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Part 2-7: Inspection, maintenance and thorough examination - Overhead travelling cranes, including portal and semi-portal cranes, hoists, and their supporting structures

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Introduction

Your comments on this draft are invited and will assist in the preparation of the resulting British Standard. If no comments are received to the contrary, this draft may be implemented unchanged as a British Standard.

Please note that this is a draft and not a typeset document. Editorial comments are welcome, but you are advised not to comment on detailed matters of typography and layout.

Submission of Comments

- The guidance given below is intended to ensure that all comments receive efficient and appropriate attention by the responsible BSI committee.

- This draft British Standard is available for review and comment online via the BSI British Standards Draft Review system (DRS) as **http://drafts.bsigroup.com.** Registration is free and takes less than a minute.

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BS 7121-2-7

Code of practice for the safe use of cranes

Part 2-7: Inspection, maintenance and through examination – Overhead travelling cranes, including portal and semi-portal cranes, hoists, and their supporting structures

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Foreword

Publishing information

This sub-part of BS 7121-2 is published by BSI Standards Limited, under license from the British Standards Institution and came into effect on XX Month 200X. It was prepared by Subcommittee MHE/3/11, *Crane safety and testing*, under the authority of Technical Committee MHE/3, *Cranes and Derricks*. A list of organizations represented on these committees can be obtained on request to their secretary.

Supersession

Together with BS 7121-2-1, BS 7121-2-3, BS 7121-2-4, BS 7121-2-5 and BS 7121-2-9, this sub-part of BS 7121-2 supersedes BS 7121-2:2003, which will be withdrawn when all the sub-parts have been published.

Relationship with other publications

The BS 7121 series is being revised. The following new sub-parts of BS 7121-2 are currently in preparation.

- Part 2-1: *Inspection, maintenance and thorough examination – General;*
- Part 2-3: *Inspection, maintenance and thorough examination – Mobile cranes;*
- Part 2-4: *Inspection, maintenance and thorough examination – Loader cranes;*
- Part 2-5: *Inspection, maintenance and thorough examination – Tower cranes;*
- Part 2-7: *Inspection, maintenance and thorough examination – Overhead travelling cranes including portal and semi-portal cranes;*
- Part 2-9: *Inspection, maintenance and thorough examination – Cargo handling and container cranes.*

When all sub-parts of BS 7121-2 have been published, CP 3010 will be withdrawn and BS 5744 will be revised to cover manually operated and light cranes only.

This sub-part of BS 7121-2 is intended to be read in conjunction BS 7212-2-1.

Information about this document

The Health and Safety Executive (HSE) commends the use of this British Standard to those who have duties under the Health and Safety at Work etc. Act 1974 [1]. This standard was drawn up with the participation of HSE representatives and it will be referred to in the relevant HSE publications.

The BS 7121-2 series has been accepted by the HSE as representing the consensus of opinion based on practical experience for safety of cranes.

Hazard warnings

WARNING. This British Standard calls for the use of procedures that can be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Use of this document

As a code of practice, this sub-part of BS 7121-2 takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this sub-part of BS 7121-2 is expected to be able to justify any course of action that deviates from its recommendations.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Particular attention is drawn to the following specific regulations:

- Health and Safety at Work etc. Act 1974 [1].
- Lifting Operations and Lifting Equipment Regulations (LOLER) 1998 [2].
- Provision and Use of Work Equipment Regulations (PUWER) 1998 [3].
- Supply of Machinery (Safety) Regulations 2008 (as amended) [4].
- Merchant Shipping Act 1995 [5].
- Road Vehicles (Construction and Use) Regulations 1986 (as amended) [6].

NOTE Details of the Lifting Operations and Lifting Equipment Regulations 1998 [2] and the Provision and Use of Work Equipment Regulations 1998 [3] together with an HSE Approved Code of Practice and HSE Guidance are given in HSE publications Safe use of lifting equipment *[7] and* Safe use of work equipment *[8].*

1 Scope

This sub-part of BS 7121-2 gives recommendations for the pre-use checks, in-service inspection, maintenance, thorough examination (following installation, in service and following exceptional circumstances) and supplementary testing of overhead travelling cranes, including portal and semi-portal cranes, hoists, and their supporting structures.

