LEEA Academy

Developing Professionals for the Lifting Equipment Industry

RCS – Step Notes – April 2017 v1.0

City & Guilds | Accredited Programme

Runways and Crane Structures

Advanced Programme (RCS)

Training Course Step Notes

City & Guilds Accredited Programme

INSTRUCTOR LED TRAINING

LEEA Learning and Development Agreement

In the interests of all parties and to ensure the successful achievement of the LEEA Runways and Crane Structures Advanced Programme, the following arrangements are to be confirmed:

Student:

I agree to:

- Follow the instructions of my LEEA training facilitator at all times
- Follow all rules and procedures regarding health and safety matters whilst on site
- Respect the tidiness and cleanliness of training areas and rest area facilities
- Notify my LEEA training facilitator immediately if I have any concerns
- Inform my LEEA training facilitator of any learning difficulties at the soonest opportunity (this may be done privately between you and your LEEA training facilitator)
- Keep to agreed session times and return from rest breaks and lunchtime periods in a timely fashion
- Keep my mobile phone on 'silent' for the duration of all training sessions and to leave the class if I have to make or receive an urgent call, for the benefit of my fellow students
- Provide feedback to the LEEA facilitator regarding the training I have received
- Respect the opinions of my fellow students and to actively engage in group discussion
- Strictly adhere to the rules regarding LEEA Assessments

Signed ____ Date __________________________

LEEA Training Facilitator

I agree to:

- Safeguard the health, safety and welfare of my students throughout the training programme
- Provide my students with quality training, maintaining the highest of professional standards throughout
- Maintain confidentiality for all students at all times
- Provide regular feedback to students on their progress, identifying areas which may need additional study
- Keep appropriate records of any assessments conducted
- Ensure that all students are able to discuss any issues or concerns which may arise during the training course

Signed ____ Date __________________________

Disclaimer

These Step Notes are a useful and authoritative source of information for the LEEA RCS Advanced Programme student.

Whilst every effort has been made to achieve the highest degree of accuracy in the generation of the data and information supplied, ultimate responsibility remains with the student and their employer to ensure that current legal requirements are followed.

First Edition.........................April 2017

Operative training for all the equipment covered in these step notes should always take the manufacturer's information and instructions for use into account.

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1. LEGISLATION

Moral, Legal and Financial Reasons for Health and Safety Legislation

- Employers have a moral responsibility to ensure appropriate working conditions are provided
    - This is known as a common law duty of care

- Unsafe working conditions are likely to have an impact on production
    - Loss of output leading to lowering of morale and motivation
    - Loss of sales turnover and profitability

- Society and customer expectations of a company's approach to managing safety - health and safety culture
    - Negative public relations would have a damaging effect on any business

- Financial cost from loss of output
    - Fines, damages, legal costs, insurance etc.

The Legislative Framework

Health and Safety at Work etc. Act 1974 (UK)

- The Act is general in nature
- There is no reference to specific articles or substances
- The Act applies to all sectors

Specific duties of care for:

- Manufacturers/suppliers of articles or substances
- Employers
- Employees

The **Health and Safety at Work Act (HSWA)** is an enabling Act for specific regulations.

Status in UK: legal requirement.
International: adopted as best practise, and requested by LEEA member companies.

Notes:

The Main Purpose of the HSWA

The Health and Safety at Work Act covers nearly all occupations. It is designed to protect people at work including staff, visitors, contractors and members of the public. The HSWA supersedes nearly all previous health and safety laws in the UK.

The main purposes of the Act are set out in section 1 as follows:

- To secure the health, safety and welfare of persons at work
- To protect other people from hazards arising from work
- To control the keeping and use of dangerous substances and materials, including explosives and highly flammable materials
- To control the emission of noxious substances from certain premises

It sets out a framework of general duties, primarily on employers, but also on employees and the controllers of premises, and on designers, manufacturers, importers and suppliers in relation to articles and substances used at work.

Regulations from the HSWA

Regulations are one form of delegated legislation made possible by Section 15 of HSWA which gives powers to the Secretary of State (UK) to make regulations for matters concerned with health and safety at work.

Regulations are not Acts of Parliament but do have the support of the law and therefore must be complied with.

Regulations are increasingly drafted by reference to European Directives (these will be discussed at a later stage in this module).

There are many sets of regulations applying to health and safety. Some apply to all places of work and others are specific to particular industries, operations, substances, materials or premises.

Here are some examples of such Regulations:

- The Manual Handling Operations Regulations
- The Control of Substances Hazardous to Health Regulations

Notes:

Health and Safety at Work Act Section 2

Duties of the Employer

“Duty to ensure so far as is reasonably practicable, the health, safety and welfare at work of all his/her employees”

- Safe plant and systems of work
- Safe use, handling, storage and transportation of articles and substances
- Information, instruction, training and adequate supervision
- Safe place of work and a safe means of access and egress
- Safe working environment and adequate welfare facilities

Health and Safety at Work Act Section 6

Duties of Designers, Manufacturers, Importers and Suppliers

- To ensure, so far as is reasonably practicable, that articles they design, construct, make, import, supply etc. are safe and without risk to health at all times e.g. when it is being set up, cleaned, used or maintained by someone at work
- To carry out or arrange such testing and examination necessary to perform the duties above
- To ensure that those supplying the item have adequate information about its designed and tested use. This includes essential conditions for dismantling and disposal
- Take steps to ensure, so far as is reasonably practicable, that those supplied are given updated information where it becomes known that the item gives rise to serious risk to health and safety

Health and Safety at Work Act Section 7

Duty of Employees

- States that employees must not endanger themselves, or others, by their acts or omissions
- Also, they must co-operate with their employers; as long as this does not lead to an increased risk to health and safety, or is an illegal act; so that employers can comply with their statutory duties

This makes responsibility for safety a joint employer/employee effort

Management of Health and Safety at Work Regulations 1992 (Revised 1999)

In addition to Section 2 (2) c of the HSWA, The Management of Health and Safety at Work Regulations 1999 require employers to ensure the effective planning, organisation, control, monitoring and review of preventive and protective measures. All these arrangements must be recorded and made known to employees. This is usually accomplished by the design of a company health and safety policy.

- MHSWR underlines the requirements for employers to provide instruction and training

- Employers must ensure that their personnel are properly trained to use any equipment necessary in the course of their work, but the regulations also place an obligation on employees to undergo such training and follow the instructions given by their employer

- Operatives are required to only use equipment for which they are trained and to use it in the manner and for the purpose for which they have been trained

Notes:

LEEA Definition of a Competent Person

The term 'Competent Person' has long been used in legislation. Current legislation uses it for a variety of duties to describe a person with the necessary knowledge, experience, training, skill and ability to perform the specific duty to which the requirement refers. There can therefore be several 'Competent Persons', each with their own duties and responsibilities, i.e. competent for the purpose.

The term has never been fully defined in law but, for the purpose of thoroughly examining lifting equipment, the LEEA definition of a Competent Person is a person having such practical and theoretical knowledge and experience of the equipment which is to be thoroughly examined that will enable him/her to detect defects or weaknesses which it is the purpose of the examination to discover and assess their importance to the safety of the equipment.

The Competent Person should have the maturity to seek such specialist advice and assistance as may be required to enable him/her to make necessary judgements and be a sound judge of the extent to which he/she can accept the supporting opinions of other specialists. He/she must be able to certify with confidence whether it is free from patent defect and suitable in every way for the duty for which the equipment is required. It is the view of LEEA that competency can be a corporate responsibility.

Primary Elements of Competency

Information
Instruction
Training
Supervision

Note: LEEA training course certificates and Advanced Programme qualifications are not evidence, declaration or proof of competency.

What are the Required Elements of Competency?

Notes:

Risk Assessment

What is "Risk Assessment"?

Put simply, it is a careful examination of what, in your work, could cause harm to people, so that you can weigh up whether you have taken enough precautions or should do more to prevent harm.

What are the 3 main reasons to assess and manage risk?

- Human Harm
    - Injury and illness
- Legal Effects
    - Duty of care and consequences of unsuitable or insufficient risk management
- Economic Effects
    - Substantial financial costs are related to accidents at work

Although there are no fixed rules about how a risk assessment should be undertaken, it is important to take a structured approach which will allow all relevant risks or hazards to be addressed.

Firstly, we have to consider the factors that contribute to accidents/ill-health in the workplace:

HAZARD | DANGER | LIKELIHOOD | SEVERITY | RISK

Hazard

A hazard is something (object or situation) that has the potential to cause harm.

Danger

A liability or exposure to harm; something that causes peril.

Likelihood

How likely is it that someone could be harmed by the hazard?

Severity

If the potential for harm was to occur, how severe would the accident be?

Risk (a Combination of Likelihood and Severity)

Risk is the likelihood that the harm from the hazard is realised.

Definitions

Net Result (Risk) = Likelihood x Severity

i.e. how likely x how severe the consequence

5 Steps to Risk Assessment...

1. Identify the hazards
2. Decide who might be harmed and how
3. Evaluate the risks and decide on control measures
4. Record your findings and implement them
5. Review your assessment and update if necessary

Notes:

Control Measures

Hierarchy of Control Measures (ERIC-PD)

Eliminate
Reduce
Isolate
Control
PPE
Discipline

Monitor and Review

Ensure control measure compliance (discipline)

Be vigilant - note changes:

- Additional hazards presented?
  - e.g. traffic, pedestrians etc., changes in production activity

Record your findings and change the risk assessment as necessary.

This may result in the requirement for additional control measures.

Are you Following a 'Safe System of Work'?

- ✓ You have evaluated the hazards
- ✓ You have identified who may be harmed
- ✓ You have decided upon and implemented control measures
- ✓ You have recorded your findings
- ✓ You will review and monitor the situation

If you have completed the above checklist, you are now following a "Safe System of Work"

The European Machinery Directive

A European Directive is a Directive to the member states of the European Community, which has been adopted by the Council of Ministers, to introduce legislation with common requirements throughout the Community. The Directives are used to remove barriers to trade and introduce common safety requirements.

The Machinery Directive is largely based on Risk Assessment and use of European Standards for critical features such as guards and emergency stops. Machinery Directive provides the harmonisation of the Essential Health and Safety Requirements (EHSRs) for machinery.

It applies only to products that are intended to be placed on or put into service in the market for the first time.

Supply of Machinery (Safety) Regulations 2008 – SM(S)R

Machinery Directive is implemented in the United Kingdom under the Supply of Machinery (Safety) Regulations:

The Supply of Machinery (Safety) Regulations 2008, SI No 1597 implement the Machinery Directive and contain essential safety requirements which the machinery, including lifting machines and lifting accessories, must meet.

Manufacturers, importers (into the European Union) and suppliers placing such equipment on the market for service in the community have a duty to:

- Design, build and supply equipment that is safe and meets the Essential Safety Requirements
- To carry out such tests as may be necessary to ensure the requirements of above are met
- To maintain records of all calculations, tests and other relevant information that go to make up a **Technical File** which may be called upon by the enforcing authorities and which must demonstrate that the Essential Safety Requirements have been met

- Issue with each item of equipment information on the installation, maintenance, care and safe use, and:
    - Issue a Declaration of Conformity and affix the CE mark, or issue a Declaration of Incorporation depending on its nature and intended use. In this context, if you manufacture or import (from outside the European Union) an item for your own use, you assume the full responsibilities of the manufacturer and must therefore meet all of the requirements of the regulations

To support the Machinery Directive, the Joint European Standards Organisation, CEN/CENELEC, has been producing Harmonised European Standards.

Most of these standards have been published but there are still some left in the pipeline. As and when they are published, they will supersede any existing British Standards or other European national standards covering the same products.

These Harmonised Standards have a special status in that products made to the standard are deemed to meet the essential health and safety requirements of the Relevant Directives, and therefore the UK Regulations, in so far as the standard addresses such essential requirements.

They therefore provide a relatively easy way for manufacturers to know that their products meet the legal requirements and equally a convenient way for purchasers to specify their needs.

Following the publication of the new Machinery Directive 2006/42/EC in 2006, all the relevant Harmonised Standards have been amended to make reference to it.

The Technical File

The Essential Health and Safety Requirements that apply to the lifting equipment:

- A description of the methods used to eliminate these hazards or reduce risks
- The standards used in the design; information from the user
- Design information (calculations, drawings, procedures, etc.)
- Material traceability; tests reports and instructions for use

What is a 'Machine'?

"*An assembly, fitted with or intended to be fitted with a drive system other than directly applied human or animal effort, consisting of linked parts or components, at least one of which moves, and which are joined together for a specific application*".

Manufacturer is responsible for verifying whether a particular product falls within the scope of the Machinery Directive.

Note: The definition here is for 'Machinery' within the scope of the directive in the 'strict' sense, but the directive also has other definitions covering machinery in the 'broader' sense. The strict sense definition excludes manual lifting machines, accessories, ropes, chains and webbing. All of which are covered by the broader sense definitions.

Supply of Machinery (Safety) Regulations 2008

Aligned to the requirements of the Machinery Directive, the Supply of Machinery (Safety) Regulations state that lifting equipment must be designed and built to sustain a static overload of:

Manually operated machines	1.5	x WLL
Other machines	1.25	x WLL
Lifting accessories	1.5	x WLL

Machinery must be capable of sustaining a dynamic overload of: -

1.1 x WLL

Previous standards and directives have used different values therefore it is important to always consult manufacturers documentation for specific requirements.

Lifting machines must also be supplied with instructions for:

- Care and safe use
- Installation, commissioning and testing
- Maintenance and adjustments
- Limitations of use and possible misuse
- Noise and vibration emissions
- Training

Notes:

PUWER and LOLER

PUWER: Provision and Use of Work Equipment Regulations 1998
Applies to all work equipment

LOLER: Lifting Operations and Lifting Equipment Regulations 1998
Applies to lifting equipment in addition to PUWER

Both LOLER and PUWER apply to all sectors of industry

Status of PUWER and LOLER

United Kingdom:	Legal requirement
International:	Good practice demanded by customers and local authorities, integral to the LEEA Code of Practice

The Essentials of PUWER

PUWER places duties on the employer to ensure that:

- It is the duty that the employer to ensure that work equipment coming into his undertaking meets with any EHSRs and in the case of lifting equipment this would be of directive 2006/42/EC.
- Work equipment is suitable for the purpose for which it is to be used
- The working conditions and risk to health and safety of personnel in which the work equipment is used is to be considered
- Equipment is suitably maintained and a log kept up to date
- Equipment is inspected on a regular basis (ref. LOLER)
- All inspection and maintenance records are kept and recorded
- All persons using work equipment have sufficient information pertaining to its use, e.g. operating manuals and guides to safe use

PUWER requires employer to address risks or hazards of equipment from all dates of manufacture and supply.

Equipment first provided for use after 31st December 1992 must comply with any 'essential requirements'

Equipment may still present a hazard or risk if:

- Application different from that originally envisaged
- Safety depends upon the way it is installed
- Technical mismatch between the supply side and user side legislation

Employers can ensure compliance by checking:

- CE Marking
- EC Declaration of Conformity

PUWER requires that, when providing equipment for use at work:

The purchaser obtains equipment complying with the relevant European Directives. E.g. In the case of grade 8 mechanically assembled chain slings, specifying BS EN 818-4 and requesting the EC Declaration of Conformity will ensure that the slings meet this requirement.

Provision and Use of Work Equipment Regulations (PUWER)

Regulation 4	Suitability of Work Equipment
Regulation 5	Maintenance
Regulation 6	Inspection
Regulation 7	Specific Risks
Regulation 8	Information and Instructions
Regulation 9	Training

Summary of the Key Requirements of PUWER

PUWER requires employer to address risks or hazards of equipment from all dates of manufacture and supply.

Equipment first provided for use after 31st December 1992 must comply with any ‘essential requirements’.

Equipment may still present a hazard or risk if:

- Application is different from that originally envisaged
- Safety depends upon the way it is installed
- Technical mismatch between the supply side and user side legislation

How does an employer check that equipment he has purchased complies with the requirements of PUWER?

- Locate the CE marking
- Obtain the EC declaration of conformity from the supplier

Notes:

Lifting Operations and Lifting Equipment (LOLER)

Regulation 4	Strength and Stability
Regulation 5	Lifting Equipment for Lifting Persons
Regulation 6	Positioning and Installation
Regulation 7	Marking of Lifting Equipment
Regulation 8	Organisation of Lifting Operations
Regulation 9	Thorough Examination and Inspection
Regulation 10	Reports and Defects
Regulation 11	Keeping of Information

Regulation 4: Strength and Stability

Requires the employer to ensure that the load they are planning to lift does not exceed the limits for strength and stability of the lifting equipment.

Regulation 5: Lifting Equipment for Lifting Persons

Details the additional safeguards that must be considered when using lifting equipment to lift people.

Regulation 6: Positioning and Installation

Details the considerations on where lifting equipment, both fixed and mobile equipment, should be sited.

Regulation 7: Marking of Lifting Equipment

Requires all lifting equipment to be marked with its SWL and information that gives the items characteristics, e.g. grade, angle of use etc.

Regulation 8: Organisation of Lifting Operations

Clarifies that each lifting operation needs to be planned, supervised and carried out safely.

Regulation 9: Thorough Examination and Inspection

Before lifting equipment is put into service for the first time it is thoroughly examined for any defect unless the lifting equipment:

- Is less than 12 months old
- Owner holds the original DOC
- Equipment that has not been used before will require thorough examination when entering service if the DOC is older than 12 months. Equipment can be damaged during long periods within the supply chain

Maximum fixed periods for thorough examinations and inspection of lifting equipment as stated in regulation 9 of LOLER are: -

Lifting Accessories	6 months
Lifting Equipment	12 months
People Carrying Equipment	6 months

- Or in accordance with a written scheme of examination
- Or each time that exceptional circumstances which are liable to jeopardise the safety of the lifting equipment have occurred

The information to be contained in the report of thorough examination is given in **schedule 1 of LOLER.**

Notes:

Minimum Requirements for a Report of Thorough Examination – Schedule 1 of LOLER

- The name and address of the employer for whom the thorough examination was made
- The address of the premises at which the thorough examination was made
- Particulars sufficient to identify the equipment including where known its date of manufacture
- The date of the last thorough examination
- The safe working load of the lifting equipment or (where its safe working load depends on the configuration of the lifting equipment) its safe working load for the last configuration in which it was thoroughly examined
- In relation to the first thorough examination of lifting equipment after installation or after assembly at a new site or in a new location:
  - That it is such thorough examination;
  - (If such be the case) that it has been installed correctly and would be safe to operate

In relation to a thorough examination of lifting equipment other than a thorough examination to which paragraph 6 relates –

- Whether it is a thorough examination:
    - Within an interval of 6 months under regulation 9(3)(a)(i)
    - Within an interval of 12 months under regulation 9(3)(a)(ii)
    - In accordance with an examination scheme under regulation 9(3)(a)(iii)
    - After the occurrence of exceptional circumstances under regulation 9(3)(a)(iv)

- (If such be the case) that the lifting equipment would be safe to operate

- In relation to every thorough examination of lifting equipment:
    - Identification of any part found to have a defect which is or could become a danger to persons, and a description of the defect
    - Particulars of any repair, renewal or alteration required to remedy a defect found to be a danger to persons

- In the case of a defect which is not yet but could become a danger to persons -
    - The time by which it could become such a danger
    - Particulars of any repair, renewal or alteration required to remedy it

- The name, address and qualifications of the person making the report; that he/she is self-employed or, if employed, the name and address of his employer

- The name and address of a person signing or authenticating the report on behalf of its author

- The date of the report

Model report of thorough examinations are available for LEEA members on the LEEA website.

Notes:

Written Schemes of Examination

The Lifting Operations and Lifting Equipment Regulations 1998 permits a scheme of examination, drawn up by a Competent Person, as an alternative to the fixed maximum periods.

The benefit of an examination scheme is that, by focusing on the most safety critical areas, the examinations can be carried out the most cost effective way. This may provide a means of reducing examination costs, however it may also provide a means of enhancing safety without increasing costs.

Information for Written Schemes of Examination

- The written scheme of examination should contain at least the following information:

- The name and address of the owner of the lifting equipment

- The name and contact details of the person responsible for the equipment. If responsibility is divided, e.g. between maintenance and operations, there may be more than one name, however it should be clear who should be notified in the event of a dangerous or potentially dangerous defect and to whom reports should be sent

- The name, qualifications and address of the person drawing up the scheme. If the Competent Person is not working on their own account, the name of their employing organisation and their position in that organisation should be given

- The identity of the equipment, i.e. a description including the make, model and unique identity number

- The location of the equipment if it is a fixed installation or the location where it is based for portable and mobile equipment

- Details of any information or references used in drawing up the scheme. For example, the manufacturer's manual, expected component life, or specific information on the design life of the crane structure and mechanisms as detailed in clause 7 of ISO 12482-1

- The basis for the scheme. For example, is it based on hours of service, duty monitoring, examining certain parts or components at different intervals to other parts?

- Details of any data logging system fitted, including a list of the parameters monitored and the means of data retrieval, monitoring and storage

- What determines when the thorough examination shall take place and who is responsible for monitoring that and instigating the examination?

- Identification of the safety critical parts requiring thorough examination

- A risk assessment should take account of:
    - The condition of the equipment
    - The environment in which it is to be used
    - The number and nature of lifting operations and the loads lifted
    - The details of any assumptions about usage, expected component life
    - Etc.

- The frequency of thorough examination of those parts identified as safety critical taking into account the degree of risk associated with each part. This may include time or loading or duty cycle limits and vary for different parts of the equipment. Where the scheme is based on such criteria, we recommend that a maximum period between thorough examinations is always specified as equipment can deteriorate whether used or not

- The method of examination of those safety critical parts, which may include the degree of dismantling required and the techniques employed e.g. visual examination, measurement, NDT, operational test, load test

- The rejection criteria or a reference to where this information may be found

- An indication of the resources required to prepare the equipment and carry out the thorough examination. This may include qualified personnel, workshop facilities, specialist NDT and metallurgical facilities

- Any changes to equipment condition, operational or environmental parameters that will require a review of the scheme by the Competent Person. These may include damage to the equipment, change of use from general duty to heavy duty or moving from an inland location to a marine environment

- A requirement for the person responsible for the equipment to monitor its circumstances of use and inform the Competent Person who drafted the scheme of any changes

- The date of drawing up the scheme and the date at which any routine review is required

Further information on written schemes of examination can be found in the LEEA COPSULE Edition 8 Appendix 1.8.

Notes:

Lifting Operations and Lifting Equipment Regulations (LOLER)

Regulation 10: Reports and Defects

A person making a thorough examination for an employer under regulation 9 shall:

- Notify the employer forthwith of any defect in the lifting equipment which in his opinion is or could become a danger to persons
- As soon as is practicable make a report of the thorough examination in writing authenticated by him/her or on his/her behalf by signature or equally secure means and containing the information specified in schedule 1 to the employer; and where there is in his opinion a defect in the lifting equipment involving an existing or imminent risk of serious personal injury, send a copy of the report as soon as is practicable to the relevant enforcing authority

Where there is in his opinion a defect in the lifting equipment involving an existing or imminent risk of serious personal injury, the Competent Person will send a copy of the report as soon as is possible to the relevant enforcing authority. In this case, an employer who has been notified of an imminent risk shall ensure that the lifting equipment is not used before the defect is rectified.

Regulation 11: Keeping of Information

An employer obtaining lifting equipment shall:

- Keep the EC Declaration of Conformity for so long as they operate the lifting equipment
- Ensure that the information contained in every report is kept available for inspection

In the case of a thorough examination for lifting equipment:

- Until he ceases to use the lifting equipment

In the case of a thorough examination for lifting accessories:

- For two years after the report is made

LOLER and the Tester/Examiner

LOLER refers to 'Thorough Examination and Inspection' of which a test may be part.

A report of thorough examination to include details of any tests carried out.

The duties of the Competent Person include ensuring that:

- Lifting equipment has been thoroughly examined before it enters service
- Second-hand, hired or borrowed equipment has a current examination report before it is used
- And, where safety of equipment depends upon installation:
    - That it has a thorough examination after it has been installed
    - That it has a thorough Examination after it has been assembled

Notes:

Manual Handling Operations Regulations

- Refers directly to lifting operations and adds to the employer's duties in section 2 of the HSWA

- Requires an assessment to be made of any operation where loads are handled manually, or where manual effort is necessary, with a view to reducing the number of injuries that result from such operations:
    - Task
    - Individual
    - Load
    - Environment

- Requires the introduction of lifting appliances where the risks are high or if the operation can be made safer by their introduction

Working at Height

The danger of people and materials falling affects not only those working at height, but also sometimes to a greater degree, those underneath.

Working at height is one of the biggest causes of fatalities and major injuries. Commonly, accidents are caused from falls from ladders and through fragile surfaces. Work at height means work in any place where, if there were no precautions in place, a person could fall a distance that could cause personal injury (for example a fall through a fragile roof).

Employers and those in control of work at height must first assess the risks.

Before working at height, you must follow these simple steps:

- **Avoid** work at height where it is reasonably practicable to do so

- Where work at height cannot be easily avoided, **prevent** falls using either an existing place of work that is already safe or the right type of equipment

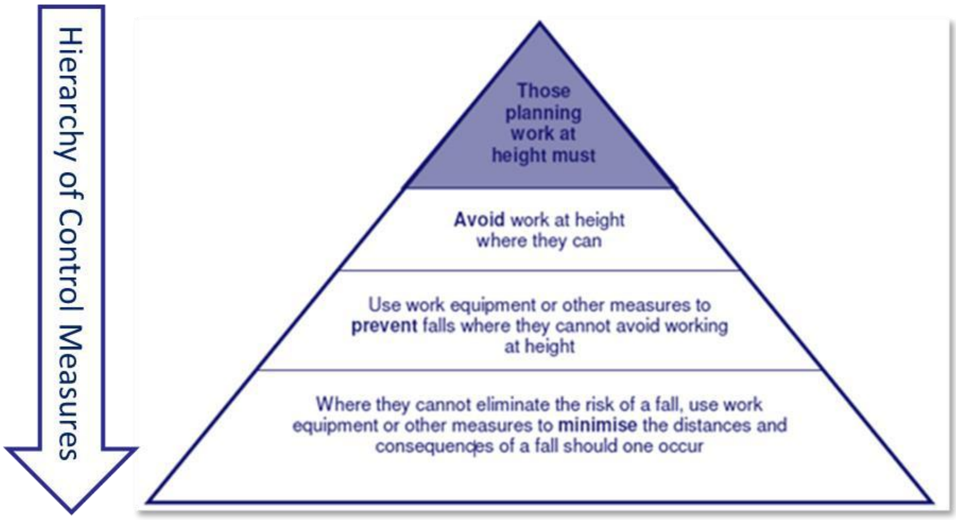
- **Minimise** the distance and consequences of a fall, by using the right type of equipment where the risk cannot be eliminated

Working at Height Regulations (UK)

The Work at Height Regulations 2005 have an influence on lifting practice.

They emphasise the need to avoid working at height if possible but, where it is necessary, they require the most suitable means of reducing and controlling the risk.

Consequently, this has affected the choice of equipment for some lifting operations.



Do:

- As much work as possible from the ground
- Ensure workers can get safely to and from where they work at height
- Ensure equipment is suitable, stable and strong enough for the job, maintained and checked regularly
- Take precautions when working on or near fragile surfaces
- Provide protection from falling objects
- Consider emergency evacuation and rescue procedures

Do not:

- Overload ladders; consider the equipment or materials workers are carrying before working at height. Check the pictogram or label on the ladder for information
- Overreach on ladders or stepladders
- Rest a ladder against weak upper surfaces, e.g. glazing or plastic gutters
- Use ladders or stepladders for strenuous or heavy tasks, only use them for light work of short duration (a maximum of 30 minutes at a time)
- Let anyone who is not competent (who doesn't have the skills, knowledge and experience to do the job) to work at height

Notes:

Working at Height – A Brief Guide

Please read the HSE document: "Working at Height – A Brief Guide", available at www.hse.gov.uk

Electricity at Work Regulations

The Electricity at Work Regulations apply to almost all places of work. The Regulations were enacted to impose duties to limit the risks involved with using electricity at work.

The following people are subject to the Regulations:

- Employers and the Self-Employed
- Employees

The duties under the Regulations are not just in relation to employers but also place a duty on employees in the following circumstances:

- To co-operate with his employer so far as is necessary to enable any duty placed on that employer by the provisions of these Regulations to be complied with
- To comply with the provisions of these Regulations in so far as they relate to matters which are within his control
- Many employees in the electrical trades and professions for example have responsibilities which are part of the duties of their employment of safety in relation to the installation of electrical equipment and systems

The definition of electrical equipment provided by the regulations includes anything used, intended to be used or installed for use, to generate, provide, transmit, transform, rectify, convert, conduct, distribute, control, store, measure or use electrical energy.

For further information, please read the HSE documents: "The Electricity at Work Regulations 1989 – Guidance on Regulations" and "Electricity at Work – Safe Working Practices". These can be found at www.hse.gov.uk.

The Electromagnetic Compatibility Directive

In order to facilitate a single European market for goods some 20 years ago the European Union began what is described as the 'New Approach'. A number of Directives were adopted with the aim of setting objectives for the harmonisation of technical rules, primarily but not exclusively, affecting the health and safety of new products by design and construction.

The principal aim of the 'New Approach' was to remove barriers to trade by requiring all products to meet common minimum health and safety objectives, which would be supported by agreed standards at the product level.

The Electromagnetic Compatibility Directive 2004/108/EC (EMC) will apply to equipment with an electrical aspect, primarily to prevent interference with other electrical equipment and its own immunity from such disturbance.

The Electromagnetic Compatibility Regulations

The EMC Directive is implemented in the UK by the Electromagnetic Compatibility Regulations which apply to electrical and electronic equipment liable to cause or be affected by electromagnetic disturbance.

The aim of the regulations is to ensure that electromagnetic disturbance generated by electrical or electronic equipment doesn't reach levels which would prevent radio, telecommunications and other equipment from working properly. They also exist to ensure that such equipment itself has adequate immunity from electromagnetic disturbance.

The rules don't deal with safety-related matters.

Whilst this is not a matter for the tester and examiner of lifting equipment, we should note that when the manufacturer affixes the CE mark to an item it implies that all the necessary directives have been complied with.

The EC Declaration of Conformity for electrically operated lifting equipment should therefore refer to both the **Machinery Directive** and the **Electromagnetic Compatibility Directive**.

Notes:

Revoked, Repealed and Amended Legislation

Prior to 5 December 1998, the Factories Act 1961 was the main legislation concerned with the use of lifting equipment and it was augmented several sets of industry specific regulations. The Provision and Use of Work Equipment Regulations 1998 and the Lifting Operations and Lifting Equipment Regulations 1998 together repeal, revoke or amend and replace the requirements for lifting equipment given in the following:

- The Factories Act 1961
- The Construction (Lifting Operations) Regulations 1961
- The Shipbuilding and Ship-repairing Regulations 1960
- The Docks Regulations 1988
- The Mines and Quarries Act 1954
- The Offshore Installations (Operational Safety, Health and Welfare) Regulations 1976
- The Lifting Plant and Equipment (Records of Test and Examination Etc.) Regulations 1992

LEEA COPSULE – Methods of Operation

Whilst the LEEA COPSULE does not include operation of powered equipment, users should be reminded of the need for power systems to be installed, maintained and examined in accordance with the relevant regulations, e.g. The Electricity at Work Regulations, The Pressure Systems Safety Regulations etc., and their need to meet any obligations these regulations impose.

Power operated equipment has the advantages of quicker operation than with manually operated equipment, often operatives can be remote from the load and heavier loads can be handled conveniently without operative fatigue.

In summary, where no power source is available, light loads are to be lifted, infrequent operation is called for or precision placement of the load is required, manual operation may be considered. Where heavy loads are to be lifted, frequent operation is called for or a more rapid operation is necessary power operation should be considered.

Summary

In this module, we have looked at the various laws that are applicable to **lifting equipment** and its examination in the United Kingdom.

Examiners of lifting equipment should always make themselves familiar with the national regulations of the country in which they are operating.

Failure to do so may lead to prosecution, due to breaches of the law.

Notes:

2. STANDARDS

There are many different standards that are directly related to Runways and Crane Structures.

It is advisable that the **Competent Person** has access to relevant standards in the course of their work in the thorough examination of runways and crane structures.

Types of Standards

Manufacturing standards detail dimensions, materials and safe working loads.

Performance standards offer a range of criteria that the final product must meet.

ISO (or International Standards) generally take the form of performance standards, which are agreed internationally by a majority vote. Their use is optional but they are often used as the basis for writing National Standards. Where the UK accepts these as written, they are published in this country as British Standards. A new practice has been adopted in recent years of using the ISO number and adding the prefix BS, for example **ISO 2330 - Fork lift trucks - Fork arms - Technical characteristics and testing** is published as **BS ISO 2330**.

ISO 9927-1 (Cranes – Inspection – General) is an example of an International Standard that sets out the minimum criteria for the inspection of overhead cranes.

Standards

Runway Design

Pre-2011: **BS 2853: 1957**
Post 2011: **BS EN 1993-6 (Design of Steel Structures – Crane Runway Beams)**

However, examination and testing is still to BS 2853: 2011 (Specification for the testing of steel overhead runway beams for hoist blocks).

- The Competent Person needs to be fully aware of **BS 2853:2011**
- This standard is for runways made from standard rolled sections
- It does not apply to proprietary or special runway profile sections
- BS 2853 does not apply to supporting structures, travelling trollies or lifting appliances

Note: Crane gantries are covered by BS7121 Part 2-1 and BS 7121 Part 2-7 and are covered in the LEEA Overhead Travelling Cranes Advanced Programme course.

BS EN 1991-3: 2006 EUROCODE (Design of Steel Structures)

BS EN 1991-3 gives design guidance and actions for the structural design of buildings and civil engineering works, including the following aspects:

- Actions induced by cranes
- Actions induced by machinery

BS EN 1991-3 is intended for clients, designers, contractors and public authorities.

Part 3 of BS EN 1991 specifies imposed loads (models and representative values) associated with cranes on runway beams and stationary machines which include, when relevant, dynamic effects and braking, acceleration and accidental forces.

BS 7333 covers slewing jib cranes which we shall visit later in this course.

Notes:

3. RUNWAYS

Definitions (BS2853:2011)

Certifier	Person signing the certificates specified in the British Standard
Runway	Runway beam and runway components
Runway Beam	Overhead track for carrying loads which are moved along it
Runway Components	Those parts of the runway immediately attached to the runway beam, e.g. splices, end stops, clamps and switches
Calculated Deflections	The deflections due to the SWL and proof load computed using the formula applicable to the particular circumstance
Measured Deflections	The deflections measured in such a manner that they relate to precisely the same conditions as those covering the calculated deflection referred to in Clause 6 of BS 2853:2011

Notes:

Duties of the Competent Person

Although the duty of the Competent Person is to thoroughly examine only the actual runways, nevertheless he must satisfy himself that the supporting steelwork is sound and suitable to carry the load to be applied.

The Competent Person should therefore seek assurance by taking sight of the confirmation issued by the architect, consulting engineer or any other competent authority, that the supporting building members are adequate for the resultant loads and suitable for the purpose.

Design of Runways

Structural Design – BSEN 1991-3 and BSEN 1993-6

Runway beams should be:

- Sufficient size and strength
- Even running surface
- Appropriately supported
- Appropriately suspended
- Readily accessible for maintenance

Slope

The runway beam and supporting structure shall not slope by more than **1mm in every 250mm** from the horizontal, or from its intended slope.

Notes:

4. SUPPORTING STRUCTURES

Materials Used for Runways and Supporting Structures

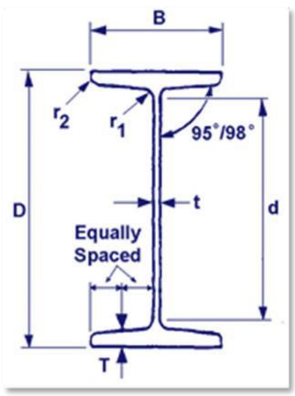
In this module, we will look at the supporting of runway structures and the materials that are commonly used for both the runway, and the supporting framework/structure, including:

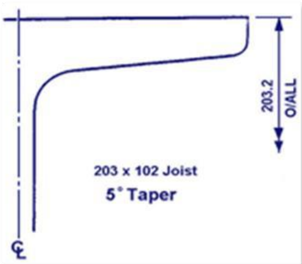
1. Rolled Steel Joists
2. Universal Beams
3. Universal Columns
4. Rolled Steel Angle
5. Rolled Steel Channel
6. European Sections
7. Steel squares, flats and plates
8. Hollow sections and tubes
9. Rail sections

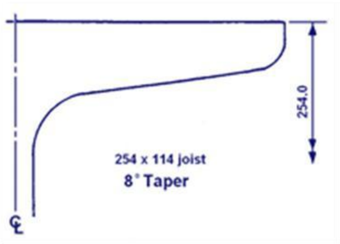
Rolled Steel Joists (RSJ)

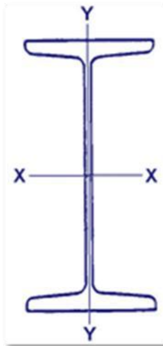
- Recognised principally by their tapered flanges
- Superseded by Universal Beams
- Previously used for OTC supporting structures
- They have a greater thickness at the root and therefore greater resistance to transverse bending due to the runners

The illustrations below are typical dimensional examples of **Rolled Steel Joists:**







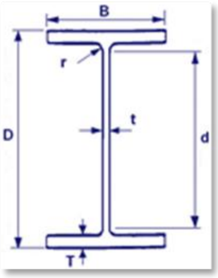


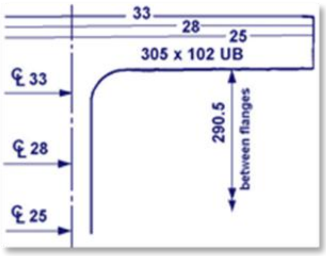
Universal Beams (UB)

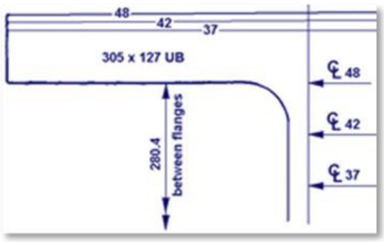
- BS EN 10025
- Recognised principally by their parallel flanges
  - Each nominal size has varying weights/m
  - Each weight has a different flange and web thickness
  - Older UBs rolled with a 3° taper – **important to note if using friction grip bolts as these should only be used with parallel flanges**

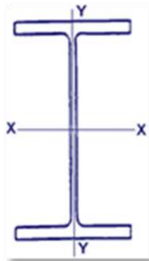
- Accurate measurements are required to establish beam weight and actual flange thickness to ascertain whether friction grip bolts will be effective

The illustrations below are typical dimensional examples of **Universal Beams:**







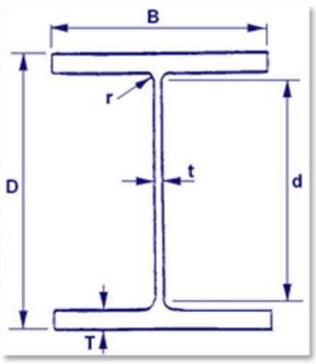


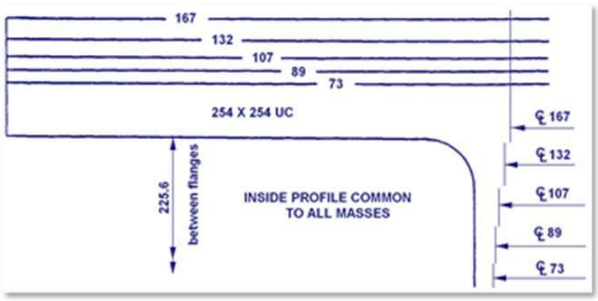
Notes:

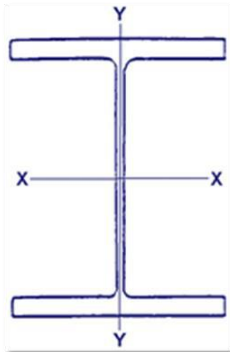
Universal Column (UC)

- BS EN 10025
- Used on some crane supporting structures
- Very thick flanges – suitable for high transverse stresses due to wheel loads
- More likely to be used for supporting columns in structures

The illustrations below are typical dimensional examples of **Universal Column:**







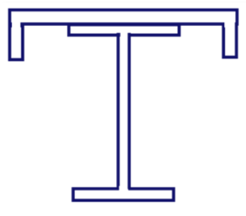
Rolled Steel Angles

- Used for bracing and lattice structures and bracings between support columns

Rolled Steel Channel

Can be used for capping beam sections

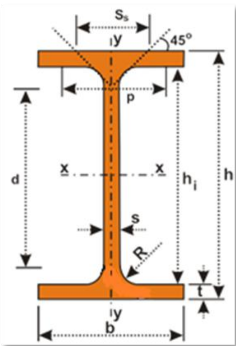
- Capping for beams – increases strength in X and Y planes
- Produces a composite section – larger spans than can be achieved with standard profiles



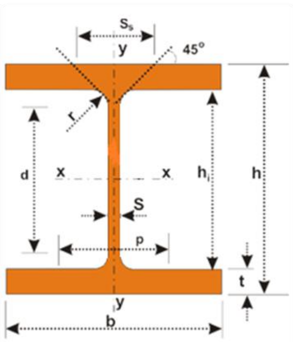
European Sections

- Sometimes used as an alternative to universal beams
- Commonly known as:
  - **IPE**
  - **HEA**
  - **HEB**

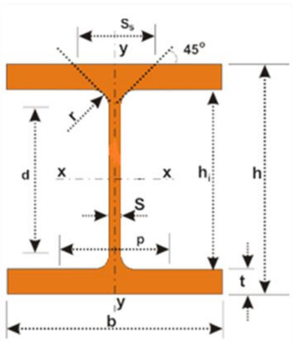
Note that HEA and HEB sections only differ by the thickness of the flange and web, which is greater in HEB sections.



IPE



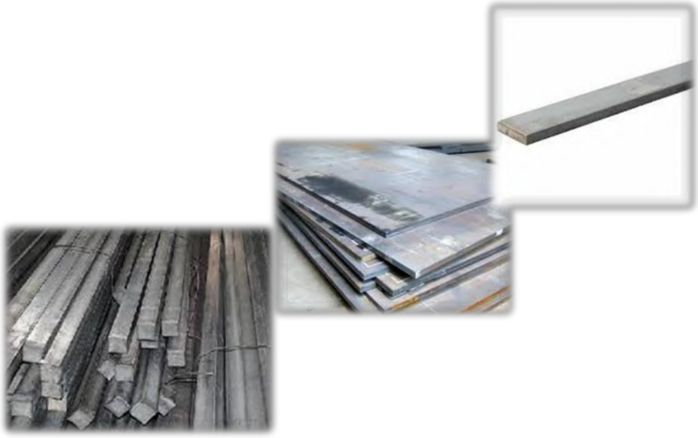
HEA



HEB

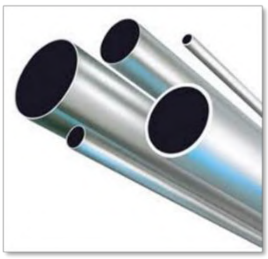
Materials – Squares, Flats and Plates

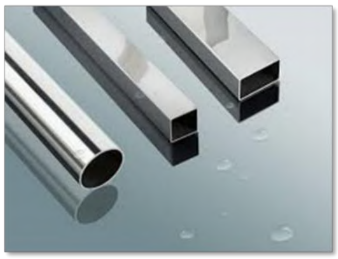
- Sometimes used as strengthening members
- A cost-effective alternative to standard crane rail sections



Hollow Sections and Tubes

Generally used as supports in structure.





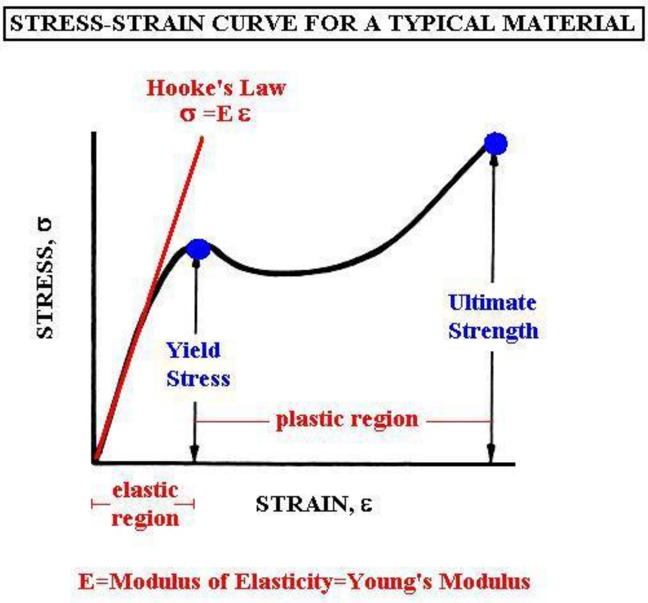
Notes:

Material Grades

The steel sections we have looked at are available in varied grades:

- S235
- S275
- S355

The grade number indicates the maximum yield strength (elastic limit) of the material.

