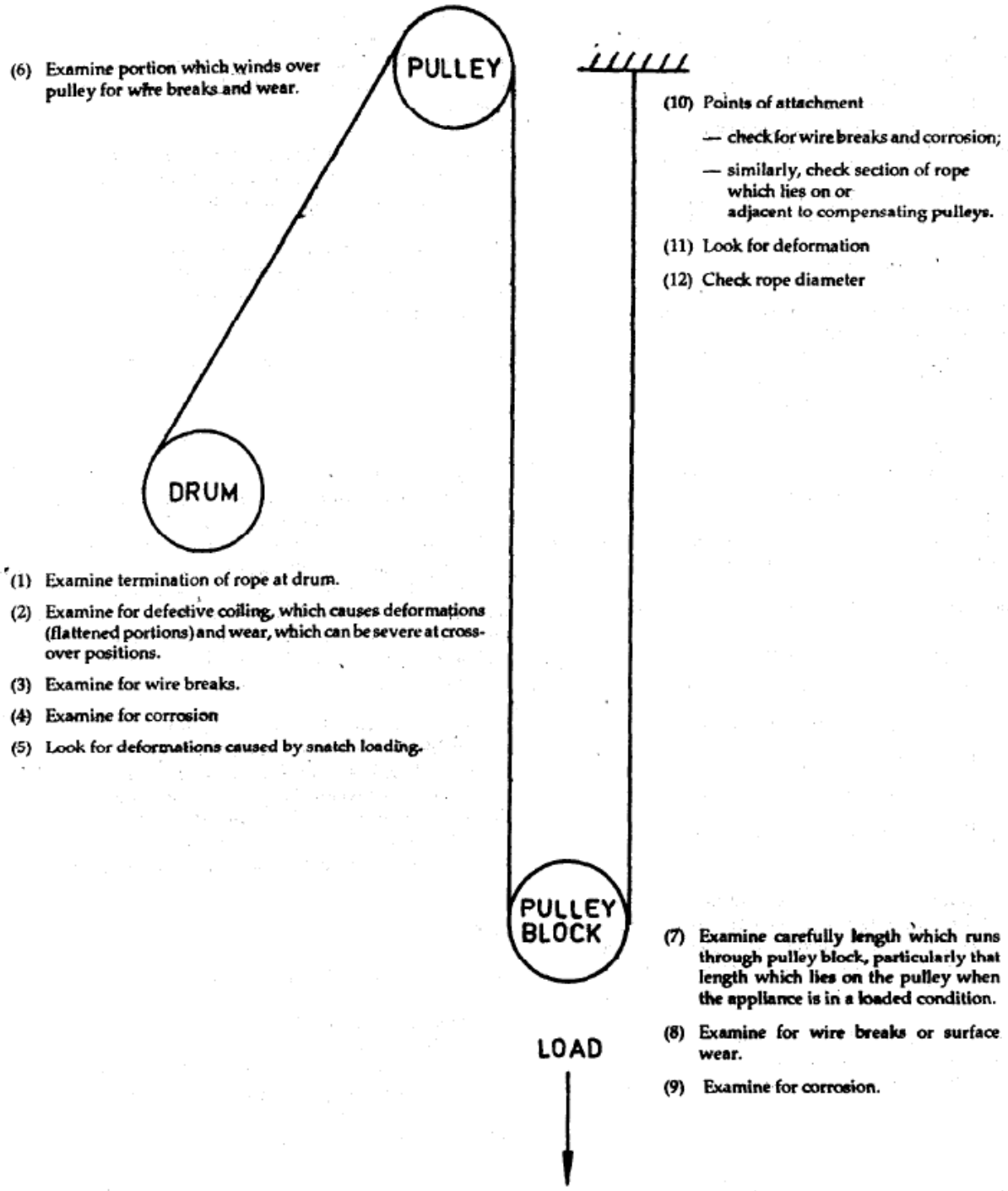


Fig. 8 Parts of the Crane to Be Considered During the Examination

14.8.2.3 Ropes operating in plastics sheaves

When any rope operates either solely or partly with plastics sheaves or metal sheaves having plastics lining, wire breaks may occur in large numbers internally before there is any visible evidence of wire breaks or substantial wear on the periphery of the rope.

Particular attention should be paid to any localized area which exhibits a dryness or denaturing of the lubrication. The rope or crane manufacturers advise should be sought regarding discard criteria but in any case this should be not less onerous than those applicable to multi strand ropes working over metal sheaves.

14.8.3 Wear

Wear may be either general or localized and results from contact of the rope with sheaves, or drums, or other hard surfaces or rope to rope pressure. Wear may be uniform along or around the rope, or may occur along one side of the rope only.

When working over metal sheaves, the rope should be discarded when the rope diameter anywhere is reduced to 90 percent of the nominal diameter in the case of 6 and 8 strand ropes.

In the case of multi strand ropes, internal wear or damage is frequently more critical than external wear. This may also be accompanied by an accumulation of internal debris. If the rope diameter falls to 97 percent of the nominal, or rises to 105 percent of the nominal, a more detailed examination should be carried out to ascertain the significance and discard may be necessary. The rope should in any case be discarded when the diameter has reduced to 90 percent of the nominal diameter.

If wear is not even, the cause should be ascertained and corrective action taken.

14.8.4 Corrosion and Chemical Attack

Corrosion and chemical attack may be external or internal, general or localized, and is significant when the surface of the wires is severely roughened or pitted, or if the wires are slack within the strands due to wastage. If any of these phenomena is present either locally or generally the rope should be discarded.

Slight rusting of the surface is not normally detrimental but may be an indication that the rope is in need of lubrication.

Internal corrosion or chemical attack are not always easy to detect and are therefore particularly dangerous. Indications are an unusual increase or decrease in rope diameter, lack of gap between the strands, dryness and deterioration of the lubricant, discoloration in the valleys between the strands, and increase in stiffness in bending. If a rope shows any of these signs it should & carefully examined and if not requiring discard it should be re-dressed (see 14.7.2).

14.8.5 Localized Damage or Distortion

Other forms of damage or distortion that may affect the safe working of wire ropes are:

a) **Waviness - Waviness** is a deformation where the longitudinal axis of the wire rope takes the shape of a helix. While not necessarily resulting in any immediate loss of strength, the deformation may transmit a pulsation which after Prolonged working will give rise to wear and wire breaks. In the case of waviness that affects the operation of the equipment, the wire rope should be discarded.

b) **Basket distortion (or birdcage) –** Basket distortion occurs in ropes when the outer layer of strands has been dislocated or when the outer layer becomes longer than the inner layer of strands. Such a condition may occur as a result of abrupt (snatch) loading of the rope from a slack condition, incorrect installation or incorrect termination. **A** basket formation is justification for discard.

c) **Strand or core protrusion -** Strand or core protrusion is frequently associated with basket deformation and is justification for immediate discard of the rope.

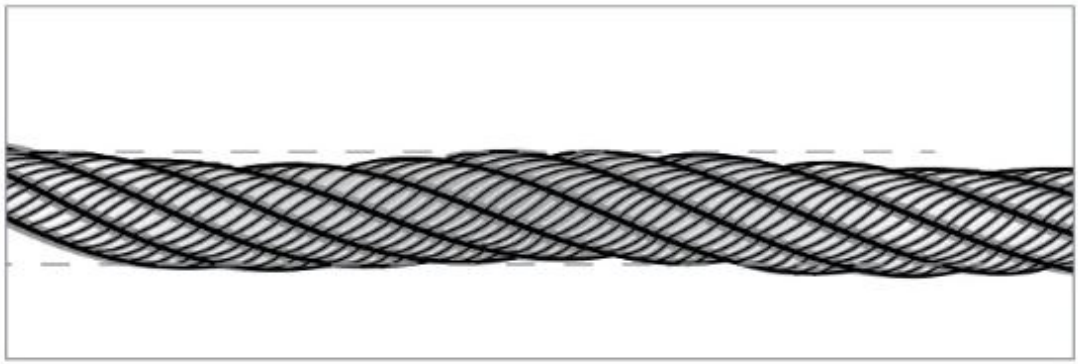
d) **Wire protrusion -** In this condition certain wires or groups of wire rise up on the opposite side of the rope to the sheave groove, in the form of loops. This feature usually results from shock loading. If the condition is severe (3 wires), there is justification for discarding the rope.

e) Local increase in diameter of rope – Local increase in rope diameter may occur and could affect a relatively long length of the rope. The condition usually relates to corrosion (see 14.8.4) or to swelling of a fibre core owing to the effect of moisture. If the condition is severe, the rope should be discarded.

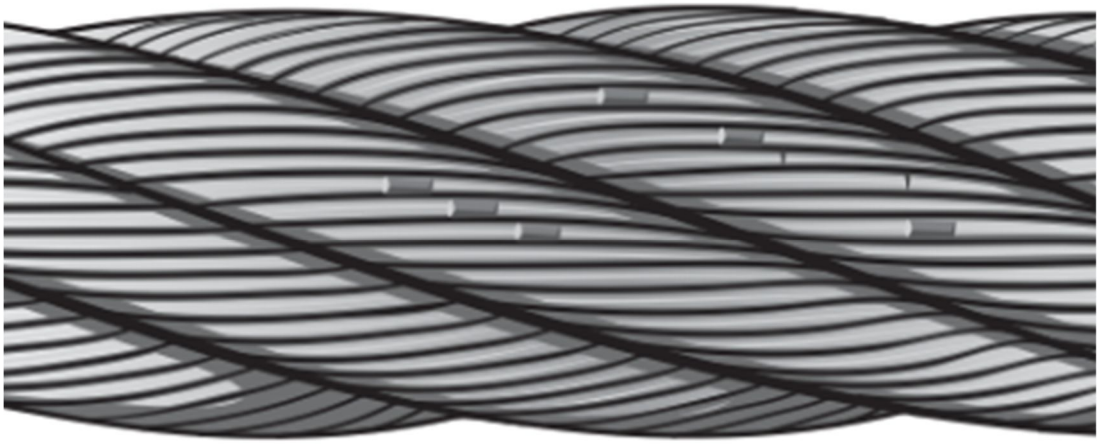
f) **Local decrease in diameter of rope -** A local decrease in tie diameter of the rope is frequently associated with fracture of the core. Positions close to terminations should be carefully examined for such deformations.
If the condition is severe the rope should be discarded.

g) **Bends and Kinks -** Bends are angular deformation of the rope. A kink is a deformation created by a loop in the rope which has been tightened without allowing for rotation about its axis. Unbalance of lay length occurs, which will cause excessive wear, and in severe cases. the rope will be so distorted that it will have only a small proportion of its strength remaining. If the bend or kink is severe there is justification for immediate discard of the rope.