For the purposes of this standard overhead travelling cranes, including portal and semi-portal cranes, and hoists are all included under the term “cranes”.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 7121-2-1:2012, *Code of practice for the safe use of cranes – Part 2-1: Inspection, maintenance and thorough examination – General*

3 Terms and definitions

For the purposes of this sub-part of BS 7121-2, the terms and definitions given in BS 7121-2-1 apply.

4 General

Regular pre-use checking, in-service inspection, maintenance and thorough examination of cranes are essential if cranes are to function safely and reliably. The nature of these activities can be summarized as follows.

- Pre-use checks are visual checks which are carried out to ensure that the crane has not suffered any damage or failure, and is safe to use.
- In-service inspections and maintenance are carried out, to ensure that components are repaired or replaced before they deteriorate to a point at which they would become unsafe.
- Thorough examinations are carried out at specified intervals, after installation on a new site, after major alteration or repair or after the occurrence of exceptional circumstances which could jeopardize the safety of the crane.

Supplementary testing is carried out in support of thorough examination and the extent and nature of any testing are specified by the competent person carrying out the thorough examination.

5 Personnel carrying out pre-use checks, in-service inspections, maintenance and thorough examinations

Attributes, competencies, competency assessment, training plans and training records of personnel should be in accordance with BS 7121-2-1:2012, Clause **5**.

6 Pre-use checks and in-service inspections

6.1 General

Pre-use checks and in-service inspection of cranes, together with a system to rectify any defects disclosed, are required by the Health and Safety at Work etc Act 1974 [1] (Section 2 (2) (a)); PUWER 1998[3] (Regulation 6) and LOLER 1998 [2] (Regulation 9 (3) (b)) to ensure that the crane is safe to use and that any deterioration is detected and rectified before the crane becomes unsafe.

The crane user should ensure that sufficient time is allowed for pre-use checks to be carried before the crane starts work. The user should also ensure that a safe system of work is in place to prevent the person who is carrying out the checks/inspections from being exposed to danger.

6.2 Pre-use checks

Pre-use checks should be carried out at the start of each shift during which the crane is to be used. These are to test the functionality of the crane and visually check for any obvious defects. Visual checks are normally be made from floor level unless a better permanent vantage point is available. The checks should include but not be limited to the following:

- pre-use checks required by the instructions for the crane;
- operation of emergency stop controls;
- operation of all crane motion controls;
- operation of electrical isolator switch;
- operation of motion limit switches, exercising caution whilst making checks in case of malfunction;
- operation of brakes;
- operation of audible warning devices, where fitted;
- a check of the general condition of the crane structure and mechanisms paying particular attention to the ropes, the sheaves, the hook and any unusual noises or erratic movement during operation;
- for cab controlled cranes and cranes with access to the bridge, a check that the work areas on the crane are tidy and free from any item which might fall, that access and egress from the cab is adequate and that the appropriate fire-fighting equipment is available;
- a visual check on the condition of the cab controls, the pendant and associated cables or remote control station as appropriate. In particular the condition of the casings and seals of pendant and remote controls should checked as damage can lead to false commands;
- a check that there are no obstructions in the path of travel of the crane or that adequate precautions are in place to prevent collisions; in particular for goliath and semi-goliath cranes a check for any debris or other track obstructions;

In the event that it does not pass the pre-use check, there should be a procedure to lock off the crane to prevent further use until the problem has been resolved.

6.3 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 crane or injury to persons. Further guidance is given in HSE document L113 [7]. It might be convenient to schedule the inspections concurrently with routine preventive maintenance (see **7.2**).

Pre-use checks and in-service inspections should only be carried out by personnel who have been adequately trained and assessed as competent to carry out the required tasks (see Clause **5**). LOLER 1998 [2] requires that results of all in-service inspections are recorded in writing. It is recommended that the results of all pre-use checks are also recorded in writing.