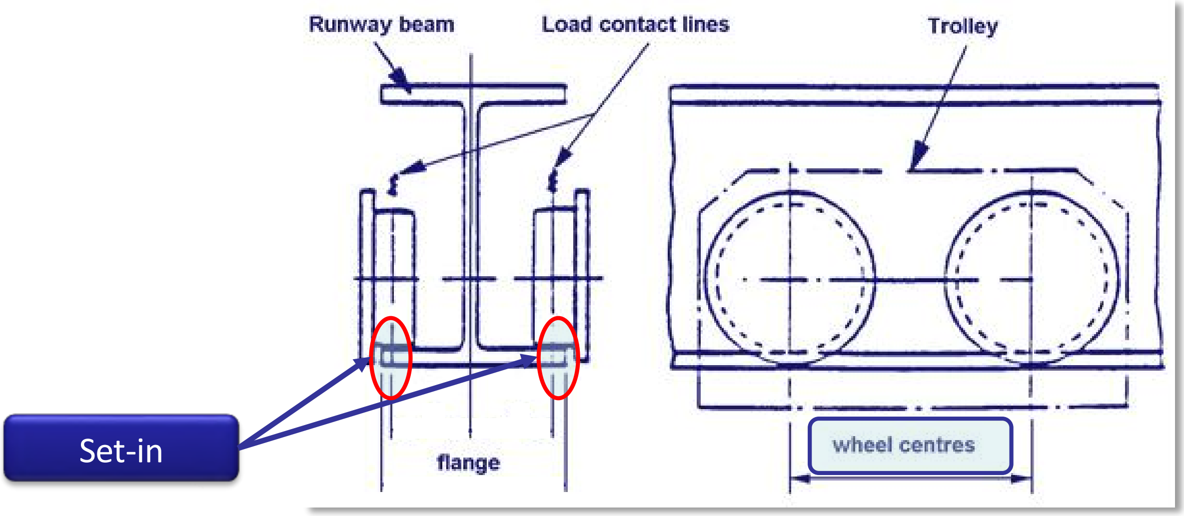


Flange Bending

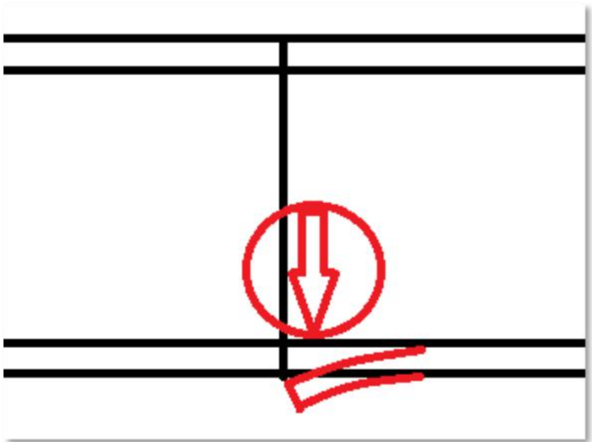
Bending of a runway lower flange will depend on:

- The amount of set-in of trolley wheels
- The distance apart of the trolley wheel centres

Set-in is the distance from the contact point of the wheel tread to the edge of the runway beam.



Runway beams that are joined together but have no reinforcement of the lower flange:

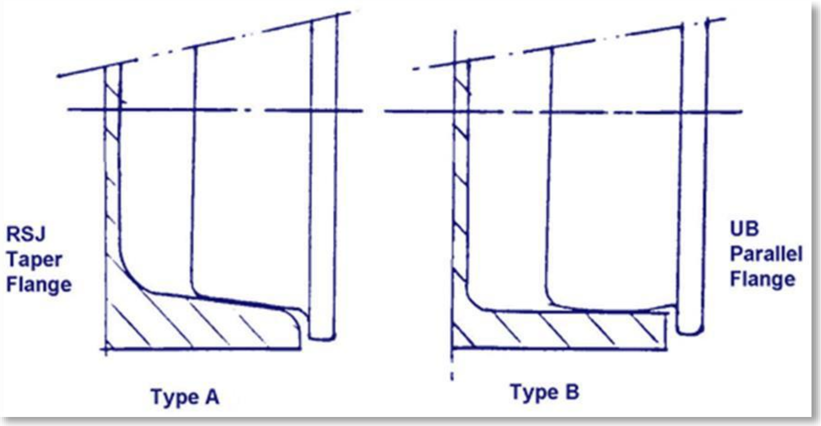


- This can cause localised permanent set at the joint and would reduce the WLL
- Correct design checks must be requested by the tester/examiner
- If flange stress is critical, end stops must also be fitted to prevent the trolley wheel centre moving within a full beam width from the end of the beam

Trolley Wheels

Type A – Angled to suit RSJ application
Type B – Radiused wheels suitable for both RSJ and UB flanges (Universal)

A trolley with tapered wheels should never be fitted to a universal beam since not only will edge contact, but also point contact will occur causing rapid wear of both track and wheels and an increase to the transverse bending on the flange, leading to early or even sudden failure.



Notes:

Supporting Runways

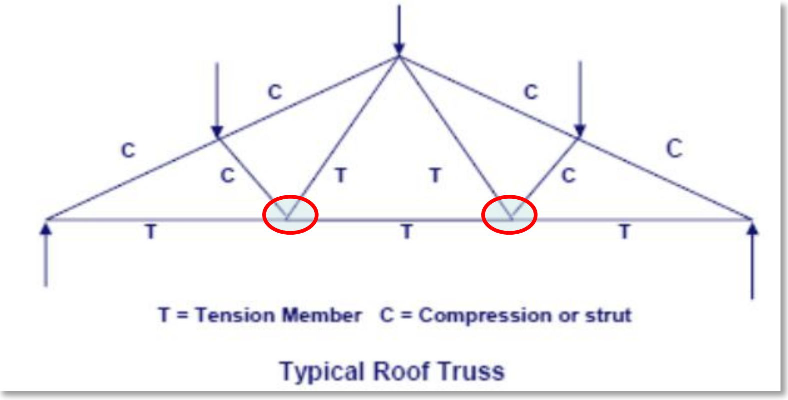
Roof Trusses

It is quite common in older factory buildings to see runways supported from the roof trusses, a favoured method since it provides a clear floor space with no obstruction.

The roof truss is what is known as a simple framework, as shown in the illustration below, i.e. the components are either in tension or compression, they are not designed to withstand bending.

Circled in red below highlights two of the node points of a typical roof truss.

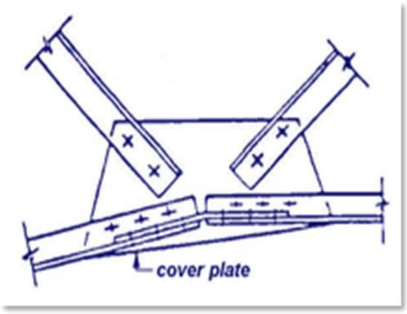
A node point is the joint between members.

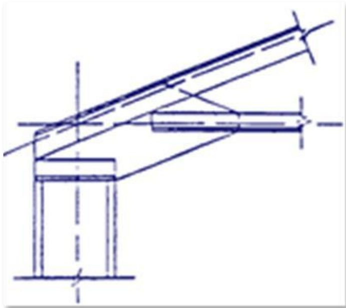


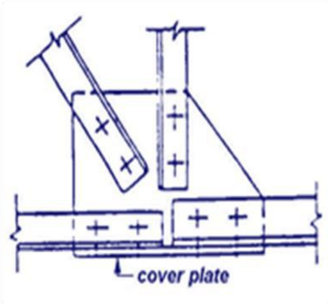
Node Connectors

The runway beam should be mounted as close to the node point as possible thus reducing any bending effect to a minimum. This type of installation must be treated with the utmost care and the Competent Person must ensure that sufficient calculations have been carried out by Competent Persons to confirm the structure is not overloaded when, and if a test load is applied.

It is usual for a structural engineer's report, confirming the intended use, to be kept with the thorough examination records.







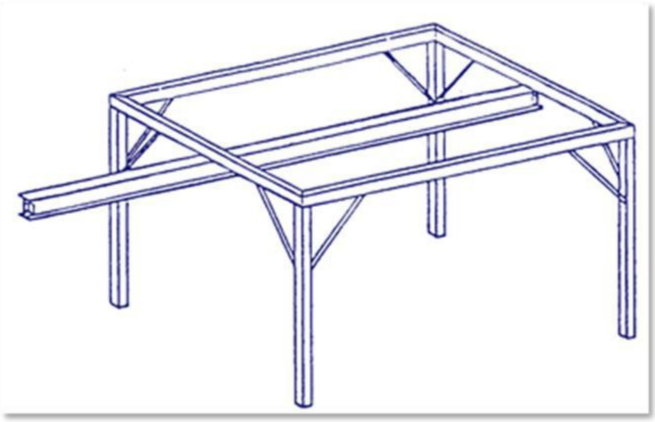
Node Point Connectors

Notes:

Steelwork Supports

Goal Post Supports

If the building framework is not strong enough then the runway is often supported on goal post type frameworks, as shown below:

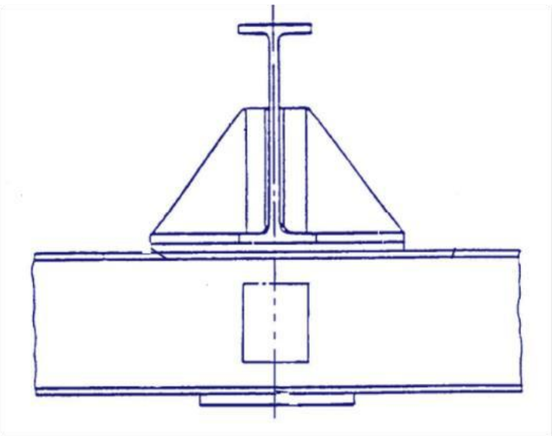


Free Standing Gantry

Note: Even though support steelwork is not the actual runway beam, it still requires Thorough Examination.

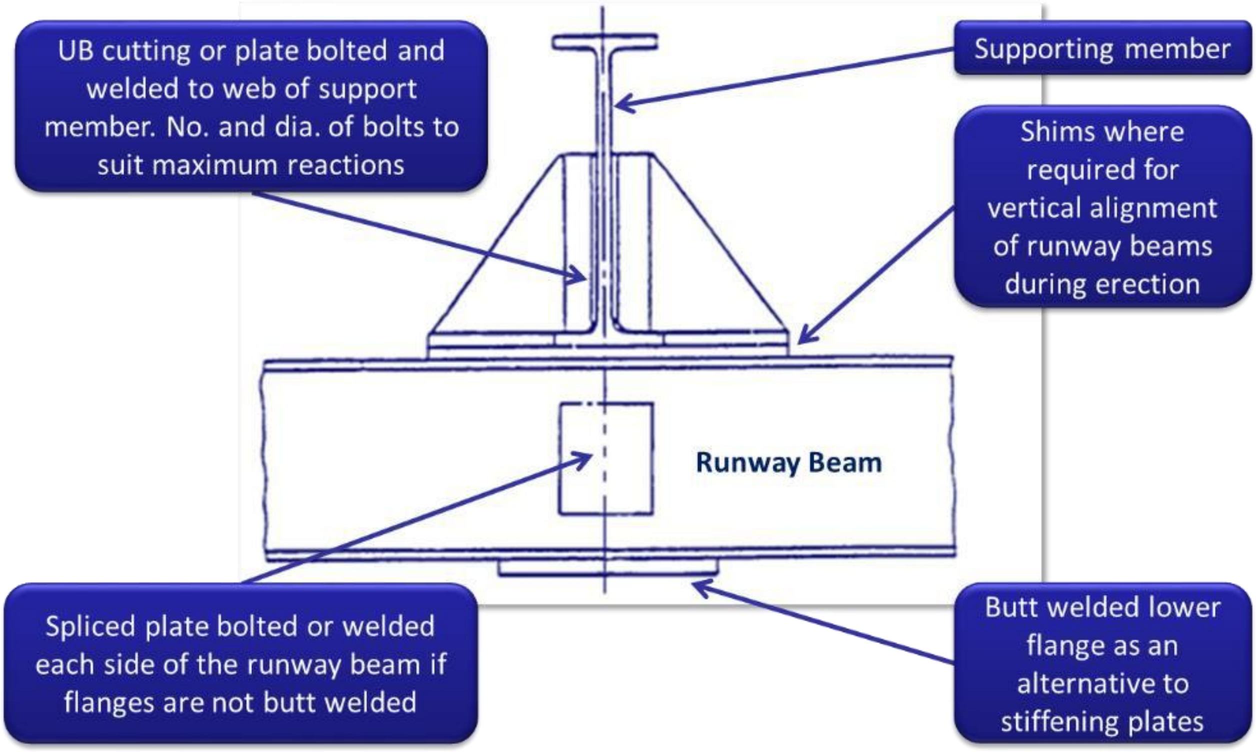
Runway Connections

The following illustration demonstrates how a rigid joint which is free from rotation:



The components and construction methods for this type of support are shown below.

City & Guilds | Accredited Programme



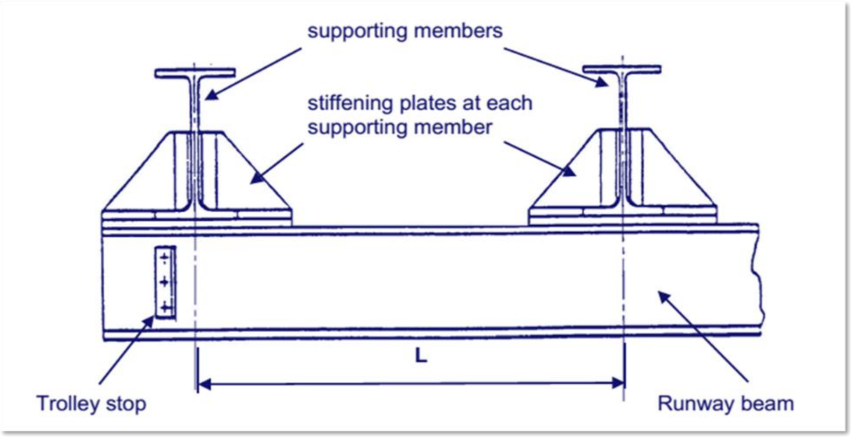
Notes:

Joint Between Continuous Runway Under a Supporting Member

- Stiffening plates are welded to lower flanges to reduce lateral local bending stresses at the joint
- If lower flanges are fully butt welded, stiffeners are not required
- Splice plates may be bolted or welded to local side of webs
- Universal Beam gussets may be bolted or welded to support the steel

Connection of Runway Beams Below Supporting Members

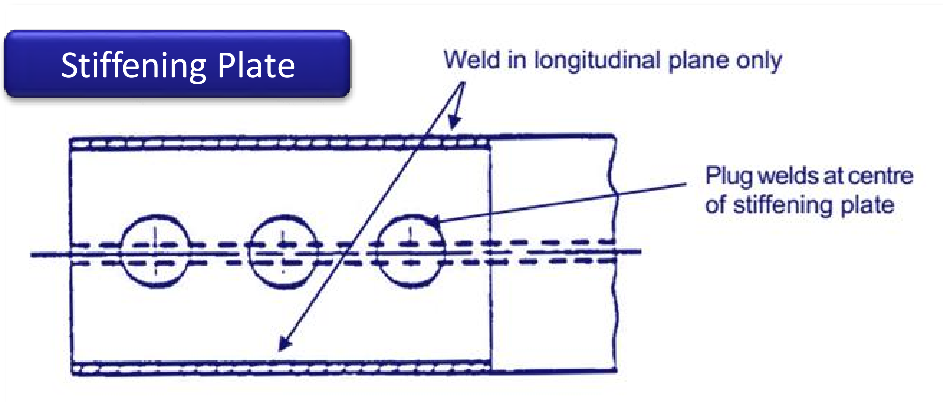
The illustration below shows a typical runway, mounted below supporting steel connections:



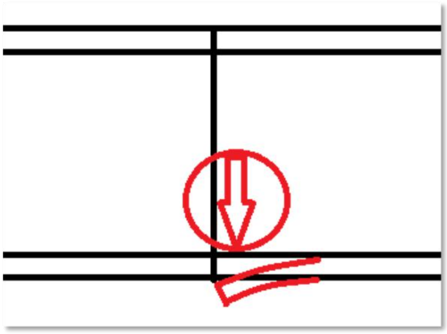
Notes:

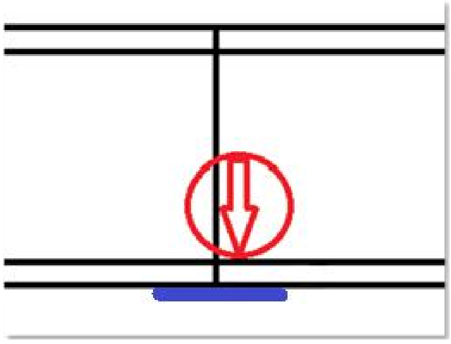
Stiffening Plates

Stiffening plates are used to reinforce the runway beam flange and are normally fitted to the top of the runway beams at all supports and to the top and underside at all joints.



In the image below left, the flange is bending at the joint. In the image below right, a stiffening plate has been fitted underneath to prevent the flange from bending.

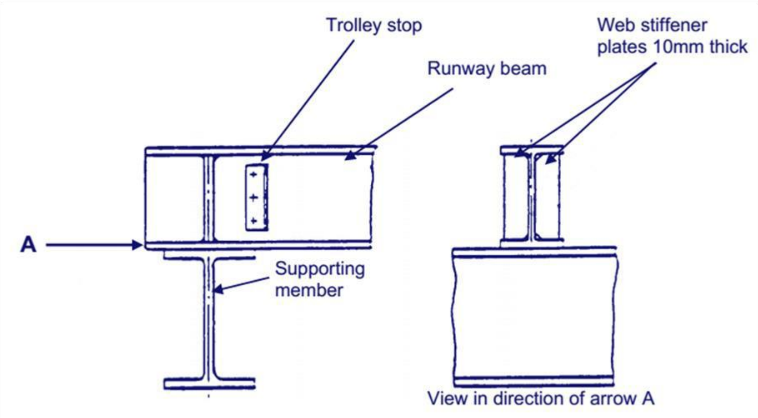




Web and Flange Stiffeners

Where a runway sits on top of supporting steelwork, web stiffeners should be fitted. This reduces the rotating effect and also local web crushing by transmitting the local crushing force between web and flange into a distributed shear force in the web of the beam.

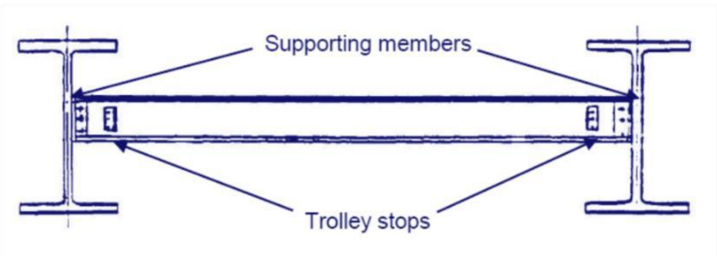
If the web stiffeners are fully welded to the flange of the beam the strength of the beam is effectively increased and therefore the SWL may also be increased.



Runway Shear Connection

Shear connection = bolts should always be fitted at connection points

- Trolley stops always to be fitted
    - Prevents the hoist colliding with the building or support structure



Unrestrained Cantilever Runway

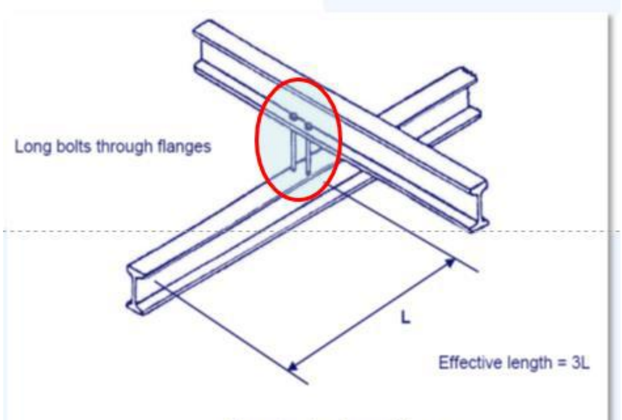
Careful consideration is required by the Competent Person to ensure the arrangement is fit for purpose.

What Connections Used?

This is important when the duly qualified person must consider allowable stresses.

The unrestrained cantilever supported by long suspension bolts is totally unrestrained against torsion at the support and unrestrained at the end.

The effective length of the cantilever is 3 x actual length (L).



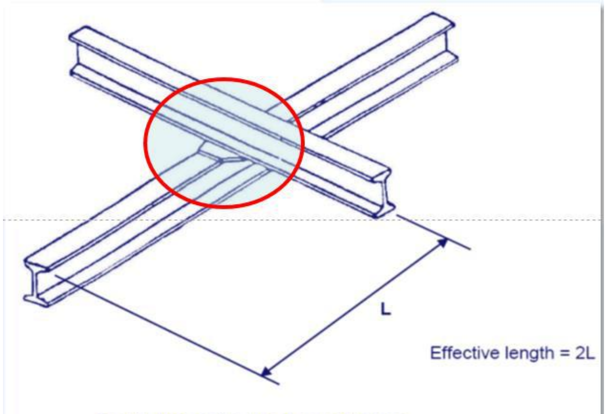
Unrestrained cantilever

Partially Restrained Cantilever Runway

Careful consideration is required by the Competent Person to ensure the arrangement is fit for purpose.

The **partially restrained cantilever** has improved support with partial restraint against torsion at the support but is unrestrained at the end.

The effective length of the cantilever is 2 x actual length (L).



Partially restrained cantilever

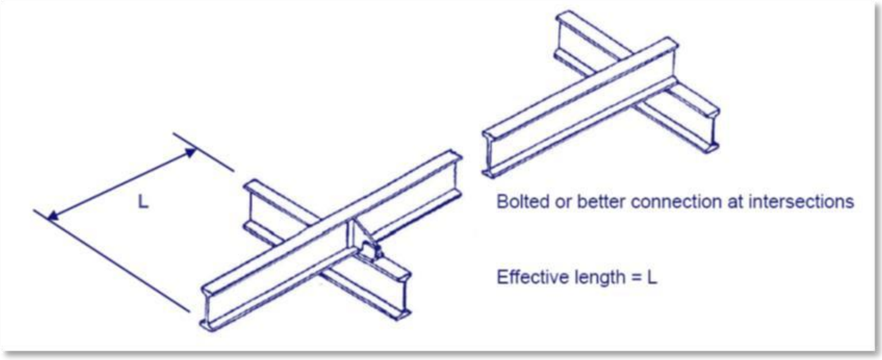
Fully Restrained Cantilever Runway

Careful consideration is required by the Competent Person to ensure the arrangement is fit for purpose.

This **fully restrained cantilever** is fully restrained against torsion but unrestrained at the end.

The effective length of the cantilever is equal to the actual length of the cantilever.

Efficient connection but restricts the use of the full beam length.



Notes:

Effective Length of Runway Beams

Effective length

Used to calculate allowable compressive bending stress in lower flange

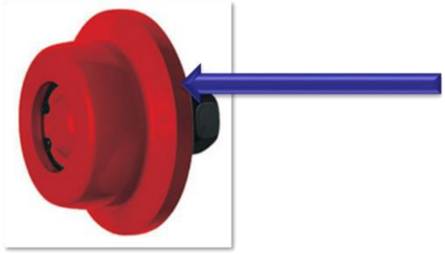
Note: The type of connection at the cantilever support could have a significant effect on allowable SWL of cantilever.

Effective Length of Simply Supported Beams

- Generally the same as the actual span
- Compressive flange and web cleated = reduced effective length to 0.85 x span (otherwise allowable compressive stresses may be exceeded)

End Stops

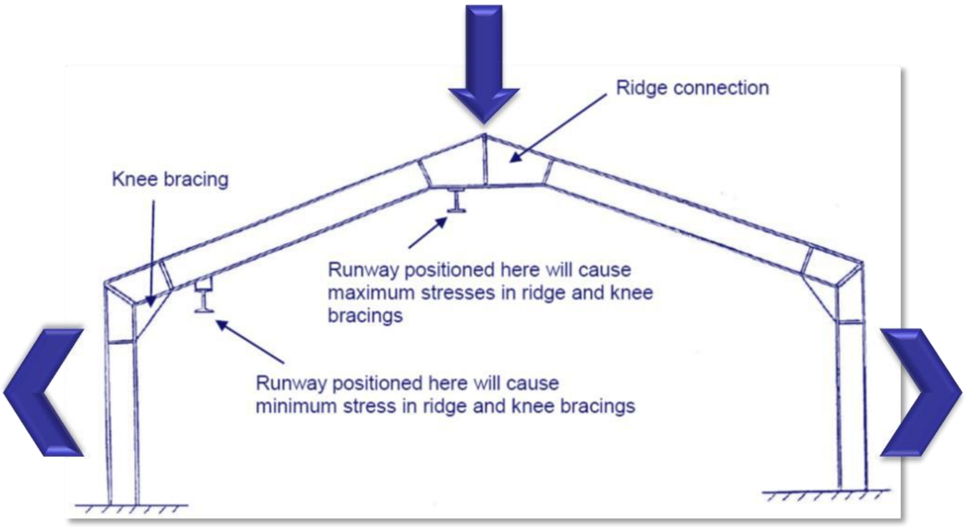
- Shall always be provided on the runway
- Prevent the trolley from falling from the beam or fouling structure of building
- Stops shall not operate on the flanges of the trolley wheels



Free Standing Structures

Roof beams are usually cantilevers that when loaded deflect down and push out the building stanchions.

Designed to accept snow loadings but not usually runway beams – **the Competent Person must check a structural engineer's report which states the building is satisfactory for runways**.



Notes:

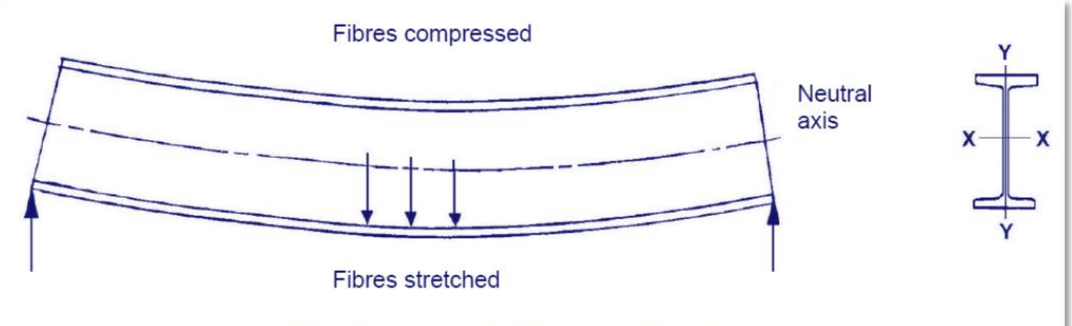
5. DEFLECTIONS AND MEASUREMENTS

Deflections

Stresses are mostly tensile and compressive. A beam deflects when it is loaded, and consequently;

- The fibres in top half of beam are compressed
- The fibres in lower half of beam are stretched (tension)

When a load is removed from a beam it should return to original position with no permanent deformation as a result of the loading (elastic).

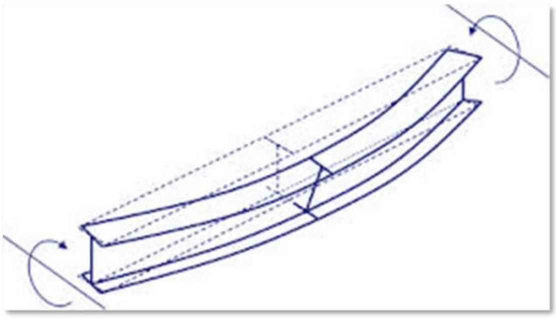


Simply supported beam in bending

If beam is overloaded, it may take on permanent set and not return to original position when load is removed.

In practice, buckling would take place before any permanent set and the beam would roll out of its plane of symmetry.

As a result, the properties of the beam section would be destroyed and the beam would collapse.

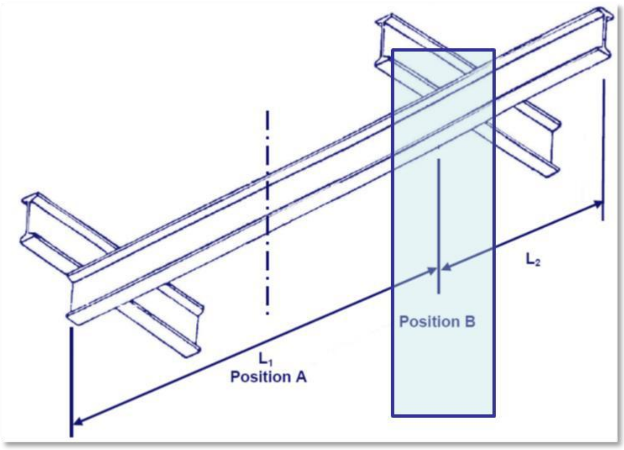


Notes:

Bending Stresses in Runway Beams

If a beam is simply supported or supported at each end, the maximum bending stress will occur at the centre when load is at centre of the span (Length L1).

In cantilever beams, the maximum stress will occur at the support (Position B) when load is at the end of the cantilever.



Runway Beam Deflections

Runways and supporting structures should be tested before putting into service.

The Competent Person needs to seek advice from manufacturer (or other suitable design authority) before deciding on:

- The nature and method of test, including amount of overload and where applicable the deflection requirements
- Information may be available from the standard the beam was made to, for example:
    - BS 2853: 2011 Clause 6 states the *maximum measured deflection of runway beams* under SWL shall not exceed *1/500th* of the span
    - For *cantilevered beams* the maximum measured deflection under SWL shall not exceed *1/250th* of the span

For example: $\frac{1}{500}$ = 2mm per 1 metre

$\frac{1}{250}$ = 4mm per 1 metre

Notes:

Measured Deflections

The Competent Person must ensure this is done correctly!

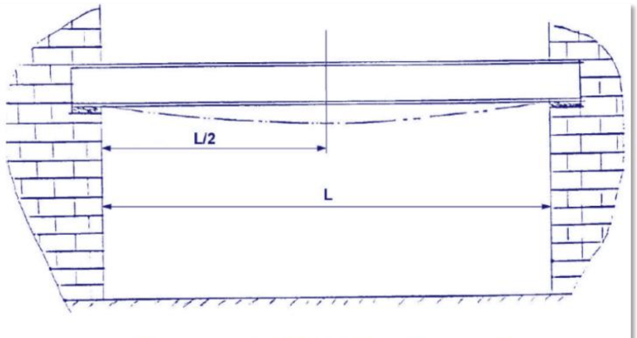
Test loads are to be applied in exactly the same conditions as the calculated deflection.

The Competent Person is to be aware that allowable deflection of a runway beam is for the beam itself and not the additional deflections from the supporting structure.

Encastre Runway Beams

Deflection measured would only be in the beam as the supporting structure is rigid and any deflection would be negligible.

Maximum deflection will be at L/2 (the centre of the beam)



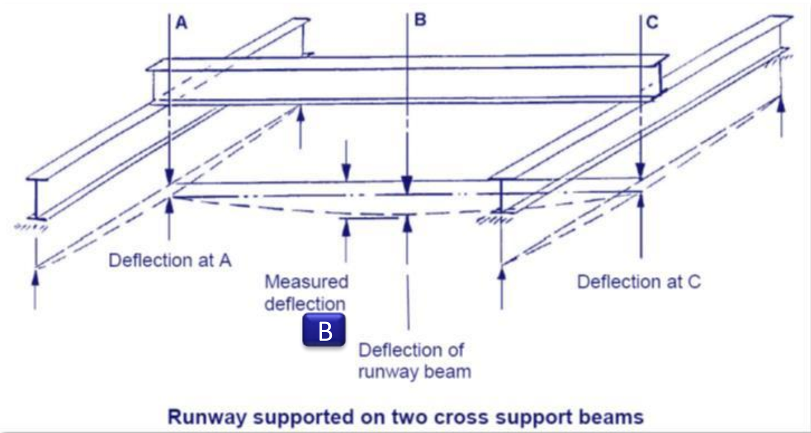
Runway set into Brick Piers (Encastre)

Supported Runway Beams

In this instance, deflection in the beam is compounded by deflection in the support beams.

We must discount deflections in the support beams to get the **theoretical deflection** (also called the Actual/True/Calculated deflection) in the highlighted beam.

$$\text{Theoretical deflection} = \text{Measured deflection (B)} - \frac{(\text{Deflection at A} + \text{Deflection at C})}{2}$$



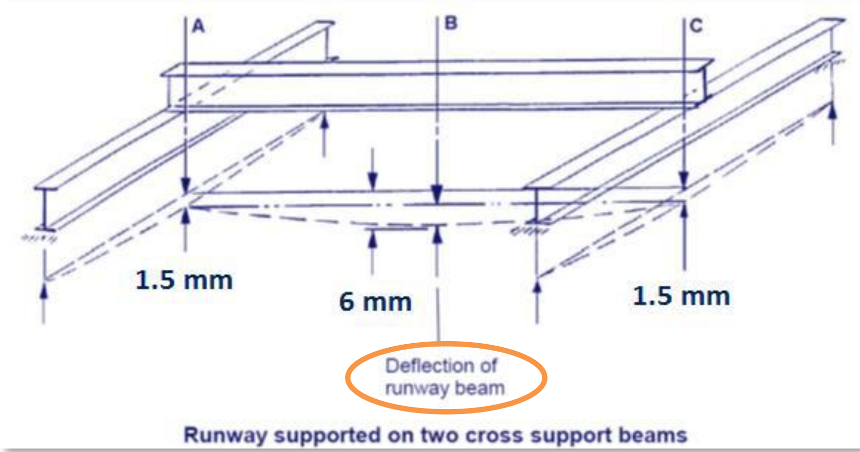
How to calculate the theoretical (actual/true) deflection for simply supported beams

For example:

Measured deflection (B) = 6 mm
Deflection A (See Figure 1) = 1.5 mm
Deflection C (See Figure 1) = 1.5 mm

Theoretical deflection =

$$\text{Measured deflection (B)} - \frac{(\text{Deflection at A} + \text{Deflection at C})}{2}$$



$$6\text{ mm} - \frac{(1.5\text{ mm} + 1.5\text{ mm})}{2} = 4.5\text{ mm}$$

So, the **theoretical deflection** is 4.5 mm.

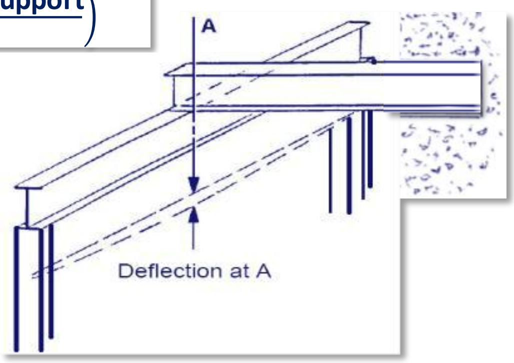
Notes:

Combination Supports

How to calculate the theoretical (actual/true) deflection for encastred beam supported by goalpost structure

Sometimes a runway beam is built into a wall at one end and supported by a goalpost structure the other end. In this case, the theoretical deflection of the runway at centre span would be:

$$\text{Theoretical deflection} = \textbf{Measured deflection at centre span} - \left(\frac{\textbf{Deflection of Cross Support}}{\textbf{2}}\right)$$



For example:

Measured deflection at centre span (B) = 6mm
Deflection of cross support (A) = 4mm

$$6 - \left(\frac{4}{2}\right) = 4 \text{ mm}$$

Maximum stresses would be where the load is directly under the goal post support at the runway beam to support connections.

Notes:

Supporting Structures

- Supporting structures are not actually a part of the runway beam (they are not covered by BS 2853)
- The Competent Person should seek advice from the runway manufacturer (or suitable design authority) before deciding on suitability of support structure
- Example: If structural steelwork is designed to BS 449, clause 15 allows a maximum deflection of $1/360^{th}$ for structural members and this cannot be exceeded!
- General practice normally treats supporting beams as a runway gantry which limits deflection to $1/500^{th}$ under maximum load
- Design of runways to BS 2853 assumes simply supported (two solid supports with no fixings) but in practice this is not acceptable
    - Joints would be bolted or clamped
- In most cases the rigidity of the joint will give the beam added resistance to bending (the fixing moment)
- An encastred beam, built into brick piers giving the highest fixing moment possible, would only deflect 25% of the amount of an identical simply supported beam loaded in the same way
- Most structural engineers ignore fixing moments when designing runway beams
    - The tester rarely finds runway beams which deflect the permissible 1/500 of the span. If you do, the installation should be treated as suspect!

Measuring Devices

Suitable Measuring Equipment

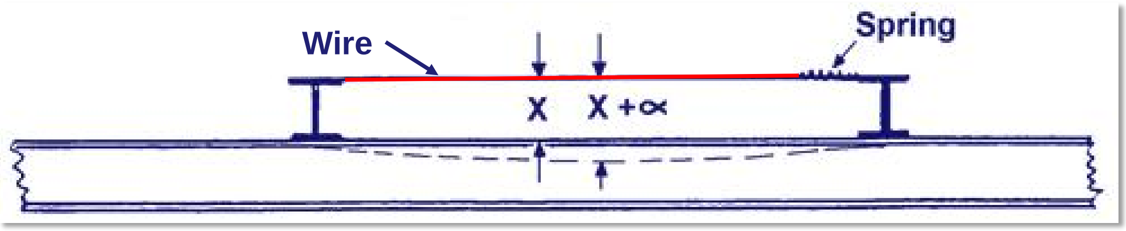
- Accurate laser or optical levels
- Suitable tape measures
- Tripods
- Adequate fixing points
- Suitable datum points

Measuring Deflection

Piano/taut wire used for measuring deflection:

A taut or sprung wire is placed between the two supports above the runway to give a datum line to measure from.

Deflection is measured from the taut wire to the top of the runway beam under no-load and loaded conditions to determine the actual deflection.



Using Steel-Stock and Other Tables

Tables are sometimes used by the tester and examiner to assess the SWL of a runway beam (the tables usually refer to simply supported beams).

Precautions:

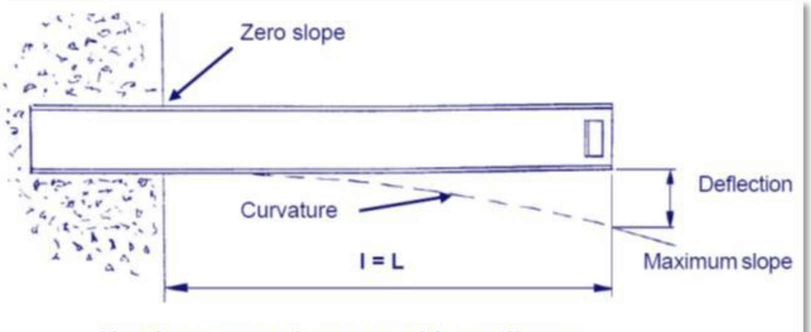
- Some structures contain beams with fully restrained ends
- Substantial fixing moments occur ate the restraining ends which allow greater loads to be supported than indicated in the tables
- The use of tables can result in an over-engineered runway beam
- For spans and capacities not covered by tables, calculations are necessary in accordance with BS 1993-6
- Some tables were made to BS 2853: 1957 and it is therefore advisable that such beams are re-checked against BS EN 1993-6

Notes:

6. RUNWAY BEAMS WITH CANTILEVERS

Extra care must be taken when testing a runway beam with a cantilever. It is not uncommon for the designer to forget to take all factors into account this invariably will cause problems at the testing stage.

- This type of installation is not often encountered but is the most stable
- The effective length 'l' is equal to the span 'L' because the fixed end is fully restrained
- With load at end of cantilever, deflection will be maximum with zero slope at the fixed end and maximum slope at the free end

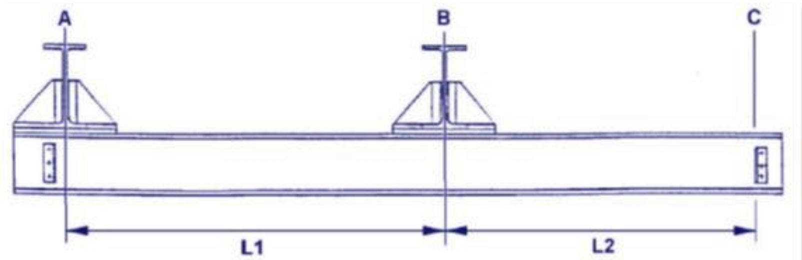


Simply supported runway with cantilever

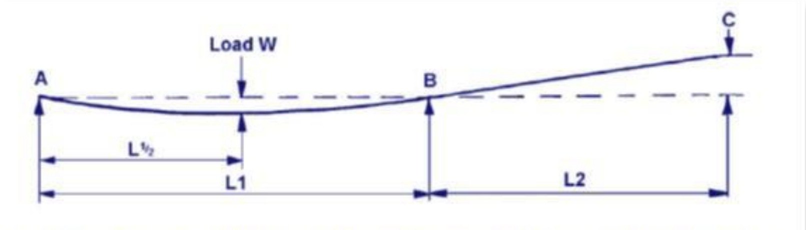
First consider the runway beam. When checking the runway beam, the tester applies his loads at:

- Fixings A and B
- Centre of span of L1
- End stops of cantilever L2

Ignoring any deflection at A and B, if we apply a load at centre span of A to B (image below) the deflection of the beam would be exactly as a simply supported beam (image above) except the beam at positions B to C would rise.

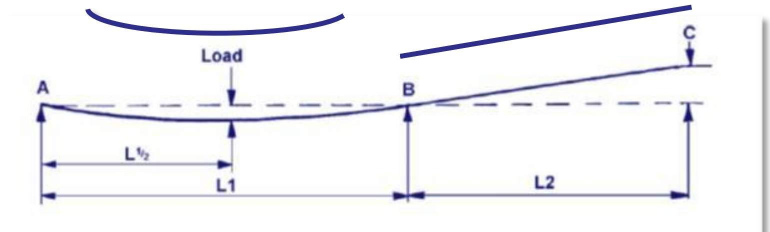


Runway beam with cantilever and two support beams



Deflection diagram of runway beam with cantilever and load W at L½

- When load is at centre span (L1÷2), the maximum slope is at A and B
- Due to the slope at B, section B to C of the beam lifts up with a continuous slope
- Section A to B is curved whilst section B to C is straight

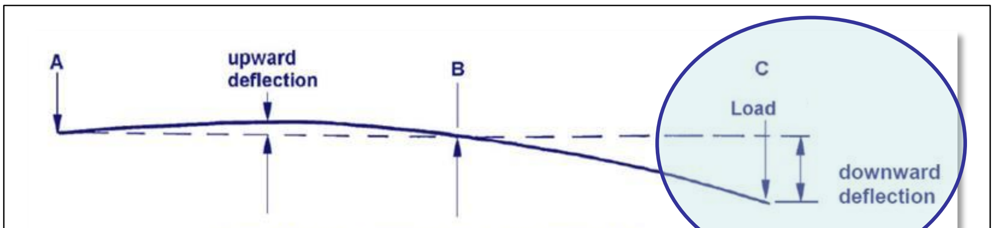


Deflection diagram of runway beam with cantilever and load at L½

When the cantilever is loaded at point C, the reactions are different:

A maximum load is applied at C, at point A the runway tries to lift off the support and the runway bends upwards between A to B

- The slope of the beam increases to a maximum at point C



Slope of beam increases to a maximum at C

- The deflection at C now is considerably greater than an 'encastre' beam because the beam is rotating about support B, the deflection is compounded
    - We have deflection due to curvature of beam from B to C plus the deflection due to the rotation at B.
    - The rotation at point B will have a huge effect on deflection at C and if not designed correctly the deflection will be excessive and therefore the installation will have to fail the examination.

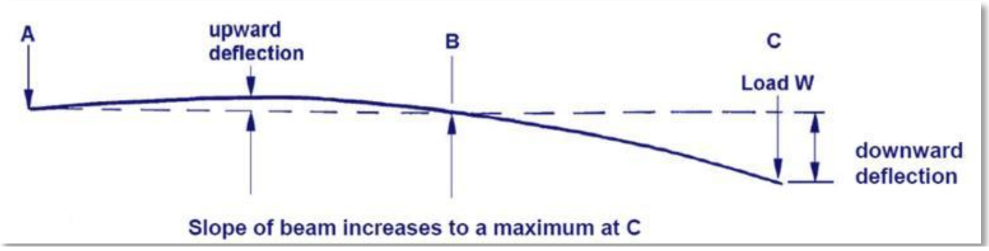
Note: With the test load at C, the reaction at B will be at maximum!

Notes:

Example

In this example we calculate the reaction at support B:

Span A to B = 4 metres
Cantilever B to C = 2 metres
Load at C = 1 tonne



To calculate the reaction at B:

$$\frac{(\text{A to B} + \text{B to C}) \times \text{Load at C}}{\text{A to B}} = \frac{(4 + 2) \times 1\ \text{Tonne}}{4} = \frac{6}{4} \times 1\ \text{Tonne} = 1.5\ \text{Tonne}$$

Therefore, reaction at B is 1500 Kg or 1.5 Tonnes

Notes:

Measuring Deflection

- The measured deflection at point C will be dimension D3
  - This is because support A will deflect upwards and support B (D1) downwards and the bending of the runway beam (D2):

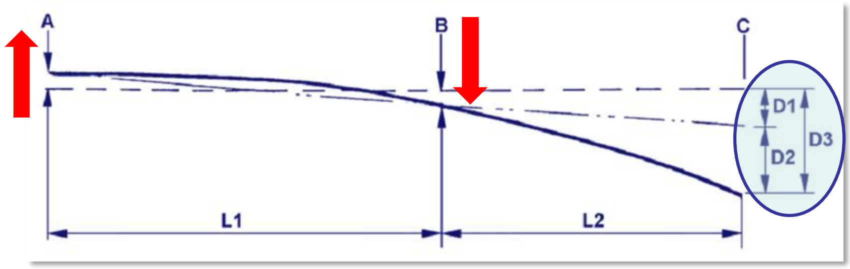
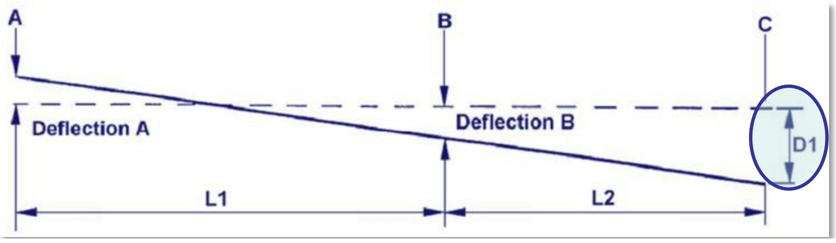


Figure 4: Compound deflection diagram of runway beam with cantilever and deflection of supports A and B

- BS 2853 states that D2 shall not exceed 1/250th of the span, B to C

To establish D2 (actual deflection), we must first calculate D1:



- With load at C, we measure the total deflection at C (D3), upward deflection at A and the downward deflection at B

- Downward deflection D1 (due to upward deflection at A and downward deflection at B) equals:

$$D1 = \text{Deflection at A x} \left(\frac{L2}{L1}\right) + \text{Deflection at B x} \left(\frac{L1+L2}{L1}\right)$$

Actual deflection of runway beam (D2) = Measured deflection - D1 = D3 – D1

Notes:

Example

Find the actual deflection (D2) of cantilever and state if it is within the allowable limit given in BS 2853 where:

Runway L1	= 6 metres
Cantilever L2	= 3 metres
Deflection A	= 1.5 mm
Deflection B	= 2.5 mm
Measured Deflection D3	= 12 mm

$$D1 = \textit{Deflection at A x} \left(\frac{L2}{L1}\right) + \textit{Deflection at B x} \left(\frac{L1+L2}{L1}\right)$$

D1 =

$$1.5\text{ mm x} \left(\frac{3\text{ m}}{6\text{ m}}\right) + 2.5\text{ mm x} \left(\frac{6\text{ m} + 3\text{ m}}{6\text{ m}}\right) = 1.5\text{ x} \left(\frac{3}{6}\right) + 2.5\text{ x} \left(\frac{9}{6}\right) = 4.5\text{ mm}$$

(1.5 x 0.5) + (2.5 x 1.5) = 0.75 + 3.75 = 4.5 mm

Actual deflection of runway beam = Measured deflection - D1

= 12 – 4.5 = 7.5 mm

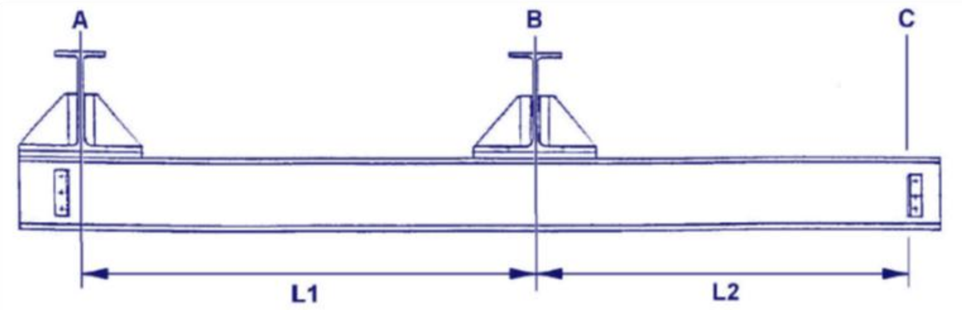
The allowable deflection = $\frac{1}{250}$ maximum.