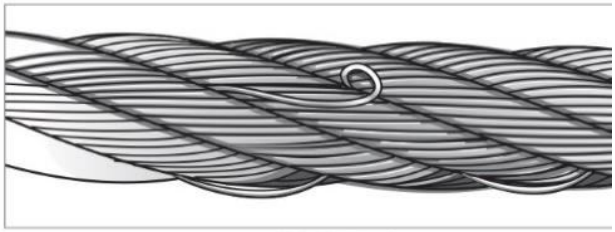
h) **Damage due to heat or electric arcing -** When there is evidence that the rope has been in any way affected by electric arcing or substantially affected by heat, the rope should be discarded. Indicators are dryness or loss of lubrication, bluing of the wire surfaces, fusion of wire surfaces and the presence of weld splatters.



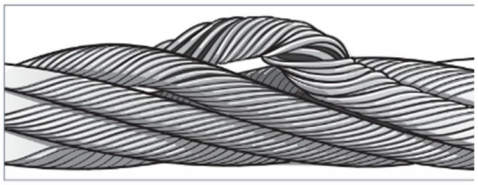
Waviness



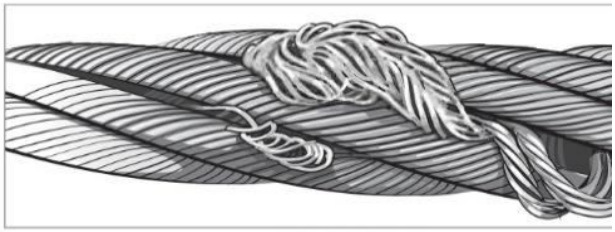
Crown Wire Breaks



Wire Protrusion

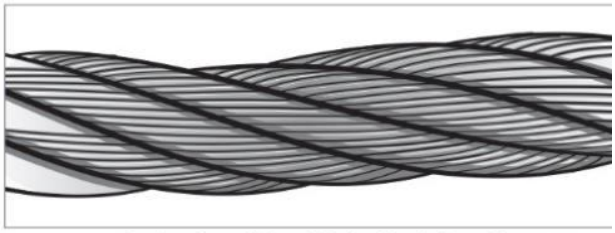


Strand Protrusion



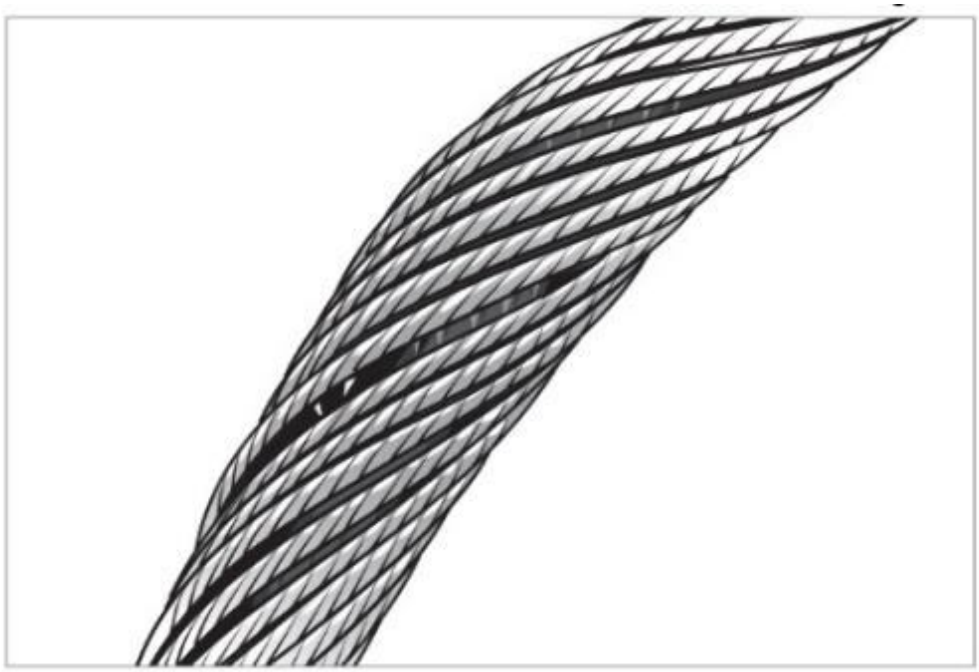
Core Protrusion

Flattened Rope



Sunken Strand/Local Reduction in Rope Diameter

Kink or Tightened Loop



Birdcage or Basket/Lantern Deformation

15. SLINGING AND HANDLING OF LOADS

15.1 Load Estimation, Weight and Centre of Gravity

15.1.1 Weight of the Load

It is important that the weight of the load to be lifted is known with reasonable accuracy. To obtain this information

a. Look to see if the weight is marked on the load. If it is checked to ensure that it is the weight of all parts of the load (a machine tool for example may not include the drive motor).
b. Check the weight stated on any documentation.
c. Look at the drawing of the load. If the weight is marked check as in (a) above to ensure it includes all parts of the load.
d. If the load is still on a trailer or truck, weigh it.
e. Estimate the weight of the load by using tables of weights. In this respect IS 808 : 1989 gives the weight of rolled steel sections. Table 4 gives weights for other materials.

15.1.2 Determination of load mass

The mass of a load, m, in kilograms, is determined using the following formula:

m = VQ

where

V is the volume of the load, in cubic metre & Q is the density of the material, in kilograms per cubic metre.

The volume of a load can be found by dividing it into single elements (fundamental bodies), for which the volumes can be calculated using one of the formulae given in table 3, and by totalling the volumes of the elements.

In the cases of complex volumes or heterogeneous material or in other cases where it is difficult to calculate the load mass, the mass should be determined by a measuring device, such as a dynamometer, which is interposed between the crane hook and the load. The densities for the most commonly used materials are listed in table 4.

Table 4 Weight of Materials

[Clause 15.1.1 (e) and 15.1.2]

Material	Weight kg/cubic metre
Aluminium	2700
Brass	8500
Bronze	8400 to 9200
Brick	1400 to 2000
Coal	1200 to 1350
Copper	8800
Concrete	1600 to 2400
Earth	1600
Iron, cast iron	7400
Lead	11200
Magnesium	1750
oil	800
Paper	1 120
Steel	7800
Wood	400 to 800

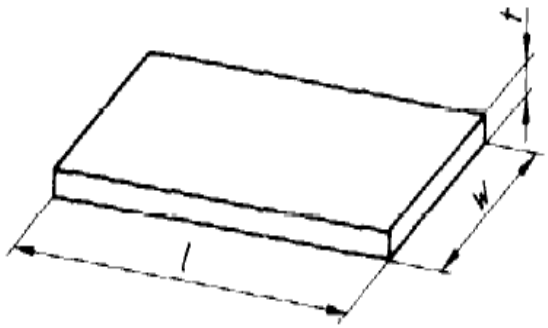
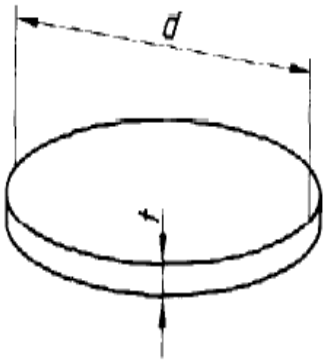
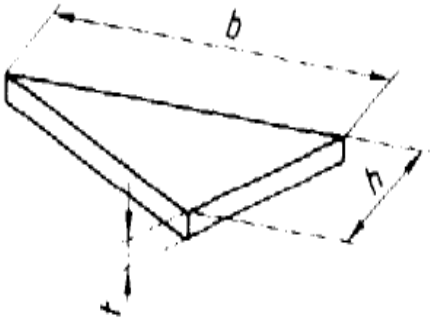
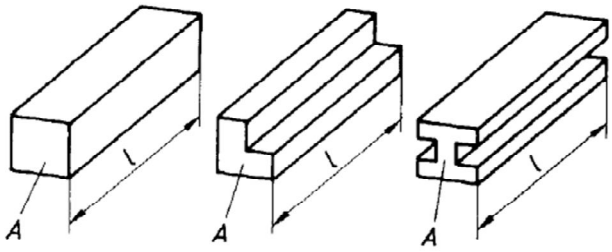
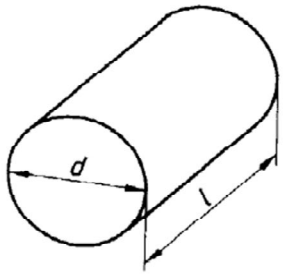
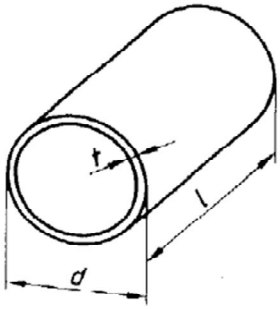
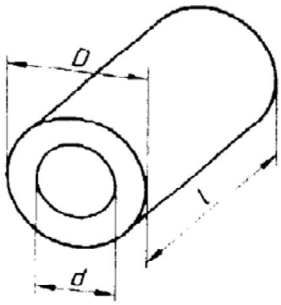
Fundamental bodies	Volume
Sheet (rectangular) 	$V = lwt$
Sheet (circular) 	$V = \left(\frac{d}{2}\right)^2 \pi t$
Sheet (triangular) 	$V = \frac{b}{2} ht$

Table 3 – Volumes of fundamental bodies

Fundamental bodies	Volume
Prism, bar or profile  A is the surface area of the base	$V = Al$
Cylinder  	$V = \left(\frac{d}{2}\right)^2 \pi l$
Tube Thin-walled  Thick-walled  	$V = d\pi lt$ $V = \pi l\left[\left(\frac{D}{2}\right)^2 - \left(\frac{d}{2}\right)^2\right]$

