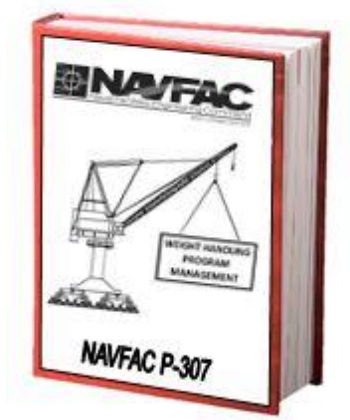
NAVFAC
Naval Facilities Engineering Systems Command
NAVY CRANE CENTER

Navy Crane Center



NAVFAC P-307 Training

MECHANICAL CRANE INSPECTOR

WEB BASED TRAINING STUDENT GUIDE

NCC-MCI-02

Naval Facilities Engineering Command
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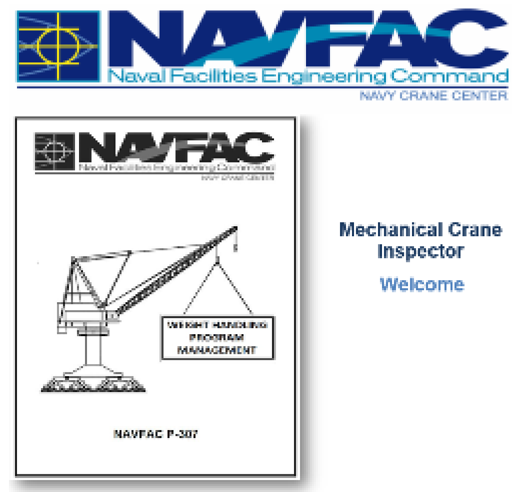
INTRODUCTION

Welcome
Welcome to the Mechanical Crane Inspector course.



Course Description
Mechanical Crane Inspector is designed to acquaint mechanical crane inspectors with Navy requirements for the safe inspection of mechanical components on Navy cranes and provide a knowledge base on which to build upon with on-the-job experience.

Mechanical Crane Inspector Course

Mechanical Crane Inspector is designed to:

- acquaint mechanical crane inspectors with Navy requirements for the safe inspection of mechanical components on Navy Cranes.
- provide a knowledge base on which to build upon with on-the-job experience.

PREREQUISITES:

NAVFAC P-307 Crane Mechanic Course
NAVFAC P-307 Mobile Crane Mechanic (if inspecting mobile Cranes)

Topics Covered
The topics covered in this course include inspection and documentation requirements for wire rope, structural components, brakes, hoist drive trains, and shaft alignments.

Mechanical Crane Inspector

Mechanical Crane Inspector covers ***Inspection*** and ***documentation*** requirements for:

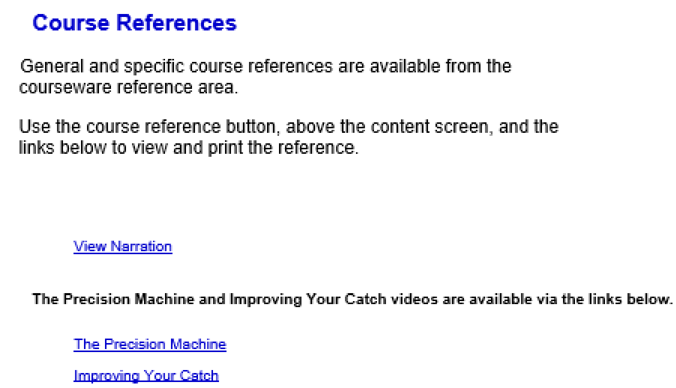
- wire rope
- structural components
- brakes
- hoist drive trains
- shaft alignments

Mechanical Crane Inspector Modules

The Mechanical Crane Inspector course presents modules on structural and wire rope inspections.

References

Support materials for this course can be located and obtained from the course reference area.



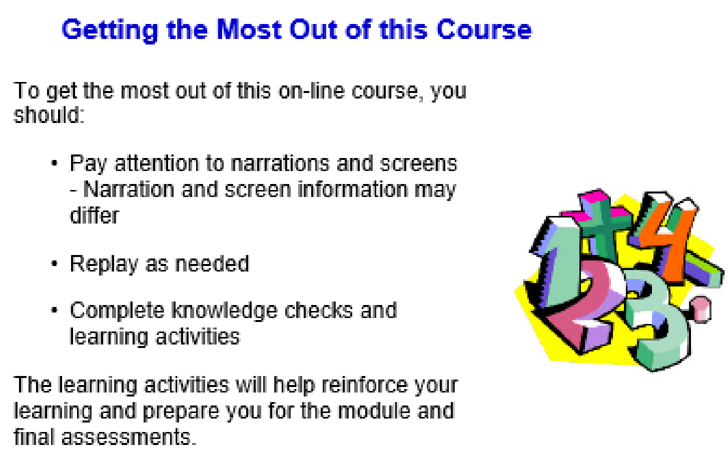
Getting the Most Out of this Course

To get the most out of this training:

Pay close attention to the narrations and information provided on each screen. There may be information in the narration that is not shown on the screen. And vice-a-versa, there may be information on the screen that is not contained in the narration.

Replay narrations and screen content as often as needed by clicking on the topic title or the tab title, as applicable.

Complete all knowledge checks and module quizzes to help re-enforce your understanding of the material covered.



Navigating Through This Course

AS YOU NAVIGATE THROUGH THIS COURSE, YOU WILL FIND SEVERAL HELPFUL TOOLS AND FEATURES THAT WILL FACILITATE YOUR LEARNING. THIS INTERACTIVITY ENABLES YOU TO EASILY NAVIGATE AND ACCESS VARIOUS TRAINING AIDS AND TOOLS USING THE FOLLOWING BUTTONS:

•THE TOPIC LIST IF PRESENT (ON THE LEFT), DISPLAYS THE TOPICS WITHIN THE MODULE. TOPICS CAN BE SELECTED BY CLICKING ON THE TITLE.
•THE NAVIGATION BUTTONS (TOP RIGHT) LOOK LIKE ARROW HEADS AND ALLOW YOU TO MOVE FORWARD TO THE NEXT SCREEN OR BACKWARD TO THE PREVIOUS SCREEN BY CLICKING ON THE ARROWHEAD POINTING TO THE RIGHT OR LEFT, RESPECTIVELY.
•THE 'HOME' BUTTON (TOP RIGHT) RETURNS YOU TO THE MAIN MODULE MENU.
•THE 'REFERENCE' BUTTON (TOP RIGHT) ALLOWS YOU TO VIEW VARIOUS REFERENCES, DOCUMENTS, OR PICTURES PROVIDED TO SUPPORT YOUR LEARNING EXPERIENCE.
•THE 'VIEW NARRATION' LINK (LOWER LEFT ON THE CONTENT SCREEN) ALLOWS YOU TO VIEW A TEXT VERSION OF THE AUDIBLE NARRATION.

Navigating Through This Course

Interactive navigation features:

- Facilitate your learning
- Access various learning tools

Buttons include:

- The topic list displays the topics within the module
- The navigation buttons (forward and reverse) to the next or previous screen
- The home button returns you to the course module menu
- The reference button accesses references, documents, and pictures
- The view narration link allows you to view a text version of the audible narration

Reference Area

Some courses require you to refer to other documents when completing the modules, exercises, and final exams. These documents are available in the reference area and can be copied to your computer or printed.

Load Test Director and General Crane Safety are two such courses and require you to have the load chart or certification packages handy. Note that the reference button is not available when taking the final exam.

Student Guides are also available from the reference area.

The Reference Area

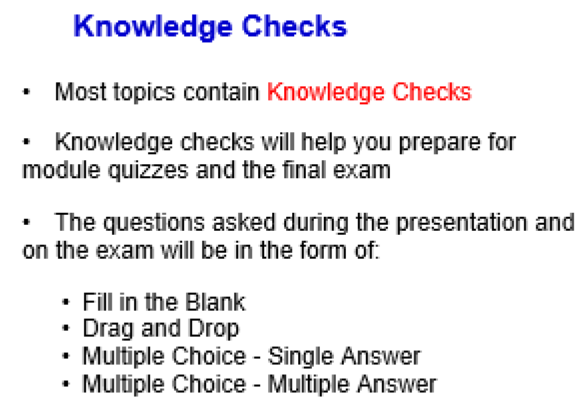
Select the link below to view and/or print NAVFAC P-307

NAVFAC P-307

Knowledge Checks

These courses use various types of questions to help you retain the material presented. As you proceed through each topic, you will be asked questions in the form of knowledge checks.

The knowledge checks will help you prepare for the module quizzes and final exam. Question types include: Fill in the Blank, Drag and Drop, Multiple Choice - Single Answer, Multiple Choice - Multiple Answer, and True/False.



Exam Directions

When taking exams, keep the following in mind…

Some questions require multiple answers and have check boxes next to the choices.

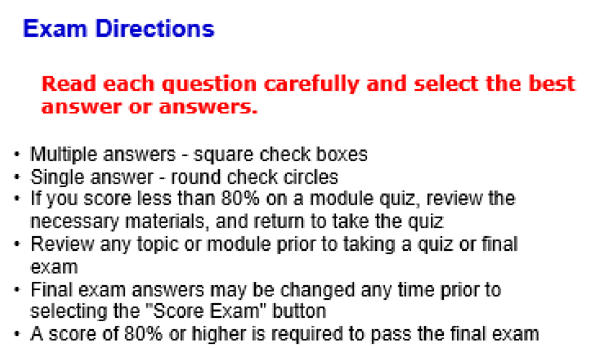
Single answer questions have circles next to the choices.

If you score less than 80% on a module quiz, review the necessary content, then return to retake the quiz.

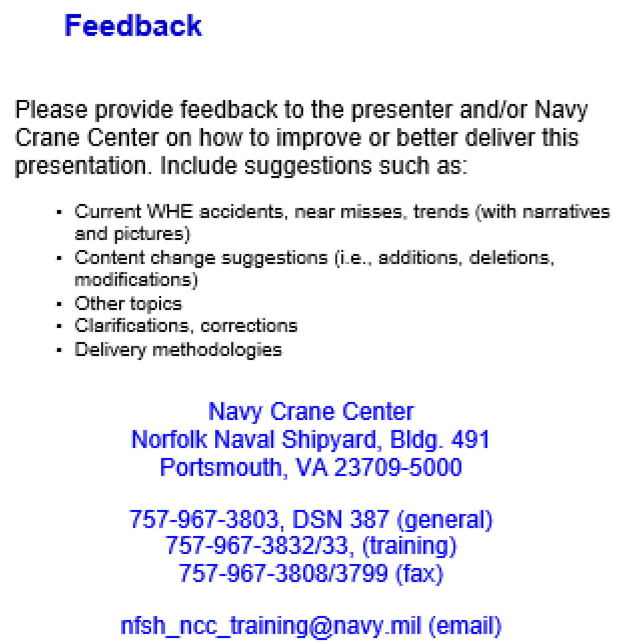
You can go back and review any content prior to taking a quiz or final exam. You can review and change your answers any time before you select the 'Score Exam' button. A score of 80% or higher is required to pass.

The final exam score will be recorded in the Navy eLearning system and on your completion certificate.

If you fail a course, you can re-enroll and retake the course.



Feedback: Help Us Help You

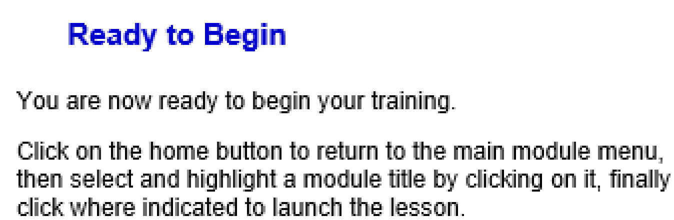


Upon completion of the training, or at any time during the training, please feel free to provide feedback to Navy Crane Center on how to improve or better deliver this presentation. Include suggestions such as:

•Current WHE accidents, near misses, trends (with narratives and pictures)
•Content changes, additions, deletions
•Other topics
•Clarifications, corrections
•Delivery methodologies

Contact information is provided on the screen and in the student guide. You can come back to this screen at any time prior to passing the final exam. After passing the final exam, the course will roll up, your information will go to "My Transcripts", and the course content will no longer be available. However, you may still refer to the student guide for contact information or you can go to the Navy Crane Center's training web page and provide feedback via the links found there.

Ready to Begin



YOU ARE NOW READY TO BEGIN YOUR TRAINING. NAVIGATE BACK TO THE MAIN MODULE MENU, SELECT THE NEXT MODULE, AND BEGIN YOUR TRAINING. GOOD LUCK.

NOTES:

NAVFAC P-307 INSPECTIONS 1

Welcome

Welcome to NAVFAC P-307 Inspections 1.

Instructional Objectives

Upon successful completion of this module, you will be able to: state the requirements for performing crane maintenance inspections, state the requirements for documentation of crane deficiencies, and list the documents required for the Crane History File.

Inspections

NAVFAC P-307 covers inspection requirements in Sections 3, and 4, record retention requirements in section 5, and provides inspection attributes, criteria, and sample forms in appendices C and D. Inspections are performed at frequencies required by NAVFAC P-307. Examination shall be by sight, sound, touch, and as necessary instrumentation non-destructive testing, and disassembly.

Inspection Safety

Primary emphasis during inspections shall be given to ensure maximum safety by maintaining all load bearing and load controlling parts and operational safety devices in a safe and sound working condition.

Inspectors shall not engage in calculated risks or depend on their judgment alone where there is a doubt in their mind regarding a questionable condition.

Questionable conditions of load bearing and load controlling parts and operational safety devices shall be referred immediately to the activity engineering organization and, if necessary, to the certifying official for resolution.

Contact the Navy Crane Center for engineering assistance if necessary.

Inspections

- Primary emphasis should be on safety
- Inspectors should not take calculated risks
- Refer questionable conditions to higher authority

Maintenance Inspection Specification and Record (MISR) Forms

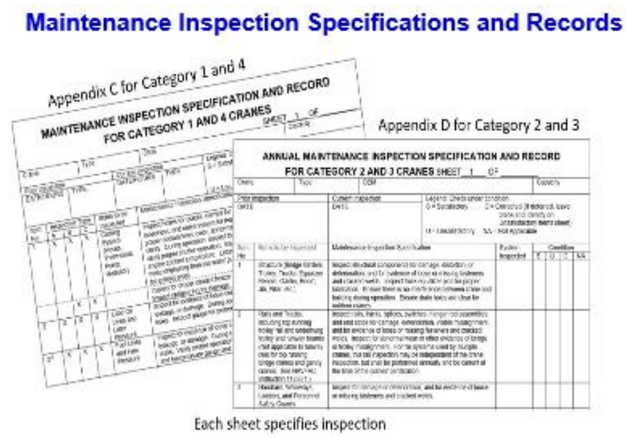
Maintenance Inspection Specification and Record (MISR) forms are identified in NAVFAC P-307, Appendices C and D. These prescribe the type of inspection (A, B, C, or Annual), the components and parts to be inspected and the inspection action.

The extent of disassembly shall be as noted. Each activity shall develop Maintenance Inspection Specification and Record (MISR) forms in accordance with the sample formats shown in Appendices C and D.

For unique items not covered, additional inspection attributes shall be included.

Inspection Specification forms for Category 4 cranes shall be developed by the activity based on applicable portions of Appendix C and as recommended by the OEM.

Maintenance Inspection and Specification Record (MISR)



Here is an example of a Maintenance Inspection and Specification Record, or MISR. The MISR pictured here is found in Appendix C and contains the inspection criteria and documentation requirements for category 1 and 4 cranes. Appendix D contains the A-MISR used for category 2 and category 3 cranes. As you can see, each item identifies the component, system, inspection type, inspection requirements, and inspection results.

Specification Data Sheets

Each activity shall augment the specifications noted above with specification data sheets.

These shall contain all guidance and technical information needed by inspectors in checking for wear, adjustments, settings, and tolerances during inspections.

This information shall be extracted from OEM's technical manuals and other authoritative technical sources. Measurement locations for verifying settings shall be clearly identified.

Brake Data Sheet

Here is an example from NAVFAC P-307 of a brake specification data sheet.

It contains all the pertinent data necessary for a thorough inspection of the brake. It includes information such as torque spring length, armature air gap, and lining thickness.

Notice that there are enough spaces on the form for nine different brakes. If your crane has more than this you would use two forms.

Inspections & Corrective Actions

Inspection conditions and corrective actions must be documented.

MISR forms shall be used to record conditions at each inspection. These shall be filed in the equipment history file.

All inspection conditions shall be recorded as satisfactory, unsatisfactory, or not applicable.

Where measurements are specified or required for acceptance, the actual readings shall be recorded.

Deficiency Reports

Deficiencies and corrective actions to load bearing and load controlling parts and operational safety devices shall be documented. Deficiency reports must be filed in the equipment history file.

Shown is a sample of the form used to report deficiencies to the Navy Crane Center.

Deficiencies include failure or malfunction of equipment, improper engineering, inspection, or maintenance procedures, and major or unsafe discrepancies between design drawings and equipment configuration. This does not include normal wear on the equipment.

In those instances where deficiencies are detected that have applicability at other Navy activities, the Navy Crane Center shall be notified within five days of the discovery. A summary report of the deficiency, including corrective actions taken or recommended, shall be forwarded to the Navy Crane Center within 21 days.

Unsatisfactory Conditions

Where an unsatisfactory condition is found, the item shall be identified on the "Unsatisfactory Items" sheet together with a statement of the condition observed.

Corrective action in terms of adjustments, repairs, or replacements of items shall be detailed on a shop repair order or other appropriate document and be identified on the "Unsatisfactory Items" sheet together with a statement of the condition observed.

Replacement Parts

Replacement parts are a concern when doing crane repairs.

Replacement load bearing and load controlling parts and safety devices shall be identical to those of the original design.

Where circumstances require substitution of either material or design configuration, such matters shall be approved by the activity engineering organization, or Navy Crane Center.

Re-inspection

Re-inspection is sometimes required for work done.

Where adjustment, repair, or replacement has been performed satisfactorily and the original unsatisfactory condition eliminated, the inspector shall sign the repair document to verify actions taken have corrected the reported deficiency.

Re-inspection shall include an operational test, where necessary.

Deferral of Maintenance Inspections, Lubrication, or Servicing/Maintenance

Deferral of Maintenance Inspections, Lubrication, or Servicing/Maintenance may exist under the following conditions:

When an emergent or other contingent condition exists precluding the timely completion of a MISR/maintenance item, the certifying official may authorize the deferral. Technical justification shall be provided. Each deferral and justification shall be in writing and shall be filed in the equipment history file. If the crane certification is extended per paragraph 4.5.1, a written deferral of the maintenance inspection/lubrication and servicing schedules is not required. The deferral shall be completed as soon as the emergent or contingent condition is resolved.

Equipment History File

Each activity shall establish and maintain an individual equipment history file on each crane.

The equipment history file, or history jacket as it’s commonly called, shall contain the documentation discussed in NAVFAC P-307, section 5.

The files shall be made available to government oversight agencies (e.g., OSHA, Navy Crane Center) upon request.

The equipment history file shall contain the documentation which we will discuss next.

Maintenance Inspections

The minimum record retention requirements for Type A Inspection documentation is to keep the latest inspection document plus the previous two inspection documents (if on a calendar basis), or the latest plus the previous two years (if on an engine hour operating basis).

For Type B and C Inspections, the latest inspection document plus one previous inspection document will be retained.

For Annual Inspections, the latest inspection plus previous Load Test year.

Maintenance Inspections

Types	Minimum Retention Requirement
"A" Inspection	Latest plus previous 2
"B" Inspection	Latest plus previous 2
"C" Inspection	Latest plus previous 2
Annual Inspection	Latest plus previous load test year

Operator's Daily Checklist

The Operator's Daily Checklist or ODCL shall be kept on file as follows: current month plus previous month, current month plus two previous months for cranes used in construction, and current month plus five previous months for 3rd party certified cranes.

Shop Repair Orders

Shop Repair Orders (SRO), or other repair documents must be included.

SRO's for repairs to load bearing/load controlling parts and operational safety devices must be included and kept in the record for seven years.

Repairs to all other components must be left in the record for one year.

Shop Repair Orders

Seven Years

Load Bearing, Load Controlling Parts and Operational Safety Devices

One Year

All others

Work Documents Invoking Crane Alterations

All crane alteration documentation, including approval, installation, and certification paperwork, whether approved by the local activity or by Navy Crane Center, shall be kept in the equipment history file for the life of the crane.

Work Documents Invoking Crane Alterations

The latest Non-Destructive Test Reports for any component must be included.

Crane Condition Inspection Record

Crane Condition Inspection Record requirements are: the current (including interim's), plus the previous load test year.

Certification of Load Test

The Certification of Load Test for each crane must appear in the history file.

Include the current with any interim's and extensions, plus one previous load test certification.

Third Party Certifications

For cranes which require Third Party Certifications, the current plus one previous certification must be included.

Wire Rope Records

For new cranes and for replacement wire rope on existing cranes, the history jacket must include the latest Wire Rope Breaking Strength Certification Record.

This is the rope manufacturer's certification that the rope meets the published breaking strength, or the actual breaking strength of a sample taken from the reel and tested.

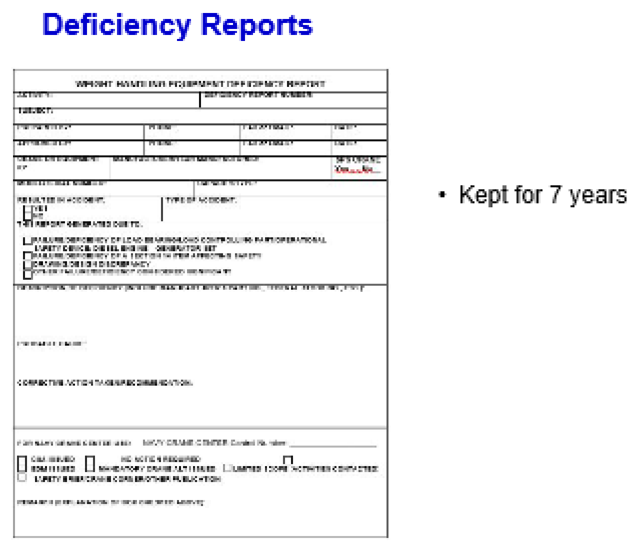
For cranes used in cargo transfer operations, certification of actual breaking strength is required.

Crane Alterations

All crane alterations, whether approved by the local activity or by Navy Crane Center, shall be kept in the equipment history file for the life of the crane.

Deficiency Reports

Deficiency reports for load bearing or load controlling parts or operational safety devices must be maintained for seven years.