7.5mm = $\frac{1}{400}$ so this deflection is allowable.

Notes:

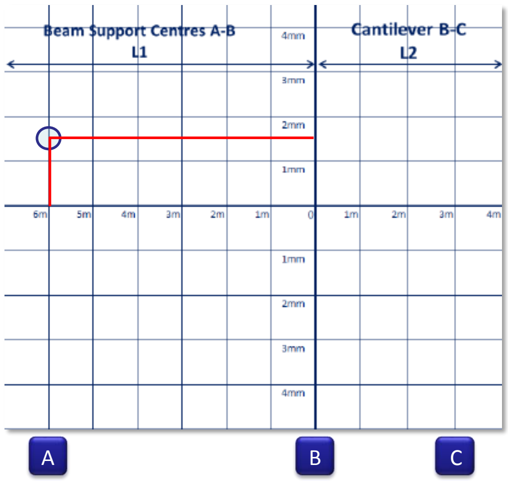
Graphical Method

To avoid calculation, D1 may be obtained using graphical method.

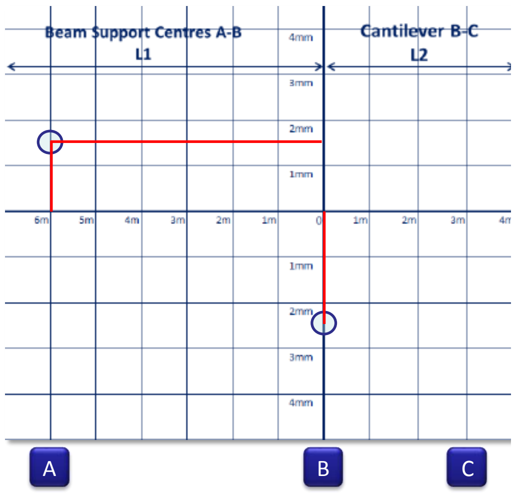


Runway beam with cantilever and two support beams

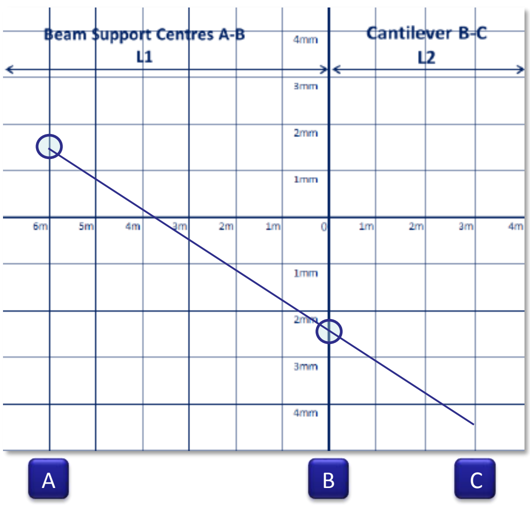
1. Mark off deflection A (1.5 mm) at 6 metres back support



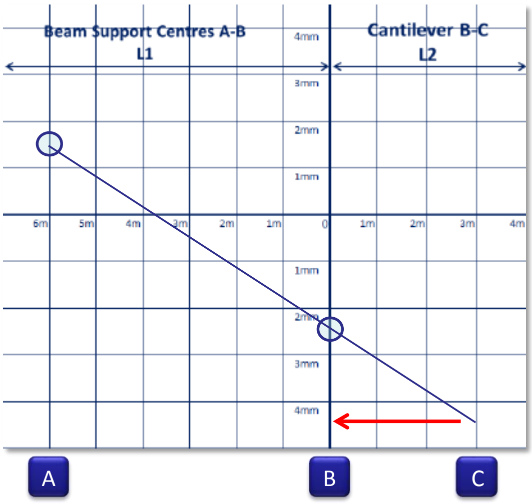
2. Mark off deflection B (2.5 mm) at front support.



3. Draw a straight line through points on A and B and extend the line until it reaches the length of the cantilever (3 metres) at point C

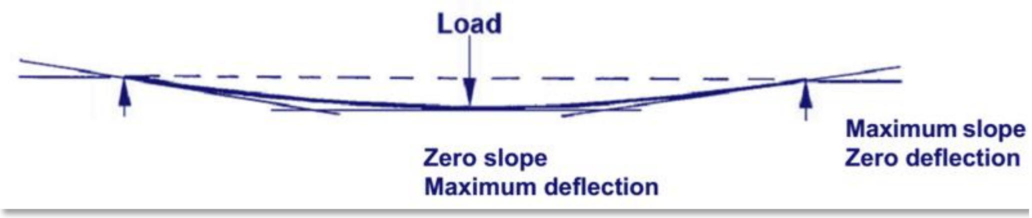


4. Take the deflection reading where the line meets point C. The reading is **4.5 mm.**



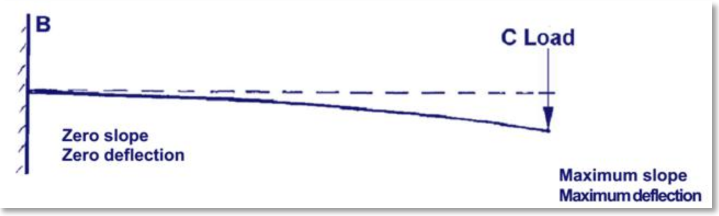
Slope: Simply Supported Beam

- Slope is possibly more critical than deflection if is not properly understood
  - Slope is the maximum slope of a runway beam
- If a runway beam is supported at each end with the load in the centre, the slope is a maximum at each end and zero in the centre
- As the load approaches either support the slope will decrease



Slope: Cantilever

- A runway beam which is cantilevered will have maximum slope at the end of the cantilever with the load at the end of this cantilever
- With the hoist block close to B, slope will be zero (see Figure 5). As it moves towards C the slope will increase.
  - If the slope allows the hoist to start running away before reaching C, the hoist will accelerate as the slope increases causing the hoist to crash into the end stop
  - Deflection of supporting steel will further increase the slope
- The Tester and Examiner must take great care to satisfy himself that the runway beam, although satisfactory within its own deflection limits, does not suffer from a combination effect of supporting steelwork or creating excessive slope



Note: If the beam is supported as in Figure 6 and loaded as in Figure 7, then the slope at position B will not be zero. The slope increases as the load approaches position C, where it will be a maximum.

With the load at the support point, bending stress is negligible and only shear and transverse stress occur. With the load at cantilever end, bending and shear stress occur at the support point. Transverse and shear stress only occur under load.

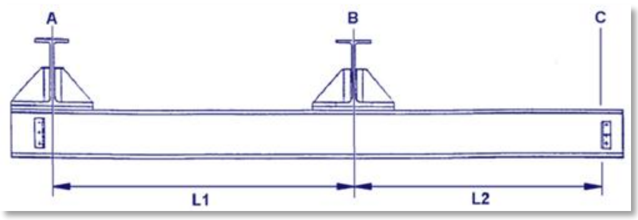


Figure 6

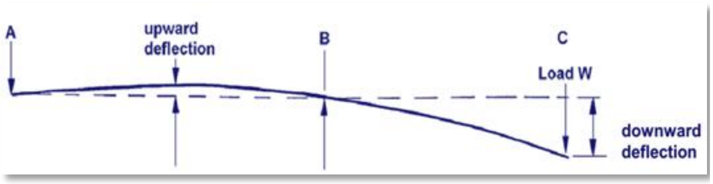


Figure 7

Notes:

7. RUNWAY BEAM FIXINGS – BOLTED CONNECTIONS

Bolted Connections

Bolts in Tension

Runways, when fixed to the underside of steel work, are normally bolted direct, clamped or fixed with special clips. Figure 1, below, shows a typical joint of a continuous runway under the support steelwork.

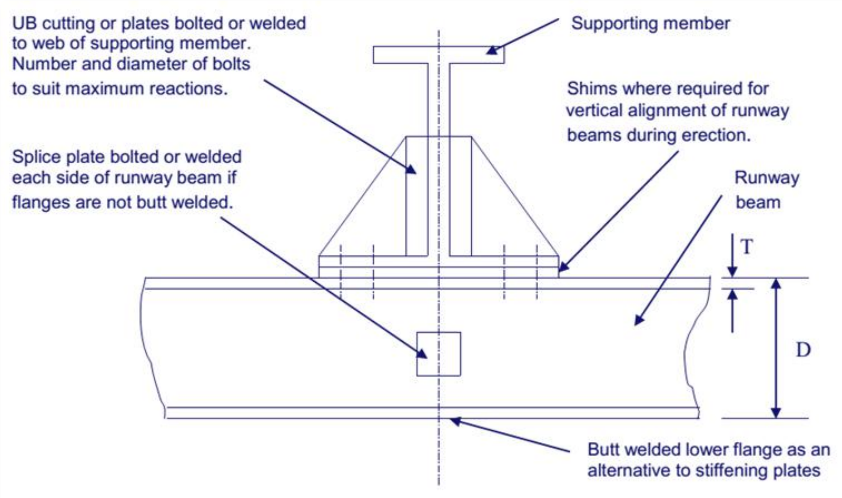
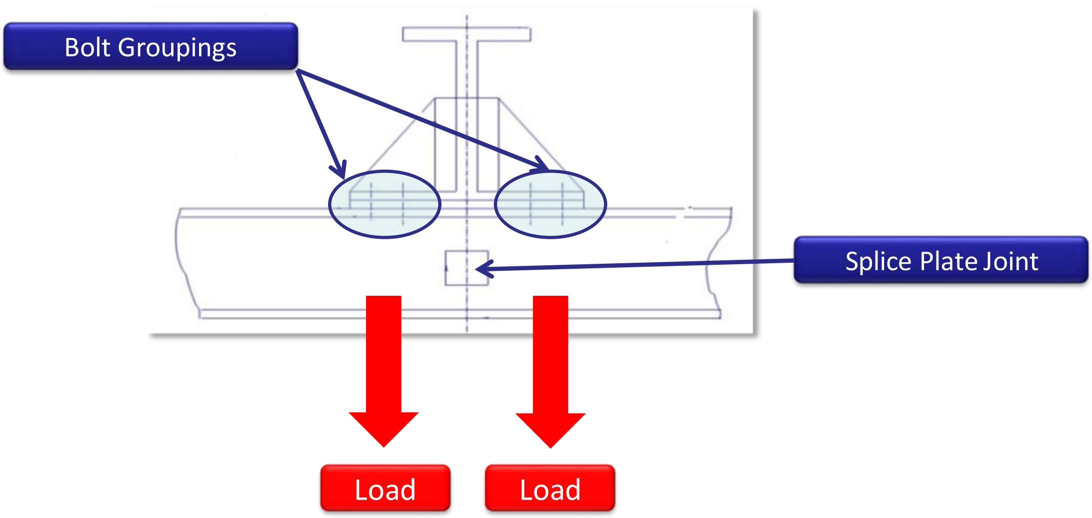


Figure 1 - Joint between a Continuous Runway and Under a Supporting Member

- When checking such a connection for strength, the bolt groupings would be taken as two groups of four bolts, assuming that no load is passed through the splice plate connection

- When testing, the load would be placed just to each side of the joint line which would place the maximum load on each bolt group



Bolts Not in Direct Tension

Some manufacturers tend to use clamp plate connections (see Figure 2).

With this type of connection the load on the bolts will be greater than a direct connection as in Figure 1 because of the leverage induced. The amount of this increase will depend on the design of these connections.

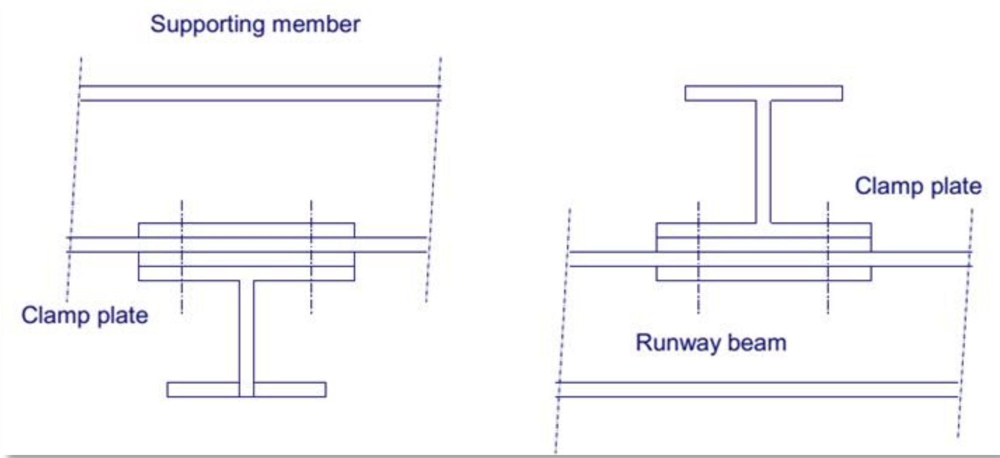


Figure 2 - Bolted Clamp Plate Connection

Notes:

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Girder Clamping Systems

One of the most popular methods for connecting beams is a Girder Clamping system, which can be used for any size and type of beam as well as for any possible arrangement. When correctly installed, the clamping systems offer a quick and effective way of connecting steel sections, as it is not necessary to drill holes in, or weld to, either of the beams.

Girder clamp connections should always be checked against the recommendations contained within the manufacturer's catalogue. Figure 3 below illustrates a typical girder clamp assembly:

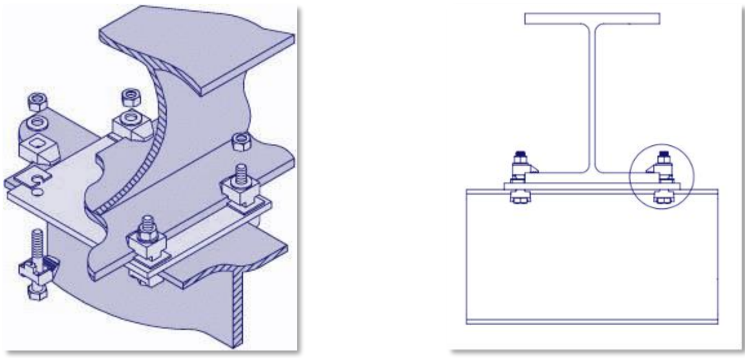


Figure 3 - Girder to Girder Assembly

- Girder Clamp connections are designed to secure steel sections and resist tensile loading. They feature a pre-drilled location plate that is placed between the beams to locate the bolts. Each bolt has two components to clamp the flange immediately above and below the plate. For thick beams, a packing piece is required to raise the height of the clamps to enable the product to sit correctly on the beam

- The diameter of the clamping bolts is chosen by ensuring the safe working load of the girder clamp assembly is in excess of the carrying capacity of the runway installation

- The assemblies for structural steel are recommended for use with grade 8.8 bolts to BS EN 14399 or BS EN 15048 and should include hardened washers

- Loadings for individual components are contained within the manufacturer's data sheets, as are the recommended tightening torques for each diameter of bolt

In most girder clamp configurations there are two types used. The type A (Figure 4) has a recess which is dimensioned to suit the hexagon head of a standard metric bolt.

The type B (Figure 5) is identical with the exception of having a flat top which enables the nut to be rotated, tightening the whole assembly.

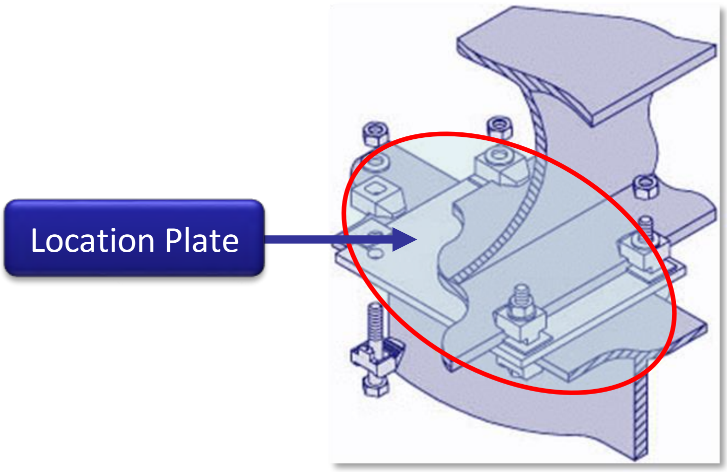
Other types are available for special applications, details of which are given in the manufacturer's catalogue.

Figure 4

Figure 5

A vital part of a girder clamp assembly is the location plate and it is essential that it is included within the overall assembly. Although the location plate is not used structurally, the loadings on the adapter in a girder clamp configuration pass along the centre line of the bolt and do not exert a bearing load on the edges of the hole or a shear stress on the bolt shank; it must be of the correct form.

Details of the minimum length, width and thickness for the location plate are determined by the manufacturer of the girder clamp assembly. These dimensions vary depending on the diameter of the bolt which is to be used and reference must be made to the manufacturer's data to ensure correct sizes are achieved.



It is also important that the assembly fits correctly onto the steel beam. To ensure that it does, the types A and B are available in different tail lengths. These tail lengths enable the girder fixing to sit squarely up against the edge of the beam flange. To ensure a correct fit, a series of packings are available which effectively lengthen this tail so that it can be fastened to any thickness of beam.

When working out these tail lengths and packing combinations (where necessary), it is very important that the beam thickness is measured correctly; at the very edge of the flange (see Figure 6). The manufacturer's data sheets should be referred to for correct tail length and packing combinations.

Figure 6

Figure 7 shows a typical connection for either parallel or tapered flanges.
Figure 8 shows a typical connection assembly.

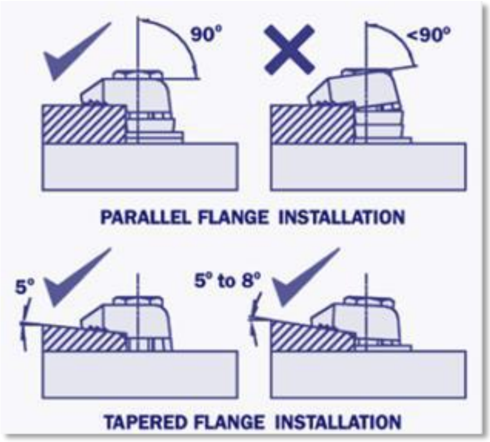


Figure 7

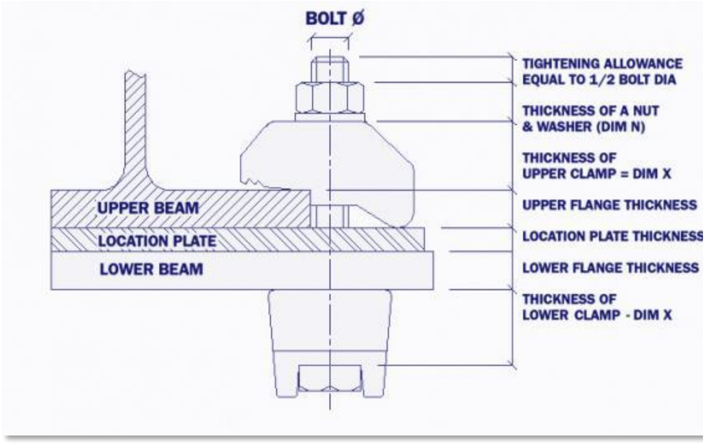


Figure 8

Notes:

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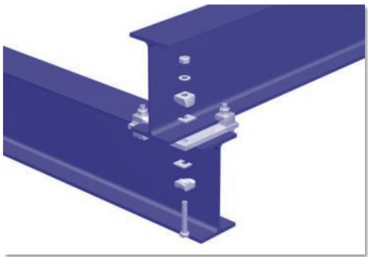
Advantages of Girder Clamping Systems

Girder clamping systems offer many advantages over standard bolted connections:

- No need to drill or weld on site
- Reduction in on site labour costs
- No requirement for special tools
- No hot work permits required
- Preserves structural integrity of steelwork
- Integrity of existing steelwork coating remains unchanged
- Provides flexibility for on-site tolerances
- Can easily be reconfigured in a different location



Bolted Connections in Shear

If a runway is set in between support steel work as in Figure 9, then the bolts would be in single shear.

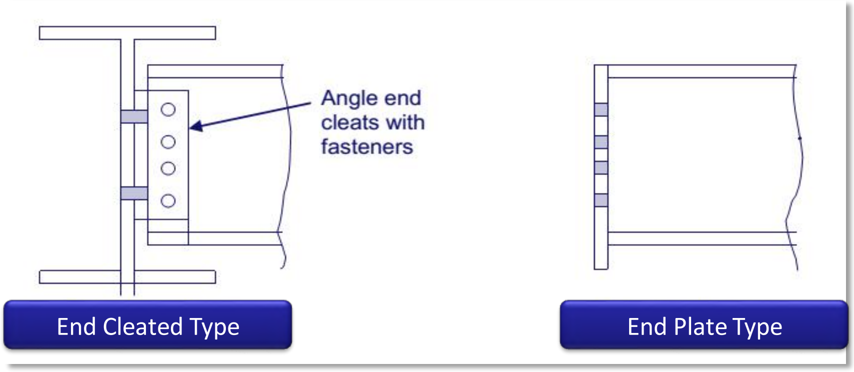


Figure 9

When a bolt is used in a shear connection as shown in Figure 10, the effect is two fold:

1. The force tries to shear the bolts in two
2. The forces try to crush the material being joined

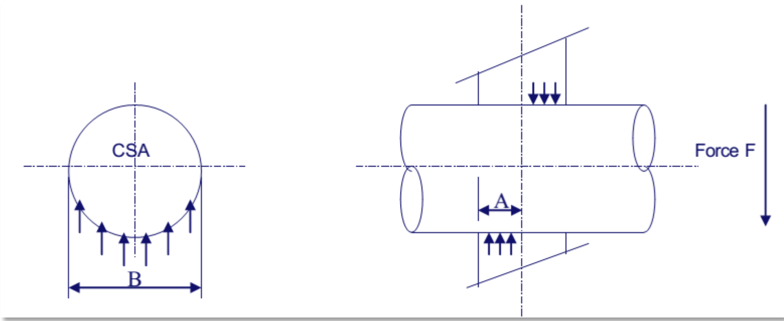


Figure 10 - Bolt in Shear

When subjected to a force F the shear stress on the bolt is:
(CSA stands for Cross Sectional Area)

$$\frac{Force\ F}{Bolt\ Area} = \frac{F}{CSA}$$

On each side of the shear line the bolt and steelwork is subjected to a crushing pressure or compressive stress:

$$Compressive\ Stress = \frac{Force\ F}{A \times B} = \frac{F}{Projected\ Area\ or\ Bearing\ Area}$$

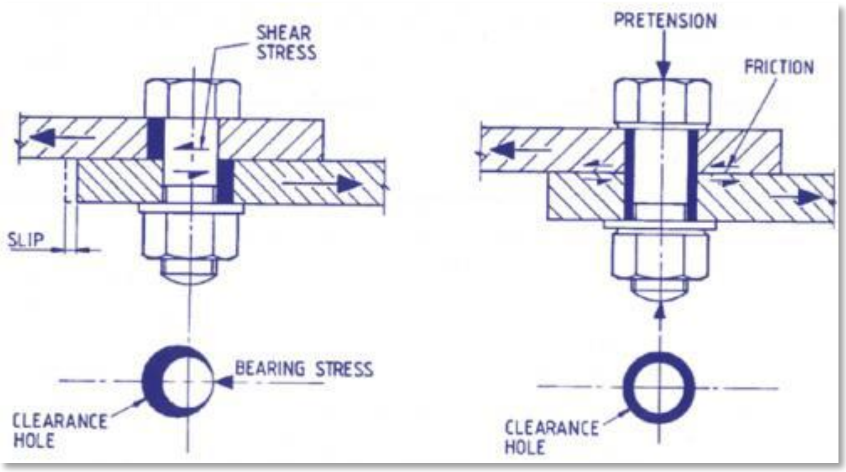
Whether the shearing value or the bearing value in a shear connection is the criteria depends on the thickness of material the bolts pass through, the number of bolts used and whether they are in single or double shear.

Notes:

Friction Grip Bolts

The definition of a friction grip bolt is:

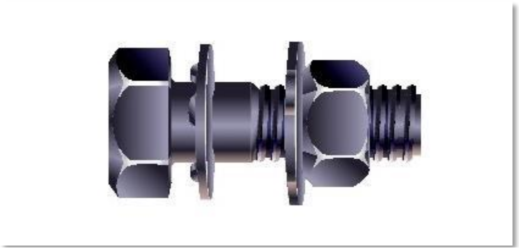
"A bolt of high tensile steel, used in conjunction with high strength nuts and hardened steel washers, which are tightened to a specified minimum shank tension so that transverse or axial loads or both can be transferred between the connected parts otherwise than by shear in, or bearing on, the bolts."



Normal Bolt

Friction Grip bolt

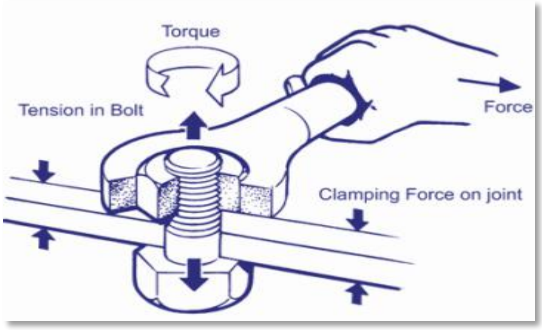
- Should the lifting equipment examiner come across this type of connection, and assuming the design of the connection is adequate, check that the assembly is correct
- Where plane parallel surfaces are involved, each bolt and nut assembly shall include one washer, placed under the bolt head or the nut, whichever is to be rotated during tightening



- The rotated bolt head or nut shall always be tightened against a surface normal to the bolt axis; this will require the use of an appropriate tapered washer where the surfaces are not parallel. Such a washer shall also be used under the non rotated components except where the angle between bolt axis and contact surface is within the limits of 87° and 93°. Tapered washers shall be correctly positioned

- No gasket or other flexible material shall be placed between the plies. Holes in parts to be joined shall be sufficiently well aligned to permit bolts to be freely inserted. Driving of bolts is not permitted. Nuts shall be so placed that their identification marks are clearly visible after tightening

- Bolts and nuts shall always be tightened in a staggered pattern and, where there are more than four bolts in a joint, from the middle of the joint outwards



- If after final tightening a bolt or nut is slackened off for any reason, the bolt nut and washer or washers shall be discarded and not re used

Notes:

8. WELDING OF STRUCTURAL STEEL

BS EN ISO 15609-1:2004 Specification and qualification of welding procedures for metallic materials. Welding procedure specification – arc welding.

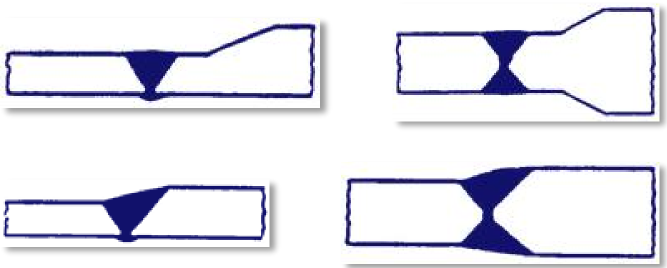
If a lifting equipment purchaser requires welds tested, the test would be in accordance with this standard.

The responsibility for the Tester and Examiner is normally limited to the visual examination of welds on site and perhaps a method of non-destructive testing (NDT), where deemed necessary.

Types of Welds

Butt Welds

Defined as a weld in which the metal lies substantially within the extension of the planes of the surfaces of the parts joined, or within the extension of the planes of the smaller of two parts of differing sizes.



Preparation

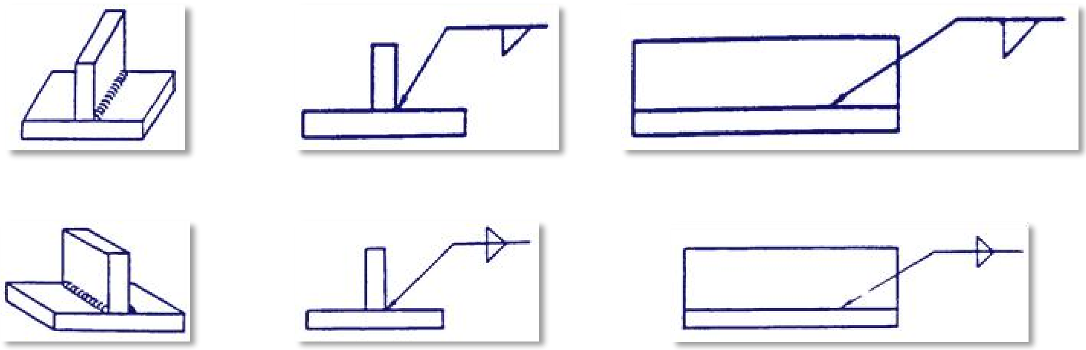
Butt welded joints between parts of unequal cross section, when subjected to repeating or alternating forces, should be tapered down to the thinner material.

When static loads only are being considered, this preparation may not be necessary and a general transition is produced by the placement of the weld metal.

Fillet Weld

A fillet weld is defined as any fusion weld approximately triangular in transverse cross section, which is not a butt weld, but including a weld at a corner joint.

Example fillet welds (1 and 2 sides):



There are many different weld preparations but the more general ones likely to be used in lifting equipment are shown in this module; the total range is specified in BS EN 22553.

Notes:

Visual Examination of Welds

Generally, the Tester and Examiner when on site would carry out visual inspections of welds paying particular attention to critical areas such as load bearing welds.

Grossly defective welds can usually be detected as a result of visual inspection alone.

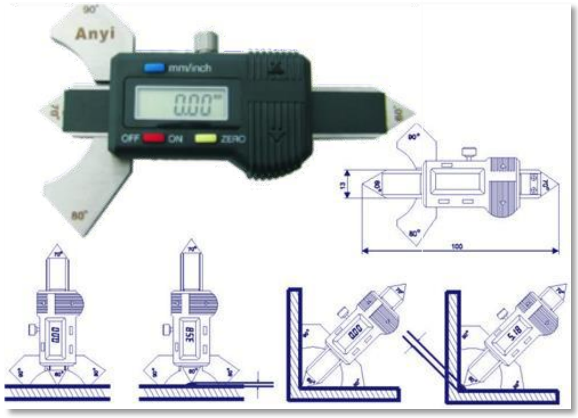
BS EN ISO 17637:2011 - Non-destructive testing of welds. Visual testing of fusion-welded joints, recommends the use of:

- Straight edge or measuring tape with a graduation of 1 mm or finer
- Vernier calliper in accordance with ISO 3599
- Feeler gauge with a sufficient number of feelers to measure dimensions between 0.1 mm and 3 mm in steps of 0.1 mm at most
- Radius gauge
- Magnifying lens with a magnification x2 to x5; the lens should preferably have a scale, see ISO 3058
- Lamps

The following items may also be extremely useful for visual examination:

- Profile measuring
- Material for impression of welds, e.g. cold setting plastic or clay
- For visual inspection of welds with limited accessibility, mirrors, endoscopes, boroscopes, fibre optics or TV-cameras may be used
- Other measurement e.g. specifically designed welding gauges, height or depth gauges, rulers or protractors

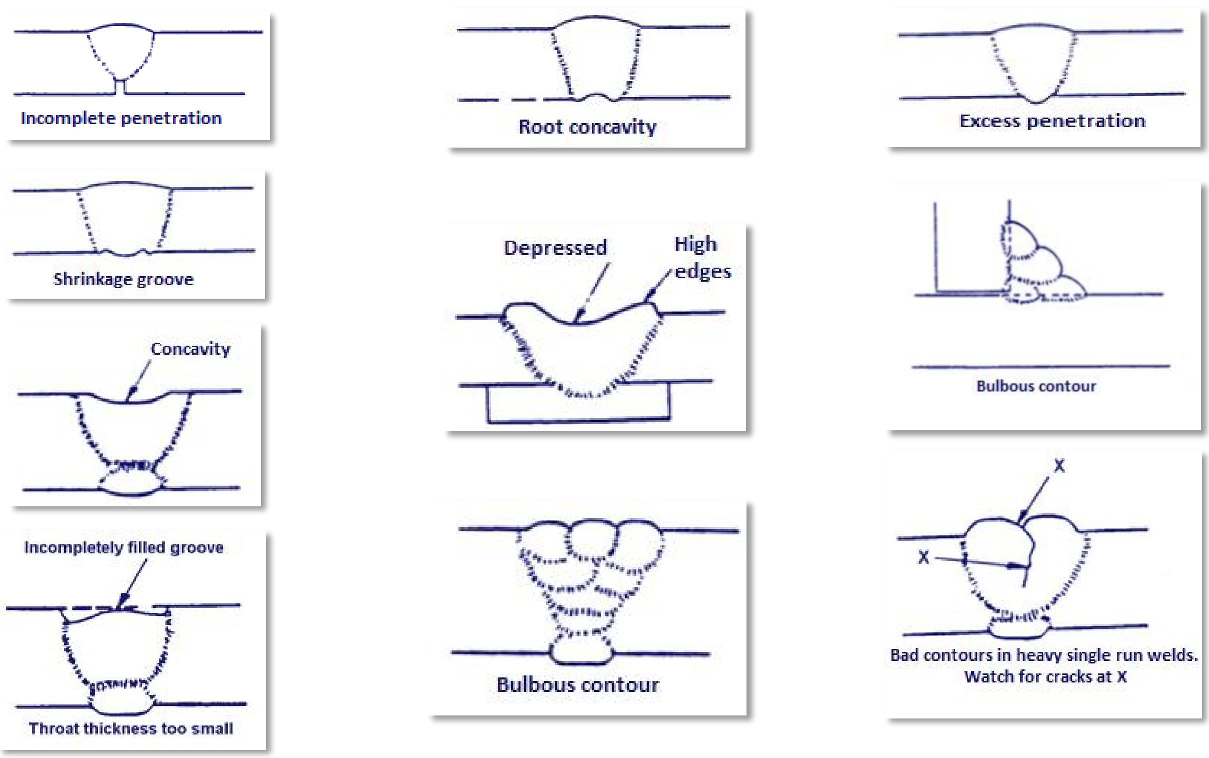
These gauges are ideal for checking angles and leg length of welds.

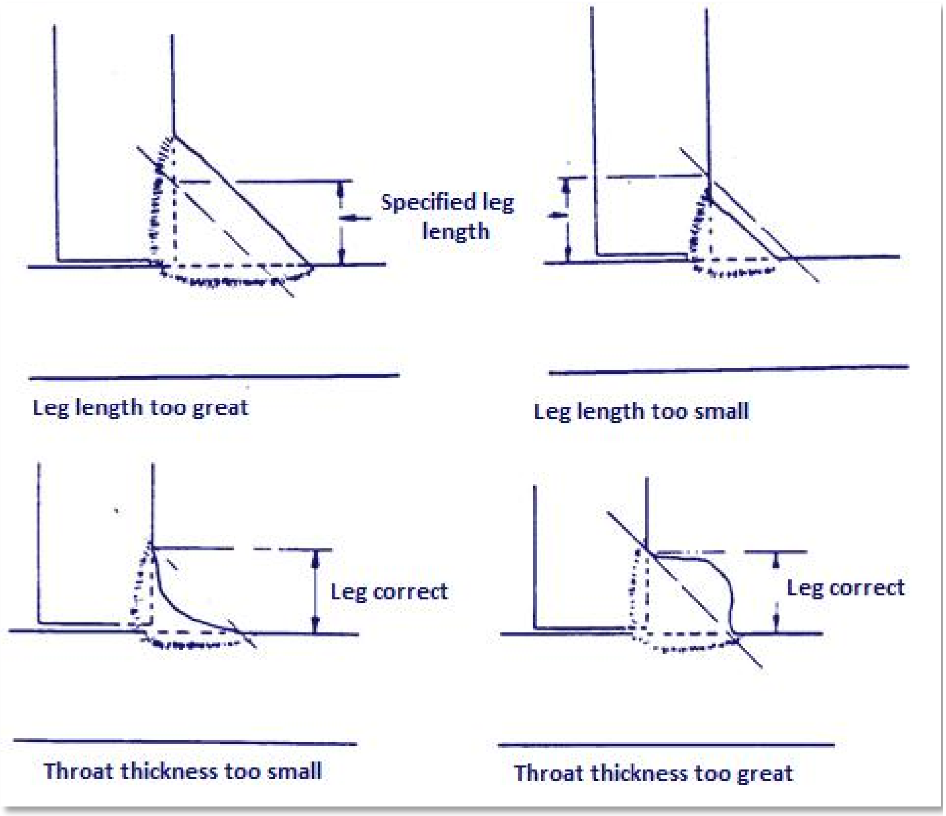


Notes:

Visual Weld Checks

Here are some examples of common weld faults:

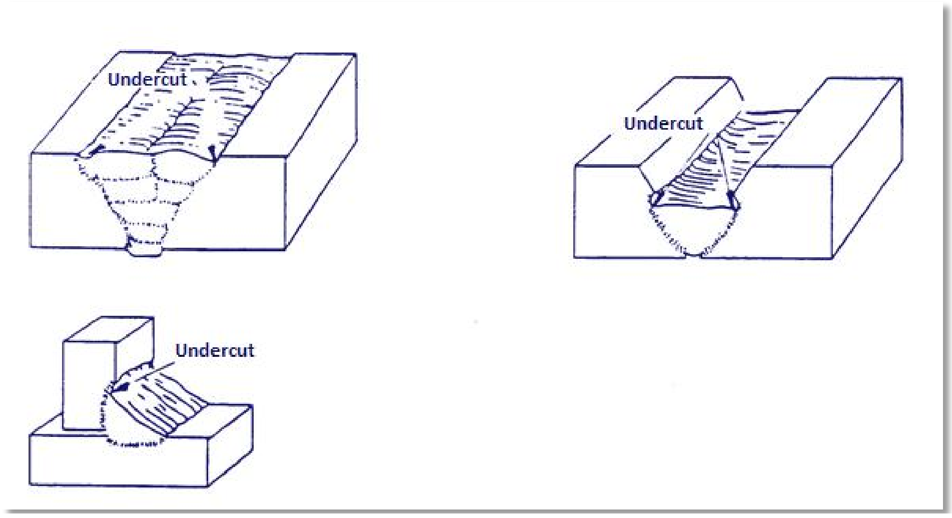




Notes:

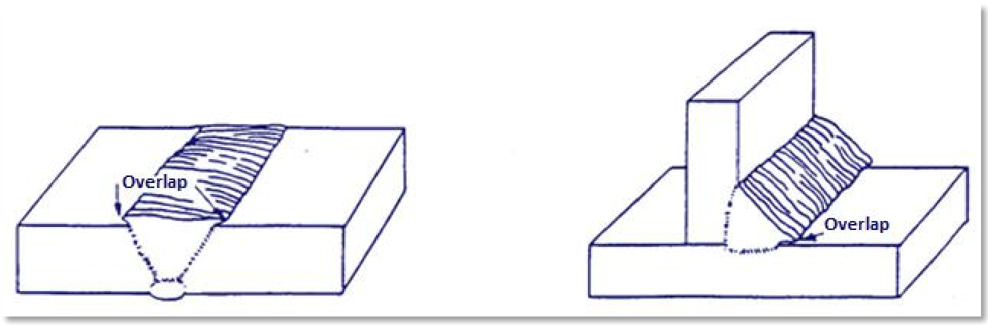
Undercut

Undercutting occurs when the base metal at the toe of the weld is burnt away. It may be caused by current adjustment that is too high, arc gap that is too long or failing to fill the crater completely with the weld metal.



Overlap

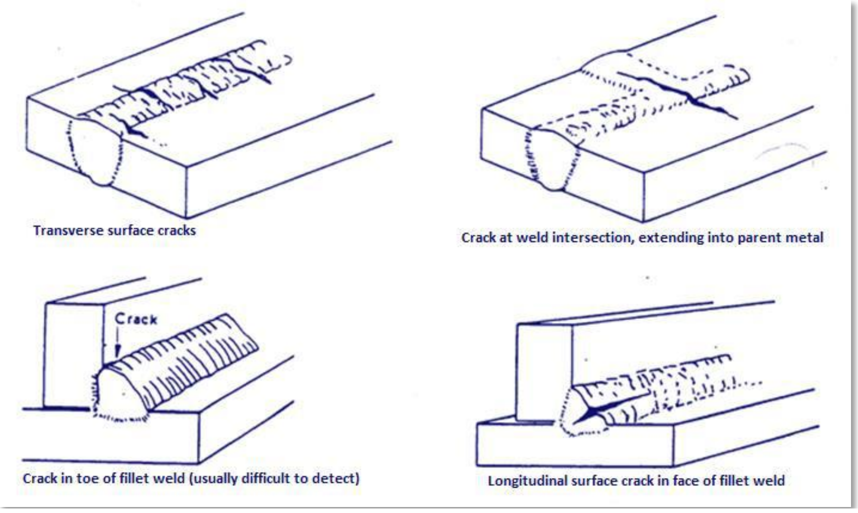
This is often caused by poor manipulation of the electrode or welding gun, especially when the weld pool is large and 'cold', where the welder allows gravity to influence the weld shape before solidification. Tightly adherent oxides or scale on the metal surface can also prevent the weld metal fusing with the parent metal to cause the overlap imperfection.



Cracks

Cracks are caused due to issues with temperature/cooling, poor application or joint decision and/or contaminants from the atmosphere, base material or filler material. They may occur within the weld material itself or originate in the base metal. The cause of the crack can be determined by the location, type and direction of the crack.

Notes:



NDT Testing of Welds

Non-destructive testing of welds is normally a part of the weld procedure and is usually a requirement of the purchaser.

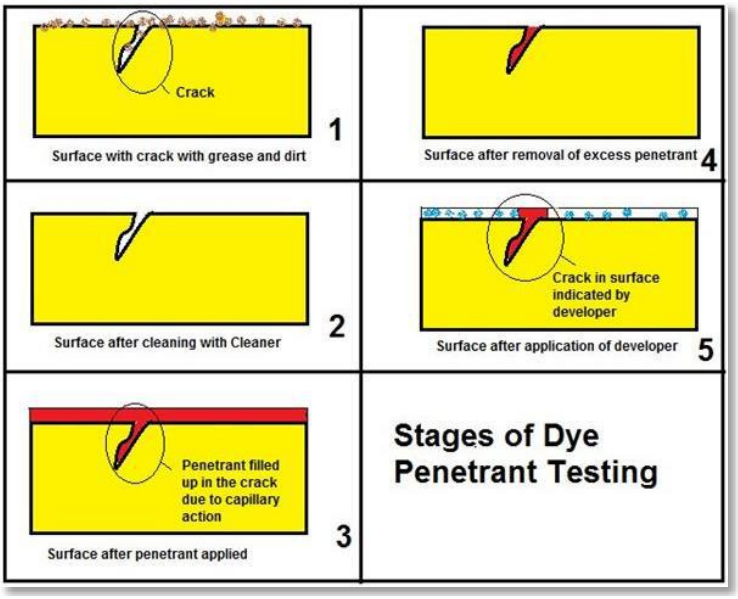
In any case, it is good practice to use some form of NDT, the extent of which would depend on the sensitivity of the weld.

General types of material flaws:

- Surface flaw visible to the naked eye or with low power magnification, e.g. cracks, imperfections, cavities, seams
- Surface flaws not readily observable, e.g. hairline cracks, seams
- Internal flaws, e.g. laminations, inclusions, defects introduced during manufacture such as welding, i.e. porosity, gaseous defects, lack of fusion, slag inclusion

Liquid / Dye Penetrant testing (PT)

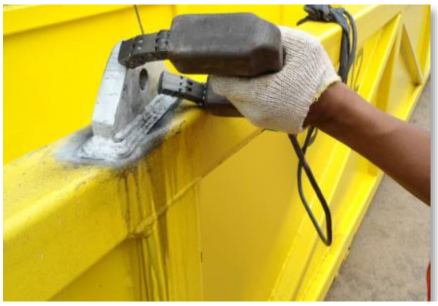
Penetrant testing locates surface-breaking discontinuities by covering the item with a penetrating liquid drawn into the discontinuity by capillary action. After removal of excess penetrant, the indication is made visible by application of a developer (colour contrast or fluorescent).

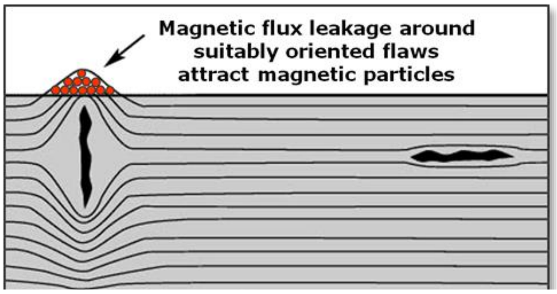


Magnetic Particle Inspection

Magnetic particle inspection (MPI) is used to locate surface and slightly sub-surface discontinuities in ferromagnetic materials by introducing a magnetic flux into the material.

