INTERNATIONAL STANDARD

ISO 19426-3

First edition
2018-05

Structures for mine shafts —

Part 3:
Sinking stages

Structures de puits de mine —

Partie 3: Plates-formes de fonçage

Reference number
ISO 19426-3:2018(E)

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Published in Switzerland

Contents

Page

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 82, *Mining*.

A list of all parts in the ISO 19426 series can be found on the ISO website.

Introduction

Many mining companies, and many of the engineering companies which provide designs for mines, operate globally so ISO 19426 was developed in response to a desire for a unified global approach to the safe and robust design of structures for mine shafts. The characteristics of ore bodies, such as their depth and shape, vary in different areas so different design approaches have been developed and proven with use over time in different countries. Bringing these approaches together in ISO 19426 will facilitate improved safety and operational reliability.

The majority of the material in ISO 19426 deals with the loads to be applied in the design of structures for mine shafts. Some principles for structural design are given, but for the most part it is assumed that local standards will be used for the structural design. It is also recognized that typical equipment varies from country to country, so the clauses in ISO 19426 do not specify application of the principles to specific equipment. However, in some cases examples demonstrating the application of the principles to specific equipment are provided in informative Annexes.

Structures for mine shafts —

Part 3:
Sinking stages

1 Scope

This document specifies the design loads and the design procedures for the structural design of stages and components of stages.

The loads specified in this document are not applicable for the design of stage ropes or sheaves. Rope sizes are determined in accordance with other standards.

This document does not cover matters of operational safety, or layout of the sinking stage.

This document adopts a limit states design philosophy.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 10721-1, *Steel structures — Part 1: Materials and design*

ISO 10721-2, *Steel structures — Part 2: Fabrication and erection*

ISO 19426-1, *Structures for mine shafts — Part 1: Vocabulary*

ISO 22111, *Bases for design of structures — General requirements*

ISO 2394, *General principles on reliability for structures*

EN 1999-1-1, *Eurocode 9 — Part 1: Design of aluminium structures — Part 1: General structural rules*

EN 1999-1-3, *Eurocode 9 — Part 1: Design of aluminium structures — Part 3: Structures susceptible to fatigue*

EN 1999-1-4, *Eurocode 9 — Par 1: Design of aluminium structures — Part 4: Cold-formed structural sheeting*

CEN/TS 13001-3-1, *Cranes — General design — Part 3-1: Limit states and proof competence of steel structures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 19426-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org

4 Symbols

C	lashing unit grab capacity (m^3)
E	emergency load, or load effect (N, Nm)
e_G	stage load eccentricity factor
E_a	emergency impact load (N)
E_p	emergency impact load on a protective platform (N)
E_R	emergency rope load (N)
F	design load, or load effect (N, Nm)
G	permanent load, or load effect (N, Nm)
G_D	jumbo unit self-weight (N)
G_L	lashing unit self-weight (N)
K	weight of the kibble and full load (N)
L	span of an element or floor beam (m)
L_1	lashing unit lever arm or the VSM lashing unit grab lever arm (m)
L_2	stage jack lever arm horizontal (m)
L_3	stage jack lever arm vertical (m)
L_4	jumbo unit centre of gravity lever arm or the VSM lashing unit centre of gravity lever arm (m)
L_{5i}	hydraulic cylinder horizontal lever arm to the boom pivot point (m)
L_{6i}	hydraulic cylinder vertical lever arm to the boom pivot point (m)
M_D	jumbo unit moment about the boom pivot point (Nm)
M_L	lashing unit moment about the boom pivot point (Nm)
N_L	total number of lashing unit cycles
P	payload used during doubling-down (N)
p_D	uniformly distributed load on stage decks (N/m^2)
P_A	canopy load (N)
P_B	blast load (N)
P_C	concentrated load on stage decks (N)
P_D	total uniformly distributed imposed load on stage decks (N)
P_G	stage skid load (N)
P_H	kibble cross-head support load (N)