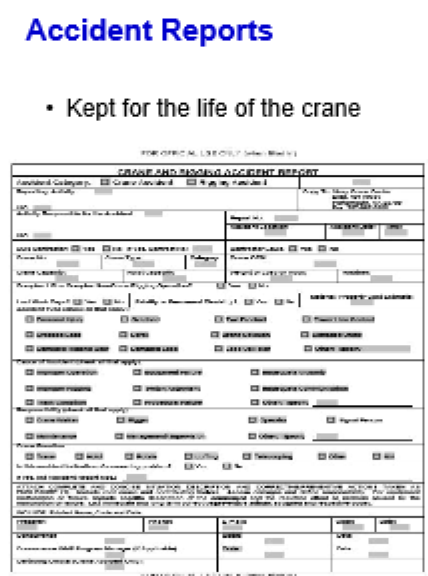


Purchase Contracts

Any purchase contracts for the crane shall be retained in the history file for the life of the crane.

Accident Reports

Crane Accident Reports are kept in the history file for the life of the crane.

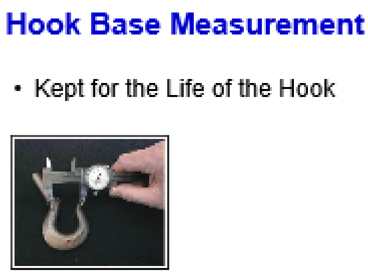


Hook Base Measurement

Hook Base Measurement must be included in the history file and is kept for the life of the hook.

Hooks must be marked and measured before installation to provide the base measurement.

When measured as part of the annual certification, the new measurement is compared to the base measurement on record.



Lifts Exceeding Capacity

Records of any operational lifts made which exceed the rated crane capacity must be kept in the Equipment History File for the life of the crane.

The crane must not be overloaded without Navy Crane Center approval. Requests must verify that there are no other safer means available (including leased equipment) to make the lift.

Specification Data Sheets

Specification Data Sheets must be kept for the life of the crane.

This will allow brake readings and other measurements to be compared with the original specifications.

Crane Acceptance Test

The records of the original Crane Acceptance Test shall be maintained for the life of the crane.

Ancillary Equipment Procedures

The manufacturer's instructions for the operation of ancillary equipment, (for example how to correctly set up a fly away jib) should be kept with the Equipment History File for the life of the crane. Completed procedures when used must be kept for seven years.

Crane Roller Clearance Data Standard of Acceptance

The 'crane roller clearance data standard of acceptance' for balance deck design cranes shall be kept in the equipment history jacket for the life of the crane.

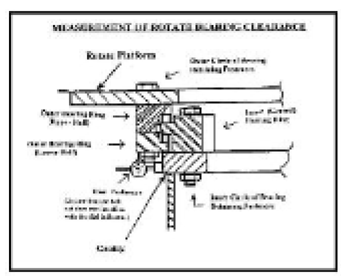
Crane Roller Clearance Data Standard of Acceptance

- Kept for the life of the crane
- For balance deck design cranes

Slewing Bearing Clearances

The bearing clearance readings for the slewing bearings shall be maintained for the life of the bearing.

Slewing Bearing Clearances



- Kept for the life of the bearing

Oil or Vibration Analysis Data

Results of oil or vibration analysis shall be kept for the life of the component.

When tests like these are done, the first set of test data becomes the baseline to which subsequent test data are compared to determine if detrimental wear is taking place.

Note: The same equipment or process should be used each time to be sure that results will be valid.

An alternative to these tests is an inspection report of the internal gears of the component, which will involve disassembly.

Floating Crane History File

The equipment history file for floating cranes must include: the latest Material Inspection per OPNAVINST 4780.6, plus the previous year, and shall include any waivers of depot availability.

The crane portion of a floating crane is handled like any other crane, but the barge is a naval vessel and there are special requirements for dry-docking, hull fitness inspections, void inspections, and so forth.

Material Inspection Report for Floating Cranes

- Reference OPNAVINST 4780.6
- Latest plus previous year
- waivers of depot availability

Coupling Alignment Data

The equipment history file must also include coupling alignment data.

The latest alignment data must be on file.

Coupling Alignment Data

- Latest alignment data kept on file

Review and Summary

This module covered: requirements for performing crane maintenance inspections, requirements for documenting crane deficiencies, and the records required for the Crane History File.

NAVFAC P-307 Inspections 1 Overview Quiz and Summary

Knowledge Check

The next several screens contain questions relating to the covered material. Check your comprehension of the course content by answering these questions.

KNOWLEDGE CHECK

Note

The next several screens contain questions relating to the material covered in this module. Check your comprehension of the covered material by answering the following questions.

Select the best answer.

Q: Where in NAVFAC P-307 would you find the electrical inspection requirements for a bridge crane installed at a Navy Shore Activity?

- Appendix B
- Appendix C
- Appendix D
- Appendix E

Check

Tries Remaining: 3

Select the best answer.

Q: NAVFAC P-307 specifies which of the following for crane inspections?

- All listed inspections
- Frequency of inspections
- Type of inspections
- Required documentation

Check

Tries Remaining: 3

Select the best answer.

Q: What determines the minimum items to be inspected during the crane inspection?

- Your own good judgment and experience.
- The Maintenance Inspection Specification Record (MISR).
- Past inspections and problem areas.
- Written guidance from the certifying official.

Check

Tries Remaining: 3

Select the best answer.

Q: Which document augments maintenance inspection forms with additional technical data and specifications?

- ◯ Technical foot notes
- ◯ Data entry forms
- ◯ Naval Technical Review pages
- ◯ Specification data sheets

Check

Tries Remaining: 3

Select the best answer.

Q: Which of the following will NOT be found in the equipment history file?

- ◯ Crane Operator's Log Sheet
- ◯ Crane Operator's Daily Checklist
- ◯ Shop Repair Orders
- ◯ Maintenance Inspection Specification and Record

Check

Tries Remaining: 3

Select the best answer.

Q: Which of the following will NOT be found in the Equipment History File?

- ◯ Crane Condition Inspection Record
- ◯ Certification of Load Test
- ◯ Crane Location Record
- ◯ Non-Destructive Test Reports

Check

Tries Remaining: 3

Select the best answer.

Q: Which of the following will NOT be found in the Equipment History File?

- ◯ Purchase Contracts
- ◯ List of Applicable Drawings
- ◯ Crane Alterations
- ◯ Deficiency Reports

Check

Tries Remaining: 3

NAVFAC P-307 INSPECTIONS 2

Welcome

Welcome to NAVFAC P-307 Inspections 2.

Instructional Objectives

Upon successful completion of this module you will be able to: state NAVFAC P-307 requirements for the certification of cranes, identify the conditions which void the certification of a crane, and list the procedures for Crane Condition Inspection Reports or CCIR.

Crane Certification Program

Navy shore activities that possess Weight Handling Equipment shall have a Weight Handling Certification Program.

The commanding officer is responsible for ensuring safety within the activity. The commanding officer shall designate the Weight Handling certifying official(s), who shall ensure the activity's Weight Handling Equipment is inspected, tested, and certified in accordance with NAVFAC P-307. Certifications shall be based on the condition inspection and load test as prescribed.

These inspections and tests shall be performed by technically competent inspection and test personnel under the direction of a designated test director.

Upon successful completion of the condition inspection and load test, a Certification of Load Test and Condition Inspection shall be signed by the test director, inspection personnel, and the certifying official.

Inspections and Test

The purpose of the condition inspection is to ensure that the overall structural, mechanical, and electrical components of the equipment have been maintained in a safe and serviceable condition and are functioning properly.

The purpose of the load test is to ensure by controlled operation with prescribed test loads that the equipment is capable of safely lifting and moving the rated load through all design motions.

Annual Certification

The certification (for all crane categories) is valid for one year from the date of signature of the certifying official. A crane shall not be used in service without a valid certification.

Except as noted, the certification process shall include a load test. Category two and three cranes shall be inspected, operationally tested (without load), and certified annually, however, a load test shall be performed at every fourth annual certification, as a minimum. The certification shall indicate when a crane is in the quadrennial load test program. If an activity performs load testing at a periodicity other than annually or quadrennial, the test periodicity shall be noted on the certification form.

For floating cranes (including mobile cranes mounted on barges), as a condition for certification, the barge shall be determined fit for further service as evidenced by a current material inspection report and documentation of a current regular overhaul (ROH), or an approved deviation of ROH, as required by OPNAVINST 4780.6.

Annual Certification

- The certification is valid for one year from the date of signature by the Certifying Official (two years for certain cranes that may be certified biennially).
- Floaters must have barge inspection.

Interim Recertification

Interim certification is done based on the following:

Re-certification is required when the adjustment, repair, disassembly, alteration, or replacement of a load bearing part, load controlling part, or operational safety device on a crane must be a load tested to verify work performed.

To determine if a load test is required, the component's impact on holding strength shall be assessed. If holding strength could be affected by the work performed (i.e., failure to make the proper adjustment, repair, etc., could result in dropping, uncontrolled shifting, or uncontrolled movement of the load), then a selective inspection, load test, and re-certification shall be performed. This includes rotate and travel components when the rotate or travel function may operate on an inclined plane, such as the rotate function on floating and barge mounted cranes, and a trolley on a luffing boom.

The extent of inspection and testing may be limited, where practical, to those parts and components of systems affected, but shall fully ensure that the adjustment, repair, disassembly, replacement, or alteration has been performed correctly, and that the crane operates properly.

Interim Recertification

- Required when crane must be load tested to verify work.
- Inspection and test may be limited to parts affected.

Recertification Not Required

Recertification is not required when the adjustment, repair, etc., of a load bearing part, load controlling part, or operational safety device does not require a load test for verification of satisfactory work, but does require an operational test.

This includes work performed on rotate and travel brakes, friction clutches, and travel components, where the load travels in a horizontal plane. Work documents for all such work shall be approved by a designated inspector, or the activity's engineering organization prior to starting the work. Work documents shall include a requirement for an operational test. All completed work shall be inspected, and the operational test witnessed, by a designated inspector.

These requirements do not apply to routine maintenance, servicing, or adjustments on diesel engines or generators recommended by the OEM. However, the re-inspection requirements of NAVFAC P-307, section 3, apply.

After all work is completed, prior to returning the crane to service, the work document shall be signed by the chief engineer or the certifying official.

Note: Interim Recertification Requirements can be found in section 4.4.2 - 4.4.3 of the NAVFAC P-307. The inspection and operational test requirements of section 3 apply to these actions.

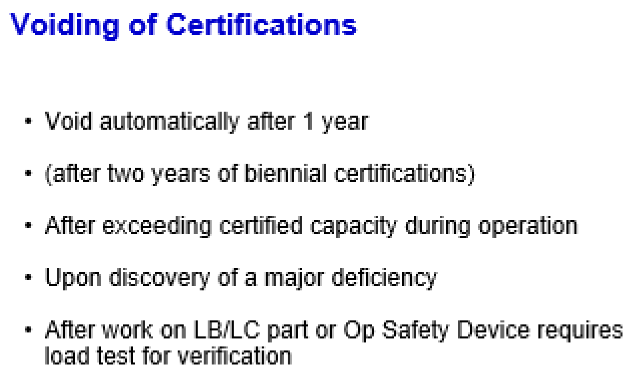
Re-certification Not Required

- Not required when crane requires only operational test
- Not required when only routine maintenance is performed
- Chief Engineer of Certifying Official must sign paperwork

Voiding of Certifications

Here are the conditions which will void the certification of the crane.

All certifications are automatically void after one year; after exceeding the certified capacity during operation; or after an adjustment, repair, disassembly, replacement, or alteration of a load bearing or load controlling part, or operational safety device which requires a load test for verification of satisfactory work.



Exceptions

There are several exceptions to the rule about voiding crane certifications.

The following exceptions apply under very specific conditions. Consult NAVFAC P-307, section 4 for the full text.

Some exceptions to this policy include:

- •A deficiency, adjustment, alteration, etc., to one function will not necessarily void the entire crane certification. For example: when a function is tagged out and prevented from operating.
- •Exceeding the certified capacity in a load test of a sample crane during a Navy Crane Center Weight Handling Equipment (WHE) program evaluation, or during a third party certification.
- •Extension of certification for emergent conditions.
- •Controlled disassembly and reassembly of components for inspection [specific conditions apply].
- •Re-reeving of mobile cranes and installation of ancillary equipment [specific conditions apply].
- •Exception for continuance for productive service (i.e., recertifying the crane prior to the expiration of the current certification and while the crane is in productive service)[specific conditions apply].
- •Re-calibration of indicating devices

Extension of Certification

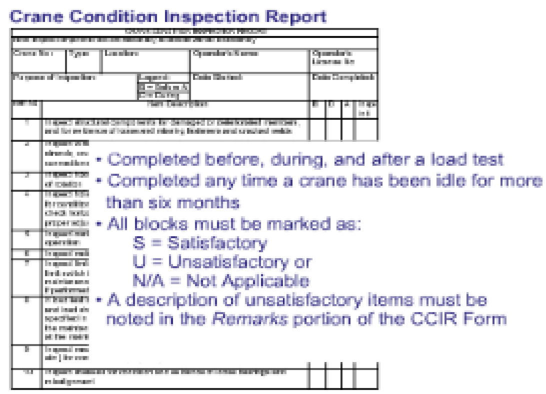
When an emergent or other contingent condition exists precluding the timely certification of a crane, the commanding officer of the activity using the crane, with concurrence by the certifying official, may approve in writing a temporary extension (not to exceed 60 calendar days) of the current annual certification.

Authority to extend a certification shall not be delegated.

Before extending the certification, the crane shall pass a complete condition inspection including functional testing through all motions at normal operating speeds.

Each authorization to extend a certification shall be filed in the crane's equipment history file.

Crane Condition Inspections



The Crane Condition Inspection Report (CCIR) is another type of inspection the crane inspector must be familiar with.

A condition inspection shall be performed before, during, and after the load test.

For cranes idle for a period greater than six months, a condition inspection shall be performed prior to placing the crane in service. A CCIR shall be used to record results of the inspection.

The inspection shall, in general, be by sight, sound, and touch with the depth and detail limited to that necessary to verify the overall condition. It is not intended to be in the same detail as a maintenance inspection.

Each item on the CCIR shall be marked as either satisfactory or unsatisfactory. A description of unsatisfactory conditions shall be noted in the "Remarks" portion of the form.

The completed CCIR shall be included with the crane certification form submitted to the certifying official. See the next presentation for the exceptions to Category 2 and 3 cranes.

Exceptions for Category 2 and 3 Cranes

There are some exceptions to the CCIR requirements for certain types of category 3 cranes.

The requirement that a condition inspection shall be performed prior to placing the crane in service for cranes idle for a period greater than six months does not apply to category 3 jib cranes, pillar cranes, monorails or fixed overhead hoists.

For category 2 and 3 cranes, if no major deficiencies are found in the maintenance inspection, and if no work is done between the maintenance inspection and the load test, the maintenance inspection may serve as the "before" portion of the condition inspection.

Both inspection forms shall be fully completed.

Load Tests

The procedures for load testing are covered in a separate module, which will be presented for those who are or will be designated as test directors.

In general, load tests are conducted by a Load Test Director.

As an inspector, you will be required to sign the Certification of Load Test and Condition Inspection, verifying that you have conducted inspections of the crane.

Summary and Review

This module covered the NAVFAC P-307 requirements for the certification of cranes, the conditions which void the certification of a crane, and the procedures for crane condition inspection reports.

NAVFAC P-307 INSPECTIONS 2 OVERVIEW QUIZ AND SUMMARY

Knowledge Check: Introduction

The next several screens contain questions relating to the covered material. Check your comprehension of the course content by answering these questions.

KNOWLEDGE CHECK

Note

The next several screens contain questions relating to the material covered in this module. Check your comprehension of the covered material by answering the following questions.

Select the best answer.

Q: Which of the items listed below is NOT required to certify a crane?

- ○ CCIR
- ○ OEM acceptance criteria
- ○ Signature of certifying official
- ○ Signatures of test director and inspection personnel

Check

Tries Remaining: 3

Select the best answer.

Q: Which of the following events will void the certification of a crane?

- ○ All listed activities
- ○ Exceeding the rated capacity
- ○ The passage of one year
- ○ Performing work on a LB/LC component which requires a load test

Check

Tries Remaining: 3

Select the best answer.

Q: Which of the statements below about crane condition inspection reports is false?

- ◯ CCIR's are filled out anytime a crane has been idle for more then 6 months.
- ◯ CCIR's are not intended to be of the same depth as a maintenance inspection.
- ◯ CCIR's are filled out daily by the operator.
- ◯ CCIR's are filled out before, during and after a load test.

Check

Tries Remaining: 3

Select the best answer.

Q: Re-certification is required after ____________.

- ◯ none of the listed conditions.
- ◯ work performed on travel brakes
- ◯ work that can be fully evaluated by an operational test
- ◯ routine maintenance and servicing of diesel engines

Check

Tries Remaining: 3

Select the best answer.

Q: What action will void a crane's certification?

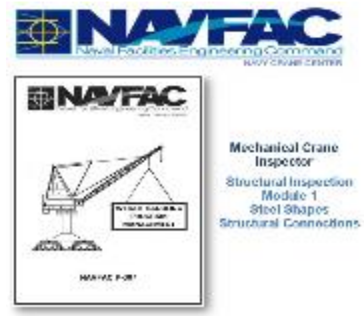
- ◯ None of the actions listed.
- ◯ Controlled disassembly and re-assembly of components
- ◯ Observing a minor deficiency
- ◯ Re-calibration of electronic load/moment indicating devices

Check

Tries Remaining: 3

STRUCTURAL INSPECTION 1

Welcome



Welcome to Structural Inspection.

Structural Inspection Overview

Rather than being standardized, structural inspection techniques have traditionally been passed along from inspector to inspector. In the following modules, we have attempted to standardize some of the more significant aspects of structural inspection. The assessment of the crane structure is one of the most important areas of crane inspection. The majority of the crane's structure falls under the definition of load bearing and/or load controlling parts. The crane structural inspector should keep two things in mind when performing his or her inspection. One many materials have flaws and too many crane structures have flaws. It's up to you, as an inspector, to locate, identify, and record these flaws as completely and accurately as possible. Structural inspection is covered in 3 modules including topics on steel shapes, structural connections, common structural defects, inspection methods, and record keeping.

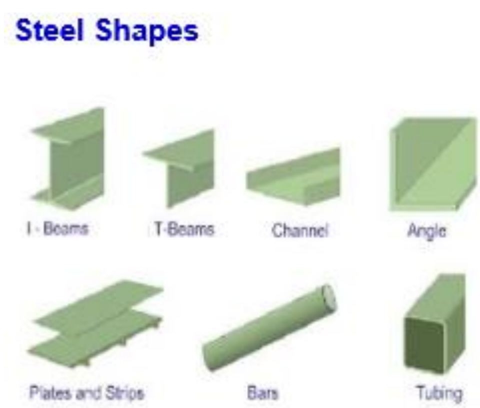
Structural Inspection Module 1 Instructional Objectives

Upon successful completion of module one, you will be able to identify different types of structural members, identify assembly methods used for structural members, and define terms relating to structural inspection.

Structural Inspection References

Before introducing specific steel shapes and basic identification protocols, there are some valuable references that may prove helpful to identify and evaluate steel members. The first reference is the Manual of Steel Construction which is an industry standard for structural steel design and is written by the American Institute of Steel Construction (AISC). The steel grades listed in this book conform to the standards of The American Society for Testing and Materials (now called ASTM International). In addition, this manual contains information and guidance for evaluating bent and damaged steel members. Another valuable reference is the original equipment manufacturers manuals or documentation, including drawings and prints. The manufacturer's specification or tolerance for specific crane components should be used in lieu of tolerances given from the AISC publication. When any crane structural problems are found, the manufacturer of the crane would normally be consulted. Additional guidance for specific members such as booms can be found in sections of NAVFAC P-307.

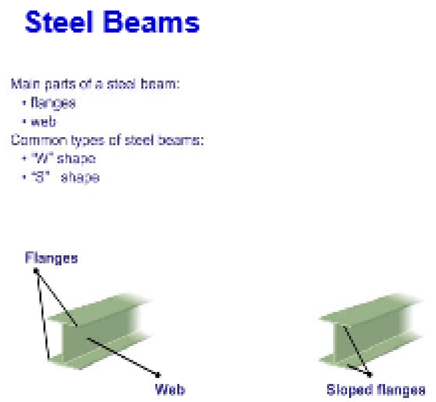
Steel Shapes



Steel is fabricated in a variety of shapes and is used in various combinations extensively for crane structures. Becoming familiar with conventional nomenclature used for the various steel shapes is important for the structural inspector when identifying, and documenting findings. Common structural steel shapes include: beams, channels, angles, tees, strips, bars, plates, and tubing. Although the specification of material for replacement and fabrication of crane components is a function of the responsible activity engineer, a general knowledge of structural shapes and sizes will help the inspector describe and document a suspected problem.

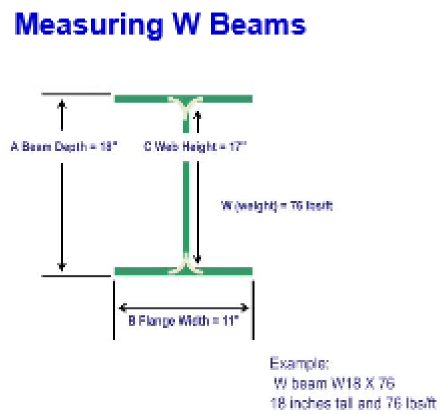
Steel Beams

Steel beams play a major role in the construction of cranes. Steel beams consist of two main parts. The horizontal members are called flanges, as shown in this illustration. The vertical member is a web. Two common types of beams shown here are the "W" shaped beam, where the outer and inner edges of the flanges are parallel and the web thickness is different than the flange thickness; and the "S" shaped beam, where the flanges are narrower for the same web depth and the inner edges are sloped at 16 2/3 degrees or a 1 to 6 slope.