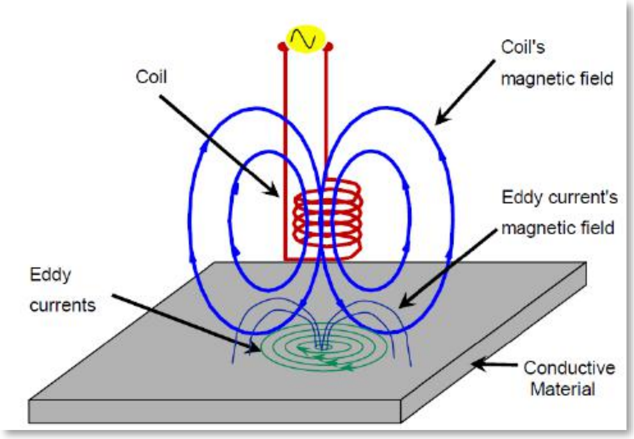
- White background lacquer is applied to the area to be inspected
- Items are magnetized and then sprayed with a solution of suspended iron filings
- Cracks or imperfections near the surface will distort the magnetic field
- Will attract the iron filings revealing the flaw by an accumulation of particles along the line of the crack
- Sub-surface defects by an accumulation in the area over the fault

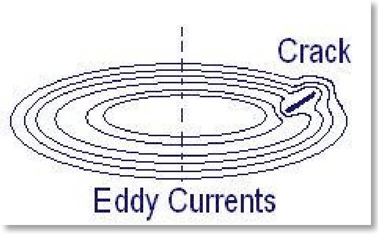




Eddy Current Inspection

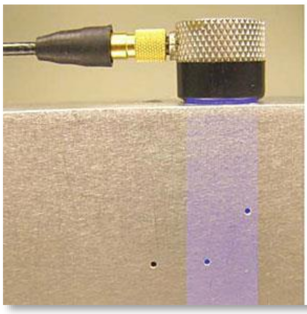
Eddy current inspection is based on inducing electrical currents in the material being inspected and observing the interaction between those currents and the material. Eddy currents generated by coils in the test probe are monitored by measuring the coils electrical impedance. As it is an electromagnetic induction process, direct electrical contact with the sample is not required; but the material must be an electrical conductor.





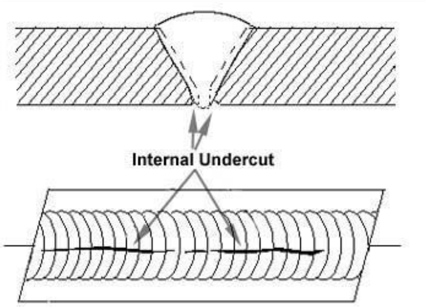
Ultrasonic Testing

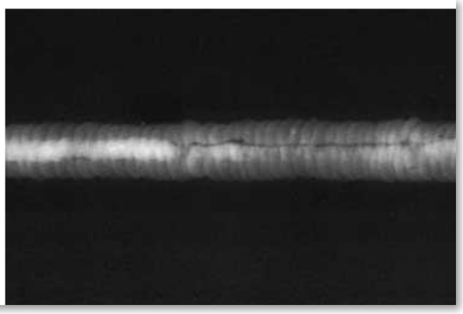
Ultrasonic testing (UT) measures the time for high frequency (0.5-50MHz) pulses of ultrasound to travel through the inspection material. If a discontinuity is present, the ultrasound returns to the probe in a period other than would be expected of a fault free specimen.



Radiography

Radiography testing (RT) monitors the varying transmission of ionising radiation through a material with the aid of photographic film or fluorescent screens to detect changes in density and thickness. It will locate internal and surface-breaking defects. As shown on the weld defect below, this would have been impossible to detect with a surface only method of NDT.





Notes:

9. SITE TESTING AND EXAMINATION

- Certain duties are imposed on persons at work to safeguard the safety of themselves and of others who may be affected by their actions, errors and omissions

- It is important to adopt safe systems of work and to ensure that the equipment is tested and examined in the correct and proper manner

- For new equipment, not within the scope of the Supply of Machinery Safety Regulations 2008, such as supporting structures or chain components, the manufacturer must issue a manufacturer's certificate and carry out a thorough examination to permit the item to enter service
    - Otherwise, an EC Declaration of Conformity would be required, then following installation a thorough examination would also be required

- It is not uncommon for the user to manufacture and install their own runway or have it designed and installed by a steel fabricator

- In this case the user acts as the manufacturer and needs the record of the test results so that they can be placed in the technical file. This is part of the necessary information needed to issue the manufacturers certificate

- Before the runway can enter service, LOLER requires the user to have the installation thoroughly examined to ensure that it is correctly installed and safe to operate

- The documentation issued will depend on the particular circumstances. For example:

If the test has been made for a **sub-contractor,** the testing organisation will only issue a report of the test, without coming to a conclusion as to the fitness for purpose; that would be for the manufacturer to determine.

If the test has been made for the **user,** the testing organisation would issue a report of thorough examination, which includes details of the test, in accordance with LOLER.

Notes:

Site Testing and Certification

Re-certification of an existing installation e.g. following a repair or modification:

- The law only requires the user to have a current examination report
    - The law also says that, in conducting an examination, the Competent Person will carry out any tests he may deem necessary in reaching his conclusion as to the fitness of the item

- Proof testing followed by a thorough examination is the accepted method of verifying most lifting equipment in the UK
    - The results of the test are then recorded on the report of thorough examination

Site Testing and Examination

Changes to legislation have meant:

- Removal from the regulations of any guidance as to the requirements for testing or for specifically recording the results of the tests
- The tester and examiner must therefore look elsewhere for guidance. They should refer to standards and Codes of Practice
- Relevant LEEA guidance is published in the Code of Practice for the Safe Use of Lifting Equipment (COPSULE), edition 8 (2014), section 11

Standards

- The current standards relevant to the design of runways are:
  - BS EN 1990: Eurocode 0 – Basis of Structural Design
  - BS EN 1991-1-1: Eurocode 1 – Actions on Structures - General Actions
  - BS EN 1991-3: Eurocode 1 – Actions on Structures - Actions Induced by Cranes and Machinery
  - BS EN 1993-1-1: – Design of Steel Structures - General Rules
  - BS EN 1993-6: Eurocode 3 – Design of steel structures - Crane supporting structures
- Prior to those standards the relevant standards were BS 2853 - The design and testing of steel overhead runway beams and BS 449 - The use of structural steel in building
- Because of the new Eurocodes covering design, BS 2853 is being revised to deal only with testing and examination of runways

Notes:

Access Runways (BS 6037 and BS 5974)

- A form of runway is often fitted to high-rise buildings to allow access for external maintenance and window cleaning

- Access runways have been excluded from this Module

- Guidance on their design and safe use is given in BS 6037 - Code of practice for the planning, design, installation and use of permanently installed access equipment and BS 5974 – Code of practice for the planning, design, setting up and use of temporary suspended access equipment

- Manufacturer's instructions should also be followed at all times

Lift Shaft Lifting Beams

- Another variation of the runway is the lift shaft lifting beam. Although these beams are usually intended for use with a fixed point lifting arrangement, their design and testing requirements are to the same criteria as runway beams

- A runway only becomes an effective lifting appliance when fitted with a trolley and block or similar lifting appliance which may be either manually or power operated

- For power operation on long systems, electric hoists are usually fitted due to the difficulties of providing compressed air over large distances

Notes:

LEEA Requirements for Site Safety

Safety whilst carrying out Site Examinations and Tests:

- Anchorages and Suspension Points
- Risk Assessment or JSA
- Lock-Out/Tag-Out
- Site Reporting
- Statutory Requirements
- Test Area Suitability

LEEA Requirements for Site Examination of Runway Beams

- Markings
- Competent Person
- Reason for Examination?
- Adequate Light
- Written Report
- Appliances Fitted?
- Last Thorough Examination Report
- Components of the Runway?

Notes:

New Installations

Site testing to BS 2853:2011

Extracts from BS 2853
Testing and Inspection

1. Duty of Certifier
The person signing the certificate specified in section 10.1 of the standard (**Note:** 10.1 refers to the report of thorough examination) shall satisfy themselves that the deflections specified in Clause 6 are not exceeded and that all other requirements of this British Standard are conformed to.

Note: The prime duty of the certifier is to test the actual runway; nevertheless, they should satisfy themselves that the supports and structures are sound and suitable for all loads which they are called upon to take.

2. Accuracy of the Loads
The loads shall be measured by a load cell calibrated to BS EN ISO 7500-1, such that the sum of the inaccuracies of the load and the load cell do not exceed ±2%.

Note: The load referred to includes the test frame, chain slings, tackle, etc. and the load cell if used on the actual test.

3. Amount of the Proof Load
The proof load applied shall be the weight of the appropriate heaviest lifting appliance supported by the runway plus **125%** of the safe working load of this appliance.

Where the runway supports more than one transporting or lifting appliance, due allowance shall be made for the permissible proximity of any other appliance or appliances supported by the runway.

4. Inspection Before Application of Loads
All joints, connections and supports shall be carefully inspected, and special attention shall be paid to the security of nuts on bolts. Attention shall be paid to the condition of walls surrounding and adjacent to the end fastening of runways fixed therein.

Where the runway beam is carried on timber supports (which in many cases might be roof trusses), it shall be the responsibility of the owner to satisfy the tester that the members are suitable for the load to be carried.

Note: It is recommended that, where reinforced concrete beams are used for the suspension of runways, the beams should be coated with whitewash or similar, to reveal any cracks that develop under the proof load.

5. Application of Loads
Once the preliminary inspection has been carried out as specified in 4, a test load equivalent to the maximum safe working load, together with the weight of the heaviest transporting or lifting appliance supported by the runway, shall be applied and traversed along the whole length of the runway. The load shall be halted at appropriate positions during its passage along the runway and kept at rest while stable

deflection readings are recorded at these positions and at the corresponding support points so that net values can be determined.

For straight, simply supported runways, the net deflection shall be determined at mid-span and at cantilever ends. In other cases, sufficient readings shall be taken to ensure that the maximum net deflection has been obtained.

The procedure outlined above shall then be repeated except that:

- Instead of the test load referred to in the first paragraph, the proof load (See 3) shall be applied
- The stable net deflection shall be recorded only at that position where the maximum reading was obtained during the application of the test load referred to in the first paragraph

6. Deflection Measuring Equipment

Deflection measuring equipment shall be capable of measuring the vertical deflection of the beam at any point within ±5% of the maximum permitted deflection of the beam.

7. Inspection and Thorough Examination

During the application of the test load referred to in 5 and of the proof load as specified in 5 the runway shall be kept under such visual observation as to ensure the ready detection of any obvious defect in the runway.

Following the application of the proof load as specified in 5 the runway shall be thoroughly examined in order to ascertain, for the purposes of Clause 10, that the runway has withstood the proof load without damage or permanent deformation.

Note: For the purpose of this sub clause, thorough examination means a careful visual examination, supplemented, where relevant, by other tests including non-destructive testing of critical welds and checking the tightness of pre-Loaded bolts, in order to arrive at a reliable conclusion as to the safety of the runway.

If dismantling is necessary for the purpose of examination, the load test and bolt tightening check shall be repeated after reassembly.

Note: Further statutory requirements are given in The Lifting Operations and Lifting Equipment Regulations 1998 [1].

Notes:

Marking

- The safe working load, identification number and any limiting conditions shall be plainly and permanently marked on the runway so as to be clearly visible to the operator

- The marking shall include either the maximum hoisting speed for a power hoist or else the words "Manual Hoist"

- The safe working load referred to above applies to the runway beam and its components only; it does not apply to a travelling trolley or lifting appliance operating on the runway beam. Hence, the actual load lifted, lowered, or transported in any particular instance, is not only governed by the safe working load of the runway beam, but also the safe working load of the trolley and lifting appliance used, and any other relevant factors, e.g. any limitation governing the operation of an adjacent trolley and lifting appliance

Report of Thorough Examination

Before any runway beam is taken into use the first time after erection, re-erection or having undergone any substantial alteration or repair, a Thorough Examination needs to be carried out to ensure the runway beam has been tested and subsequently thoroughly examined as required by clause 7.

The Report of Thorough Examination shall identify the runway beam to which it refers, quoting its distinguishing number or mark and grades of steel, its size and length, and state:

a) The date on which the proof load was applied and thorough examination made;
b) The position and magnitude of the deflections obtained during the traversing of the maximum safe working load and of the proof load
c) The maximum safe working load
d) That the runway beam conforms in all respects to this British Standard, i.e. BS 2853:2011

The Report of Thorough Examination, which shall be signed by the person making the test and examination, shall indicate clearly that it applies to the runway beam only and not to any trolley or lifting appliance travelling on it.

Note: Further statutory requirements are given in The Lifting Operations and Lifting Equipment Regulations 1998.

Notes:

REPORT OF THOROUGH EXAMINATION

This report complies with the requirements of the Lifting Operations and Lifting Equipment Regulations 1998

Date of Thorough Examination:		Date of Report:		Report number:			
Name and Address of employer for whom the thorough examination was made:			Address of premises at which the examination was made:				
Description and identification of the equipment:			Safe Working Load(s):	Date of manufacture if known:	Date of last thorough examination:		

Is this the first examination after installation or assembly at a new site or location?	YES		NO		Was the examination carried out:					
					Within an interval of 6 months?	YES		NO		
					Within an interval of 12 months?	YES		NO		

10. PURPOSE BUILT RUNWAYS

Special Track Sections

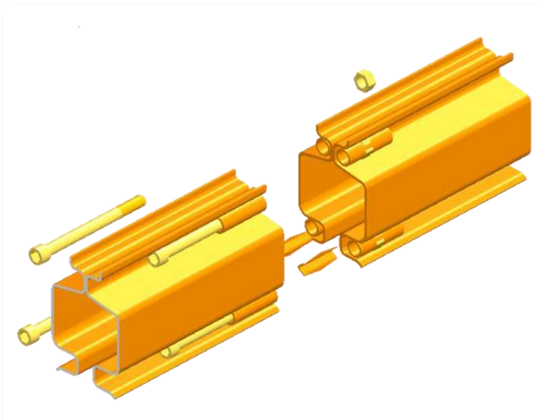
The previous module covered runways which are constructed from standard rolled steel sections, but runways may also be manufactured from special track sections.

The illustration below shows typical track profiles and support brackets for a special track system. These permit the runway to be suspended from suitable building members or free standing structures.

Track Connections

There are various methods of connecting the runway track profiles together. The illustrations below show an aluminium machined profile track connection and a standard steel profile track connection:

Aluminium Track Section Joint



Steel track Section Joint

Special Track Sections

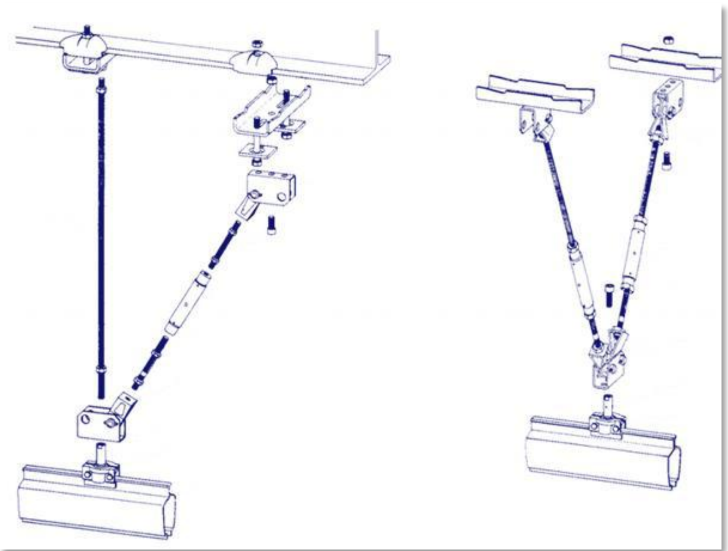
- Special track sections can typically meet the need to lift and transport relatively light loads of approximately 25kg up to 3.2 tonnes in some configurations

- Runway section made in a range of sizes may be cold rolled and welded or cold drawn

- They are based on 'C' or door track sections and there are numerous manufacturers

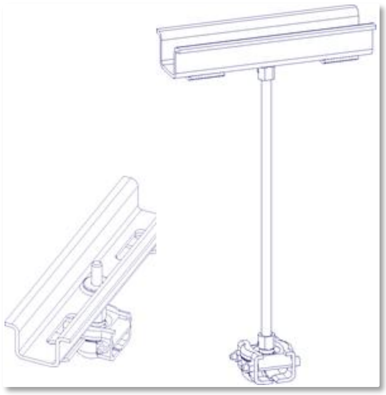
Track Suspensions

Special track systems, unlike the heavy duty type, often tend to be suspended. Suspension removes unnecessary stresses, not only on the track but in the supporting structure. The track is easily aligned using turn buckles in the suspension rods:

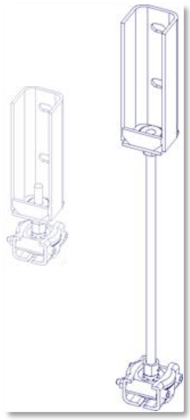


Various examples of suspension brackets are shown below:

UB/RSJ Suspension



Flat Ceiling Suspension



Bracket Suspension

Special Track Systems

- These systems can be simple runway installations or complicated systems complete with switches, power feeds etc., components are bolted or clamped.

- Extreme care should be taken when examining them to ensure that all joints are secure, sections have not moved in splice connections and stops are secure.

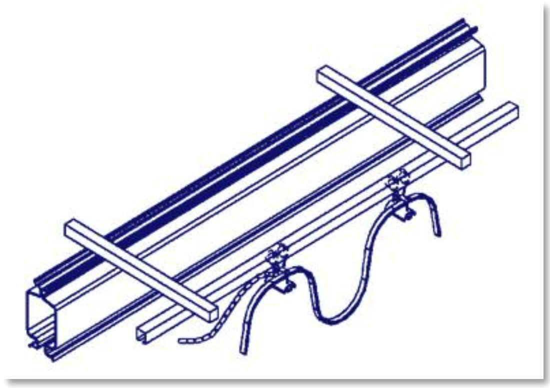
Suspension Trolleys

- Suspension trolleys are purpose built to suit the track with ball raced runners, generally sealed for life

- Suspension trolleys are usually manual, push travel operation or can be motor driven

- Motor driven trolleys can be powered via a flat-form cable festoon or from internal 4-bar conductors built into the track section

Internal Conductors

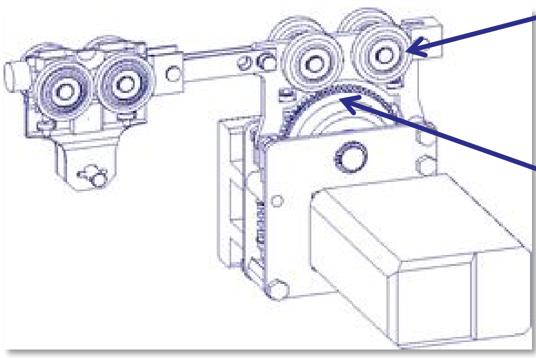


External Festoon System

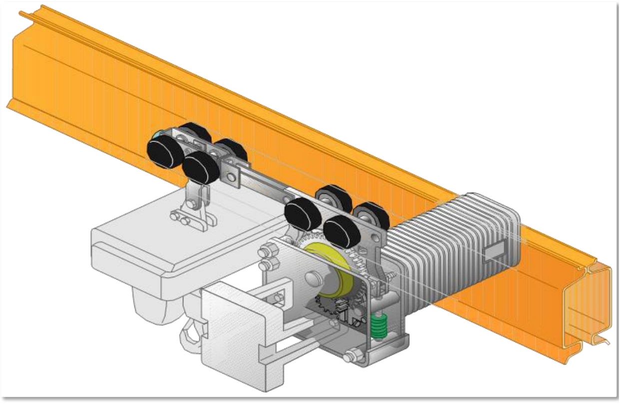
Notes:

Motor Driven Trolleys

The motor driven trolley uses traction to drive along the runway. The illustration below shows the drive arrangement:

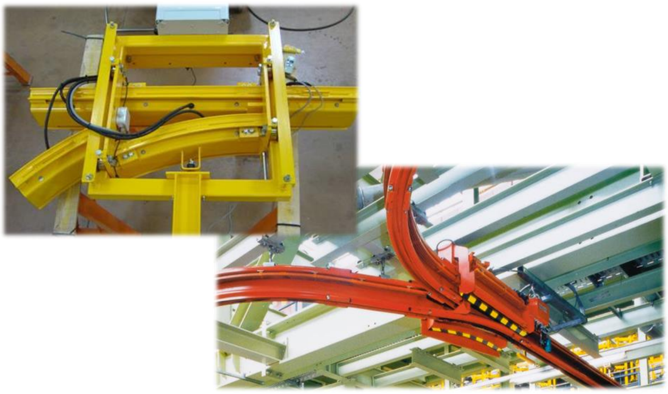


The tractor drive wheel is adjusted to press against the lower flange of the runway beam. When the motor is energised, drive is provided to this rubber traction wheel and it pushes the trolley along the beam.



Special Track Switch

The use of a runway switch, as shown in the illustration below, allows the lifting appliance to be diverted from one runway system to another adjacent system.



Special Track Turntable

Turntables allow the suspended hoist to change direction. Turntables can be manually or electrically driven to redirect the trolley onto a new section of track.

Special Track Sections

Advantages

- Easy installation
- Modular in design therefore easily interchangeable
- High strength to weight ratio
- Low maintenance
- Only minimal horizontal forces are transmitted to the support structure thanks to the articulated suspension system

Limitations

- Limited lifting capacity (In some configurations a maximum of 3.2t)
- Only relatively small cantilevers and spans are allowed
- Not normally used for outdoor applications or in aggressive atmospheres

Note: It is strongly recommended to obtain as much manufacturer's technical information as possible in order to be acquainted thoroughly with the product.

Notes:

11. CRANES AND COMPONENTS

This module looks at light crane systems that are manufactured from special track systems.

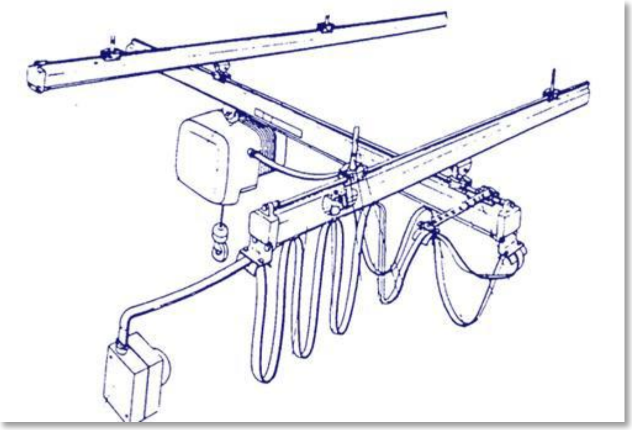
- The modular profile can be adapted to manufacture single and double girder overhead cranes, suspended from supporting structures

- The choice of crane construction depends upon the application, available dimensions and load requirements

There are numerous manufacturers of light suspended crane systems in the market using their own special profile of monorail track as the crane bridge and gantry:

- Produced in kit form, these systems are extremely versatile and light in weight, requiring the minimum of support steelwork

- The systems are not built to a British Standard but are designed and manufactured to a manufacturer's specification

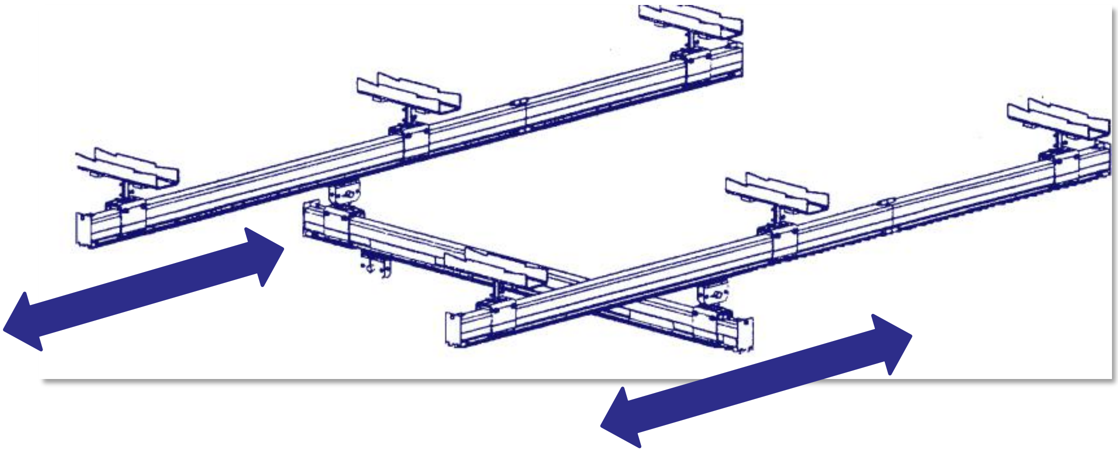


Notes:

Single Girder Construction

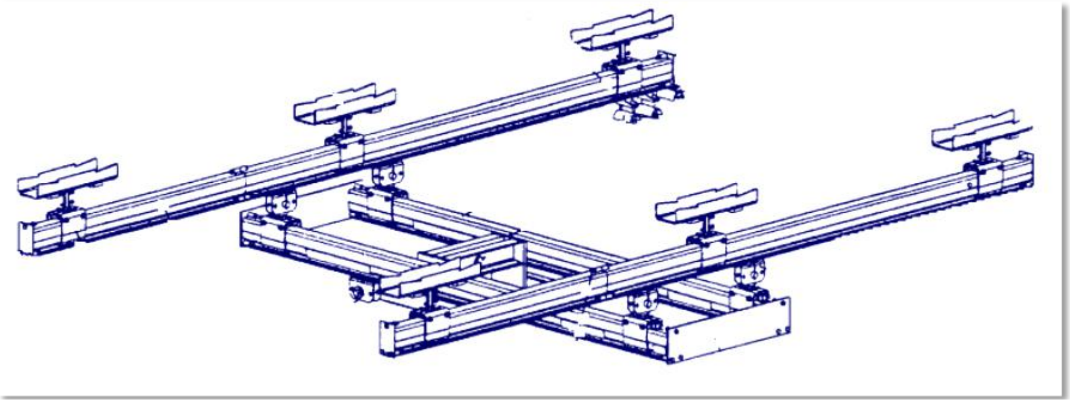
The single girder application is usually used for manually operated bridge motions and maximum bridge spans of 5 to 6 metres, depending on the manufacturer.

The illustration below shows how the crane bridge is connected to the runway using a totally articulated system. When pulled along, the crane bridge tends to snake or zig-zag along the track.



Double Girder Construction

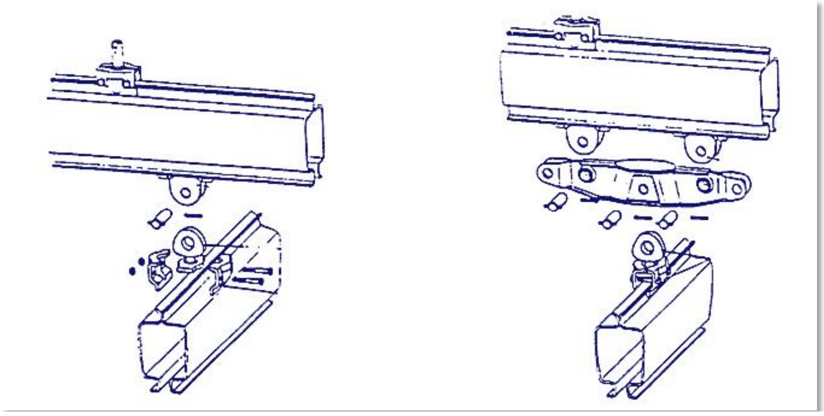
The double girder bridge construction allows for increased span capability and improved headroom.



End Carriage Connections

- The bridge girder will always swing in the plane of the load from the suspension eye which can also rotate in its housing

- The Tester and Examiner will be looking for all these points when examining, as for any other runway installation. However, care must be taken to ensure all components are correctly fitted in accordance with the manufacturer's instruction manual



Track Connections

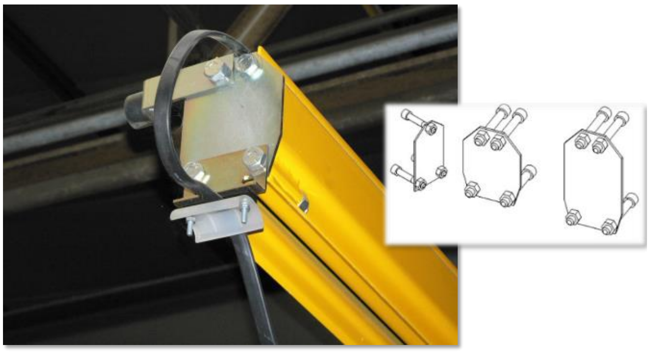
Tracks are normally bolted or clamped, special care must be taken to ensure all bolts and clamps are properly fitted.

Aluminium Track Joint

Steel Profile Track Joint

End Plates

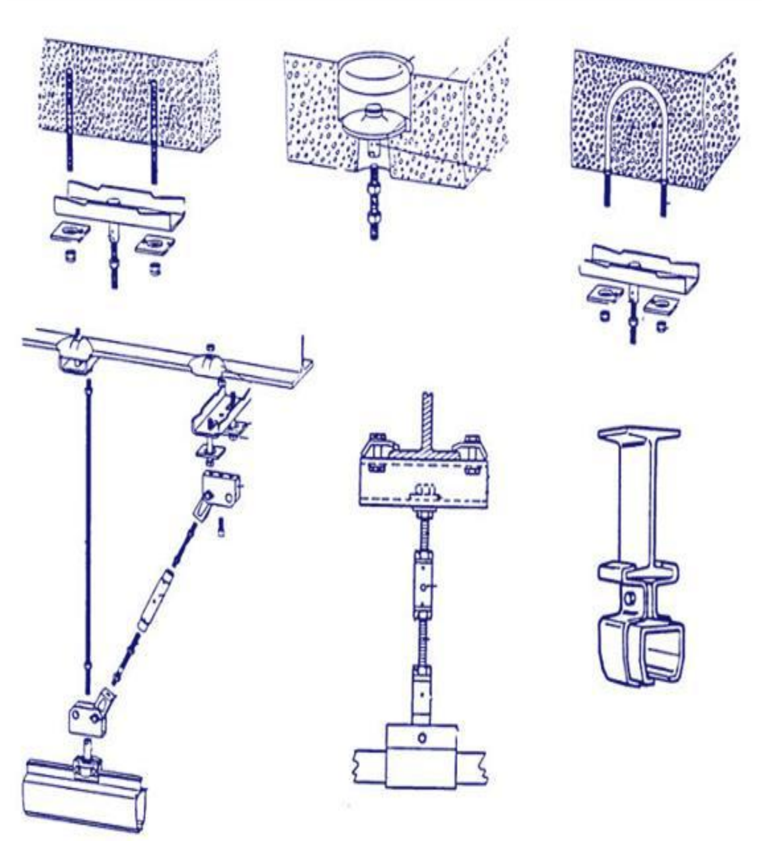
- End plates are fitted to the profile sections to prevent the trolley from over-travel
- Different sizes are available to suit different section sizes and they are normally fitted with a minimum of grade 8.8 bolts



Suspensions

Suspension points are part of the total installation and are therefore the responsibility of the Tester and Examiner to ensure they are adequate. Types and methods of suspension are many and varied and generally of particular manufacturer's design.

Where fixings are set into existing concrete, i.e. floors, or butted to existing steelwork the Tester and Examiner must satisfy himself that the fixings were properly designed and approved by an appropriate authority.



Notes:

12. BEAM CLAMPS

Beam clamps provide a ready means of attaching lifting appliances to suitable structural steelwork.

BS EN 13155: 2003 – Cranes – Safety – Non fixed load lifting attachments, is a Harmonised European standard and includes clamps of all kinds.

Previous to this, there was no British Standard dealing specifically with beam clamps and they were normally proprietary items which vary widely in design. It is not therefore possible to cover every variation and for certain designs, special precautions or instructions may apply. The manufacturer or supplier's instructions should always be sought and followed.

This section deals with the use of beam clamps intended as a means of suspending lifting appliances from suitable steel sections.

Types of Beam Clamp

An adjustable type beam clamp, as the name implies, is adjustable to fit beams of various size. Some, such as the type illustrated in Figure 1 are self adjusting whilst others, such as the type shown in Figure 2, require the operative to make the adjustment.

There are some designs which, while not adjustable, will nevertheless accommodate beams of various size and may therefore be conveniently placed in this class, e.g. Figure 3.

Depending on the design, adjustable clamps are only capable of adjustment within specific limits and are therefore manufactured in a series of size ranges.

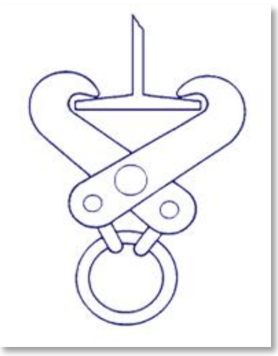


Figure 1

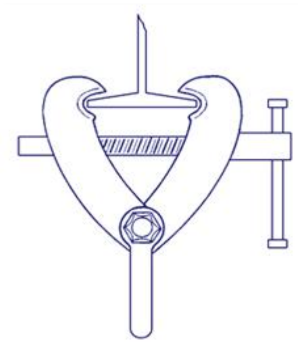


Figure 2

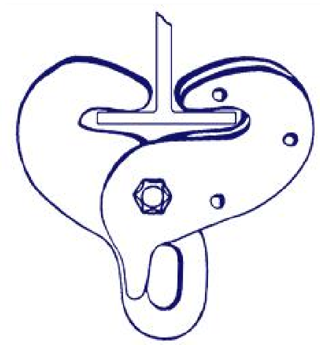


Figure 3

Beam Clamps

Line of Loading

Many designs of clamp are intended for ‘in line’ use only – i.e. the line of force must be at right angles to the beam flange to which it is attached (Figure 4)

It is therefore important to ensure that for ‘angled’ applications (Figure 5) a clamp of suitable design is selected.

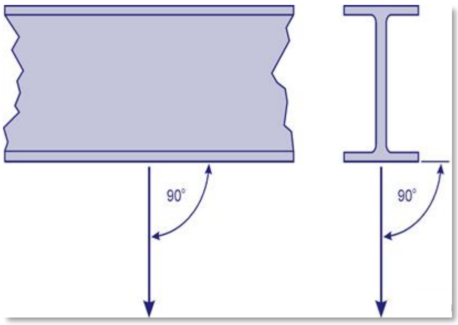


Figure 4

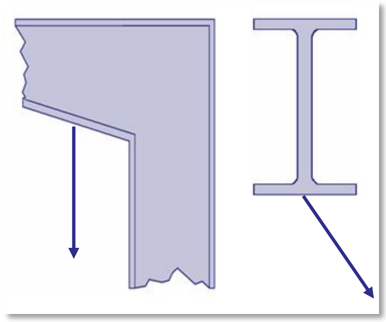
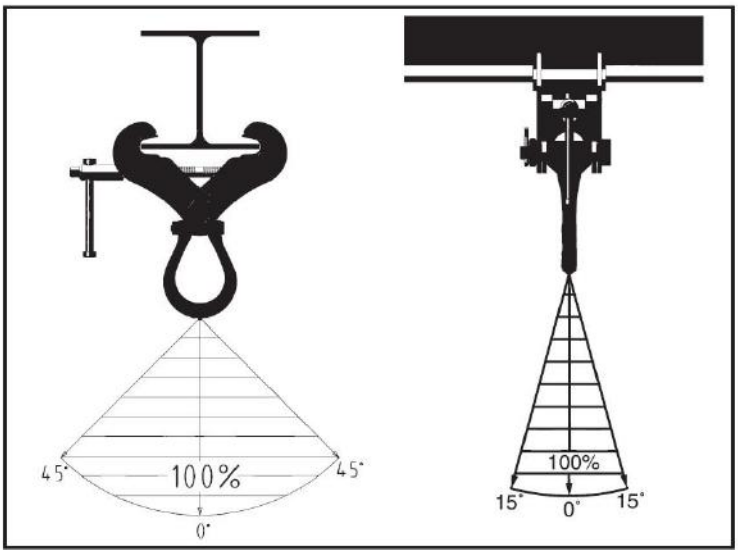


Figure 5

Example of permitted lifting angles (refer to manufacturer)



Notes:

Documentation

- When selecting a beam clamp, ensure that it is covered by the necessary documentation required by legislation (EC Declaration of Conformity or report of thorough examination as appropriate)

- If this is not on record refer the clamp to a Competent Person for thorough examination

Information which should be exchanged between the User and the Designer or Supplier

The minimum amount of information which should be exchanged between the user and the designer or supplier:

- Details of the beam to which the clamp is to be attached. These details must be sufficient to fully identify the particular rolled section or, in the case of a fabricated section, the various elements from which it is manufactured. This information is required to ensure that the clamp fits correctly onto the beam. Figure 6 indicates the information required

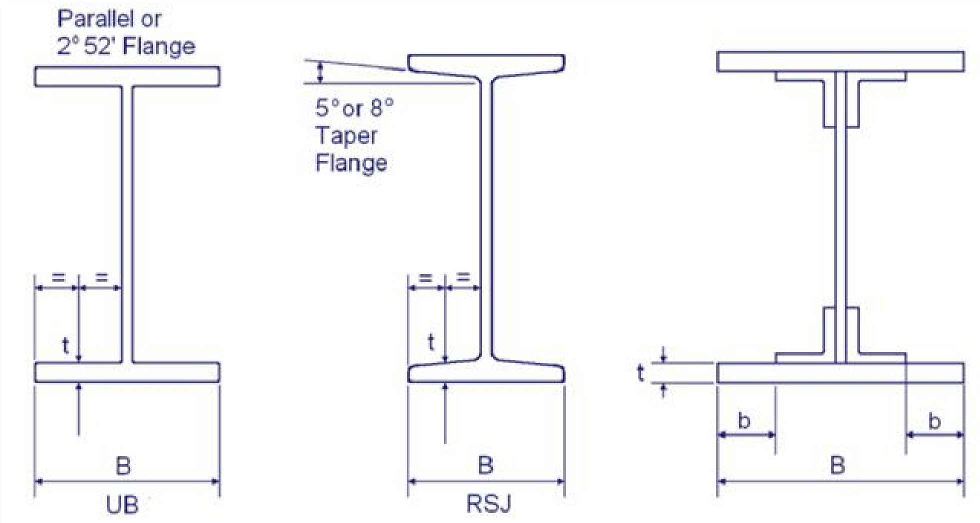


Figure 6

- The maximum weight of the load to be lifted including the weight of the hoist and any other tackle used, together with any other forces which may be superimposed on the load

- The intended application, including information on the angle and plane in which the load is to be applied, and whether the installation is to be temporary or permanent

- Environmental considerations, such as extremes of temperature or corrosive atmospheres

- The type of attachment point required (e.g. shackle, ring, etc.) or dimensions of the equipment which is to be attached to the beam clamp

Note: Although not required by legislation, new beam clamps will usually be issued with a manufacturer's record of proof load testing in addition to, although possibly combined with, the EC Declaration of

Conformity. This document forms an important part of the record of the clamp. It should be retained and cross referenced to the clamp's historical records for inspection by the Competent Person or HSE.

Notes:

Pre Use Inspection / Thorough Examination

- The degree of pre-use inspection or thorough examination required will, to some degree, depend on the type of clamp used and the installation conditions. Some types of clamp are designed and intended for temporary installation by the user to a suitable beam, e.g. in maintenance applications
    - It is the user's responsibility to ensure the adequacy and suitability of the beam. It will usually be sufficient for a Responsible Person to inspect the installation prior to use to ensure it is correctly fitted.
    - Other types of clamp are designed and intended for more permanent installations, often requiring an amount of dismantling and reassembly, which may call for a higher degree of examination to be made by a Competent Person

- Where the Competent Person deems a proof test is necessary as a part of his thorough examination, the test load applied will be governed by the limitations of the overall installation, the test load for which may differ from that of the clamp
    - The proof load for beam clamps will usually be twice the WLL, unless the manufacturer's instructions state otherwise

Marking Requirements

Each beam clamp should be permanently and legibly marked with the following information:

- Identification mark
- Safe working load
- Width of beam for which the clamp is designed or, in the case of an adjustable clamp, the range of widths and the section of beam if applicable
- Toe thickness of beam if applicable

The marking should be either by means of a suitable metal tab permanently attached or by stamping, provided that no mechanical property of the clamp is significantly impaired.

Storage and Handling

All beam clamps (other than those fixed permanently in position) should be returned to safe storage after use. The storage area should be dry, free from dangerous pollution and extremes of temperature, together with the following:

- Equipment returned to storage should be checked by a Responsible Person to ensure that it is in good order and that all parts of a clamp are present. It is particularly important in the case of clamps which require dismantling for erection or adjustment to ensure that all the individual parts are the correct ones and that substitutions have not been made

- When being handled, clamps should not be dropped or thrown down. Any fasteners used to assemble the clamp should be reassembled immediately after the removal of a clamp from the beam

In Service Inspection

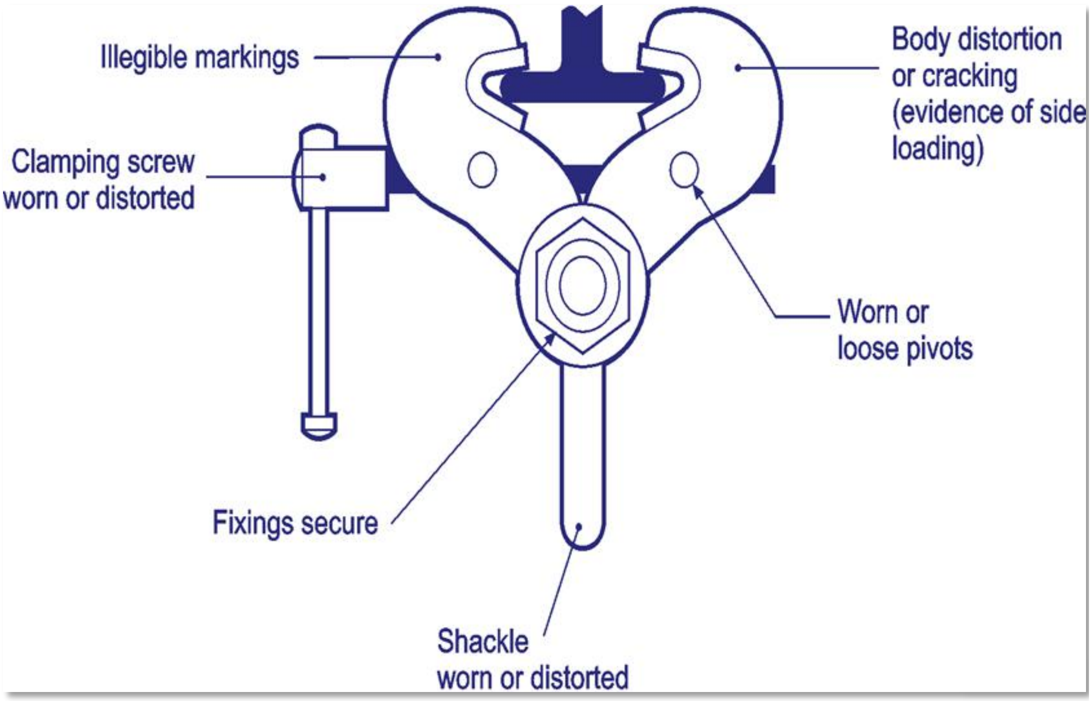
In addition to the thorough examination required by statutory provisions, all beam clamps should be visually inspected by a Responsible Person prior to use or on a regular basis, taking account of the conditions of service. If any of the following faults are present, the clamp should be withdrawn from service and referred to a Competent Person:

- In the case of a clamp in-situ, distortion of beam to which clamp is attached
- Distortion of any part of the clamp
- Cracks especially at bends or changes of section, nicks, gouges and corrosion
- Wear at application and suspension points, pins, pivots and other moving parts
- Insecure locking arrangements including substitute nuts and bolts where used
- Illegible safe working load or other markings

In addition, for clamps in-situ, if either of the following faults are found the appropriate actions should be taken:

- Clamp of incorrect profile and/or width for the beam. Replace clamp with one of the correct width and profile
- Incorrect fitting of any hook, shackle, etc. used for attaching other lifting equipment to the clamp. (Other equipment attached to the clamp should be securely retained within the fixing and free to align itself under load). Exchange clamp and/or other lifting equipment for equipment which is compatible, or insert additional linkage of suitable capacity and which will correct the defect

Thorough Examination Points



Notes:

13. Mobile Lifting Gantries

- A mobile gantry is a free standing structure comprising a runway beam and two supports assembled in a goalpost-like configuration

- Their portability enables them to be used conveniently in more than one location, but this imposes restrictions as to their use

- Mobile gantries are widely used in industry in conjunction with hand or power operated lifting appliances where a temporary runway structure is required to perform both lifting and linear moving operations

- They represent a cost effective method of providing a lifting structure where the purchase of a permanent installation cannot be justified or where the load cannot be positioned under a fixed structure

- The supports are usually mounted on wheels or castors to enable the structure to be relocated by man power only; they may however be mounted on free-standing feet requiring the structure to be dismantled for transportation

- They are usually available up to 5 tonne capacity, although higher capacities can be manufactured

Mobile Gantries – Movement Under Load

Note: Mobile gantries are **not** intended for movement under load!