The period between inspections should be decided on the basis the duty of the crane and the environmental conditions and might need to vary between a week and six months. The period should be kept under review and adjusted according to the results of the inspections. The inspection should include, but not be limited to, the following:

- inspection given in the manufacturer's instructions for the crane;
- visual inspection of all wire ropes for broken wires, flattening, basket distortion or other signs of damage, excessive wear and surface corrosion;
- visual inspection of all rope terminations, pins and retaining devices, and inspection of all sheaves, for damage, worn bushes or seizure;
- visual inspection of hooks, safety catches and other load lifting attachments for damage, free movement or wear and visual inspection of the hook shank thread and securing nut for undue movement, which might indicate wear or corrosion;
- visual inspection of the structure for damage, for example cracked welds and loose bolts and other fasteners;
- a check of whether all moving parts are adequately lubricated with an appropriate lubricant;
- a check of whether all controls are clearly marked and operate correctly;
- operation of the crane though all its motions while checking for any unusual noises or erratic movement during operation;
- a check of the operation of all motion limiting devices, anti-collision devices and emergency stops;
- a visual inspection of any load limiter. This should at least comprise a physical check of the load limiter components, paying particular attention to cables, connectors and mountings;
- a visual inspection of the electrical equipment and a check for exposure to contamination by oil, grease, water or dirt;
- verify the functional effectiveness of braking system and that it is suitable for the application. This might need to include seeking confirmation from the crane operator;
- a visual inspection of rails and end stops;
- a check for the presence of, and of the condition of, all guards.

In the event that it does not pass inspection, there should be a procedure to isolate and lock-off the crane to prevent further use until the problem has been resolved.

6.4 Reporting of defects

The pre-use checks are generally carried out by a crane operator. In-service inspections are generally carried out by the maintenance personnel.

LOLER 1998 [2] requires that defects be reported immediately they are identified.

There should be provision for the personnel carrying out the pre-use checks or in-service inspection(s) to make written reports of defects or observations immediately they are identified.

6.5 Record of checks and inspections

A written record of all pre-use checks and in-service inspections should be kept. The record of a pre-use check should include at least the following information:

- identity of the crane;
- date of inspection;
- result of the check, i.e. whether or not the crane passed;
- name and signature of person carrying out the check.

This may be kept to a minimum by, for example, completing a single line of a pro-forma record card located near the crane.

The record for an in-service inspection should include details of the condition of critical components which need to be monitored, for example a wire rope showing signs of wear. It should be related to the crane's historical records and made available to the competent person responsible for the thorough examination (see Clause **8**).

6.6 Inspection of second-hand cranes

When purchasing second-hand cranes their condition should be inspected and assessed; nothing should be taken for granted. Second-hand cranes might contain latent defects which might otherwise only become apparent when the crane is put into service. They might have suffered significant damage and have been inadequately repaired. Second-hand cranes might also have been imported into the European Community without being modified to meet EU requirements, so called "Grey imports".

The assessment of a second-hand crane should include a review of maintenance records and previous reports of thorough examination, together with consultation of the manufacturer to obtain details of any major repairs etc. The contents of any data logger should be downloaded and reviewed. The assessment might require the removal of access covers or stripdown of major assemblies to reveal parts that could not ordinarily be seen. Once the crane's condition has been fully assessed any necessary repairs should be carried out and an appropriate in-service inspection interval established (see **6.3**).

7 Maintenance of cranes and supporting structures

7.1 Access for maintenance

NOTE Attention is drawn to the Work at Height Regulations 2005 (as amended) [9].

To maintain and repair cranes and their supporting structures in a safe and efficient manner, employers and maintenance contractors should ensure that procedures are in place to enable the maintenance personnel to access all relevant parts as and when required. Where it is important to gain access within a limited time, e.g. to repair a breakdown, contingency plans should be put in place.

In drawing up plans, consideration should be given to the following. Some parts might be accessible by using permanent facilities such as access ladders to the gantry combined with gantry and cross bridge walkways. However such facilities do not always provide access to

all parts and maintenance personnel 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. See BS 8437 for details on the selection and use of PPE for personal fall protection.

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 personnel who deploy and use such facilities should be trained for the purpose and the equipment used should be in serviceable condition.

Whilst routine maintenance should be carried out at a convenient time and with the crane in a position of choice, consideration should be given to repair in the event of a breakdown with the crane positioned at any point along the gantry and the crab or hoist positioned at any point across the crane bridge. The possibility of a breakdown with a load in the air should also be considered.

Where maintenance or repair is contracted out, the employer and contractor should agree in advance who is responsible for providing any PPE and its use, or providing temporary access facilities.

7.2 Routine preventive maintenance

Routine preventive maintenance should be carried out in accordance with the manufacturer's instructions (see also BS 7121-2-1:2012, Clause **7**). It might be convenient to schedule in-service inspections (see **6.3**) concurrently with the routine preventive maintenance.

8 Thorough examination of cranes and supporting structures

8.1 General

LOLER 1998 [2] Regulation 9 requires cranes and supporting structures to be examined in the following circumstances (see BS 7121-2-1:2012, **8.3**):

- after installation and before being put into use for the first time;
- periodically (maximum interval 6 months for cranes that lift people and 12 months for cranes that lift goods only) or in accordance with a written examination scheme;

  *NOTE These maximum intervals may be reduced to take into account environmental factors or the general age and condition of the crane etc., (see BS 7121-2-1:2012, **8.7**).*

- after exceptional circumstances have occurred.

8.2 Preparation for thorough examination

The crane 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.

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 crane 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 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.

The crane should be made safe by isolating and locking-off the power supply when necessary and reinstating it as appropriate.

8.3 Defined scope of thorough examination

8.3.1 General

The examination should be undertaken in accordance with a defined scope of thorough examination (see BS 7121-2-1:2012, **8.10**).

A defined scope of thorough examination should be drawn up in advance of the examination for each individual crane to be examined. The competent person undertaking thorough examination should regard this as the minimum scope of examination and add to the scope as appropriate. The scope should include details of any functional or supplementary testing that may might be required and whether the tests need to be witnessed by the competent person undertaking thorough examination. The scope should also include details of any non-destructive testing examinations required of the crane structure or mechanisms.

The defined scope of thorough examination for each crane should be reviewed on a periodic basis to check whether it is still appropriate and amended accordingly if necessary. A copy of the defined scope of thorough examination should be kept in the machine history file.

The scope should, as a minimum, include operation of the crane through all the motions while listening for any sounds that might indicate defects and observing any other malfunctions, and inspection of the components listed in **8.3.2**. These components should be assessed against the criteria listed in **8.3.3**, taking into account the path of the load through the crane's structure and mechanisms. It is essential that the scope is risk based and takes into account the consequences of failure of the crane. The examination should be undertaken in a systematic manner to ensure that all components and structures are examined.

8.3.2 Components to be included

The scope of the thorough should include examination of the following components, if fitted:

- end carriage structures;
- long travel drive, wheels, axles, bearings and brakes;
- bridge girders;
- crab structure;
- cross travel drive, wheels, axles, bearings and brakes;
- hoist mechanism including motor, brake, couplings, gearbox, drum and bearings;
- wire rope, guides, sheaves, bearings bottom block and hook;
- electrical control panel and wiring;
- operator cab and seating if fitted;
- operator controls whether cab, pendant or cable less;
- limit switches;
- platforms and access ladders;
- gantry rails and fixings;
- end stops and buffers;
- down shop conductor system.

8.3.3 Assessment criteria to be included

The following assessment criteria should be included in the defined scope of thorough examination:

- alignment - within manufacturer's tolerance;
- corrosion - affecting strength or functionality;
- cracks - affecting strength or functionality;
- damage - affecting strength or functionality;
- distortion - affecting strength or functionality;
- functionality - as intended by the manufacturer;
- leaks - affecting strength, functionality and slips;
- lubrication – adequacy;
- markings - presence, accuracy and condition;
- mode of operation - as intended by the manufacturer;
- obstructions - impeding safe access;
- security - attachment of components and sub structures, fasteners, welds etc.;
- seizure - full or partial seizure of rotating components;
- tidiness - general housekeeping;
- wear - affecting strength or functionality.

8.4 Rated capacity indicator/rated capacity limiter (RCI/RCL) calibration check and functional test

There are many different types of RCI/RCL fitted to overhead travelling cranes and some older cranes might not have an RCI or RCL at all.

Where it is reasonably practicable to carry out a calibration check and functional test of the RCI/RCL this should be undertaken in accordance with BS 7121-2-1:2012, **10.15** as part of the thorough examination. Where it is not reasonably practicable, the individual parts and components of the RCI/RCL system should be checked individually.

9 Overload testing of cranes and supporting structures

9.1 General

All cranes and supporting structures should be overload tested before first use. In some circumstances it might be necessary to treat them as separate entities, for example where a structure supports more than one crane.

The extent of the testing should be clearly stated in the test report.