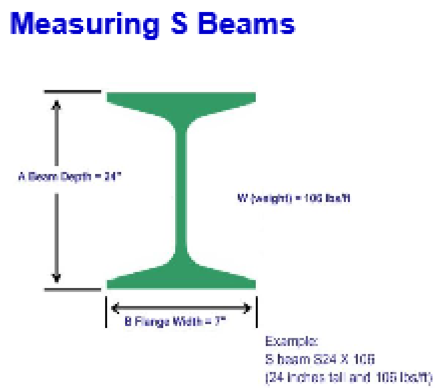


Measuring W Beams

Understanding the basic method used for measuring shapes is important when identifying members and documenting deficiencies for engineering evaluation. The dimensions shown are needed to properly identify a “W” beam. Dimension A is the measurement of the beam's depth (or the outside dimension of the overall "height" of the beam). Dimension B is the measurement of the flange's breadth or the overall "width" of the beam. Dimension C is the measurement of the web height or the inside dimension between the flanges. Other important dimensions of note include the flange thickness, web thickness, and weight per foot of the beam. The dimensions needed to identify a "W" beam are dimension A and W. In this example, dimension A equals 18 inches and the weight per foot is 76 pounds. The AISC designation for this beam would be W18X76. Some manufacturer charts may show beam sizes using dimensions A and B, which, in this case would be 18 x 11. Note that dimensions are relative for designation purposes. For example, an A dimension of 18 may actually range anywhere between 17 and 20 inches. For the example used here, the W18 x 76 I-beam actually measures 18.2" in depth, 11" in width, has 0.68" thick flanges, a web height of 16.84", and weighs 76 pounds per foot. Always check the AISC manual for specific designations.



Measuring S Beams

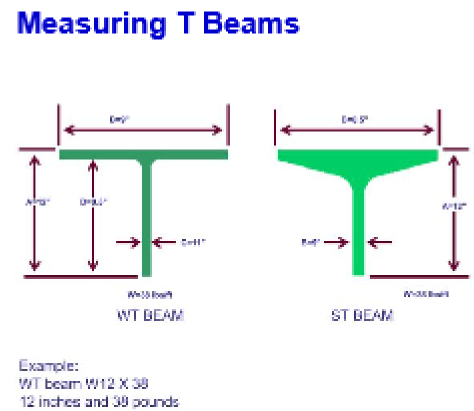


Measuring steel “S” Beams is similar to measuring “W” beams. To identify or describe an "S" beam measure dimension A, the beam's depth or overall "height", dimension B, the flange's breadth or the overall "width". Note the weight per foot of the beam. The dimensions needed to identify an "S" beam are similar to those needed to identify a "W" beam. Dimension A and W. In this example, dimension A equals 24 inches and the weight per foot is 106 pounds. The AISC designation for this beam would be S24X106. Some manufacturer charts may show beam sizes using dimensions A and B, which, in this case would be 24 x 7. Note once again that dimensions are relative for designation purposes. For example, an A dimension of 24 may actually range anywhere between 24 and 24.5 inches. For the example used here, the S24 x 106 I-beam actually measures 24.5" in depth, 7.87" in width, has 1.09" thick tapered flanges, a web height of 22.32", and weighs 106 pounds per foot. Always check the AISC manual for specific designations.

Steel Structural “T” Beams

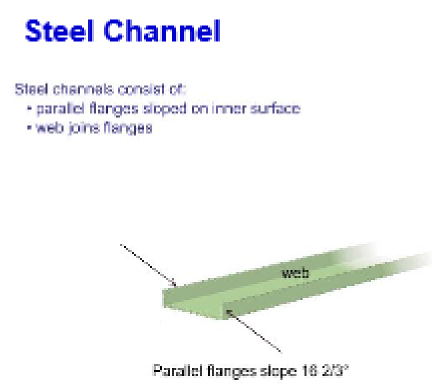
Structural Tees (WT or ST sections) are obtained by splitting the webs of various beams. They have a single horizontal flange and a web or a stem. They may be split from a W-shape or an S-shape beam.

Measuring T Beams



Shown here are two styles of T beams: the WT beam and the ST beam. Measuring T beams is similar to measuring the "W" and "S" beams discussed previously. The necessary dimensions are A (the depth or height) and W (the weight per foot). Dimensions B (flange breadth or width), C (web height) and D (web thickness), while not needed to identify the beam, can be useful when additional information is needed to confirm correct beam sizing.in this example, the WT beam is classified as WT12X38, indicating a T beam, 12 inches deep, weighing 38 pounds per foot with a non-tapered flange. Per AISC, the actual dimensions of the WT12X38 beam are 38 pounds per linear foot, 12 inches deep with an 8.99 inch flange breadth, having a 0.68 inch flange thickness and a 0.44 web thickness. This can be verified in the AISC size charts.

Steel Channel



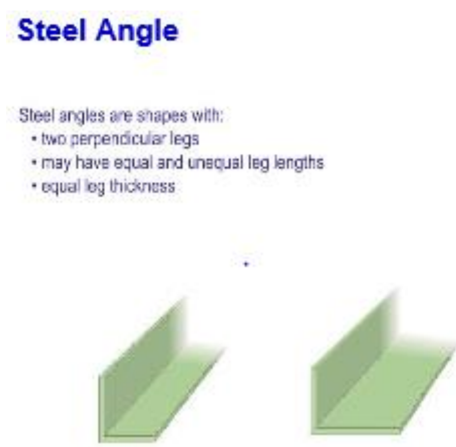
Channels are made up of flanges and a web. The two parallel flanges have a slope of 16 2/3 degrees on the inner surfaces. The web joins the flanges along one edge.

Measuring Channel

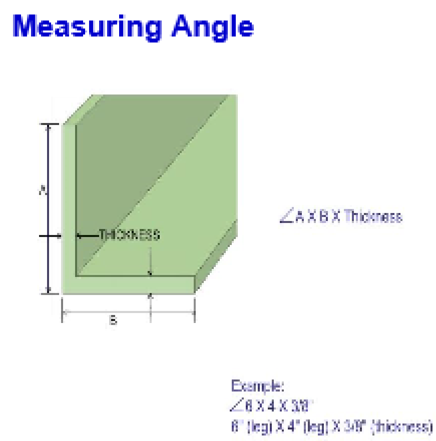
Channel is one beam shape that you can easily determine the nominal size. To find the nominal size, simply measure from flange to flange as shown by dimension "A." For example, a designation C12X20.7 indicates a channel with a depth, outside to outside flange, of 12" and a weight per linear foot of 20.7 pounds.

Steel Angle

Steel angles are shapes with two legs of rectangular cross section that are perpendicular to one another. The inner and outer surface of each leg is parallel. The thickness of each leg should be equal. In some cases, equal and unequal leg lengths may be encountered.

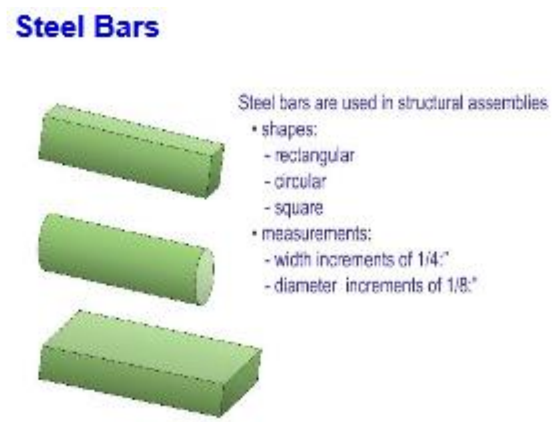


Measuring Angle



Measuring steel angle is relatively simple. Measure both legs, dimensions A and B as shown in the illustration. The thickness should be the same for both legs. This shape will be recorded as “angle A by B by thickness” on a drawing or print. For example: A 6X4X3/8" indicates an angle with unequal legs, one 6" long and 3/8" thick, and the other one 4" long and 3/8" thick. When measuring angle with unequal legs, the longest measurement is recorded first. On some drawings or blueprints, the angles may be designated using the angle symbol (shown on the screen), an ”L”, or “A”, or the word ”angle” in front of the dimensions.

Steel Bars



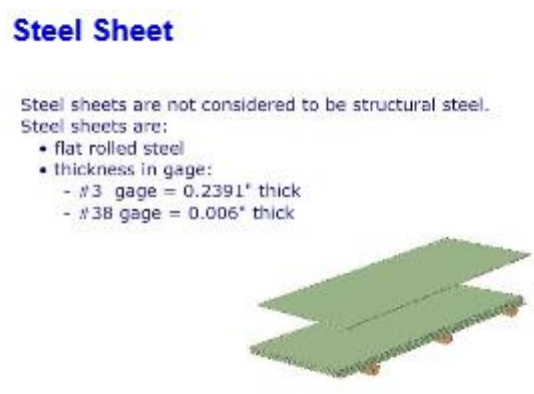
Steel bars are shapes that can be used in structural assemblies. Steel bars can be rectangular, circular, or square and usually specified in 1/4” increments for width and in 1/8” increments for diameters.

Steel Strip

Steel strip is not considered to be structural steel although for identification purposes, it deserves a brief mention. Steel strip is flat-rolled steel that is relatively thin (less than 1/4”) and usually 12” or less in width.

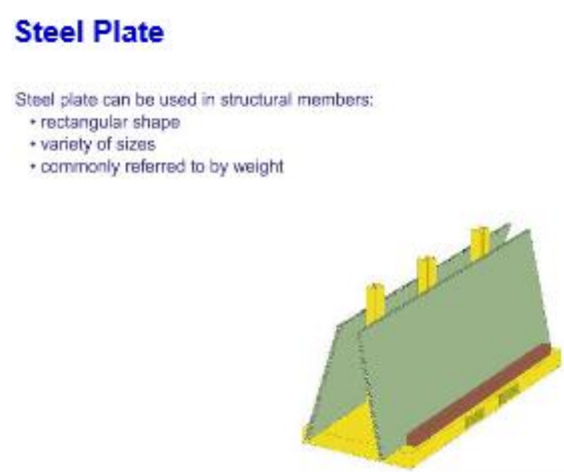
Steel Sheet

Steel sheet is also a non-structural steel. It is flat-rolled steel with thicknesses expressed by gage. For example, Number 3 gage sheet is equal to .2391 inches thick. Number 38 gage sheet is equal to .006" thick.



Steel Plate

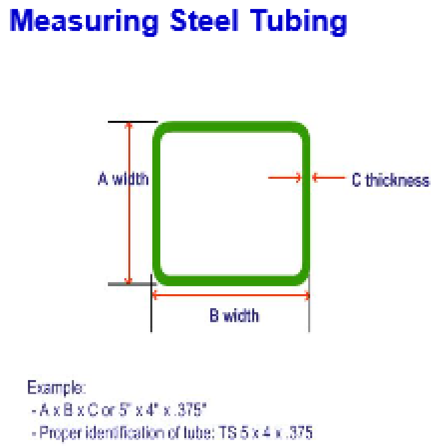
Steel plate is a common steel shape that is often used in the manufacture of structural members. Steel plate is frequently welded together to form box girders and plate girders on larger cranes. Steel plate is usually rectangular in shape and is available in a variety of sizes. It is commonly referred to by its weight per square foot. For example: 1 inch thick plate is commonly called 40-pound plate since it weighs 40.8 pounds per square foot.



Steel Tubing

Square, rectangular and circular steel tubing of various shapes and sizes is another steel product used on cranes. The designation for this material is "TS". Thin-walled, high-strength tubing is used by many manufacturers for the construction of crane booms, jibs, and masts. Tubular crane boom construction is strong and light weight although less tolerant to impact damage than angle steel crane boom construction. Any dents, corrosion or bends found on crane boom members must be evaluated immediately by engineering.

Measuring Steel Tubing



To measure tubing, first measure the outside dimensions, A and B as shown in the illustration. Both dimensions of the cross section of these shapes are called the width. Then measure the thickness of the wall, dimension C. The thickness may be stated in decimal or fractional form. The description is written as A x B x C. For example, TS 5X4X.375. Notice that the largest width is listed first. You should now have a fairly good idea of how to measure various steel shapes and be able to describe them for documentation and evaluation purposes. Let's take a look at some of the ways these members are connected.

Types of Connectors

There are three common connections used to connect structural members: riveting, bolting, and welding.

Riveted Connections

Riveted connections were a very common method of attaching steel shapes in the past, but they have been largely superseded by bolted and welded connections. A typical rivet installation is as follows: A pin or bolt with a rounded head on one end is inserted into aligned holes in two or more structural shapes. It is then peened on the plain end with a special impact gun until the plain end also forms a rounded head. A "hot rivet" is worked while it is hot. As it cools, the riveted pieces are drawn tightly together by the shrinking of the rivet.

Replacing Rivets

When a rivet becomes loose or damaged, it must be replaced. It is normally replaced with a structural bolt. When a rivet is replaced by a bolt, the bolt should be of the same nominal size as the rivet. If the rivet hole is distorted or rough, ream the hole to the next nominal size, generally, 1/32" clearance over the bolt shank size.

Bolted Connections

Bolted connections for structural members use a special grade of bolt. Structural bolts are designed for structural connections. For example, a common structural bolt used in crane construction is the A-325, although there are other grades in use as well. Structural bolt tightening must be done according to established procedures, industry standards or manufacturer's instructions. Two common methods include the turn-of-the-nut method and the calibrated torque wrench method. Both methods should only be used in conjunction with written and approved procedures or work documents.

Welded Connections

Welded connections are common in today’s structural assemblies. Welding is used extensively to fabricate and connect structural members. This is largely due to advances in welding technology, and, it is a cost-effective method of fabrication. When a welding repair must be done to a structural member, consult the crane manufacturer, and the responsible activity engineer to determine the welding process and material requirements.

Loads, Stresses, and Strains

A crane structure is subject to loads, stresses and trains, even when there is no load on the hook. Let's discuss further. There are three types of loads that affect a crane: dead loads, live loads, and outside forces or influences. Dead loads are stresses imposed by the crane itself, by its own weight. Live loads are imposed by the lifting of actual loads and include forces related to acceleration, hoisting, luffing, and rotating, etc. Outside forces or environmental stresses include things like wind, snow, ice, heat, and sometimes, seismic forces.

Stresses on Cranes

Cranes are subject to various stresses. Stress is defined as internal forces resisting loads that act upon a crane or structural member. Crane designers calculate working stresses and compare them to allowable stresses for a particular component. The allowable stress is the maximum that is considered safe when the structure is subjected to working loads and forces. This should not be confused with ultimate strength or yield stress, which is the point at which the material will fail. When these stresses exceed the maximum allowable stress, damage to the structure occurs.

Strains on Cranes

There is a distinct difference in the meanings of the terms stresses and strains. Strains are defined as the dimensional changes in the structural members that are caused by stress. A good example is deflection in a bridge girder.

Safety Factors

Safety factors give equipment a safety margin. Safety factors are built into component design and are a ratio of yield stress to allowable stress. Safety factors help ensure the user of the equipment that it will not fail when used within design limits. Understanding some of the engineering considerations may help inspectors identify structural defects on a crane.

Review and Summary

Structural Inspection, Module 1, reviewed different types of structural members, identification protocols, assembly methods, and loads, stresses, and strains.

NOTES:

Structural Inspection 1 Overview Quiz and Summary

Knowledge Check: Introduction

The next several screens contain questions relating to the covered material. Check your comprehension of the course content by answering these questions.

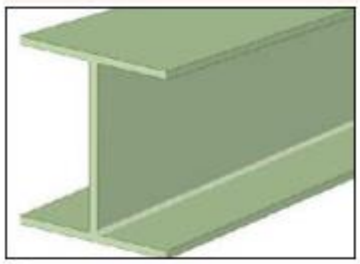
KNOWLEDGE CHECK

Note

The next several screens contain questions relating to the material covered in this module. Check your comprehension of the covered material by answering the following questions.

Select the best answer.

Q: What is the common name for the structural element shown?



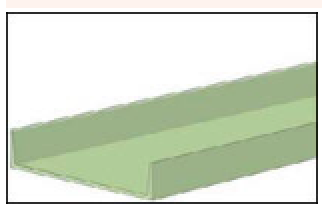
- ◯ Bar
- ◯ Beam
- ◯ Tee
- ◯ Plate

Check

Tries Remaining: 3

Select the best answer.

Q: What is the common name for the structural element shown?



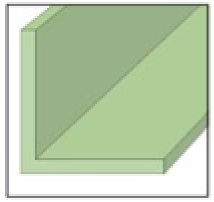
- ◯ Tee
- ◯ Channel
- ◯ Beam
- ◯ Plate

Check

Tries Remaining: 3

Select the best answer.

Q: What is the common name for the structural element shown?



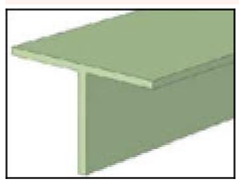
- ◯ Angle
- ◯ Beam
- ◯ Tee
- ◯ Bar

Check

Tries Remaining: 3

Select the best answer.

Q: What is the common name for the structural element shown?



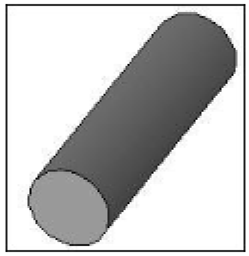
- ◯ Plate
- ◯ Bar
- ◯ Tee
- ◯ Beam

Check

Tries Remaining: 3

Select the best answer.

Q: What is the common name for the structural element shown?



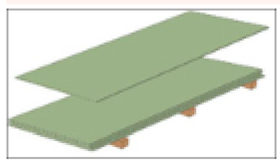
- Plate
- Angle
- Tubing
- Bar

Check

Tries Remaining: 3

Select the best answer.

Q: What is the common name for the steel shape shown?



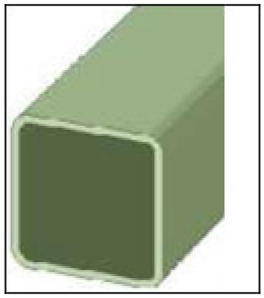
- Channel
- Bar
- Angle
- Plate

Check

Tries Remaining: 3

Select the best answer.

Q: What is the common name for the structural element shown?



- ◯ Tubing
- ◯ Bar
- ◯ Channel
- ◯ Beam

Check

Tries Remaining: 3

Select the best answer.

Q: The two main parts that make up a beam are the _______ ______.

- ◯ flange and web
- ◯ web and gusset
- ◯ leg and web
- ◯ gusset and flange

Check

Tries Remaining: 3

Select the best answer.

Q: The primary difference between the type "W" and "S" beams is that the inner flanges of the __________ slope at approximately 16 2/3 degrees.

- ◯ "S" beam
- ◯ "W" beam

Check

Tries Remaining: 3

Select the best answer.

Q: A loose or damaged rivet shall be replaced with a ________ bolt of the same nominal size as the rivet it is replacing.

- ○ grade 5
- ○ dead
- ○ structural
- ○ grade 8

Check

Tries Remaining: 3

Select the best answer.

Q: For modern cranes, the most common methods for joining structural steel members are:

- ○ bolting and riveting
- ○ welding and bolting
- ○ riveting and welding
- ○ riverting and pinning

Check

Tries Remaining: 3

Select the best answer.

Q: _____ can be defined as a force that acts upon a crane's structure and components.

- ○ Stress
- ○ Strain
- ○ Compression
- ○ Tension

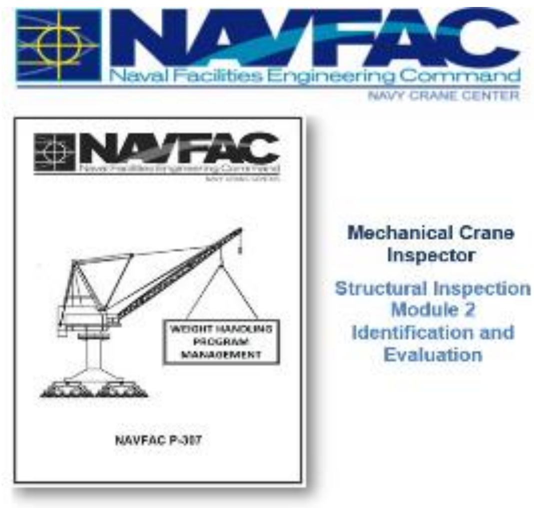
Check

Tries Remaining: 3

STRUCTURAL INSPECTION 2

Welcome

Welcome to Structural Inspection, Module 2, Defects: Identification and Evaluation

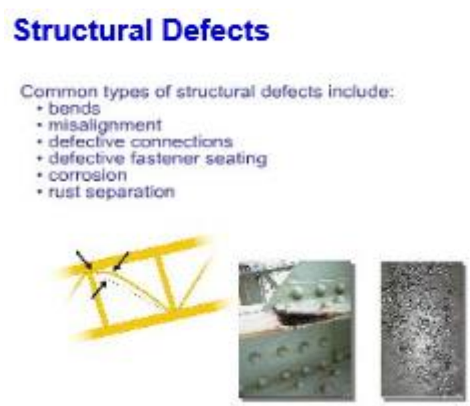


Structural Inspection Module 2 Instructional Objectives

Upon successful completion of this module, you will be able to identify common structural defects and describe methods to evaluate the extent of the damage.

Structural Defects

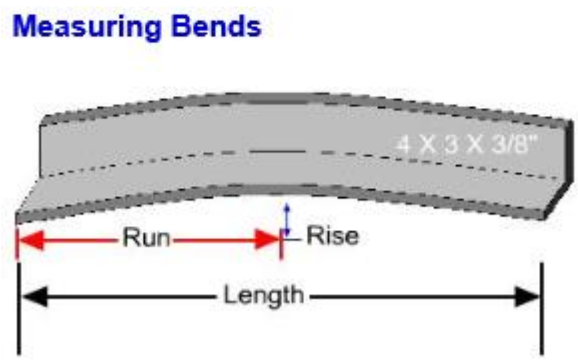
Structural defects can be grouped according to several types. Some of the more common types of defects a crane mechanical inspector would look for in a structural inspection are bends, misalignments, defective connections, defective fastener connections, corrosion, and rust separation.
In this module, we will examine each of these defects, ways to identify them, and some guidelines to help describe and effectively document the observed condition.



Bends

Bends are a common defect found on structural members of crane booms. Bends may be of two types. First is the gradual bend. Gradual bends may be caused by an overload or some other uniformly applied force. Second is the sharp bend. Sharp bends may be caused by a collision or some type of impact. When documenting an inspection finding involving a bend, describe it using one of the following methods. Bends to structural components may be described either as a ratio, such as 1 to 4 (which would indicate that there is 1 inch of bend for every 4 inches of length), or by an accurate description of the extent of deviation from its original position. For example, if a normally straight boom member was found to be bent 2 inches out of alignment, simply describe it that way.