- There are gantry runway structures which may be moved from one place to another to enable the runway to be positioned over the point of lift

- The only intended movement of the raised load is along the runway

- It should also be noted that 'special gantries' can be manufactured which are suitable for movement under load, but are uncommon due to their high cost compared to other methods of handling and moving loads

- Caution must be exercised as such designs are often visually indistinguishable from standard mobile gantry designs. Unless the manufacturer's confirmation of suitability for this purpose is clear, it must be assumed that the gantry is of standard design only
- Special gantries are not covered by this module

Mobile Gantries

- Typical examples of the use of mobile gantries are loading and unloading in yards and open areas, the installation/removal of plant and equipment and periodic maintenance purposes; in fact, any application where a lifting point, runway or crane cannot conveniently or economically be permanently installed

- There is no British Standard specifically for mobile gantries
    - BS EN 1993-6 and BS 2853: 2011 are relevant references

- A mobile gantry cannot on its own be used for lifting operations and only becomes an effective lifting structure when fitted with a block, block and trolley or similar lifting appliance

- Although not required by legislation, new gantries will usually be issued with a manufacturer's record of proof load testing in addition to, although possibly combined with, the manufacturers certificate. This document forms an important part of the record of the clamp. It should be retained and cross referenced to the gantry's historical records for inspection by the Competent Person or HSE

- This module covers manually re-locatable mobile gantry cranes for static use only. They may be manufactured from standard rolled steel sections or proprietary track sections and will usually be mounted on wheels or castors but may have free standing feet. The range of designs and intended use covers all common types including demountable, fold away and self erecting gantries

- This module excludes gantries with:
    - Cantilever runways
    - Tubular shear legs (tripods)
    - Gantries designed for manual movement under load
    - Power operated travelling goliath cranes
    - Straddle carriers and gantry structures on fixed foundation (although the latter may have features in common with the mobile type)
    - Mobile gantries used for man carrying applications

Notes:

Duty Classification

There is no formal duty classification for mobile gantries, but manufacturers commonly refer to light duty and heavy duty or similar terms to indicate the intended duty as follows:

- **Light duty** - Infrequent use, manually operated lifting appliance, loads usually below the marked safe working load. Also commonly known as economy, junior or lightweight

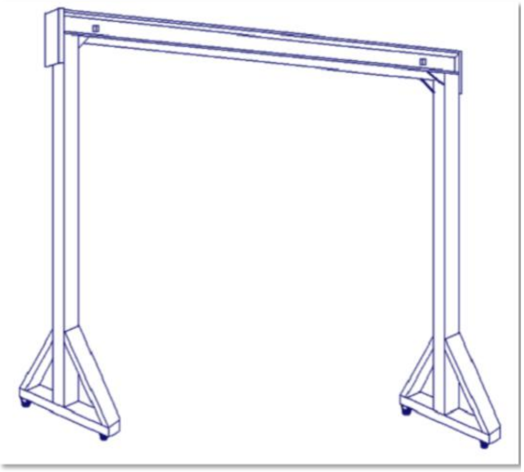
- **Heavy duty** - Frequent use manual or power operated lifting appliance, high proportion of loads up to the marked safe working load, applications where a more robust structure is required. Also commonly known as colossus, robust or senior

Types of Mobile Gantry

Mobile gantries are available in a wide range of designs and varying facilities may be provided to suit a particular site or application. Gantries are usually mounted on castors for complete mobility of the unloaded structure, however they are available with fixed wheels or with freestanding feet for certain applications.

Goalpost Gantry

The simplest form of mobile gantry is the goalpost type. This comprises a runway beam, often of proprietary track section, with single column supports. Lateral stability is provided by a base member on which the column is mounted. This design is limited to light loads, usually up to **500kg**, and light duty applications.



'A' Frame Gantry

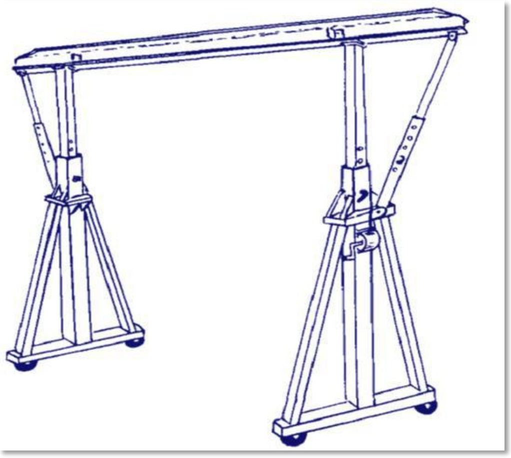
The 'A' frame gantry is the most common type of mobile gantry. This comprises a runway beam, usually of standard rolled steel section, with supports in the form of an 'A'.

Lateral stability is given to the structure by the shape of the supports. This design is available in all capacities, usually up to **5 tonnes**.

Adjustable Height Gantry

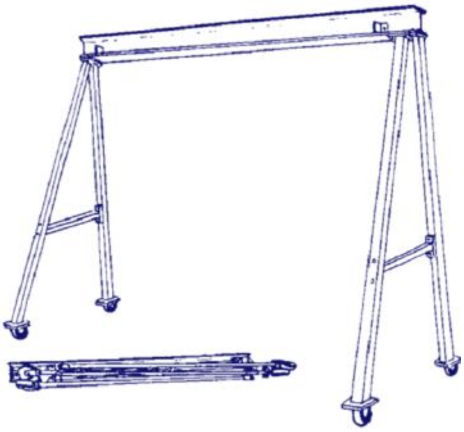
To provide limited variations to the erected height of the runway, an adjustable height gantry has telescopic supports enabling the runway to be raised or lowered to suit differing site conditions.

This facility is not intended for use under load but is to allow for varying lifting height requirements only. This design is available in all capacities, usually up to **5 tonnes**.



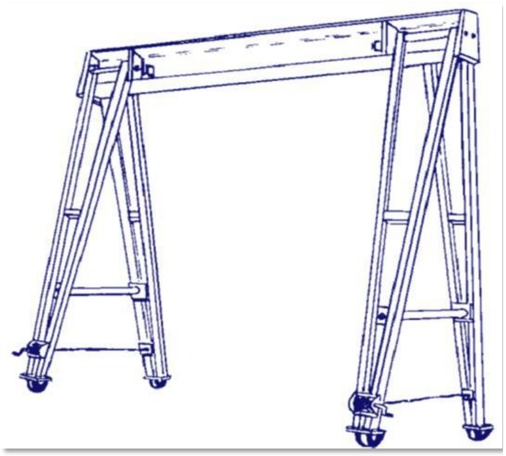
Foldaway Gantry

Foldaway gantries are designed for easy dismantling and storage. They are intended for applications where regular dismantling and transportation is necessary or where the usage is such that long periods of storage occur. This design is usually limited to loads of up to **2 tonnes**.



Self Erecting Gantry

Self erecting gantries are designed with the provision of hand winching mechanisms which allow the structure to be assembled horizontally on the floor. Operation of the winches pulls the side members of the 'A' frame supports together until the gantry is in its operating position. Additional locking structural components are then inserted making the structure rigid. This design is usually available in the higher capacities from **2 tonnes** upward.



Demountable Gantry

Demountable gantries are a further design variation which permits the structure to be dismantled for relocation. The construction is fully bolted, although some joints may utilise locking pins, which enables the structure to be dismantled and erected using other lifting facilities to assist in the operation. Demountable gantries are intended for applications where long periods of service with occasional dismantling for storage or transportation is necessary. This design is available in all capacities, usually up to **5 tonnes**.

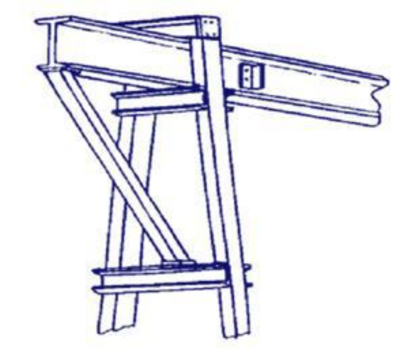
Notes:

Bracing

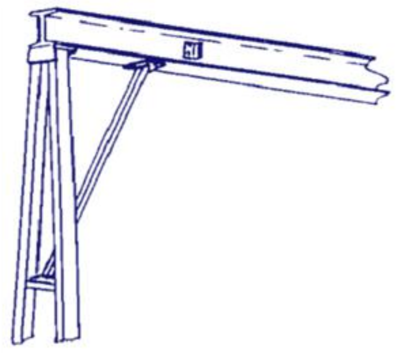
Bracing is used to give support, rigidity and longitudinal stability to the runway. There are four common methods of bracing:

- **External bracing** - A mobile gantry is said to be externally braced when the runway is given rigidity by a diagonal bracing member positioned from the support to the runway on the outside of the goalpost arrangement

- **Internal bracing** - A mobile gantry is said to be internally braced when the runway is given rigidity by a diagonal bracing member from the support to the runway on the inside of the goalpost structure



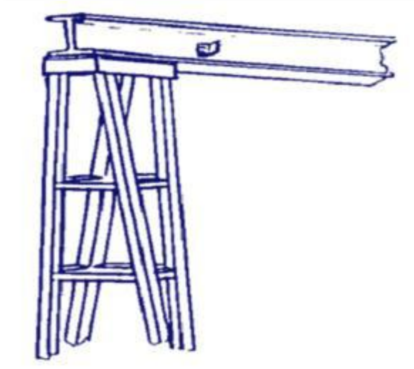
External Brace



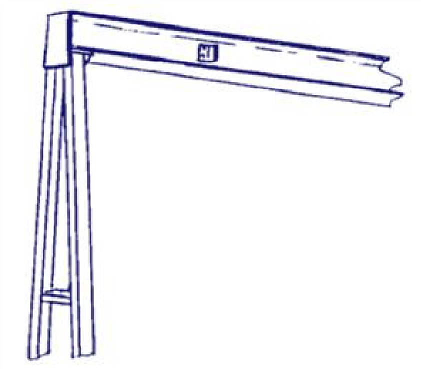
Internal Brace

- **Box bracing** - A mobile gantry is said to be box braced when the runway is given rigidity by the box-like design of the supports

- **Rigid or splice bracing** - A mobile gantry is said to be rigid or splice braced when the runway is given rigidity by the design of the joint or splice between the supporting member and the runway



Box Brace

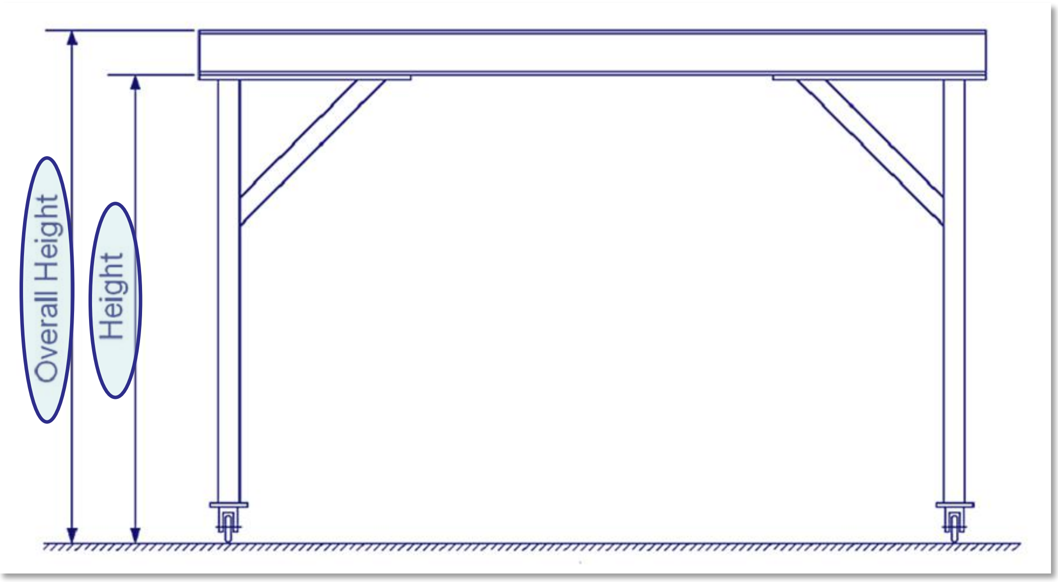


Rigid/Splice Brace

Notes:

Height

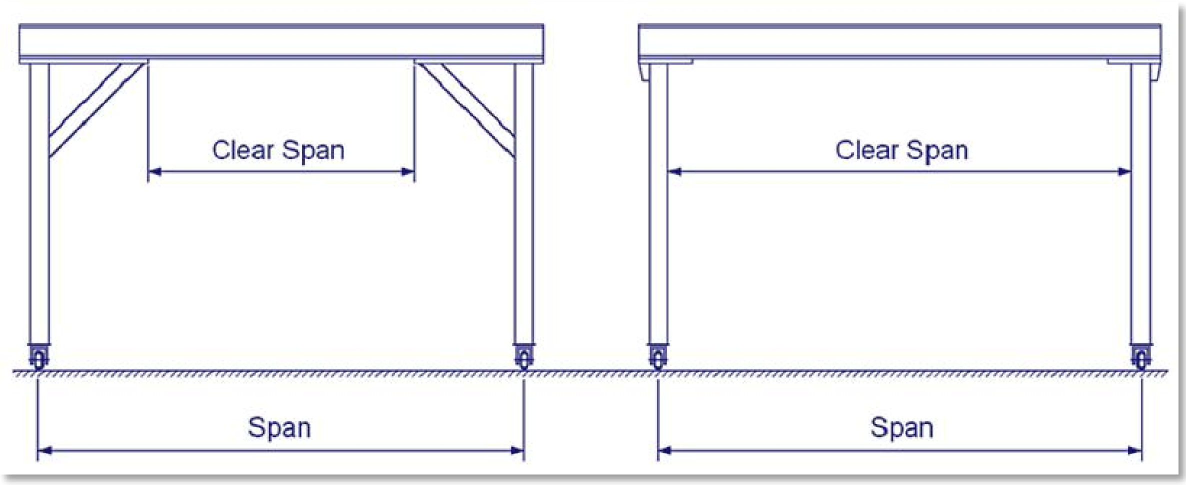
The height of a mobile gantry is normally measured from the floor to the under side of the runway beam. The overall height is measured from the floor to the top of highest point of the structure.



Span

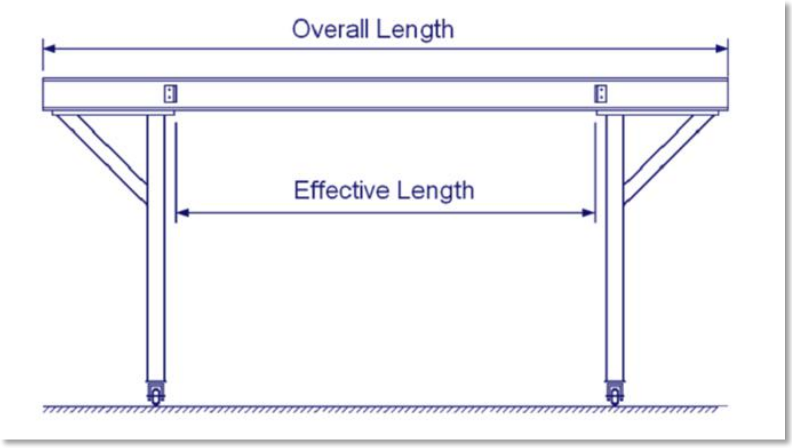
- The span of a mobile gantry is normally measured between the wheel centres along the line of the runway (longitudinally)

- The clear span is the clear distance between any internal structural members and represents the maximum width of any item over which the gantry may be positioned or passed



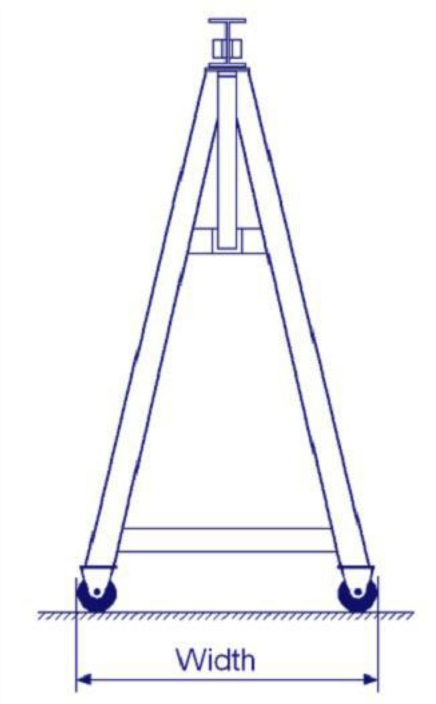
Effective Length

- The effective length of a gantry is the distance the lifting appliance and trolley may travel along the runway between the end (travel) stops
- Overall length is the distance between the extremities of the structure measured along the line of the runway (longitudinally) and represents the minimum width through which the gantry may pass when an allowance is added for clearance



Width

The width of the gantry is measured across the base member of the support.



Castors

Swivelling Castors

- Castors are normally fitted with roller bearing wheels and are of the cast iron, rubber tyre or composite

- In some cases, the castors are only capable of supporting the weight of the gantry structure
    - Jacks must then be used to ensure that the load is not imposed on castors when lifting

- Heavy duty castors are sometimes used which can sustain the force of the load and the weight of the structure, however there are conditions which must be met when considering the suitability of such castors

The castor must be capable of taking the total load applied without any distortion or permanent deformation of the type used or supporting framework. The maximum load for each castor would be:

$$\frac{\text{(Half the total weight of gantry + Weight of hoist + SWL + 25\% of the SWL)}}{2}$$

For example:

Gantry weight	= 1000kg
Weight of hoist	= 30kg
SWL	= 500kg

$$\frac{(0.5\,x\,1000) + 30 + 500 + (0.25\,x\,500)}{2}$$

$$\frac{500 + 30 + 500 + 125}{2} = \frac{1155}{2} = 577.5\,kg$$

So, the maximum load for each castor would be 577.5kg.

- The type of wheel or tyre fitted will depend on the running surface, either to minimise damage to the floor or to the castor

- Swivel castors should always be fitted where the wheel centre is offset from the centre of rotation of the castor frame, this ensures that the line of force is always in the direction of rotation of the wheel

Notes:

Parking Jacks

Gantries may be fitted with jacks which are intended to make the structure more permanent by taking the load off the castors. This is essential in the case of light duty castors.

- Usually of the screw down type and mounted in board of the 'A' frame legs
- The jacks are fitted to prevent movement of the gantry when load is lifted
- They are not to support the load by jacking castors off the ground
- They are never to be used to compensate for sloping or uneven surfaces

Testing Mobile Gantries

When testing mobile gantries:

1. Ensure level surface with parking jacks screwed down and/or castor brakes on

2. Apply SWL gradually as close as possible to one end

3. Lift load just clear of ground and slowly travel it to the opposite end, paying particular attention to the beam, its supports and bracings

4. Place the load in the centre of the gantry and lower it. Take a reference dimension at beam centre. Lift the SWL, taking a second reference dimension at beam centre and check deflection

Allowable Deflection

- Manufactured from UB: 1/500th span @ SWL (BS 2853:2011 – best practice)
    - Span = distance between centre line of two A frames

- As no standards exist, manufacturer's recommendations are to be referred to before load testing
    - In the absence of manufacturer's information, a suitable design authority must be consulted before testing

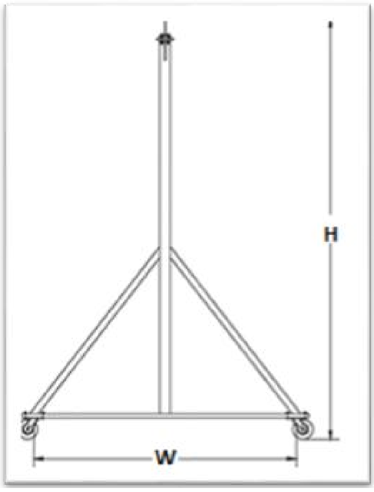
- It is of the utmost importance, therefore, that when carrying out a deflection test, the deflection under the SWL is checked against the calculated deflection

- The Competent Person will generally find that the deflection is as previously discussed - with load at centre span the gantry frames will bow. With no load applied check that runway beam returns to its original position

Notes:

Stability of 'A' Frame Gantries

- The general rule to apply is a height to underside of runway to wheel centres of 3:1. So, the height of the frame should be at least 3 times its width



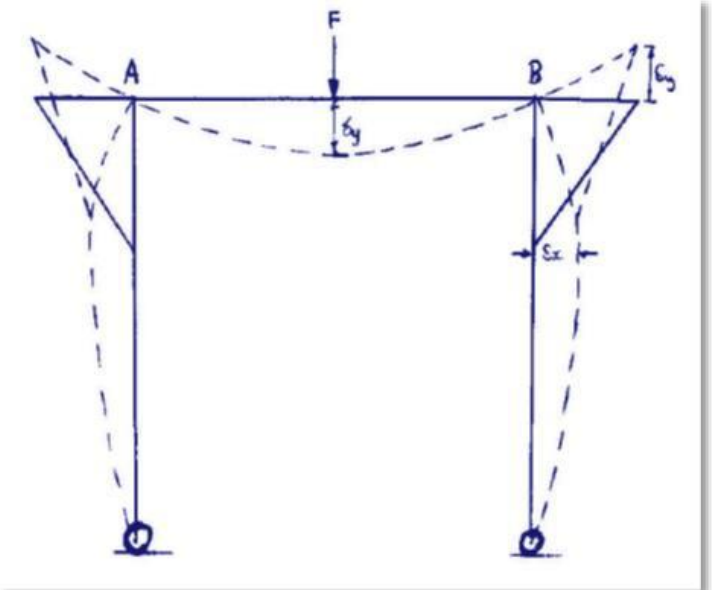
- Where parking jacks are used to level the gantry on an uneven surface, the 3:1 ratio needs to be drastically increased since parking jacks usually sit inside the castors

- Unless it is proved to the Competent Person that a mobile gantry has been specifically designed to stand on its jacks under full test conditions, the Tester must always assume that the castors take and are, in fact, designed for full load

Notes:

Mobile Gantry Deflection

- The beam acts as a runway beam and maximum deflection will occur at its centre
- Connections at A and B are rigid
- Turning moment will be at A and B, raising the ends of the beam upwards
- This upward bending pulls on the bracing and bows the uprights outwards
- Castors and parking jacks act as a pinned constraint
- More deflection in beam = increased bend in uprights
- Deflection is measured, recorded and compared with future tests on the structure. Changes would then warrant investigation



Notes:

Pre Use Inspection / Thorough Examination

- The degree of pre-use inspection or thorough examination required will to some degree depend on the type of mobile gantry used and the installation conditions

- Mobile gantries are generally proof load tested and thoroughly examined on completion at the manufacturer's works, they are then dismantled ready for transportation to site
  - Further load testing after erection on site is not usually required as the manufacturer's test record remains valid, providing the erection has been carried out fully in accordance with his instructions using his original components

- Some types of mobile gantry are designed and intended for the user to dismantle and re-erect, e.g. foldaway and self erecting gantries. In such cases, it may be sufficient for a Responsible Person to inspect the installation to ensure the correct assembly and attachment of the lifting appliance
  - For more complex installations and those requiring a high degree of dismantling and reassembly a higher degree of examination by a Competent Person may be called for

- Where the Competent Person deems a proof test is necessary as a part of his thorough examination, e.g. if the gantry has been supplied without a test certificate or following a structural repair, the proof load should be at least 1.25 times the safe working load. The testing will usually include deflection, dynamic and overload tests in accordance with BS 2853

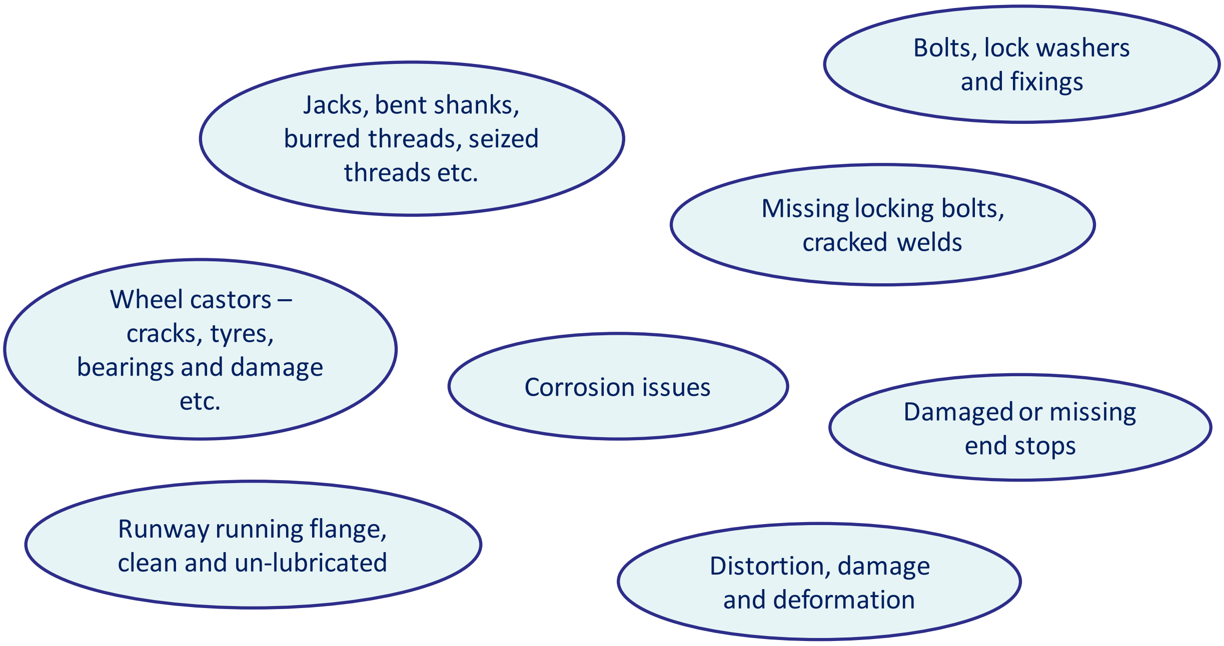
- On satisfactory completion of all tests and thorough examination, the Competent Person will issue the necessary report of thorough examination, which will include details of the tests he has made. As with the manufacturer's original documentation, this should give details of the support points, i.e. 'on jacks' or 'on castors'

- Since most lifting appliances will be detachable from the gantry and may have differing proof load requirements, an individually detailed or separate report should be issued for the gantry, the connecting device, e.g. trolley, beam clamp etc. and the lifting appliance. These should be retained and cross referenced to the equipment's historical records

Notes:

Thorough Examination

Theoretical checks unnecessary when manufacturer is known and dimensions are as per the specification published.



In Service Inspection

In addition to the periodic thorough examination by a Competent Person required under statutory provisions, all mobile gantries should be visually inspected by a Responsible Person prior to use or on a regular basis, taking into account the conditions of service.

If any of the following faults are present, the gantry should be withdrawn from service and referred to a Competent Person:

- Structural defects; signs of damage, distortion or deformation of the supporting members, bracing, tie bars and lateral stiffening members. Missing structural members. Cracked welds. Distorted, loose or missing bolts and fixings. Missing locking devices and washers, in particular spring and taper washers. The overall condition of the structure should be sound with no signs of corrosion

- Deformation or damage to the runway; bent or twisted beam, damaged or distorted flanges, twisted web. The surface on which the trolley runs should be clean, un-lubricated and even and there should be no corrosion

- Damaged or missing end stops; distorted contact face, loose or missing fixing bolts

- Damaged locking and pivot pins; bent, distorted or burred pins. Missing or damaged retaining devices. Particular attention should be paid to pins on which structural members pivot, e.g. on self erecting gantries; there should be no signs of scoring, burring or excessive wear

- Damaged wheels and castors; chipped wheel treads, damaged tyres, bent axles, seized bearings, collapsed housing, missing or distorted fixing bolts. If brakes are fitted, they should be in good order;

attention should be given to their operation which should prevent movement of the wheel. Similarly, rotational locks must prevent the castor from swivelling

- Damaged jacks; bent screw shanks, burred threads, seized threads, bent, distorted or missing feet

Note: Any damage or defect to the wheels, castors or jacks should be viewed seriously as this may affect the stability of the structure and may give rise to the gantry overturning.

Notes:

Marking Requirements

The following information should be permanently and legibly marked on a suitable part or parts of the mobile gantry:

- Business name and address of the manufacturer
- Serial number
- Safe working load, including any limiting conditions
- Year of manufacture
- Maximum hoisting speed for powered hoists or else the words '**Manual Hoist Only**'

In addition, it is advisable that the weight of the structure is marked or otherwise made readily available.

Special care must be taken with regard to the safe working load of the mobile gantry and lifting appliance(s). The maximum load to be lifted, including the weight of the equipment, should not exceed the marked safe working load of the gantry. This is particularly important in cases where the lifting appliance is regularly removed and replaced as may be the case with self erecting or foldaway gantries, or where more than one lifting appliance is being used, i.e. multi-point lifting.

Storage

The choice of storage method will depend on several factors which will vary from site to site and will be related to the application, design, site conditions and utilization. The selected storage arrangements should therefore be reviewed from time to time to ensure they remain applicable to the site.

There are two principal cases of storage:

1. Gantries which are left in their erected condition for storage
2. Gantries which are dismantled for storage

Storage of Erected Gantries

- When not in use, the mobile gantry should be positioned so that it does not present a hazard to persons, goods or vehicles etc. which may be working or stored in the area

- Where practicable, if the gantry is not in regular use the lifting appliance should be removed for storage. If this is not possible or desirable, the lifting appliance should be parked where it will not present a hazard. This may be found to be against an end stop adjacent to one of the supports. Where appropriate, the lifting appliance should be disconnected from the power source and offered suitable protection from weather etc.

- It is advisable that, when not in use, the gantry is parked with the jacks taking the weight off the castors to prevent accidental movement. This should be done whether the castors are fitted with brakes or not as certain types of wheels and tyres may develop flats on the treads if left supporting a weight for long periods. Gantries which are not fitted with jacks or wheel brakes should be given special attention to ensure that they cannot be accidentally moved, e.g. by winds

Storage of Dismantled Gantries

- When not in use, gantries which have been dismantled for storage should be packed and stored in such a way that all the components and structural members are kept together with no danger of loss or risk of later substitution of incorrect items

- Prior to placing in store, the Operative should check to ensure that all the components are present and undamaged

Notes:

14. Swing Jib Cranes

Swing jib cranes are widely used in industry in conjunction with manual or power operated lifting appliances where a permanent facility is required to perform both lifting and limited moving operations.

Typical examples of their use being over work benches, in fitting and maintenance shops, over machine tools and in loading and unloading bays.

They offer a wide area of floor coverage within the slewing radius of the jib arm and are ideal where full overhead travelling crane coverage may be either impracticable or uneconomic. They are often used to supplement overhead travelling cranes.

BS 7333: 1990 - Slewing Jib Cranes, specifies the design, construction and testing of slewing jib cranes or, more properly, slewing jib arms. Note that a slewing jib arm becomes an effective crane only when fitted with a block, block and trolley or similar lifting appliance.

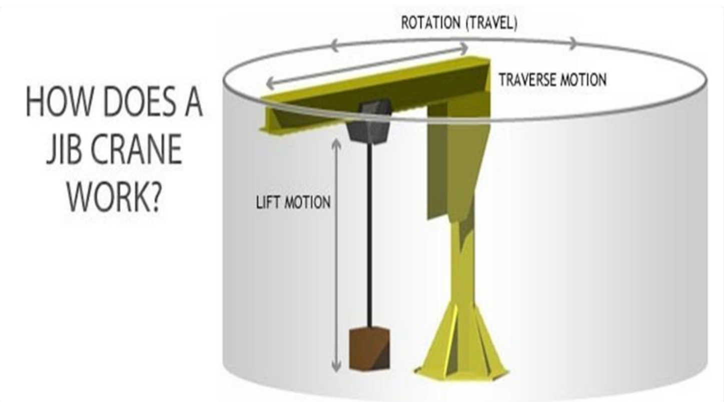
Note: BS EN 14985:2007 – Cranes - Slewing jib cranes, has a similar title but does not apply to the type of crane covered by this module. It applies to electrically or hydraulically powered slewing jib cranes mounted in one position or free to travel on horizontal rails.

This module covers slewing jib cranes which may be wall mounted, column mounted or free standing in design and manufactured from standard rolled steel sections or proprietary track sections, used for multi-purposes.

The use of jib cranes is always associated with a lifting appliance, usually a hand chain block or power operated hoist and normally includes a trolley.

This module does not cover derricking (luffing) cranes, lifeboat cranes, cranes used on offshore installations to load and unload vessels and cranes used for man carrying applications.

- Before 1990, swing jib cranes were made according to established custom and practice
- BS 7333 Includes a classification system for swing jib cranes and allowable deflections by class of swing jib crane
- The Tester and Examiner needs to also understand various loading conditions and resultant stresses



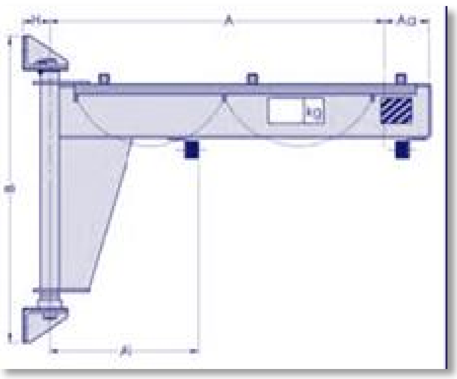
A fixed location swing jib crane allows a load to be lifted, traversed along its main lifting arm and rotated. Degrees of rotation can be limited, for example 270˚. Swing jib cranes can also be manufactured with a continuous 360˚.

Notes:

Types of Swing Jib Cranes

Over Braced

Under Braced

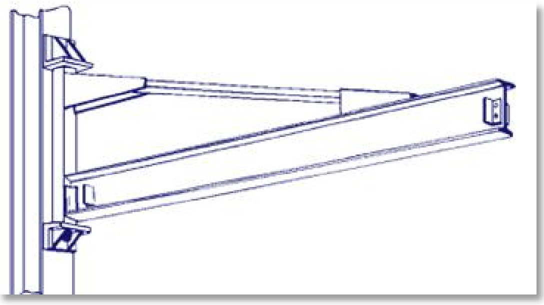


Wall Mounted

360° or Limited Slew

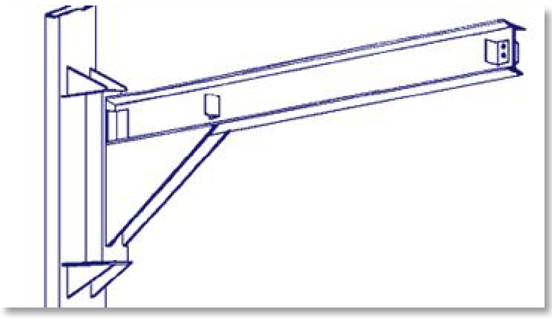
Over-Braced

A jib is said to be over-braced when the cantilever runway arm extending from the king post is supported by bracing coming down from above the arm.



Under-Braced

A jib is said to be underbraced when the cantilever runway arm extending from the king post is supported by bracing coming up from below the arm.



Notes:

King Post

The king post is the moving upright part of the structure to which the runway beam and bracing are anchored.

It may be in the form of an upright member with journals top and bottom which fit into the bearing brackets and allow the jib to slew (see Figure 1) or in the form of a fabricated section with bearing spigots and rollers which perform a similar function on tubular column free standing jibs. (see Figure 2)

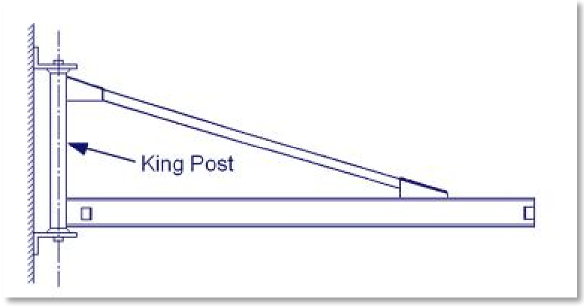


Figure 1

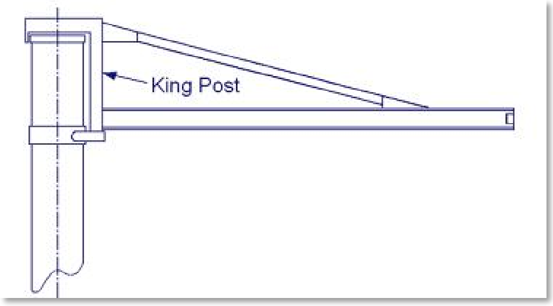
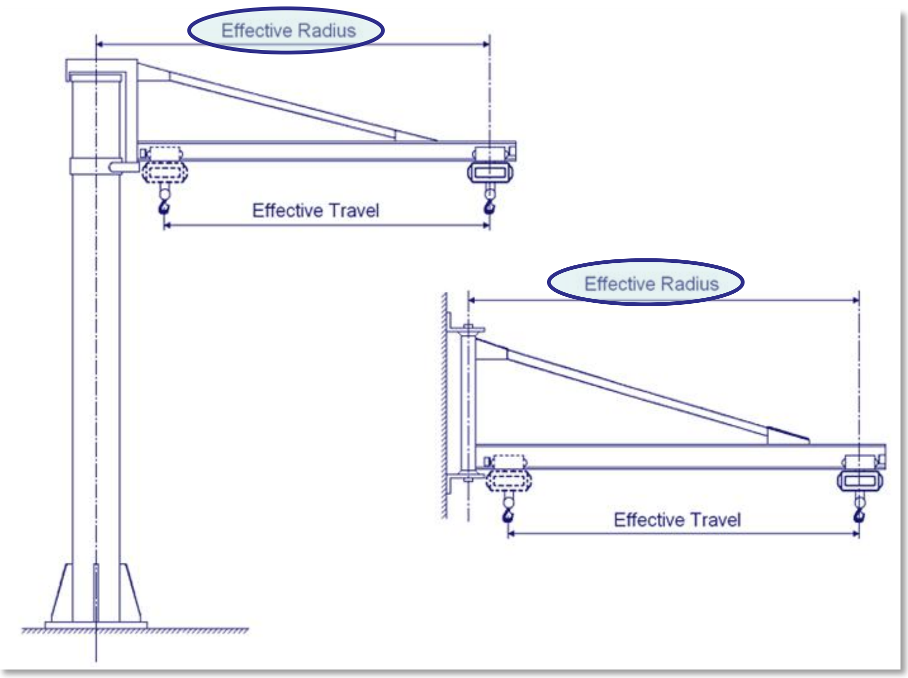


Figure 2

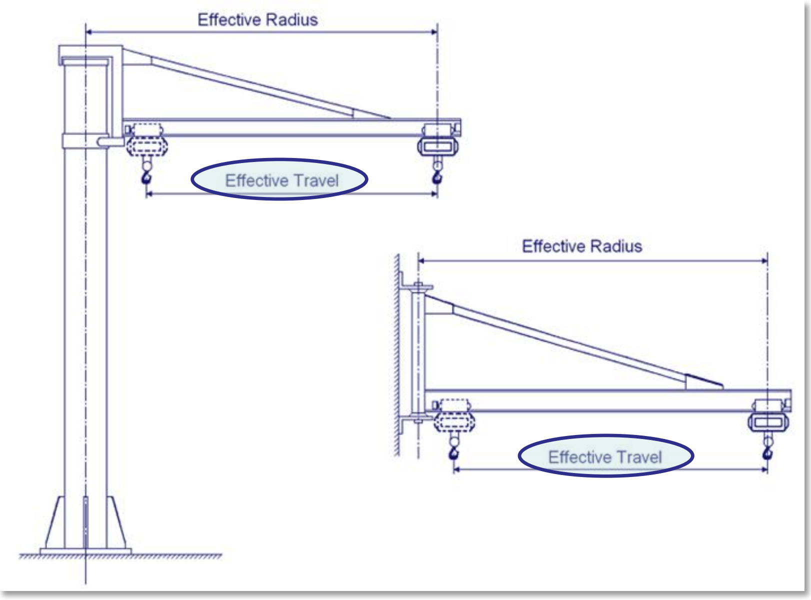
Effective Radius

The effective radius is the horizontal distance between the centre line of rotation and the vertical centre line through the load lifting attachment at the extreme point of outward travel.



Effective Travel

The effective travel is the distance along the runway which the trolley and block may travel between the fixed end stops.

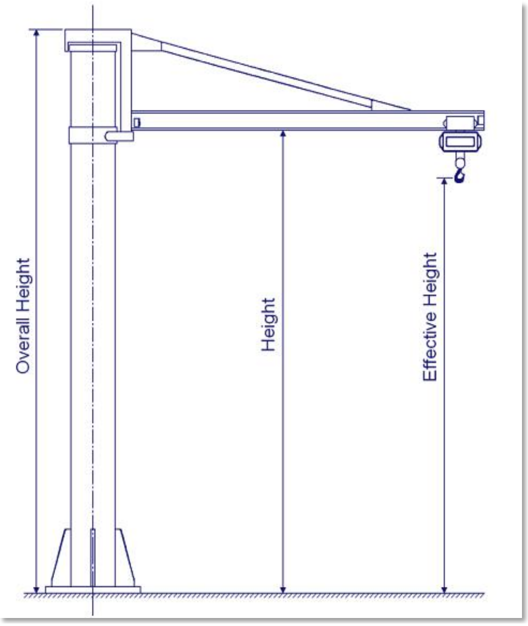


Height

The height of a jib crane is normally measured from floor to the underside of the jib arm; overall height being from floor to the top of the highest point of the structure.

Effective Height

The effective height is the distance from the floor level to the seat of the bottom hook of the lifting appliance in its raised position.



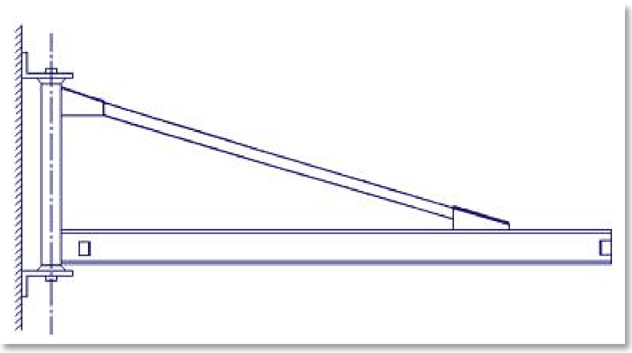
Notes:

Wall or Column Mounted

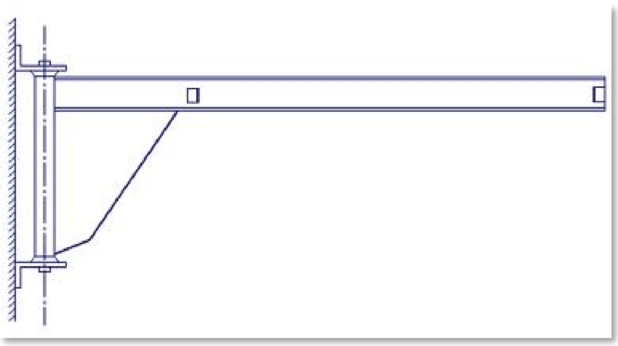
In the case of wall or column mounted jib cranes the jib arm, king post and bracing are assembled as a single unit.

They may be either over-braced or underbraced in design, depending on the intended use and the location of the installation. Top and bottom bearing brackets fit onto the king post and these in turn are fixed to the supporting structure.

The design of bearing brackets varies with the intended use and may be provided with drilled bolt holes for wall mounting or clamp fixings for mounting onto or clamping around a column.



Over Braced



Under Braced

Wall Mounted

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- Wall mounted swing jib cranes have a limited slew, depending on the design of the bearing brackets and the supporting structure onto which they are erected

- Wall mounted jibs are usually limited to 180° slew, whereas a greater angle of slew may be obtained if the jib is column mounted

- The angle of slew may be increased if the length of the bearing brackets is extended and can, in the case of column mounted jibs, be as great as 270°

- Stops may be fitted to limit the angle of slew at any position within the arc of travel

Free Standing

- The jib arm and supporting column are assembled as a single unit which includes all mountings and bracing

- They may be either over-braced or underbraced in design dependent on the intended use and the location of the installation

- The supporting column is usually manufactured from square box section, fabricated sections or tube dependent on the required angle of slew. The angle of slew and intended use will also affect the design of the king post and mounting structure

- Free standing jibs are available with a wide variety of slewing angles. They may have a full 360° angle of slew, allowing for continuous rotation if a tubular column is used, or be limited to 270° angle of slew if a square box or similar section column is used

- Stops may be fitted to limit the angle of slew at any position within the arc of travel

Continuous Rotation

- Where continuous jib rotation is required and electrically operated hoists are to be used, slip ring units are incorporated so that there is no limitation in rotation from the power pick-up

- If pneumatic hoists are to be used, the air supply may be piped through the centre of the column and passed along the jib arm via a flexible hose. In this case, slewing stops are necessary to limit the rotation, thus preventing damage to the hose or the loosening of couplings

- A similar arrangement may also be used with certain flexible cable electrical supplies

Notes:

Loading on a Jib Arm (Over-braced)

Irrespective of how a jib arm is made the Tester and Examiner should understand how the forces are distributed.

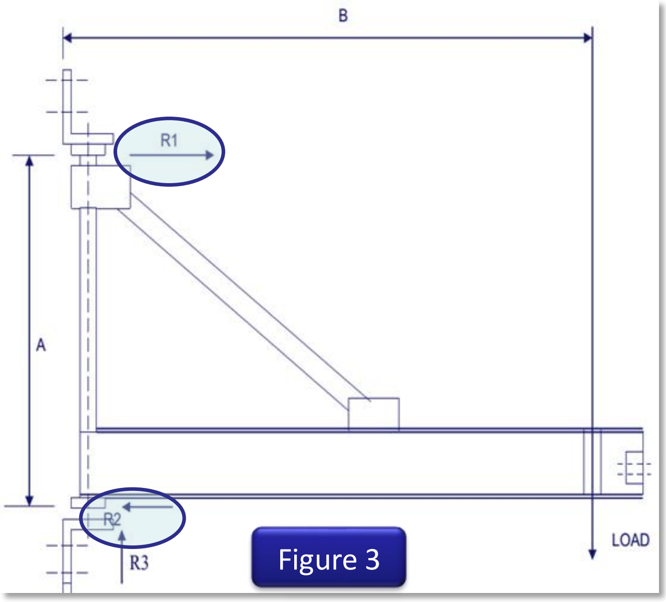
The illustration below shows an over-braced jib arm, generally used where headroom is not a problem and, in the form shown, suitable for bolting to the column of a building structure.

When under load, the jib arm would be subjected to horizontal forces, pulling the arm away from the king post, as well as vertical shear on the bolts from the weight of the load.

Figure 3 illustrates the load bearings on the over-braced wall mounted jib arm:

Example (Figure 3):

Radius B = 4 metres
Bearing centres A = 1 metre
Load = 1000 kg



We know from the simple lever rule, the reaction R1 on the top bearing would be:

$$R1) = \frac{(\text{Load x Radius B})}{\text{Distance A}}$$

$$(R1) = \frac{(1000 \times 4)}{1} = 4000\text{kg (i.e. 4 tonne)}$$

The bolts would be in tension.