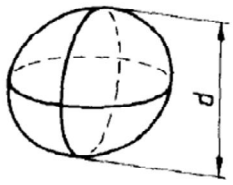
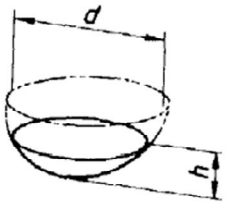
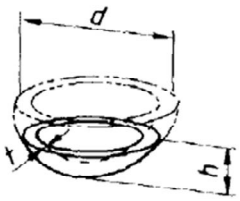
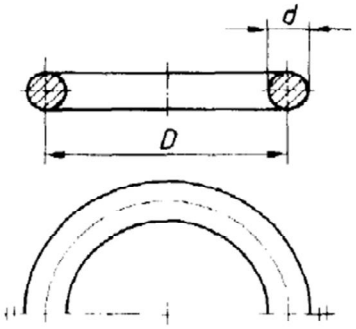
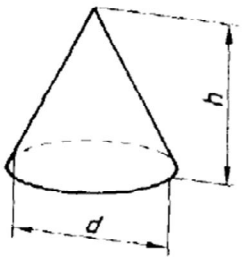
Fundamental bodies	Volume
Sphere 	$V = \frac{4}{3}\pi\left(\frac{d}{2}\right)^3$
Spherical segment 	$V = \frac{1}{6}\pi h\left[3\left(\frac{d}{2}\right)^2 + h^2\right]$
Spherical shell segment 	$V = \frac{\pi}{4}(d^2 + 4h^2)t$
Torus (cylindrical ring) 	$V = \frac{1}{4}\pi^2 Dd^2$
Cone 	$V = \left(\frac{d}{2}\right)^2 \pi \frac{h}{3}$

Table 4 Weight of Materials
[Clause 15.1.1 (e) and 15.1.2]

Material	Weight kg/cubic metre
Aluminium	2700
Brass	8500
Bronze	8400 to 9200
Brick	1400 to 2000
Coal	1200 to 1350
Copper	8800
Concrete	1600 to 2400
Earth	1600
Iron, cast iron	7400
Lead	11200
Magnesium	1750
oil	800
Paper	1 120
Steel	7800
Wood	400 to 800

15.1.3 Centre of Gravity

It is important to know the position of the centre of gravity. This is the point at which the total weight of a body may be regarded as being concentrated. Another way of saying this is that the centre of gravity is the point about which the parts of a body exactly balance each other.

For more complex shapes, it may be necessary to estimate the centre of gravity of the various parts of the load and then combine them to get a centre of gravity for the whole. When handling irregular shaped loads such machine tools where the position of the centre of gravity is not readily ascertainable it is essential to determine this by trial and error without lifting the load completely off the ground & Having established this the tackle should be adjusted to ensure that the load is evenly balanced for lifting without a tendency to topple over and that no part of the load is subjected to excessive strain which might cause damage to the load. Slings should be protected against any sharp edges on the load. The weight of all slings tackle and lifting beams should be regarded as part of the load to be lifted.

15.1.4 Load stability

General

Before lifting with slings, it is important to ensure that the load will be stable when it is raised clear of the ground. It is dangerous if a load can tilt or swing in an uncontrolled manner, or if it can topple over.

A load will not tilt, if, before lifting, the sling(s) is fare) arranged so that the load is suspended with its centre of gravity aligned directly below the main point of attachment of the hook (see figure 1). (The centre of gravity is the point about which the parts of a body, when left free, exactly balance each other.)

Effect of "out of balance"

If a load is out of balance when lifted, it will tilt and swing towards the position of balance, until the centre of gravity settles directly below the main point of attachment. This movement can give rise to hazardous situations, such as :

a) the swinging load might strike persons or obstacles;
b) the individual sling legs might become overloaded;
c) the load might move within the sling;
d) in severe cases, the load may topple or be displaced from the sling with consequent damage.

If there is uncertainty about the balance of a load, it may be necessary to have a series of trial lifts before the position of balance can be determined. The load shall be lifted only sufficiently for the degree and direction of any tilt and swing to be determined. The tendency to tilt and swing shall be corrected by moving the slinging points and the supporting hook a little at a time, each time making a trial lift until the position of balance is obtained (see figure 2).

Effect of a high centre of gravity

To minimize the risk of toppling, the points of attachment of the sling legs shall, where practicable, be above the centre of gravity of the load (see figure 3).

Where the centre of gravity of the load is above the point of sling attachment a greater stability will result where the angle between the horizontal and the sling leg is substantially greater than the angle formed between the horizontal and a line between the centre of gravity and the attachment point (see figure 4).

15.2 Use of Lifting Gear

Only slings and lifting gear for which a valid test certificate has been issued and which have been thoroughly examined within the previous six months should be used. Slings and lifting gear should clearly have marked with the safe working load and an identification number (for test record purposes). All slings and lifting gear should be visually inspected on
each occasion before use. When not in use such lifting gear should be maintained in a serviceable condition in a suitable store Lifting gear should be released from the store only on the instruction of a responsible person.
When use in connection with the handling of molten metal or slag the safe working load of all lifting gear should be de-rated to half the normal safe working load.

15.3 wire rope slings

15.3.1 Before lifting a load

a) It is necessary to ensure that the load is suitable for lifting with a wire rope sling. The sling shall not be allowed to damage the load nor shall the sling itself be damaged. It the sling is to be attached to the load, me points used for attachment, e.g. lugs and eyebolts, should be suitable and adequate for the purpose of lifting the load.
b) The mass of the load to be lifted shall be assessed. If the gross mass is not marked, the information may be obtained from the consignment notes, manuals, plans, etc. If there is no information, the mass should be assessed by the person responsible for the lifting.
c) Once the slinging method has been decided on, a suitable sling shall be chosen and the working load limit (WLL) shall be adequate for the load to be lifted. As far as is reasonably practicable, the effective diameters of pins, hooks or other components over which soft eyes are used shall not be less than twice the rope diameter.

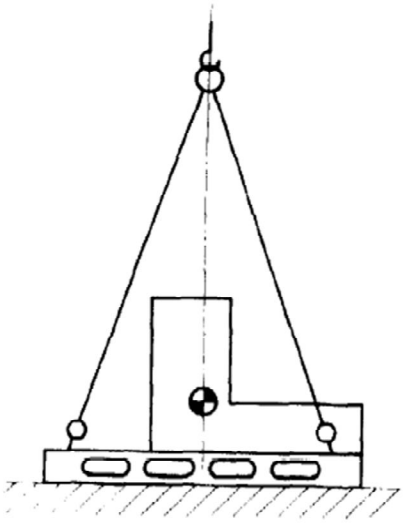


Figure 1 — Alignment of centre of gravity

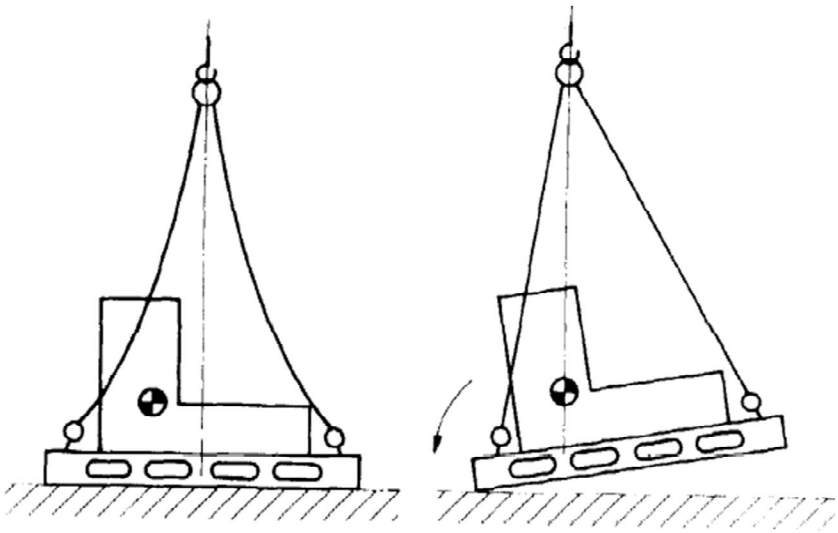


Figure 2 — Example showing effect of centre of gravity misalignment

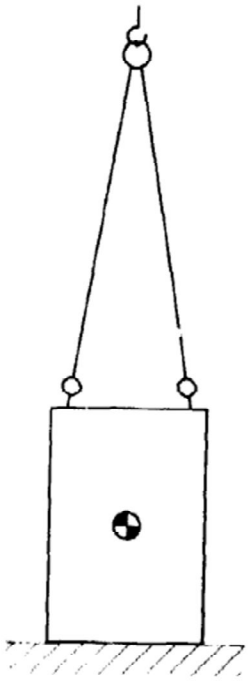


Figure 3 — Example of stable load

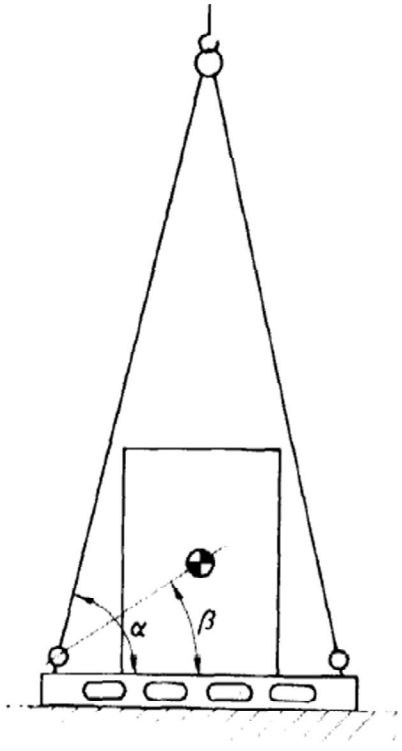


Figure 4 — Example of high centre of gravity relative to attachment points

d) It is necessary to ensure that the sling is in good condition. Slings found to be damaged or to have deteriorated to
e) such an extent that they are considered not safe for use shall be withdrawn from service immediately (see clause 15.3.5).
f) It is necessary to ensure that the load will be balanced when lifted The slings shall be attached to designed lifting points, where provided. If lifting points are not marked on the load, the position of the centre of gravity shall be assessed. The type of sling and the slinging methods used shall ensure that the load will not topple or slip. The supporting hook shall be positioned directly above the centre of gravity. Where this is not practicable, particular care shall be taken when lifting the load (see 15.3.3)
g) It is necessary to ensure that the load contains no loose accessories. If the load comprises a number of pieces, for instance a bundle of pipes, a slinging method shall be chosen which will secure all the pieces. The sling shall not be attached to banding or strapping unless they are designed for lifting purposes.
h) If a sling leg is likely to rotate during lifting of the load, hand splices shall not be used.