Measuring Bends



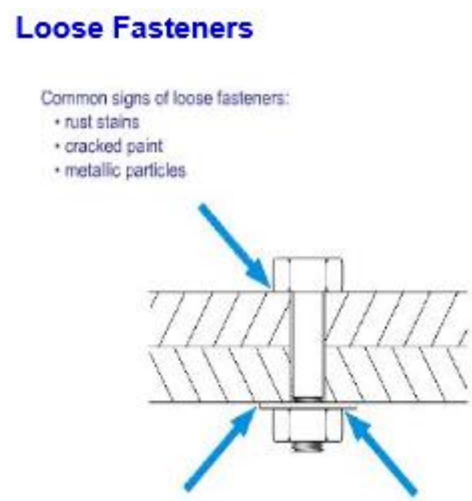
When measuring bends, recording the following information will make it possible to perform an evaluation based on an accurate description of the defect. First, record a description of the member. In this example, the angle is 4” x 3” x 3/8”. Record the overall length of the member, usually from one support or connection to the next. Next, measure and record the length of bend, which can also be called the run as shown in the illustration. Then, record the rise or total deviation from straight. To make the description as clear as possible, draw a picture of the damaged component, including all dimensions.

Misalignment Check

Misalignment is another common structural defect. Where two or more structural members meet at a common joint, their “lines of action” should intersect. If they do not line up as shown in the illustration, they should be evaluated by the activity's crane engineering department to determine if a problem exists.

Loose Fasteners

A bolted or riveted connection may show signs of looseness as indicated by rust stains, cracked paint, or metallic particles in the areas where the bolt or rivet head or the nut and washer make contact the pieces being joined. Keep in mind, a fastener may be loose and not show any indications.



Fastener Tightness Checks

There are two acceptable methods commonly used for checking loose fasteners. One method is called"sounding", which involves striking the fastener with a hammer while listening to the sound it makes. A tight fastener will respond with a crisp, resonant sound that should be comparable to the sound of the adjacent fasteners on the component. A dull or flat sound is an indication that the fastener is loose. The second method is called a "partial-torque check". This method involves the use of a calibrated torque wrench to apply a percentage of the torque value to the fastener. Any rotation would be a sign of a loose fastener.

Sounding Loose Fasteners

When using the sounding method to detect loose fasteners, use these precautions. Strike bolt heads squarely. Strike the fasteners in a clock-wise direction to prevent loosening of the fastener. Avoid damage by not striking the edges of the hex-head or nut, as this may impede wrench use. Avoid using a hammer capable of deforming the fastener head, nut, or any threads protruding beyond the nut. Do not hit a fastener repeatedly, as this action may cause it to become loose.

Science and Art of Sounding

At this point, you may be asking yourself “Is sounding an art or a science?” And you're probably wondering things like: what size hammer should I use and how hard do I strike the fastener? Sounding requires experience and judgment, so it's probably a combination of both art and science. For general use, a hammer weighing between eight and sixteen ounces will be sufficient for bolted connections up to 3/4". Fasteners should be struck with a light to medium impact. Remember, you're sounding the fastener, not pile driving. If fastener tightness is questionable after sounding, try changing the position of the crane or component, thereby altering the tension on the fastener. Then sound it again. If still in doubt, follow-up with a tightness check using a calibrated torque wrench. Be sure to get authorization and follow proper procedures before engaging in tightness checks using a torque wrench. Report any suspect fasteners to your supervisor and engineering for evaluation. Make sure you mark and diagram the location of the fastener(s) in question.

Sounding Method Environmental Concerns

Sounding can disturb coatings, such as paint. Some coatings may be hazardous. Where environmental and personnel health concerns exist, sounding may not be the best method to use for tightness checks. Check your activity's policy on working in, on, and around components with hazardous coatings, such as lead painted surfaces or surfaces with other types of corrosion inhibitors or surface protection. If necessary, choose another method to check fasteners for looseness. If there are no acceptable alternatives, mark the fastener, document the problem on an inspection report, and request an engineering evaluation.

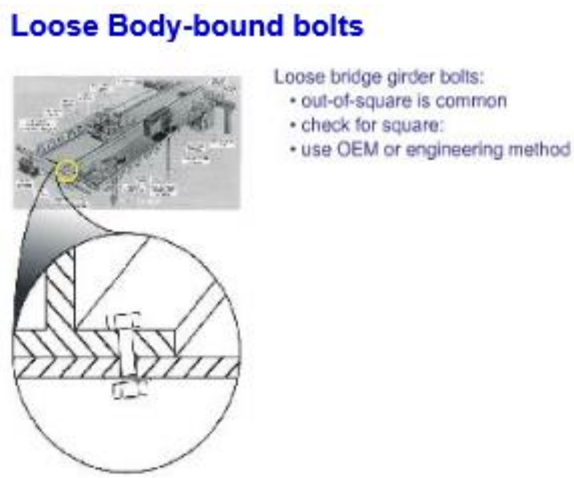
Checking For Tightness

Another method for checking fastener tightness would be to perform a partial-torque check. Use a torque wrench to apply a percentage of the torque value for a specific fastener to test for movement. Any rotation or movement of the fastener indicates that the bolt is loose. Reuse may not be allowed and replacement of structural bolts may be required. Follow local procedures for performing partial torque checks.

Defective Body-bound Bolts

Body-bound bolted connections can be damaged if they become loose. Most standard bolted connections have drilled or reamed holes that allow a clearance of 1/32". In cases where there are bolted members with body-bound or interference-fit bolts, having little or no clearance, there can be no visible movement or clearance when the parts are assembled. One example is the bolted connections that secure the bridge crane girders to the end or travel trucks. The body-bound connections are required to maintain bridge alignment. Movement in these areas is not acceptable and should be closely inspected during operation.

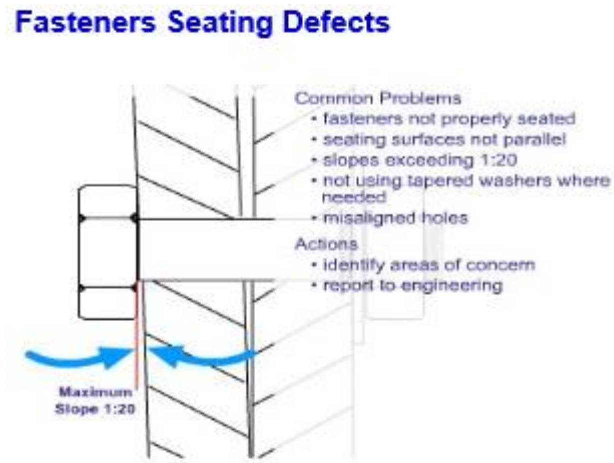
Loose Body-bound Bolts



Loose body-bound bolts can be a perplexing problem. For example, if the bolts securing the bridge girders to the trucks are loose, the cause needs to be determined. Loosening of these bolts may re-occur after tightening or re-reaming and fitting with oversized fasteners. A common cause of loose body-bound fasteners on bridge cranes is often a result of the bridge being out-of-square with the rails and stops. One method used to check for proper bridge alignment is to see if the bridge bumpers contact the rail stops at the same time, however, this test may not always be valid in cases where the entire bridge crane is “skewed.” When using this method, ensure that the trolley is centered on the bridge, travel 20 to 30 feet in a slow speed point, and carefully move up to the rail stops. If the trolley is not centered, or if the bridge is moved or stopped abruptly, the bridge can become “skewed” and give a false indication of being out of square. The crane manufacturer or the responsible activity engineer should be consulted to determine an acceptable method to use.

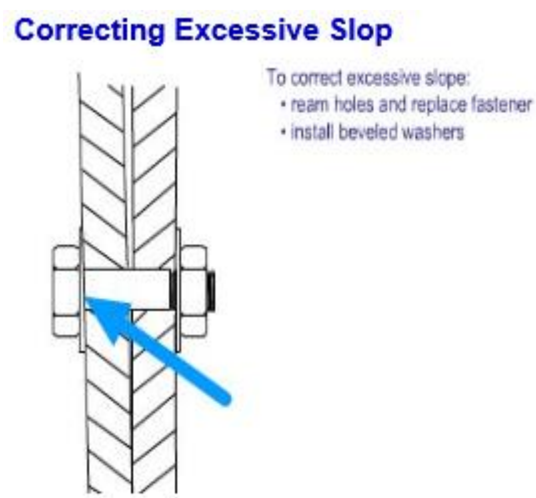
Fastener Seating Defects

Fastener seating defects are common, especially with members having sloped surfaces, such as “S” beams and channels. The planes of the seating surfaces between the fastener and component should always be parallel. On riveted joints, a general rule-of-thumb is, the slope formed by non-parallel surfaces should not exceed a ratio of 1 to 20. This illustration shows a typical bolted joint on non-parallel surfaces having a slope between the bolt head and the component surface. On bolted joints, any fastener that is not fully seated should be identified by the mechanical crane inspector for evaluation by the activity's engineering department.



Correcting Excessive Slope

When a riveted or bolted component is found to have a contact ratio greater than 1 to 20, possible corrective actions may include reaming the holes, if misaligned, and replacing the fasteners and/or installing beveled washers to level the seating surface.



Types of Corrosion

The most common types of corrosion are surface pitting, crevice, and fretting. The following screens will cover each one of these types of corrosion, where it occurs, and some design issues that may increase the potential for corrosion.

Surface Pitting

Surface pitting is a common type of corrosion found on cranes. Generally, surface pitting does not adversely affect structural strength, although in tubular crane booms, material loss in main chords and lacings, may adversely affect the strength of the boom. As an example, one crane manufacturer has a requirement stating that "pits of three thousandths to eight thousandths of an inch in depth be documented and pits greater than eight thousandths of an inch in depth be cause for rejection in 1 inch tubular boom chords. Pits greater than thirty thousandths of an inch would be cause for rejection of 4 inch tubular boom chords." Hidden corrosion frequently occurs near the boom heel-pin of some mobile cranes. Moisture and condensation collect inside the tubular boom and causes internal loss of metal. This material loss is normally detected using special testing equipment that measures the thickness of the tube wall. Pitting corrosion is more difficult to measure and describe than uniform corrosion since it is usually concentrated in a few small areas. Measuring the depth of pitting may require the use of a special depth micrometer having a pointed tip or with such specialized equipment as surface profilometers.

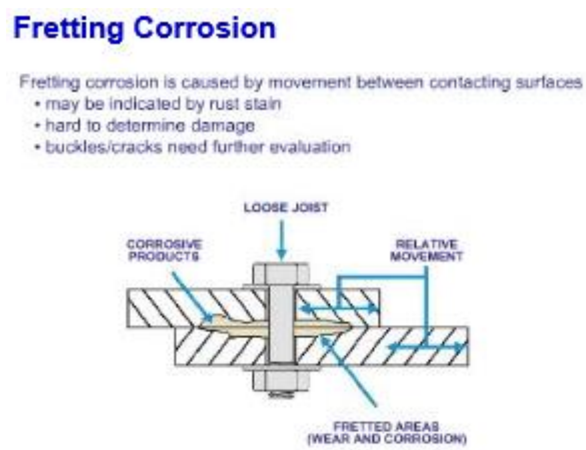
Estimating Material Loss

To estimate material loss due to surface pitting corrosion, first remove the loose scale using a wire brush or its equivalent. Obtain engineering approval prior to performing any metal removing operations such as wire brushing, filing, grinding, etc., as the wall thickness and integrity of thin-walled tubing can be adversely affected by metal removing operations. In many cases, the surface condition may require extensive cleaning before an inspection may be performed. Environmental concerns should also be considered, such as peeling paint, oily waste, and other hazardous materials requiring proper disposal. After removing any dirt and scale, use a straight edge and a feeler gauge or wire gauge to estimate the percentage of material that has been lost to corrosion.

Crevice Corrosion

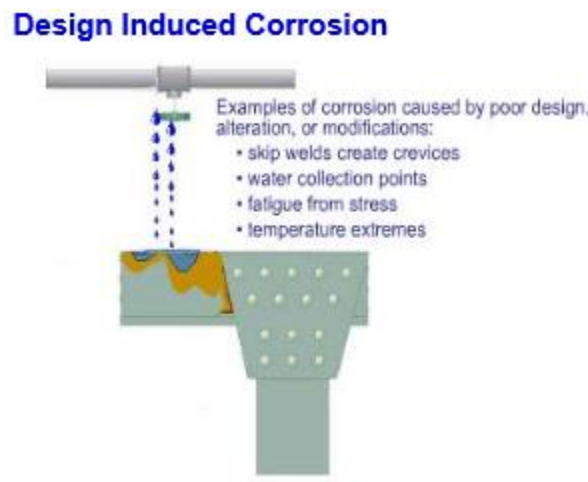
"Crevice corrosion" is another type of corrosion often found during weight handling equipment inspections. Crevice corrosion is a localized form of corrosion usually associated with fissures or gaps, allowing moisture to become trapped under gaskets, washers, insulation material, fastener heads, surface deposits, disbonded paint, threads, lap joints and clamps. Corrosion on the outside of the crevice is easy to detect because it is visible on the outside edges of the crevice. Damage resulting from corrosion occurring inside the crevice may be difficult to assess since the only indication might be a rust stain on the metal surrounding the crevice. Further inspection would require disassembly of the components.

Fretting Corrosion



"Fretting Corrosion" is another type of corrosion the mechanical crane inspector may encounter. It occurs where motion between two mating surfaces results in a mechanical removal of protective films. The most common type of fretting is caused by vibration and the resulting loss of material. Fretting corrosion is often accelerated by the abrasive effects of corrosion product debris, especially in equipment with moving or vibrating parts. Moisture introduced between the abraded surfaces contributes to the loss of material. An indication of fretting corrosion is usually in the form of rust stains much like that seen from crevice corrosion. As with crevice corrosion, it is hard to determine the extent of the damage without disassembly. This is not intended to imply that every joint should be disassembled because of rust stains, but rather to explain some of the conditions the mechanical inspector may find while inspecting cranes. Where other indications are observed, such as buckling plates or cracks, an engineering evaluation should be performed.

Design Induced Corrosion



Many corrosion problems are the result of crane design, alterations or modifications. By recognizing some of the design issues that can promote corrosion, your inspection of the crane may uncover some problems before they weaken or cause damage to the crane. Some examples of these design induced problems include skip welds that create or form crevices, areas permitting water, salt, or abrasive materials to collect, fatigue in highly stressed areas, or effects of temperature extremes.

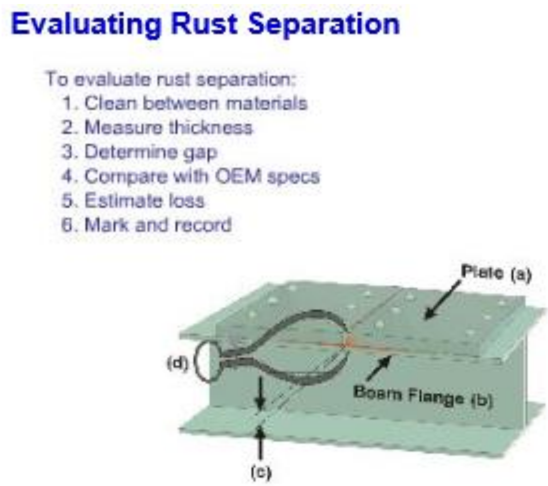
Design Induced Corrosion

Some additional examples of design problems include: joining incompatible materials or material types such as new steel placed next to old steel; galvanic corrosion damage induced when two dissimilar materials are coupled, for example, aluminum placed next to steel; steel surface finish from mill scale; unprotected, brightly cut surfaces resulting from machining such as cutting pipe threads or drilled holes; metals attacked by corrosive gases; and stray electrical currents that cause metal loss.

Rust Separation

Another type of corrosion related defect found on cranes and on supporting structures is called rust separation. Rust separation is caused by rust and scale building up between two or more plates or components. Rust separation may cause bolts or rivets to fail prematurely, and warping and buckling of joined structural members. This type of corrosion damage requires an evaluation on a case-by-case basis. An estimate of the extent of damage may be made by determining how much material is lost and how much remains.

Evaluating Rust Separation



The mechanical inspector should follow these steps, or those provided by the activity engineer, to evaluate the extent of damage caused by rust separation. In the example shown, a structural beam flange and riveted plate connection are being pushed apart and distorted as a result of corrosion growing between the components. The first step in evaluating this condition is to clean out the affected area between the plate and flange as much as possible. Next measure the overall thickness of the affected area (d). Finally, determine the gap (c) by subtracting the individual thicknesses of the flange (b) and plate (a) from the overall thickness of the affected area (d). Compare your results with OEM specifications. Blueprints, specification sheets, or drawings may be used to identify components, sizes, and to aid in recording the findings. An estimate of the percentage of material loss in terms of strength lost should be made and documented by the mechanical inspector. Components should be marked for easy identification and location. Record the findings on the appropriate document for evaluation or to identify needed repairs.

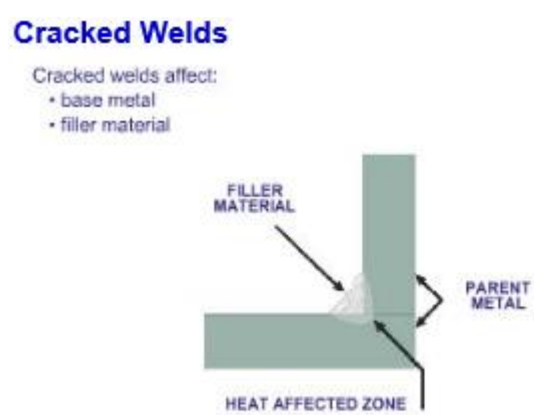
MISR

Accurate descriptions and documentation of corrosion in structural members is important for record keeping and further evaluation, and shall be documented on the applicable “MISR Unsatisfactory Items Sheet”. After determining whether the corrosion is general or localized, the mechanical inspector will record the location of the affected area, the amount of reduction in net cross-section, and the depth of local corrosion. In addition, an estimate of the percentage of lost material which relates directly to loss of component strength shall be reported and documented.

Cracks

Other common defects often found by the mechanical inspector are cracks in structural members. Cracks may be found in the structural members or in the welds that join them. Cracks may not be visible to the eye due to their size or, in some cases, they may be large enough to be easily seen. A good indication for the mechanical inspector is cracked paint on welded joints. Cracks showing on painted-over welds often reveal cracks that are otherwise not easily visible to the unaided eye. In cases where a crack may be suspected, a deficiency should be reported and documented, and a non-destructive test (or NDT) of the suspect area should be done. It is important to differentiate between assembly tacks and structural welds. In some cases, structural members may be temporarily tack welded as an aid to assembly and then followed up by permanently bolting. Although these temporary assembly tacks may later develop cracks or break, it should not be reported as a deficiency as it will have no effect on the strength of the assembly.

Cracked Welds



Understanding some basic welding technology will help the mechanical inspector identify and describe cracked welds. When metal is welded, changes may occur in the base metal, the filler material, and/or the heat affected zone. These changes result from the heat generated by the welding process that may alter the crystalline structure of the metal. Cracks in welds may be divided into two categories: base metal cracks and filler material cracks. In either case, these types of cracks may lead to significant weakening of the crane's structure.

Cracked Welds

Both filler material and base metal cracks can be difficult to see, even when the area is clean and well lit. To make cracks more visible, use a wire brush to clean suspect areas. Use a small amount of cleaning solvent applied with a rag or brush to help identify the extent of the crack. When you find cracks, mark the location with approved marking methods so it may be easily located. Identifying marks should be clear and indelible.If there are multiple findings, number them, and accurately record the number and their locations. Often, it's someone other than yourself who must be able to locate the problem area for evaluation, repair, or to post-inspect the job.

Review and Summary

This module covered common structural defects and methods used for evaluating the extent of damage or defects.

STRUCTURAL INSPECTION 2 OVERVIEW QUIZ AND SUMMARY

Knowledge Check: Introduction

The next several screens contain questions relating to the covered material. Check your comprehension of the course content by answering these questions.

Note

KNOWLEDGE CHECK

The next several screens contain questions relating to the material covered in this module. Check your comprehension of the covered material by answering the following questions.

Select the best answer.

Q: Two inspection techniques used to determine whether a fastener is loose or not are _________.

- ○ sounding and partial-torque inspections
- ○ visual and operational inspections
- ○ manual and visual inspections
- ○ Sounding and volume

Check

Tries Remaining: 3

Select all that apply.

Q: Bends in structural components may be described as a (an) _________________.

- ☐ structural deformation
- ☐ ratio
- ☐ deviation
- ☐ angle

Check

Tries Remaining: 1

Select the best answer.

Q: Another way to describe a bend, whether gradual, or sharp, is to describe the total ___________ from the original position.

- ○ misalignment
- ○ deviation
- ○ deformation
- ○ Offset

Check

Tries Remaining: 3

Select the best answer.

Q: The seating surfaces of a bolt and the surface of the material it is clamping should be __________to one another.

- ◯ at right angles
- ◯ vertical
- ◯ parallel
- ◯ horizontal

Check

Tries Remaining: 3

Select the best answer.

Q: The type of boom construction that is least tolerant of dents and corrosion is the ___________.

- ◯ angle lattice
- ◯ jib
- ◯ tubular lattice
- ◯ Beam

Check

Tries Remaining: 3

Select the best answer.

Q: When any type of corrosion is found on structural members, the primary concern is determining how much material is lost.

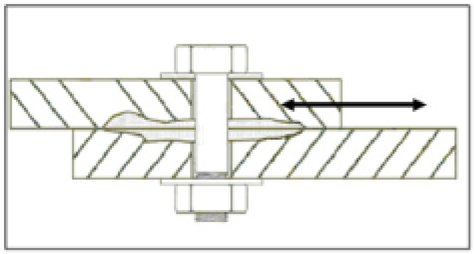
- ◯ True
- ◯ False

Check

Tries Remaining: 1

Select the best answer.

Q: What type of corrosion is shown below?



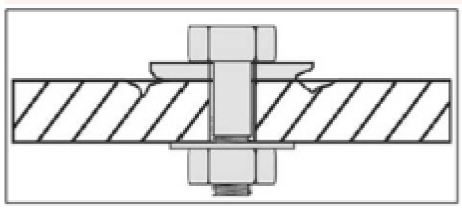
- ◯ Fretting corrosion
- ◯ Surface corrosion
- ◯ Surface pitting corrosion
- ◯ Crevice corrosion

Check

Tries Remaining: 3

Select the best answer.

Q: What type of corrosion is shown below?



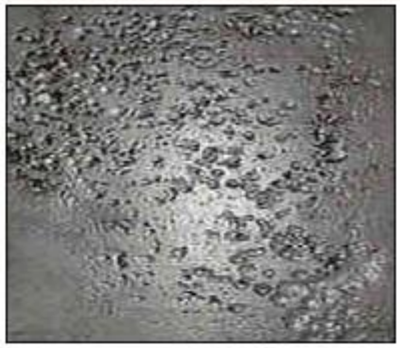
- ◯ Fretting corrosion
- ◯ Crevice corrosion
- ◯ Surface pitting corrosion
- ◯ Spot corrosion

Check

Tries Remaining: 3

Select the best answer.

Q: What type of corrosion is shown below?