R1 = Tension
R2 = Compression
R3 = Lifting motion caused as structure tries to bend due to the load

The reaction at R2 would be the same:

$$(R2) = \frac{(1000 \times 4)}{1} = 4000\text{kg (i.e. 4 tonne)}$$

- In addition to the horizontal forces R1 and R2, the vertical shear on the bolts would be the weight of the load (1000 kg in the previous example).

- It is quite common for the designer to overlook what happens when the jib arm rotates through 90°

- The forces R1 and R2 would be exactly the same but instead of trying to pull R1 away from the column and push R2 into the column, the brackets try to slide across the face of the column so the fixing bolts in the brackets would be in shear

- Very often a jib arm may be clamped around a column, relying on the friction to keep the brackets from sliding. This is bad practice unless steps are taken to prevent any slip and the Tester and Examiner should be watchful since any slip would cause the load to run away

Notes:

Load on the Tie Rod

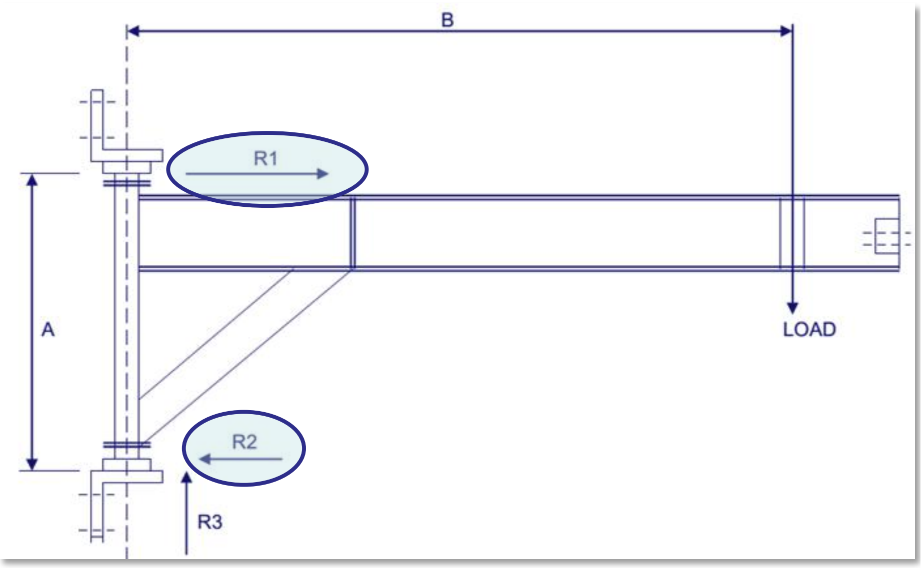
Tie Rod

The supporting rod within the brace to the runway. It reduces deflection in the beam, acting to strengthen it by providing support.

The connection of the tie rod to the kingpost and to the top of the jib arm are critical areas since any failure at these points would total.

Loading on a Jib Arm (Under-Braced)

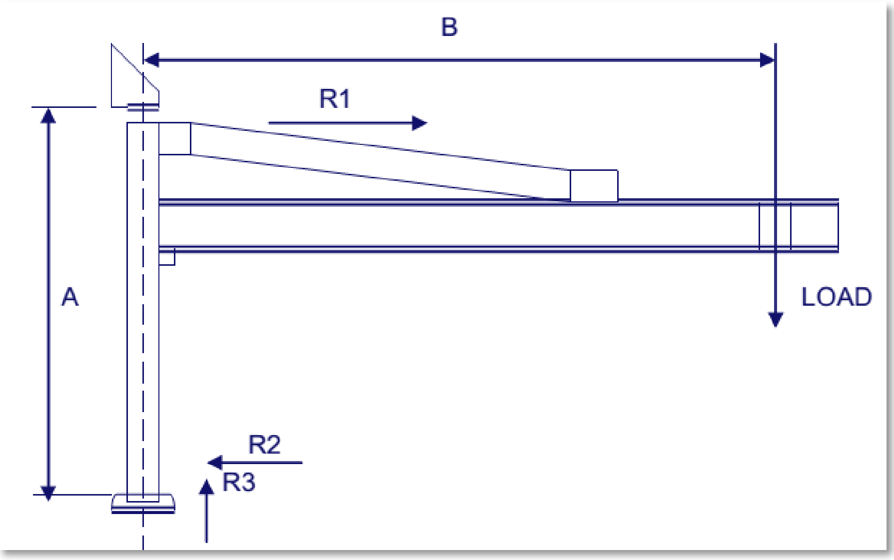
The under-braced jib arm allows maximum headroom, although some hook travel is lost. Again, the reactions R1 and R2 are directly proportional to the ratio of B to A:



$$(R1\ max) = Load \times \left(\frac{B}{A}\right)$$

In addition to the bending stress, the jib arm will be subjected to high buckling stresses where the load is at a maximum distance from the kingpost. The arm would normally be strengthened with gusset plates to support the flange and also to transmit the shear force into the web. High loads will also be transmitted into the kingpost at the base of the strut and runway connection.

The illustration below is an example of a part column and part floor mounted jib. Although requiring a large kingpost, the combined mounting reduces the loading on the building structure to a minimum.



Notes:

Effects of Reactions on a Building Column

Effects of Reactions R1, R2 and R3

Most modern factory units comprise a steel skeleton with metal or brick cladding, the columns being of a universal beam section.

If a swing jib crane is bolted to a building column with the jib arm in the position shown in Figure 4 below, the forces R1 and R2 will try to bend the column whilst at R3 they produce a lifting motion. Calculations show that the beam is strong enough.

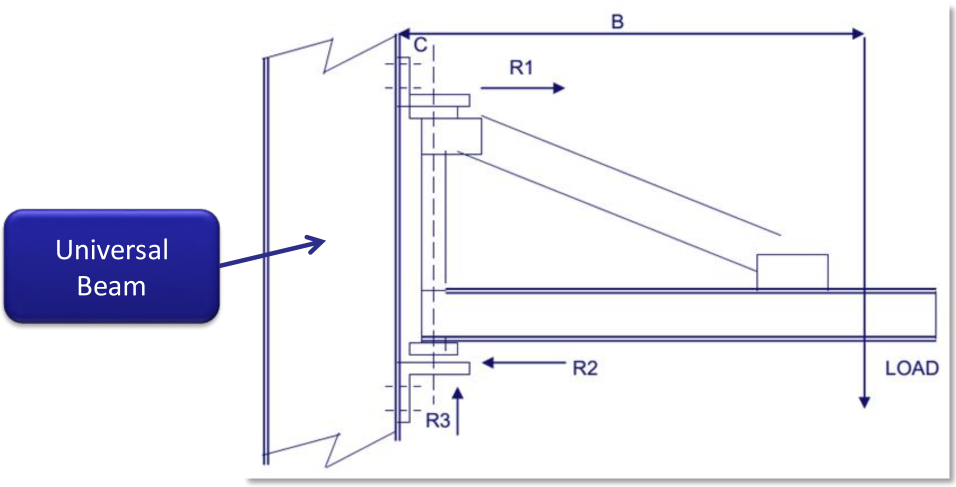


Figure 4

What is very often overlooked is when the jib arm is swung through 90°, although the reactions R1 and R2 will be the same, the beam strength is drastically reduced.

Assuming the universal beam in question is a 305mm x 165mm then with the load in the position shown in Figure 4 we are trying to bend a complete beam.

With the load at 90°, we are now virtually trying to bend one flange, which has less than 1/10 the strength of the whole beam. On top of which, due to the kingpost standing away by a distance C from the flange, the forces are trying to twist the flange as well. This is a common cause of failure.

Note 1: When testing such an installation the load should be moved as close to the kingpost as possible, the jib arm slewed at 90° and the load carefully run out towards the end of the jib arm monitoring the deflection at the same time.

Note 2: It is quite common for a user to purchase a jib crane from a catalogue and erect it themselves without having the required design checks carried out. Although the responsibility for the supporting structure is the user's, the responsibility for the safe use when issuing a test certificate is the Tester and Examiner's.

Notes:

Free Standing Jib Cranes

If a suitable building structure is not available, then the jib arm may be mounted on a freestanding post. The jib arm may be over strutted or under braced, exactly as with a wall-mounted jib.

Opposite is an example of a limited slew jib with the brackets welded and bolted to the column. The circular column is ideal for mounting jib arms because it has only one moment of inertia and its resistance to bending will be the same for any position of the jib arm.

With a limited slew crane which has the jib arm in the position shown here, the column is only trying to bend over. As the arm is rotated, the brackets try to twist the column, which now has a bending stress and a torsional stress at R2.

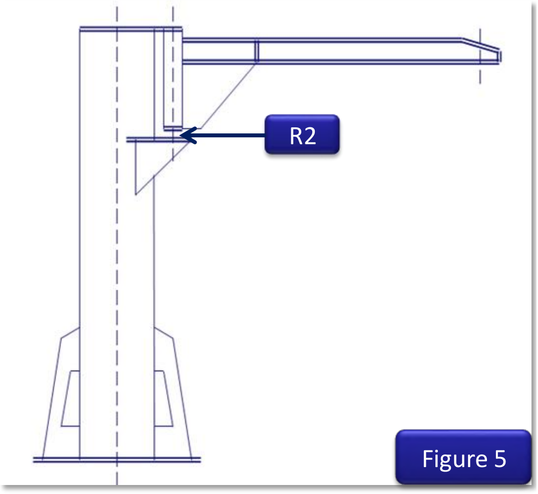


Figure 5

Limited Slew Swing Jib

In Figure 6, the jib arm is mounted on a thrust and journal bearing in the top cap with rollers running round the circular column at R2. The post now will only try to bend in the plane of the jib arm, the amount of bending being constant for any position of the jib.

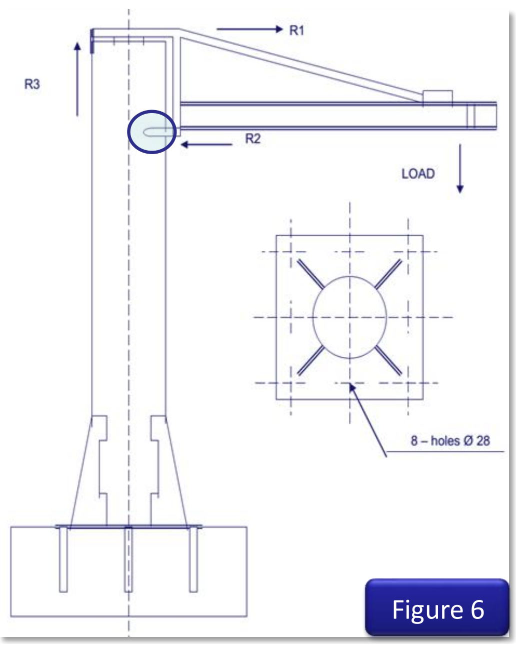


Figure 6

The lower rollers at R2 can be subjected to high loads, in addition to which, the roller is in line contact with column. To overcome the very high local stresses at R2, a reinforcing ring may be welded round the post.

The Examiner should be looking for any weld cracking in this area since the welds can also be subject to very high stress.

Very heavy duty posts would be reinforced internally which eliminates the local buckling effect or crushing of the tube.

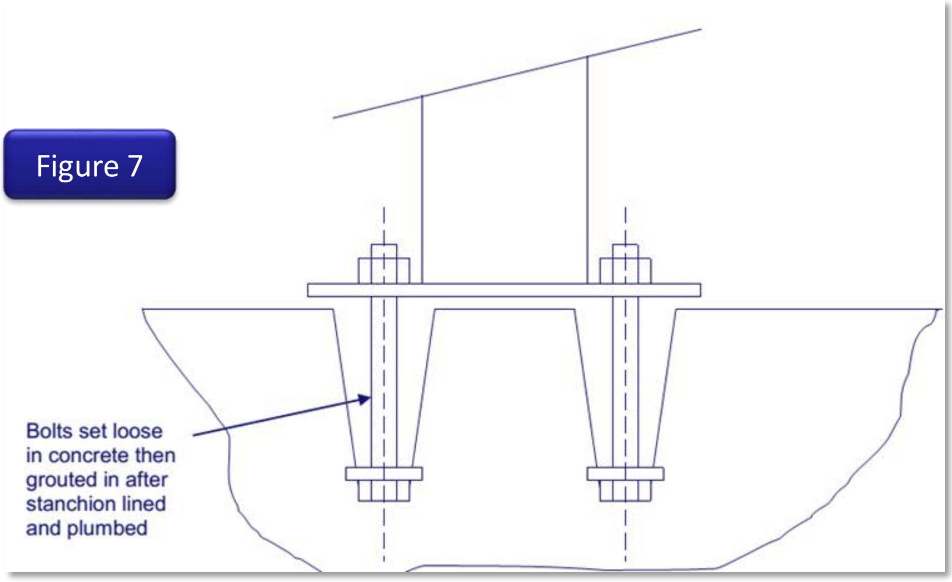
Notes:

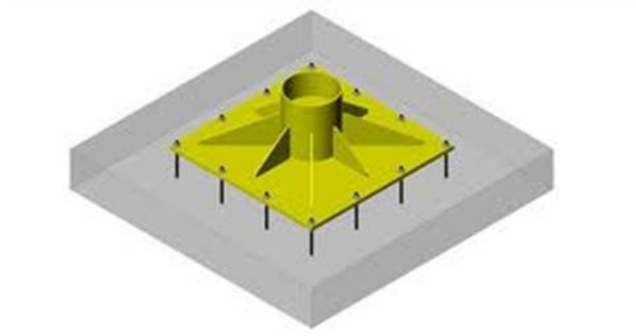
Foundations

It is normal for the manufacturer of the jib crane to state in the contract that the jib cranes will be supplied and erected on prepared foundations. The manufacturers will supply the foundation bolts together with a template for their positioning and it will be the responsibility of the purchaser to arrange for these bolts to be set into a suitable foundation.

In Figure 7 we can see how the foundation bolts are set into the block. This is a typical swing jib crane foundation.

Figure 7





Example of Foundations for Free Standing Jib Cranes

Caution!

Many modern factory floors have a hard-core base with a 150mm raft of concrete, which may be wire, reinforced. The Tester will no doubt encounter an installation where the column has been bolted direct to the concrete raft which, depending on the size of the jib crane, could result in serious cracking of the concrete.

Concrete is only strong in compression, it is very weak in tension, holding down bolts are normally 300mm to 450mm long minimum. Under maximum load conditions the Tester should check to make sure no cracking has taken place and that all nuts are tight.

Foundation Pressure

The foundation block should be designed in conjunction with a local building surveyor as allowable soil pressures vary.

The crane manufacturer would provide the user with a moment figure for the jib crane (Figure 8).

The jib crane is kept erect by the self-righting effect of the foundation block and the pressure it exerts on the surrounding sub-soil.

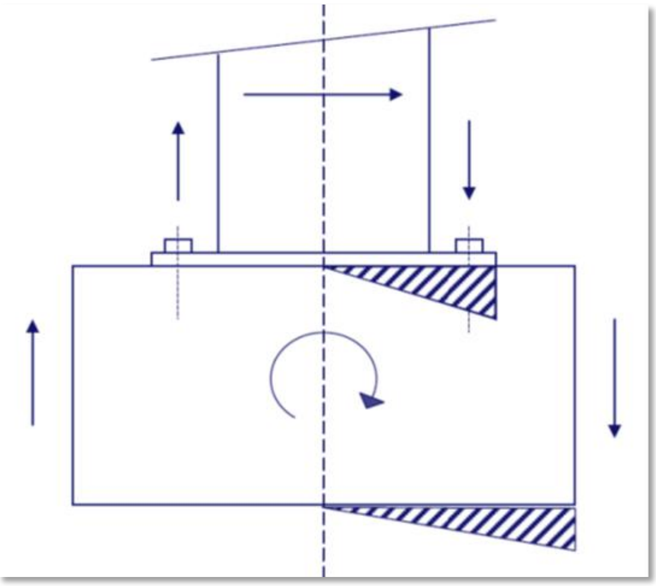


Figure 8

Overturning Moment

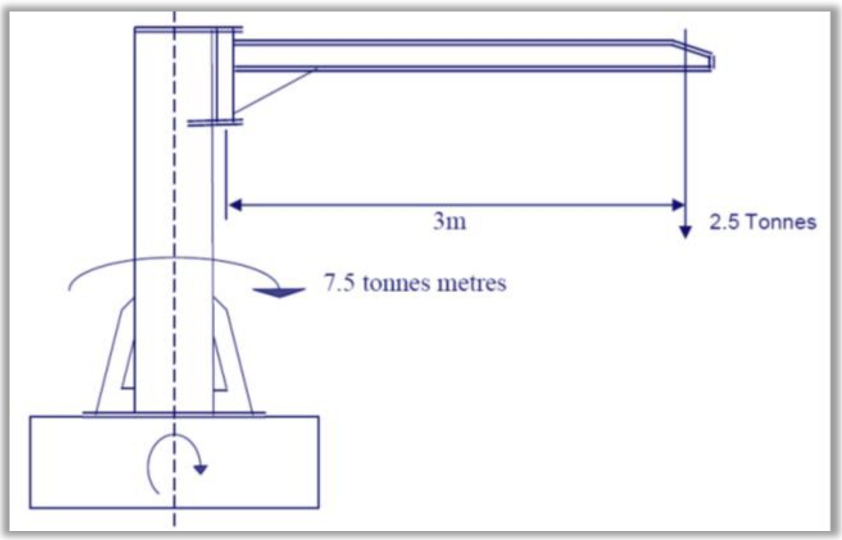
Example

A jib crane has an effective radius of 3 metres with a maximum test load of 2.5t.

What is the overturning moment on the foundation i.e. the point at which the crane would tip over?

Force x Distance = Overturning Moment

2.5 Tonnes x 3 metres = 7.5 Tonnes Metres

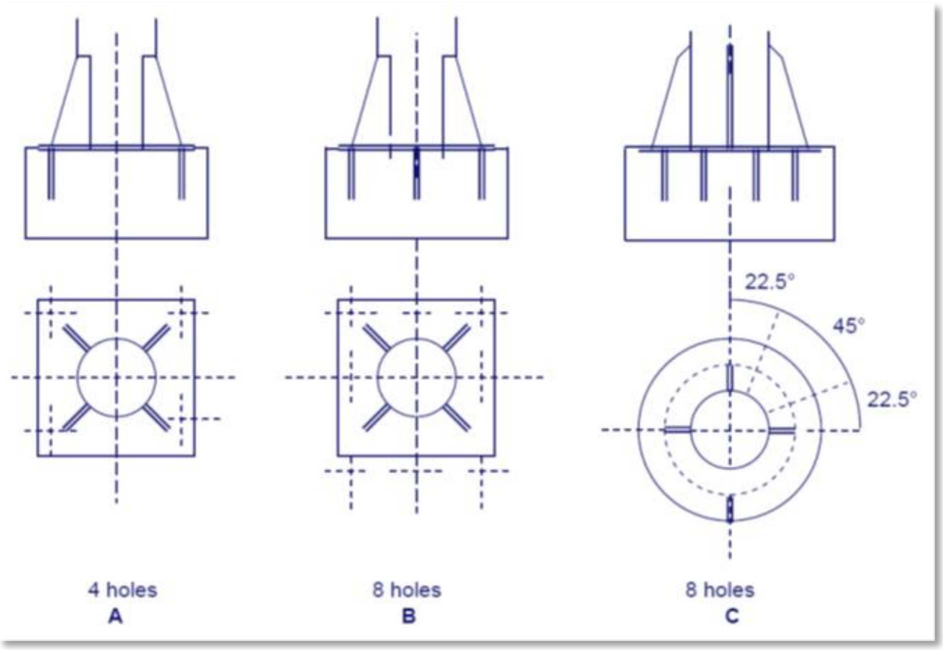


Notes:

Swing Jib Column Bases

Column bases are either square or round.

Figure 9



Light duty cranes will very often have a square base with a fixing bolt in each corner (Figure 9-A) or a square base with 8 fixing bolts (Figure 9-B) or a circular base (Figure 9-C). Base design is very involved since they are highly stressed and any deflection must be negligible.

Classification

- BS 7333:1990 Slewing Jib Cranes
- Classification relates the state of loading to the utilisation of the crane. The class determines recommended maximum deflection limits and operating speeds of the hoist fitted.
- Classification is on a scale from A1 to A8
    - A crane lifting light loads below its SWL and only used occasionally would be classified as an A1
    - An A8 would normally lift loads near to or at its SWL very frequently in its working day

Classification	Duty	Typical Applications
A1 to A3	Stand By	Maintenance or breakdown duties
A1 to A4	Very Light	General machine shop duties
A2 to A4	Light	Loading and unloading, stores and similar duties
A4 to A6	Medium	Production line and assembly duties
A6 to A8	Heavy	Shipyard and process duties, hazardous environment or loads etc.

Notes:

Classification: Maximum Lifting Speeds

Classification indicates the robustness of the design. Therefore, dynamic loading will be more severe on a light duty crane than on a heavy duty crane.

BS 7333 recommends maximum lifting speeds as follow:

Classification	Maximum Lifting Speed
A1, A2 and A3	< 8 metres/minute
A4, A5 and A6	< 12 metres/minute
A7 and A8	< 20 metres/minute

Notes:

Deflection

BS 7333 states maximum allowable deflections and relates these to the following classifications:

Classification	Deflection
A1, A2 and A3	R/250 or (R + UA)/250*
A4, A5 and A6	R/250
A7 and A8	R/400

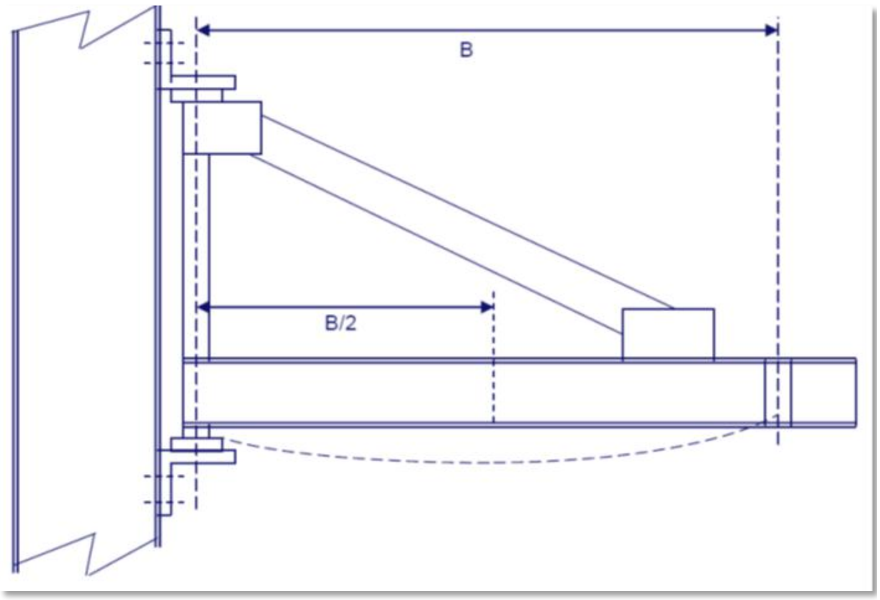
*(R + UA)/250 is only applicable to post-mounted jib cranes

R = Effective radius of jib (expressed as L in our text)
UA = deformable length (i.e. height of post to underside of jib + effective radius)

Notes:

Example Deflection 1

Measuring deflection is a means by which the Tester and Examiner can verify that a design is adequate for the resulting stresses.



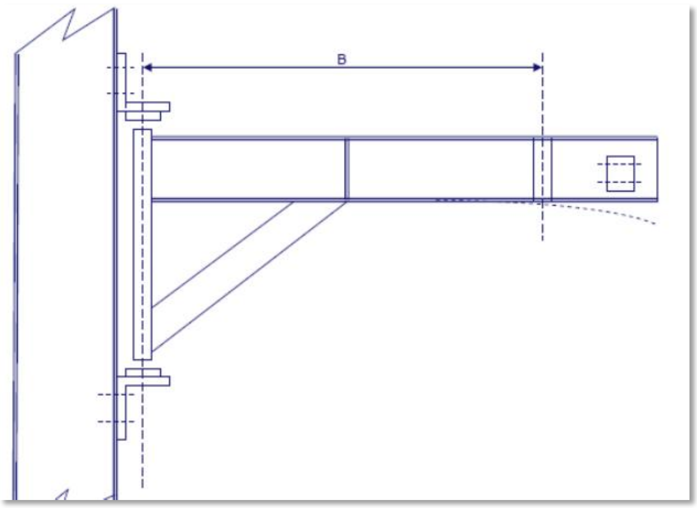
- With the load at radius B, we would expect little or no appreciable deflection of the jib due to the deflection of the jib itself. Since the load is directly under the tie rod connection, the runway would experience only compression

- With the load in the centre of the simply supported section, then we would expect some deflection but **not more than L/500**

If the jib arm is rotated through 90° and the same SWL applied at radius B, an increase in deflection would suggest lack of rigidity of supports or movement of brackets on steelwork. This is true for both over and under-braced arms.

Notes:

Example Deflection 2



- For an under braced jib arm with the SWL at B, we would expect the jib to deflect because it is a pure cantilever. We would not expect the jib arm only to deflect more than **B/250**

- The total measured deflection may be a lot higher due to the supporting steelwork moving

Notes:

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Free Standing Jib Deflection

- The deflection of the jib arm is a result of a number of deflections
- All structural members deflect under load and the jib cranes indicated could be treated as cantilevers
- **Note:** In accordance with standard practice for cantilever members, deflection 'B' is limited to L1/250 and actual deflection of the jib is limited to L2/250
- If the column and jib are of equal structural sections, the permissible deflection of L1 + L2/250 is acceptable, but this is the ONLY case where this applies

Understanding the Formulae

This information applies to the examples that follow this page:

$$D1 = (\text{Deflection at A} + \text{Deflection at B}) \times \left(\frac{L2}{L1}\right)$$

$$D1 = \text{Deflection B} \times \left(\frac{L2}{L1}\right)$$

D1 = Downward deflection of jib due to column deflections A + B
D2 = Calculated actual deflection of jib. (D3-D1)
D3 = Total measured deflection of jib

Notes:

Free Standing Jib Deflection

For free standing jibs, the formula to calculate deflection is:

$$D1 = (\text{Deflection at A} + \text{Deflection at B}) \times \left(\frac{L2}{L1}\right)$$

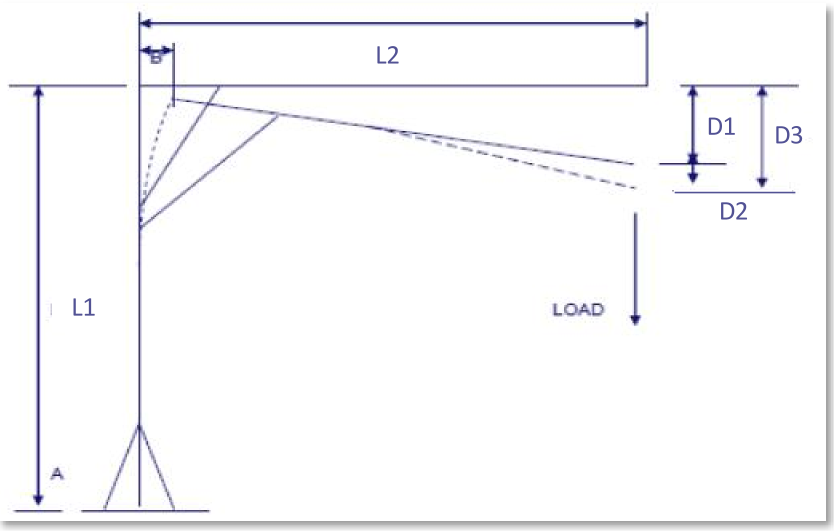
Where D1 = Downward deflection of jib due to column deflections A + B

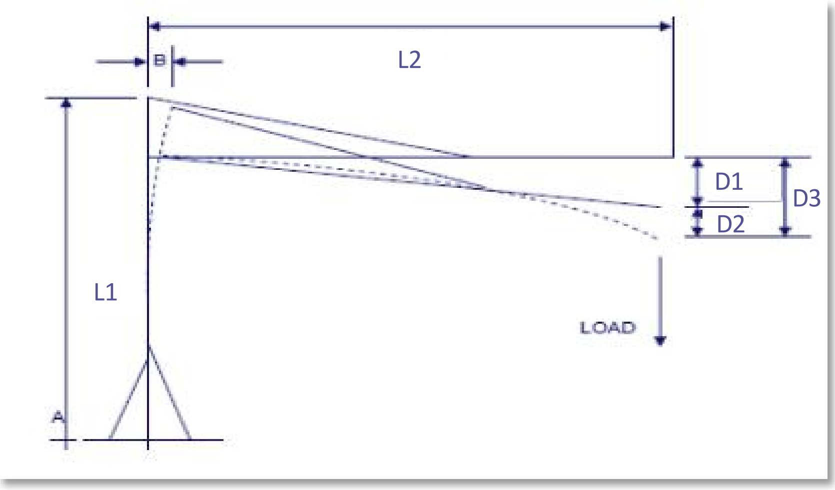
D2 = Calculated actual deflection of jib = D3 − D1

D3 = Total measured deflection of jib

For the following jib types, the columns have fixed bases and deflection ‘A’ = zero, therefore the formula is reduced to:

$$D1 = \text{Deflection B} \times \left(\frac{L2}{L1}\right)$$





Notes:

Column Mounted Jib Crane

The couple on the support column introduced by the load at the jib end causes deflections A and B.

To calculate the deflections:

$$D1 = (\text{Deflection at A} + \text{Deflection at B}) \times \left(\frac{L2}{L1}\right)$$

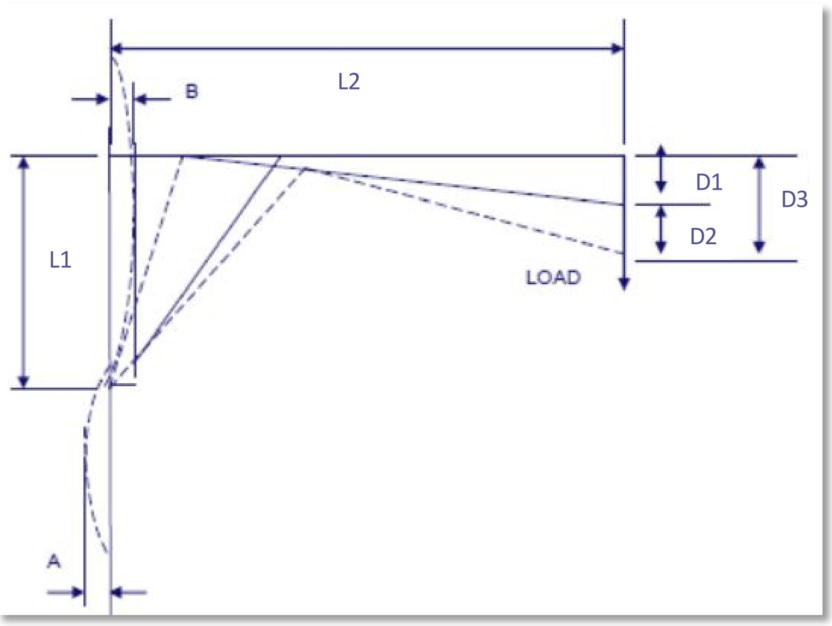
Where D1 = Downward deflection of jib due to column deflections A + B

D2 = Calculated actual deflection of jib = D3 − D1

D3 = Total measured deflection of jib

Alternatively, the total deflection of L1 (slope over A and B) may be used as deflection B.

$$D1 = \text{Deflection B} \times \left(\frac{L2}{L1}\right)$$



Notes:

15. DAVITS

Introduction

A **davit** is a portable structure typically constructed from a beam or strut, which is fastened to a vertical post and used with a socket. It can be fitted with a portable lifting appliance which is positioned to provide easy access to the operator.

A **socket** is a permanent or temporary interface for the davit with a structure. It can facilitate slewing motion. These also can be portable, designed with a base and may include ballast to ensure stability.

Owing to its simple design and versatility, davits and sockets are increasingly being used as portable structures primarily for light duty maintenance, lifting people, and fall arrest applications.

To maintain portability, these davits are usually of the manually operated type, although some will operate with power operated lifting appliances.

The advantage of the socket is that one davit could be used with a number of sockets situated at key locations around a worksite.

Note: A davit is a name more commonly associated with the system used to raise and lower rescue or work boats on or off a ship or offshore installation. They are also commonly used as the suspension rig for Suspended Access Equipment.

Each of these applications are covered by EU regulations and standards, such as the Marine Equipment Directive and BS EN 1808:1999+A1:2010; Safety requirements on suspended access equipment; Design calculations, stability criteria, construction; Tests. For this reason, they have been excluded from the scope of this course.

This module has been designed to support the installer, Tester and Examiner in the correct method of verifying portable davits.

This module does not cover the design of the davit and socket, neither does it apply to jib cranes covered by BS 7333.

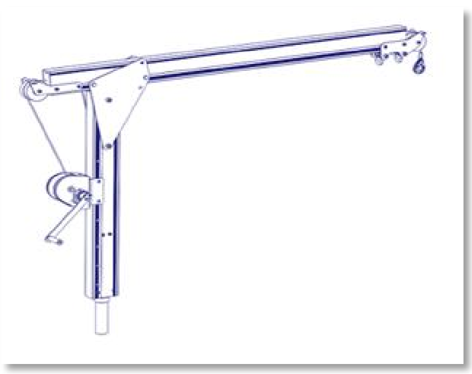
This guidance does not cover davits installed in masonry, where special guidance must be sought from the manufacturer or BS 8539.

Terms and Definitions

Davit

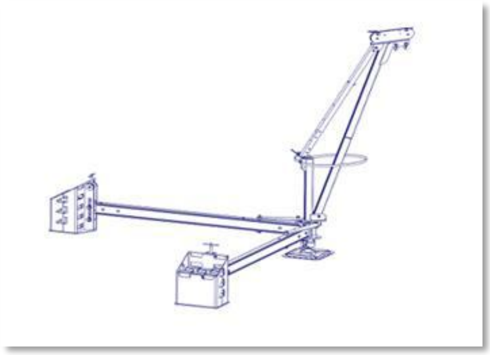
A portable structure typically constructed from a beam or strut, which is fastened to a vertical post and used with a socket. It can be fitted with a portable lifting appliance which is positioned to provide easy access to the operator.

Typically, a winch wire would then extend along the beam or strut, which has a sheave mounted at its end to allow the wire rope to hang vertically. Another configuration would exclude the winch and sheave and instead the strut would terminate in a hook or shackle to which a portable lifting appliance could be fitted, refer to the examples on the next slide.

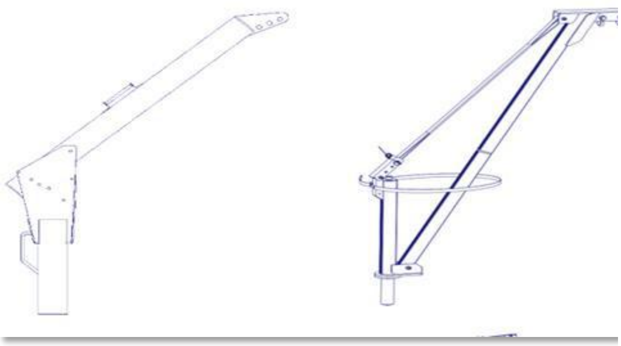


Davit with Winch

Free Standing Davit



Counterweight Free Standing Davit



Davits with Appliance Suspension Points

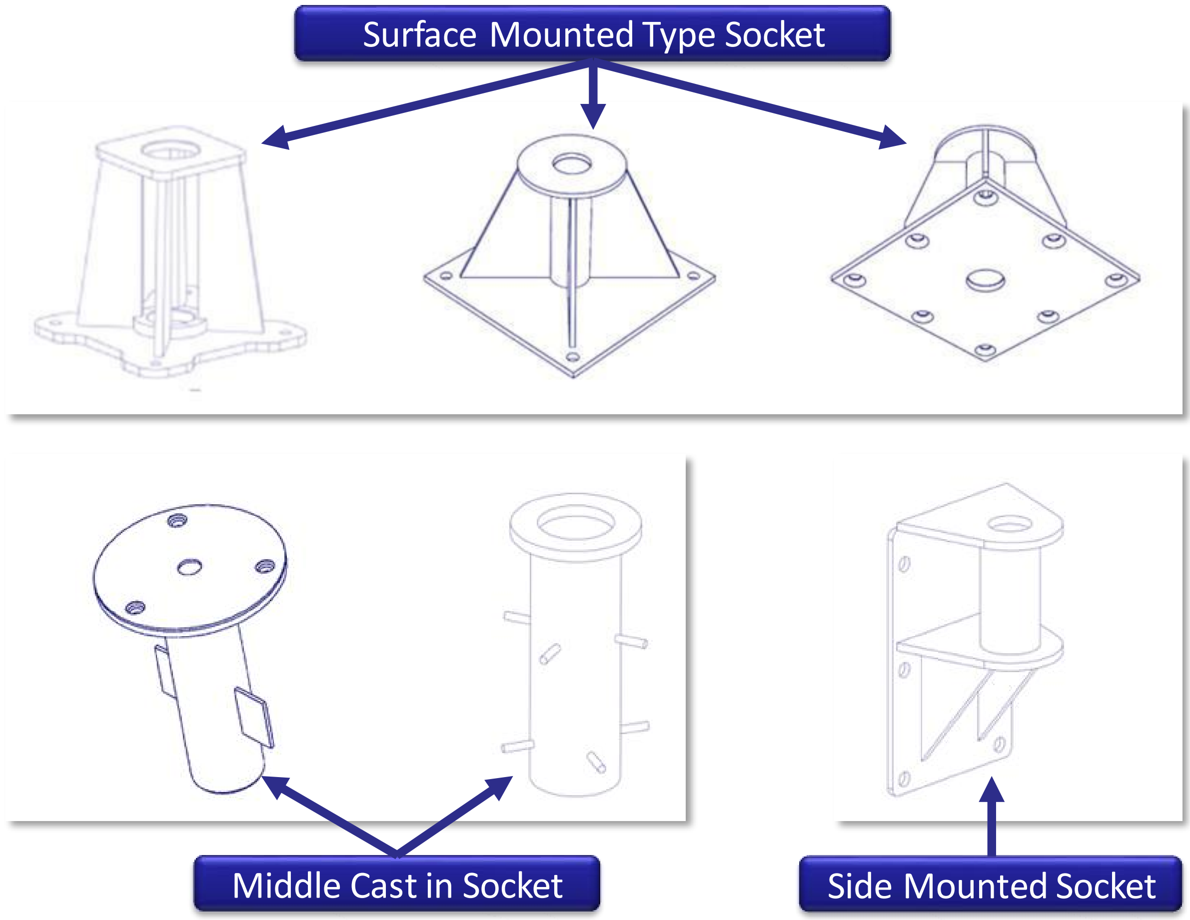
Fall Arrest Davit
A “davit” designed to be used in conjunction with relevant PPE.

Goods Lifting Davit
A “davit” generally used for low duty cycles and maintenance applications.

Socket
A permanent or temporary interface for the davit with a structure - examples shown on the next page. It can facilitate slewing motion. These also can be portable, designed with a base and may include ballast to ensure stability.

Typical Socket

Typical Sockets



Notes:

Working Load Limit (WLL)

The working load limit (WLL) is the maximum load (mass) that an item of lifting equipment is designed to raise, lower or suspend. In some standards and documents the WLL is referred to as 'maximum safe working load' or 'rated capacity'.

Standards and Legislation

The legislation for this equipment will vary slightly depending on the design intent. Also in the absence of a specific standard, the choice of standard would also be dependant on the intended use. The following sections offer guidance as to the specific choices that should be made. In terms of supply legislation, section 6 of the Health and Safety At Work etc. Act 1974 always applies.

Supply Legislation for Lifting Davits and Davits for People Carrying.

If the davit is fitted with a winch or other lifting appliance the Supply of Machinery (Safety) Regulations 2008 would also be applicable and would require the assembly to be CE marked. If it is just supplied as a davit without a lifting appliance, then the regulations do not apply as supporting structures are not within scope. However, if the manufacturer does not supply the lifting appliance, but specifies the limitations on the lifting appliance that can be used with a davit, i.e. type, speed, weight and installation instructions for example, then the davit manufacturer can take responsibility for the final assembly and can CE mark it and issue an EC Declaration of Conformity.

Supply Legislation for Fall Arrest Davits

For davits that can be used for fall arrest, the PPE directive applies and the structure must be CE marked. These structures are also within the scope of EN 795 class B.

In Service Use

Davits are considered as work equipment and therefore the Provision and Use of Work Equipment Regulations 1998 (PUWER) apply regardless of the intended use.

The Lifting Operations and Lifting Equipment Regulations 1998 (LOLER) apply if used for lifting.

If the davit is used for people carrying and/or fall arrest, then the Work at Height Regulations 2005 would apply.

Notes:

Documentation

Supply Documentation

Due to the differences in standards and legislation concerning lifting davits and those used for fall arrest the supply documentation requirements vary. The following sections describe the requirements for each.

Lifting Davit Supply Documentation

Davits supplied without a lifting appliance are considered as supporting structures and are therefore not within the scope of the Supply of Machinery (Safety) Regulations 2008. They should however be sent with a manufacturer's certificate that contains at least the following information:

- Name and address of the manufacturer
- Description of the equipment, type, and working load limits
- Serial number, if any
- The test loads to be applied
- Name, position and signature of the responsible person

For davits that are fitted with a portable lifting appliance, or supplied as described in section 4.1 of "LEEA-061 Guide to the Verification of Davits", then they must be issued with a EC Declaration of Conformity which must contain the following minimum information:

- The name and address of the manufacturer
- The name and address of the manufacturers authorised representative, where appropriate
- The name and address of the person responsible for compiling the technical file
- Description of the equipment, type, serial number and WLL
- The standards and specifications used
- The place and date of the declaration
- A declaration claiming conformance with the essential health and safety requirements as defined in the directive 2006/42/EC
- Name, position and signature of the person making the declaration

Fall Arrest Davit Supply Documentation

With regards to fall arrest equipment an EC Declaration is required as follows:

- The name and address of the manufacturer
- The name and address of the manufacturers authorised representative, where appropriate
- Description of the PPE, make, type, serial number, etc.
- Declaration claiming conformity with council directive 89/686/EEC and the harmonised standard EN 795
- Where applicable certificate numbers of the notified body
- Where applicable, the PPE directive quality control system in place and the monitoring notified body and their identifying number

Notes:

Instructions for Use

Instructions for use and maintenance must be supplied with the davit. These will vary depending on the intended use. The intended use must be specified in the instructions as well as any reasonably foreseeable misuse. The following sections offer guidance to the content for each type.

Contents

Each instruction manual must contain at least the following generic information, however, additional information may be required for bespoke davits or additional fitted devices:

- The business name and full address of the manufacturer
- Name or code number given to the model of davit to which the instructions are for
- If supplied with hoist or winch incorporated, then a copy of the particulars within the EC Declaration of Conformity
- A general description of the davit
- Drawings, diagrams, descriptions and explanations necessary for use, maintenance and repair of the davit and for checking correct functioning
- The technical characteristics of the davit, and in particular:
    - The working load limit
    - The reactions at the supports or anchors
    - Where appropriate, the definition and the means of installation of the ballast
- The test loads that must be applied following installation
- A description of the controls
- A description of the intended use
- Warnings concerning ways in which the davit must not be used that experience has shown that may occur
- Assembly, installation and connection instructions, including drawings, diagrams and the means of attachment to the davits foundation. **Note:** The foundation is the responsibility of the end user
- Instructions for the putting into service and use of the davit and, if necessary, instructions for training of operators
- Information about residual risks that remain despite the inherent safe design measures, safeguarding and complementary protective measures adopted
- Instructions on the protective measures to be taken by the user, including, where appropriate, the PPE to be provided
- The essential characteristics of devices that may be fitted to the davit Instructions with a view to ensuring that transport, handling and storage operations can be made safely, given the mass of the davit and of its various parts where these are regularly transported separately
- The operating method to be followed in the event of accident or breakdown
- A description of the adjustment and maintenance operations that should be carried out by the user and the preventive maintenance measures that should be observed
- Instructions designed to enable adjustment and maintenance to be carried out safely, including the protective measures that should be taken during these operations
- The specifications of the spare parts to be used, when these affect the health and safety of operators

Contents of the Instructions for Fall Arrest Davits

The instructions for fall arrest davits are generally as above. However, this information is complementary to the information required by BS EN 365 Personal protective equipment against falls from a height, general requirements for instructions for use, maintenance, periodic examination, repair, marking and packaging and BS EN 795 Personal fall protection equipment, Anchor devices.

Notes:

Marking Requirements

Davits should be clearly and permanently marked by the manufacturer as follows:

- The name and address of the manufacturer
- The CE mark, if supplied with integrated lifting appliance or as described in section 4.1 of "LEEA-061 Guide to the Verification of Davits"
- Number of the notified body responsible for verifying the quality process, where applicable
- The serial number, if any
- Designation of series or type
- Year of construction
- Maximum working load in tonnes or kilograms, or for people carrying the maximum number of people and weight restrictions

Marking for Fall Arrest Davits

The fall arrest davit must be marked with the following information:

- Means of identification, e.g. manufacturer's name, supplier's name, or trademark;
- The CE mark
- The number of the notified body responsible for verifying the quality process, where applicable.
- Manufacturer's production batch or serial number or other means of traceability;
- Model and type/identification
- Statement that specifies the maximum number of people it can be used with
- Pictogram or other method to indicate the necessity for users to read the instructions for use
- Number and year of the document to which it conforms, i.e. EN 795:2012

Marking for Sockets

Sockets must be marked with information that defines the type of davit (i.e. manufacturer, size or capacity) that can be used safely with it.

Notes:

Verification Following Installation

- In general, the davit will have been factory tested, however sockets must be tested following installation to supplement the PUWER inspection or LOLER thorough examination.

- This section concentrates on the testing following installation, as it is much more critical in placing the item into service, particularly if one davit is used with multiple sockets.

- An adequate test specification must be drawn up against the design criteria, which should be obtained from the manufacturer. Acceptance criteria, such as maximum permissible deflections, deformations or no free movement for worst case loading conditions, etc., must be included in the specification.

- A load test should always be planned on the assumption that the item under test might fail. Adequate precautions should be in place to prevent injury to any persons or damage to anything other than the item under test. For guidance, refer to **LEEA 017 Process Control Procedures**.