15.3.2 Fitting the sling

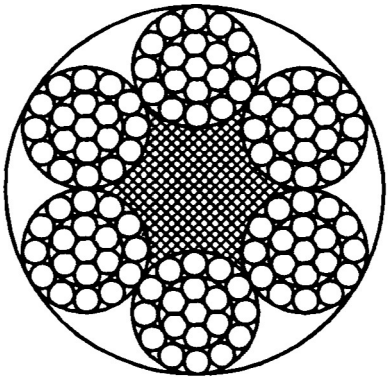
When fitting the sling, it is necessary to ensure that

a. sling legs are free of any tendency to kink;
b. the terminations are properly seated without overcrowding;
c. the relevant leg angle does not exceed that for which the sling is rated and marked;
d. the sling is not bent around any sharp corners that might damage the sling or reduce its effective strength where necessary, suitable packing pieces should be used;
   NOTES
   i. A sharp corner is considered to have a radius of curvature of less than the rope diameter.
   ii. 2 When a rope is bent over Its own diameter, It can lose 50 % of its original strength.
e. and, when using a choke hitch, to ensure that
   i. the angle of choke is allowed to form itself naturally and is not forced,
   ii. a thimble or stirrup is used, where practicable, at the eye to reduce damage to the rope and thereby prolong the life of both the eye and the main part of the rope;
f. sling in choke hitch is not used to turn, rotate or drag a load unless special precautions are taken to ensure that neither the sling nor the load is damaged - such special precautions may entail a reduction of the safe working load;
g. a tag line(s) or control rope(s) is available to assist in the control of the swing or rotation of the load.

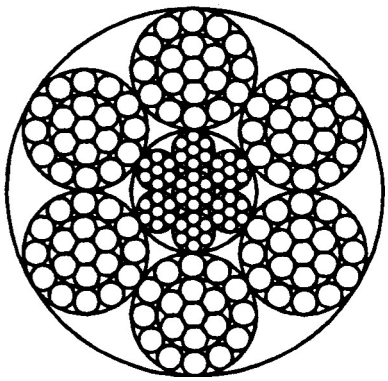
Table 5A SAFE WORKING LOADS FOR TWO-LEG SLING

Safe Working Load of One-Leg Sling	Safe Working Load of Two-Leg Sling	Included Angle between Legs				
		0° kN	30° kN	60° kN	90° kN	120° kN
5	10	10	9.65	8.65	7.05	5.00
7.5	15	15	14.50	13.15	10.00	7.50
10	20	20	19.60	17.50	14.10	15.00
15	30	30	29.00	26.30	21.20	10.00
20	40	40	38.60	35.00	28.30	20.00
25	50	50	48.30	43.80	35.30	25.00
30	60	60	58.00	52.50	42.40	30.00
40	80	80	77.80	70.00	65.50	40.00
50	100	100	96.60	86.60	70.70	50.00
60	120	120	116.00	105.00	84.80	60.00
75	150	150	145.00	131.50	106.00	75.00
Lower Reduction Factor		1.00	0.966	0.866	0.707	0.500
Approximate Reduction Percent		0	3.5	13.5	29.5	50
Note: Safe working load is for vertical hitch.						

Table 5 B Mass and Breaking Force for 6 x 19 Ropes



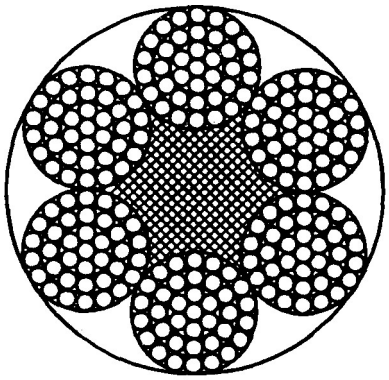
8 to 52 mm
With Fibre Core (CF)



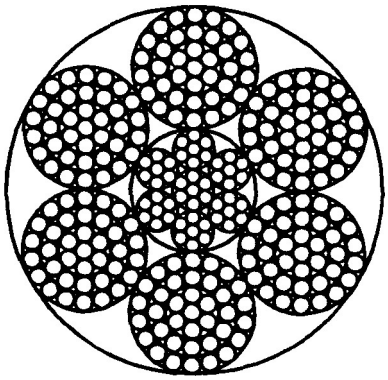
8 to 40 mm
With Steel Core (CWR)

Nominal Diameter	Approximate Mass		Minimum Breaking Force Corresponding to Rope Grade of					
			1570		1770		1960	
	Fibre core	Steel core'	Fibre core	Steel core'	Fibre core	Steel core'	Fibre core	Steel core'
	(CF)	(CWR)	(CF)	(CWR)	(CF)	(CWR)	(CF)	(CWR)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
mm	Kg/100m		kN	kN	kN	kN	kN	mm
	22.1	24.4	31	33	35	38	39	42
9	28.0	30.8	39	42	44	48	49	53
10	34.6	38.1	48	52	54	59	60	65
11	41.9	46.1	58	63	67	71	73	79
12	49.8	54.8	69	75	78	85	87	94
13	58.5	64.3	82	88	92	99	102	110
14	67.8	74.6	95	102	107	115	118	128
16	88.6	97.4	124	133	139	150	154	167
18	112	123	156	169	176	190	195	211
19	125	137	174	188	196	212	217	235
20	138	152	193	208	218	235	241	260
22	167	184	234	252	263	284	292	315
24	199	219	278	300	313	338	347	375
26	234	257	326	352	368	397	407	440
28	271	298	378	409	426	461	472	510
32	354	390	494	534	557	602	617	666
36	448	493	625	675	705	761	781	843
38	500	550	697	752	785	848	870	939
40	554	609	772	834	870	940	964	1041
44	670	--	934	--	1053	--	1166	--
48	797	--	1112	--	1253	--	1388	--
52	936	--	1305	--	1471	--	1629	--

Table 5 C Mass and Breaking Force for 6 x 37 Ropes



8 to 64 mm



8 to 52 mm

Nominal Diameter	Approximate Mass		Minimum Breaking Force Corresponding to Rope Grade of					
			1570		1770		1960	
	Fibre core	Steel core'	Fibre core	Steel core'	Fibre core	Steel core'	Fibre core	Steel core'
	(CF)	(CWR)	(CF)	(CWR)	(CF)	(CWR)	(CF)	(CWR)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
mm	Kg/100m		kN	kN	kN	kN	kN	mm
8	22.1	24.4	30	32	33	36	37	40
9	28.0	30.8	37	40	42	46	47	51
10	34.6	38.1	46	50	52	56	58	62
11	41.9	46.1	56	60	63	68	70	76
12	49.8	54.8	67	72	75	81	83	90
13	58.5	64.3	78	84	88	95	98	105
14	67.8	74.6	91	98	102	110	113	122
16	88.6	97.4	118	128	134	144	148	160
18	112	123	150	162	169	183	187	202
19	125	137	167	180	188	203	209	225
20	138	152	185	200	209	225	231	250
22	167	184	224	242	253	273	280	302
24	199	219	267	288	301	325	333	359
26	234	257	313	338	353	381	391	422
28	271	298	363	392	409	442	453	489
32	354	390	474	512	534	577	592	639
36	448	493	600	648	676	730	749	809
38	500	550	668	722	753	814	834	901
40	554	609	741	800	835	902	924	999
44	670	737	986	968	1010	109	1119	1208
48	797	887	1066	1152	1202	1298	1331	1438
52	936	1029	1252	1352	1411	1524	1562	1687
56	1085	--	1451	--	1636	--	1812	--
60	1246	--	1666	--	1878	--	2080	--
64	1417	--	1896	--	2137	--	2367	--
	With Fibre Core (CF)				With Steel Core (CWR)			

Note:

For sling legs up to about 20 mm diameter, a rope in the 6 x 19 Group will generally provide sufficient flexibility and will offer good wearing properties. For larger size 6x37 Group is generally preferred on account of its increased flexibility.

Safe Working Load- For normal conditions of service, the safe working load shall not exceed

- one-sixth of the minimum breaking strength for Single Part Spliced Sling Legs and,
- one-eighth of the minimum breaking strength for Double-Part Spliced Endless Sling Legs

of 6 X37 construction wire rope with wires of tensile designation 1770 conforming to IS: 2266-1977.

Please refer IS:2762 and IS 2266-1977 for more information about rope specifications and wire rope slings specifications

15.3.3 Raising or lowering the load

When raising or lowering the load, it is necessary to ensure that

a) a recognized code of signals is used which is fully understood by all concerned;
b) there is nothing to prevent the tree movement of the load, e.g. bolts holding down the load or jointing
c) there are no obstacles, such as cables or pipes, which can be fouled, and there is sufficient height for the lift.
d) every person concerned with the operation can see and/or communicate with all other persons concerned
e) all personnel are clear of the load;

NOTE If a person has to be near the load, special care during starting the hoisting and control of the movement of the load should be taken.

f) the load is balanced
g) the load is raised ot lowered steadily avoiding snatch loading;
h) the sling is not trapped under the load it necessary, place suitable battens, etc. In positions so that the load can be put down without damage to Itself and without trapping the sling;
i) there are no free swinging legs; even when hooked back these might constitute a danger and should be careful control.

15.3.4 Precautions

The following precautions shall be taken :

a) no one shall be allowed to ride on the load;
b) the load shall not be allowed to be carried over anyone without due care being exercised;
c) a suspended load shall not be left unattended;
d) slings shall not be dragged along the floor;
e) the slings shall not be unnecessarily exposed to corrosive liquids, solids or vapours;
f) if the sling is to be used in an environment where the temperature exceeds 100 deg centigrade, advice of the sling manufacturer shall be sought.

15.3.5 Inspection, thorough examination and discard criteria

15.3.5.1 General

During service, slings are subjected to conditions which affect their safe working characteristics. It is necessary therefore to ensure, as far as is reasonably practicable, that the sling is safe for continued use.

The sling shall be inspected for damage or deterioration before each period of use and thereafter shall be checked for obvious defects at suitable intervals during service. In addition, thorough routine examinations shall be carried out by a competent person.

If at any time there is reason to doubt the safe condition of the sling, it shall be withdrawn from service and subjected to a thorough examination (see 15.3.5.3).

15.3.5.2 Inspection (for details, see 15.3.5.4)

An inspection is a visual check on the condition of the sling to identify damage or deterioration which might affect its fitness for use, such as:

a) broken wires;
b) distortion of the rope (crushing, kinking, etc.);
c) distortion of ferrules, splicing or fittings:
d) excessive wear:
e) heat damage;
f) corrosion

15.3.5.3 Thorough examination

A thorough examination is a visual examination carried out by a competent person and, where necessary, supplemented by other means, such as non-destructive testing, in order to detect damage or deterioration which might affect the fitness for use of the sling.