- ○ Surface pitting corrosion
- ○ Crevice corrosion
- ○ Fretting corrosion
- ○ Hidden corrosion

Check

Tries Remaining: 3

STRUCTURAL INSPECTION 3

Welcome

Welcome to Structural Inspection, Module 3, Inspection and Recording Methods.

Instructional Objectives

Upon successful completion of this module, you will be able to describe methods for inspecting structural members and the requirements for recording structural defects.

Preparing For Inspection

Before doing a structural inspection on a crane, it is important to research the OEM manual and the equipment history file for the crane. Information provided by the manufacturer can provide valuable insight into specific areas on which to focus for defects. Equipment history records from previous inspections may show structural defects already identified and evaluated. Researching records will help the mechanical inspector avoid duplicating efforts and monitor the current condition of previously identified defects.

Preparing For Inspection

Whenever structural inspections are done in areas of the crane outside of walkways and in high areas such as on crane booms, a-frames, or bridge-crane spans that are five feet or more off the ground, fall protection equipment shall be used. It is always good practice to use the “buddy system” while inspecting moving equipment. A second person serves as a safety person to relay signals especially in cases where an emergency stop may be required. When the inspector is required to enter voids, ensure any gas-free testing requirements have been met and always have a second person nearby to assist in case of an emergency.

Inspection Guidelines

When preparing to do a structural inspection, the following guidelines will help. Consider obvious as well as hard-to-see defects. Defects such as bent boom lacings and dented boom chords are usually easy to identify. Other defects, such as a slightly twisted or bent member, or a hairline crack, may not be so easy to spot. When inspecting structural members, it is a good practice to look at it in two different ways. First, use a “big-picture” approach on the overall structure for obvious problems such as bends, twists, or misalignments. Then, make a more detailed inspection of systems or components, looking for problems such as cracked welds, loose fasteners, area corrosion, etc. Any suspect areas or defects found should be carefully recorded and marked appropriately so that it may be located for repairs, later inspection, or further evaluation by engineering.

Inspection Methods

There are various methods which can be used to inspect cranes. The primary method is sight, or visual inspection. However, there are other tools and techniques that can be used to help verify suspected defects. An example might be where a machinist's scale or precision straight edge is used to verify straightness or to measure the amount of bend in a given distance. Longer distances may require using a tool as simple as a carpenters line pulled taut along the length of a suspect section. Torque wrenches are commonly used to help identify loose fasteners while feeler gauges may be used to check for proper fastener seating. Other inspection aids may include more advanced tools such as laser alignment equipment.

Non-destructive Tests (NDT)

Various non-destructive testing methods (also known as NDT) are used to find hidden damage not visible to the naked eye, in a crane's structural or critical components. One commonly used non-destructive test is called a magnetic particle test (also known as MT or MPT). Magnetic particle tests are performed by applying a light coating of iron powder to a suspect area and then bracketing the area with an NDT tool in the form of a u-shaped electro-magnet. When the electro-magnet is energized, the filings tend to follow the path of any crack in the surface, allowing the crack to be detected. Another test commonly used is called a dye-penetrant test. Dye-penetrant tests are made by first cleaning the base metal thoroughly in the suspect area and then applying a thin coat of red dye. Next, the surface is wiped clean with a cloth and then sprayed with a white developer. Any cracks that may be in the suspect area will retain some of the red dye that bleeds through the developer, revealing their location.

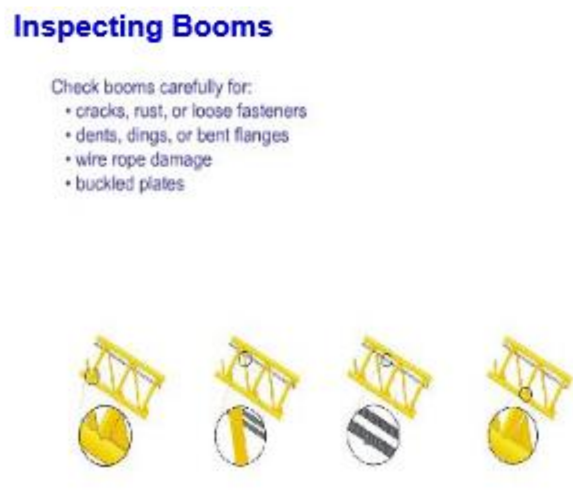
Special Considerations

The crane mechanical inspector will often work with various types of cranes, each having unique inspection considerations. The following discussion will cover mobile cranes, bridge cranes, and fabricated voids in beams and girders.

Mobile Crane Inspections

As mentioned earlier, prior to performing a structural inspection on mobile cranes, it is important to lay the proper groundwork. A typical structural inspection should begin by researching to important resources, the OEM manual and the equipment history file. The crane manufacturer's manual will inform the inspector of procedures and tolerances particular to the equipment and the equipment history jacket will have records of any outstanding deficiencies or patterns of recurring problems.

Inspecting Booms



Crane booms are very important inspection areas that are critical to the structural integrity and safe operation of a crane. To thoroughly and properly inspect a crane's boom, the inspector should anticipate spending a significant amount of time carefully examining this vital crane component. When inspecting crane booms, components should be carefully checked for cracks, corrosion, loose fasteners, dents, dings, or bent flanges. When any element of a tubular boom is dented or damaged in any manner, it is significantly weakened. Tubular booms with seemingly minor damage have been known to fail under loads that were within the crane's rated capacity. Follow the boom damage criteria in NAVFAC P-307 and where possible, consult the OEM manual for specific criteria on boom component imperfections. In addition to bent or dented components, the boom should be inspected for damage resulting from wire rope chafing. On tubular booms, any accumulation of grease build-up deposited from wire rope lubricants, should be cleaned off the boom to expose any chafing damage from wire rope contact. The inspector should check closely for buckled plates or separated members, such as on boxed area of telescopic booms.

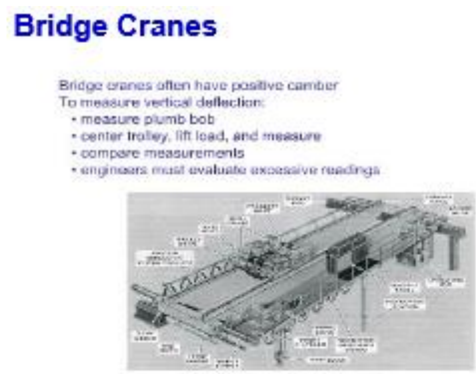
Carrier Inspection

Additional Inspection points specific to mobile crane carriers should include checking the carrier frame and cross member connections for cracks, broken welds or deformations.

Carrier Inspection

The outrigger assemblies are another important checkpoint on mobile cranes. The condition of all cylinders and hydraulic supply lines should be carefully checked. In addition, the outrigger beams and storage tubes must be inspected for any deformation or cracked welds. Finally, the condition of the outrigger pads should be closely checked for any signs of broken welds, cracks, or deformation.

Bridge Cranes



There are some special inspection considerations for overhead electric traveling (OET) cranes. OET cranes are commonly referred to as bridge cranes. The box girders of an OET crane often have a positive camber, that is, with the trolley centered on the bridge and no load on the hooks, the center of the span of the bridge will be slightly higher than the ends. The trolley should not move if the brakes are released. For top running cranes, the maximum vertical deflection of a single web or double web girder should not exceed one-hundred-thirteen-hundred-thousandths, or point zero zero one one three, inches per inch of span with the trolley centered and a capacity load on the hook. This computes to about one quarter inch per twenty foot span. Therefore, a forty foot span would allow up to five-thousand-four-hundred-twenty-four-ten-thousandths of an inch [or point five four two four] - a little over a half an inch - of vertical movement with a capacity load. Under-hung cranes have slightly different criteria. To measure vertical deflection, hang a plumb bob at the center of the girder span with the trolley parked at either end. The plumb-bob should be suspended slightly off the floor and measurements will be taken from the tip of the plumb-bob to the floor. Move the trolley to the center of the span, lift a capacity load, and re-measure. Compare the two measurements. The difference between the two is the amount of deflection. Any readings exceeding the specified limit must be evaluated by engineering.

Inspecting Box Beams, Girders, and Voids

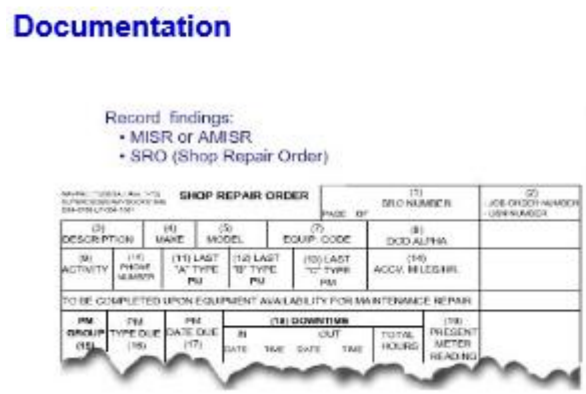
Inspecting the interior structural condition of a box beam, girder, or voids, may be required on some cranes during major services. If these areas have been closed to the atmosphere, it may be necessary to ventilate them and have them certified as gas-free before entering. When inspecting inside voids, use the “buddy system” so someone knows you are there and can help you if you need it. Never attempt to rescue someone who has lost consciousness in a void. Call trained emergency personnel immediately. Use these same inspection techniques for exposed members. In some cases, there will be limitations, such as minimal space and lighting which could make a thorough inspection difficult.

Documentation

All findings for structural inspections will be recorded on one or more of the following documents. For normal maintenance inspections, record your findings on the maintenance inspection specification record, or MISR which can be found in NAVFAC P-307, appendix C for Category 1 and 4 cranes and appendix D for Category 2 and 3 cranes.

Documentation

For the repair process, record your findings on the shop repair order or SRO.



Documentation

For structural defects found during the annual certification and load test, record your findings on the crane condition inspection record or CCIR.

Records

Findings recorded by the mechanical inspector shall include a description of the defect, the location including measurements, the standards or criteria used to measure and document the finding, the corrective actions taken to fix the defect, if any, and any periodic evaluations specified.

Records

All records must be clearly written using correct terminology, as detailed as necessary and kept for the required period described in NAVFAC P-307 Table 5-1.

Review and Summary

Structural Inspection, Module 3, discussed methods for inspecting crane structural members and requirements for recording structural defects.

STRUCTURAL INSPECTION 3 OVERVIEW QUIZ AND SUMMARY

The next several screens contain questions relating to the covered material. Check your comprehension of the course content by answering these questions.

KNOWLEDGE CHECK

Note

The next several screens contain questions relating to the material covered in this module. Check your comprehension of the covered material by answering the following questions.

Select the best answer.

Q: The primary method employed by an inspector to perform a structural inspection is ____________.

- ○ dye penetrate
- ○ visual
- ○ hands on
- ○ sounding

Check

Tries Remaining: 3

Select the best answer.

Q: Two commonly used non-destructive test methods used to detect small cracks in structural materials are the _____________ tests.

- ○ ultrasonic sounding and galvanic rendering
- ○ magnetic particle and dye penetrate
- ○ magnetic resonance and dye permeation
- ○ Liquid magnet solution and UV light

Check

Tries Remaining: 3

Select the best answer.

Q: A tool, which may be helpful to verify whether a rivet is loose or not, is a ____________.

- ○ hammer
- ○ phase rotation meter
- ○ torque wrench
- ○ screw driver

Check

Tries Remaining: 3

Select the best answer.

Q: When checking the deflection of a bridge span, a simple tool that can be helpful is a ____________.

- plumb bob
- hammer
- machinist scale
- level

Check

Tries Remaining: 3

Select the best answer.

Q: When entering an unventilated void such as a box girder or watertight compartment on a floating crane, have the space _______________ before you enter.

- sounded
- ventilated
- gas-free tested
- visually inspected

Check

Tries Remaining: 3

Select the best answer.

Q: When inspecting booms, gantries, and A-frames, outside of walkways and platforms, what additional safety equipment is required?

- Lifelines
- PPP
- Personnel baskets
- Safety harness

Check

Tries Remaining: 3

Select the best answer.

Q: What is a major concern when removing grease, oil, paint, or debris to do an inspection?

- ○ All listed concerns
- ○ Hazardous-waste disposal
- ○ Environmental contamination
- ○ Health issues

Check

Tries Remaining: 3

Select the best answer.

Q: Before doing a structural inspection on a mobile crane, which of the following two references should be reviewed carefully for important information?

- ○ The OEM Manual and the Equipment History File
- ○ The OSHA Manual and the Equipment History File
- ○ The Operators Manual and the NAVFAC P-307
- ○ Work Pending File and the OEM Manual

Check

Tries Remaining: 3

Check all that apply.

Q: While performing a Type-B inspection on a mobile crane's angle-lattice boom, you discover a broken weld. Select the item(s) from the list below that should be used to document both the finding and the repair of this condition.

- ☐ Certification of Load Test and Condition Inspection
- ☐ MISR
- ☐ CCIR
- ☐ SRO (or other local work authorizing document)

Check

Tries Remaining: 3

Check all that apply.

Q: You are performing your post-test inspection after completing the load test of a mobile crane. You notice a twist in one of the box-boom sections. Select the item(s) from the list below that should be used to document both the finding and the repair of this condition.

☐ Certification of Load Test and Condition Inspection

☐ CCIR

☐ SRO (or other local work authorizing document)

☐ MISR

Check

Tries Remaining: 3

Check all that apply.

Q: While performing your pre-test inspection of a wall mounted jib crane, you observe a crack between the web and flange on the beam. Select the item(s) from the list below that should be used to document both the finding and the repair of this condition.

☐ MISR

☐ Certification of Load Test and Condition Inspection

☐ SRO (or other local work authorizing document)

☐ CCIR

Check

Tries Remaining: 3

Q: It's cold, overcast, and windy and you've been assigned to perform a Type-C inspection on a 50 ton mobile crane which is set up on the test slab. You bundle up, head out and begin your inspection. About half way through your inspection you find extensive surface corrosion on an outrigger beam box. Select the item(s) from the list below that should be used to document both the finding and the repair of this condition.

☐ MISR

☐ Certification of Load Test and Condition Inspection

☐ SRO (or other local work authorizing document)

☐ CCIR

Check

Tries Remaining: 3

WIRE ROPE INSPECTION 1

Welcome

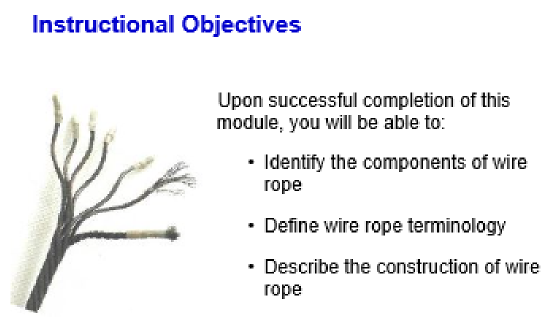
Welcome to Wire Rope Inspection.

Wire Rope Inspection Modules

Wire rope inspection is covered in five modules. Listed here are the separate topics within each module.

Instructional Objectives

Upon successful completion of this module, you will be able to identify the components of wire rope, define wire rope terminology, and describe the construction of wire rope.



Wire Rope Definition

A wire rope is a number of multi-wire strands coiled around a core.

The Precision Machine

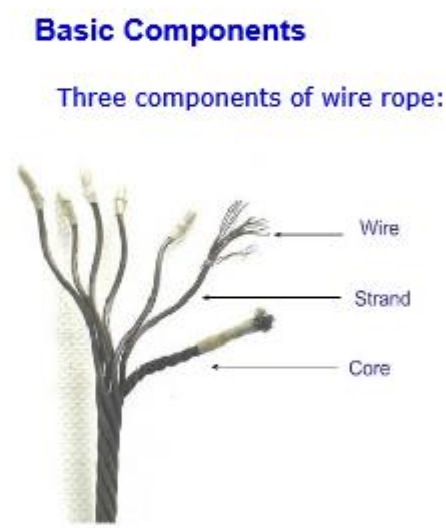
What three basic components are used to construct a wire rope? What is a lay length? What is considered the foundation of a wire rope? What are the two most common types of wire rope lay?

Keep these questions in mind as you watch the video “The Precision Machine”.

If you would like to view the video, click on the provided link. If you don't want to watch the video, continue to the next screen.

Basic Components

The three basic components of a standard wire rope design are the individual wire, the strand, and the core. These components vary in both complexity and configuration in order to produce ropes designed for specific purposes or working characteristics.

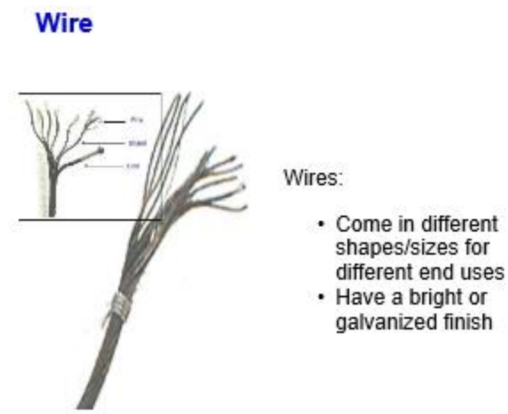


Wire

Wire is the basic element used in the construction of wire rope. Wires come in different shapes and sizes for a variety of end uses. Wire intended for wire rope purposes is heat treated, then cold drawn to the desired diameter.

Wire may either have a natural, uncoated finish called bright, or a special surface treatment such as galvanization. The most common finish for steel wire used in the construction of wire rope is bright finish.

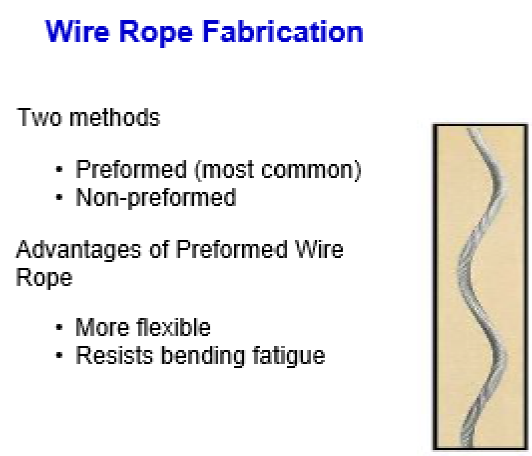
Note: "Drawn galvanized" wire has the same strength as bright wire, but wire "galvanized at finished size" is usually 10 percent lower in strength.



Wire Rope Fabrication

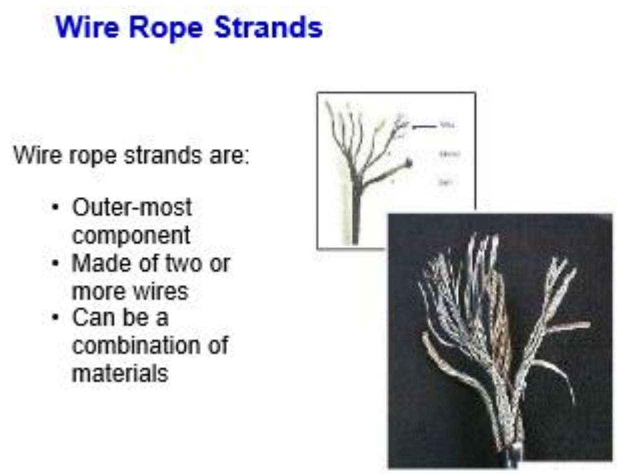
There are two methods of wire rope fabrication: preforming and non-preforming. Preforming is the most common. Preforming is a fabrication process that mechanically manipulates wires and strands into the continuous permanent helical shapes they will assume in the wire rope. These preformed wires and strands are then assembled to form the wire rope.

The advantage of preformed wire rope is that when it bends, each of its many wires and strands slide and adjust to accommodate the differences in length between the inside and outside of the bend, while maintaining the integrity of its design and shape.
In other words, it's more flexible and resistant to bending fatigue.



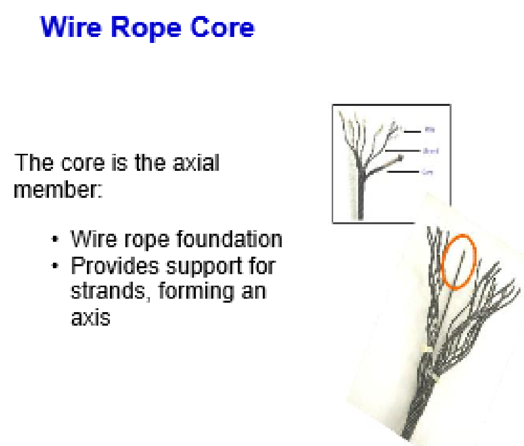
Wire Rope Strands

A strand is the outer-most component of a wire rope. Strands are made up of two or more wires laid in a spiral fashion around a wire center in one or more layers. A strand can also be constructed of a combination of steel wires combined with other materials such as natural or synthetic fibers. A strand can be made up of any number of wires and a rope can have any number of strands.



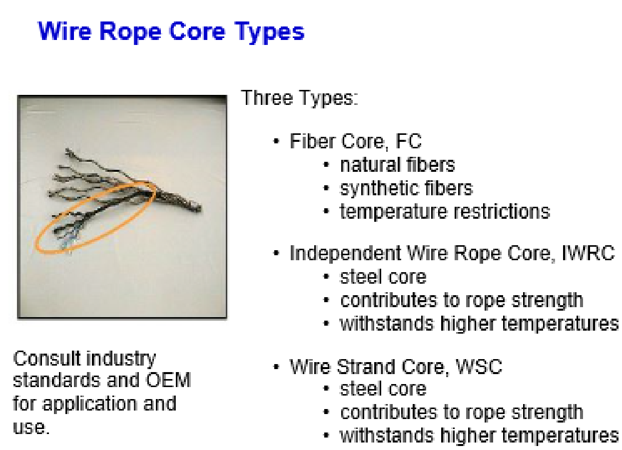
Wire Rope Core

The core is the axial member around which strands are laid to form the wire rope assembly and is considered to be the foundation of a wire rope. The core is made from materials that will provide proper support for the strands under normal bending and loading conditions.



Wire Rope Core Types

There are three types of cores typically used in wire rope construction. Fiber core, or FC, is made of natural or synthetic fibers such as sisal, hemp and polypropylene. Independent Wire Rope Core, or IWRC, and wire strand core, or WSC, have metallic cores, which contribute to the overall strength of the wire rope. Steel cores should be used when there is any evidence that a fiber core will not provide adequate support. Also, if the temperature of the environment may be expected to exceed 180 degrees Fahrenheit, steel cores must be used. Consult industry standards and OEM for application and use.



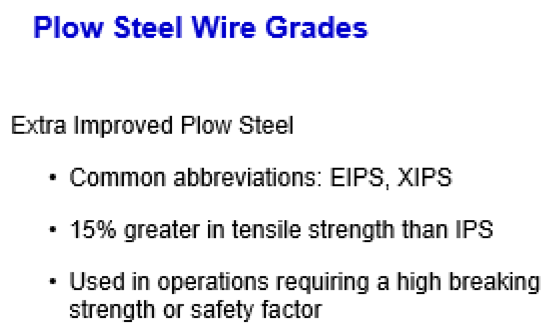
Plow Steel Wire Grades

The following three wire grades are the most common types for use on weight handling equipment.

The first wire grade, Improved Plow Steel or IPS, is 15% higher in tensile strength than plow steel, fatigue and abrasion resistant, and has good bending qualities.

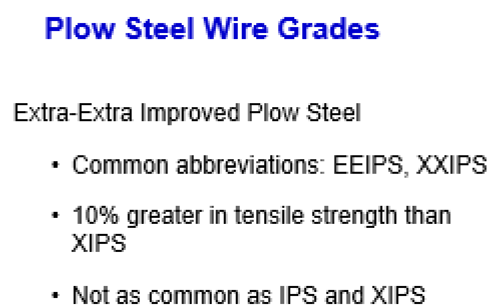
Plow Steel Wire Grades

Extra Improved Plow Steel (abbreviated EIPS or XIPS) is 15% greater in tensile strength than IPS, and can be used in operations requiring a higher breaking strength or safety factor.



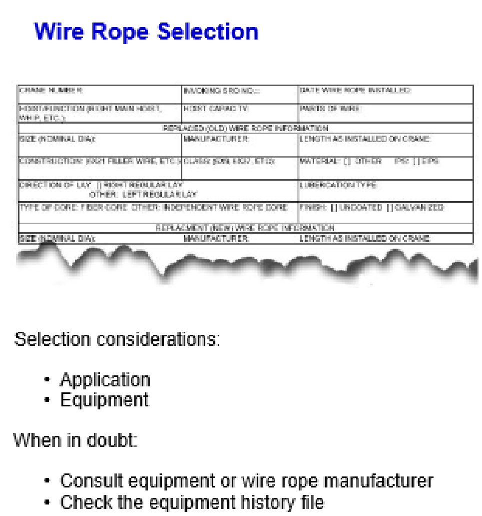
Plow Steel Wire Grades

Extra Extra Improved Plow Steel (abbreviated EEIPS or XXIPS) is 10% greater in tensile strength than XIPS. It is not as commonly used as IPS and XIPS.

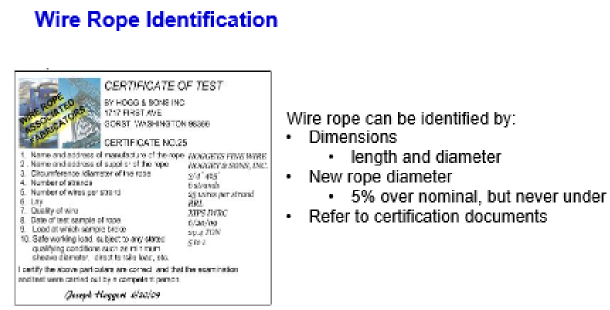


Wire Rope Selection

When selecting wire rope, first consider the application and equipment type for the ropes intended use. When in doubt, consult the equipment manufacturer or wire rope manufacturer to ensure the proper replacement rope is used. Equipment history records for the specific crane should be checked for wire rope identification and certification requirements.

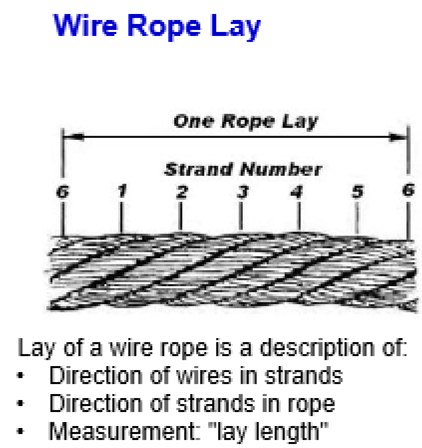


Wire Rope Identification



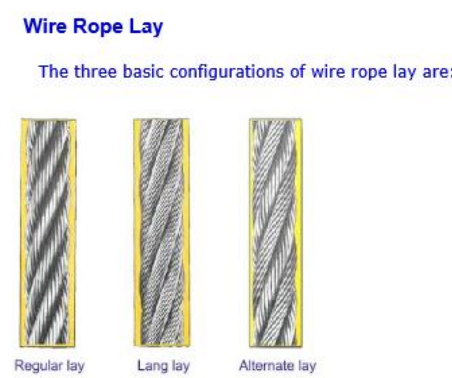
When identifying wire rope, the first identifying factor will be its dimensions. The length and diameter of the rope will be dependent on the size and capacity limitations of the equipment. The diameter of a new wire rope can be up to 5% over the nominal size, but never less. The wire rope certification documents can provide additional information for identification purposes.

Wire Rope Lay



The lay of a wire rope is a description of the way wires and strands are arranged during construction. Right lay and left lay refer to the direction of the strands. Right lay means that the strands pass from left to right across the rope. Left lay means just the opposite, strands pass from right to left. Lay length is a term of measurement, and in its simplest form, is equal to one complete revolution of a strand around the circumference of the wire rope core.

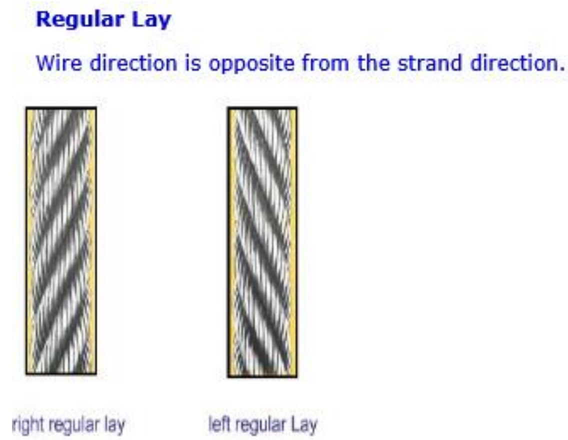
Wire Rope Lay



The three basic configurations of wire rope lay are: regular lay, lang lay, and alternate lay. The following screens will describe the construction and characteristics of each of these wire rope lay types.

Regular Lay

In regular lay wire rope, the individual wires appear parallel with the axis of the rope. Regular lay ropes are constructed so that the direction of the wires in the strand is opposite to the direction of the strands in the rope. Regular lay wire rope will be either right regular lay, referred to as RRL, or left regular lay, known as LRL.

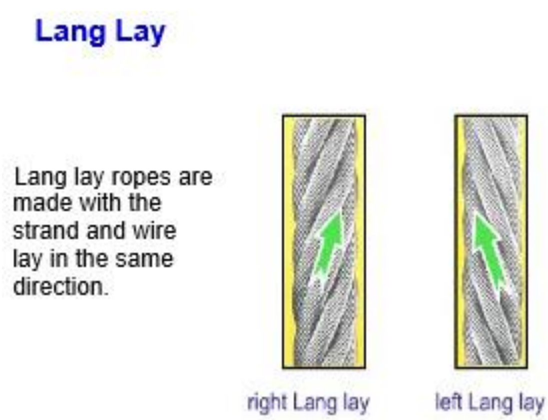


Regular Lay Characteristics

Regular lay wire rope is preferred in applications where stability of the rope and resistance to crushing are required. Since regular lay rope has less surface area of exposed wires, wear resulting from exposure to any external abrasion is minimized.

Lang Lay

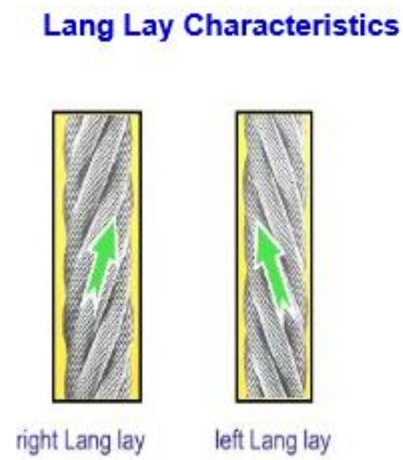
In Lang lay ropes, the wires form an angle with the axis of the rope. Lang lay ropes are made with the strand and wire lay in the same direction. The direction of lay can be right or left. Right Lang lay is identified as RLL and left Lang lay is identified as LLL.



Lang Lay Characteristics

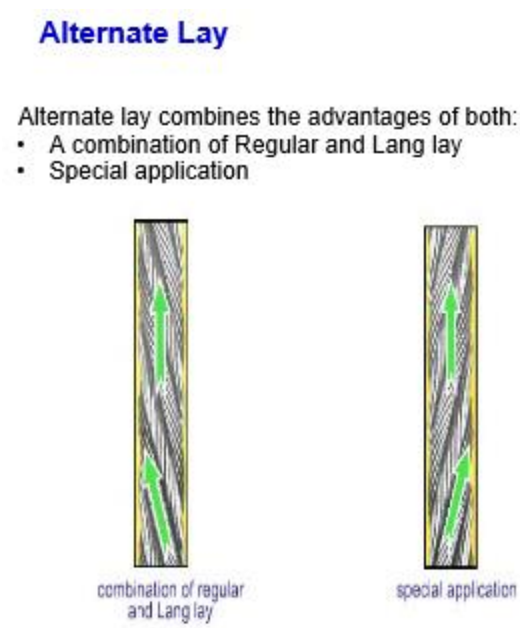
Some of the characteristics of Lang lay rope include greater flexibility than other wire rope types, and greater fatigue and abrasion resistant qualities because wear is spread over a greater length of exposed wire.

Lang lay rope is more susceptible to kinking and less capable of withstanding crushing forces, and is not recommended for use on single part hoist lines because of the greater tendency to un-lay. Both ends of this rope type must be securely fastened to prevent rotation under load.



Alternate Lay

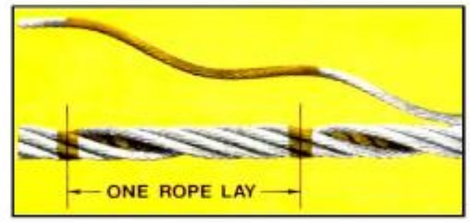
The third type of wire rope lay is called alternate lay. Alternate lay rope is a combination of regular and Lang lays. As seen in the illustration, regular lay strands are combined with Lang lay strands in the same rope. This is a special application use rope, which combines the advantages of both regular and Lang lay rope in the same rope.



Lay Length

The term “lay length" is also used as a measurement of wire rope. The wire rope’s lay length is the length along the rope in which one strand makes one complete turnaround the rope core.

Lay Length

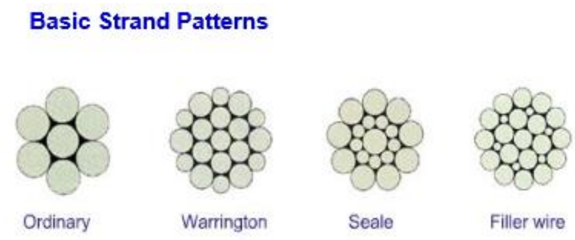


Lay length is the length along the rope in which one strand makes one complete turn around the rope core.

Wire Rope Classification

The purpose of wire rope classification is to group ropes according to the number of strands in the rope and the number of wires in each strand. Wire ropes within a class of the same size, grade, and core have the same nominal strength and weight, due to the total cross-sectional area of the wires. Wire ropes within a class, having different construction, will have different working characteristics.

Basic Strand Patterns



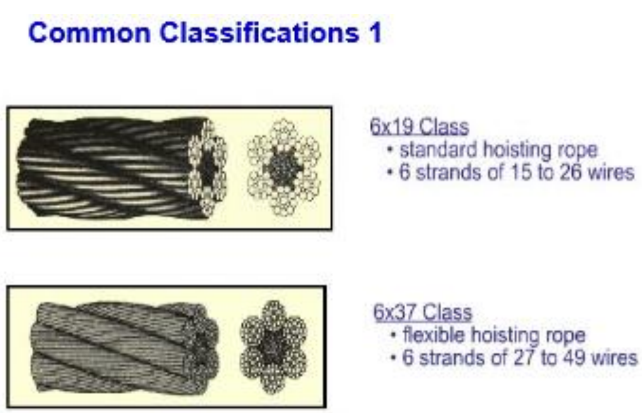
There are four basic strand patterns used in wire rope construction; however, there are several possible combinations of these constructions. These four patterns are Ordinary, Warrington, Seale, and Filler. The pattern called Ordinary or “single layer” is constructed with all wires being the same size.

The Warrington pattern has two layers with one diameter of wire in the inner layer, and two diameters of wire alternating large and small in the outer layer. The larger outer-layer wires rest in the valleys, and the smaller ones on the crowns of the inner layer.

Seale pattern construction utilizes two layers of wires around a center wire with the same number of wires in each layer. All wires in each layer are the same diameter. The strand is designed so that the large outer wires rest in the valleys between the smaller inner wires.

Filler wire type wire rope is constructed with two layers of uniform-size wire around a center wire with the inner layer having half the number of wires as the outer layer. Small filler wires, equal in number to the inner layer, are laid in valleys of the inner layer.

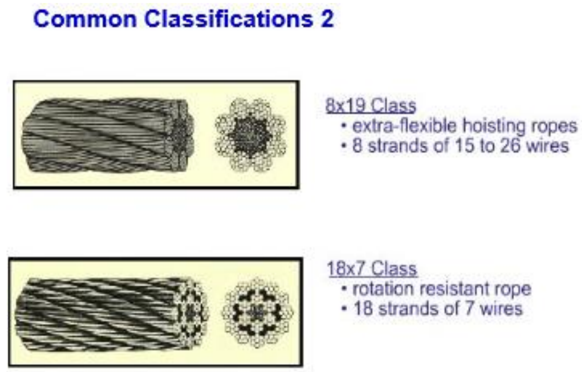
Common Classifications 1



The most common classifications of wire rope used on weight handling equipment are the 6 x 19 class and the 6 x 37 class. The 6 x 19 class is used for standard hoisting ropes and contains six strands of 15 to 26 wires. The advantages of this wire rope type are good balance of abrasion and fatigue resistance. The 6 x 37 class is known as “flexible hoisting rope”. It is made up of six strands of 27 to 49 wires. The advantages of this wire rope type are greater fatigue resistance and greater flexibility, although it is less resistant to abrasion than the 6 x 19 class.

Common Classifications 2

Two other common classifications are the 8 x 19 class and the 18 x 7 class. The 8 x 19 class is known as "extra-flexible hoisting ropes". It contains eight strands of 15 to 26 wires. It is high in flexibility, although lower in crush resistance. The 18 x 7 class, known as "rotation resistant wire rope", contains 18 strands having seven wires each. This class of wire rope has layers of strands which are counter-laid to achieve opposing torque under load and reduce the tendency of the rope to rotate under load.

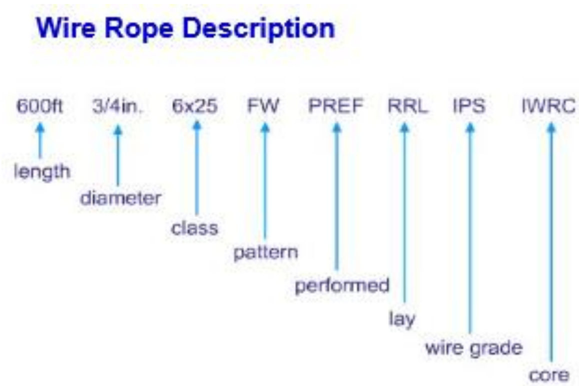


Rotation Resistant Rope

Rotation resistant ropes are a special class of wire rope which are constructed with layers of strands which are counter-laid to achieve opposing torque under load, and reduce the tendency of the rope to rotate under load. This type of wire rope is primarily used for single part hoist lines such as a crane's whip hoist. Rotation resistant wire rope is not recommended for luffing applications.

Wire Rope Description

The wire rope description is used for selecting and identifying the various rope types. A complete wire rope description should include length, diameter, classification, pattern, fabrication process, lay, finish, wire grade, and core type. If the desired fabrication process, i.e., pre-formed or non-pre-formed, is omitted from the description, then pre-forming will be presumed. If finish is omitted from the description, then uncoated bright finish is presumed. In reading the description on the screen, we note that six hundred feet of 3/4 inch 6 x 25 Filler wire rope, with a pre-formed Right Regular Lay made of Improved Plow Steel, and an Independent Wire Rope Core is what is being specified. No mention of finish in the description means the rope will be manufactured with an uncoated bright finish.



Review and Summary

Wire Rope Module 1 covered the basic components of wire rope, wire rope terminology, and wire rope construction.

WIRE ROPE INSPECTION 1 OVERVIEW QUIZ AND SUMMARY

Knowledge Check: Introduction

The next several screens contain questions relating to the covered material. Check your comprehension of the course content by answering these questions.

Note

KNOWLEDGE CHECK

The next several screens contain questions relating to the material covered in this module. Check your comprehension of the covered material by answering the following questions.

Select all that apply.

Q: Select the two most common grades of carbon steel used in the manufacture of wire rope.

- ☐ Stainless steel
- ☐ Improved plow steel
- ☐ Cold rolled steel
- ☐ Spring wire
- ☐ Extra improved plow steel

Check

Tries Remaining: 1

Select the best answer.

Q: In wire rope terminology, the term "bright" means __________.

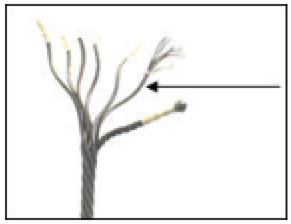
- ○ wire coated with zinc or tin
- ○ non-corrosive wire
- ○ wire without lubrication
- ○ wire that is not coated

Check

Tries Remaining: 3

Select the best answer.

Q: What is this component of wire rope?



- ◯ diameter
- ◯ lay
- ◯ strand
- ◯ wire
- ◯ helix
- ◯ core

Check

Tries Remaining: 3

Select the best answer.

Q: What is this component of wire rope?

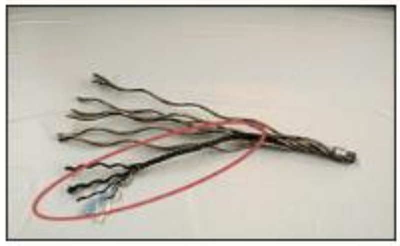
- ◯ wire
- ◯ strand
- ◯ core
- ◯ lay
- ◯ diameter
- ◯ helix

Check

Tries Remaining: 3

Select the best answer.

Q: What is this component of wire rope?



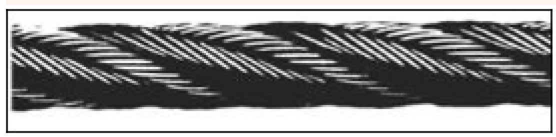
- ○ wire
- ○ lay
- ○ core
- ○ strand
- ○ diameter
- ○ helix

Check

Tries Remaining: 3

Select the best answer.

Q: The graphic below displays what lay type?



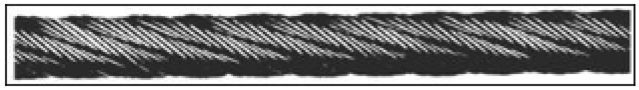
- ○ Left regular lay
- ○ Left Lang lay
- ○ Right alternate lay
- ○ Right regular lay
- ○ Right Lang lay

Check

Tries Remaining: 3

Select the best answer.

Q: The graphic below displays what lay type?



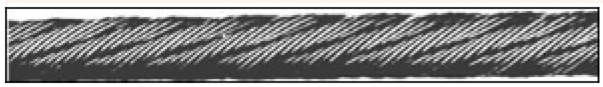
- ◯ Right Lang lay
- ◯ Right alternate lay
- ◯ Right regular lay
- ◯ Left regular lay
- ◯ Left Lang lay

Check

Tries Remaining: 3

Select the best answer.

Q: The graphic below displays what lay type?



- ◯ Right Lang lay
- ◯ Left Lang lay
- ◯ Right regular lay
- ◯ Left regular lay
- ◯ Right alternate lay

Check

Tries Remaining: 3

Select the best answer.

Q: The graphic below displays what lay type?

- ◯ Right regular lay
- ◯ Left regular lay
- ◯ Left Lang lay
- ◯ Right alternate lay
- ◯ Right Lang lay

Check

Tries Remaining: 3

Select the best answer.

The graphic below displays what lay type?

- ◯ Left Lang lay
- ◯ Right Lang lay
- ◯ Right regular lay
- ◯ Right alternate lay
- ◯ Left regular lay

Check

Tries Remaining: 3

Select the best answer.

In regular lay ropes, the wires appear to run __________ to the axis of the rope.

- ◯ parallel
- ◯ at an angle

Check

Tries Remaining: 1

True or False

All wire rope in the 6 X 37 class has six strands of wire with 37 wires in each strand.

- ◯ True
- ◯ False

Check

Tries Remaining: 1

Select all that apply.

Select four identifying factors found in a complete wire rope description.

- ☐ Core Type
- ☐ Manufacturer
- ☐ Wire Grade
- ☐ Lay Type
- ☐ Diameter

Check

Tries Remaining: 1

Select the best answer.

Q: The term lay length is best described as __________.

- ◯ the length in which one strand makes one complete spiral around the rope core
- ◯ the area it takes to lay out a complete length of wire rope
- ◯ a linear measurement in inches
- ◯ a linear measurement in feet

Check

Tries Remaining: 3

Select the best answer.

Q: Rotation resistant rope is primarily used for __________.

- ◯ single part lines
- ◯ slings and pendants
- ◯ mooring lines
- ◯ extra heavy loads

Check

Tries Remaining: 3

WIRE ROPE INSPECTION 2

Welcome

Welcome to Wire Rope Inspection Module 2, Wire Rope Measurement, Installation, and Associated Hardware.

Instructional Objectives

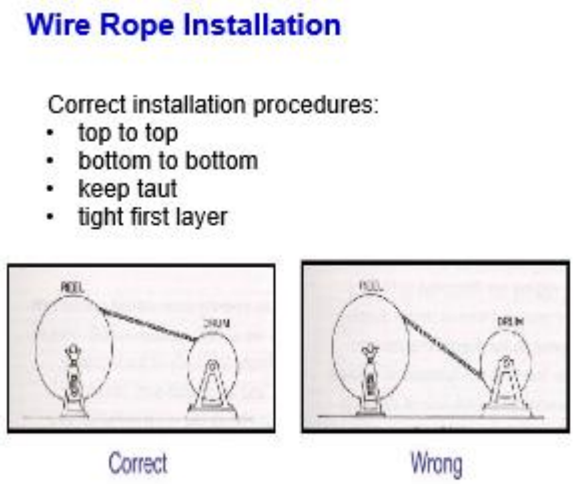
Upon successful completion of this module, you will be able to explain the proper method for measuring the diameter of a wire rope, describe proper wire rope installation, handling, and storage techniques, and identify acceptable wire rope end attachments and associated hardware.

Measuring Wire Rope

While performing a wire rope inspection, it is important to carefully measure the wire rope diameter to check for the amount of wear and compression that may have occurred during use. When taking wire rope measurements, use a machinist's caliper, making sure to measure the widest diameter (crown-to-crown). After taking measurements, NAVFAC P-307 should be referenced to check the readings against acceptable tolerances. The Federal specification for wire rope is RR-W-410.

Wire Rope Installation

To avoid putting a reverse bend in wire rope, ensure correct installation procedures are followed. Wire rope should always be installed so that it pays out from the top of the dispensing reel to top of the crane's wire rope drum. The rope may also be installed so that it pays out from the bottom of the dispensing reel to the bottom of the crane's wire rope drum. When transferring wire rope from a reel to a crane's wire rope drum, the rope should always be kept tensioned by using a reel brake. Having a tight first layer on the drum is critical to preventing crushing of the rope under a load.



Improper Spooling

Improper drum spooling may result in flattening, crushing, abrading, distorting or kinking of the wire rope.

Handling Wire Rope

When handling wire rope, care must be taken to prevent loops from forming, which is a major cause of kinking. Wire rope should never be dragged over the ground or any abrasive surfaces. Dragging the rope could reduce the wire diameter. While installing wire rope, take care to avoid any chafing, which can result from dragging the rope over sharp edges. Improper handling and installation of wire rope may cause future operational difficulties, such as spooling problems, or excessive "spin-up" under load.

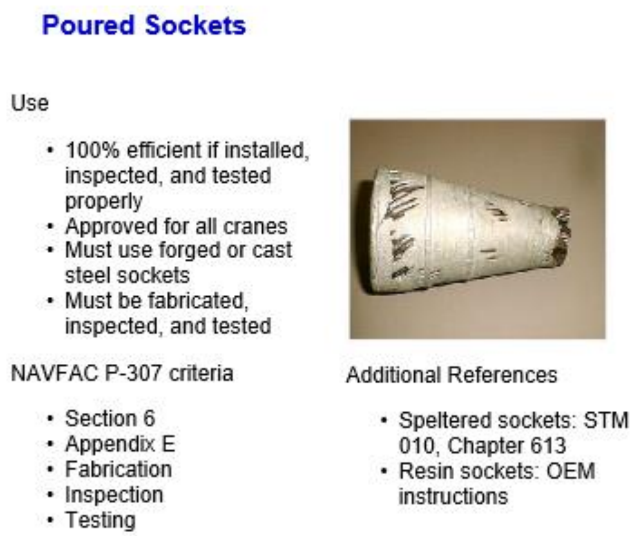
Wire Rope Storage

Proper storage of wire rope is essential for maintaining the rope in a serviceable condition. Rope should be stored in a clean, dry place, either coiled or on a reel. Outdoor storage may be utilized if the surfaces are covered to prevent foreign material or moisture from collecting on the rope. Rope must also be stored away from heat or steam. Coiled wire must not be stored on concrete floors for lengthy periods of time due to corrosion resulting from the lime in the concrete.

Poured Sockets

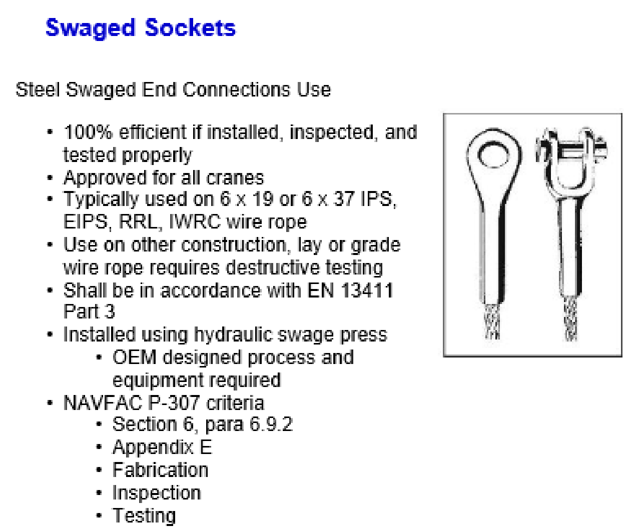
Poured spelter and resin end connections using forged and cast steel sockets are approved for all cranes. Fabrication, inspection and test requirements can be found in NAVFAC P-307, section 11 and appendix E. The proof test for the installed socket shall be the NAVFAC P-307 appendix E load test for the crane.

Poured speltered socket end connections, fabricated using molten zinc, are fabricated in accordance with Naval Ships Technical Manual S9086-UU-STM-010 Chapter 613, Wire and Fiber Rope and Rigging. Resin socket end connections shall be fabricated in accordance with resin OEM's instructions.



Swaged Sockets

Steel swaged end connections, fabricated on a swage press designed for such purposes using procedures and parts approved by the swage press OEM, are approved for all cranes. Swage sockets are installed by compressing a steel sleeve over the wire rope. Fabrication, inspection and test requirements can be found in NAVFAC P-307, section 6 and appendix E. The proof test for the installed socket shall be the NAVFAC P-307 appendix E load test for the crane. Refer to NAVFAC P-307 for additional guidelines regarding the use of swaged sockets on rotation resistant wire rope.

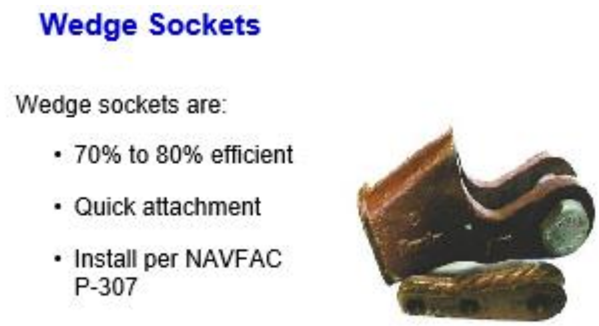


Wedge Socket Use

The use of wedge sockets is limited to mobile cranes. They may be acceptable for use as the dead end connection at the wire rope hoist drum or the dead end on the hoist block and frame of category 3 cranes. Use of wedge sockets shall conform to OEM and NAVFAC P-307 instructions.

Wedge Sockets

Wedge sockets are rated at 70% to 80% efficient due to the crushing action of the wedge on the wire rope and should only be used when necessary. They are designed as a quick-change-wire-rope-end-fitting and shall be installed following OEM and NAVFAC P-307, section 6 guidelines.



Other End Connections Exceptions

The OEM's design configuration for dead end connection devices at the hoist drums are acceptable as originally installed and for replacement. The OEM's design configuration for dead end connections on the hoist block and frame of category 3 cranes and mobile boat hoists are acceptable as originally installed and for replacement. Except that swaged connections for rotation-resistant rope shall comply with NAVFAC P-307, paragraph 6.9.2.

Review and Summary

Wire Rope Inspection Module 2, Wire Rope Measurement, Installation, and Associated Hardware, explained the proper method for measuring the diameter of a wire rope, reviewed proper wire rope installation, handling, and storage techniques, and identified acceptable wire rope end attachments and associated hardware.

WIRE ROPE INSPECTION 2 OVERVIEW QUIZ AND SUMMARY

Knowledge Check

The next several screens contain questions relating to the covered material. Check your comprehension of the course content by answering these questions.

KNOWLEDGE CHECK

Note

The next several screens contain questions relating to the material covered in this module. Check your comprehension of the covered material by answering the following questions.

Select the best answer.

Q: The amount of wear and compression that has occurred while the rope has been in use is determined by measuring the smallest crown-to-crown diameter of the wire rope.

- ○ True
- ○ False

Check

Tries Remaining: 1

Select all that apply.

Q: When transferring wire rope from a reel to a drum always ___________.

- ☐ transfer from the top of the reel to the bottom of the drum
- ☐ transfer from the bottom of the reel to the top of the drum
- ☐ transfer wire from bottom of reel to bottom of drum
- ☐ transfer from the top of the reel to the top of the drum

Check

Tries Remaining: 3

Select the best answer.

Q: Improper drum spooling of wire rope can result in which of the following?

- ○ Crushing
- ○ Abrasion
- ○ Distortion
- ○ All results listed

Check

Tries Remaining: 3

Select the best answer.

Q: Kinks are normally the result of improper handling by allowing ________ to form in the wire rope.

- ◯ loops
- ◯ slack
- ◯ stress
- ◯ knots

Check

Tries Remaining: 3

Select all that apply.

Q: The efficiency of a properly poured, installed, and tested socket end connection is ___________.

- ☐ 85%
- ☐ 90%
- ☐ 95%
- ☐ 100%

Check

Tries Remaining: 3

Select the best answer.

Q: Which end connection is installed on wire rope using a hydraulic press?

- ◯ Swaged socket
- ◯ Resin socket
- ◯ Wedge socket
- ◯ Speltered socket

Check

Tries Remaining: 3

Select the best answer.

Q: When swaged sockets are properly installed using the proper materials, methods, and equipment, their efficiency is rated at ___________.

- ◯ 70%
- ◯ 85%
- ◯ 90%
- ◯ 100%

Check

Tries Remaining: 3

Select the best answer.

Q: Wedge sockets are only 70% to 80% efficient.

- ◯ True
- ◯ False

Check

Tries Remaining: 1

Select all that apply.

Q: The use of wedge socket end connections is restricted to certain types of cranes. On which of the cranes listed below are wedge socket end connections prohibited?

- ☐ mobile crane
- ☐ bridge crane
- ☐ mobile boat hoist
- ☐ portal crane

Check

Tries Remaining: 3

<u>WIRE ROPE INSPECTION 3</u>

Welcome

Welcome to Wire Rope Inspection Module 3, Documentation, Defects, Inspection Procedures, and Rejection Criteria.

Instructional Objectives

Upon successful completion of this module, you will be able to list the materials needed for performing a wire rope inspection, identify techniques for inspecting a wire rope core, and explore common wire rope defects and associated NAVFAC P-307 rejection criteria.

Improving Your Catch

What tools are needed to perform a wire rope inspection? What are some common causes of broken wires? What usually causes kinks in wire rope? What causes broken wires at end fittings?

Keep these questions in mind as you watch the video “Improving Your Catch”.

If you would like to view the video, click on the provided link. If you don't want to watch the video, continue to the next screen.

Inspection Tools

Typical inspection tools commonly used to inspect wire rope include dial calipers, tape measure, an awl or marlin spike, and groove gauges.

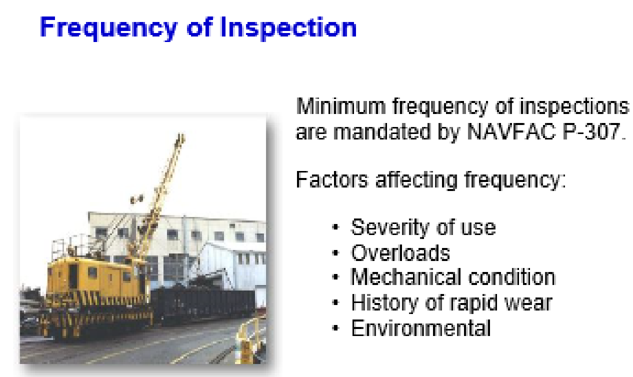
Documentation

Be sure to document your findings when inspecting wire rope. Inspection criteria can be found in NAVFAC P-307 appendices C and D. The MISRs found in these appendices should be used to record findings. Previous inspection findings should be reviewed for trends, problem areas, and other related concerns prior to performing your inspection.

Locally developed checklists can be used to assist with the inspection. Individual activities may have additional specifications for unique or special equipment.

Frequency of Inspection

The minimum frequency of wire rope inspections are mandated by NAVFAC P-307; however, activities may elect for more frequent inspections based on the wire rope's operating environment. Factors that may call for increased inspection frequencies are exceeding rated capacity, mechanical condition of the crane, prior history of abnormal wear, and/or exposure to harsh work environments.



Inspection Conditions

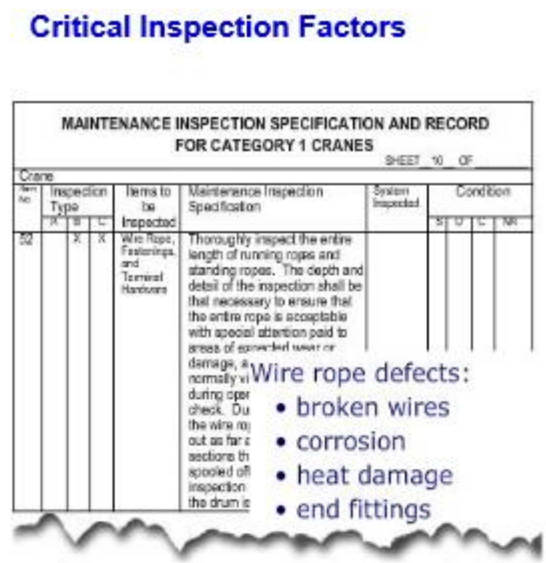
The proper wire rope inspection is normally performed while the rope is at rest, or in a relaxed state, and with no load applied. Annual inspections of the luffing wire and portions in contact with equalizer sheaves should be conducted with the boom resting on a boom stand. The entire length of each rope, to the maximum extent possible, shall be examined visually for defects with particular attention paid to those areas exposed to maximum wear and abuse, such as equalizer sheaves, saddles, and areas having poor drainage.

Wire Rope Condition

The wire rope must be cleaned sufficiently to allow a proper inspection. Rope dressing or lubrication shall be removed from all areas that would prevent a thorough and accurate inspection of the wire rope. When the rope condition is determined to be satisfactory, replace lubrication as necessary.

Critical Inspection Factors

The crane inspector should closely examine wire rope for defects such as broken wires, corrosion, heat damage, and deficiencies at end fittings. The following screens will cover these and other wire rope defects in greater detail.



Broken Wires

While performing a wire rope inspection, individual wires that make up the wire rope strands may be found to be broken or protruding. Most often, this condition is the result of fatigue caused by repeated bending beyond the elastic limits of the wire. Other contributing factors may involve tension caused by forces exceeding the nominal strength of the wire or abrasion, which is the major cause of metal loss resulting in the reduction of wire diameter and overall strength.

Locating Broken Wires

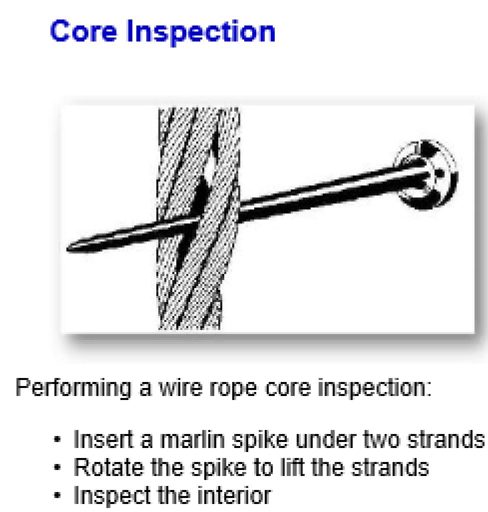
Locating broken wires requires close observation of the wire rope end fittings, the portions in close proximity to equalizer sheaves, and at “pick-up points”, which are the areas of continuous bending and wear around sheaves caused by repetitive operations.

Core Inspection

Internal core inspections should be performed only if evidence such as a reduction in diameter has been found in a segment of wire rope that otherwise shows little or no signs of external wear. A sign of internal wear in non-rotational wire rope may be “popping” sounds that occur when the rope is bent.

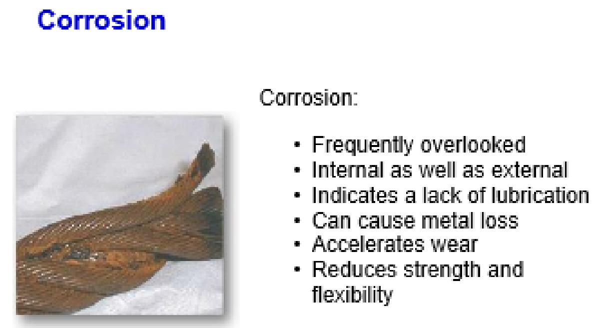
Core Inspection

To inspect a wire rope core, insert a marlin spike under two strands and rotate to lift strands and provide view of interior.



Corrosion

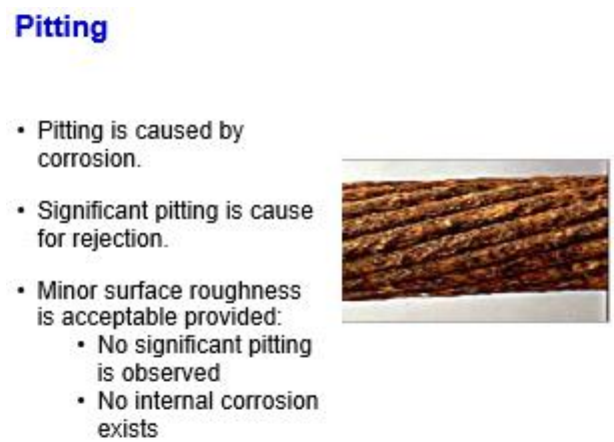
Corrosion is a frequently overlooked deficiency. A proper wire rope inspection requires close observation for evidence of corrosion - internal as well as external. Corrosion indicates a lack of lubrication. Corrosion leads to increased wear and metal loss, which eventually reduces the strength and flexibility of the wire rope.



Pitting

Pitting on wire rope results from corrosion. Significant pitting occurs when corrosion is severe enough to cause pitting that cannot be removed abrasively, without removing one third of the individual wire's original diameter. In other words, if you have to remove one third or more of an individual wire's diameter to remove pits, the rope, or portions thereof, should be rejected for use.

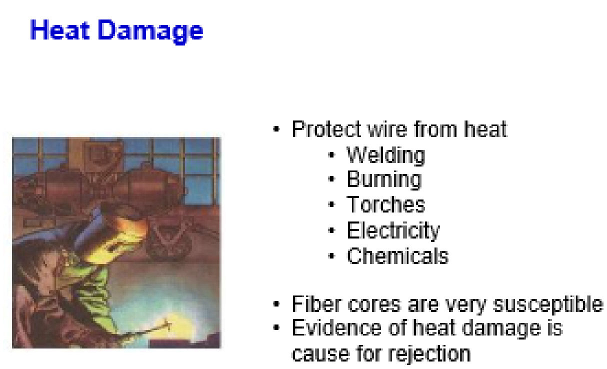
Minor surface roughness on outside wires is acceptable provided there is no significant pitting and the rope is not corroded internally.



Heat Damage

Wire rope should be protected from heat sources such as welding or burning processes, electricity, or chemically induced heat, etc. Synthetic and natural fiber core wire ropes are particularly sensitive to heat damage. Inspectors should pay close attention to areas of wire rope where heat damage is suspected.

Evidence of heat damage from any source is cause for rejection per NAVFAC P-307 Appendix C and D requirements.



End Fittings

End fitting inspection is critical. End fittings, by design, captivate wires and reduce their ability to move, slide, and adjust as the wire rope bends and tensions. These restrictions on movement may result in broken wires and loosening of the fitting. The inspector should pay close attention in the area near the end connection. Check for broken wires and that the end fitting is installed correctly on, and adequately secured to the wire rope. Two broken wires within one lay length of an end connection is grounds for rejection.

End Fittings

Properly installed and operational end fittings are critical to crane operations - so is their inspection.

Inspect for:

- Proper installation
- Any looseness
- Any broken wires

Two broken wires within one lay length of an end connection is grounds for rejection.

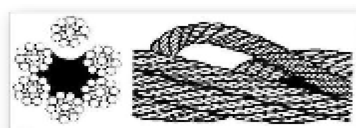
Flattened Sections

Flattened sections, where the diameter across the flat is less than five-sixths of the nominal diameter, is cause for rejection. This criteria does not apply to wire rope runs around eyes, thimbles, or shackles.

High or Low Strand

High or low strand is a defect that is normally the result of a sudden release of tension, or from the rope operating through a tight groove. High or low strand is unacceptable where the height or depth exceeds one-half the strand diameter.

High or Low Strand



High strand is the result of:

- Sudden release of tension
- A tight sheave groove

High strand is unacceptable where the height or depth exceeds one-half the strand diameter.

Kinks

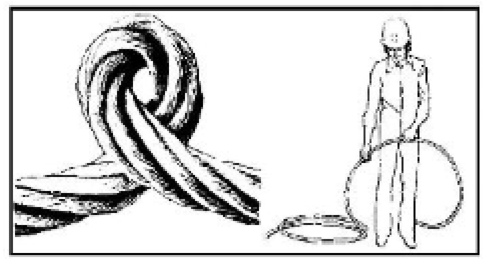
Kinks are defects that often result from improper handling by allowing loops to form in the wire rope. The wire rope should be removed from service if the core is missing or protruding, or if the wire rope will not fit properly in the sheave or drum grooves.

Kinks

Kinks result form improper handling.

Remove rope from service if:

- The core is missing or protrudes out of the rope
- Improper fit in the drum or sheaves



Birdcage

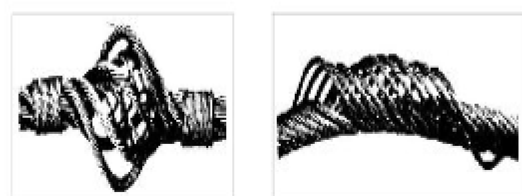
Bird-caging is a defect that is usually the result from a sudden release of tension. The wire rope should be removed from service if the core is missing or protruding, or if the wire rope does not fit properly in the sheave or drum grooves.

Birdcage

A birdcage results from a sudden release of tension.

Remove rope from service if:

- The core is missing or protrudes from the rope
- Improper fit in the drum or sheaves



Dogleg

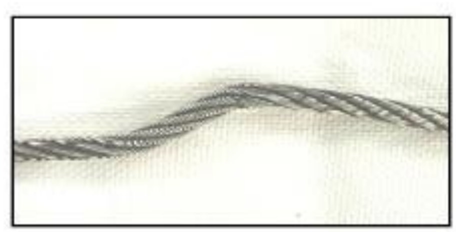
Doglegs are often the result of wire rope being tensioned around too small of a radius. The wire rope should be removed from service if the core is missing or protruding, or if the wire rope fails to fit properly in sheave or drum grooves.

Dogleg

A dogleg results from tension on wire around a small radius.

Remove rope from service if:

- The core is missing or protrudes from the rope
- An improper fit on the drum or sheaves



Crushed Sections

Crushed sections of rope are frequently the result of improper drum spooling, and/or a loose first layer on multi-layer wire rope drums. The wire rope should be removed from service if the core is missing or protruding, or if the wire rope fails to fit properly in sheave or drum grooves.

Crushed Sections

Crushed sections result from improper drum spooling.

Remove rope from service if:

- The core is missing or protrudes from the rope
- An improper fit in drum or sheaves

Running Ropes

NAVFAC P-307 rejection criteria for broken wires on running ropes is defined as six randomly distributed broken wires in one lay length, three broken wires in one strand in one lay length, or two broken wires within one lay length of the end connection.

Running Ropes

NAVFAC P-307 rejection criteria for broken wires on running ropes:

- Six randomly broken wires in one lay length
- Three broken wires in one strand in one lay length
- Two broken wires within one lay length of the end connection

Rotation Resistant Rope

NAVFAC P-307 rejection criteria for broken wires on rotation resistant wire rope is defined as two broken wires in a length equal to six times the rope diameter, or four broken wires in a length equal to thirty times rope diameter.

Rotation Resistant Rope

NAVFAC P-307 rejection criteria for broken wires on rotation resistant wire rope:

- Two broken wires in a length equal to six times the rope diameter
- Four broken wires in a length equal to thirty times rope diameter

Standing, Guy, and Boom Pendants

NAVFAC P-307 rejection criteria for broken wires on standing, guy, and boom pendant wire rope is defined as three broken wires in one lay length in sections beyond the end connection, or two broken wires within one lay length of end connection.

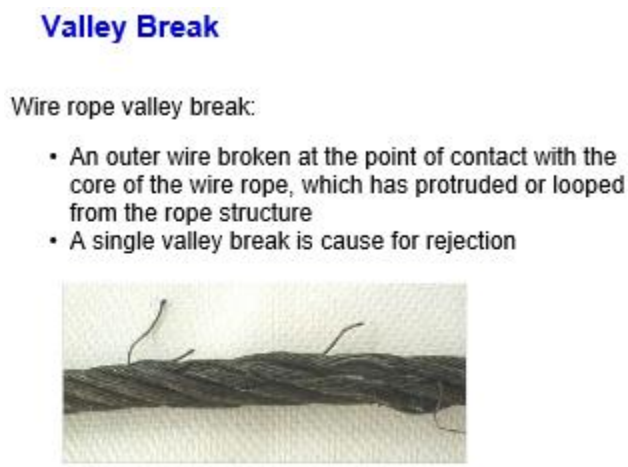
Standing, Guy, and Boom Pendants

NAVFAC P-307 rejection criteria for broken wires on standing, guy, and boom pendant wire rope:

- Three broken wires in one lay length in sections beyond the end connection
- Two broken wires within one lay length of the end connection

Valley Break

A wire rope valley break is defined as one outer wire broken at the point of contact with the core of the wire rope, which has protruded or looped from the rope structure. A single valley break is cause for rejection.



Summary and Review

Wire Rope Inspection Module 3, Documentation, Defects, Inspection Procedures, and Rejection Criteria listed the materials needed for performing a wire rope inspection, identified techniques for inspecting a wire rope core, and explored common wire rope defects and associated NAVFAC P-307 rejection criteria.

NOTES:

WIRE ROPE INSPECTION 3 OVERVIEW QUIZ AND SUMMARY

Knowledge Check

The next several screens contain questions relating to the covered material. Check your comprehension of the course content by answering these questions.

KNOWLEDGE CHECK

Note

The next several screens contain questions relating to the material covered in this module. Check your comprehension of the covered material by answering the following questions.

Select all that apply.

Q: Select three tools needed to perform a wire rope inspection.

- ☐ Dial caliper
- ☐ Marlin spike
- ☐ Tape measure
- ☐ Adjustable wrench

Check

Tries Remaining: 3

Select the best answer.

Q: Factors that would increase the frequency of wire rope inspections might include:

- ◯ overloads
- ◯ work environment
- ◯ history of rapid wear
- ◯ all factors listed above

Check

Tries Remaining: 3

Select the best answer.

Q: Performing a thorough wire rope inspection requires the inspector to __________.

- ◯ measure with all the wire rope extended out completely
- ◯ measure the diameter of the rope only in areas of high wear
- ◯ clean the wire in areas requiring close inspection.
- ◯ position the crane components so the wire is under tension

Check

Tries Remaining: 3

Select the best answer.

Q: All wire rope inspections require inspection of the core.

- ◯ True
- ◯ False

Check

Tries Remaining: 1

Select all that apply.

Q: Which of the following conditions warrant a core inspection?

- ☐ after a load test
- ☐ when bending non-rotational wire produces "popping" sounds with no outward signs of damage
- ☐ when diameter reduction occurs without signs of external wear
- ☐ when new wire is installed on crane

Check

Tries Remaining: 3

Select all that apply.

Q: What conditions, that upon discovery, could be cause for rejection?

- ☐ broken wires
- ☐ fatigue
- ☐ heat damage
- ☐ corrosion

Check

Tries Remaining: 3

Select the best answer.

Q: Internal corrosion is acceptable, providing the outside wires are properly lubricated.

- ◯ True
- ◯ False

Check

Tries Remaining: 1

Select the best answer.

Q: Significant pitting is unacceptable when abrasive removal would reduce the diameter of individual outside wires by ___________.

- 1/5
- 1/4
- 1/3
- 3/4

Check

Tries Remaining: 3

Select the best answer.

Q: Heat damage from any cause is unacceptable.

- True
- False

Check

Tries Remaining: 1

Select the best answer.

Q: Flattened sections of wire should be removed from service when the diameter across the flat is less than ________ of the nominal diameter.

- 1/4
- 1/2
- 5/6
- 7/8

Check

Tries Remaining: 3

Select the best answer.

Q: A dogleg is normally the result of ___________.

- tension on wire around a small radius
- an overload condition
- improper handling of rope
- a sudden release of tension

Check

Tries Remaining: 3

Select the best answer.

Q: Crushed rope is usually the result of improper drum spooling.

- True
- False

Check

Tries Remaining: 1

Select the best answer.

Q: Running ropes should be replaced when there are six or more randomly distributed broken wires in one lay length or __________ or more broken wires in one strand in one lay length.

- 2
- 3
- 6
- 10

Check

Tries Remaining: 3

Select the best answer.

Q: Three broken wires within one (1) lay length of an end connection would be considered acceptable.

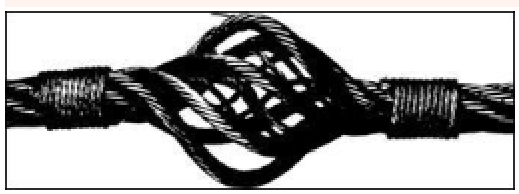
- True
- False

Check

Tries Remaining: 1

Select the best answer.

Q: The defect in the following picture is commonly known as:



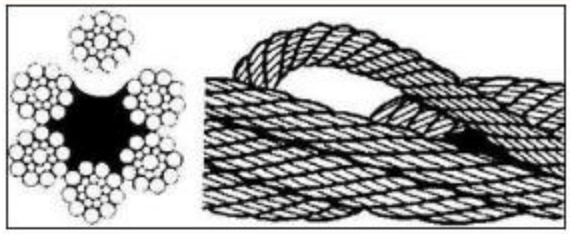
- dog leg
- kinked rope
- popped core
- bird cage

Check

Tries Remaining: 3

Select the best answer.

Q: The common defect shown below is known as:



- crushed rope
- bird cage
- high strand
- flattened rope

Check

Tries Remaining: 3

NOTES:

Wire Rope Inspection 4

Welcome

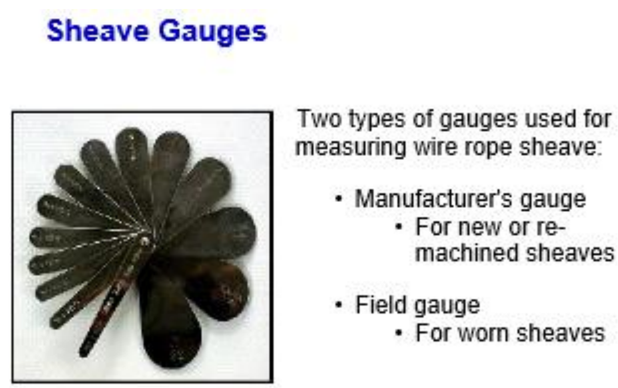
Welcome to Wire Rope Inspection Module 4, Inspection of Sheaves, Drums, Load Chains, and Fleet Angle.

Instructional Objectives

Upon successful completion of this module, you will be able to inspect sheaves and drums, identify proper fleet angle, and inspect and measure load chain.

Sheave Gauges

Two types of gauges are commonly used for measuring wire rope sheaves. The manufacture's gauge is used when measuring new or re-machined sheaves. Readings taken using the manufacture's gauge represent the nominal wire size plus the maximum allowance for rope oversize. The other sheave gauge type is a field gauge, which is normally used for measuring sheaves that have service wear. Readings taken using the field gauge represent minimum groove size, or the nominal wire size plus one half of the allowable wire oversize. When both gauges are available they can be used as “go no go” gauges for a greater degree of accuracy in determining acceptable groove sizes.



Sheave Groove Condition

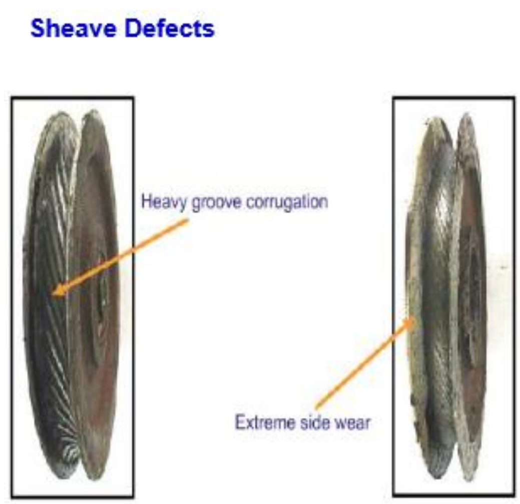
These illustrations, showing sheave groove cross sections, demonstrate three wire rope seating conditions. Illustration "A" shows a worn wire rope in a worn sheave groove. This arrangement will result in a fit that is too loose. Illustration "B" shows new wire rope installed in a worn sheave groove, making the seat for the wire rope too tight. Illustration "C" is an example of new rope in a new sheave groove, which would normally result in a fit that is just right. As shown in illustration "C", the sheave groove should provide 135º to 150º support of rope diameter.

Sheave Inspection

When performing a sheave inspection, the sheaves should be checked for cracks, excessive side wear, condition of bearings and shaft, corrugation of the groove, and alignment. Sheaves must be inspected for any out-of-round conditions or inability to run true. In addition, inspect all sheaves for run out and excessive wear by gauging each sheave in four representative quadrants where accessible.

Sheave Defects

Two common sheave defects which would require sheave replacement are evidence of heavy groove corrugation and extreme side wear.



Drum Groove Condition

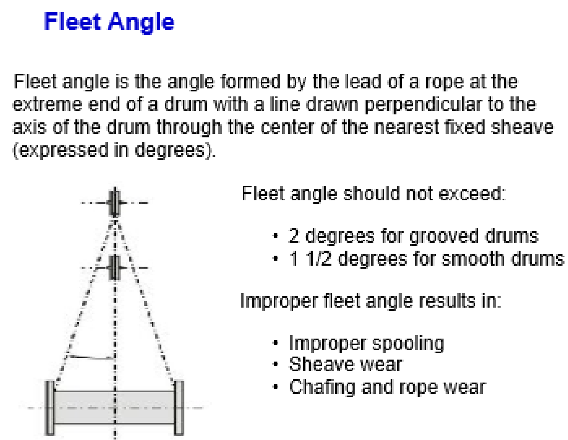
The condition of wire rope drum grooves shall be inspected for proper contour and smoothness. In addition, the inspection should include checking for excessively worn grooves, and proper clearance between ropes when seated in the drum grooves.

Drum Condition

Inspect the condition of the wire rope drum for distortion or deterioration, cracks, and loose or missing hardware. While the drum is in operation, ensure at least two complete wraps of wire rope remain on grooved drums in all operating conditions. Smooth or un-grooved drums shall maintain a minimum of three complete wraps.

Fleet Angle

Fleet angle is the angle formed by the lead of a rope at the extreme end of a drum with a line drawn perpendicular to the axis of the drum through the center of the nearest fixed sheave (expressed in degrees). The maximum fleet angle should not exceed 2 degrees for grooved drums or 1 1/2 degrees for smooth drums. Excessive fleet angle may result in improper spooling, excessive sheave wear, or excessive chafing and wear of wire rope. Inspectors should ensure wire rope fleet angle has not caused overriding of the drum flange.



Load Chain Inspection

Load chains should be inspected for smooth operation while hoisting and lowering a load on the hook. If binding, jumping, or a noisy condition is observed, inspect the load chain more closely for nicks, gouges, corrosion and twisted, bent, worn, or broken links.

Load Chain Thickness

When measuring load chain, link thickness should be measured at the bearing point of the link and the finding compared to an unworn, un-stretched link. Refer to OEM or the National Association of Chain Manufacturers (NACM) acceptance criteria. All chain should be removed from service if the material thickness at any location on the link is less than the listed minimum value as specified by the OEM or NACM.

Load Chain Stretch

Load chains shall be inspected for stretch by comparing the working chain to an equivalent length of unworn, un-stretched length of chain taken from the slack end or anchor point of the hoist. An unworn, un-stretched length of load chain is defined as that part of the chain that has not been pulled through a sprocket. A linear measurement approximately 12 to 24 inches in length shall be taken from the random sections of used chain and compared to the unworn, un-stretched length. If the used chain exceeds the hoist manufacturer's recommended length (or in the absence of such recommendation, if the used chain for hand chain-operated hoists is 2 1/2% longer than the unused chain, or the used chain for powered hoists is 1 1/2% longer than the unused chain), replace the chain. Repairing of load chain by welding or any other means shall not be attempted by anyone other than the chain manufacturer. When manufacturer's specifications are not available, refer to ASME B30.16 for acceptance and rejection criteria.

Review and Summary

Wire Rope Inspection Module 4, Inspection of Sheaves, Drums, Load Chains and Fleet Angle covered sheave and drum groove gauges, sheave and drum inspection, proper fleet angle and load chain inspection and measurement.

WIRE ROPE INSPECTION 4 OVERVIEW QUIZ AND SUMMARY

Knowledge Check

The next several screens contain questions relating to the covered material. Check your comprehension of the course content by answering these questions.

KNOWLEDGE CHECK

Note

The next several screens contain questions relating to the material covered in this module. Check your comprehension of the covered material by answering the following questions.

Select all that apply.

Q: Name the two types of sheave gauges.

- ☐ field
- ☐ alignment
- ☐ manufacture's
- ☐ side wear

Check

Tries Remaining: 3

Select all the apply.

Q: List four items that should be checked when inspecting a sheave.

- ☐ diameter
- ☐ cracks
- ☐ bearing
- ☐ alignment

Check

Tries Remaining: 3

Select the best answer.

Q: Sheaves should support the wire in the groove a minimum of ___________ degrees.

- ○ 90
- ○ 120
- ○ 135
- ○ 180

Check

Tries Remaining: 3

Select the best answer.

Q: Field gauges are used to measure __________ sheaves.

- ◯ cracked
- ◯ side wear
- ◯ new
- ◯ worn

Check

Tries Remaining: 3

Select the best answer.

Q: Excessive fleet angle can cause ___________.

- ◯ improper spooling
- ◯ excessive sheave wear
- ◯ excessive chafing of wire rope
- ◯ all causes listed above

Check

Tries Remaining: 3

Select the best answer.

Q: Load chain stretch should be compared to an equivalent ________ length of chain.

- ◯ stretched
- ◯ new
- ◯ worn
- ◯ unworn

Check

Tries Remaining: 3

WIRE ROPE INSPECTION 5

Welcome

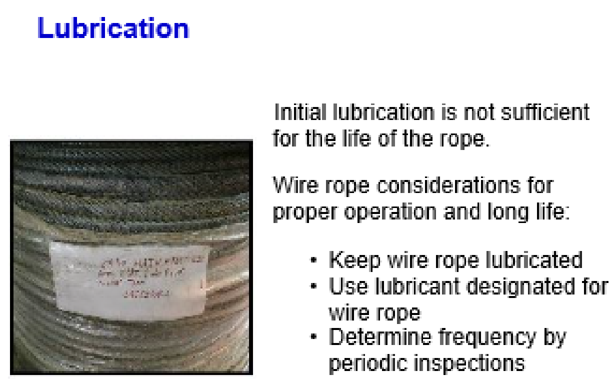
Welcome to Wire Rope Inspection Module 5, Lubrication and Safety Considerations.

Instructional Objectives:

Upon successful completion of this module, you will be able to identify desirable characteristics of wire rope lubricants, describe the safe application of wire rope lubricants, explain lubrication intervals, and describe safe working conditions when working in, on, and around wire rope.

Lubrication

Another component of wire rope is its lubrication. The initial application of lubricant by the manufacture is not sufficient for the life of the rope. Lubricants for wire ropes should be designated as wire rope lubricants or recommended by the wire rope manufacturer. Wire rope should be kept lubricated at all times. Periodic inspection determines how often the wire should be lubricated. Proper lubrication is essential for normal operation and life expectancy of wire rope.



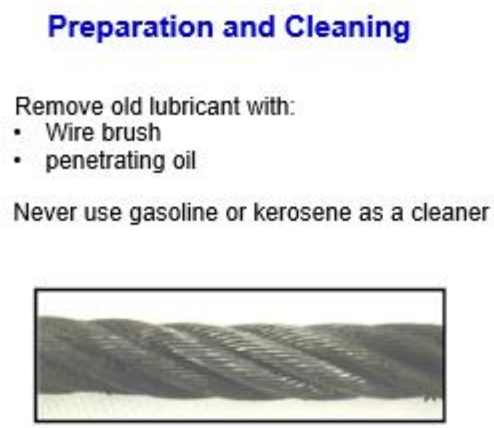
Lubrication Characteristics

Wire rope lubricants should be corrosion resistant, water repellent, penetrating, chemically neutral, and adhesive. Never apply used crank case oil to wire rope as it may be acidic and contain abrasive metallic particles.

Preparation and Cleaning

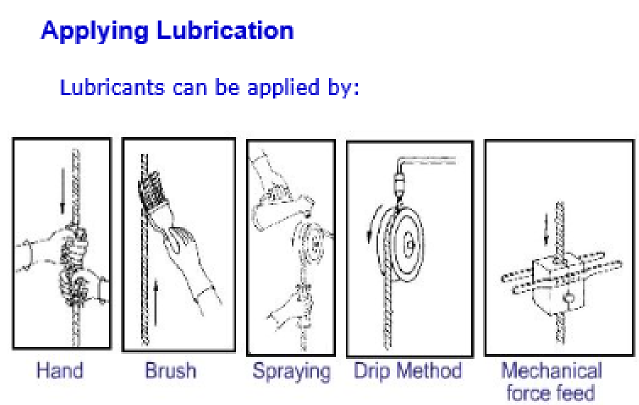
Wire rope should be properly cleaned prior to applying any new lubricant. Old lubricant should be removed by a wire brush and a light penetrating oil for built-up spots of old lubricant.

Note: never use gasoline or kerosene as a cleaner because it removes internal lubricants.



Applying Lubrication

Rope should be clean and dry prior to applying lubrication. Lubricants can be applied by hand, brushing, spraying, the drip method, or mechanical force feed.



Safety Considerations

Good safety considerations should always be followed when working around wire rope. Use extreme caution when working around moving wire rope. If it's necessary, ensure wire is moving in the direction which will allow the greatest margin of safety (i.e., away from sheave or drum). Never place hands on moving wire rope. If it is necessary to use hands to detect defects in the wire, bring the wire to a stop. Inspect wire rope in a team of at least two people. Use the Buddy System for increased safety. Employ an emergency stop switch when possible.

Communication

Continuous communication should be maintained at all times when inspecting wire rope. Verbal communication relayed by a second person is necessary when the one inspecting the wire is out of the operators view. Hand signals may be necessary when verbal communication is not practical. Radio communications must ensure unbroken contact. Radios may not be suitable in noisy machine houses.

Review and Summary

Wire Rope Inspection Module 5, Lubrication and Safety Considerations, identified desirable characteristics of wire rope lubricants, described the safe application of wire rope lubricants, explained lubrication intervals, and described safe working conditions when working in, on, and around wire rope.

WIRE ROPE INSPECTION 5 OVERVIEW QUIZ AND SUMMARY

Knowledge Check

The next several screens contain questions relating to the covered material. Check your comprehension of the course content by answering these questions.

KNOWLEDGE CHECK

Note

The next several screens contain questions relating to the material covered in this module. Check your comprehension of the covered material by answering the following questions.

Select all that apply.

Q: Desirable characteristics for wire rope lubricants are __________.

- ☐ Corrosion Resistant
- ☐ Adhesive
- ☐ Water Soluble
- ☐ Chemically Neutral

Check

Tries Remaining: 3

Select the best answer.

Q: Wire rope should be ____________________ prior to lubricating.

- ◯ inspected and tested
- ◯ clean and dry
- ◯ new and uninstalled
- ◯ lubricated and painted

Check

Tries Remaining: 3

Select the best answer.

Q: The frequency for applying wire rope lubrication is best determined by periodic ____________.

- ◯ testing
- ◯ communication
- ◯ inspection
- ◯ scheduled maintenance

Check

Tries Remaining: 3

Select the best answer.

Q: Sufficient lubrication is ____________ for efficient use and long life of wire rope.

- ○ not important
- ○ not required
- ○ non-essential
- ○ essential

Check

Tries Remaining: 3

Select the best answer.

Q: Old crank case oil is an acceptable and frequently used wire rope lubricant.

- ○ True
- ○ False

Check

Tries Remaining: 1

Select the best answer.

Q: Gasoline or kerosene should be used to remove old lubricant.

- ○ True
- ○ False

Check

Tries Remaining: 1

Select the best answer.

Q: Continuous ________________ should be maintained at all times when inspecting wire rope.

- ○ communication
- ○ operation
- ○ lubrication
- ○ testing

Check

Tries Remaining: 3

Select the best answer.

Q: Placing hands on moving wire rope is an acceptable practice to detect variations in wire rope.

- ○ True
- ○ False

Check

Tries Remaining: 1

Select the best answer.

Q: For increased safety, the buddy system should be used when inspecting wire rope.

- ○ True
- ○ False

Check

Tries Remaining: 1