- To meet the design criteria the test must accurately simulate the in-service loading conditions for which the davit has been designed

- Depending on the design intent, i.e. lifting or fall arrest, the test procedure will vary slightly as the following sections will explain

Notes:

Foundation Specification and Verification

It is the responsibility of the davit manufacturer to specify the size and type of anchor to be used and to provide worst case reaction forces at each anchor under normal operation. It is recommended that the anchors used meet the requirements of a European Technical Approval (ETA). This information should then be passed on to the building owner, who is responsible for ensuring that adequate foundations are provided for the davit.

If the foundations are of adequate strength, the davit can be installed and then tested in accordance with the instructions as follow, and as applicable.

Load Testing Lifting Davits

Prior to the application of the test load in accordance with the manufacturer's installation instructions, special attention must be paid to:

- The security of nuts and bolts
- Condition and grade of the concrete or other supporting structure, whether a 'cast in', surface mounted socket or other type is used
- Level of the socket in accordance with manufacturers tolerances
- Joints, connections and supports

Once the preliminary inspection has been carried out, a test load equivalent to the working load limit shall be applied to the test davit. The load shall be kept at rest while stable deflection readings are recorded and compared with the manufacturer's limits.

For davits that can be fitted with a portable lifting appliance to facilitate the lifting, the test load should include the self-weight of the appliance unless the manufacturer has specified the type or size and weight of appliance that has been included in the design.

Likewise, the self-weight of lifting accessories used should also be taken into account.

- The loads shall be measured by a load cell calibrated to BS EN ISO 7500-1, such that the sum of the inaccuracies of the load and the load cell do not exceed ±2%. Where containers may be required to house the weights, the self-weight of these containers must be considered

- Repeat the procedure above using the proof load and record the stable net deflection
    - The proof load applied shall be 125% of the working load limit for goods lifting, or 150% of the working load limit for people carrying
    - For multipurpose davits and their sockets, the test load would be applied to the rated capacity for each purpose. The proof load may only be applied to whichever is the higher
    - The davit should also be rotated through 360˚ to simulate the use of the davit and to load all combinations of socket/anchors accordingly
    - Where site constraints prevent 360˚ rotation, loadings should include rotation through the most probable arc of usage

Note: During the application of the test load and of the proof load, keep the davit, socket and foundation under visual observation to detect any obvious defects in the installation.

- For davits fitted with a running trolley the maximum measured deflection under the working load limit, relative to its supports, shall not exceed the manufacturer's specification

- To ascertain whether or not the acceptance criteria has been met, the tester will need to use measuring equipment. This measuring equipment will depend on the acceptance criteria, but it must be calibrated, and may include dial test indicators, strain gauges, etc. Equipment used for measuring deflections must have a sufficient resolution to allow the measurement to within ±5% of the permitted deflection of the structure under test

- Following the proof force test, the davit must be thoroughly examined.

- This test procedure should be conducted for all sockets in all worst case loading conditions with which a davit is to be used

Notes:

Tests to Check Quality of Installed Anchors

- To prove the installation of the anchor bolts installed in accordance with the ETA for the davit socket, they can be tested using a hydraulic pull cylinder. The cylinder must have a calibrated dial or used with a calibrated load cell such that the sum of the inaccuracies of the load and the load cell/dial do not exceed ±2%

- The load must be applied to a minimum of 2.5% and at least 3 of the total number of anchors installed for each socket. The test load to be applied is 1.25 times the maximum, worst case, reaction load on the anchor as specified by the davit manufacturer

- Anchors can be said to have satisfied the test if the required load is held without movement and without any damage or deformation occurring to either the fixing or the foundation. It is recommended that the foundation is white washed so that any cracks will be more visible

Note: There are other variables to consider when verifying the installation of a davit so it may be more practicable to test the socket and davit together to verify that the anchors, socket and davit have been installed correctly. In this case, and providing the foundation is of known strength, then the guidance provided in this module should be followed where applicable.

The Thorough Examination

- Regardless of use, a davit will need to be thoroughly examined following installation, periodically and following exceptional circumstances

- When conducting the thorough examination, the davit and socket must be cleaned of dirt and debris. Any accumulation of water should be drained to ensure that all critical components can be examined effectively

- If the local lighting is not adequate for examination purposes it should be supplemented by portable lighting

Thorough Examination Following Installation

Following installation, the davit should be tested according to intended use as per the procedures defined in this module, then thoroughly examined. The examinations should include these checks:

- Check for clear identification number
- Check for clear marking of WLL
- Check structure of davit and socket is free from distortion, corrosion, cracks, gouges, or wear
- Check all welded connections are free from cracking or corrosion
- Check that any bolted connections are free from corrosion and cracking and that all are secure using the correct bolts
- Check all major components of any integrated portable lifting appliance for wear, damage or corrosion
- Check bottom hook and loose end anchor pins for wear, damage, and security to load chain/hoist
- Check the portable lifting appliance rope along its whole length for kinks, exposure of inner core, flattening, broken wires, broken strands, and corrosion. Refer to ISO 4309 for rejection criteria. Or for chain, check along its whole length for stretched, distorted, worn, corroded, chain links. Refer to ISO 7592 for rejection criteria
- Check hoist rope ferrule eye for security, cracking, indentations, or corrosion
- Check hoist rope for its security to its anchorage point and the winch drum
- Check the winch for correct operation and that the brake operates correctly and is effective
- Check functionally in the up/down mode preferably with a light load to confirm the integrity of the brake and other load bearing components
- Check that sheave wheels are free from cracks, chips, distortion, nicks, gouges or wear
- Check that axle pins are free from distortion, nicks, gouges or wear
- Check that any shackles are free from distortion, nicks, gouges or wear
- Check that all shackle pins are captivated preferably with a nut and pin arrangement
- Check free standing or counterbalance davits for correct configuration

Note: That this list is not exhaustive and some configurations may require additional checks. Manufacturer's instructions should also be referred to.

Notes:

Documentation Following the Installation Examination

The use of the davit will determine the legislative requirements and therefore the minimum documentation required. However, the requirements only differ slightly and all requirements are good practice regardless of use, so LEEA have merged the requirements into one report to be used as a best practice document. This is referred to as a **Report of Thorough Examination** and the contents are as follows:

- The date on which the proof load was applied and the thorough examination made
- Date of the report
- Report number
- Name and address of employer for whom the thorough examination was made
- Address of the premises at which the examination was made
- Description and identification of the equipment which must include its distinguishing number or mark
- The position and magnitude of the deflections obtained during the test at WLL and the proof load
- The working load limit
- Date of manufacture and service life expiry date, if applicable
- Reason for the examination, i.e. after first installation and before being used for the first time
- Particulars of any defect found during the examination and affecting the working load limit and the particulars of the steps taken to remedy such defect
- A statement stating that the equipment is safe to operate or not
- A statement indicating clearly that it applies to the davit only and not to any trolley or lifting appliance that may be fitted separately and at the discretion of the user
- Date of next thorough examination
- Name, signature and qualifications of the person making the report
- Name and signature of person authenticating the report
- Name and address of the employer of persons making and authenticating this report

The report should also include a warning against misuse of the davit drawing attention for the need to inspect the sockets and davits before each occasion of use.

Periodic Thorough Examination

Periodic Thorough Examination

- All davits and their sockets will be subject to statutory periodic examinations. Typically, this will be every 12 months, however, for davits used for lifting people the requirement would be every 6 months. In addition to the thorough examination, the davit and socket must be checked before each use for any damage or deterioration

- The examination should be a careful visual examination, supplemented where relevant by other tests including non-destructive testing of critical welds and checking the tightness of pre-loaded bolts, in order to arrive at a reliable conclusion as to the safety of the davit. If dismantling is necessary for the purpose of the examination, the load test and bolt tightening checks shall be repeated after assembly. This does not include any dismantling as intended by the manufacturer in terms of normal use, i.e. the removal of the davit from the socket

- The periodic examination should follow the same checklist procedures as specified for Thorough Examination following installation

Note: Load testing is at the discretion of the Competent Person, but routine overloading is not recommended. The Competent Person may want to verify the deflections as recorded in the initial report, but this can be achieved at working load limit.

Notes:

Documentation Following Periodic Thorough Examination

When a thorough examination only is made of a socket and davit already in use and for which a report of thorough examination has been granted, the report of such examination must contain the following information:

- The date of the report
- Date of the report
- Report number
- Name and address of employer for whom the thorough examination was made
- Address of the premises at which the examination was made
- Description and identification of the equipment which must include its distinguishing number or mark
- The working load limit
- Date of manufacture and service life expiry date, if applicable
- Reason for the examination, i.e. 6 monthly, 12 monthly or in accordance with an examination scheme
- Particulars of any defect found during the examination and affecting the working load limit and the particulars of the steps taken to remedy such defect
- A statement stating that the equipment is safe to operate or not
- A statement indicating clearly that it applies to the davit only and not to any trolley or lifting appliance that may be fitted.
- Date of next thorough examination
- Name, signature and qualifications of the person making the report
- Name and signature of person authenticating the report
- Name and address of the employer of persons making and authenticating this report

Verification Following Exceptional Circumstances

Lifting equipment will require a thorough examination after exceptional circumstances which could affect the safe operation of the equipment. An exceptional circumstance would include, for example, a major modification, repair, over load, known or suspected damage or a change in the nature of use.

Due to their portable nature, davits will inevitably get abused or even misused in service resulting in damage and the need for repair. Whenever a davit requires repair it is advisable that the cause of the damage is investigated. It may be that the equipment is no longer adequate for the task.

Verification Following Repairs

Following the repair the equipment should be thoroughly examined by a Competent Person. If the repair is such that the load bearing capability may be affected, then the thorough examination may need to include NDT and/or a load test.

Modification and Verification

- There are a variety of reasons why a davit may be modified during its life. It may be that the product it lifts has been altered requiring different reach distances or an increase in weight for example

- If the davit or socket is modified in a manner that is not supported by the original manufacturer, then the modifier is fully responsible for the modified socket and/or davit

- Whatever the reason, it is important that the original design specification, test data, and technical file is referred to where possible. In the absence of this information then the person responsible for the modification will have to make assumptions about certain aspects of the design in order to minimise the risks associated with the modification. For example, assume the lowest grade of steel for calculation purposes

- The modification should then be treated as making a new davit from second hand materials and the modifier must ensure that all applicable essential health and safety requirements are met

Pre-Use Inspection

- Pre-use checks should be carried out before each new use or at the start of each shift during which the davit and socket are to be used. These are to test the functionality of the davit and socket and visually check for any obvious defects. It is essential that these are carried out from a position of safety.

- In the event that equipment fails the pre-use check, then there should be a procedure to quarantine the equipment and effectively prevent further use until the problem has been resolved.

In Service Inspection

- A regular in-service inspection should be made to identify any defects which might not be detected by the pre-use checks. In-service inspections should be carried out at intervals which ensure that any deterioration is identified before there is a risk of failure of the davit or socket or injury to persons

- It might be convenient to schedule the inspections concurrently with planned preventive maintenance

- The period between inspections should be decided on the basis of the frequency of use and the environmental conditions and might need to vary between 1 week and 6 months. The period should be kept under review and adjusted according to the results of the inspections

- In the event that equipment fails the pre-use check, then there should be a procedure to quarantine and effectively prevent further use until the problem has been resolved

Storage

- It is important that when the davit is not required for use it can be set down and stored such that it is protected from damage

- If the davit is fitted with ancillary items, then the storage should also provide effective protection for them

- Alternatively, these items should be removed and stored separately. In the latter case the identity of the equipment must be maintained

Notes:

16. EXAMINATION AND TESTING OF SLEWING SWING JIB CRANES

Safety During Site Examinations and Tests

Safety whilst carrying out Site Examinations and Tests

Prior to working on site, the Tester and Examiner must always adopt the following precautions to ensure the safety of themselves and others:

- The person carrying out the examination or tests on site must report initially to a responsible person on site, giving full information of the work to be done and the safety precautions to be adopted by both the examiner and site personnel
- Observe all statutory safety requirements as to safety on working on cranes, hoists, ladders, scaffolding and other equipment detailed in the various Acts and Regulations
- Check or obtain assurance of the adequacy of anchorages and points of suspension to or from which equipment is to be attached or suspended, taking full account of the test load that is to be applied
- Obtain assurance as to the adequacy of floors, passages and standing over which the test weights will travel and stand
- Isolate power supplies during examination and take steps to prevent the reconnecting of power supplies before the examination or tests are completed
- Carefully select the test areas and take steps to protect personnel and property

Existing Installations

Prior to the examination the person carrying out the examination shall:

- Check previous records such as a declaration of conformity, test certificate, examination report and company records
- Enquire or have been informed of the Act or Regulations under which the examination is to be carried out, e.g. the Lifting Operation Lifting Equipment Regulations 1998 (LOLER) so that any special requirements can be incorporated in the examination and the official report

The examination shall be carried out by a Competent Person in adequate natural or artificial light and shall cover the jib crane, fixings and components. These shall include:

- Foundation bolts
- Base plates
- Web plates
- King post
- Bearing brackets (bolts, welds etc.) running surfaces
- End stops
- Tie rods or struts and power feed system

The operation of the trolley used on the jib arm must be checked for suitability of use and examined in accordance with the LEEA Code of Practice for Lifting Machines, power or manual, as applicable.

The identification number, SWL and description shall be checked with the test certificate and any discrepancies with the original description reported. Where markings have become illegible they shall be re-stamped or marked.

The written report shall give description of the jib crane examined, the date of the examination and a clear statement of its fitness for further use or details of the defects which affect the SWL and other observations, the name of the person carrying out the examination and the Regulations or Acts under which this examination was carried out. Where an article is defective, a responsible representative of the user must be informed.

If dangerously defective, arrangements must be made for preventing its further use. Where Regulations or Acts require statutory notification of defective equipment steps must be taken to ensure notification to the correct authority.

Notes:

Thorough Examination and Testing of New Installations

Testing and Inspection

Duty of the Certifier

The person signing the certificate shall satisfy himself that the crane complies with BS 7333 which requires that allowable stresses for structural steel are not exceeded and that all other requirements where applicable to BS 2573 Part 1 are complied with.

Deflection Parameters

Where necessary, the Tester and Examiner should make their self familiar with the deflection parameters of a particular make of jib crane as proprietary track systems may be more restrictive than permitted by the classification given in BS 7333.

Accuracy of the Weights

Where practicable, the load used shall be made up of certified weights. In other cases, the weight shall be measured by a recognised form of certified weighing machine, such that the sum of the inaccuracies of the load and weighing machine do not exceed ±2%. The load referred to includes the test frame, chain slings, tackle, etc. and the weighing machine used on the actual test.

Amount of Proof Load

The proof load applied shall be 25% in excess of the SWL of the jib crane or lifting appliance, whichever is the smaller.

Note: If the lifting appliance to be used with the crane is of lower capacity than the crane the crane can only be marked with the SWL of the appliance. Where the full SWL of the crane is required it is then necessary to use a lifting appliance of suitable capacity for the test.

Inspection before Application of Loads

All foundation bolts, base plates, web plates, king posts, bearing, brackets (bolts, welds etc.), running surfaces, end stops, tie rods or struts shall be examined. If wall or column mounted special attention must be paid to the condition of walls, methods of fixing and in all cases it shall be the responsibility of the purchaser in consultation with their architect, consulting engineer or other competent authority, to satisfy the examiner that the supporting structure is suitable for the loading to be applied.

Special consideration must be given to free standing jib cranes, the method and adequacy of fixing and type of foundation.

Likely Causes of Failure

Likely causes of failure of a Jib Crane

	Cause of Failure	Reason
1	**Trolley running away**	Due to excessive slope, which is a result of excessive deflection, movement in bearings etc.
2	**Jib slewing out of control**	Due to excessive movement of column supports, inadequate foundations loose bearings or if king post is out of plumb
3	**Bounce**	Normally the result of incorrect crane classification or of wrong block selection. E.g. loading components on to a machine bed using a single speed hoist when a dual speed hoist should have been fitted results in damaged components and machine
4	**Excessive effort to bring trolley back along jib arm**	Due to excessive slope, which is a result of excessive deflection

Notes:

Examination and Testing of Swing Jib Cranes

Maximum Deflection Allowances

Although BS 7333 gives figures for the maximum allowable deflections, it makes clear that whilst these deflections must not be exceeded, they are not the main criteria. A jib may satisfy the deflection requirements, thereby confirming that the stress allowances are adequate, but fail the test as the resulting slope causes the trolley to run away or become difficult to operate. Deflection can also result in the jib arm slewing on its own and other similar occurrences which make it unsafe to use. In most cases these effects will become apparent long before the maximum deflection is reached

Maximum deflection allowances apply to the crane structure only. That is, the deflection of the jib arm (if wall or column mounted) or the combined deflection of the post and jib arm (if free standing). Other deflections may arise from the supporting structure, foundations, slackness in bearings and of pins etc. The overall effect of all of the possible deflections must therefore be taken into account when assessing the safety and suitability of the crane

Jib Crane Selection

Many jib cranes are the cause of dissatisfaction although theoretically adequate for the SWL. This is generally the result of poor selection and incorrect classification, it is essential that the crane duty is satisfied, e.g.

- Maximum load to be lifted
- Maximum required radius
- How often used at maximum radius with maximum SWL
- Number of lifts per day
- Type of Block
- Hand or Power
- Chain or wire rope
- Single or dual speed
- Hand or power slew
- Types of load, e.g. sacks of potatoes, general warehouse goods, precision machine tools
- Loading on to: lorries, warehouse floors, machines such as lathes and grinders

The parameters for jib crane selection are all essential and it is equally important that the tester appreciates these points when testing a particular installation.

It is therefore important that the tester has a copy of BS 7333 in order to confirm the correct class of crane is selected for the state of loading and utilisation.

Application of Loads: CASE 1 - Wall or Column Mounted Over-Braced Jib Crane

Application of Loads
Case 1: Wall or Column Mounted Over-Braced Jib Crane

Following preliminary examination, loads should be applied as follows:

1. Measure the height of the jib at the point B and point C against a datum height (reference point)
2. Apply a test load equal to the SWL at the maximum radius (point C)
3. Measure the deflection at B and C. The deflection D3 (measured at C) must not exceed the maximum allowable deflection for the type and class of crane
4. Calculate the actual deflection of the cantilever only

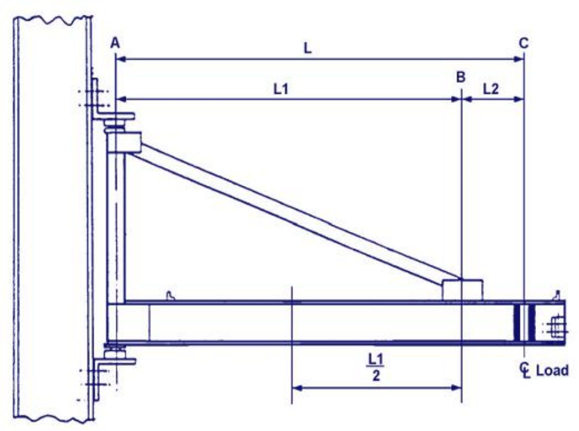


Figure 1

The measured deflection (D3) comprises the true deflection of the cantilever section (D2) plus the deflection arising from the deflection of the supporting brace at B (D1). Deflection B is magnified by the ratio of the overall length L divided by the distance L1 from A to B.

The **actual/true** deflection of the cantilevered section of the jib arm (D2) is

D2 = D3 - D1

D2 must not exceed 1/250th of the cantilever length L2.

$$D1 = \text{deflection at B} \times \left(\frac{L}{L1}\right)$$

Notes:

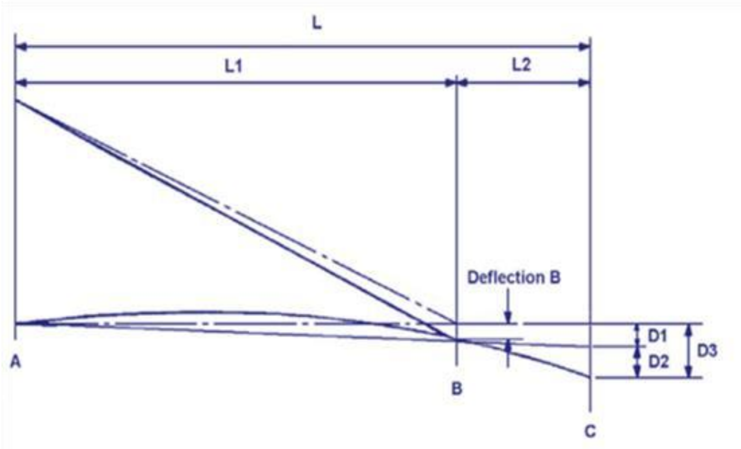
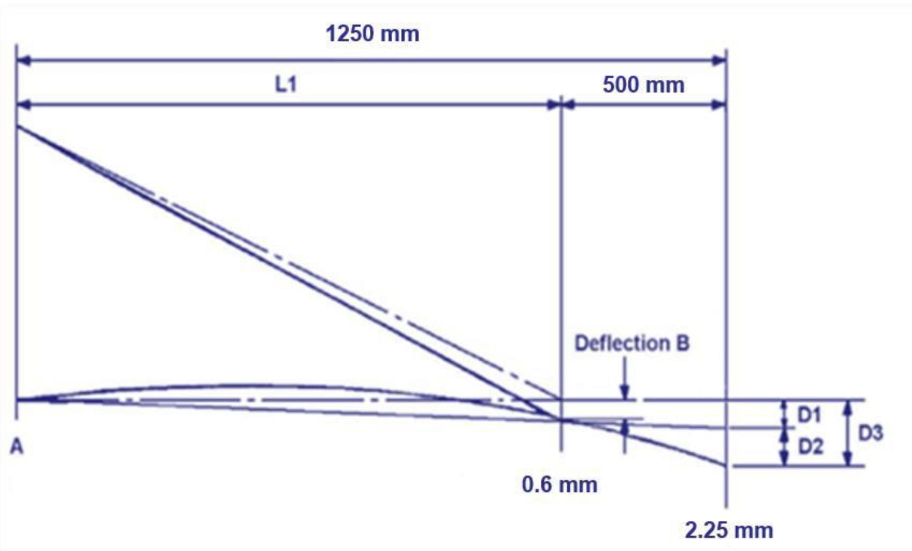


Figure 2

Example:

Overall length (L) = 1250 mm
Canitlever (L2) = 500 mm
Deflection B = 0.6 mm
Measured Deflection (D3) = 2.25 mm



$$D1 = \text{deflection at B} \times \left(\frac{L}{L1}\right) \qquad 0.6\text{ mm} \times \left(\frac{1250\text{ mm}}{750\text{ mm}}\right) = 1\text{ mm}$$

D1 = 1 mm
D2 = D3 - D1
D2 = 2.25 – 1 = **1.25 mm**

Actual/True deflection = D2 = **1.25 mm** Allowable deflection = $\frac{1}{250}$ of L2 = 2 mm

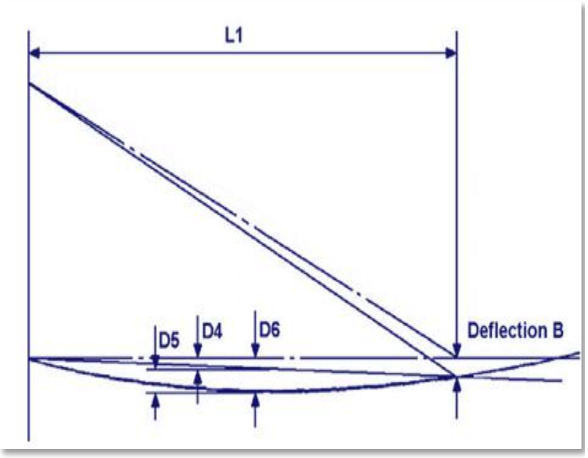
Therefore, in this case the **actual/true** deflection is within the allowable deflection.

Notes:

Application of Loads Case 1: Wall or Column Mounted Over-Braced Jib Crane (continued)

After testing the load on the cantilever end, the load should then be tested on the centre span. Figure 3 shows how the jib arm deflects when the load is at the centre of the span AB.

Figure 3



Deflection of a Simply Supported Section

D4 = deflection of supporting brace
D5 = actual/true deflection at B
D6 = measured deflection

To calculate the actual deflection with the load at this point:

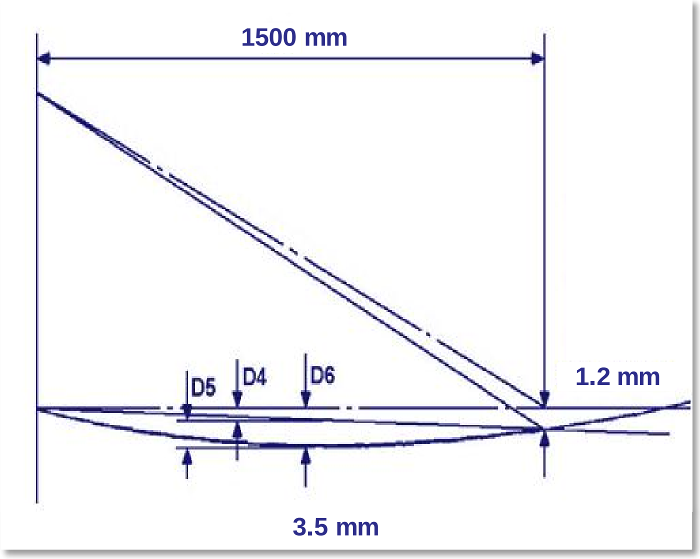
1. Measure the height of the centre span against the datum height.
2. Apply a test load equal to the SWL at the centre of span A to B.
3. Measure the deflection at that position and at point B.

The measured deflection at the centre span comprises the true deflection of the span (D5) plus the deflection arising from the deflection of the supporting brace at B (D4). Deflection B is diminished by the ratio of the distance from A to the centre span divided by L1.

The actual/true deflection must not exceed 1/500th of the span length L1.

Example:

L1	= 1500 mm
Deflection B	= 1.2 mm
Measured Deflection (D6)	= 3.5 mm



$$\textbf{D4} = \text{deflection at B} \times \frac{(½ \times L1)}{L1} = ½ \text{ of deflection at B}$$

$$D4 = 1.2 \times \frac{750}{1500} = 0.6 \text{ mm}$$

D6 = 3.5 mm

D4 = 1.2 mm

The **actual/true** deflection of the span section of the jib arm (**D5**) = D6 - D4.

D5 = 3.5 – 1.2 = **2.3 mm**

Allowable deflection = $\frac{1}{500}$ of L1 = 3 mm

Therefore, in this example, the **actual/true** deflection is within the allowable deflection.

Notes:

Application of Loads Case 1: Wall or Column Mounted Over-Braced Jib Crane (continued)

Note 1: Certain manufacturers of slewing jibs which use proprietary brands of track work to a higher deflection in their light weight installations. The Tester should be aware of such information when testing. (See notes Guidelines on Deflections).

Note 2: With an over strutted jib arm, any vertical deflection at position B would mainly arise from deflection of the supporting structure. This should be allowed for as the permitted deflections stated in the standard are for the crane structure only.

- The jib arm should be rotated through 90°, the SWL lifted again and applied at the maximum radius. The deflection should again be measured at end of jib, position C. Any deflection measured in excess of previous measurement would indicate movement of the fixings or excessive deflection of supporting steelwork

- If no excessive deflection occurs, then jib should be checked with load at maximum radius and moved through the full range of slew

- An overload of the SWL plus 25% should be applied and test procedure repeated. Deflection readings should be taken at 0° and 90° and all motions checked to ensure that satisfactory braking occurs, and there is no tendency to run away or slew unintentionally

Application of Loads: CASE 2 - Column Mounted Under Braced Jib Crane

Case 2: Column Mounted Under Braced Jib Crane

The testing of a column mounted under strutted jib crane (Figure 4) is similar to Case 1, except for checking jib deflection criteria:

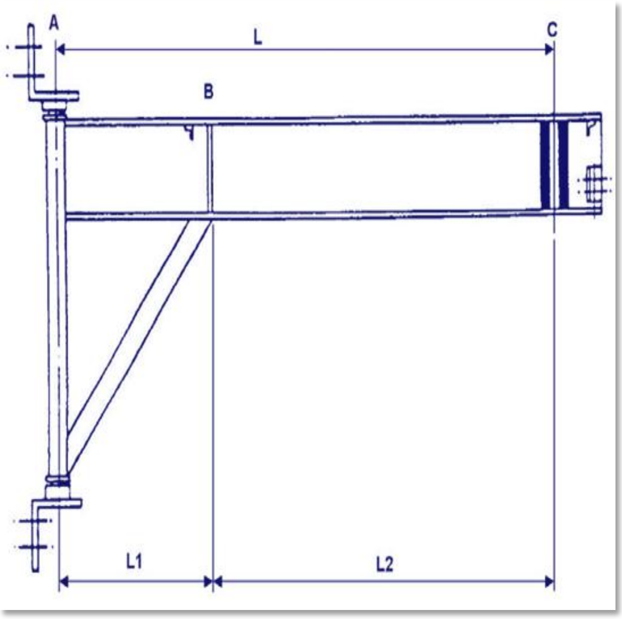


Figure 4

1. Measure the height of the jib at points B and C against a datum height
2. Apply a test load equal to the SWL at the maximum radius, position C
3. Measure the deflection at B and C.

The deflection measured at C must not exceed the maximum allowable deflection for the type and class of crane.

Note: This measured deflection will include any deflection arising from the supporting structure. If it is within the maximum allowable and remains so when the jib is rotated through 90°, then it also proves the rigidity of supporting structure. If it exceeds the maximum allowable, then further measurement will be required to take account of the deflection arising from the supporting structure.

- As with the over braced type of jib, the effect of any deflection at B will be magnified by the ratio of the overall length (L) divided by the distance from A to B (L1)

Therefore the deflection at C arising from the deflection at B will be: $\text{Deflection at B} \times \left(\frac{L}{L1}\right)$

The true deflection of the cantilevered section of the jib arm will be the measured deflection at C minus the deflection at C arising from the deflection at B.

This true deflection should not exceed 1/250th of the cantilever length L2.

Notes:

Application of Loads: CASE 3 - Free Standing Over Braced Jib Crane with Limited Slew

Case 3: The loading of a free standing over braced jib crane with limited slew.
Having carried out the preliminary examination including safety procedures, apply the load and measure as follows:

1. Measure the height of the jib at position C against a datum height.
2. Slew the jib to its extreme positions and measure again.

If the readings are the same, this proves that the axis of the king post bearings is vertical. Any out of vertical could cause the load to slew out of control due to gravity so adjustments must be made to ensure it is vertical before proceeding further

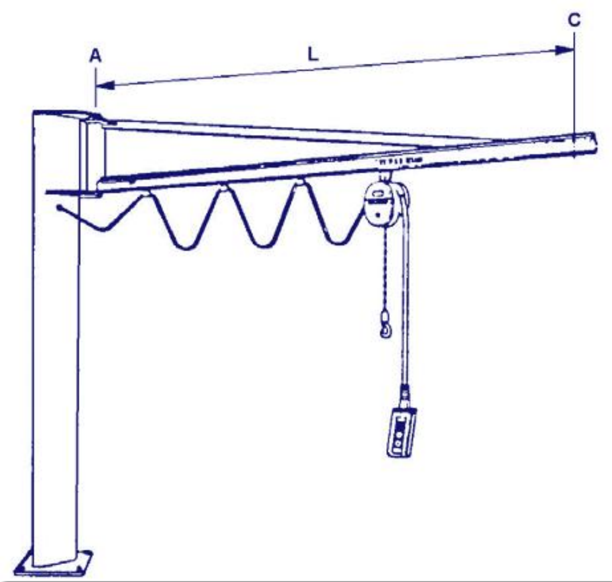
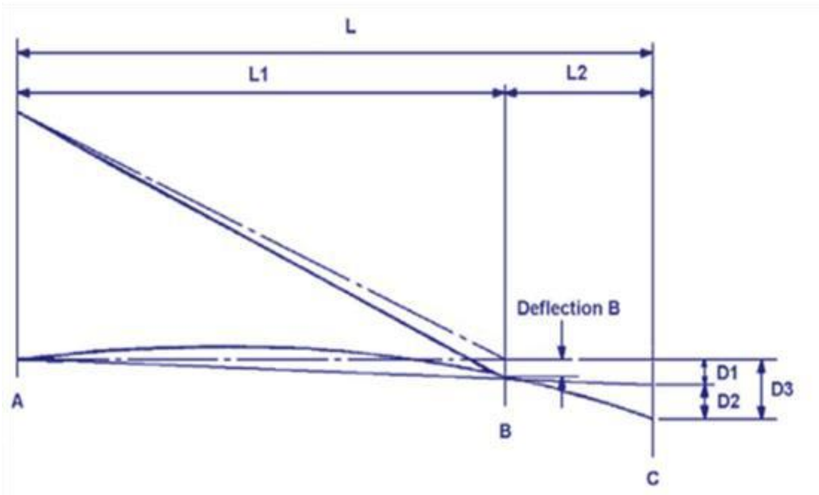


Figure 5

3. Apply a test load equal to the safe working load at the maximum radius. Measure the deflection at C.

It must not exceed the maximum allowable deflection for the type and class of crane. This deflection will be the total combined deflection due to the deflection of the column and some deflection of the jib arm cantilever section. (See below)

4. With the test load applied, slew the jib arm through the full slew range, checking the deflection at several positions. These readings should be virtually the same as the first and within the maximum allowable deflection for the type and class of crane.
5. The true deflections of the cantilever and span sections of the jib arm should then be checked in the same way as shown in Case 1 (Wall/Column Mounted Over Braced Jib Crane)



Notes:

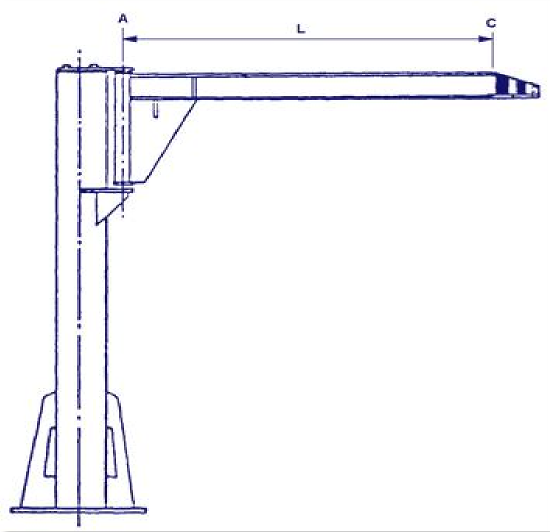
Guidelines on Deflection

Note: Some manufacturers of proprietary brands of track specify a deflection of their jib cranes other than to the British Standard, in which case the Tester and Examiner would avail himself of this information. If this deflection is not exceeded, the hoist unit functions correctly with no tendency to run away, or the jib arm to slew out of control then it is reasonable to accept this deflection as it will be considerably less than that permitted by BS 7333.

Depending on the manufacturer this total deflection could vary from as much as 1/250 of the radius and as small as 1/160.

Application of Loads: CASE 4 - Free Standing Under Braced Jib Crane with Limited Slew

Case 4: The loading of a free standing under braced jib crane with limited slew



1. Check that the axis of the king post bearings is vertical and adjust as necessary to ensure that it is (As shown in Case 3)
2. Apply the SWL at the maximum radius and check the deflection readings through full range of slew. These should be virtually the same and within the maximum allowable for the type and class of crane. This deflection will be the combined deflection due to the deflection of the column and in this case the deflection of the cantilevered jib arm
3. The true deflection of the cantilever section of the jib arm should then be checked in the same way as shown in Case 2 (Column Mounted Under Braced Jib Crane)

This type of jib crane generally requires much heavier sections due to much higher deflection characteristics of the cantilever jib as against an over braced jib.

Notes:

Application of Loads: CASE 5 - Free Standing Jib Crane with 360˚ Slew

- This type of jib crane would be tested in exactly the same way as a limited slew construction except deflection readings would be taken at 0°, 90°, 180°, 270° of slew

- The rollers and roller path are subject to very high stresses because of the line contact between the roller and path. The path in particular should be carefully examined for excessive wear or plastic deformation of the metal with possible cracking of the surface

- If an external ring is fitted, check for cracking of the welds securing it

- Welds in the hammer head where it attaches to the jib arm are also subject to high tensile stresses and should be closely examined

Notes:

General Information

- BS 7333 requires jib cranes to be designed to the stress allowances in BS 2573 - Rules for the design of Cranes. It is doubtful then that jib cranes will be over stressed even if the recognised deflection limits for cantilevers of 1/250th is exceeded

- It is therefore essential that the tester and examiner should make full use of the information set out in this course in order to calculate the deflection of a jib crane and to ensure that a well designed crane does not fail except upon the grounds of faulty installation or faults laid down in this and previous units

- Testers and examiners should also realise that jib deflections are not always due solely to the deflection of steel members. Some deflection may be due to slackness in bearings, pivot points and/or bolted connections moving. In these circumstances, taking deflection readings at zero loading and various loading to SWL, calculations may be made to calculate actual jib crane deflection: it is most important that the slope in the arm resulting from all the possible deflections will allow safe use at maximum load and at any angle of slew

Safety Precautions on Site

Safety whilst carrying out Site Examinations and Tests.

Consider:

- Reporting to RP
- Access/Egress
- Risk Assessment / JSA
- Adequacy of anchorages and suspension points
- Floors, passages, route obstacles
- Test areas
- Lock-out/Tag-out
- Statutory requirements

Site Examination

- Check previous records – certificate, report of thorough examination (ROTE) etc.
- Competent Person
- ID Number, SWL and description – check with test cert and report discrepancies
- What regulations or Act is the examination being carried out to?
- Lighting
- Bolts, welds
- Operation of the trolley and suitable examination
- Running surfaces, bearings and brackets
- Foundations/bolts base plates, web plates, king post
- Check previous records – certificate, report of thorough examination (ROTE) etc. Description of the crane
- Markings
- Power Feed System
- End-stops, tie rods and struts

Report of Thorough Examination

- Description of the crane
- Date of examination
- Statement of fitness for purpose
- Any defects affecting the SWL
- Other observations
- If dangerous: requirements for preventing further use
- Notify authorities where required by law

In Service Inspection

In addition to the statutory thorough examination by a Competent Person, slewing jib cranes should be visually inspected by a Responsible Person prior to use or on a regular basis, taking into account the conditions of service and any statutory requirements. The inspection should include the fixings and anchoring devices and extend to the block, trolley and any associated power feed system.

Common Defects:

The following are examples of common defects of the crane and structure which may become apparent in use or during the regular inspection. If any of these faults are found the jib crane should be withdrawn from service and referred to a Competent Person:

- Any signs of corrosion, damage or deformation of the structure, such as bent or twisted jib arm, distortion of the column etc.
- In the case of wall mounted jibs, any signs of cracking walls or crumbling brickwork etc.
- Damaged or missing end stops. These are safety devices which prevent the trolley, block or load colliding with the structure or becoming detached from the jib if travelled to the extremes of the jib arm
    - Their effectiveness should be confirmed and they should not make contact with trolley wheel flanges. Bolts securing end stops must all be in place and kept fully tightened
- If bolts are loose, missing, corroded or otherwise damaged. Missing or damaged washers including tapered washers where appropriate
    - All bolts and fixing devices used in the construction of the crane and, in the case of column mounted jibs, for erection onto its supporting structure, should be in place and fully tightened
- If foundation bolts are found to be loose, consult manufacturer's instructions. Some types of foundation bolt require periodic tightening during the initial period of use. If the manufacturer's instructions do not mention periodic tightening or if the problem recurs, withdraw from service and refer to a Competent Person
- Difficulty in slewing the jib arm or if the jib slews on its own with no load if push/pull trolleys run to the end of the jib arm with no load
- If the jib slews on its own when loaded or if the load runs away along the jib arm. If there is difficulty in traversing the load along the jib arm. This may be the result of overloading. Lower and check the load, and if the load is found to be excessive, adjust the load or use an alternative means of lifting. The jib crane should be inspected to ensure no damage has occurred prior to continuing the lift

Notes:

17. POWER FEED SYSTEMS

Introduction to Power Feed Systems

Electric Power Operation

Electricity is the most common form of power used with lifting appliances. It is used on blocks, winches, trolleys and cranes to provide power for both lifting and travelling or slewing motions.

Although examples of DC supply appliances still exist, AC supply is considered to be the norm. Most types of electric power operated lifting appliances are available for three phase operation. Single phase and low voltage hoists and winches are available in the lower capacities and some types of vehicle winches are available for battery operation.

Pneumatic Power Operation

Pneumatic power operation is used on hoists, trolleys, winches and some cranes. It is less efficient and more difficult to carry to the appliance than electricity. For this reason, it is less common in general use than electricity, but it has many advantages making it more suitable for certain applications.

Hydraulic Power Operation

Hydraulic power is the least common form of power operation associated with lifting appliances, usually being restricted to special purpose equipment and to some types of winch.

Electrical Supply Systems

The use of electricity is highly developed throughout industry. It has the advantage over other forms of power of being more readily available and is easily carried from the power source to the appliance by cable or bus-bar conductor systems.

As a result, electricity is the most common form of power associated with general purpose lifting appliances.

The dangers associated with electricity are well known and there is much experience in protection to guard against them and in overcoming them. It is necessary to protect the operative from the dangers of electric shocks, either by insulation or by the use of low voltages.

Single phase and low voltage drives are less common in lifting appliances and are restricted to the lower capacity items due to the difficulties associated in providing motors of adequate capacities and ratings. Instead, the operative is usually protected by the use of low voltage control circuits as this is the main danger to the operative exists.

The current supply should include a means of isolating the equipment from the power source. Switch fuses and isolators are used in practice to fulfil this requirement. The isolator, which is considered to be part of the supply system, should be positioned at the start of the conductor system so that the system will be isolated from the power source as well as the appliance.

Electricity has the disadvantage of requiring special protection in certain environments, e.g. **explosive atmospheres**, and steps are necessary to contain the danger within the appliance. These appliances and their power feed systems are far more expensive than standard equipment. They tend to be heavy and bulky and armoured cable offers little flexibility making travel difficult.

ATEX Explosive Atmosphere Symbol

Various types of conductor systems may be used to carry the supply to travelling hoists and cranes.

The main factory supply is taken to a point adjacent to the equipment and terminated with a switch fuse/isolator. The power feed to the actual hoist or crane is then taken from this in one of several ways.

There are five basic power feed systems that are commonly used for electrically powered hoists:

1. Coiled cable
2. Cable reeling drum
3. Festoon cables
4. Insulated conductors
5. Energy chain cable carriers

In the past, bare copper conductors were used to provide a power supply for overhead travelling cranes. They are no longer considered suitable in all cases and are not used for new power supply installations. We will consider these systems and the limitations/dangers they present.

Notes:

Bare Copper Conductors

Although this system is considered unsuitable for new installations nowadays, it was widely used in the past on all types of installations. Many of these old installations may still be found in service.

The general advice is to review the installation:

- If the bare wires present a possible danger to people working in the area, advice must be given to change this for a more suitable supply system
- If it may be considered that the system is safe by virtue of its position, then it may be left in service

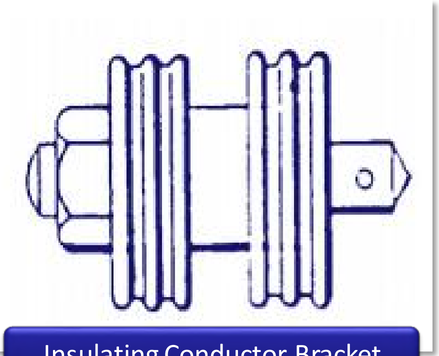
The owner has a responsibility under section 2 of the Health and Safety at Work Act to provide safe systems of work and it is his responsibility to change this if it is considered necessary.

In this system, copper wires are stretched parallel to the beam by means of strainer screws with insulators. A collector bracket is fitted to the hoist, on which the collectors are mounted.

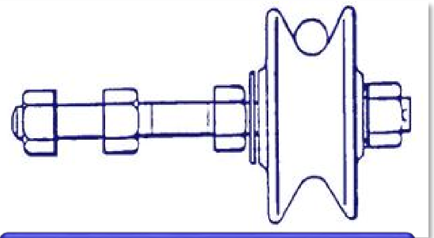
The most common form of collector is the bronze roller, graphite bushed, thus providing good electrical contact and bearing surfaces. Each collection shaft is insulated from the collector bracket.

For long runs, the wires are supported on porcelain reels. The collectors lift the wires off the reels as they pass over them.

As bare copper wires are not generally recommended they have been superseded by safer and more efficient systems which are outlined in this module.



Insulating Conductor Bracket



Wheel Type Collector

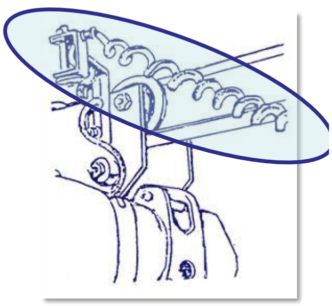
Notes:

Coiled Cable

In the coiled cable the conductors are contained in a PVC compound insulate which is coiled in a similar manner to a tension spring. The cable is fixed to a swivelling bracket on the side plate of the trolley with the supply end fixed at a convenient point adjacent to the runway.

As the hoist is moved along the runway the cable expands. As the hoist is moved back, the cable contracts.

This type of cable is suitable where only short travel distances are required due to the sag in the cable. The normal extension ratio of such a cable is 3:1 with a nominal 3 metres extended length.



Notes:

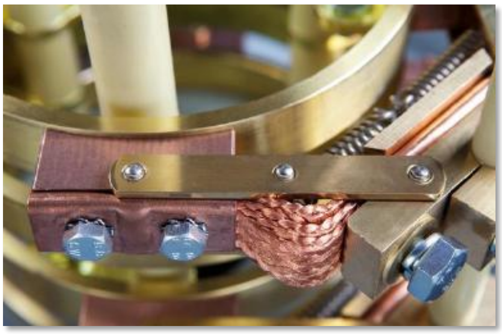
Cable Reeling Drum

The cable reeling drum provides a means of power on control using a flexible cable wound onto a drum which can be played out and then recovered. At the heavy end of the range reeling drums can be very large and equipped with geared motors actuated by torque sensing for cable recovery. This unit deals only with the more common spring operated type.

Construction is very simple, comprising a steel drum mounted onto a fixed shaft and rotating on sealed bearings. The power feed cable is clamped to the drum and the wire ends are connected back to the carbon brush gear, which rotates with the drum. The power feed to the drum passes through the fixed shaft to the slip rings which are fixed.