A thorough routine examination shall be carried out at intervals not exceeding six months and this interval shall be less where deemed necessary in the light of service conditions or where required by statutory requirements.

Records of such tests shall be kept in accordance with national standards and regulations.

15.3.5.4 Assessment of the condition of the sling and discard criteria

A Broken wires

A.1 General

Broken wires are detrimental because of

a) the possibility of injury to user's hands;
b) the loss of strength in the rope.

Broken wires are usually caused by mechanical damage, although corrosion may be a significant factor.

The appearance of well distributed broken wires may have no marked effect on the strength of the sling, but it might be indicative of mechanical or corrosive damage. In general, the loss of strength caused by the mechanical or corrosive action on the rope as a whole is more critical than the loss in strength resulting from the actual wire breaks.

To prevent injury to the user's hands, protruding wires shall be broken off in the gusset by reverse bending until fracture occurs.

A.2 Randomly distributed breaks

If the total number of visible broken wires in any length of six rope diameters exceeds 5 % of the number of wires in the rope, the sling shall be withdrawn from service and referred to a competent person for thorough examination.

A.3 Localized breaks

If there are three or more broken wires closely grouped, the sling shall be **discarded**.

A.4 Excessive wear

If surface wear reduces the measured diameter of the rope at any point to less than 90 % of the nominal diameter, the sling shall be discarded.

A.5 Corrosion

Corrosion may occur where slings have been improperly stored or have been used in particularly corrosive conditions, such as in moving loads in and out of acid/alkali baths. The effect is readily identified through the loss of flexibility and roughness to the touch. While slight surface rusting is

unlikely to affect the rope strength, it may be indicative of internal corrosion, the effect of which is not predictable.
Where internal corrosion or corrosion beneath the serving of a hand splice is suspected, the sling shall be withdrawn from service and referred to a competent person for thorough examination.

A.6 Significant distortion of the rope
The sling shall be **discarded** when distortion due to kinking, crushing, core collapse, or knotting is identified. However, in certain circumstances, permanent deformation may occur without necessarily affecting the strength of the sling, e.g. flattening when the rope is bent around a small diameter under heavy loading**.**
In cases where it is difficult to distinguish between detrimental distortion and acceptable deformation, the sling shall be withdrawn from service and referred to a competent person for examination.

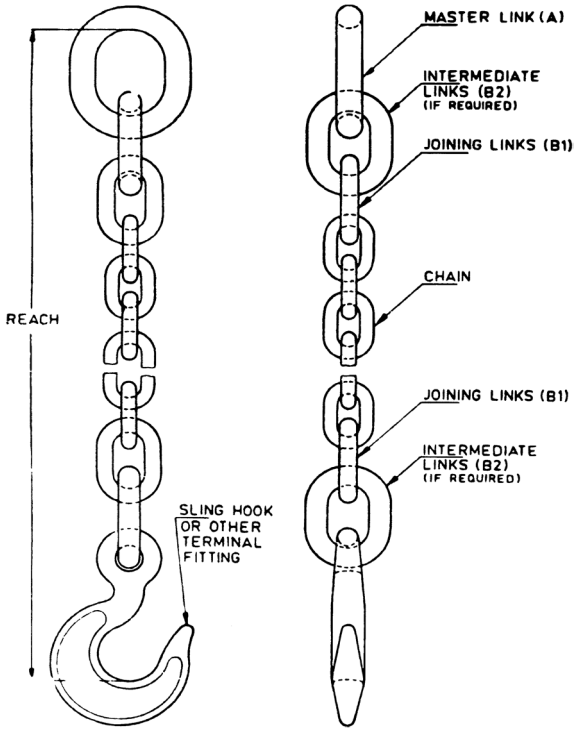
A.7 Heat damage
Discolouration of the wires and other evidence of overheating, such as loss of lubrication or pitting of the wires caused by electrical arcing, etc., may be detrimental.
A sling which has been exposed to excessive temperatures for an excessive length of time may have a significantly reduced strength.
Where such conditions are identified, the sling shall be withdrawn from service and referred to a competent person for examination.

A.8 Damaged or defective fittings, ferrules or splices:
Particular attention shall be paid to signs of

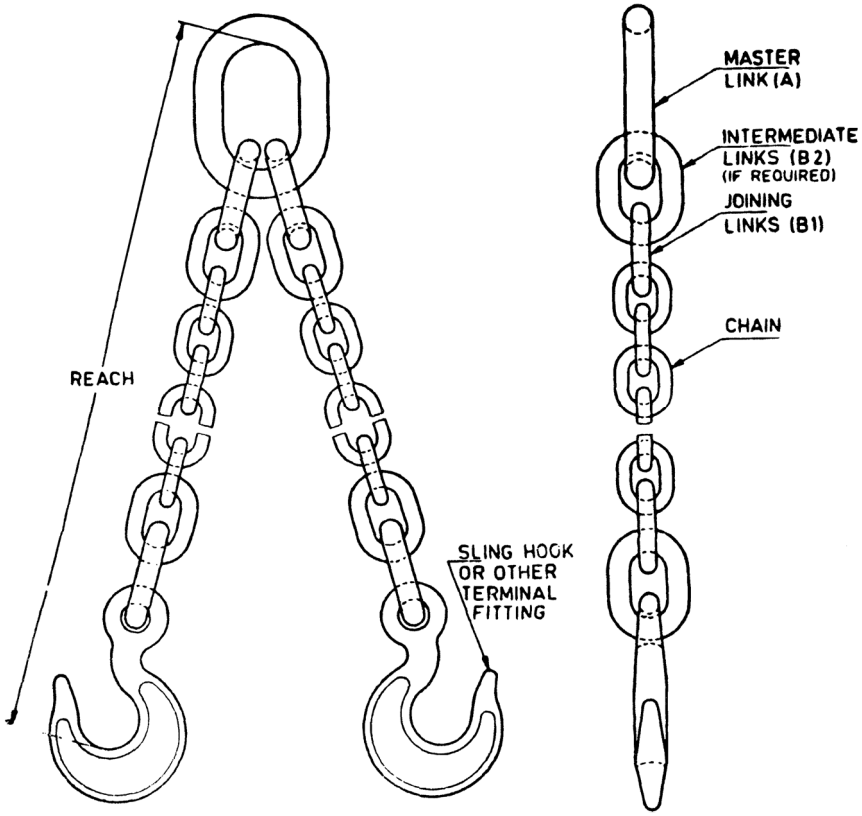
a) opening up, distortion or cracking of the hook;
b) distortion and wear of links or closing of the thimble;
c) cracks in the ferrule;
d) severe crushing or abrasion of the ferrule or hand splice;
e) pulling out of splice or ferrule;
f) concentrations of broken wires near to the ferrule or splice, or in the splice;
g) the effect of bursting stress at the throat of the eye due to the use of a pin of excessive diameter or certain types of thimble;
h) fractured wires on the outside surface of the eye, e.g. where a soft eye has been used with an excessively small pin;
i) effect of friction on bearing surface of a soft eye

The conditions described under items a) and b) may be an indication of overloading and will usually be justification for withdrawin**g** the sling from service.

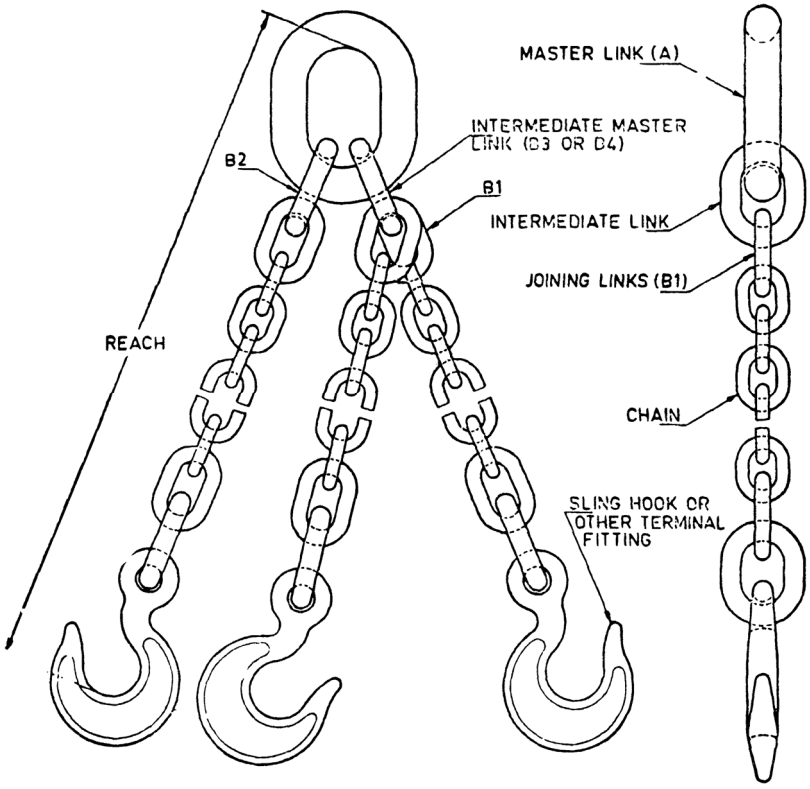
15.4 Chain Slings
Chain(s) should not be joined by means of bolts or wire and when shackles are used it is essential that the proper pins be fitted. Under no circumstances should chains be knotted. Chains and slings should never be dragged along the ground or floor.
Designation of chain slings
The following designations shall be used in specifying slings conforming to this standard.



