BRITISH STANDARD

BS EN
13155:2003
+A2:2009

Cranes — Safety — Non-fixed load lifting attachments

ICS 53.020.30

BSI
British Standards

National foreword

This British Standard is the UK implementation of EN 13155:2003+A2:2009. It supersedes BS EN 13155:2003 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by ⟨A1⟩ ⟨A1⟩.

EN 13155:2003 covers a wide range of non-fixed load lifting attachments which have never previously been standardized by BSI, CEN or ISO. The lack of previous standards as a starting point, together with the wide scope of the equipment covered and the wide variety of current practices among the established manufacturers, made this standard particularly difficult to draft and to get agreement on. Nevertheless considerable progress has been made, to the point where the parties involved were sufficiently in agreement to enable the first edition of this standard to be published.

BSI Technical Committee MHE/3, which is responsible for the United Kingdom input to EN 13155, is of the view that, while further development may be required, this standard in its present form contains much useful information to guide manufacturers, and it represents an important step forward. Experience of applying this standard will doubtless reveal some matters which, with the benefit of hindsight, have not been adequately dealt with, and will need to be reconsidered in the next edition. In particular, readers are advised to exercise a degree of caution about the rigour of some of the verification clauses.

The UK participation in its preparation was entrusted to Technical Committee MHE/3, Cranes and derricks.

A list of organizations represented on this committee can be obtained on request to its secretary.

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.

This British Standard, was published under the authority of the Standards Policy and Strategy Committee on 27 August 2003

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13155:2003+A2

March 2009

ICS 53.020.30

Supersedes EN 13155:2003

English Version

Cranes - Safety - Non-fixed load lifting attachments

Appareils de levage à charge suspendue - Sécurité – Equipements amovibles de prise de charge

Krane - Sicherheit - Lose Lastaufnahmemittel

This European Standard was approved by CEN on 17 November 2001 and includes Amendment 1 approved by CEN on 24 June 2005 and Amendment 2 approved by CEN on 17 February 2009.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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Foreword

This document (EN 13155:2003+A2:2009) has been prepared by Technical Committee CEN/TC 147 “Cranes - Safety”, the secretariat of which is held by BSI.

This document shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2009, and conflicting national standards shall be withdrawn at the latest by December 2009.

This document includes Amendment 1, approved by CEN on 2005-06-24 and Amendment 2, approved by CEN on 2009-02-17.

This document supersedes EN 13155:2003.

The start and finish of text introduced or altered by amendment is indicated in the text by tags ⟨A1⟩ ⟨A1⟩ and ⟨A2⟩ ⟨A2⟩.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EC Directive(s).

⟨A2⟩ For relationship with EC Directive(s), see informative Annexes ZA and ZB, which are integral parts of this document. ⟨A2⟩

For the relationship with other European standards for cranes, see informative Annex H.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

This European Standard has been prepared to be a harmonized standard to provide one means for non-fixed load lifting attachments used on cranes to conform with the essential health and safety requirements of the Machinery Directive, as amended.

This European Standard is a type C standard as stated in EN 1070.

The machinery concerned and the extent to which hazards are covered are indicated in the scope of this standard.

When provisions of this type C standard are different from those which are stated in type A or B standards, the provisions of this type C standard take precedence over the provisions of the other standards, for non-fixed load lifting attachments which have been designed and built according to the provisions of this type C standard.

1 Scope

This European Standard specifies safety requirements for the following non-fixed load lifting attachments for cranes, hoists and manually controlled load manipulating devices:

— plate clamps;

— vacuum lifters;

  — self priming,

  — non-self priming (pump, venturi, turbine);

— electric lifting magnets (battery fed and mains-fed);

— permanent lifting magnets;

— electro-permanent lifting magnets;

— lifting beams;

— C-hooks;

— lifting forks;

— clamps;

defined in clause 3.

This standard does not specify the additional requirements for:

— non fixed load lifting attachments in direct contact with foodstuffs or pharmaceuticals requiring a high level of cleanliness for hygiene reasons;

— hazards resulting from handling specific hazardous materials (e.g. explosives, hot molten masses, radiating materials);

— hazards caused by operation in an explosive atmosphere;

— hazards caused by noise;

— electrical hazards;

— hazards due to hydraulic and pneumatic components.

This standard does not cover the hazards related to mechanical strength of structural elements of attachments designed for more than 20 000 lifting cycles.

NOTE The coefficient of utilization specified in clause 5.1.1 ensures that no fatigue verification is needed for less than 20 000 cycles. This is in accordance with the well accepted calculation codes e.g. FEM 1001.

This standard does not cover attachments intended to lift above people.

This standard does not cover slings, ladles, expanding mandrels, buckets, grabs, or grab buckets.

The hazards covered by this European Standard are identified in clause 4.

This European Standard does not cover hazards related to the lifting of persons.

This European Standard is applicable to non-fixed load lifting attachments which are manufactured after the date of approval by CEN of this standard.

2 Normative references

[A1] The following referenced documents are indispensable for the application of this European Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. [A1]

[A2] *deleted text* [A2]

EN 287-1, *Approval testing of welders for fusion welding — Part 1: Steels*

EN 349:1993, *Safety of machinery — Minimum gaps to avoid crushing of parts of the human body*

EN 457, *Safety of machinery — Auditory danger signals — General requirements, design and testing*

EN 818-4, *Short link chain for lifting purposes — Safety — Part 4: Chain slings — Grade 8*

EN 818-5, *Short link chain for lifting purposes — Safety — Part 5: Chain slings —Grade 4*

EN 842, *Safety of machinery — Visual danger signals — General requirements, design and testing*

EN 981, *Safety of machinery - System of auditory and visual danger and information signals*

EN 1070: 1998, *Safety of machinery — Terminology*

EN 1492-1, *Textile slings — Safety — Part 1: Flat woven webbing slings, made of man-made fibres, for general purpose use*

EN 1492-2, *Textile slings — Safety — Part 2: Roundslings, made of man-made fibres, for general purpose use*

ENV 1993-1-1: 1992, *Eurocode 3: Design of steel structures — Part 1-1: General rules and rules for buildings*

EN 10025, *Hot-rolled products of non alloy structural steels — Technical delivery conditions*

EN 10045-1, *Metallic materials — Charpy impact test — Part 1: Test method*

prEN 13414-1, *Steel wire rope slings — Safety — Part 1: Slings for general lifting service*

prEN 13557:2003, *Cranes — Controls and control stations*

EN 25817, *Arc-welded joints in steel — Guidance on quality levels for imperfections (ISO 5817:1992)*

〚A2〛 EN ISO 12100-1:2003, *Safety of machinery – Basic concepts, general principles for design – Part 1: Basic terminology, methodology (ISO 12100-1:2003)* 〚A2〛

〚A2〛 EN ISO 12100-2:2003, *Safety of machinery – Basic concepts, general principles for design – Part 2: Technical principles (ISO 12100-2:2003)* 〚A2〛

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 1070:1998 and the following terms and definitions apply:

3.1
adhesion force
force required to remove the load from a vacuum lifter

3.2
building area
area where buildings, bridges, roads etc are being erected or renovated or demolished
NOTE In these areas the environment is permanently changing. Any risks are higher than in plants or warehouses.

3.3
C-hook
equipment in the form of a ‘C’ used for lifting hollow loads e.g. coils, pipes

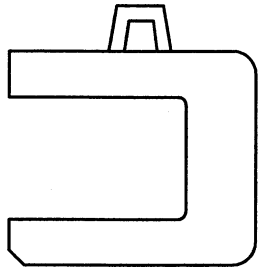


Figure 1 — Example of a C-hook

3.4
coefficient of utilisation
arithmetic ratio between the maximum load held by the lifting attachment and its working load limit

3.5
clamp
equipment used to handle loads by clamping on a specific part of the load.

NOTE Clamps are also known as tongs. For definition of plate clamps see 3.12.

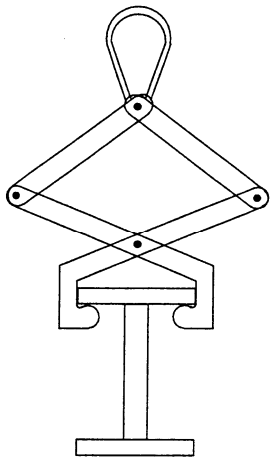


Figure 2 — Example of a clamp

3.6
individual verification
verification carried out on every item produced

3.7
lifting beam
equipment consisting of one or more members equipped with attachment points to facilitate the handling of loads which require support at several points

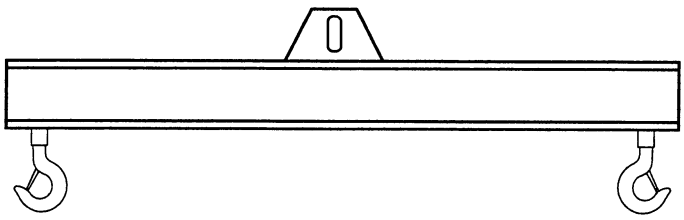


Figure 3 — Example of a lifting beam

3.8
lifting forks
equipment consisting of two or more arms fixed to an upright with an upper arm, essentially to lift palletised or similar loads

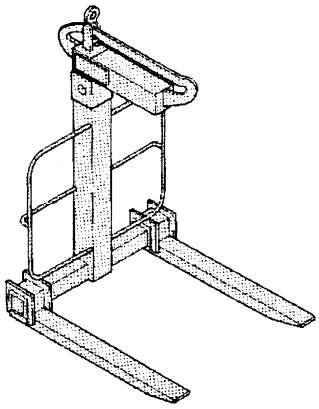


Figure 4 — Example of lifting forks

3.9
lifting magnet

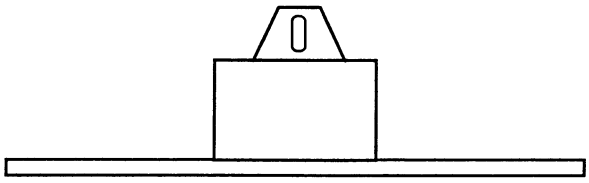


Figure 5 — Example of a lifting magnet

3.9.1
electric lifting magnet
equipment with a magnetic field generated by an electric current creating sufficient force for gripping, holding and handling loads with ferro-magnetic properties.

3.9.2
permanent lifting magnet
equipment with a permanent magnetic field which creates sufficient force for gripping, holding and handling loads with ferro-magnetic properties. The magnetic field is controlled by mechanical means

3.9.3
electro-permanent lifting magnet
equipment with a permanent magnetic field which creates sufficient force for gripping, holding and handling loads with ferro-magnetic properties. The magnetic field is controlled by an electric current which is not required to sustain the magnetic field

NOTE Electro-permanent lifting magnets can be energized by the mains or by battery or stand-alone generator.

3.10
No-go area
area from which persons are excluded during normal operation

3.11
non-fixed load lifting attachment
lifting attachment which can be fitted directly or indirectly to the hook or any other coupling device of a crane, hoist or manually controlled manipulating device by the user without affecting the integrity of the crane, hoist or manually controlled manipulating device

3.12
plate clamps
non powered equipment used to handle steel plates by clamping them between jaws.

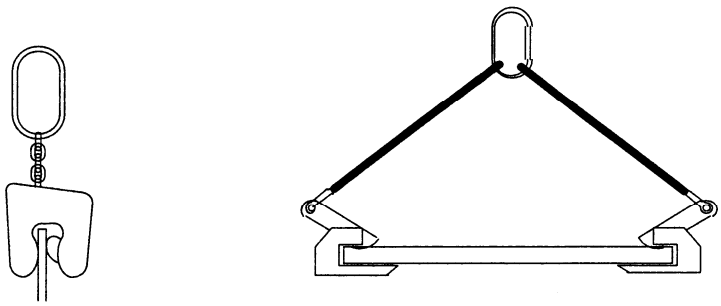


Figure 6 — Example of plate clamps

3.13
positive holding device
device making a direct mechanical connection to the load and which does not rely solely on friction, suction or magnetic adhesion to the load

3.14
secondary positive holding device
device to hold loads if the primary holding means fails and which does not rely on friction, suction or magnetic adhesion to the load

3.15
tear-off force
force applied at a right angle to the plane of the magnet poles which is required to detach the load from the switched-on magnet

3.16
two-action control
control which, in order to be operative, requires the performance of two separate actions with one or two hands, such as:

a) operation of two separate hold-to-run controls;

b) sequential operation of two movements of a control device;

c) previous unlocking of the control with self-locking in the neutral position.

3.17
type verification
verification carried out on one or more samples representative of a particular design and size of product before it is first placed on the market

NOTE Although the term "type verification" is normally associated with series produced equipment, for the purpose of this standard it also applies to single unit produced attachment.

3.18
vacuum lifter (suction pad)
equipment which includes one or several suction pads operating by vacuum

3.18.1
self priming vacuum lifter
vacuum lifter using the load to create the vacuum

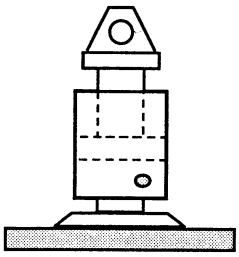


Figure 7 — Example of a self priming vacuum lifter

3.18.2
non self priming vacuum lifter
vacuum lifter using an external source of energy

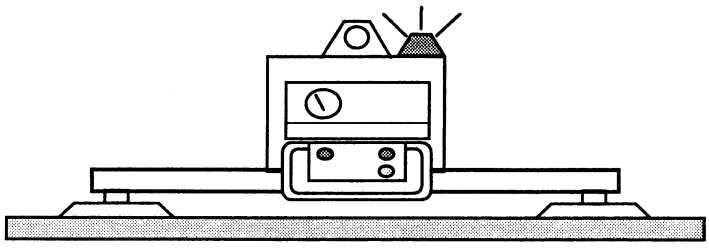


Figure 8 — Example of a non self priming vacuum lifter

3.19
working load limit
maximum load that the non-fixed load lifting attachment is designed to lift under the conditions specified by the manufacturer

4 List of significant hazards

Tables 1 to 7 show a list of significant hazardous situations and hazardous events that could result in risks to persons during normal use and foreseeable misuse. They also contain the relevant clauses in this standard that are necessary to reduce or eliminate the risks associated with those hazards.