Cranes and supporting structures should be overload tested after major repairs or modifications.

9.2 Overload testing of cranes

9.2.1 Thorough examination and functional testing

Before overload testing, the crane and the part of the supporting structure within the test area should be thoroughly examined to determine whether it is in a safe state and condition to be overload tested.

The crane should be functionally tested without a load applied to determine whether the controls, switches, contactors, relays and other devices operate correctly. The operation and correct adjustment of the brakes and limit switches should be checked and tests carried out to determine whether primary safety and emergency systems are operating correctly.

9.2.2 Test at rated capacity

After the functional tests, the crane should be tested with a load equivalent to the rated capacity. At the start of the test, the crane should be positioned over a supporting stanchion or column of the gantry or beneath the connection point of a suspended track, as appropriate, with the crab or hoist positioned adjacent to the end carriage. With the crane in this position, provision should be made for measuring the deflection of the crane main girders at the centre span.

The load should then be raised until each tooth of the train of gears has been subjected to the load, then the load should be lowered to 100 mm to 200 mm above the ground. The load should be held in this position for 10 min to check the brake. The load should then be raised from the suspended position by a further 200 mm to check the ability to re-hoist and then lowered to 100 mm to 200 mm above the ground. The crab should be traversed to mid-span and the deflection measured. The load should be lowered to the ground to relieve the structure and then raised to determine whether the deflection remains constant.

The load should be traversed to the opposite gantry, and the crane should be travelled along the track until each tooth of the train of gears of the long travel motion has been subjected to the load. The load should be traversed across the bridge to the opposite gantry and the crane should be returned to its original lift position.

The maximum deflection of the main bridge with the crab and load at the centre of the bridge should not exceed 1/750 of the span.

9.2.3 Overload test

The load should then be increased by 25% to form an overload test load and the overload test load should be hoisted until each tooth of the train of gears has been subjected to the overload, then lowered to 100 mm to 200 mm and the procedures detailed in **9.2.2** repeated with the overload test load suspended from the crane.

During the overload test the crane should remain stable and structurally sound and the brakes on each motion should function effectively. The traverse and travel braking systems should also function effectively with the overload applied.

During the overload test the crane should be operated at speeds appropriate to the safe control of the load, for example the lowest speed possible for the crane.

9.2.4 Testing of cranes with two or more hoists

For cranes with two or more hoists, separate tests in accordance with **9.2.2** and **9.2.3** should be carried out for each hoist. Where the use of more than one hoist at a time is permitted, all tests including the measurement of deflection should be carried out with all these hoists loaded simultaneously.

9.2.5 Post test thorough examination of the crane

On completion of the tests, a further thorough examination of the crane should be carried out by the competent person (see BS 7121-2-1:2012, **8.12**) and any overload protection devices should be reset and their correct operation checked.

When the testing and subsequent thorough examination have been completed, the competent person should issue a report of thorough examination which should include details of the overload test.

9.3 Overload testing of supporting structures

9.3.1 Assessment and thorough examination

Cranes can be supported in a variety of different ways. This could include a free-standing structure, or a gantry or track supported by the structure of the building or an engineering structure.

Those parts of the supporting structure which are not solely for the support of the crane gantry or track should be assessed by a structural engineer before any overload test is carried out. Those parts of the supporting structure which are solely for the support of the crane should be subjected to an overload test.

Prior to the application of the test loads, the competent person should carry out a thorough examination of the structure to determine whether it is in a safe condition to be overload tested.

An unloaded crane should then be travelled the full length of the supporting structure to check the alignment.

NOTE BS 466:1984 contains detailed information about the alignment of gantries.

9.3.2 Testing

9.3.2.1 General

Testing should be carried out using the combination of loadings, cranes and crane positions that imposes the maximum loadings on the structure under test. This includes cranes in an adjacent bay.