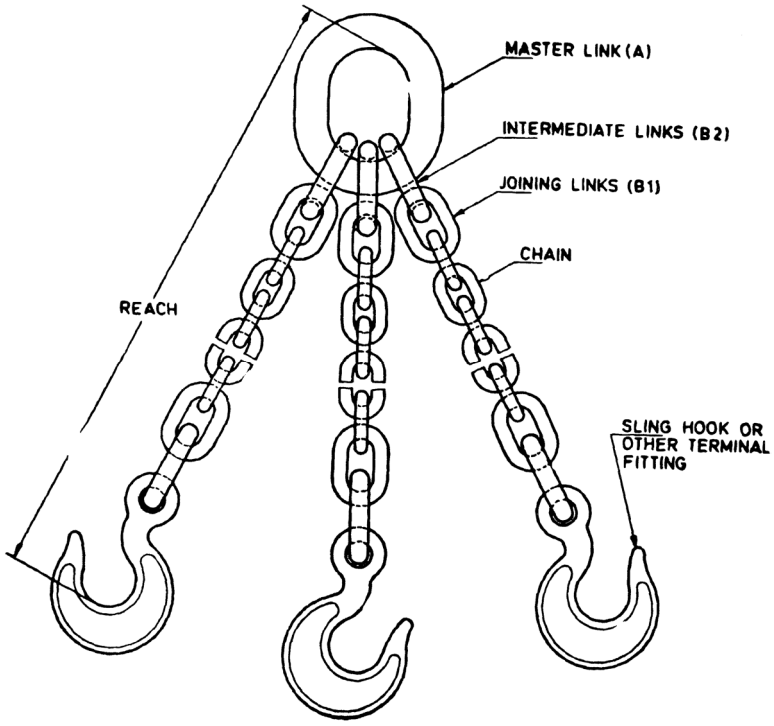
SINGLE-LEG SLING



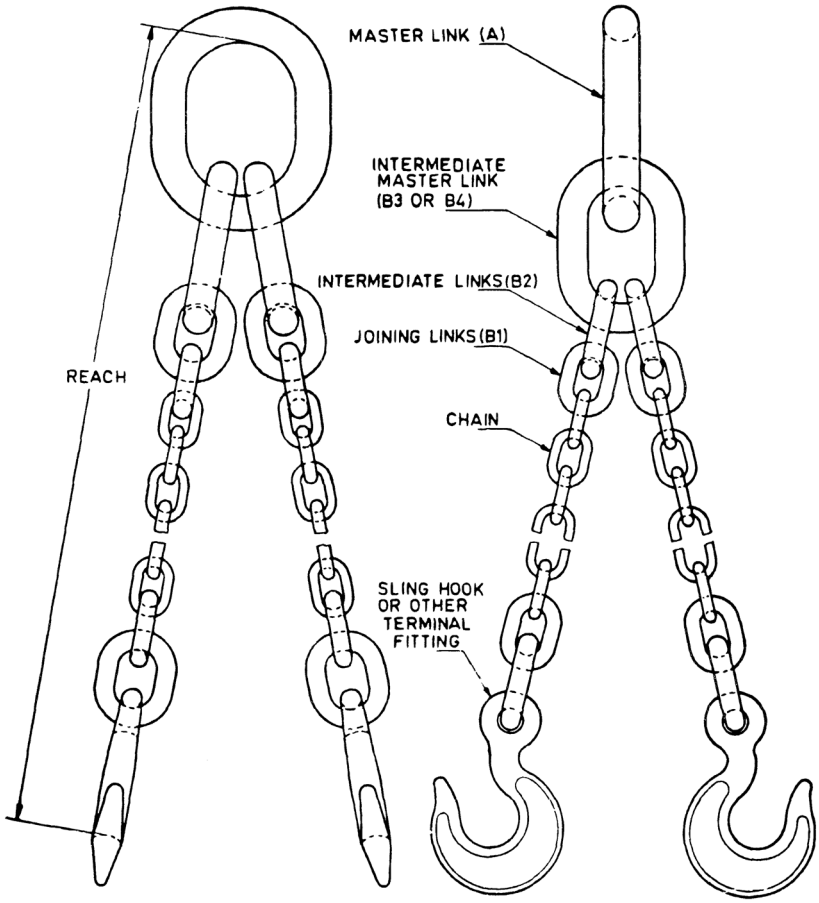
TWO-LEG SLING



THREE-LEG SLING



ALTERNATIVE CONSTRUCTION OF THREE-LEG SLING



FOUR-LEG SLING

Nominal Size — The nominal size of a chain sling is the nominal size (dn) of the short link chain used in its manufacture.

The nominal size of each individual master link, joining or intermediate link is the nominal diameter of the material from which it is made.

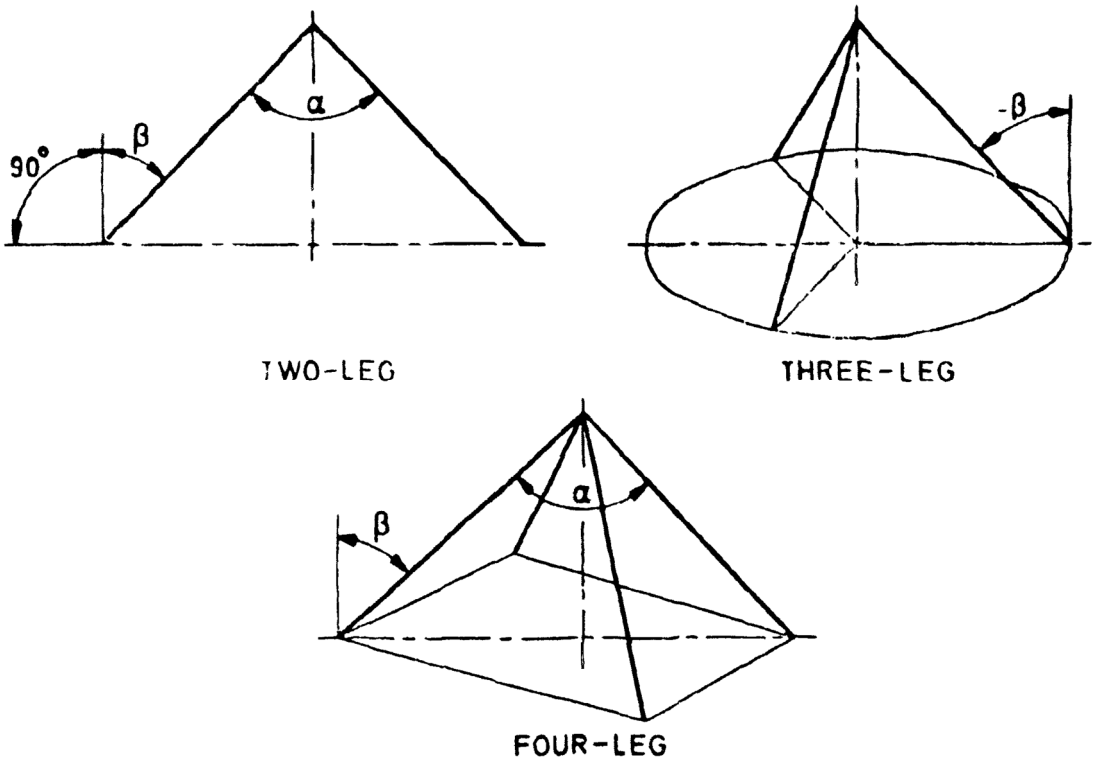
Nominal Reach of Sling (L) — The nominal reach of the finished sling is the effective length from the inside of the lower terminal fitting to the inside of the upper terminal fitting (see Fig. 4).

The Grade of a Sling — The grade of a sling shall be the same as the grade of the chain used, that is, L, M, S or T corresponding to Grades 30, 40, 63 and 80 chains respectively. All components used in the construction of a sling shall be made from the same grade.

Rating

Single Branch Sling — Single branch slings shall have a working load limit equal to that of the Chain used in their construction.

Multi-Branch Slings — Multi-branch slings shall be rated at a uniform working load limit for any angle between branches of 0-90° (0-45° to the vertical) or additionally at a uniform working load limit for any angle between branches of 90-120° (45-60° to the vertical).



INCLINATION OF SLING LEGS

Uniform Load Method

a) Double branch slings:

For all angles between branches from 0-90° (0-45° to the vertical)
WLL = 1.4 × WLL of a single branch made from similar chain.
When additionally marked for angles between branches of 90-120° (45-60° to the vertical)
WLL = 1 × WLL of a single branch made from similar chain.

b) Three and four branch slings:

For all angles between branches from 0-90° (0-45° to the vertical)
WLL = 2.1 × WLL of a single branch made from similar chain.
When additionally marked for angles between branches of 90-120° (45-60° to the vertical)
WLL = 1.5 × WLL of a single branch made from similar chain.

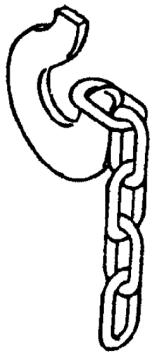
NOTE — In the case of a three branch sling the angle between branches shall be taken as twice the angle to the vertical, that is, 2 ×.

In the case of a four branch sling the angle between branches shall be that between diagonally opposite branches.

Nominal Rating — The nominal rating of any multi-branch sling whether rated by the uniform load method shall be the WLL for that sling when used at an angle of 90° between the branches (45° to the vertical).

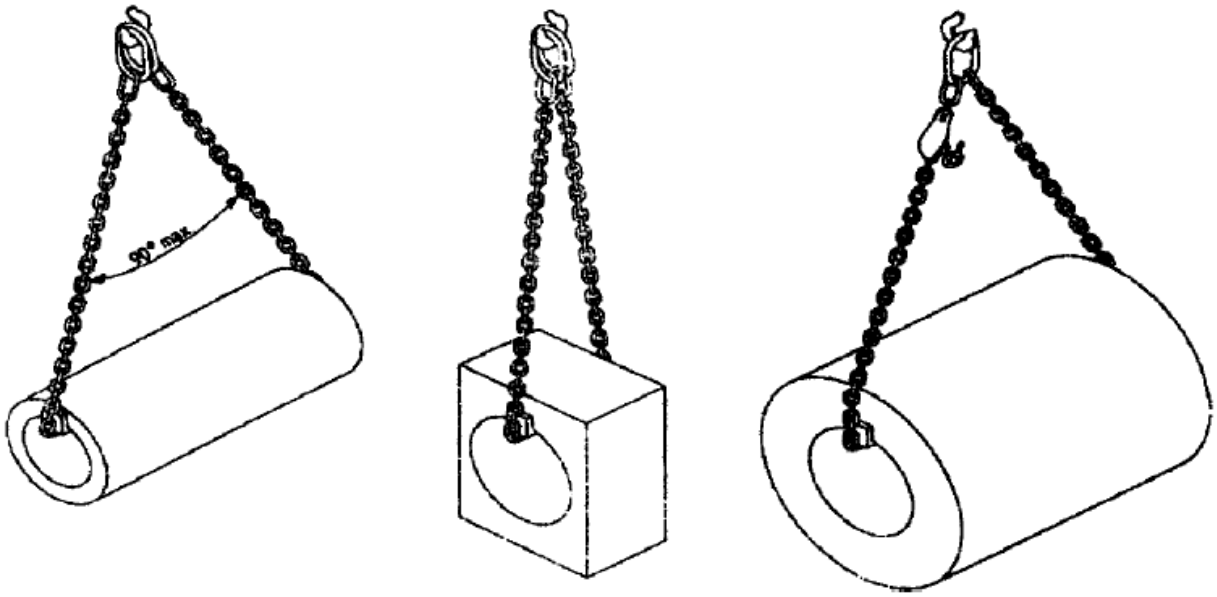
Handling the Load

4.1 A lifting chain is usually attached to the load and the lifting device by means of terminal fittings, such as hooks and links. Chains should be straight, without twists, knots or kinks. The load should be seated well down in a hook, never on the point or wedged in the opening; the hook should be free to incline in any direction so as to avoid bending. For the same reason, the master link should be free to incline in any direction on the lifting device hook. Egg or pear-shaped links should not be used as master links or as lower terminals in any situation where the link could be inverted leading to a wedging action and subsequent distortion of the link.