NOTE The numbers in the left hand columns correspond to those in annex A of EN 1050: 1996 'Safety of machinery — Principles for risk assessment'.

Table 1 — Plate clamps - List of significant hazards and associated requirements

	Hazard	Relevant clause(s) in this standard
1	**Mechanical hazards** Generated by machine parts or workpieces caused, for example, by:	
1 e)	Inadequacy of mechanical strength	5.1.1.1, 5.1.1.2, Fatigue is not dealt with
1 c)	Stability	5.1.5, 7.1.1
1.1	Crushing hazard	5.1.3, 7.1.1, 7.1.2
1.2	Shearing hazard	5.1.3, 7.1.1, 7.1.2
8	**Hazards generated by neglecting ergonomic principles**	
8.1	Unhealthy postures	5.1.3
8.6	Human errors	5.2.1.2
15	**Errors of fitting**	5.2.1.4, 5.2.1.6
27	**Mechanical hazards and hazardous events**	
27.1	From load falls, collisions, machine tipping caused by:	
27.1.1	Lack of stability	5.1.5
27.1.4	Unexpected/unintended movement of loads	5.2.1.1, 5.2.1.2, 5.2.1.3, 5.2.1.4,
27.1.5	Inadequate holding devices/accessories	5.2.1.4, 5.2.1.5, 7.1.1, 7.1.2
27.4	From insufficient mechanical strength of parts	5.1.1.1 Fatigue is not dealt with
27.6	From inadequate selection/integration into the machine of chains, ropes, lifting accessories	5.1.4, 5.2.1.6
27.8	From abnormal conditions of assembly/testing/use maintenance	5.2.1.5, 5.2.1.6, 7.1 to 7.2

Table 2 — Vacuum lifters - List of significant hazards and associated requirements

	Hazard	Relevant clause(s) in this standard
1	**Mechanical hazards** Generated by machine parts or workpieces caused, for example, by:	
1 e)	Inadequacy of mechanical strength	5.1.1.1, 5.1.1.2, Fatigue is not dealt with
1 c)	Stability	5.1.5, 7.1.1
1 h)	The effect of vacuum	5.2.2
1.1	Crushing hazard	5.1.3, 7.1.1, 7.1.2
1.2	Shearing hazard	5.1.3, 7.1.1, 7.1.2
8	**Hazards generated by neglecting ergonomic principles**	
8.1	Unhealthy postures	5.1.3
8.2	Inadequate consideration of hand-arm anatomy	5.1.2
8.6	Human errors	5.2.2.1 to 5.2.2.10
8.7	Inadequate design of manual controls	5.1.2
10	**Unexpected start-up, unexpected overrun/overspeed**	5.1.6
13	**Failure of the power supply**	5.2.2.5, 5.2.2.6, 5.2.2.7
14	**Failure of the control circuit**	7.1.1, 7.1.2
15	**Errors of fitting**	7.1.1, 7.1.2
17	**Falling objects**	5.2.2.1, 5.2.2.2, 5.2.2.3,, 5.2.2.4
18	**Loss of stability of machinery**	5.1.5
27	**Mechanical hazards and hazardous events**	
27.1	From load falls, collisions, machine tipping caused by:	
27.1.1	Lack of stability	5.1.1.2
27.1.2	Uncontrolled loading - overloading - overturning moments exceeded	5.1.1.1, 7.1.1
27.1.3	Uncontrolled amplitude of movements	5.2.2.10
27.1.4	Unexpected/unintended movement of loads	5.2.2.1, 5.2.2.2, 5.2.2.3, 5.2.2.4, 5.2.2.5, 5.2.2.6, 5.2.2.9, 5.2.2.10, 7.2.3
27.1.5	Inadequate holding devices/accessories	5.2.2.1, 7.1.1, 7.1.2
27.4	From insufficient mechanical strength of parts	5.1.1.1 Fatigue is not dealt with
27.6	From inadequate selection/integration into the machine of chains, ropes, lifting accessories	5.1.4
27.8	From abnormal conditions of assembly/testing/use maintenance	5.2.5, 5.2.6, 7.1, 7.2

Table 3 — Lifting magnets - List of significant hazards and associated requirements

	Hazard	Relevant clause(s) in this standard
1	**Mechanical hazards** Generated by machine parts or workpieces caused, for example, by:	
1 e)	Inadequacy of mechanical strength	5.1.1.1, 5.1.1.2, Fatigue is not dealt with
1 c)	Stability	5.1.5, 7.1.1
1.1	Crushing hazard	5.1.3, 7.1.1, 7.1.2
1.2	Shearing hazard	5.1.3, 7.1.1, 7.1.2
8	**Hazards generated by neglecting ergonomic principles**	
8.1	Unhealthy postures	5.1.3
8.2	Inadequate consideration of hand-arm anatomy	5.1.2
8.6	Human errors	5.2.2.1 to 5.2.2.10
8.7	Inadequate design of manual controls	5.1.2
13	**Failure of the power supply**	5.2.3.3, 5.2.3.4.2, 5.2.3.4.3, 5.2.2.7
14	**Failure of the control circuit**	7.1.1, 7.1.2
15	**Errors of fitting**	7.1.1, 7.1.2
17	**Falling objects**	5.2.3.3, 5.2.3.4, 5.2.3.5, 5.2.3.6
18	**Loss of stability/overturning of machinery**	5.1.5
27	**Mechanical hazards and hazardous events**	
27.1	From load falls, collisions, machine tipping caused by:	
27.1.1	Lack of stability	5.1.1.2
27.1.2	Uncontrolled loading - overloading - overturning moments exceeded	5.1.1.1, 7.1.1
27.1.4	Unexpected/unintended movement of loads	5.2.3.1, 5.2.3.3, 5.2.3.4, 5.2.3.5, 5.2.3.6, 7.2.3
27.1.5	Inadequate holding devices/accessories	5.2.3.2, 7.1.1, 7.1.2
27.4	From insufficient mechanical strength of parts	5.1.1.1 Fatigue is not dealt with
27.6	From inadequate selection/integration into the machine of chains, ropes, lifting accessories	5.1.4
27.8	From abnormal conditions of assembly/testing/use maintenance	5.2.5, 5.2.6, 7.1, 7.2

Table 4 — C-Hooks - List of significant hazards and associated requirements

	Hazard	Relevant clause(s) in this standard
1	**Mechanical hazards** Generated by machine parts or workpieces caused, for example, by:	
1 e)	Inadequacy of mechanical strength	5.1.1.1, 5.1.1.2, Fatigue is not dealt with
1 c)	Stability	5.1.5, 7.1.1
1.1	Crushing hazard	5.1.3, 7.1.1, 7.1.2
1.2	Shearing hazard	5.1.3, 7.1.1, 7.1.2
8	**Hazards generated by neglecting ergonomic principles**	
8.1	Unhealthy postures	5.1.3, 5.2.4.1
8.2	Inadequate consideration of hand-arm anatomy	5.1.2
8.7	Inadequate design of manual controls	5.1.2
17	**Falling objects**	5.2.4.2
18	**Loss of stability/overturning of machinery**	5.1.5
27	**Mechanical hazards and hazardous events**	
27.1	From load falls, collisions, machine tipping caused by:	
27.1.1	Lack of stability	5.1.1.2
27.1.2	Uncontrolled loading - overloading - overturning moments exceeded	5.1.1.1, 7.1.1
27.1.4	Unexpected/unintended movement of loads	5.2.4.2
27.1.5	Inadequate holding devices/accessories	5.2.4.1, 7.1.1, 7.1.2, 7.2.3
27.4	From insufficient mechanical strength of parts	5.1.1.1 Fatigue is not dealt with
27.6	From inadequate selection/integration into the machine of chains, ropes, lifting accessories	5.1.4
27.8	From abnormal conditions of assembly/testing/use maintenance	7.1, 7.2

Table 5 — Lifting forks - List of significant hazards and associated requirements

	Hazard	Relevant clause(s) in this standard
1	**Mechanical hazards** Generated by machine parts or workpieces caused, for example, by:	
1 e)	Inadequacy of mechanical strength	5.1.1.1, 5.1.1.2, 5.2.5.6 Fatigue is not dealt with
1 c)	Stability	5.1.5, 7.1.1
1.1	Crushing hazard	5.1.3, 7.1.1, 7.1.2
1.2	Shearing hazard	5.1.3, 7.1.1, 7.1.2
1.9	High pressure fluid ejection	5.1.7
8	**Hazards generated by neglecting ergonomic principles**	
8.1	Unhealthy postures	5.1.3, 5.2.5.1
8.2	Inadequate consideration of hand-arm anatomy	5.1.2
8.7	Inadequate design of manual controls	5.1.2
17	**Falling objects**	5.2.5.2, 5.2.5.3, 5.2.5.4, 5.2.5.5,7.1.1, 7.2.3
18	**Loss of stability/overturning of machinery**	5.1.5
27 27.1	**Mechanical hazards and hazardous events** From load falls, collisions, machine tipping caused by:	
27.1.1	Lack of stability	5.1.1.2
27.1.2	Uncontrolled loading - overloading - overturning moments exceeded	5.1.1.1, 7.1.1
27.1.4	Unexpected/unintended movement of loads	5.2.5.2, 5.2.5.3, 5.2.5.4, 5.2.5.5
27.1.5	Inadequate holding devices/accessories	5.2.5.2, 5.2.5.3, 5.2.5.4, 5.2.5.5, 7.1.1, 7.1.2, 7.2.3
27.4	From insufficient mechanical strength of parts	5.1.1.1, 5.2.5.6 Fatigue is not dealt with
27.6	From inadequate selection/integration into the machine of chains, ropes, lifting accessories	5.1.4
27.8	From abnormal conditions of assembly/testing/use maintenance	5.2.5.3, 5.2.5.4, 5.2.5.5, 7.1, 7.2

Table 6 — Lifting beams - List of significant hazards and associated requirements

	Hazard	Relevant clause(s) in this standard
1	**Mechanical hazards** Generated by machine parts or workpieces caused, for example, by:	
1 e)	Inadequacy of mechanical strength	5.1.1.1, 5.1.1.2, 5.2.6.3.1 Fatigue is not dealt with
1 c)	Stability	5.1.5, 7.1.1
1.1	Crushing hazard	5.1.3, 5.2.6.1.3, 5.2.6.2, 5.2.6.3.4, 7.1.1, 7.1.2
1.2	Shearing hazard	5.1.3, 5.2.6.1.3, 5.2.6.2, 5.2.6.3.4, 7.1.1, 7.1.2
1.3	Entanglement hazards	5.2.6.3.4, 7.1.1, 7.1.2
8	**Hazards generated by neglecting ergonomic principles**	
8.1	Unhealthy postures	5.1.3
8.2	Inadequate consideration of hand-arm anatomy	5.1.2
8.7	Inadequate design of manual controls	5.1.2
10	**Unexpected start-up, unexpected overrun/overspeed**	5.2.6.3.3
17	**Falling objects**	5.2.6.2, 5.2.6.3.2
18	**Loss of stability/overturning of machinery**	5.1.5
27 27.1	**Mechanical hazards and hazardous events** From load falls, collisions, machine tipping caused by:	5.1.1.2, 5.2.6.1.3, 5.2.6.3.3
27.1.1	Lack of stability	5.1.1.1, 7.1.1
27.1.2	Uncontrolled loading - overloading - overturning moments exceeded	7.1, 7.2
27.1.4	Unexpected/unintended movement of loads	5.2.6, 7.2.3
27.1.5	Inadequate holding devices/accessories	5.1.4, 7.1.1, 7.1.2
27.4	From insufficient mechanical strength of parts	5.1.1.1 Fatigue is not dealt with
27.6	From inadequate selection/integration into the machine of chains, ropes, lifting accessories	5.1.4
27.8	From abnormal conditions of assembly/testing/use maintenance	5.2.5, 5.2.6, 7.1, 7.2

Table 7 — Clamps - List of significant hazards and associated requirements

	Hazard	Relevant clause(s) in this standard
1	**Mechanical hazards** Generated by machine parts or workpieces caused, for example, by:	
1 e)	Inadequacy of mechanical strength	5.1.1.1, 5.1.1.2, 5.2.7.6 Fatigue is not dealt with
1 c)	Stability	5.1.5, 7.1.1
1.1	Crushing hazard	5.1.3, 7.1.1, 7.1.2
1.2	Shearing hazard	5.1.3, 7.1.1, 7.1.2
8	**Hazards generated by neglecting ergonomic principles**	
8.1	Unhealthy postures	5.1.3
8.2	Inadequate consideration of hand-arm anatomy	5.1.2
8.6	Human errors	5.2.7.4, 5.2.7.5, 5.2.7.7
8.7	Inadequate design of manual controls	5.1.2, 5.2.7.4
15	**Errors of fitting**	5.2.7.2, 7.1.1, 7.1.2
17	**Falling objects**	5.2.7, 7.1.1, 7.2.3
18	**Loss of stability of machinery**	5.1.5
27	**Mechanical hazards and hazardous events**	
27.1	From load falls, collisions, machine tipping caused by:	
27.1.1	Lack of stability	5.1.1.2
27.1.2	Uncontrolled loading - overloading - overturning moments exceeded	5.1.1.1, 7.1.1, 7.2.1
27.1.4	Unexpected/unintended movement of loads	5.2.7.1, 5.2.7.2, 5.2.7.3, 5.2.7.4, 7.2.3
27.1.5	Inadequate holding devices/accessories	5.2.7.2, 5.2.7.3, 5.2.7.5, 5.2.7.7, 7.1.1, 7.1.2, 7.2.3
27.4	From insufficient mechanical strength of parts	5.1.1.1, 5.2.7.6 Fatigue is not dealt with
27.6	From inadequate selection/integration into the machine of chains, ropes, lifting accessories	5.1.4
27.8	From abnormal conditions of assembly/testing/use maintenance	5.2.7.5, 7.1, 7.2

5 Safety requirements and/or measures

5.1 General requirements

The attachment shall comply with the safety requirements and/or measures of this clause. In addition, the attachment shall be designed according to the principles of [A2] EN ISO 12100 [A2] for hazards relevant but not significant which are not dealt with by this standard.

5.1.1 Mechanical load bearing parts

5.1.1.1 The mechanical load bearing parts shall have a mechanical strength to fulfil the following requirements:

1) the attachment shall be designed to withstand a static load of three times the working load limit without releasing the load even if permanent deformation occurs;

2) the attachment shall be designed to withstand a static load of two times the working load limit without permanent deformation.

5.1.1.2 Attachments intended to tilt shall be designed for an angle exceeding minimum 6° the maximum working angle. Attachments not intended to tilt shall be designed for an angle of minimum 6°.

5.1.2 Controls

The controls of the attachment shall be in accordance with the following clauses of prEN 13557:2003 where applicable:

5.1.1, 5.1.10, 5.2.3.1.1, 5.2.3.1.2, 5.2.3.1.3, 5.2.3.2.1, 5.2.3.2.2, 5.2.3.2.3, 5.2.3.2.4, 5.2.3.2.5, 5.2.3.2.6

5.1.3 Handles

An attachment that is intended to be guided manually shall be equipped with handle(s), arranged so that finger injuries are avoided. Handles are not required if features have been built in to provide natural handholds.

5.1.4 Requirements for slings which are integrated

Slings which are an integrated part of the attachment shall be in accordance with the appropriate following standards:

— EN 818-4;

— EN 818-5;

— prEN 13414-1;

— EN 1492-1;

— EN 1492-2.

5.1.5 Stability during storage

When not required for use it shall be possible to set down the attachment so that it is stable during storage. To be regarded as stable it shall not tip over when tilted to an angle of 10° in any direction. This shall be achieved either by the shape of the attachment or by means of additional equipment such as a stand.

5.2 Specific requirements for each category of attachment

5.2.1 Plate clamps

5.2.1.1 Under the conditions specified by the manufacturer, it shall not be possible to unintentionally release the load, in particular by the following influences:

a) contact of the plate clamp particularly the locking mechanisms with an obstacle;

b) weight of the crane hook, bottom block or other connections bearing down on the device;

c) intended tipping and/or turning.

5.2.1.2 Plate clamps intended to transport vertically suspended plate shall incorporate a device to prevent the load from unintentional detachment when it is set down.

5.2.1.3 The safety factor to prevent the load from slipping shall be at least 2.

5.2.1.4 In the case of plate clamps where the range of thickness does not start at 0, a safety range in which the gripping force does not fall below the value given in 5.2.1.3 is required below the smallest specified thickness, in order to be able to compensate for the manufacturing tolerances, elastic deformation etc.

The following minimum safety ranges are required:

a) for a minimum thickness less than or equal to 50 mm: 10 % of the minimum thickness;

b) for a minimum thickness between 50 and 100 mm: 5 mm;

c) for a minimum thickness more than 100 mm: 5 % of the minimum thickness.

5.2.1.5 If the lifting attachment is designed to use more than one clamp, the working load limit of each clamp shall take account of the share of the load which can foreseeably be imposed on it (including any inequality of share due to the rigidity of the load) and any intermediate equipment between the clamps and the crane e.g. a lifting beam.

5.2.1.6 The method of connecting to the crane or intermediate equipment shall ensure that the forces are transmitted through the plate clamp in the correct alignment. Where this is not possible by design, the marking and/or operating instructions shall clearly indicate how it should be connected.

5.2.2 Vacuum lifters

5.2.2.1 Vacuum lifters shall be dimensioned to hold at least a load corresponding to two times the working load limit at the end of the working range and the beginning of the danger range respectively at all intended angles of tilt. The maximum angles of tilt shall be increase in accordance with 5.1.1.2.

NOTE The pressure range with which it is possible to work is termed the working range. The danger range adjoins the working range. In some vacuum lifting systems, in particular self-priming vacuum lifters, the pressure decrease arising depends upon the weight of the load.

5.2.2.2 Non-self-priming vacuum lifters shall be equipped with a pressure measuring device showing the working range and the danger range of the vacuum.

5.2.2.3 Self-priming vacuum lifters shall be equipped with an indicator showing to the operator that the end of the working range is reached.

5.2.2.4 The measuring device or the indicator respectively shall be fully visible for the slinger or, if there is no slinger, for the driver of the crane in his normal working position.

5.2.2.5 Means shall be provided to prevent the risks due to vacuum losses. This shall be:

a) in the case of vacuum lifters with a vacuum pump: a reserve vacuum with a non return valve between the reserve vacuum and the pump, located as close as possible to the reserve vacuum;

b) in the case of vacuum lifters with Venturi-system: a pressure-reserve-tank or vacuum-reserve-tank with a non return valve between the reserve vacuum and the Venturi system, located as close as possible to the reserve vacuum;

c) in the case of turbine vacuum lifters: a supporting battery or an additional flywheel-mass;

d) in the case of self-priming vacuum lifters: a reserve-stroke at least equal to 5 % of the total stroke of the piston.

NOTE Vacuum losses can occur for example, due to leaks, or in the case of non self-priming vacuum lifters, due to a power failure.

5.2.2.6 There shall be a device to warn automatically that the danger range is reached, when vacuum losses cannot be compensated. The warning signal shall be optical or acoustic, depending upon the circumstances of use for the vacuum lifter, and in accordance with EN 981, EN 842 and EN 457. The warning device shall work even if there is a power failure of the vacuum lifter.

NOTE The warning device is not the pressure measuring device of 5.2.2.2 or the indicator of 5.2.2.3.

5.2.2.7 In case of power failure, the vacuum lifter shall be able to hold the load for 5 minutes. This is not necessary in no-go areas and this is not necessary for turbine vacuum lifters if all the following conditions are met:

— the operator maintains control of the load through steering handles which ensures that the operator is outside the danger zone in case of the load falling;

— in addition to clause 5.2.2.6 a warning device shall be activated as soon as the power fails;

— the manufacturer shall prohibit lifting of the geometric centre of the suction pads above 1,8 m by marking and instructions for use.

5.2.2.8 For vacuum lifters intended to be used in a building area a secondary positive holding device is required or there shall be two vacuum reserves each fitted with non return valves. Each vacuum reserve shall be connected to a separate set of vacuum pads. Each set of vacuum pads shall fulfil the requirement of the clause 5.2.2.1.

5.2.2.9 The releasing of the load shall be actuated by a two action control. This is not necessary if the release of the load is not possible until the load has been put down or in no-go areas.

5.2.2.10 Controls for tilting or turning movements shall be hold-to-run type.

5.2.2.11 The shape of the suction pad shall be matched to that of the intended load(s). If more than one suction pad is used in conjunction with a lifting beam, the layout and working load limit of the suction pads shall be matched to that of the intended load(s). The share of the load which can foreseeably be imposed on each suction pad shall not exceed its working load limit taking account of the rigidity of both the load and the vacuum lifter.

5.2.3 Lifting magnets

5.2.3.1 General

5.2.3.1.1 The releasing of the load shall be actuated by a two action control. This is not necessary if the release of the load is not possible until the load has been put down or in no-go areas.

5.2.3.1.2 The shape of the magnet shall be matched to that of the intended load(s). If more than one magnet is used in conjunction with a lifting beam, the layout and working load limit of the magnets shall be matched to that of the intended load(s). The share of the load which can foreseeably be imposed on each magnet shall not exceed its working load limit taking account of the rigidity of both the load and the lifting beam.

5.2.3.2 Battery-fed electric lifting magnets

5.2.3.2.1 They shall provide a tear-off force corresponding to at least 2 times the working load limit under the conditions specified by the manufacturer.

5.2.3.2.2 An automatic warning device shall be provided which monitors the power supply and provides a warning at least 10 minutes before the supply reaches the level where the load will be release. The warning device shall be optical or acoustic.

5.2.3.2.3 A safety device shall be provided, which, after the low power warning device has been activated and the magnet has been switched off, prevents the magnet from being switched on again until the battery is recharged to the minimum level at which the low power warning device is not activated.

5.2.3.2.4 An indicator shall be provided to show if the magnet is magnetised (ON/OFF).

NOTE The indicator does not necessarily indicate that there is sufficient magnetic field.

5.2.3.3 Mains-fed electric lifting magnets

5.2.3.3.1 They shall provide a tear-off force corresponding to at least 2 times the working load limit under the conditions specified by the manufacturer.

5.2.3.3.2 An automatic warning device shall be provided to warn if the mains power supply fails. The warning device may be optical or acoustic. This is not necessary in no-go areas.

5.2.3.3.3 A stand-by battery shall be provided to supply power in case the mains supply fails. It shall be capable of providing the current needed to hold the working load limit for at least 10 minutes. This is not necessary in no-go areas.

5.2.3.3.4 Requirements of clause 5.2.3.3.2 and 5.2.3.3.3 are not necessary if all the following requirements are met:

— The manufacturer shall prohibit lifting the pole geometric centre above 1,8 m by marking and instructions for use;

— The load mass is less than 20 kg.

5.2.3.3.5 In cases where it is difficult to leave the danger zone (e. g. in a building area or in ships during loading and unloading) a redundancy of the flexible cables of the DC supply lines between the control cabinet and the attachment (e.g. spreader beam or single magnet) and of the power control unit of the magnet system is required. Alternatively a secondary positive holding device is required.

5.2.3.3.6 Magnets for lifting loads such as plates, sheets, or bars from the top of a stack, shall have controls to reduce the power supply so as to facilitate the shedding of excess load. After the excess load has been shed the controls shall permit restoration of full power.

5.2.3.3.7 The magnet system shall have an indicator to show when the magnet(s) are magnetized. For magnets with variable power control, the indicator shall distinguish between full and partial magnetization.

NOTE The indicator does not necessarily indicate that there is sufficient magnetic field.

5.2.3.4 Permanent lifting magnets

5.2.3.4.1 They shall provide a tear-off force corresponding to at least 3 times the working load limit under the conditions specified by the manufacturer;

5.2.3.4.2 The control shall clearly indicate whether the magnet is ON or OFF;

5.2.3.4.3 The control for operating the magnet shall be in accordance with EN 349: 1993 with regard to the place for the operator's hands.

5.2.3.5 Electro-permanent lifting magnets

5.2.3.5.1 They shall provide a tear-off force of at least 3 times the working load limit under the conditions specified by the manufacturer.

5.2.3.5.2 The magnets shall have an indicator to show when the magnet(s) are magnetized. For magnets with variable power control, the indicator shall distinguish between full and partial magnetisation.

5.2.4 C-hooks

5.2.4.1 The unloaded C-hook shall hang with the lower arm within 5° of horizontal to facilitate access to the load.

5.2.4.2 One of the following means shall be provided to prevent the load from sliding on the lower arm, or the load or part of the load from falling:

a) the C-hook tilted backwards with an angle greater or equal to 5° in the loaded position;

b) for the C-hook intended for handling single steel sheet coils the lower arm shall be horizontal or titled backward in the loaded position;

c) a chain, strap or bar to close the C-hook opening;

d) a clamping system to secure the load;

e) an end stop on the lower arm.

5.2.5 Lifting forks

5.2.5.1 The unloaded lifting fork shall hang with the fork arms within 5° of horizontal to facilitate access to the load.

5.2.5.2 Within the intended load range and position of the load centre of gravity, the fork arms shall be tilted backwards with an angle greater or equal to 5° to prevent the load from sliding from the fork arms.

5.2.5.3 Lifting forks for loose material (e.g. bricks and tiles) to be used in a building area shall have a secondary positive holding device (e.g. net, cage).

The secondary positive holding device shall prevent the release of the complete load or any loose parts of the load.

For handling loose materials (e.g. bricks and tiles) the secondary positive holding device (e.g. nets or cages) shall not have side and bottom openings of more than 50 mm ▌A1⟩ *deleted text* ⟨A1▐.

NOTE It is recommended that the secondary positive holding device is automatically activated.

5.2.5.4 Lifting forks fitted with a secondary positive holding device required in the clause 5.2.5.3 shall be capable of holding a uniformly distributed load equal to 50% of the WLL in all four horizontal directions.

5.2.5.5 Lifting forks for unit load (e.g. plastic wrapped palletised load) to be used on building area shall have a retaining device (e.g. chain, strap or bar) to prevent the unit load sliding off the forks.

5.2.5.6 Lifting forks with a retaining device as required in clause 5.2.5.5 shall be capable of holding a uniformly distributed load equal to 50% of the WLL.

5.2.6 Lifting beams

5.2.6.1 Attaching the lifting beam to the crane

5.2.6.1.1 Any connection made by moving or removing a lifting beam component shall be such that it can be locked before lifting so as to prevent any accidental uncoupling of this connection.

5.2.6.1.2 Means shall be provided to prevent any dangerous movement and damage to the suspended parts of the lifting beam parts during storage, coupling or uncoupling from the crane.

5.2.6.2 Securing the load to the lifting beam

5.2.6.2.1 Lifting beams with load attachment points which move along the beam shall have the means to prevent them falling off.

5.2.6.2.2 Load attachment points which move along the beam shall have the means to lock them in positions when they are under load

5.2.6.2.3 If the means of locking the load attachment points is operated manually, the state of locking shall be visible to the slinger.

5.2.6.3 Structure

5.2.6.3.1 If the lifting beam is intended to tilt, the manufacturer shall indicate the maximum permissible angle of tilt from the horizontal. If the lifting beam is intended for horizontal use, the design shall tolerate a tilt of up to 6° from the horizontal.

5.2.6.3.2 Moving parts of the structure shall have devices to hold them in position when loaded. These devices shall be effective up to 6° from the maximum tilting angle permitted for the lifting beam. If these devices operate on a friction basis the safety factor shall be at least 2.

5.2.6.3.3 If free movement presents a hazard, lifting beams fitted with a rotation or tilting mechanism shall be equipped with a device to stop movement and to immobilise the load in its intended position.

5.2.6.3.4 When the spacing between moving parts of the beam is controlled by a power source, protection devices shall be provided to avoid crushing and shearing hazards as specified in EN 349: 1993.

5.2.7 Clamps

5.2.7.1 The holding force of clamps holding by friction to prevent the load from slipping shall be at least 2 times the working load limit.

5.2.7.2 In the case of clamps holding by friction, where the range of thickness does not start at 0, a safety range in which the holding force does not fall below the value given in clause 5.2.7.1 is required below the smallest specified thickness, in order to be able to compensate for the manufacturing tolerances, elastic deformation etc.

The following minimum safety ranges are required:

a) for a minimum thickness less than or equal to 50 mm: 10 % of the minimum thickness;

b) for a minimum thickness between 50 and 100 mm: 5 mm of the minimum thickness;

c) for a minimum thickness more than 100 mm: 5 % of the minimum thickness.

NOTE Due to the wide variety of applications for clamps, it is impossible to specify a safety range which is suitable for all. The above ranges should therefore be treated with caution and increased as appropriate to the application

5.2.7.3 In the case of clamps holding by friction, the clamping mechanism shall be designed to ensure that the clamping force will be maintained in case of deformation of the load(e.g. surface crushing and elastic and plastic deformation).

NOTE This can be achieved by, for example, a scissor mechanism activated by gravity or by a pressure compensation device (e.g. springs, hydraulic accumulators) etc.

Clamps holding the load hydraulically or pneumatically shall be fitted with a device to compensate for any pressure drop below working pressure. If it is not possible to maintain the requirement of clause 5.2.7.1 an acoustic or optical warning signal shall be automatically activated.

5.2.7.4 For clamps which are not self closing the releasing of the load shall be actuated by a two action control.

This is not necessary, if the release of the load is not possible until the load has not been put down or in no-go areas.

5.2.7.5 Clamps to be used in a building area shall have a positive holding device or a secondary positive holding device (e.g. slings, net, cage).

The positive holding device or secondary positive holding device shall prevent the release of the complete load or any loose parts of the load.

For handling loose materials (e.g. bricks and tiles) the positive holding device or secondary positive holding device (e.g. nets or cages) shall not have side and bottom openings of more than 50 mm^2.

NOTE It is recommended that the secondary positive holding device is automatically activated.

5.2.7.6 For handling loose materials (e.g. bricks and tiles) the positive holding device or secondary positive holding device (e.g. nets or cages) shall be capable of holding a uniformly distributed load equal to 50% of the WLL in all four horizontal directions and 200% of the WLL in the vertical direction.

5.2.7.7 The requirements of 5.2.7.5 and 5.2.7.6 shall not apply, if the clamp is intended to be used only to lift the lowest part of the clamp to a height less than 1.8 m and is either:

— for moving single bricks or building components with a weight less than 50 kg or,

— for unloading lorries to the ground.

6 Verification of the safety requirements and/or measures

Conformity to each safety requirement and/or measure (given in clause 5 and 7) shall be verified by the methods specified in table 8 and detailed in annexes A to G.

For single unit designed and produced products, type verification and individual verification shall be done. For series produced product type verification shall be done on one or more representative product of the series and the individual verification shall be done on each product produced.

Table 8 — Methods to be used to verify conformity with the safety requirements and/or measures

Equipment	Requirement		Verification	Method
	Descriptor	Clause number	Type verification	Individual verification
Plate clamps	Mechanical load bearings parts	5.1.1.1	A.2	A.3
	Tilting limit	5.1.1.2	A.2	
	Controls	5.1.2	A.4	
	Handles	5.1.3	A.4	
	Lifting slings	5.1.4	A.4	
	Stability in storage	5.1.5	A.4	
	Preventing unintentional release	5.2.1.1	B.1	
	Preventing unintentional release when setting down	5.2.1.2	B.1	
	Friction coefficient	5.2.1.3	B.2 + B.3	
	Tolerances on range of thickness	5.2.1.4	B.4	
	Foreseeable share of the load	5.2.1.5	A.4	
	Connection to the crane	5.2.1.6	A.4	
	Information for use	7.1	A.4	A.4
	Marking	7.2	A.4	A.4

Equipment	Requirement		Verification	Method
	Descriptor	Clause number	Type verification	Individual verification
Vacuum lifters	Mechanical load bearings parts	5.1.1.1	A.1 or A.2	A.1 or A.3
	Tilting limit	5.1.1.2	C.10 or A.2	C.9
	Controls	5.1.2	A.4	
	Handles	5.1.3	A.4	
	Lifting slings	5.1.4	A.4	
	Stability in storage	5.1.5	A.4	
	Adhesion force	5.2.2.1	C.10 or A.2	
	Pressure measuring device	5.2.2.2		C.1
	Leakage indicator	5.2.2.3		C.2
	Visibility of measuring device or indictor	5.2.2.4	C.3	
	Means to prevent risks of vacuum losses	5.2.2.5		C.4 and C.6
	Warning device	5.2.2.6		C.5 and C.8
	Holding time	5.2.2.7		C.4
	Building area	5.2.2.8	A.4	
	Two action control	5.2.2.9	C.7	
	Controls for tilting or turning	5.2.2.10	A.4	
	Design appropriate for the load	5.2.2.11	A.4	
	Information for use	7.1	A.4	A.4
	Marking	7.2	A.4	A.4

Equipment	Requirement		Verification	Method
	Descriptor	Clause number	Type verification	Individual verification
Battery fed Lifting magnets	Mechanical load bearings parts	5.1.1.1	A.1 or A.2	A.1 or A.3
	Tilting limit	5.1.1.2	A.2	
	Controls	5.1.2	A.4	
	Handles	5.1.3	A.4	
	Lifting slings	5.1.4	A.4	
	Stability in storage	5.1.5	A.4	
	Two action controls	5.2.3.1.1	D.2	
	Design appropriate for the load	5.2.3.1.2	D.7	
	Tear-off forces	5.2.3.2.1	D.1	
	Warning devices	5.2.3.2.2	D.3 and D.4	D.3 and D.4
	Safety device preventing switched on	5.2.3.2.3	A.4	A.4
	Magnetisation indicator	5.2.3.2.4	D.5	D.5
	Information for use	7.1	A.4	A.4
	Marking	7.2	A.4	A.4

Equipment	Requirement		Verification	Method
	Descriptor	Clause number	Type verification	Individual verification
Mains fed Lifting magnets	Mechanical load bearings parts	5.1.1.1	A.1 or A.2	A.1 or A.3
	Tilting limit	5.1.1.2	A.2	
	Controls	5.1.2	A.4	
	Handles	5.1.3	A.4	
	Lifting slings	5.1.4	A.4	
	Stability in storage	5.1.5	A.4	
	Two action controls	5.2.3.1.1	D.2	
	Design appropriate for the load	5.2.3.1.2	D.7	
	Tear-off forces	5.2.3.3.1	D.1	
	Warning devices	5.2.3.3.2	D.3 and D.4	D.3 and D.4
	Discharge time of batteries	5.2.3.3.3	D.4	D.4
	Exception	5.2.3.3.4	A.4	A.4
	Redundancy or back-up devices	5.2.3.3.5	D.6	D.6
	Shedding	5.2.3.3.6	D.2	
	Magnetisation indicator	5.2.3.3.7	D.5	D.5
	Information for use	7.1	A.4	A.4
	Marking	7.2	A.4	A.4

Equipment	Requirement		Verification	Method
	Descriptor	Clause number	Type verification	Individual verification
Permanent Lifting magnets	Mechanical load bearings parts	5.1.1.1	A.1 or A.2	A1 or A.3
	Tilting limit	5.1.1.2	A.2	
	Controls	5.1.2	A.4	
	Handles	5.1.3	A.4	
	Lifting slings	5.1.4	A.4	
	Stability in storage	5.1.5	A.4	
	Two action controls	5.2.3.1.1	A.4	
	Design appropriate for the load	5.2.3.1.2	D.7	
	Tear-off forces	5.2.3.4 1	D.1	
	Position of the controls	5.2.3.4 2	A.4	A.4
	Safety distance	5.2.3.4 3	A.4	A.4
	Information for use	7.1	A.4	A.4
	Marking	7.2	A.4	A.4

Equipment	Requirement		Verification	Method
	Descriptor	Clause number	Type Verification	Individual verification
Electro Permanent Lifting magnets	Mechanical load bearings parts	5.1.1.1	A.1 or A.2	A.1 or A.3
	Tilting limit	5.1.1.2	A.2	
	Controls	5.1.2	A.4	
	Handles	5.1.3	A.4	
	Lifting slings	5.1.4	A.4	
	Stability in storage	5.1.5	A.4	
	Two action controls	5.2.3.1.1	D.2	
	Design appropriate for the load	5.2.3.1.2	D.7	
	Tear-off forces	5.2.3.5.1	D.1	
	Magnetisation indicator	5.2.3.5.2	D.5	D.5
	Information for use	7.1	A.4	A.4
	Marking	7.2	A.4	A.4

Equipment	Requirement		Verification	Method
	Descriptor	Clause number	Type Verification	Individual verification
C-hooks	Mechanical load bearings parts	5.1.1.1	A.1 or A.2	A.1 or A.3
	Tilting limit	5.1.1.2	A.2	
	Controls	5.1.2	A.4	
	Handles	5.1.3	A.4	
	Lifting slings	5.1.4	A.4	
	Stability in storage	5.1.5	A.4	
	Unloaded position	5.2.4.1	A.4	A.4
	Preventing load slipping or falling	5.2.4.2	A.4	A.4
	Information for use	7.1	A.4	A.4
	Marking	7.2	A.4	A.4

Equipment	Requirement		Verification	Method
	Descriptor	Clause number	Type Verification	Individual verification
Lifting forks	Mechanical load bearings parts	5.1.1.1	A.1 or A.2	A.1 or A.3
	Tilting limit	5.1.1.2	A.2	
	Controls	5.1.2	A.4	
	Handles	5.1.3	A.4	
	Lifting slings	5.1.4	A.4	
	Stability in storage	5.1.5	A.4	
	Unloaded position	5.2.5.1	A.4	A.4
	Preventing load slipping or falling	5.2.5.2	A.4	A.4
	Building area	5.2.5.3	A.4	A.4
	Strength of secondary holding device	5.2.5.4	F.1	
	Retaining device for unit load	5.2.5.5	A 4	
	Strength of the retaining device	5.2.5.6	A.1 or A.2	
	Information for use	7.1	A.4	A.4
	Marking	7.2	A.4	A.4

Equipment	Requirement		Verification	Method
	Descriptor	Clause number	Type verification	Individual verification
Lifting beams	Mechanical load bearings parts	5.1.1.1	A.1 or A.2	A.1 or A.3
	Tilting limit	5.1.1.2	E.1 or E.2	
	Controls	5.1.2	A.4	
	Handles	5.1.3	A.4	
	Lifting slings	5.1.4	A.4	
	Stability in storage	5.1.5	A.4	
	Connecting to the crane	5.2.6.1.1	A.4	
	Damage to suspended parts	5.2.6.1.2	A.4	
	Securing the load to the lifting beams	5.2.6.2	A.4	
	Tilting limit	5.2.6.3.1	E.1 or E.2	
	Securing moving parts of the structure	5.2.6.3.2	E.1 or E.2	
	Securing tilting and rotation mechanism	5.2.6.3.3	A.4	
	Spacing between moving parts	5.2.6.3.4	A.4	
	Information for use	7.1	A.4	A.4
	Marking	7.2	A.4	A.4

Equipment	Requirement		Verification	Method
	Descriptor	Clause number	Type verification	Individual verification
Clamps	Mechanical load bearings parts	5.1.1.1	A.1 or A.2	A.1 or A.3
	Tilting limit	5.1.1.2	A.1 or A.2	
	Controls	5.1.2	A.4	
	Handles	5.1.3	A.4	
	Lifting slings	5.1.4	A.4	
	Stability in storage	5.1.5	A.4	
	Safety coefficient	5.2.7.1	G.1 + G.2	
	Range thickness	5.2.7.2	G.5	
	Deformation of the load	5.2.7.3	A.4	A.4
	Two action control	5.2.7.4	A.4	A.4
	Holding devices	5.2.7.5	A.4	A.4
	Strength of secondary holding devices	5.2.7.6	A1 or A.2	
	Exception	5.2.7.7	A.4	A.4
	Information for use	7.1	A.4	A.4
	Marking	7.2	A.4	A.4

7 Information for use

7.1 Instruction handbook

7.1.1 General information

To allow purchasers to safely select, install, use and maintain removable lifting equipment during its normal lifetime, the manufacturer shall at least provide the following information and guidance in an instruction handbook, specific to the equipment supplied ▌A2⟩ (see EN ISO 12100-2:2003, 6.5) ⟨A2▐:

a) brief description;

b) working load limit;

c) intended use;

d) characteristics of the load including the performance and the number of parts that can be handled at one time;

e) determination of the operating range;

f) instructions for operation and use;

g) fitting, securing, coupling/uncoupling and adjustment of the equipment on the crane;

h) handling and storage of equipment;

i) stability (where applicable);

j) the range of temperature within which the attachment can be operated;

k) restriction for operation in special atmospheres (e.g. high humidity, explosive, saline, acid, alkaline);

NOTE Chains slings in accordance with EN 818-4 are not recommended for use in pickling baths due to the danger of hydrogen embrittlement.

l) restriction for handling dangerous goods (e.g. molten masses, radioactive materials);

m) where appropriate, prohibition of handling above persons;

n) specific training of operators, if necessary.

7.1.2 Specific information

In addition to the above general information, the manufacturer shall provide specific information on the following:

7.1.2.1 Plate clamps

a) vertical lifting for one part at a time;

b) turning plates over when on the ground;

c) operation of the safety locking device;

d) surface condition (grease, paint or coating) of the part to be handled;

e) clamping ranges to be observed;

f) surface hardness of parts to be handled;

g) measures to prevent unintentional release of the load due to the weight of the crane hook, bottom block or connections acting on the clamp (e.g. short length of chain);

h) [A1] the importance of the WLL min. [A1]

7.1.2.2 Vacuum lifters

a) checking of the vacuum level;

b) measures to be taken as soon as the warnings are actuated;

c) checking of the condition of the vacuum connections and hoses;

d) checking of the condition of the suction pads;

e) holding time in case of power failure;

f) intended ambient maximum noise level up to which warning devices are effective.

7.1.2.3 Battery and mains-fed lifting magnets

a) safety measures to be taken as soon as the warnings are activated;

b) checking of the condition of cables;

c) guidance for the maintenance and checking of the state of charge and capacity of battery;

d) holding time in case of power failure (if applicable);

e) intended ambient maximum noise level up to which warning devices are effective.

7.1.2.4 C-hooks and lifting forks

a) checking the suitability of the load;

b) required load range and position of the load's centre of gravity to prevent the load from sliding;

c) when using lifting forks in building areas, a check that the secondary positive holding device is in its place.

7.1.2.5 Lifting beams

a) the lifting beam's manufacturer shall provide information in the instruction handbook about the methods of attaching the load, to enable the user to ensure that the combined lifting beam and load will be stable when lifted.

The information shall identify the centre of rotation of the lifting beam to the crane, the centre of rotation of the suspension points to the load, and the vertical distance between them. This is illustrated

schematically in Figure 9 in one plane only, together with similar illustrations for the centre of rotation of the suspension points to the load and the vertical distance to the centre of gravity.

NOTE An object with a narrow base and a high centre of gravity will need less force to topple it than one with a wide base and a low centre of gravity. As the height of the centre of gravity increases relative to the width of the base, a point will be reached where the object will fall over unless it is supported by external means. At this point, the object is regarded as being unstable and the greater the support required the more unstable it is. A similar situation exists with a suspended load. Forces which try to topple the load will inevitably be present (e.g. wind, acceleration, braking). It is important therefore, when slinging a load, to ensure that it is sufficiently stable to resist these toppling forces. A load will be inherently stable if the lifting sling is attached above the centre of gravity and properly disposed around it.

In Figure 9, Lifting beam 1 has a positive stability height, and Lifting beam 2 has a negative stability height. Load 1 has a positive stability height, and Load 2 has a negative stability height. For stability of the combined lifting beam and load, the total stability height shall be positive. Although illustrated in one plane only, this shall apply to each horizontal axis of rotation. The result of each combination is as follows:

Lifting beam 1 + Load 1: will always be stable

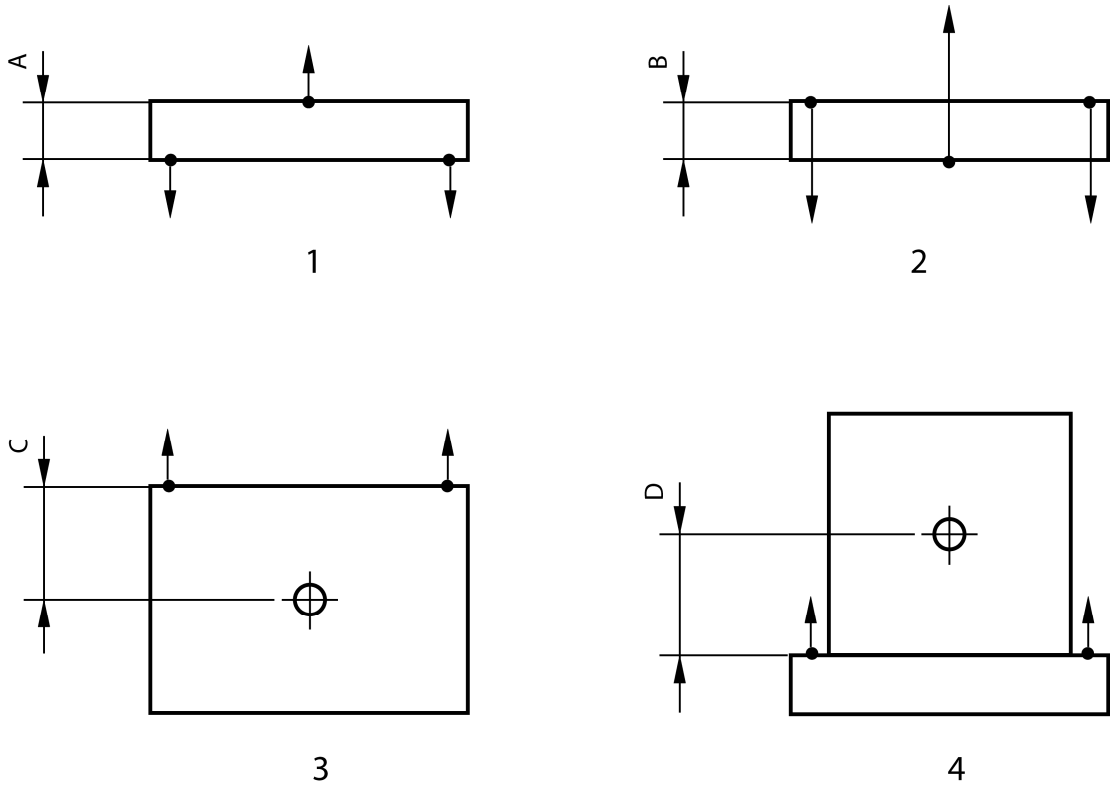
Lifting beam 1 + Load 2: will be stable if A>D*

Lifting beam 2 + Load 1: will be stable if C>B

Lifting beam 2 + Load 2: will always be unstable

The load shall be supported in more than one vertical plane to be stable in both horizontal axes.

b) Maximum tilting angle permitted for the lifting beams.



1 Lifting beam 1
2 Lifting beam 2
3 Load 1
4 Load 2
⊕ denotes centre of gravity
• denotes centre of rotation

Figure 9 — Centres of rotation of a load and lifting beam

7.1.2.6 Clamps

a) surface condition (grease, paint or coating) of the part to be handled;

b) clamping ranges to be observed;

c) surface hardness of parts to be handled;

d) measures to prevent unintentional release of the load due to the weight of the crane hook, bottom block or connections acting on the clamp (e.g. short length of chain).

7.1.3 Guidance for maintenance

The manufacturer shall provide sufficient information to ensure the proper maintenance of the attachment, to include:

a) instructions for periodic maintenance;

b) instructions for repair;

c) precautions to be taken during repairs;

d) use of original spare parts;

e) maintenance records, if necessary;

f) list of parts requiring particular operation and checking;

g) use of special lubricants.

7.1.4 Verifications and inspections

The manufacturer shall indicate the inspections and verifications that are necessary:

a) before commissioning;

b) after repair or recoupling;

c) during the equipment service life.

The manufacturer shall also include:

1) list of the parts which require special operation and checking;

2) defects to look for.

7.2 Marking

7.2.1 Minimum marking

All removable equipment shall bear in a clearly visible place a durable identification with the following information:

a) [A2] the business name and full address of the manufacturer and, where applicable, his authorised representative [A2];

b) [A2] designation of the machinery [A2];

c) serial number;

d) weight of unloaded attachment, when it exceeds 5 % of the Working load limit of the equipment or 50 kg, whichever is the less;

e) [A2] the year of construction, that is the year in which the manufacturing process is completed. It is prohibited to pre-date or post-date the machinery when affixing the CE marking [A2];

f) working load limit in tonnes or kg. When the attachment is used in several configurations, the resulting working load limits shall also be indicated;

7.2.2 Additional marking

7.2.2.1 In addition to the data in clause 7.2.1, the following shall be stated, where applicable:

a) on attachment which holds the load using clamping forces, the permissible gripping range;

b) on self-priming vacuum lifters, the minimum load;

c) on equipment connected mechanically to the load, indication on the connectors fitted on the load (e.g. connectors integrated in prefabricated concrete parts);

d) on C- hook and lifting forks the limits of the intended position of the load centre of gravity;

e) on lifting forks where a minimum load is required to tilt the fork in accordance with 5.2.5.2, the minimum load;

f) [A1] on plate clamps, the WLL min. and max. [A1]

7.2.2.2 For turbine vacuum lifters with a holding time in case of power failure of less than 5 minutes the following shall be marked:

“Warning – Load must not be lifted above 1,8 m”

7.2.2.3 Clause 7.2.1 item f) does not apply for load lifting magnets, provided the lifting capacity can be taken from documents at the place of use.

In the case of magnets, the lifting capacity depends, amongst other things, upon the material of the load, its thickness and surface, and the air gap between the load and the magnet. It is therefore recommended to state the maximum permissible loading as a function of the various parameters. However, it shall be recognized that the lifting capacity does not depend solely upon the magnetic forces but also can be limited by the lifting capacity of the suspension.

7.2.3 Additional safety plates

It is recommended that additional plates or decals are affixed, indicating basic safety instructions such as:

a) persons are forbidden to walk or stand in dangerous areas;

b) the nature of loads which can be handled by the equipment should be observed;

c) prohibition to use in a building area if the attachment does not meet the requirements for building area in clause 5.

The operator should read the instruction handbook provided by the equipment manufacturer.

Annex A
(normative)

General verification methods

A.1 Verification of mechanical strength without static tests

This method is applicable to non alloy structural steel in accordance with EN 10025.

A.1.1 Load case

The following load case shall be considered:

〚A1〛 $X = S_{DL} + 2.\ S_{WLL}$ 〚A1〛

With
S_{DL} = loads due to dead weight of the attachment
S_{WLL} = loads due to the working load limit

The factor 2 takes into account the dynamic effect due to lifting, and the static test. This factor does not take into account wind loads.

A.1.2 Verification to the elastic limit

For this load case the σi normal stresses and τ shear stresses in the structural members shall be lower or equal to the admissible stress given in table A1.

In case of combined stresses the equation (A.1) shall be also verified.

$$\left(\frac{\sigma_x}{f_y}\right)^2 + \left(\frac{\sigma_y}{f_y}\right)^2 - \frac{\sigma_x \times \sigma_y}{f_y^{\,2}} + 3\left(\frac{\tau}{f_y}\right)^2 \leq 1 \qquad \text{(A.1)}$$

Table A.1 — Admissible stress

Steel	Thickness in mm	Admissible stress in tension/compression f_y in MPa	Admissible stress in shear $f_y/\sqrt{3}$ in MPa
S 235	$t \leq 16$ $16 < t \leq 40$	235 225	135 130
S 275	$t \leq 16$ $16 < t \leq 40$	275 265	160 153
S 355	$t \leq 16$ $16 < t \leq 40$	355 345	205 200

For this load case the σ_{wi} normal weld stresses shall be lower or equal to the admissible stress $\alpha f_y/\gamma$ and the τ_w weld shear stresses shall be lower or equal to the admissible stress $\alpha_s f_y/\gamma$ with γ = 1.1.

In case of combined stresses the equation (A.2) shall be also verified.

$$\left(\frac{\gamma\cdot\sigma_{wx}}{\alpha\cdot f_y}\right)^2+\left(\frac{\gamma\cdot\sigma_{wy}}{\alpha\cdot f_y}\right)^2-\frac{\gamma\cdot\sigma_{wx}\times\gamma\cdot\sigma_{wy}}{(\alpha\cdot f_y)^2}+\left(\frac{\gamma\cdot\tau_w}{\alpha_s\cdot f_y}\right)^2\le 1 \qquad \text{(A.2)}$$

Table A.2 — Admissible stress in the weld

Type of weld ENV 13001-3-1 clause 4.4	Kind of stressing	Quality level EN 25817	α tension	α compression	α_s
Weld with full penetration or backwelded • Butt welded • Double semi V-weld, semi V-weld for T joint	Stress across the weld direction	B,C	1	1	1/√2
		D	0,9	1	1/√2
Weld with full penetration or backwelded • Weld with small web • Double semi Y-weld, semi Y-weld for T joint	Stress across the weld direction	B,C	0,9	1	1/√2
		D	0,8	0,9	1/√2
Weld without full penetration • Double semi Y-weld, semi Y-weld for T joint • Double fillet weld • Fillet weld	Stress across the weld direction	B,C,D	0,7	0,8	1/√2
All types of welds	Stress in the weld direction	B,C,D	1	1	1/√3

A.1.3 Verifications of the stability of structural components

The lateral stability of structural components shall be verified in accordance with ENV 1993-1-1 clause 5.5.4 buckling and clause 5.5.2 torsional buckling for the load case defined in A.1.1.

Verification of web buckling by shearing in accordance with clause 5.6 of ENV 1993-1-1 shall be done except if the following is verified for girder without stiffener

$$d/tw \le 69\,(235/f_y)^{0,5} \qquad \text{(A.3)}$$

with
d = web height in mm
tw = web thickness in mm
f_y = yield strength in MPa

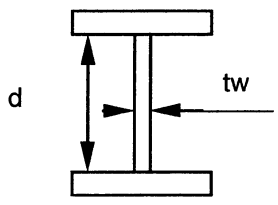


Figure A.1 — Girder without stiffener

A.1.4 Verifications against brittle fracture

The resistance to brittle fracture shall be verified in accordance annex C of ENV 1993-1-1 or shall be verified with the table A.3.

Steel quality	Maximum thickness (in mm) for the lowest working temperature					
	0°C			-20°C		
	S1	S2	S3	S1	S2	S3
S235 JR , JR G1	32	10	No	17	5	No
S355 JRG1 or JR G2	32	10	No	17	5	No
S235 J0	40	24	10	40	13	5
S235 J2G3 or J2 G4	40	40	27	40	30	14
S275 JR	22	6	No	11	No	No
S275 J0	40	16	7	28	8	No
S275 J2G3 or J2 G4	40	39	18	40	20	9
S 355 JR	11	No	No	5	No	No
S355 J0	28	8	No	15	No	No
S355 J2 G3 or J2 G4	40	21	9	37	11	5
S355 K2G3or K2G4	40	21	9	37	11	5
S1 : no weld S2 : welded structure with local stress less than 0,67 f_y S3 : welded structure with local stress greater than 0,67 f_y NOTE This table is based on ENV 1993-1-1, Annex C.						

Table A.3 — Maximum thickness in mm and steel quality to prevent brittle fracture

For quality JR, JR G1 and JR G2 a test certificate shall prove a minimum level of energy rupture of 27 J since the toughness test in accordance with EN 10045-1 is optional for those qualities.

A.1.5 Verifications of the quality of the welds

It shall be proven that the welds have been done by welders certified in accordance with EN 287-1.

It shall be verified that the quality level of the welds are in accordance with EN 25817 with reference to table A.2

A.2 Verification of mechanical strength on the type by a static test.

A.2.1 Conditions

The test shall be conducted by applying a static force F3 in a manner which replicates the conditions in which the attachment is intended to be used.

A.2.2 Procedure

The attachment shall be loaded through its suspension and load attachment points so that the lines of force through these points are the same as they will be in service. The test force F3 ± 2 % shall be applied without shock for a minimum period of 1 minute.

Where the intended use of the attachment permits or requires it to tilt or move in any way such that the lines of force through the suspension or attachment points will vary, the test shall be repeated at several positions throughout the range of movement. These positions shall be selected to simulate the worst operational conditions and take account of the tilting tolerance required by 5.1.1.2.

After the force has been removed the attachment shall be examined for deformation, cracks and other defects.

A.2.3 Acceptance criteria

An attachment representative of the type shall withstand the static force F3 = 3 x working load limit, the attachment shall withstand the force even if permanent deformation occurs.

A.3 Verification of mechanical strength on each individual attachment by a static test.

A.3.1 Conditions

The test shall be conducted by applying a static force F2 in a manner which replicates the conditions in which the attachment is intended to be used.

A.3.2 Procedure

The attachment shall be loaded through its suspension and load attachment points so that the lines of force through these points are the same as they will be in service. The test force F2 ± 2 % shall be applied without shock for a minimum period of 1 minute.

Where the intended use of the attachment permits or requires it to tilt or move in any way such that the lines of force through the suspension or attachment points will vary, the test shall be repeated at several positions throughout the range of movement. These positions shall be selected to simulate the worst operational conditions.

After the force has been removed the attachment shall be examined for deformation, cracks and other defects.

A.3.3 Acceptance criteria

Each individual attachments of a series shall withstand a static force F2 equivalent to 2 x working load limit without permanent deformation and after removal of the force, there shall be no visible defects.

A.4 Verification by inspection

A.4.1 Procedure

The equipment shall be inspected and the feature checked to see whether it is present and/or functions in the manner required. In assessing compliance with the requirements, the manufacturer's instructions shall be taken into account.

The markings on each sling and the certificates provided with each sling shall be inspected for conformance with:

EN 818-4
EN 818-5
prEN 13414-1
EN 1492-1
EN 1492-2

A.4.2 Acceptance criteria

The equipment shall meet the appropriate requirements according to clauses 5 and 7.

Annex B
(normative)

Verification methods for plate clamps

B.1 No detachment when the load is brought down and in case of impact

B.1.1 Conditions

The equipment shall be suspended from a crane. The test load weight shall be at least equal to the working load limit.

B.1.2 Procedure

NOTE The tester can be at risk when disconnecting and reconnecting the locking mechanism because, if the plate clamp does not hold the load it can fall against him.

The load shall be attached to the equipment and the locking mechanisms brought into the closed position. The load shall be lifted and put down onto the ground during a maximum duration of 5 seconds. The load shall be lifted again without any operator's intervention on the equipment.

The procedure shall then replicate the impact of the equipment against an obstacle. If the equipment is fitted with a locking mechanism, the impact shall occur against this device.

With the load lifted from the ground the locking mechanisms shall be moved to the open position and the plate clamp shall hold the load. The locking mechanisms shall be return to the lock position and the load shall be put down on the ground and the connection between the crane hook and the equipment allowed to go slack. This shall be done under the conditions specified in the instructions handbook (e.g. length of chain) which prevent the weight of the crane hook acting on the equipment in a way which releases the load.

B.1.3 Acceptance criteria

The load shall not detach from the equipment at any time during the simulation.

B.2 Determination of the friction coefficient

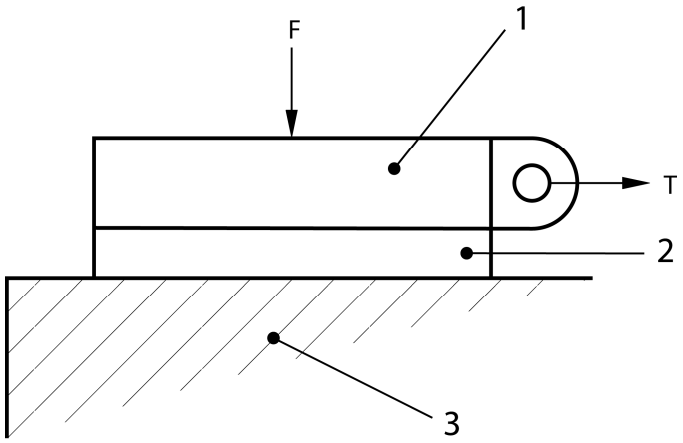
B.2.1 Conditions

The test apparatus shall include:

a) the load, or a material sample corresponding to the load under the maximum conditions specified in the instruction manual (e.g. material hardness);

b) a support covered with the clamp material which is in contact with the load;

c) the shape of the coating shall be reproduced (e.g. teeth of the clamp jaws).



1 Support

2 Clamp coating

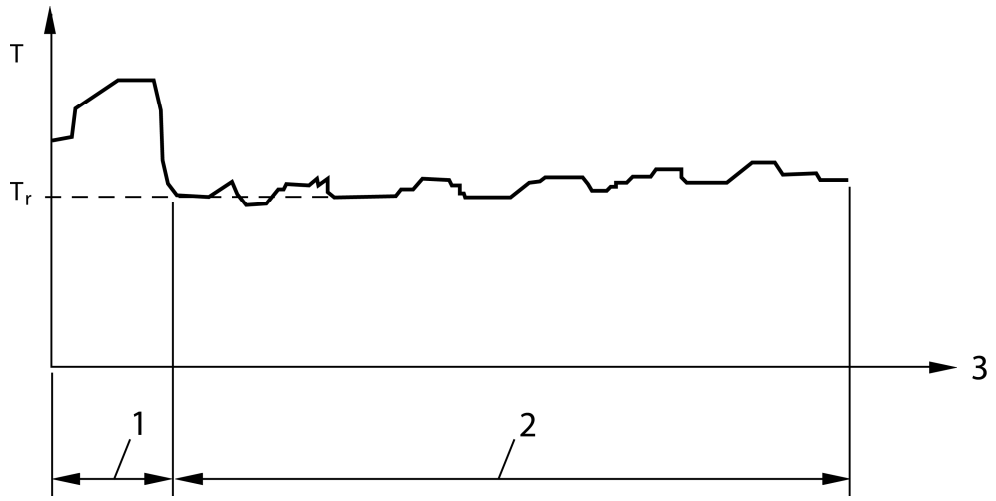
3 Load sample

Figure B.1 — Test apparatus and forces applied

The actual environmental conditions which are of importance for friction (e.g. presence of oil or moisture) shall be reproduced.

B.2.2 Procedure

A vertical force F shall be applied on the support, producing a pressure between 2 and 3 corresponding to the minimum contact pressure between the clamp and the load when the load is lifted. A horizontal tensile force T shall be applied between 1 + 2 and 3, until the part 1 + 2 starts moving. The variation of this tensile force represents a curve usually corresponding to the diagram below:



1 Transitory state

2 Steady state (motion)

3 Displacement

Figure B.2 — Characteristics of tensile force T

B.2.3 Acceptance criteria

The friction coefficient μ used for the calculations is the ratio of T_r (average horizontal tensile force in steady state) to the vertical force F.

A minimum of 3 tests is required, and the friction coefficient shall be taken as the smallest of the 3 measurements.

B.3 No slipping of the load - clamping by friction or penetration

B.3.1 Procedure

The maximum obtainable force to hold a load is called holding force. It is determined by:

$T = S (\mu_1 + \mu_2)$

with:

S = clamping force of the clamp

μ_1 = friction coefficient between load and one clamping part

μ_2 = friction coefficient between load and the other clamping part

P = work piece

The holding force is determined by calculation. The calculation shall be done for the most unfavourable gripping range.

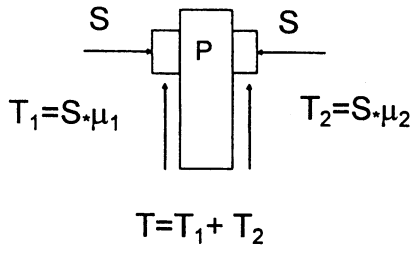


Figure B.3 — Clamping forces

B.3.2 Acceptance criteria

The holding force T holding the load shall be 2 times the load to be held.

This requirement shall be verified throughout the lifting operation, regardless of whether the clamping force S is due to self-actuation (in proportion to the load weight), or to a mechanical actuator.

B.4 Range of thickness of clamps

B.4.1 Conditions

The clamp shall be tested using a sheet sample with a thickness equal to the lower limit of the range of thicknesses less the safety range.

Example: clamp with a range of thicknesses of 30-60 mm, test with a 30 mm sheet - 10 %, i.e. a thickness of 27 mm.

B.4.2 Procedure

The sheet sample shall be lifted vertically.

B.4.3 Acceptance criteria

The clamp shall not release the sheet sample.

Annex C
(normative)

Verification methods for vacuum lifters

C.1 Verification of pressure measuring device

C.1.1 Conditions

The test to verify the correct functioning of the pressure measuring device. The arrangement shall be such as to avoid risk in event of vacuum drop.

C.1.2 Procedure

A condition for which the device is required shall be simulated by reducing the maximum vacuum level in the vacuum system.

C.1.3 Acceptance criteria

The pressure measuring device indicates the vacuum level reduction. The working range and the danger range are clearly shown.

C.2 Verification of leakage indicator

C.2.1 Conditions

Test to verify the correct functioning of the leakage indicator. The arrangement shall be such as to avoid risk in event of vacuum drop.

C.2.2 Procedure

A condition for which the device is required shall be simulated by creating leakage under the suction pads. The size of the leakage shall correspond with the agreed minimum hanging time of the load, to be specified in the instruction handbook.

C.2.3 Acceptance criteria

When the fault or condition is simulated the device shall comply with clause 5.2.2.3.

C.3 Verification of visibility of measuring device or indicator

C.3.1 Conditions

The test is to verify the visibility of the measuring device or the indicator.

C.3.2 Procedure

Check if the measuring device or the indicator can be seen from the normal position of the operator or the crane driver. When the position of the crane driver is unknown, the instruction handbook shall indicate the correct position of the lifting equipment with respect to the crane driver.

C.3.3 Acceptance criteria

The measuring device or the indicator can be seen properly.

C.4 Verification of devices to compensate for vacuum losses

C.4.1 Conditions

The test is to verify that the devices for compensation for vacuum losses function correctly. The arrangement shall be such as to avoid risk when the load is dropped.

C.4.2 Procedure

The vacuum lifter shall be loaded with the WLL per suction pad, which shall be indicated in the instruction handbook. The material and other conditions, (e.g. dirt) shall be comparable with the load which will be manipulated in practice. In case of self-priming vacuum lifters, and in the case of non-self-priming vacuum lifters, (the power shall be switched off) the hanging time shall be measured or extrapolated.

C.4.3 Acceptance criteria

This time shall be at least equal to the hanging time specified in the instruction handbook. The time shall be long enough for all persons to leave the danger area and comply with clauses 5.2.2.5 and 5.2.2.7.

C.5 Verification of warning device

C.5.1 Conditions

The test is to verify the correct functioning of the warning device, indicating that the limit of the safe working range of the vacuum system has been reached.

C.5.2 Procedure

The vacuum lifting device shall be sucked onto a load and a small non-compensated leakage shall be made in the vacuum system. When the safe working range of the vacuum system has been reached, an automatically acting warning device shall come into action.

C.5.3 Acceptance criteria

The moment the warning device comes into action shall correspond with the limit of the working range of the vacuum.

The warning device is optical and/or acoustical and easily seen/heard by the operator.

C.6 Verification of the non-return valve

C.6.1 Conditions

The test is to verify the correct functioning of the non-return valve and its position.

C.6.2 Procedure

The vacuum pump shall be energized for sufficient time to generate vacuum in the vacuum system with the load. When the vacuum pump is stopped the vacuum level shall be checked visually for any noticeable decrease.

C.6.3 Acceptance criteria

The valve shall comply with the requirement specified in clause 5.2.2.5. If there is no noticeable decrease in the vacuum level, this indicates an air-tight vacuum system, including the non-return valve.

C.7 Verification of controls

C.7.1 Conditions

A test load shall be sucked by the vacuum lifter. The arrangement shall be such as to avoid risk in event of control malfunction.

C.7.2 Procedure

One representative sample of each design and size shall be inspected and operated. The controls shall be inspected and operated in all combinations foreseen by the manufacturer. In addition, a power failure shall be simulated to check if it alters the condition of the vacuum system.

C.7.3 Acceptance criteria

The vacuum lifting system shall comply with clause 5.2.2.9.

C.8 Verification of energy source failure warning system

C.8.1 Conditions

The test is to verify that the automatically warning device functions correctly. The test is to be conducted in the unloaded condition.

C.8.2 Procedure

A failure in the energy source shall be simulated.

C.8.3 Acceptance criteria

When the failure is simulated the device shall comply with clause 5.2.2.6.

C.9 Verification of the position of the load

C.9.1 Conditions

A test load equal to the working load limit and representative of the intended loads.

C.9.2 Procedure

The test load shall be lifted and placed at the maximum intended tilting angle plus 6° but not more than 90°.

The vacuum level shall be at the end of the working range and the beginning of the danger range.

C.9.3 Acceptance criteria

The test load shall not slip.

C.10 Verification of adhesion force by calculation

C.10.1 Procedure

The friction coefficient between the suction pads and the material to be handled shall be determined in accordance with C.11 and the components of the adhesion force at the end of the working range shall be calculated.

$Fa \perp = P\ S$

〚A1〛 $Fa\ // = \mu\ (PS - WLL\ g \cos \alpha)$ 〚A1〛

P: the vacuum level in Pa

$S = \Sigma$ Si: total interior surface of the suctions pads in m^2

μ : friction coefficient

C.10.2 Acceptance criteria

Both effective components of the adhesion force shall be greater or equal to two times the corresponding effective component of the working load limit.

$Fa \perp = PS \geq 2\ WLL\ g \cos \alpha$

〚A1〛 $Fa\ // = \mu\ (PS - WLL\ g \cos \alpha) \geq 2\ WLL\ g \sin \alpha$ 〚A1〛

g: gravity acceleration in m/s^2

WLL: Working load limit in kg

The calculation shall be carried out for the maximum intended tilting angle plus 6° except for vacuum lifter designed for a vertical position of the vacuum pads.

The above calculations determine the components of the adhesion force. To fully verify the requirement, the moments arising from the position of the centre of gravity of the load and the geometry of the vacuum lifter shall also be taken into account.

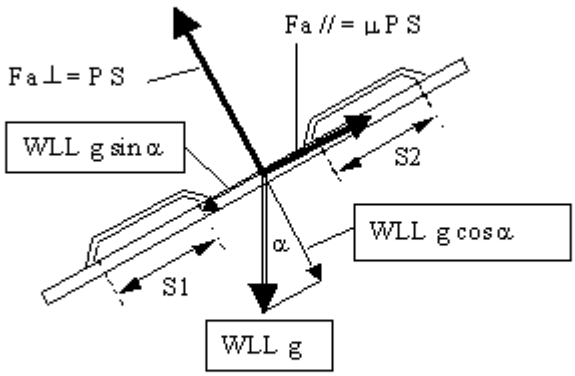


Figure C.1 — Adhesion force and effective component of the working load limit weight.

C.11 Determination of the friction coefficient

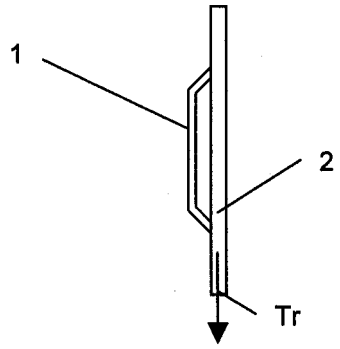
C.11.1 Conditions

The test apparatus shall include:

a) the load, or a material sample corresponding to the load under the maximum conditions specified in the instruction manual;

b) the suction pad connected to a system able to create a vacuum level corresponding to the end of the working range;

c) a load cell to record the variation of the tensile force necessary to move the load.



1 Suction pad with a vacuum level equal to the end of the working range
2 Load material sample
Tr Vertical tensile force

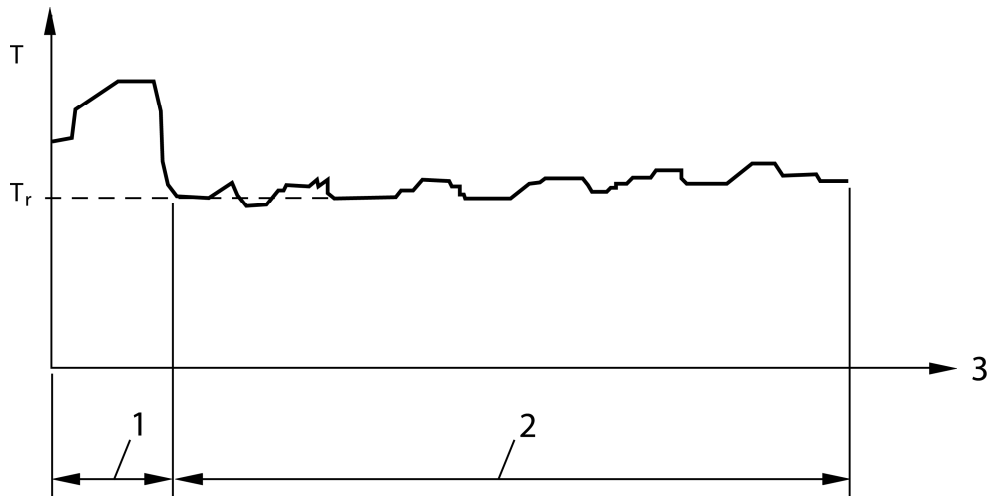
Figure C.2: Test apparatus and forces applied

The actual environmental conditions which are of importance for friction (e.g. presence of oil or moisture) shall be reproduced.

C.11.2 Procedure

A Pressure level equal to the end of the working range shall be applied to the suction pad.

A vertical displacement shall be applied on the load to move it . The tensile force necessary to move the load shall be measure. The curve obtain is usually corresponding to the diagram below:



1 Transitory state

2 Steady state (motion)

3 Displacement

Figure C.3: Characteristics of tensile force T

C.11.3 Acceptance criteria

The friction coefficient μ used for the calculation is the ratio of Tr (average horizontal tensile force in steady state) plus the weight of the material sample to the adhesion force PS.

$\mu = (Tr + m\ g) / P\ S$

where:
m = mass of material sample in kg
g = gravity acceleration in m/s^2

A minimum of 3 tests is required, and the friction coefficient shall be taken as the smallest of the 3 measurements.

Annex D
(normative)

Verification methods for lifting magnets

D.1 Verification of tear-off force

D.1.1 Verification by pull test

D.1.1.1 Conditions (referring to figure D.1):

a) Test piece length:

$1_2 \geq 1_1 \times 1{,}2$ for rectangular magnets

$1_2 \geq d_1 \times 1{,}1$ for round magnets

b) Test piece width:

$w_2 \geq w_1 \times 1{,}2$ for rectangular magnets

$w_2 \geq d_1 \times 1{,}1$ for round magnets

c) Test piece thickness t_{min} at least equal to:

— half of the middle pole diameter for round magnets;

— the width of the middle pole for three-polar magnets;

— two times the width of the pole for bi-polar magnets.

d) Test piece shape: flatness smaller than 0,1 mm/500 mm;

e) Test piece material: low carbon steel (such as S 235);

f) One out of the following gaps shall be chosen for the verification of the tear-off force:

1) for round magnets: no gap, 1/300 or 1/100 of the outer diameter;

2) for rectangular magnets: no gap, 1/300 or 1/100 of width over the poles;

The chosen gap shall correspond to the specified use of the magnet in the instructions for use.

g) Magnet supply current shall be as rated;

h) Ambient temperature range: + 10 °C to 30 °C;

As an alternative, at the manufacturer's discretion, special purpose magnets may be tested in conditions which simulate the intended purpose.

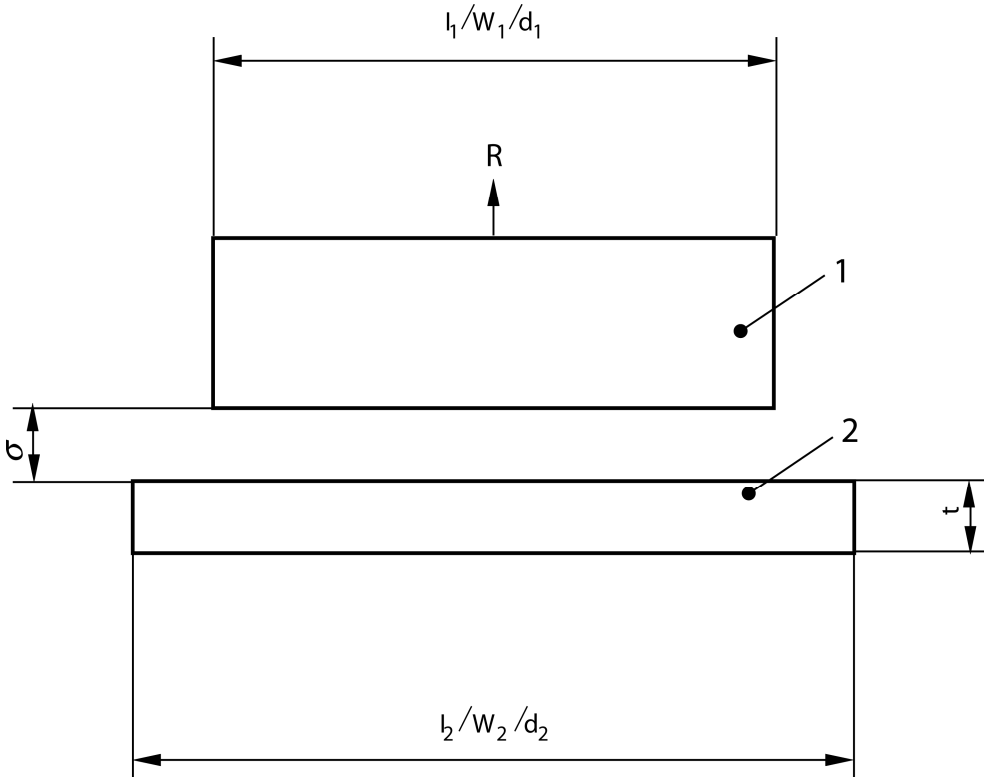


Figure D1: Test set up for verification of lifting magnets

Where:

d_1	Diameter over poles of round magnets
d_2	Diameter of the test piece
l_1	Length over poles of rectangular or bipolar magnets
w_1	Width over poles of rectangular or bipolar magnets
l_2	Length of the test piece
w_2	Width of the test piece
t	Thickness of the test piece
1	Magnet poles
R	Tear-off force
2	Test piece
σ	Air gap

D.1.1.2 Procedure

The magnet shall be placed on the test piece so that all the poles are covered and then fully energised at the minimum allowable voltage. The test force F ± 2 % shall be applied without shock through the attachment point of the magnet and at right angles to the plane between the magnet and the test piece.

D.1.1.3 Acceptance criteria

The test force F reaches the tear-off force specified in clauses 5.2.3.2.1, 5.2.3.3.1, 5.2.3.4.1 or 5.2.3.5.1, as appropriate.

D.1.2 Verification by flux measurement and calculation

D.1.2.1 Conditions

The same conditions apply as specified in D.1.1 except they shall always be no gap. The magnet shall be placed directly upon the work piece. As an alternative, at the manufacturer's discretion, special purpose magnets may be tested in conditions which simulate the intended purpose.

D.1.2.2 Procedure

The flux shall be measured at the surface of contact between magnet and work piece around the middle pole for round and three-polar magnets and around one pole of bipolar magnets. The force shall be calculated from this measured flux.

D.1.2.3 Acceptance criteria

The calculated force F reaches the tear-off force specified in 5.2.3.2.1, 5.2.3.3.1, 5.2.3.4.1 or 5.2.3.5.1, as appropriate.

D.2 Verification of controls

D.2.1 Conditions

A nominal load or test piece shall be provided against which the magnet can be operated. The arrangement shall be such as to avoid risk in the event of a control malfunction.

D.2.2 Procedure

One representative sample of each design and size of controls shall be inspected and operated in all functions foreseen by the manufacturer.

D.2.3 Acceptance criteria

The magnet complies with clause 5.2.3.1 1 and 5.2.3.3.6 as appropriate.

D.3 Verification of back-up and warning devices

D.3.1 Conditions

The test to verify that the back-up and warning devices function correctly shall be carried out on either the control circuits and warning devices only, or on the complete magnet.

D.3.2 Procedure

The fault or condition for which the device is required shall be simulated by reducing or cutting the power supply as appropriate to the requirement.

D.3.3 Acceptance criteria

When the fault or condition is simulated the device shall comply with clauses 5.2.3.2.2, 5.2.3.2.3, 5.2.3.3.2 and 5.2.3.3.3, as appropriate.

D.4 Verification of the discharge time of batteries

D.4.1 Conditions

The tests to verify the discharge time of batteries shall be carried out using batteries which meet the magnet manufacturer's minimum specification in terms of capacity and state of charge.

The magnet shall be tested against the test piece specified in procedure D.1. As an alternative, at the manufacturer's discretion, special purpose magnets may be tested against a test piece which simulates the intended purpose.

D.4.2 Procedure

The magnet shall be placed on the test piece so that all the poles are covered and then fully energized. The test force F, equal to the working load ± 2 %, shall be applied without shock through the attachment point of the magnet and at right angles to the plane between the magnet and the test piece. The fault or condition for which the requirement applies shall then be simulated.

One sample of each design and size of magnet shall be tested.

D.4.3 Acceptance criteria

The magnets sustain the test force F for the minimum time specified in clauses 5.2.3.2.2 or 5.2.3.3.3, as appropriate.

D.5 Verification of indicating devices

D.5.1 Conditions

The test to verify the indicating devices shall be carried out by applying the rated voltage to the magnet(s).

D.5.2 Procedure

The indicating device shall be tested simultaneously with procedures D2, D3 and D4.

D.5.3 Acceptance criteria

The indicating device shall indicate magnetisation. For variable power control the indicator shall distinguish between full and partial magnetisation in accordance with clauses 5.2.3.2.4, 5.2.3.3.7, and 5.2.3.4.2, as appropriate

D.6 Verification of alternative mechanical back-up devices

D.6.1 Conditions

The magnet or magnets and any associated lifting beam shall be tested with a representative sample load equal to the maximum capacity of the magnet(s) under conditions where failure of the power supply and back-up device can be simulated without risk.

D.6.2 Procedure

The magnet(s) shall be placed on the load and fully energised. The load shall be lifted a sufficient height to permit the mechanical back-up device to be put in place. After the back-up device is in place the magnet shall be switched off.

D.6.3 Acceptance criteria

After release by the magnet(s) the load is retained by the back-up device as specified in clause 5.2.3.3.5.

D.7 Verification that the magnet is matched to the intended load(s)

D.7.1 Procedure

For special purpose magnets where details of the intended load(s) are known to the manufacturer, the design of the magnet or magnets and any associated lifting beam shall be reviewed to ensure it meets the requirements in clause 5.2.3.1.2.

D.7.2 Acceptance criteria

The design review confirms that the magnet satisfies clause 5.2.3.1.2.

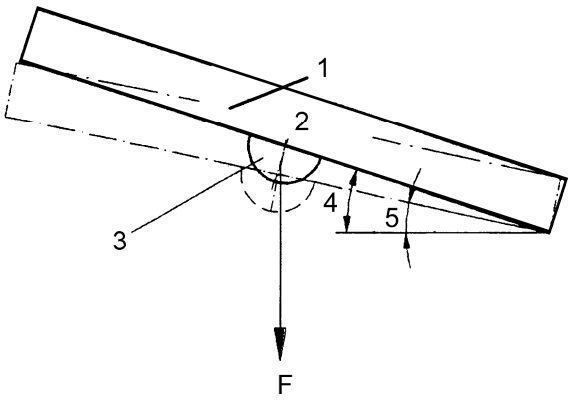
Annex E
(normative)

Verification methods for lifting beams

E.1 Verification of locking or holding devices by testing

E.1.1 Conditions

The test shall be conducted either by lifting a live test load or by means of a static force applied by a test rig.



1 & 2 Lifting beam at different working angles

3 Moving part

4 Maximum working angle of the lifting beam plus 6°

5 Maximum working angle of the lifting beam

F Test force

Figure E.1 — Angles associated with verification of lifting beams

E.1.2 Procedure

The moving part shall be locked in position by means of its locking device and subjected to a force F without shock for a minimum period of 1 minute and equal to 2 x the static force that it is required to sustain in service at an angle of 6° in excess of that specified by the manufacturer, see figure E.1. The test shall be repeated in both directions about each horizontal axis and both horizontal axes in combination for each available locking position. If the moving part does not have predetermined positions but locks by friction the test shall be carried out at the two extremes of travel and at one intermediate point.

After the force has been removed the moving part and its locking device shall be examined for deformation, cracks and other defects.

E.1.3 Acceptance criteria

The moving part and its locking device sustains the test force F without slippage, deformation or failure and, after release of the load, there are no visible defects and the moving part and its looking device operate freely.

E.2 Verification of the locking or holding by calculation

The mechanical parts shall be calculated in accordance with annex A.1 for the maximum intended tilting angle plus 6° except for lifting beams designed for a vertical position.

If the moving parts of the structure are held in position by devices operating on a friction basis (e.g. resulting from brake torque) the calculation shall demonstrate that the friction force is at least twice the force due to the self weight of the parts and the working load limit for the maximum intended tilting angle plus 6° except for lifting beams designed for a vertical position.

Annex F
(normative)

Verification methods for lifting forks

F.1 Verification of mechanical strength of the secondary positive holding device for lifting forks in horizontal direction

F.1.1 Conditions

The test shall be conducted by applying a uniformly distributed static force equal ½ WLL on the 90° tilted lifting forks.

F.1.2 Procedure

The empty attachment shall be tilted and fixed in a manner such that the secondary positive holding device is not in contact with anything other than the lifting forks or the test load and has enough space to deform. A force equal to half the WLL shall be applied to the lower part of the secondary positive holding device. The test shall be carried out for at least the two most unfavourable directions.

F.1.3 Acceptance criteria

The secondary positive holding device shall withstand the force even if permanent deformation occurs.

Annex G
(normative)

Verification methods for clamps

G.1 Determination of the friction coefficient

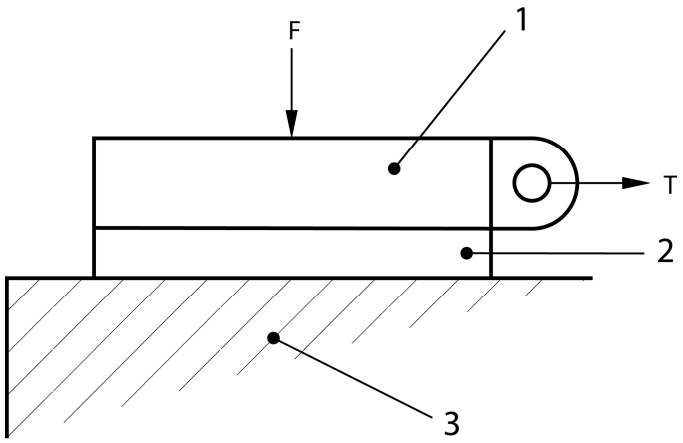
G.1.1 Conditions

The test apparatus shall include:

a) the load, or a material sample corresponding to the load under the maximum conditions specified in the instruction manual (e.g. material hardness);

b) a support covered with the clamp material which is in contact with the load;

c) the shape of the coating shall be reproduced (e.g. teeth of the clamp jaws).



1 Support

2 Clamp coating

3 Load sample

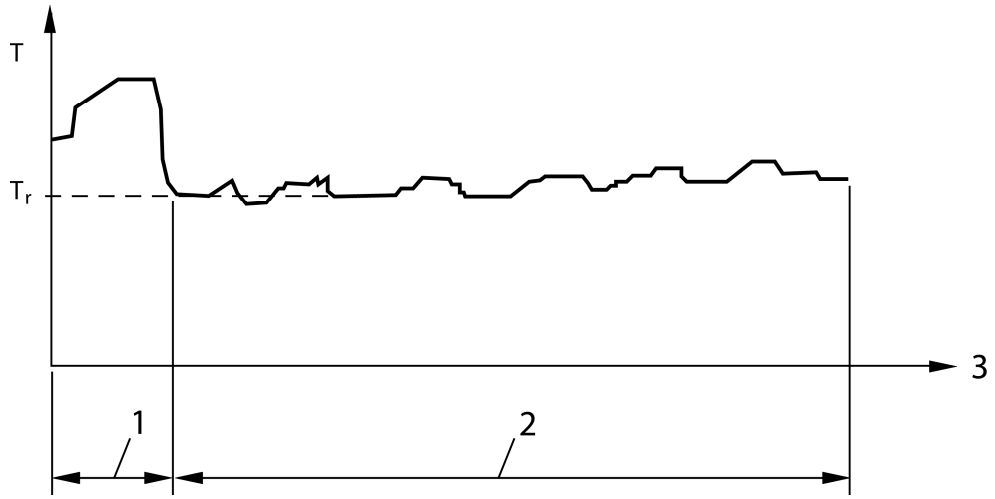
Figure G.1: Test apparatus and forces applied

The actual environmental conditions which are of importance for friction (e.g. presence of oil or moisture) shall be reproduced.

G.1.2 Procedure

A vertical force F shall be applied on the support, producing a pressure between 2 and 3 corresponding to the minimum contact pressure between the clamp and the load when the load is lifted.

A horizontal tensile force T shall be applied between 1 + 2 and 3, until the part 1 + 2 starts moving. The variation of this tensile force represents a curve usually corresponding to the diagram below:



1 Transitory state

2 Steady state (motion)

3 Displacement

Figure G.2: Characteristics of tensile force T

G.1.3 Acceptance criteria

The friction coefficient μ used for the calculations is the ratio of T_r (average horizontal tensile force in steady state) to the vertical force F. A minimum of 3 tests is required, and the friction coefficient shall be taken as the smallest of the 3 measurements.

G.2 No slipping of the load - clamping by friction or penetration

G.2.1 Conditions

The maximum obtainable force to hold a load is called holding force. It is determined by:

$T = S (\mu_1 + \mu_2)$

with:

S = clamping force of the clamp or the tong

μ_1 = friction coefficient between load and one clamping part

μ_2 = friction coefficient between load and the other clamping part

P = work piece

The holding force is determined by calculation. The calculation shall be done for the most unfavourable gripping range

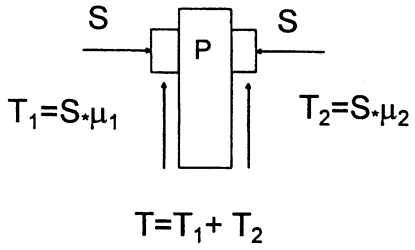


Figure G.3 clamping forces

G.2.2 Acceptance criteria

The holding force T holding the load shall be 2 times the load to be held.

This requirement shall be verified throughout the lifting operation, regardless of whether the clamping force S is due to self-actuation (in proportion to the load weight), or to a mechanical actuator

G.3 Verification of mechanical strength of the secondary positive holding device for clamps in horizontal direction

G.3.1 Conditions

The test shall be conducted by applying a uniformly distributed static force equal ½ WLL on the 90° tilted attachment.

G.3.2 Procedure

The empty attachment shall be tilted and fixed in a manner such that the secondary positive holding device is not in contact with anything other than the clamp or the test load and has enough space to deform. A force equal to half the WLL shall be applied to the lower part of the secondary positive holding device. The test shall be carried out for at least the two most unfavourable directions.

G.3.3 Acceptance criteria

The secondary positive holding device shall withstand the force even if permanent deformation occurs.

G.4 Verification of mechanical strength of the secondary positive holding device for clamps in vertical direction

G.4.1 Conditions

The test shall be conducted by applying a uniformly distributed static force equal to 2 WLL.

G.4.2 Procedure

A uniformly distributed load corresponding to 2 times the WLL shall be applied to the secondary positive holding device. The clamping mechanism shall be locked open. The secondary positive holding device shall not be in contact with anything other than the clamp and the test load and shall have enough space to deform.

G.4.3 Acceptance criteria

The secondary positive holding device shall withstand the force even if permanent deformation occurs.

G.5 Range of thickness of clamps

G.5.1 Conditions

The clamp shall be tested using a sample with a thickness equal to the lower limit of the range of thickness less the safety range.

Example: clamp with a range of thickness of 30-60 mm, test with a 30 mm sample - 10 %, i.e. a thickness of 27 mm.

G.5.2 Procedure

The sample shall be lifted vertically.

G.5.3 Acceptance criteria

The clamp shall not release the sample.

Annex H
(informative)

Selection of a suitable set of crane standards for a given application

Is there a product standard in the following list that suits the application?	
prEN 13000: 1997	Cranes – Mobile cranes
prEN 14439: 2002	Cranes – Tower cranes
	Cranes – Slewing jib cranes
	Cranes – Bridge and gantry cranes
prEN 13852-1: 2001	Cranes – Offshore cranes – Part 1: General purpose offshore cranes
prEN 13852-2: 2002	Cranes – Offshore cranes – Part 2: Floating cranes
	Cranes – Power driven winches and hoists – Part 1: Power driven winches
prEN 14492-2: 2002	Cranes – Power driven winches and hoists – Part 2: Power driven hoists
EN 12999: 2002	Cranes – Loader cranes
prEN 13157: 1998	Cranes – Hand powered cranes
prEN 13155: 1998	Cranes – Non-fixed load lifting attachments
prEN 14238: 2001	Cranes – Manually controlled load manipulating devices

YES

Use it directly, plus the standards that are referred to

NO

Use the following:	
	Cranes — Terminology
prEN 13001-1: 1997	Cranes — General design — Part 1: General principles and requirements
prEN 13001-2: 1997	Cranes — General design — Part 2: Load effects
	Cranes — General design — Part 3.1: Limit states and proof of competence of steel structures
	Cranes — General design — Part 3.2: Limit states and proof of competence of rope reeving components
	Cranes — General design — Part 3.3: Limit states and proof of competence of wheel / rail contacts

	Cranes — General design — Part 3.4: Limit states and proof of competence of machinery
prEN 13135-1: 1998	Cranes — Equipment — Part 1: Electrotechnical equipment
prEN 13135-2: 2001	Cranes — Equipment — Part 2: Non-electrotechnical equipment
prEN 13557: 2003	Cranes — Controls and control stations
EN 12077-2: 1998	Cranes safety — Requirements for health and safety — Part 2: Limiting and indicating devices
prEN 13586: 1999	Cranes — Access
prEN 14502-1: 2002	Cranes — Equipment for the lifting of persons — Part 1: Suspended baskets
	Cranes — Equipment for the lifting of persons — Part 2: Elevating control stations
	Cranes — Equipment for the lifting of persons — Part 3: Spreader beams
prEN 12644-1: 1998	Cranes — Information for use and testing — Part 1: Instructions
prEN 12644-2: 1998	Cranes — Information for use and testing — Part 1: Marking

Annex ZA
(informative)

A2 Relationship between this European Standard and the Essential Requirements of EU Directive 98/37/EC amended by Directive 98/79/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 98/37/EC on machinery amended by Directive 98/79/EC.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with the relevant Essential Requirements except 1.5.8 and 1.7.4 f) of that Directive and associated EFTA regulations.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard. A2

Annex ZB
(informative)

A2 Relationship between this European Standard and the Essential Requirements of EU Directive 2006/42/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 2006/42/EC on machinery.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with the relevant Essential Requirements except 1.5.8 and 1.7.4.2 u) of that Directive and associated EFTA regulations.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard. A2

Bibliography

[1] EN 1050: 1996, *Safety of machinery — Principles of risk assessment*

[2] FEM 1001: 1998, *Rules for the design of hoisting appliances*

NOTE FEM is Fédération Européenne de la Manutention

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