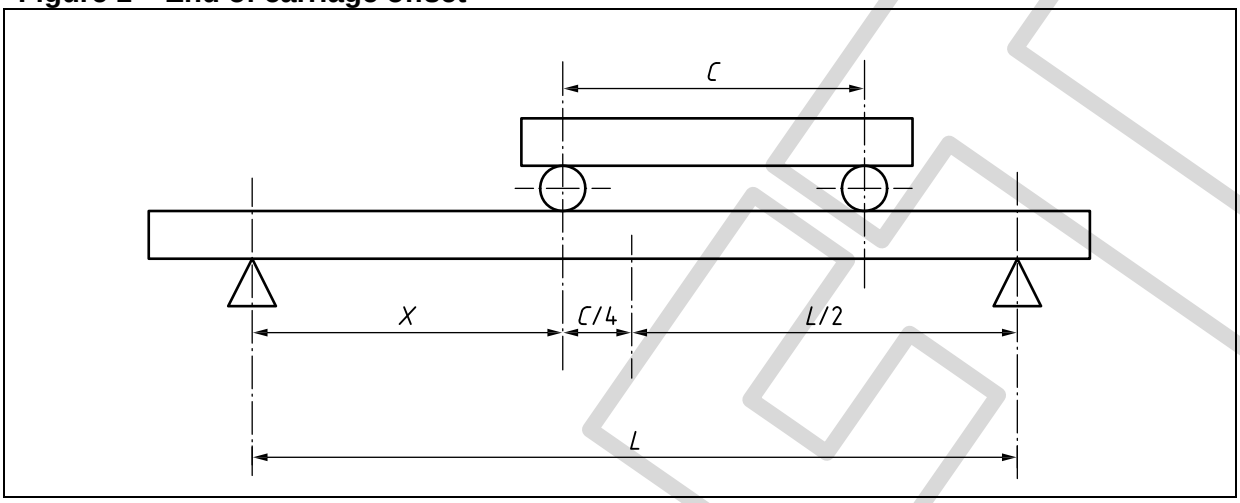
9.3.2.2 Test at rated capacity

Each crane involved should lift a load equivalent to its rated capacity 100 mm to 200 mm above the ground. The load lifted by each crane should be traversed to the end of the crane bridge nearest the side of the structure being tested. The cranes should be positioned along the span of the structure so as to provide the maximum deflection at the span centre. The deflection should be measured. The deflection measurement should be repeated for each span along the complete length of the structure. The procedure should be repeated for the other side of the structure.

For structures built in accordance with BS 449-2 the maximum deflection should not exceed 1/360 of the span. For structures built in accordance with BS 5950-1 or BS EN 1993-6, the maximum deflection should not exceed 1/600 of the span.

NOTE For a single crane where the end carriage wheel centres are less than half the span of the structure, the maximum stress will occur when the end carriage is offset as shown in Figure 1. The maximum deflection will occur at the span centre L/2. If it is possible for more than one crane to be on the same span of the structure, the position of maximum stress will depend upon the wheel loadings and wheel centres when the cranes are in their closest possible proximity.

Figure 1 – End of carriage offset



9.3.2.3 Overload test

Each crane involved should then lift an overload which is 25% in excess of the load equivalent to the rated capacity of the crane 100 mm to 200 mm above the ground. The load lifted by each crane should be traversed to the end of the crane bridge nearest the side of the structure being tested. The cranes should be travelled the full length of the structure in such relative positions as to impose the maximum combined loading. The procedure should be repeated for the other side of the structure.

9.3.3 Post test thorough examination of the supporting structure

On completion of the test a further thorough examination of the supporting structure should be carried out by the competent person (see BS 7121-2-1:2012, **8.12**).

When the testing and subsequent thorough examination has been completed, the competent person should issue a report of thorough examination which should include details of the tests.

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 449-2 (now withdrawn), *Specification for the use of structural steel in building – Part 2: Metric units*

BS 466:1984, *Specification for power driven overhead travelling cranes, semi-goliath and goliath cranes for general use*

BS 5950-1 (now withdrawn), *Structural use of steel in building – Part 1: Code of practice of design – Rolled and welded sections*

BS 8437, *Code of practice for selection, use and maintenance of personal fall protection systems and equipment for use in the workplace*

BS EN 1993-6, *Eurocode 3 – Design of steel structures – Part 6: Crane supporting structures*

Other publications

[1] GREAT BRITAIN. The Health and Safety at Work etc. Act 1974. London: The Stationery Office.

[2] GREAT BRITAIN. The Lifting Operations and Lifting Equipment Regulations (LOLER) 1998. London: The Stationery Office.

[3] GREAT BRITAIN. The Provision and Use of Work Equipment Regulations (PUWER) 1998. London: The Stationery Office.

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