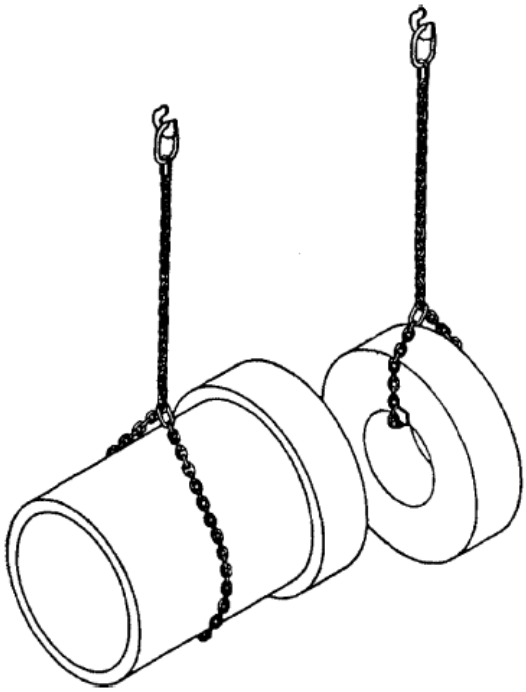


Avoided point loading of hook

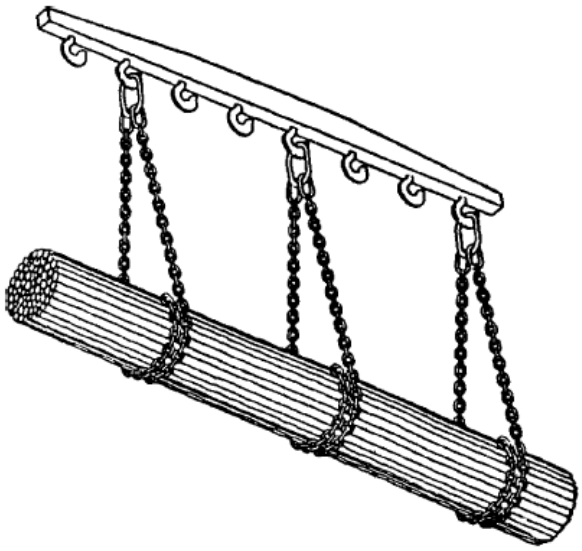
a. The chain may be passed under the load in a basket hitch or choke hitch It is necessary that in the case of a basket hitch where there is a danger of the load tilting, more than one chain sling be applied to the load, preferably in conjunction with a spreader beam.



Basket Hitch



Choke Hitch



Use of spreader beam

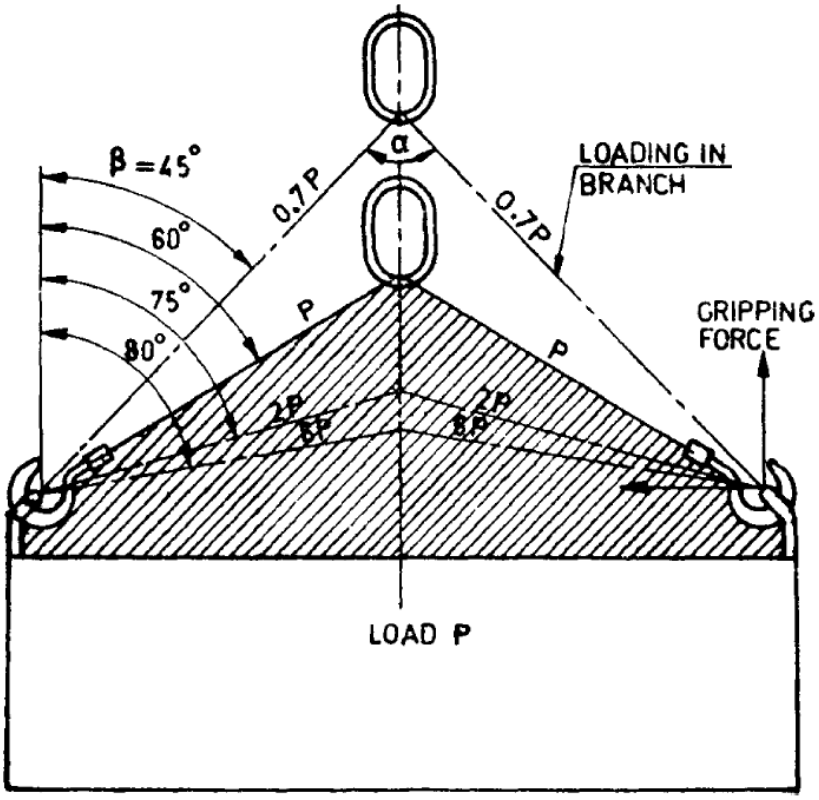
b. Damage to a chain may be caused by dragging it from under the load or by rolling a load on to it; these practices should be avoided.

c. When a choke hitch is employed, very high tensile forces are imposed and the use of a larger chain for a given load may be necessary. Alternatively, the sling should be de-rated as recommended by the manufacturer, or national legislation or standards. In the absence of such recommendations or requirements, the WL should not exceed 80 percent of WLL. Care should also be taken to avoid repeated engagement of the terminal fitting in the same link, as this will eventually cause damage.

d. All multi-branch slings exert a gripping force (see Fig.) on the load which increases as the angle between the sling branches is increased. Where hooks or other fittings are threaded on a loop of chain, for example, case slings and drum slings, the gripping force is much greater and consequently, the angle between such branches should not exceed 60° (30° to the vertical). Care should always be taken to ensure that the load to be moved is able to resist the gripping force without being damaged.

e. Packing may be required where a chain contacts a load, to protect either the chain or the load or both. A sharp corner of the hard material may bend or damage the chain links. Conversely, the chain may damage the load because of high contact pressure. Packing, such as wooden blocks, may be used to prevent such damage. Hands and other parts of the body should be kept away from the chain to prevent injury as the slack is taken up.

f. A tag line is recommended to prevent swaying or rotation of a load and to position it for landing.



Shaded portion indicates included angles between branches of greater than 120° (60° to the vertical) at which angles, slings should not be used.

VARIATION OF SLING BRANCH LOADING WITH BRANCH ANGLE FOR A GIVEN LOAD P

g. When ready to lift, the slack should be carefully taken up until the chain is taut, the load raised slightly and a check made that the load is secure and remains level; this is specially important with basket or other loose hitches where friction retains the load. If the load tilts, it should be lowered and the lifting device hook re-positioned towards the low end. This can be accomplished by repositioning the lifting points or by the use of shortening devices in one or more legs. When all is in order, the lift can proceed.

h. The load should be landed carefully. Before slackening the chain, a check should be made that the load is properly supported; this is specially important when several loose objects are in basket hitch and choke hitch.

i. When loads are accelerated or decelerated quickly, high dynamic forces occur which increase the stresses in the chain. Such situations which should be avoided, arise from snatch or shock loading, for example, from not taking up the slack chain before starting to lift or by the impact of arresting falling loads

15.4.1 Common Malpractices to be Avoided:

The following shall be particularly avoided:

a) Overloading slings and continuing to use chain after it has been stretched by overloading,

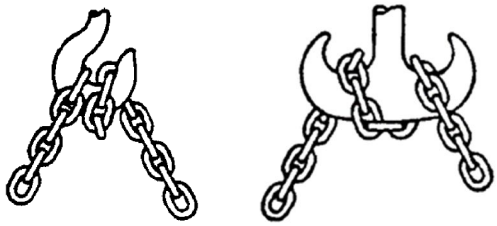
b) Using long link chain (that is, pitch > 3d) for lifting,

c) Using hoist chains as sling chains,

d) Using components of lower grade than the chain,

e) Using a sling with any broken or deformed links,
f) Connecting chain links with bolts or wires (See below),
g) Point loading of hooks
h) Wrapping the chain several times around a hook (See below) and
j) Using a worn out chain beyond the limits stated in (see 15.4.3.3)

Connection chain with bolt or wires



Wrapping the chain several times around a hook

15.4.2 Inspection

15.4.2.1 Frequent Inspection — This is a regular visual inspection by the operator or other designated personnel. No records need be kept of such inspections. The chain sling should be examined throughout its working length including all attachments to detect any evidence of wear, distortion or external damage. The frequency of these inspections should be related to severity of the service.
If faults are found during this inspection, the procedure given in **5.2** should be followed.

15.4.2.2 Periodic Inspection — This is a thorough examination by a competent person of which records should be made to provide the basis for a continuing evaluation.
Chain slings should be thoroughly cleaned so as to be free from oil and dust prior to inspection. Any cleaning method which does not damage the parent metal is acceptable. Methods to avoid are those that may cause hydrogen embrittlement, overheating, removal of metal or movement of metal which may cover cracks or surface defects.
Adequate lighting, free from shadows, should be provided and the sling examined throughout its length to detect any evidence of wear, distortion or external damage.
The sling should be withdrawn from service for maintenance and repair if any of the following faults are observed:

a) The sling markings are illegible, that is, information on the sling identification and/or the working load limit.
b) Distortion of the upper or lower terminal fittings.
c) Chain stretch — If the chain links are elongated or if there is any lack of free articulation between the links or noticeable difference in the branch length of multi-branched slings, the chain may have been stretched. Where possible, as an initial inspection procedure, it is recommended that the actual reach of the sling be measured and recorded. This procedure allows a rapid indication of major deviation from the original product.
d) Wear — Wear by contact with other objects usually occurs on the outside of the straight portions of the links where it is easily seen and measured. Wear between adjoining links is

hidden. The chain must be slack and the adjoining links rotated to expose the inner end of each link.

e) Cuts, nicks, gouges, cracks, excessive corrosion, heat discolouration, bent or distorted links or any other defects in chain or fittings. Shallow and rounded indentations in areas of low tensile stress may not be significant but deep nicks in high tension areas and sharp transverse nicks are unacceptable.

f) Signs of opening out of hooks, that is, any noticeable increase in throat openings or any other form of distortion in the lower terminal fitting. The increases in throat opening should not exceed 10 percent of the nominal, or be such as to allow the safety catch, if fitted, to become disengaged.

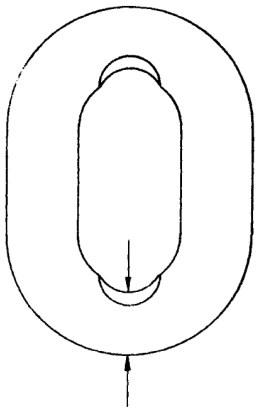
g) In correct assembly of the mechanical joining devices in slings of non-welded construction (refer to manufacturer's instructions).

15.4.3 Maintenance and Repair

15.4.3.1 The repair or replacement of individual links, fittings or lengths of chain should only be carried out by the manufacturer or by those organizations which have the necessary knowledge and equipment (such as welding, heat-treatment, proof testing and crack detection facilities).

15.4.3.2 Links that are cracked, visibly bent or twisted, severely corroded or have deposits which cannot be removed should be discarded and replaced, as should visibly distorted components.

15.4.3.3 Inter-link wear may be tolerated until the thickness of the material at the point of contact has been reduced to 80 percent of the nominal diameter (0.8 dn). In those cases where wear occurs at more than one point on the same cross-section, the mean diameter should be measured and such wear may be tolerated until the mean diameter has been reduced to 90 percent of the nominal diameter (0.9 dn).



Inter-Link Wear on Links

15.4.3.3.4 Where appropriate, for example, in the case of large hooks and sling fittings, minor defects, such as nicks and gouges, may be removed by careful grinding or filing. Following repair, the surface should blend smoothly into the adjacent material without abrupt change of section. The complete removal of the defect should not reduce the thickness of the section at that point by more than 10 percent.

15.4.3.5 In the case of slings whose repair has involved welding, each repaired sling shall be proof tested and inspected before it is returned to use. However, where repair is accomplished by the insertion of a mechanically assembled component, proof testing is not required provided that the component has already been proof tested by the manufacturer.

A proof force has been established for each size and grade of chain sling. These are given in the relevant Indian Standards which should be consulted.

15.4.3.6 If the tag or label identifying the sling and its Working Load Limit (WLL) becomes detached and the necessary information is not marked on the master link itself, or by some other means, the sling should be withdrawn from service.

15.4.4. Storage and Care of Chain Slings

15.4.4.1 Chain slings should normally be kept on a properly designed rack. They should not be left lying on the ground after use where they may be damaged.

15.4.4.2 If the chain slings are to be left suspended from a crane hook, the sling hooks should be engaged in an upper link.

15.4.4.3 If chain slings are expected to be out of use for some time they should be cleaned (see **15.4.2.2**), dried and protected from corrosion for example, lightly oiled.

Note — Chain slings should not be galvanized or subjected to any plating processes without the approval of the manufacturer.

15.4.5. Record Keeping

15.4.5.1 Adequate records are essential for the proper use and maintenance of lifting equipment. The record is a continuous history of the chain sling and should show dates of inspection, testing and maintenance.

15.4.5.2 The initial record is a description of the chain sling and its identification markings. Inspection periods and test intervals should be determined and entered in the record.

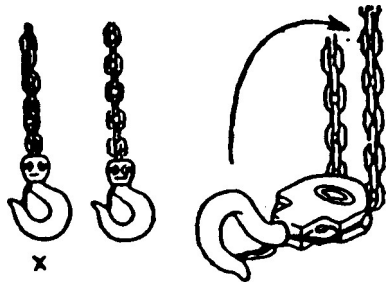
15.4.5.3 After each periodic inspection, the condition of the chain sling should be noted in the record, The results of each proof test should be recorded.

15.4.5.4 Each time the sling is repaired the reasons for, and the details of the repairs should be entered in the record.

16. RECOMMENDATIONS FOR SAFE USE AND MAINTENANCE OF HAND-OPERATED CHAIN PULLEY BLOCKS

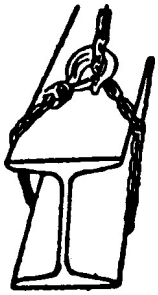
a) Never lift a load in excess of the safe working load marked on the block. The block has been proof-loaded to one- and-a-half times the safe working load, but this has been done under carefully controlled conditions. Use of the block at any load greater than the safe working load may result in damage.
b) Never use a load chain as a sling, that is, by back hooking.
c) Before use, examine the load chain to ensure that there is no twist. In the case of a block lifting on two falls, twist can arise from the bottom block being accidentally turned over.
d) Keep load chains well lubricated along their whole length and especially at the contact points between the links. In special circumstances, chain may be used dry, but their life will be considerably reduced.
e) If the load chain jumps, does not work smoothly or marks in use, it is probably out of pitch and should be replaced.
f) Do not allow, dirt and hard grease together in the pockets of the load or hand chain wheels.
g) Do not store, or leave the pulley blocks lying on the ground where they can collect dirt.
h) Chain pulley blocks are designed for lifting loads vertically and should not be used for pulling horizontally or at an angle.
i) Never lift with the point of the hook.

j) Never run the load chain out too far. When the block is run, out beyond the extended dimensions, an excessive and dangerous load is imposed at the load chain slack end anchorage.
k) All pulley blocks shall be registered and, at periodic intervals, should be thoroughly cleaned, inspected and lubricated.
l) Care shall be taken when replacing the chains
m) Check the suspension fixture for top hook for that the same grade of chain is fitted. Blocks shall be adequate strength to support the load being lifted and marked with the grade of chain. the weight of the chain pulley block.



1. No Twisting No capsizing

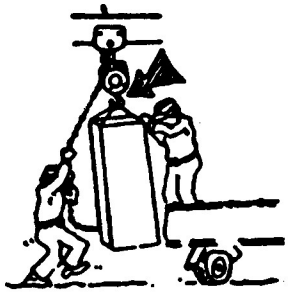
2. Sling load from the Centre of hook

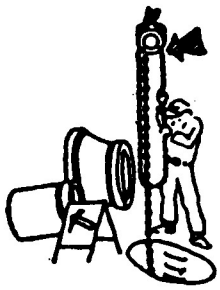


3. No direct binding of load with load chain

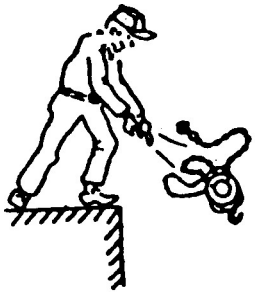
4. No overloading

5. No extreme slant slinging

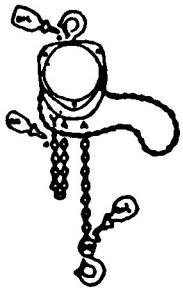




6. No over lifting No over lowering



7. No rough handling



8. Don't forget to oil the Load chain after use

Illustrations for the safe use of hand-operated chain pulley block

Schedule I

Register of periodic test & examination of lifting appliances and gears

Part I – A: Initial and periodic load tests of lifting appliances			
1 Situation and description of lifting appliances tested with distinguishing number/ marks, if any	2 Number of certificate of test and examination of competent person	3 I certify that on the date I have appended my signature, the lifting appliances shown in column I was tested and no defects affecting its safe working condition were found other than those shown in column 4	4 Remarks, to be signed and dated with seal
1 2 3			

Part I – B: Annual thorough examination I certify that on the date on which I have appended my signature, the lifting appliance shown in column 1 was thoroughly examined and no defects affecting its safe working conditions were found other than those shown in column 11						
5 Date & signature with seal	6 Date and signature with seal	7 Date and signature with seal	8 Date and signature with seal	9 Date and signature with seal	10 Date and Signature with seal	11 Date and signature with seal
1 2						

Part II

Initial and periodical load test of loose gear and annual thorough examination List of loose gears:

The following classes of loose gear, namely –

Chains made of malleable cast iron;
Plate link chains;
Chains, rings, hooks, shackles and swivels made of steel;
Pitched chains;
Rings, hooks, shackle and swivels permanently attached to pitched chains;
Pulley blocks, containers, spreaders, trays, slings, baskets, etc. and any other similar gears;
Hooks and swivels having screw threaded parts or ball bearings or other casehardened parts;
Bordeaux connections.

<table>
<tr><th colspan="5">Initial test and periodical load test of loose gears</th></tr>
<tr><td rowspan="2">1
Distinguishing number or marks</td><td rowspan="2">2
Description of loose gear tested and examined</td><td rowspan="2">3
Number of certificate of test and examination of competent person</td><td colspan="2">I certify that on the date to which I have appended my signature, the loose gears shown in column 1 and 2 were tested and no defects affecting the safe working condition were found other than those shown in the remark column 6</td></tr>
<tr><td>4 Date and signature with seal</td><td>5 Date and signature with seal</td></tr>
<tr><td colspan="5">1
2
3</td></tr>
<tr><th colspan="5">Annual thorough examination of loose gears</th></tr>
<tr><td rowspan="2">6
Remarks, to signed & dated</td><td colspan="4">I certify that on the date to which I have appended my signature the loose gear shown in column 1 and 2 were thorough examined by me and no defects affecting their safe working condition were found other those shown column 10</td></tr>
<tr><td>7
Date and signature with seal</td><td>8
Date and signature with seal</td><td>9
Date and signature with seal</td><td>10
Date and signature with seal</td></tr>
<tr><td colspan="5">Part III
Annealing of chains, rings, hooks, shackles and swivels (other than those exempted)</td></tr>
</table>

1 Distinguishing number or marks	2 Description of gear annealed	3 No, of certificate of test & examination	I certify that on the date on which I have appended my signature, the gear described in column 1 & 2, was effectively annealed under my supervision; that after being so annealed, every article was carefully inspected and that no defects affecting its safe work condition were found other those shown in column 7	7 Remarks, signed and sealed

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