Slip Rings

Slip Ring Assembly



Slip Ring Brushes

Notes:

Cable Reeling Drum (continued)

Since a reeling drum spiral wound spring does not provide a constant torque, spring selection is very important.

The cable should not be overloaded by too great a tension or have too much slack, nor should the appliance run back (a possible hazard with coiled cables and reeling drums if used in association with light weight push/pull trolleys).

Before a drum can be selected the cable size must be determined taking a number of factors into account:

- **Voltage Drop** - Unless otherwise stated, it is usual to work to IEE Regulations. These state that voltage drop shall not exceed 5% of the rated voltage based on the normal operating current, subject to confirmation from the manufacturers of both drum and cable
- **Temperature Correction** - Generally for ambient temperatures above 30°C the continuous rated current capacities should be eliminated
- **Reeling Configurations** - Rated cable capacities should be further de-rated according to the configuration of the reel to be chosen
- **Short Time Rated Motors** - In many cases the motors on a lifting appliance may be short time rated thus allowing cable carrying capacities to be increased

Note: Although not expected to design electrical power supply systems, the Tester and Examiner would be expected to understand the fundamental requirements of a system, for example to identify the reason for a performance deficiency of a hoist under test.

Cable Selection

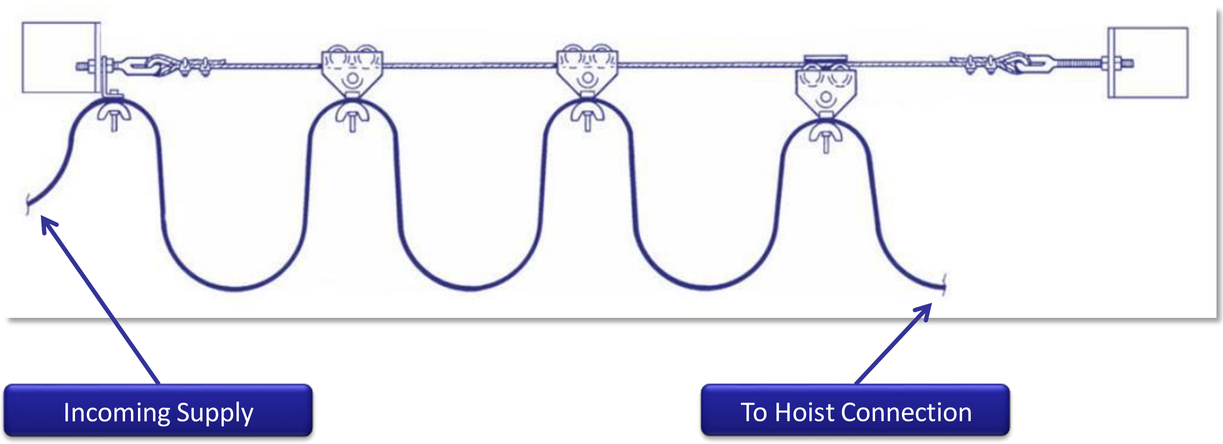
In practice, the cable is selected on the criteria discussed against technical data provided for a particular product.

An example of cable selection will be discussed in the next section. The example could apply to both cable reeling drum and festoon cable systems.

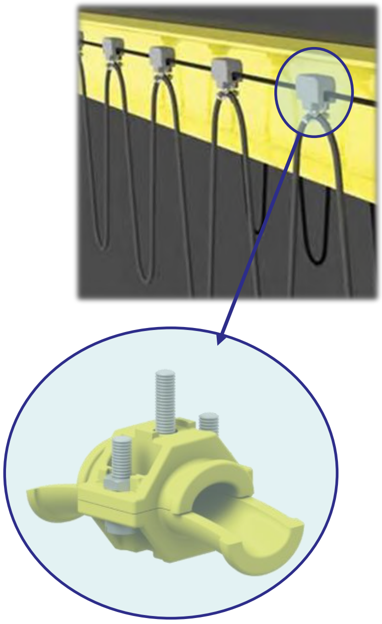
Festoon Cables

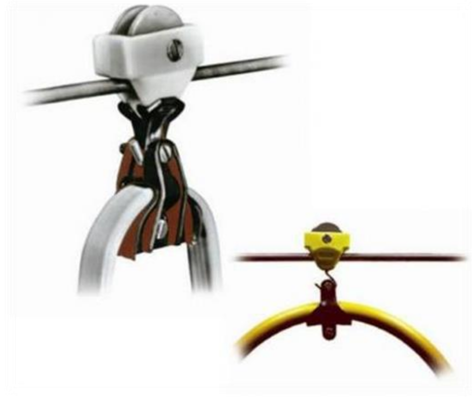
Taut Wire

The taut wire system is suitable for light duties over lengths not exceeding 30 metres and is simple and economical to install. The strainer wire is made taut by means of straining screws whilst the cable is carried on trolleys.



Festoon Trolleys

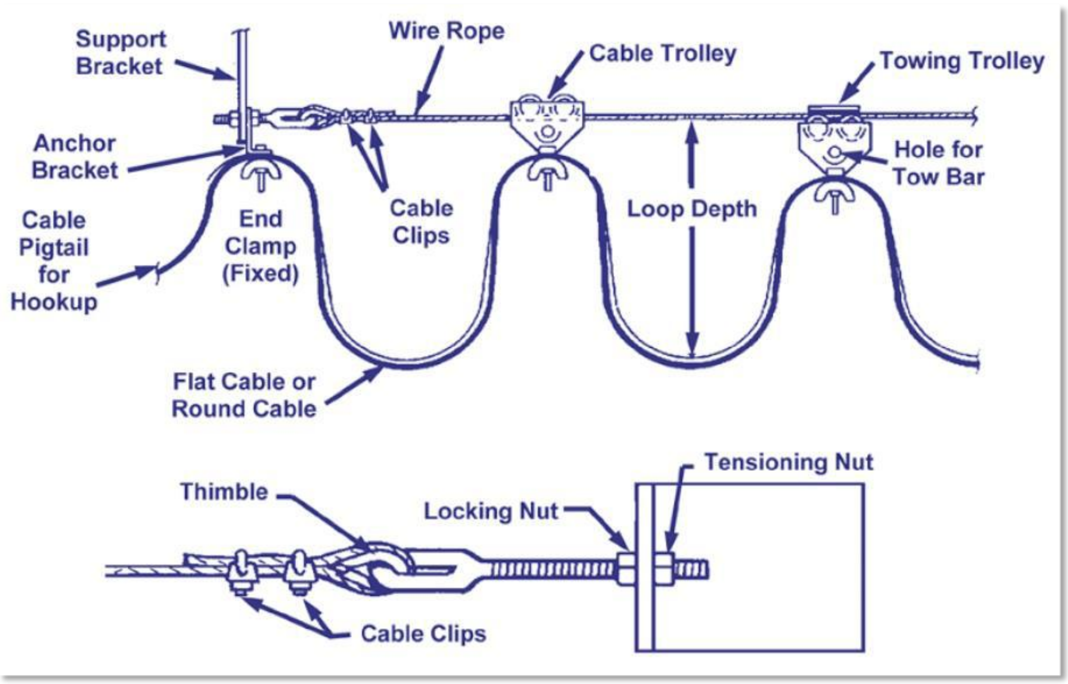




Notes:

Festoon Cables (continued)

Typical taut wire system:



Notes:

Tracked Cable Systems

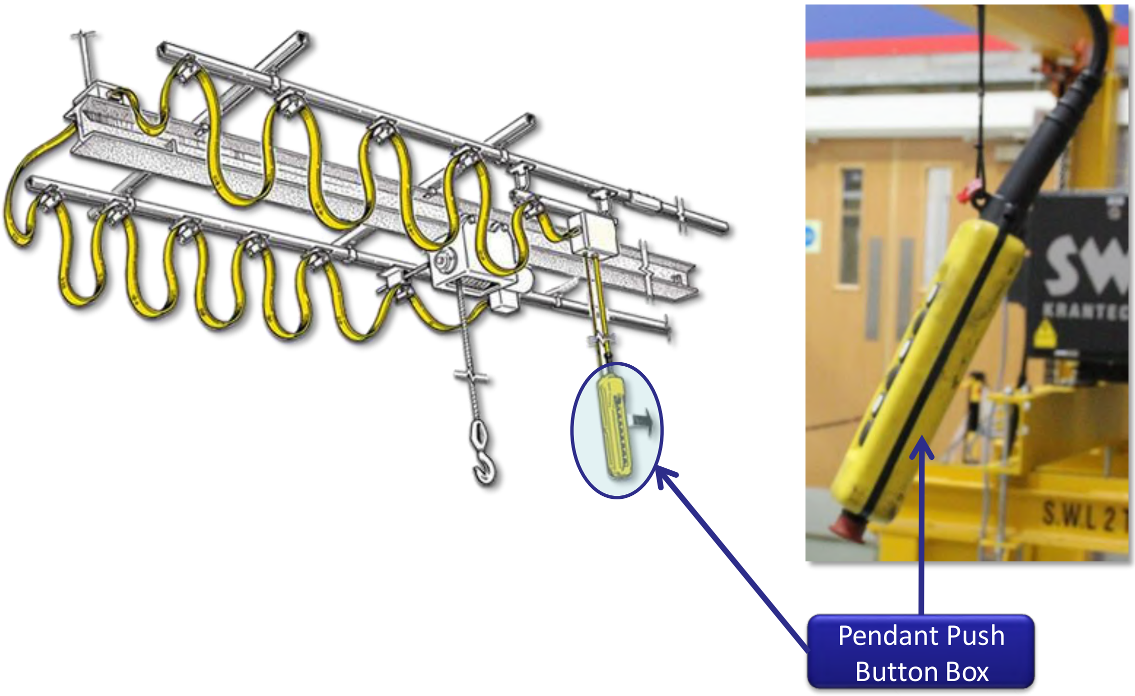
The tracked system is a development of the taut wire system. It can support greater loads and is suitable for higher speeds. Most systems incorporate an inverted `U‘ or ‘C’ section track, the cable support trolleys running on the two inner ledges.

The manufacturers of these systems offer a range of profile sections for most loading conditions from light to heavy duty.

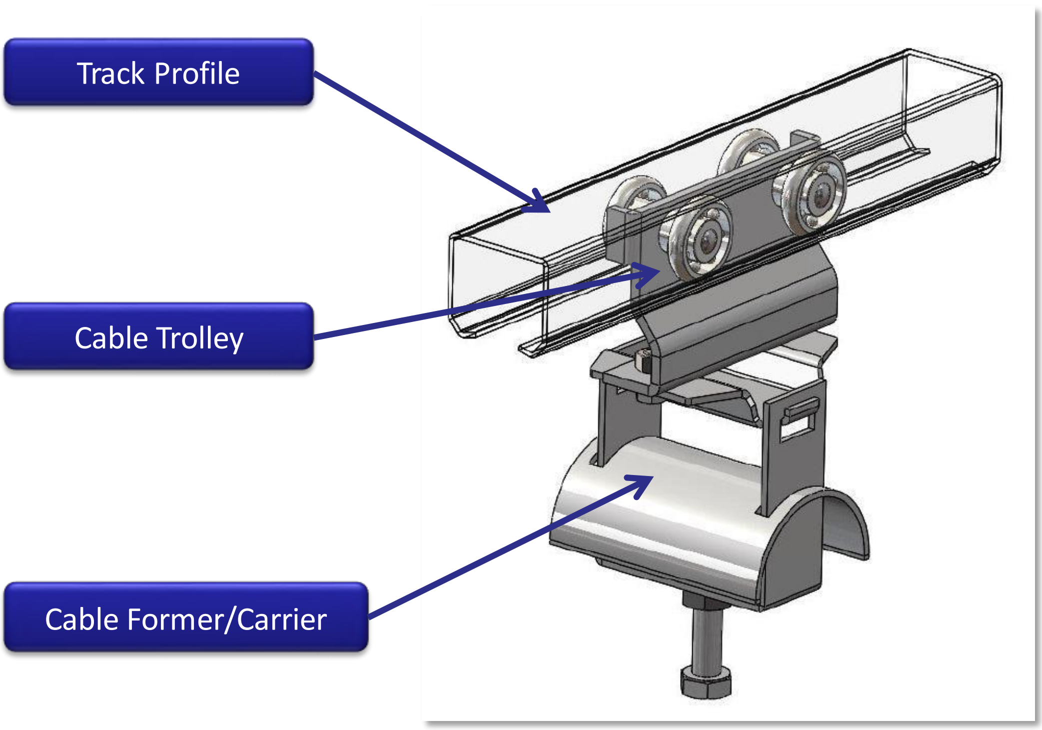
The tracked festoon systems are very safe with perfect insulation hence no loss of energy or voltage drop where current has to pass from conductor to collector. Also on long track installations the size of cables would need to be increased to limit voltage drop hence requiring a heavier track system to support them.

In many cases a lifting appliance will have two festoon tracks one to carry power to the hoist the other providing a mobile **pendant push button box**, e.g. on the bridge of the crane.

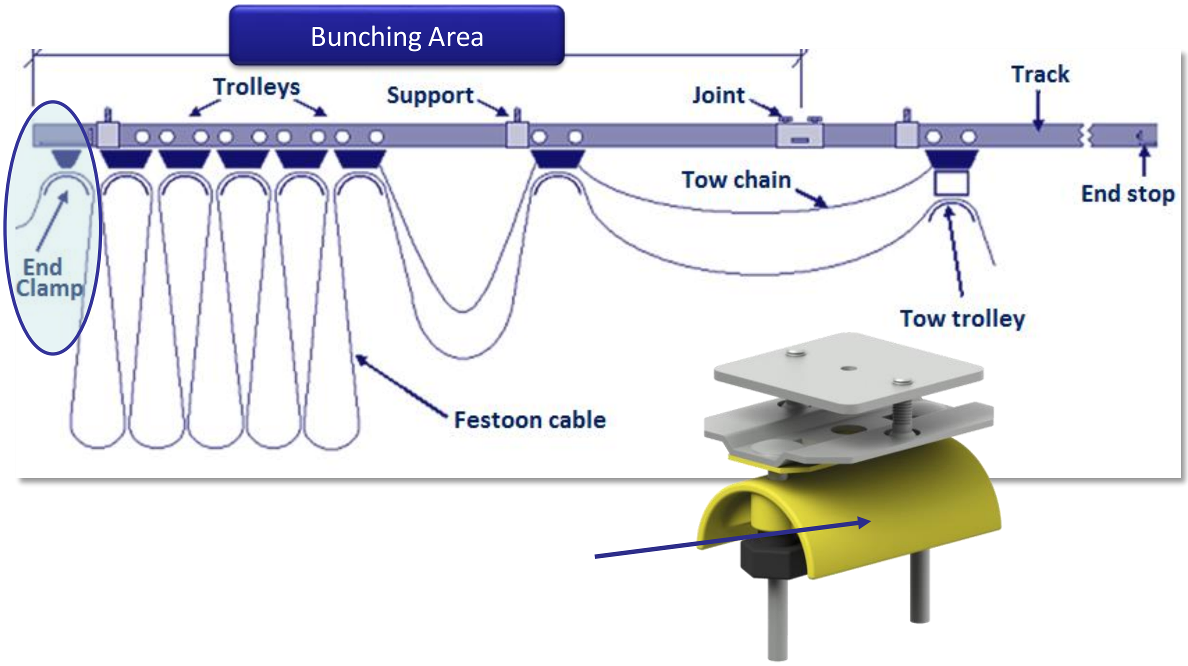
When a mobile **pendant push button box** is fitted, the festoon cable will terminate in the pendant control box. The push button box is suspended from the control box by the pendant cable.



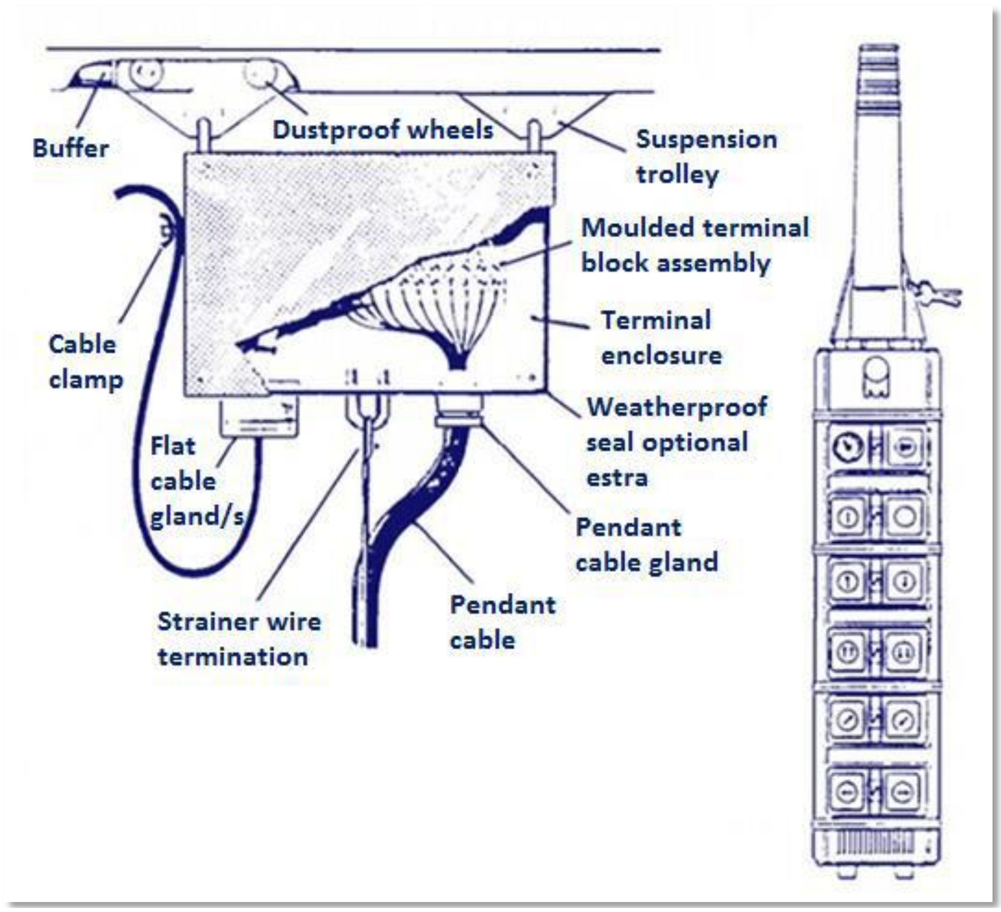
Typical components of a tracked festoon cable supply:



A limiting factor of the festoon system could be loss of travel of the hoist unit due to bunching of the trolleys especially on long track applications.



Typical mobile pendant push button box assembly and connection to the pendant connection box on the festoon:



Hoist Control

With the majority of electric hoists, the contactor panel is mounted on the main frame and therefore travels with the hoist. It is recommended practice that control voltages should not exceed 115 volts which is achieved by transforming down from a single phase of the three phase supply. The low voltage control signals are transmitted via the push button box and multicore pendant cable to the hoist contactor panel.

Pendant Cables

Pendant cables may have as many as 25 separate cores depending on the number of push buttons/motions required. The modern pendant cable has **two independent strainer wires** (circled below) built in to support itself and the weight of the push button box.

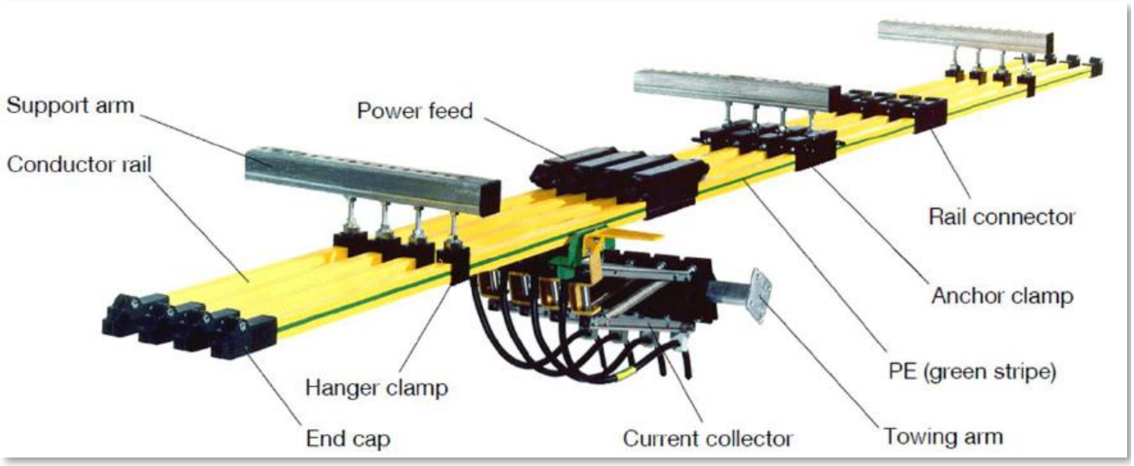
Notes:

Insulated Conductors

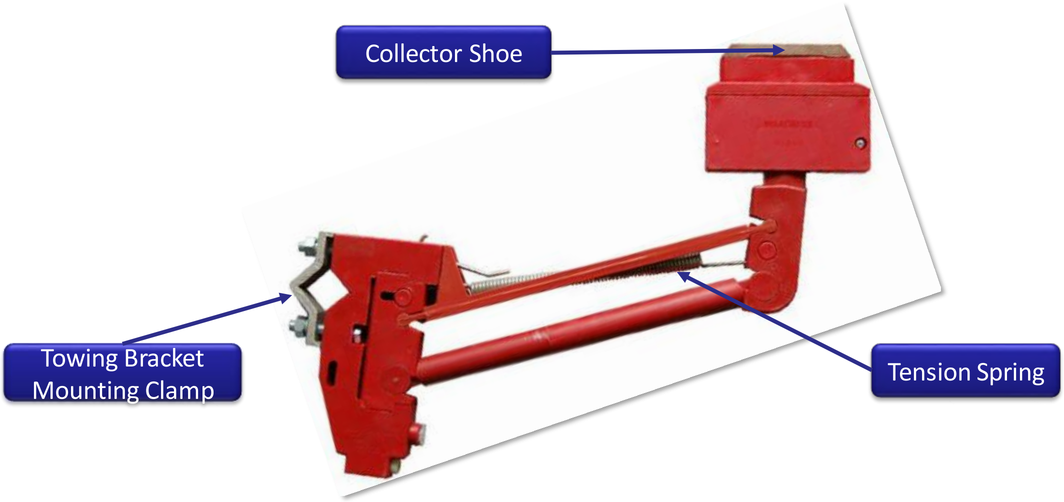
Shrouded Conductor Systems

Shrouded conductor systems are of various cross sections and the conductor bar is sufficiently shrouded with a PVC cover to ensure finger safety yet provide access for a collector shoe to pick up the current.

Typical components of a 4-bar (3 x phase and 1 x Earth conductor) shrouded system:



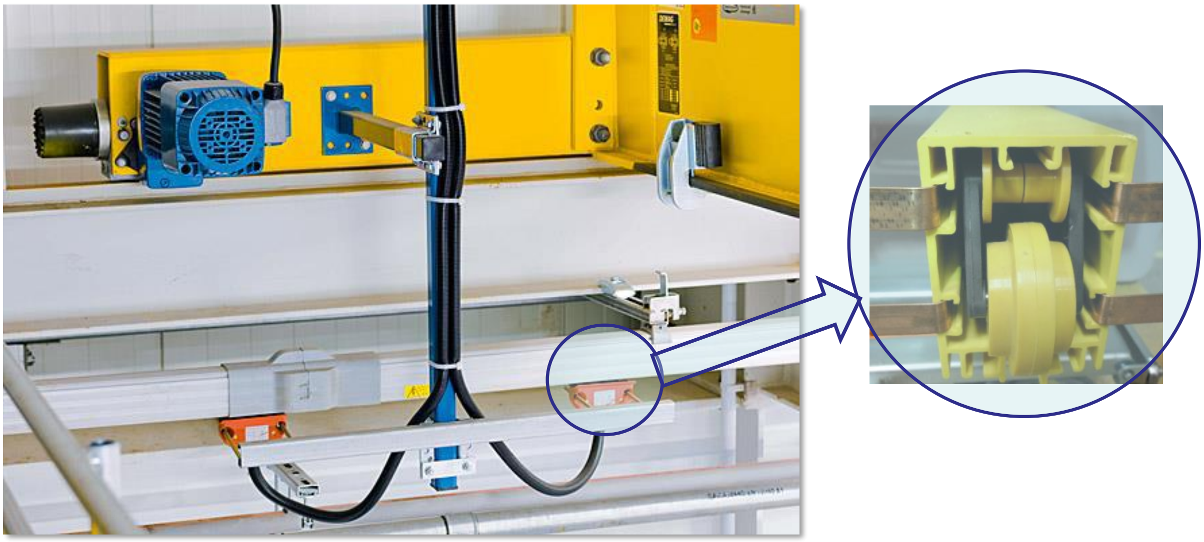
The collection assembly is spring loaded to ensure good contact with the conductor bar and articulated to enable the contact shoe to follow the track without binding.

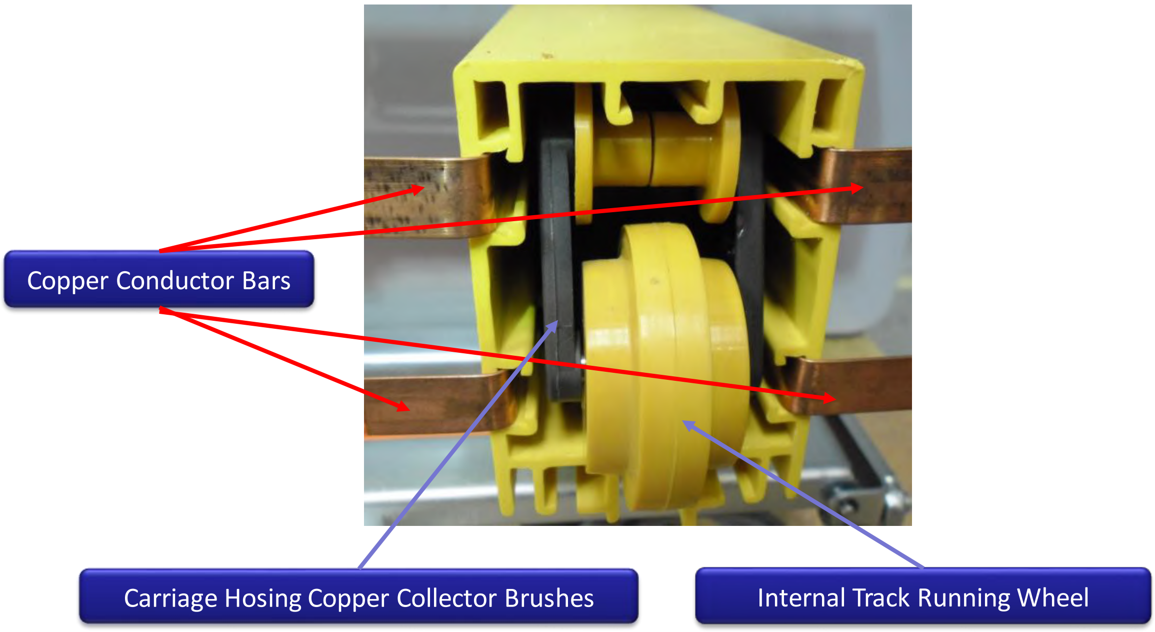


Notes:

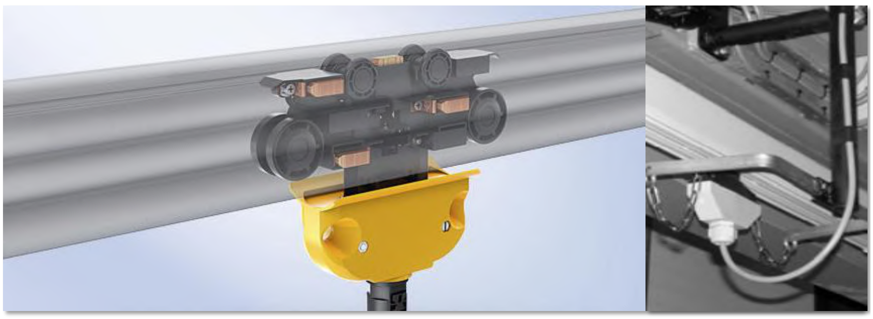
Totally Enclosed Conductor Systems

A totally enclosed conductor system is used where multiple conductors are required in one housing. It is a rigid and compact system. They are commonly used in overhead crane applications but also for traveling hoists.





The illustration below shows how the fully enclosed conductor head collects the power from the enclosed bus-bars and feeds this direct to the hoist.



The merits of shrouded conductor systems are a much greater protection against accidental contact and a suitability for long runs since intermediate feeders can be added.

These systems are available up to 300 amps. They are however unsuitable for flame proof or similar applications.

Higher operating temperatures can be achieved by using polycarbonate covers (-40°C to 121°C) or laminated fibre glass (-45°C to 149°C).

Expansion

With any rigid system particular attention must be paid to expansion and expansion couplings fitted, in accordance with manufacturers recommendations, if problems are to be avoided.

Shrouded Conduction Systems

With the shrouded conduction system, the power feed need not be connected to one end. By connecting in the centre rather than to one end voltage drop is halved and by connecting a power feed to each end the voltage drop is halved again.

Notes:

Energy Chain Systems

Most energy chain cable carriers have a rectangular cross section, inside which the cables lie.

Cross bars along the length of the carrier can be opened from the outside, so that cables can be easily inserted and plugs connected.

Internal separators in the carrier separate the cables. Cables can also be held in place with an integrated strain relief.

Mounting brackets fix the ends of the carrier to the machine.

Besides only bending in one plane due to the rigid jointed structure, cable carriers also often only permit bending in one direction.

In combination with rigid mounting of the ends of the carrier, this can prevent the enclosed cables from flopping in undesired directions and becoming tangled or crushed.

Cable carriers are used anywhere on cranes where moving components require power, control and communication power feeds in a flexible media.

Energy chain cable carriers are quiet in operation, lightweight and provide covered cable design and that can be quickly opened. They can be used in extreme conditions such as heat-resistant or clean room environments.

Notes:

Compressed Air Supply Systems

The production of a clean, dry supply of compressed air suitable for pneumatic power operated lifting appliances is expensive and it is less easily carried from the power source to the appliance than electricity.

Due to these reasons, its use is more limited than that of electricity.

Although electric power operated lifting appliances are the usual choice for general purposes, pneumatic power operated appliances have advantages for certain applications as most of the dangers associated with electricity do not exist with compressed air.

Standard pneumatic equipment is flame proof.

It can therefore be used in atmospheres where electric equipment would require special insulation and protection to contain the danger.

With pneumatic equipment, this danger does not exist.

Pneumatic Hoist

Pneumatic motors offer variable speeds of operation.

Air flow rate to the motor is controlled by the operative via a supply valve. By careful manipulation the operative can control the air delivery rate, the motor speed being governed by the volume of air supplied. At normal working pressure it is impossible to overload a pneumatic motor.

Once the load increases beyond the design load of the motor, it will stall and, unlike an electric motor, it will not be harmed by this.

Although pneumatic motors are robust in design, in capacity they tend to be smaller and lighter than equivalent electric motors. They will withstand a high degree of heat and moisture. Due to the internal pressure whilst in operation, the motor is self-purging.

This makes standard pneumatic equipment suitable for use in steamy atmospheres, such as paper mills and laundries, and in dusty conditions, such as flour mills without any special steps being taken, unlike electrical equipment which requires enclosures to protect the equipment from their effects.

Compressed air is less efficient than electricity. It contains a high proportion of moisture which has to be removed.

Whilst motors will purge and expel this moisture when in operation, condensation will occur when the motor is idle. This will lead to corrosion and contamination of residual lubricants unless steps are taken to prevent this.

Pneumatic appliances usually exhaust spent air to atmosphere direct from the motor. Although compressed air is generally considered to be less dangerous than electricity, some dangers do exist. Small leaks are usually harmless, though expensive. However, in dusty environments exhausting air and leaks can cause particles to be propelled through the air and be a hazard to eyes etc.

Notes:

Inspection/Examination

Ensure total isolation of the power supply using a lock-out/tag-out routine before inspection:

Bare Copper Wires

1. Assess if the system is safe
2. Check wires for burns due to arcing. Replace if burns exceed 25% of diameter
3. Check collector shoes for burns
4. Check roller collectors for burns, loss of metal and wear of graphite bearings

Most burns are caused by vibrations or defective collector mechanisms. Wires must not be greased as this will cause arcing.

Coiled Cable

1. Check PVC cover for cracks in the insulation especially at terminations. Replace if cracked or damaged.
2. Check security of terminations, cable glands etc.

Cable Reeling Drum

1. Check drum for smooth running. If movement is erratic bearings should be checked.
2. Check slip rings, carbon brushes and pressure springs.
3. Check cable tension with drum fully wound
4. Check cable tension with cable fully extended, i.e. the hoist at the opposite end.
5. Check spare rotation capacity of drum and for a minimum of two remaining turns of cable on the drum.
6. Check cable for cracks and damage.

Festoon Systems

1. Check taut wire anchors and runners for free movement.
2. If a track system, inspect each joint section is tight and properly closed up.
3. Inspect cable for cracking, check for loose trolley clamps.
4. Check pendant control box is running freely and that festoon and pendant connections are secure.
5. Check pendant secure to push button box.
6. Check operation of buttons including any emergency stop and key switch etc.

Shrouded Conductor Systems

1. Check for tightness of joints, signs of burning and that covers are in place.
2. Check shoes for wear and alignment.
3. Check spring tension and general operation.

General

- All power feeds must terminate at a fused, lockable isolator. This should have good access from the shop floor and be clearly identified. The isolator is considered to be part of the power feed system and should also be carefully examined for correct operation.

- When examining a supply system, hoist or crane, the isolator should be locked off with an approved locking mechanism for safety.

Summary

It is of paramount importance that **lifting equipment inspectors or examiners do not work on live equipment.**

Lock-out/Tag-out routines should always be considered as part of your risk assessment and equipment must be checked by a Competent Person to confirm power supplies are isolated before work commences.

Notes:

18. SAFETY ESSENTIALS – WORKING ON RUNWAYS AND CRANE SYSTEMS

There is no job so important and no service so urgent that we cannot take the time to perform our work safely and correctly!

A Few Essential Rules

- Do not take shortcuts in the planning of safety for the work to be done
- Do not take risks
- If your job cannot be done safely, your employer will not want you to do it
    - Always talk to your line manager if you have any concerns
- Report any unsafe conditions or working behaviour immediately

Isolation of Energy – Basic Rules

The basic rules are:

- There should be isolation from the power source (usually, but not exclusively, electrical energy)
- The isolator should be locked in position (for example by a padlock), and a sign should be used to indicate that inspection work is in progress
- Isolation requires use of devices that are specifically designed for this purpose; not devices such as key-lockable emergency stops or other types of switches that may be fitted to the machine
- Any stored energy (e.g. hydraulic or pneumatic power) should be dissipated before the work starts

- If more than one examiner is involved in the work, each of them should lock off the power with their own padlock. Multi-padlock hasps can be used in such circumstances. Such isolation procedures can also be applied to locking off valves for services (such as steam) and material supplies

- Before entering or working on the equipment, it is essential that the effectiveness of the isolation is verified by a suitably Competent Person

Electrical Isolation

Unqualified personnel should not perform **any** electrical examinations or testing of any kind on any electrical equipment associated with the system/crane/hoist unless they can demonstrate competency in electrical service and hazardous energy isolation, have been suitably and sufficiently trained in electrical safety, and authorised by their company management to perform such tasks. (Where applicable)

Unqualified personnel should not be allowed to perform **any** work on or near energised electrical equipment.

Other Motion Isolation

The Tester and Examiner will need to ensure that all other mechanical, hydraulic or pneumatic drives are fully isolated and locked in position before attempting to gain access for the thorough examination.

Examples include:

- Swing Jib Cranes (manual slewing – could knock personnel off scaffold or collide with MEWPS)
- Switches and turntables in special runway systems
- Castors and wheels on mobile gantries

Accident Report

"Two dock workers suffered injuries in a high voltage electric shock when they were trying to fix a crane. The maintenance worker was temporarily blinded – and is now scarred permanently - and both he and an electrician were burned. Two other men working on the job could also have suffered burns as a result and all four could easily have been killed. None of the men had received adequate training or been given sufficient information about the electricity supplies to the dockside cranes. All four workers were put at risk because their employer did not have procedures in place to ensure electrical work was carried out safely."[1]

[1] *Source:* http://www.hse.gov.uk/safemaintenance/experience.htm

Personnel Carrying Out Thorough Examinations

BS 7121-2-1 2012 (5) states:

"It is essential that the in-service inspection and maintenance of cranes is always carried out by personnel who have been assessed by their employer as competent and have adequate training and information to carry out the work required."

LOLER also requires that thorough examinations are carried out by Competent Persons.

"Competent Persons should have the necessary attributes, competencies, knowledge and experience to enable them to carry out effective thorough examinations of cranes. The nature and extent of these will depend on the purpose of the examination to be undertaken, the complexity of the cranes to be examined and the consequences of failure of those cranes. It is essential that such persons have adequate training, information and independence to carry out the work required"

Note: Module 1 (Legislation) of this training course provides the definition of a Competent Person.

Attributes

Competent Persons should[2]:

- Be physically fit for the tasks they are to undertake
- Have adequate eyesight (with correction if needed)
- Be comfortable working at height, over water or in a confined space (if required)
- Have a responsible attitude
- Be able to communicate clearly with other personnel in the location where thorough examination is taking place, including the need to take the crane out of service if it is unsafe to use
- Be able to demonstrate adequate literacy and numeracy
- Be aware of their own limitations in knowledge and experience

[2]*BS 7121:2-2012 5.3.2*

Competencies

Competent Persons should be[3]:

- Fully conversant with the machinery they are required to examine and its hazards, including operation necessary for thorough examination activities
- Properly instructed and trained
- Familiar with the procedures and precautions required for safe work at height, over water or in a confined space (where required)
- Fully conversant with the appropriate sections of the manufacturer's instruction manual
- Familiar with the use of permit to work systems where they are required by the safe system of work, and able to operate them correctly
- Familiar with site specific safety requirements (e.g. manufacturing, construction, process plant, nuclear, docks, airports, railways)
- Trained and competent in the selection, pre-use inspection and correct use of their personal protective equipment

[3]*BS 7121:2-2012 5.3.2*

Knowledge Base

Competent Persons should have[4]:

- An understanding of the applicable crane design standards and codes of practice for the selection and use of the relevant cranes, together with the applicable examination criteria
- An understanding of the safety rules and associated codes of practice that are applicable to the relevant cranes
- An understanding of the inspection and maintenance requirements of cranes
- Knowledge of appropriate test procedures which may be employed and the interpretation and limitations of those techniques
- An understanding of drawings and manufacturing literature relevant to the cranes to be examined
- Knowledge of the materials and techniques used in the manufacture and assembly of the type of cranes to be examined

[4]*BS 7121:2-2012 5.3.4*

Practical Skills

Competent Persons should[5]:

- Be capable of detecting defects or weaknesses in cranes which could compromise the safety of the system/crane/hoist
- Have sufficient knowledge and experience to assess the importance of defects or weaknesses in the system/crane/hoist and identify what actions need to be taken in order to rectify them. In particular they should be able to:
    - Determine whether the system/crane/hoist is operating as intended
    - Specify the appropriate time-scales within which identified defects or weaknesses need to be rectified
    - Determine whether defects identified in the previous report of thorough examination have received attention

- Determine whether all safety devices are functioning correctly
- Check whether warning notices are correctly fixed and legible, and where necessary specify any limitations on the use of the system/crane/hoist
- Witness any testing required as part of the thorough examination and evaluate the results
- Report on the findings of the thorough examination

[5]*BS 7121:2-2012 5.3.5*

Assessment of Competence

Employers should determine through a formally documented assessment process the competence of each individual person, both existing employees and new entrants, based on the attributes, competencies, knowledge and skills listed in 5.3.2 to 5.3.5. A shortfall in attainment level does not necessarily preclude employment in this role but it is essential that such shortfalls are addressed before the person is allowed to carry out unsupervised thorough examinations of cranes.

All Competent Persons should be assessed on appointment, again within their first 12 months, and at regular intervals (not exceeding 4 years) thereafter. Assessment should form part of any training.[6]

[6]*BS 7121:2-2012 5.3.9*

Training Records

A comprehensive individual training record should be established for all personnel carrying out thorough examinations. This should be updated as training is undertaken and as a minimum should include[7]:

- When the training, refresher training, assessment or re-assessment took place
- Where the training took place
- The scope of the training, including types and models of crane
- The duration of the training
- The outcome of the training
- Who delivered the training
- When refresher training is required

[7]*BS 7121:2-2012 5.3.10*

Continual Professional Development

Continuing professional development is a joint responsibility between the Competent Person and their employer.

The employer should maintain a Continual Professional Development (CPD) record for each Competent Person. The record should include details of how CPD is being achieved and should include for example[8]:

- Specific training towards enhancements/additions to competency
- Familiarization/re-familiarization, ongoing training and mentoring
- Any alterations and/or withdrawals of competency

- Enhancements to qualifications
- Membership of professional bodies/institutions
- Attendance at seminars and refresher training courses
- Visits to manufacturers and trade shows

[8]*BS 7121:2-2012 5.3.11*

Maintenance and Thorough Examination

Selection of the Competent Person

It is essential that the Competent Person undertaking the thorough examination of cranes has not been involved in the maintenance of the cranes as laid down in BS 7121-2-1:2012. This also applies to the inspection of cranes under MCA LOLER 2006:6 Regulation 12(1).

Preparation for the Thorough Examination

- The system/crane/hoist should be checked to determine whether it is clean enough not to conceal the structure or mechanisms to an extent that would prevent an effective examination. If necessary the crane should be cleaned as required
- The system/crane/hoist should be positioned in a suitable area to enable the thorough examination to be undertaken safely
- Additional means of safe access should also be provided as required by the Competent Person, e.g. scaffolding, working platforms or mobile elevating work platforms

These recommendations also apply to an inspection made under Maritime and Coastguard Agency (MCA) LOLER 2006:6 Regulation 12(1).

Note: Attention is drawn to the Work at Height Regulations 2005 (as amended) [15].

Access

- Employers and Competent Persons should ensure that procedures are in place to enable the Competent Person to access all relevant parts as and when required

- Some parts might be accessible by using permanent facilities such as access ladders to the system/crane/hoist

- Such facilities do not always provide access to all parts, and the Competent Person might need to use personal protective equipment (PPE) to protect against the risk of a fall

- Use of PPE requires suitable anchor points and a recovery plan in the event that a fall occurs

- Temporary access facilities, such as a mobile elevating work platform (MEWP) or scaffolding, might be required to reach some parts

- Such temporary facilities usually stand on the ground or floor of a building and require a suitable surface, space for access, space to operate in and time to deploy

- The Competent Persons who deploy and use such facilities should be trained for the purpose, and the equipment used should be in a serviceable condition

Preparation for the Thorough Examination

- If the local lighting is not adequate for examination purposes it should be supplemented by portable lighting

- The identification and rated capacity marked on the system/crane/hoist should be checked against the records, for example the test certificate, declaration of conformity, the manufacturer's instructions for use and the report of the last thorough examination

- The system/crane/hoist should be made safe by isolating and locking-off the power supply when necessary and reinstating it as appropriate

- The Competent Person carrying out the thorough examination should determine if there is any history of defects or malfunctions, and whether any repairs, alterations or additions have been made. The last report of thorough examination and in-service inspection reports should be consulted

- Where it is not possible to ascertain the condition of hidden mechanism parts, for example ropes, chains, sheaves or terminations, dismantling prior to thorough examination should carried out as required by the Competent Person

Method Statements and Work Instructions

- Generic risk assessments will normally suffice

- Unusual or potentially hazardous tasks may require specific risk assessment

- Always follow a 'Safe system of work'

- Toolbox talk
  - All team members are fully briefed
  - Focussed
  - Discuss the 'job specific' method statement
  - Briefings should be recorded
  - Unusual features of the job to be highlighted

Notes:

Safety Precautions when Working on Runways and Structures


HSE
Health and Safety Executive
Risk assessment
A brief guide to controlling risks in the workplace

Working Above Ground Level

Hierarchy of Control Measures

1. Working Platforms (where applicable)
2. Scaffolding
3. MEWPs
4. Controlled Zones
5. Safety Nets and Air bags
6. Work Positioning
7. Horizontal and Vertical Lifelines
8. Fall Arrest Equipment

Avoid
Prevent
Minimise

Rescue Plan

A Rescue Plan must be developed whenever fall-arrest systems are in use and when personnel may not be able to perform a self-rescue should a fall occur.

Before requesting a Rescue Kit (which is the last resort) you must first consider whether ladders, stepladders, MEWPs, controlled decent devices or other equipment can be used to perform a rescue.

If all else fails, then a Rescue Kit should be utilised.

Other things to consider for a rescue plan:

- You must never rely upon the emergency services as a primary rescue plan
- What obstructions may be in the way of reaching a suspended worker?
- How will the rescue be assured within 10 minutes of the fall to minimise the risk of further injury or suspension trauma?
- How will the safety of the rescuers be assured as well as the suspended worker?
- What communications will be used between the suspended worker and the rescue team?

High Ambient Temperatures

Special attention and planning are required for inspecting systems/cranes/hoists in hot areas. Due to the adverse environment, these cranes may not receive the inspection time they deserve.

The temperature in certain applications/environments (coupled with seasonal high temperatures) may mean that on occasion, the crane structure may be hot, and gloves are recommended for manoeuvring on the structure during an inspection.

Your risk assessment may identify reduced exposure time for the personnel working on the crane(s).

Summary

In this module, we have looked at the various safety considerations that are to be incorporated into our risk assessments, method statements and review procedures to ensure that all examiners involved in work on runways and crane structures are afforded the highest level of protection from injury or fatality.

Examiners of runways and cranes structures should always make themselves familiar with any national regulations of the country in which they are operating.

Failure to do so may lead to prosecution, due to breaches of the law.

Notes:

TRAINING

Operative training for all the equipment covered in these step notes should always take the manufacturer's information and instructions for use into account.

COURSE FEEDBACK

We would be grateful for your feedback regarding these Step Notes, after completing this training course. Please make your comments known to us – you can use the note box below to list anything you would like to bring to our attention.

We value your views and will use your comments to help our continual improvement of our learning and development materials.

Thank you in advance for your participation.

Andrew Wright
LEEA Learning and Development Manager

Step Notes - feedback to LEEA: