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Earth-moving machinery — Lifting and tying-down attachment points — Performance requirements

Engins de terrassement — Points d'ancrage pour le levage et l'arrimage — Exigences de performance

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15818 was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*, Subcommittee SC 3, *Machine characteristics, electrical and electronic systems, operation and maintenance*.

Introduction

This International Standard has been developed to define the performance requirements of lifting and tying-down attachment points fitted on, or incorporated into, earth-moving machinery for the purposes of its effective and safe transportation.

Although manufacturers of machines do not have direct responsibility for such transportation, the method and precautions necessary for lifting, tying down and disassembling for transportation are described in informative annexes which can be used by the manufacturer as guidance when preparing the operator's manual.

The tying-down requirements and recommendations given in this International Standard are intended to match widely applied practices such as those described in IMO/ILO/UNECE guidelines (CTU). However, where this is not the case, another or other supplemental methods to secure the machine will need to be provided in the operator's manual.

Earth-moving machinery — Lifting and tying-down attachment points — Performance requirements

1 Scope

This International Standard specifies the performance requirements for the lifting and tying-down attachment points of earth-moving machinery as defined in ISO 6165.

It can also be applied to heavy components and subassemblies of earth-moving machinery in cases where these need to be lifted and/or tied down. If, however, the attachment points of the components or subassemblies cannot be used for lifting or tying down the parent machine, this must be made evident by a label near the attachment point.

This International Standard can be applied except where national or local regulations are more stringent than its requirements and except beyond transportation-system-related limitations justified by the machine manufacturer.

NOTE Due to the size or mass of certain machines (components or subassemblies), their transport is limited by infrastructures, the transporter's capacities or human factors (e.g. capability of workers slinging and/or tying down).

This International Standard is not applicable to airlift or transport by air, nor to the tying-down attachment points used to secure working machines in maritime, river or similar work vessels.

2 Normative references

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

ISO 6016, *Earth-moving machinery — Methods of measuring the masses of whole machines, their equipment and components*

ISO 6165, *Earth-moving machinery — Basic types — Identification and terms and definitions*

ISO 6405-1:2004, *Earth-moving machinery — Symbols for operator controls and other displays — Part 1: Common symbols*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
lifting attachment point
device fitted on, or incorporated into, an earth-moving machine, used for lifting the machine

NOTE The attachment point can be a hole, a lifting eye or any specific part of the machine as specified by the manufacturer.

3.2
lifting accessories
combination of tools and materials (shackles, wire ropes, slings, etc.) used for lifting the machine

3.3
tying-down attachment point
device fitted on, or incorporated into, earth-moving machinery, used for tying down when transporting the machine

NOTE The attachment point can be a hole, a tying-down eye or any specific part of the machine as specified by the manufacturer.

3.4
tying-down accessories
combination of tools and materials (square timbers/skids, chains, chain blocks, wire ropes, shackles, etc.) used for tying down and fastening when transporting machines

3.5
sling
assembly of slinging components, such as chains, wire ropes or textile material joints to upper or lower terminals, suitable for attaching to a lifting attachment point

NOTE A sling can also be used as special equipment to allow balanced lifting of the machine.

3.6
lifting configuration
manufacturer's recommended position(s) of the machine for lifting

3.7
machine tying-down configuration
manufacturer's recommended position(s) of the machine for transport

3.8
disassembled machine unit mass for calculation
⟨machines disassembled during transport⟩ mass of each disassembled unit of a machine, used for calculating forces exerted on lifting or tying-down attachment points

3.9
machine mass for calculation
⟨all other machines⟩ mass of the machine, used for calculating forces exerted on lifting or tying-down attachment points, including the heaviest combination of cab, canopy, operator-protective structures, if any, with all their components and mountings, and any combination of equipment and attachment approved by the manufacturer of the machine, including full-liquid systems according to ISO 6016

3.10
distributed lifting force
force applied onto each lifting attachment point during lifting

NOTE 1 Based on machine manufacturer's lifting instructions, because of machine configuration or lifting accessories, the distributed lifting force magnitude and direction for a given lifting attachment point will need to be adjusted to account for unequal distribution of loads and non-vertical lifting accessories.

NOTE 2 See Table 1.

3.11
distributed tying-down force
force potentially applied onto each tying-down attachment point during transport

NOTE See Table 2.

3.12
working load limit
WLL
maximum load (mass) that the lifting accessory is designed to lift under the conditions specified by the manufacturer

NOTE It is expressed in tonnes.

3.13
lashing capacity
LC
maximum allowable direct force that a tying-down accessory may sustain in use

3.14
transport vehicle
vehicle to which the earth-moving machine is tied down for transportation purposes

3.15
proof force
maximum force at which the lifting or tying-down attachment point exhibits no visible permanent structural deformation

3.16
breaking force
maximum force reached during the static tensile test, at which the lifting or tying-down attachment point retains the load

4 Lifting attachment points

4.1 Location and number

The lifting attachment points should be located to provide access using the principles given in ISO 2867.

There shall be enough space around the lifting attachment points for fixing of the lifting accessories.

Sufficient numbers of lifting attachment points shall be placed so that distributed and balanced lifting with a lifting accessory or accessories is possible. An example is shown in Figure B.1.

The lifting attachment points shall be so located that damage of the lifting accessories due to sharp edges, etc., is avoided when the machine is lifted according to the manufacturer's instructions.

Each lifting attachment point shall be so located to avoid contact between the corresponding lifting accessory and the machine (except at the attachment point). If this is not possible, a specific procedure for lifting shall be described in the operator's manual and on the machine (e.g. spreader bar).

Where there are no appropriate central lifting attachment points [see Figures B.2 and B.3 b)], points shall be spaced the maximum practicable distance for appropriate stability and balance.

A lifting attachment point or points should be fitted to hold the terminal fittings of the lifting accessories in the foreseen position to avoid slipping.

The dimensions of lifting attachment points such as holes should be appropriate for the appropriate lifting accessories.

If a machine structural member is used as a lifting attachment point, the method for fixing the lifting accessories at the structural member shall be described in the operator's manual.

4.2 Strength and safety

Each lifting attachment point shall fulfil the strength requirements of Table 1 and shall be verified according to Clause 9. Alternatively, each lifting attachment point may be evaluated individually based on a proof factor 1,5 for the proof force and a safety factor of 4 for the breaking force.

Open-end lifting attachment points such as hooks shall have a safety latch or other device to prevent unintended disengagement of the mating lifting accessory.

Table 1 — Lifting attachment points — Strength requirements

Distributed lifting force N	**Strength requirement**	
	Proof force[a] N	**Breaking force**[b] N
$\frac{m \times g}{n \times \cos\theta}$	$\frac{m \times g \times 1{,}5}{n \times \cos\theta}$	$\frac{m \times g \times 4{,}0}{n \times \cos\theta}$
m is the machine mass for calculation (kg)		
g is the acceleration due to the force of gravity ($g = 9{,}8$ m/s^2)		
n is the number of effective lifting attachment points, maximum 2 for calculation, used simultaneously		
θ is the angle between the vertical line and the sling leg at the lifting attachment point. It shall be 60° for calculation (see Figure 1), if appropriate. For single-leg slings, θ is equal to 0° and n is equal to 1.		
a For verification purposes.		
b For design purposes.		

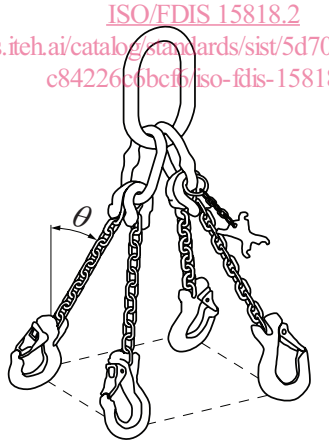


Figure 1 — Lifting attachment points — Angle between vertical line and sling leg

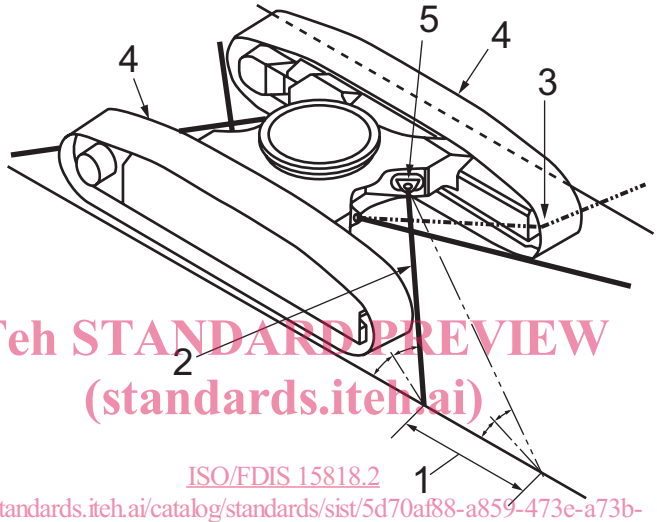
5 Tying-down attachment points

5.1 Location and number

The tying-down attachment points should be located for access using the principles in ISO 2867.

There shall be enough space around the tying-down attachment points for the fixing of the tying-down accessories.

The tying-down attachment points shall be positioned so that damage of the tying-down accessory is avoided when the points are used according to the manufacturer's instructions. See Figure 2.



Key

1 appropriate angle range
2 tying-down accessory (within appropriate angle range)
3 tying-down accessory interfering with the machine component beyond the appropriate angle range
4 track shoe of the machine
5 tying-down attachment point

Figure 2 — Tying-down attachment points — Appropriate angle range

Each tying-down attachment point shall be so located to avoid contact between the corresponding tying-down accessory and the machine (except at the attachment point). If this is not possible, a specific procedure for tying down shall be described in the operator's manual and on the machine (e.g. appropriate edge protectors).

The dimensions of tying-down attachment points such as holes should be appropriate to the appropriate tying-down accessories.

If a machine structural member is used as a tying-down attachment point, the method for fixing the tying-down accessories at the structural member shall be described in the operator's manual.

A sufficient number of tying-down attachment points shall be provided to allow acceptable distributed tying-down forces for tying-down accessories.

5.2 Strength

Each tying-down attachment point shall fulfil the strength requirements of Table 2 and shall be verified in accordance with Clause 9.

NOTE Annex C provides a road, rail and sea transportation calculation method for diagonal lashing.

Alternatively, each tying-down attachment point may be evaluated individually based on a proof factor of 1,25 for the proof force and a safety factor of 2 for the breaking force.

Table 2 — Tying-down attachment points — Strength requirements

Direction of force relative to transport vehicle	Distributed tying-down force N	Strength requirement	
		Proof force[a] N	Breaking force[b] N
Forward	$F_F = \frac{(C_x - \mu_D \times C_z) \times m \times g}{n \times (\cos\alpha \times \cos\beta_x + \mu_D \times \sin\alpha)}$	$1{,}25 \times F_F$	$2 \times F_F$
Backward	$F_B = \frac{(C_x - \mu_D \times C_z) \times m \times g}{n \times (\cos\alpha \times \cos\beta_x + \mu_D \times \sin\alpha)}$	$1{,}25 \times F_B$	$2 \times F_B$
Lateral	$F_L = \frac{(C_y - \mu_D \times C_z) \times m \times g}{n \times (\cos\alpha \times \cos\beta_y + \mu_D \times \sin\alpha)}$	$1{,}25 \times F_L$	$2 \times F_L$

m is the machine mass for calculation (kg)

g is the acceleration due to the force of gravity (g = 9,8 m/s²)

n is the number of effective tying-down attachment points, a maximum of two for calculation, used simultaneously for each direction

α is the angle between the horizontal vertical line and the tying-down attachment accessory at the tying-down attachment point

β_x is the angle between the longitudinal axis and the tying-down accessory at the tying-down attachment point in the loading plane of the transport vehicle

β_y is the angle between the transverse axis and the tying-down accessory at the tying-down attachment point in the loading plane of the transport vehicle

μ_D is the dynamic friction coefficient for design (μ_D = 0,2 reference value)

F_F is the forward force actuated by the load

F_B is the backward force actuated by the load

F_L is the transverse force actuated by the load

C_x is the longitudinal direction acceleration coefficient

C_y is the transverse direction acceleration coefficient

C_z is the vertical acceleration coefficient (C_z = 1 for road transport)

C_x, C_y and C_z multiplied by the acceleration due to gravity, g, gives the acceleration, $a = C \times g$, of the load. These shall be the most stringent values between all accepted modes of transportation as specified by the manufacturer. Except for rail shunting, C_x (forward) and C_x (backward) shall each be equal to 1,0, and C_y shall be equal to 0,8. Tables C.1, C.2 and C.3 provide maximum values for a load on a vehicle for the specific type of transportation (road, rail and sea).

For the calculation of the strength of tying-down attachment points for larger machines, the friction factor can be increased using special materials, e.g. strap rubber, between the machine and the carrier surface. This shall be clearly described in the operator's manual and given as an indispensable requirement for the user. It can also be increased for wheeled machines but, if the friction factor is different from the reference value (0,2), it shall be ensured by the earth-moving machinery manufacturer and indicated in the operator's manual.