P_J	stage jack load (N)
P_{JA}	stage jack axial load (N)
P_{JT}	stage jack transverse load (N)
P_K	kibble guide load (N)
P_{DH}	jumbo unit horizontal load (N)
P_{DV}	jumbo unit vertical load (N)
P_{LH}	horizontal lashing unit load (N)
P_{LV}	vertical lashing unit load (N)
P_P	special load (N)
P_R	hand railing load (N/m)
P_T	temporary stage support load (N)
P_W	winch load (N)
Q_1	predominant imposed load, or load effect (N, Nm)
Q_3 to Q_n	additional independent imposed loads, or load effects (N, Nm)
V_E	predominant imposed load, or load effect (N, Nm)
W_C	weight of the kibble cross-head (N)
W_{CHi}	horizontal hydraulic cylinder loads at maximum capacity (N)
W_{CVi}	vertical hydraulic cylinder load (N)
W_G	weight of the cactus grab including the grab crosshead (N)
W_{PL}	weight of rock in the lashing unit grab (N)
W_{DL}	jumbo drilling load (N)
W_K	weight of kibble and full load (N)
W_R	rated shutter winch load (N)
W_S	weight of the shutter (N)
W_W	grab winch safe working load (N)
α_B	bellmouth impact factor
α_C	impact factor for kibble cross-head support
α_D	jumbo unit impact factor
α_E	impact factor for emergency rope load
α_H	hydraulic cylinder impact factor
α_K	kibble guide impact factor

α_L lashing unit impact factor

α_J impact factor for stage jack load

α_R winch rated load impact factor

α_S formwork weight impact factor

α_T stage support impact factor

η efficiency factor

γ_e partial load factor for emergency load

γ_{fo} partial load factor for permanent load

γ_{f1} partial load factor for the predominant imposed load

γ_{f2} to γ_{fn} partial load factors for imposed load

Ψ_2 to Ψ_n load combination factors

5 Materials

5.1 Steel

5.1.1 Structural steel grades

The materials used for structural steel members should comply with the requirements of EN 10025-1 and EN 10025-2.

5.1.2 High strength steel grades

The materials for high strength steel members should conform to the requirements of EN 10025-6, EN 10149-1, EN 10149-2, or EN 10149-3.

5.2 Aluminium alloys

The materials used for aluminium alloy members should conform to the requirements of EN 573-3, EN 485-1 to EN 485-4 and EN 755-1 to EN 755-9.

NOTE The preferred alloys include 5083 H32 for 4 mm, 6 mm and 8 mm thick plates or 6082 T651 or 6061 T651 for 10 mm, 12 mm and 15 mm thick plates and 6061 T6 or 6082 T6 for extrusions.

6 Nominal loads

6.1 Permanent load

The permanent load, G, shall be as given in ISO 22111 and shall include the stage and all permanent fixtures and equipment necessary for the sinking and lining of the shaft.

6.2 Imposed loads

6.2.1 Stage deck load

The imposed load, P_D or P_C, on stage decks shall be the most adverse of the following:

a) a uniformly distributed load, P_D, of 3 000 N/m^2, which shall be taken to include concrete build-up loads, unless it can be demonstrated that there will be no build-up of concrete in which case take a uniformly distributed load, P_D, of 1 500 N/m^2. P_D is the total uniformly distributed load on stage decks which shall be calculated from the uniformly distributed load multiplied by the entire stage deck area; or

b) a concentrated load, P_C, of 5 000 N, placed in the position that produces the most severe effects in the member under consideration.

No area reduction factors shall be included when deck loads from one or more decks are being combined.

Due allowance shall be made for possible eccentric application of stage deck loads. Unless it can be shown that procedures are in place to ensure concentric placement of all deck loads, it shall be assumed that one half of each stage deck carries a load of 0,75 P_D, whilst the other half of the deck carries a load of 0,25 P_D.

6.2.2 Shaft formwork winch load

The shaft formwork winch load, P_W (N), shall be the greater of:

$$P_W = \alpha_S W_S \text{, and} \quad (1)$$

$$P_W = \alpha_R W_R \quad (2)$$

where

W_S is the weight of the shaft formwork (N);

W_R is the rated shaft formwork winch load (N);

α_S is the formwork weight impact factor, which may be taken as 2,0;

α_R is the winch rated load impact factor, which may be taken as 1,5.

The shaft formwork winch load shall be appropriately distributed between the winches assuming that any one winch can fail.

6.2.3 Kibble cross-head support load

The kibble cross-head support load, P_H (N), shall be obtained from the following:

$$P_H = \alpha_C W_C \quad (3)$$

where

α_C is the impact factor for the kibble cross-head support, which if no better information is available may be taken as 2,0;

W_C is the weight of the kibble cross-head (N).

6.2.4 Jumbo unit load

The jumbo unit loads, P_{DH}, P_{DV} and M_D, shall be the greater of:

a) operating loads determined from the geometry and operation of the jumbo unit. The most critical position of the boom shall be considered, and an impact factor of not less than 3,0 shall be applied;

b) maximum equipment loads determined from the geometry and maximum capacity of the jumbo unit equipment. An impact factor of not less than 1,5 shall be applied.

Examples are provided in Annex B.

6.2.5 Lashing unit load

The lashing unit loads, P_{LH}, P_{LV} and M_L, shall be the greater of:

a) operating loads determined from the geometry and operation of the lashing unit. The most critical position of the equipment shall be considered, and an impact factor of not less than 3,0 shall be applied;

b) maximum equipment loads determined from the geometry and maximum capacity of the lashing unit equipment. An impact factor of not less than 1,5 shall be applied.

Examples are provided in Annex C.

For evaluation of the fatigue life of the lashing unit supports, the total number of lashing unit cycles, N_L, shall be taken as:

$$N_L = \frac{1{,}7 V_E}{C\eta} \qquad (4)$$

where

V_E is the excavated volume of the shaft (m^3);

C is the lashing unit grab capacity (m^3);

η is the efficiency factor, taken as 0,7 in the absence of better information.

6.2.6 Stage jack load

The stage jack load, P_J, shall be determined based on the geometry of the stage and the jack locations, and the jumbo drill rig and lashing unit loads P_{DH}, P_{DV}, M_D, P_{LH}, P_{LV} and M_L.

Examples are provided in Annex D.

6.2.7 Stage skid load

Where stage skids are incorporated into the stage, the load, P_G (N), for each stage skid shall be taken as:

$$P_G = e_G (G + P_D) \qquad (5)$$

where e_G is the stage load eccentricity factor, which shall be taken as not less than 0,05.

The stage skid load shall be applied to the top and bottom skids on the stage.

Where the stage has an unsymmetrical shape, where there is heavy equipment placed eccentric to the geometrical centre of the stage, or where the stage rope tension with the sheave geometry induces a moment on the stage, e_G shall be calculated on the basis of the actual location of the centre of gravity of the stage and the equipment, and the actual moment induced by the maximum tension in the stage ropes.

Where the shaft being sunk is not vertical, the stage skid load shall include the appropriate component of the stage weight.

6.2.8 Canopy load

The canopy load, P_A, shall be calculated from a uniformly distributed load of 3 000 N/m^2, multiplied by the area of the canopy.

6.2.9 Kibble guide load

Where the creep hoisting speed of the kibble through the stage does not exceed 0,5 m/s, the kibble guide load, P_K, may be taken as zero.

Where the creep hoisting speed exceeds 0,5 m/s, the kibble guide load shall be as defined in (a) and (b) below.

a) The horizontal kibble guide load, P_K (N), shall be taken as:

$$P_K = \alpha_K W_K \tag{6}$$

where

α_K is the kibble guide impact factor, which may be taken as 0,1;

W_K is the weight of kibble and full load (N).

The horizontal kibble guide load, P_K, shall be applied to the kibble guide as a uniformly distributed load acting over the length of the kibble.

b) The vertical and horizontal impact loads on the bellmouth on the underside of the stage shall be taken as

$$P_K = \alpha_B W_K \tag{7}$$

where α_B is the bellmouth impact factor, which may be taken as 0,2 provided the creep speed through the stage does not exceed 1,0 m/s.

6.2.10 Temporary stage support load

Where appropriate during erection or maintenance, the temporary stage support load, P_T (N), which can include load reversal, shall be taken as:

$$P_T = \alpha_T (G + P_D) \tag{8}$$

where α_T is a stage support impact factor, which may be taken as 2,0 provided the impact speed does not exceed 0,1 m/s, unless a rational impact load calculation indicates a different value.

6.2.11 Blast load

In the absence of better information, the blast load, P_B, shall be calculated from a static pressure of 3 000 N/m^2 acting in a vertical upward direction, multiplied by the total area for each of the stage decks.

6.2.12 Guard railing load

Where guard railing is used, the load, P_R, shall be taken as a uniformly distributed load of not less than 1 500 N/m, acting in any direction perpendicular to the hand rail.

6.2.13 Special load

From time to time new sinking equipment or methodologies can be introduced or stages can be used for other operations, including for example:

— installation of a brattice wall;

— transport of heavy underground equipment;

— support of jumbo drill rigs;

— other sinking or equipping requirement.

Special loads, P_P, applied to the stage under these conditions shall be assessed on a rational basis.

6.3 Emergency load

6.3.1 Emergency rope load

The emergency rope load, E_R (N), on the critical load bearing components of the stage shall be obtained from the following:

$$E_R = \alpha_E \left(G + P_D\right) \tag{9}$$

where α_E is the impact factor for emergency rope load, which shall be taken as not less than 3,0.

6.3.2 Emergency impact load

Unless otherwise specified by the client, the following emergency impact loads, E_a, shall be considered:

a) a vertical concentrated load of 20 000 N applied on an area of 0,1 m × 0,1 m anywhere on the canopy or the top deck of the stage;

b) the load resulting from impact having an energy of 20 kJ, applied anywhere on the beams comprising the top deck of the stage.

7 Design procedures

7.1 Design loads

The nominal loads for operating and emergency conditions shall be obtained from Clause 6. Structural reliability shall be ensured to the extent envisaged in ISO 2394. This can be achieved by the application of partial load factors and load combinations in accordance with ISO 22111 together with appropriate resistance factors.

See Annex A for additional guidance.

7.2 Design codes

Members of sinking stage structures shall be designed using limit state design procedures as given in ISO 10721-1 and ISO 10721-2, for steel components, and in EN 1999-1-1, EN 1999-1-3 and EN 1999-1-4, for aluminium components. Structural members made from high strength steels shall be designed using limit state design procedures as provided in CEN/TS 13001-3-1.

7.3 Load reversal

Stages can be constructed in their vertical position before or during deployment, in the shaft. There is also the possibility of the stage being lowered onto the shaft bottom during sinking, in order to change the stage ropes or damaged sheaves. Both of these conditions could lead to a load reversal on the main vertical members and other affected members. This load reversal shall be considered during the design.

7.4 Design of replaceable members

The parties concerned are permitted to designate selected members (other than critical load bearing components) of the stage as replaceable items on the basis that once they are damaged they will be replaced. Provided that the material used is a ductile material, the design action effect can exceed the design resistance of the replaceable member by 20 %. This does not apply for the connections or supporting members.

7.5 Impact energy design of top deck

The top deck beams shall not deflect by more than 15 % of their span under the action of the specified impact energy.

7.6 Deflection limitations

Deflection of decks and floor beams shall not exceed $L/200$. For a cantilever, L shall be taken as equal to twice the length of the cantilever.

NOTE Deflection limitations need not be considered in emergency conditions.

Annex A
(informative)

Load factors and load combinations

A.1 General

This annex provides guidance with respect to load factors and load combinations which comply with the requirements of 7.1. The partial load factors and combination factors given in this Annex provide for the level of reliability envisaged in ISO 22111 for ordinary consequences of failure.

NOTE Throughout this annex, "load" can also be read as "load effect".

A.2 Operating conditions

A.2.1 Partial load factors and load combination factors

The appropriate values given in Table A.1 for partial load factors and load combination factors should be used.

Table A.1 — Partial load factor γ_{f1} and load combination factor Ψ_i

Type of load	Partial load factor γ_{f1}		Load combination factor
	Ultimate	Serviceability	Ψ_i
1. Permanent loads (G)			
a) maximum self-weight load acting in isolation	1,5	1,0	—
b) maximum self-weight load acting in combination	1,35	1,1	1,0
2. Imposed loads (Q_i)			
c) stage deck load (P_D;P_C)	1,5	1,0	1,0[b]
d) winch load (P_W)	1,35	1,0	0,0
e) lashing load (P_{LH}+ P_{LV})	1,5	1,0	0,0
f) kibble cross-head support load (P_H)	1,5	1,0	1,0
g) stage jack support load (P_J)	1,5	1,0	1,0
h) stage skid load (P_G)	1,5	1,0	0,0
i) canopy load (P_A)	1,5	1,0	0,0
j) kibble guide load (P_K)	1,5	1,0	1,0
k) temporary stage support load (P_T)	1,5	1,0	1,0
l) blast load (P_B)	1,5	1,0	0,0
m) hand railing load (P_R)	1,5	1,0	0,0
n) special load (P_P)	1,5[a]	1,0	1,0
3. Emergency loads (E)			
o) emergency rope load (E_R)	(see A.3)		
p) emergency impact load (E_a)	1,3	NA	0,0

[a] Where the mass of the special load is well known, a partial load factor of 1,35 may be used.

[b] Where the blast load is applied, this factor is taken as zero.

A.2.2 Load combinations

For load combinations, the design load, F, should be obtained from the following Formula:

$$F = \gamma_{fo} G + \gamma_{f2} Q_2 + \left(\Psi_3 \gamma_{f3} Q_3 + \ldots + \Psi_n \gamma_{fn} Q_n \right) \quad \text{(A.1)}$$

where

γ_{fo}	is the partial load factor for permanent loads;
γ_{f2}, γ_{fn}	are the partial load factors for imposed loads;
G	is the permanent load, including long-duration components of imposed load;
Q_2	is the dominant imposed load under consideration;
Q_3, Q_n	are the additional independent imposed loads;
Ψ_3, Ψ_n	are the load combination factors.

A.3 Emergency conditions

A.3.1 For load combinations that incorporate the rope emergency load, the design load, F, should be obtained from the following Formula:

$$F = \gamma_e E_r \quad \text{(A.2)}$$

where γ_e is the partial load factor, taken as 1,3.

A.3.2 For all other emergency load combinations, the recommendations given in A.2 should apply.

Annex B
(informative)

Examples of jumbo unit loads

B.1 Operating loads

The jumbo unit operating loads (the position of which are shown in Figure B.1) should be taken as follows:

a) a vertical load, P_{DV} (N), being the greater of:

$$P_{DV} = \alpha_D (W_{DL} + G_D) \tag{B.1}$$

$$P_{DV} = \alpha_H \sum W_{CVi} \tag{B.2}$$

b) a horizontal load, P_{DH} (N):

$$P_{DH} = \alpha_L \sum W_{CHi} \tag{B.3}$$

and

c) a moment about the pivot point, M_D (Nm), being the greater of:

$$M_D = \alpha_D (W_{DL} L_1 + G_D L_4) \tag{B.4}$$

$$M_D = \alpha_H \left(\sum W_{CVi} L_{5i} + \sum W_{CHi} L_{6i} \right) \tag{B.5}$$

where

α_D is a jumbo unit impact factor, which may be taken as 3,0 in the absence of better information;

α_H is a hydraulic cylinder impact factor, which may be taken as 1,5 in the absence of better information;

G_D is the jumbo unit self-weight (N);

L_1 is the jumbo drilling load lever arm (m);

L_4 is the jumbo unit centre of gravity lever arm (m);

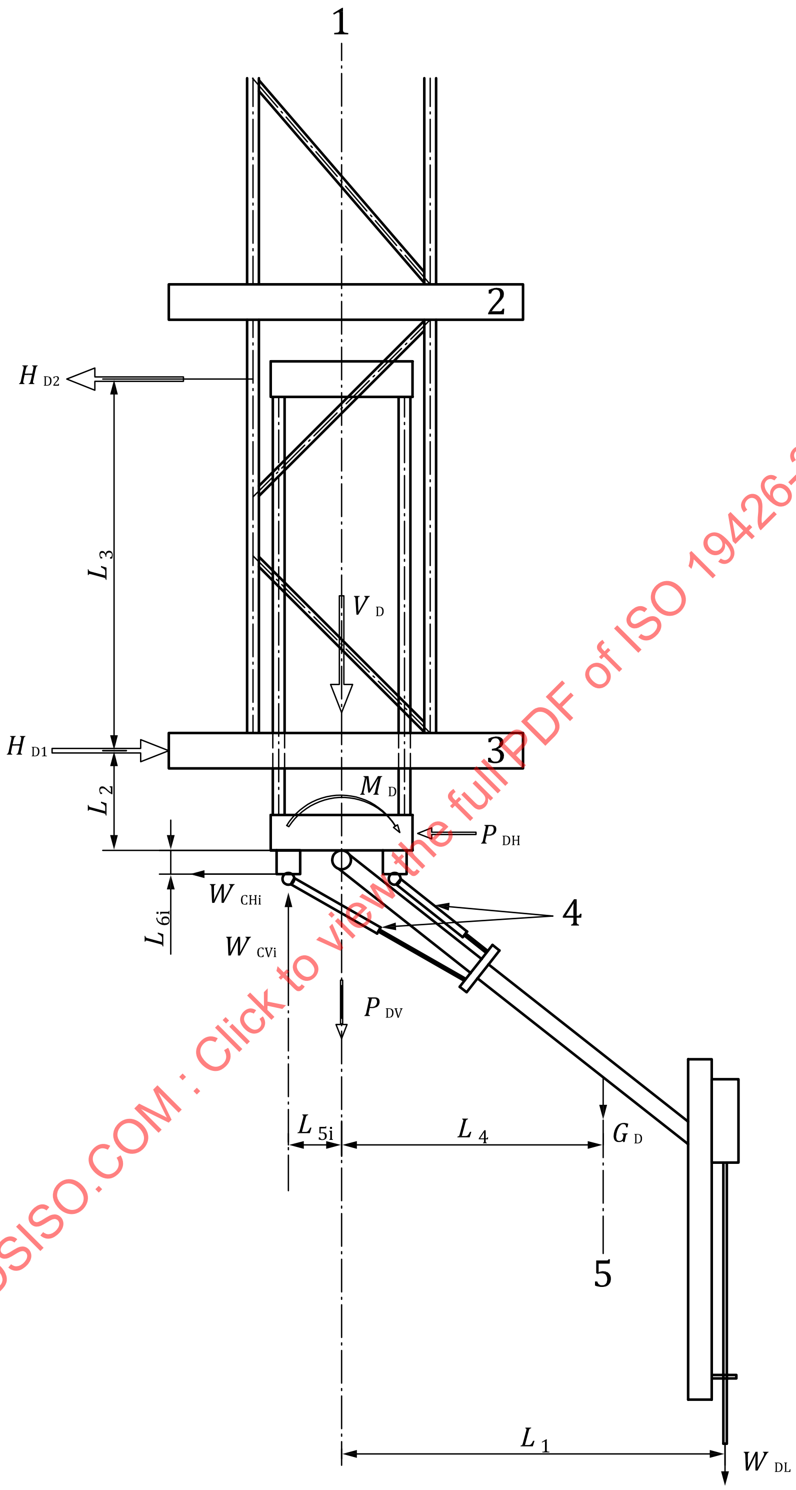
L_{5i} is the hydraulic cylinder horizontal lever arm to the boom pivot point (m);

L_{6i} is the hydraulic cylinder vertical lever arm to the boom pivot point (m);

W_{CHi} is the horizontal hydraulic cylinder loads at maximum capacity (N);

W_{CVi} is the vertical hydraulic cylinder loads at maximum capacity (N);

W_{DL} is the jumbo drilling load (N).



Key

1 centreline of tower
2 stage deck
3 stage bottom deck
4 hydraulic cylinders
5 jumbo unit centre of gravity

Figure B.1 — Jumbo unit loads (P_{DV}, P_{DH} and M_D)

B.2 Distribution of loads onto stage structure

These jumbo unit loads should be rationally distributed to the points at which the jumbo unit is supported on the stage, i.e. the loads V_D and H_{Di} in Figure B.1.

Annex C
(informative)

Examples of lashing unit loads

C.1 Lashing unit with cactus grab

The lashing unit cactus grab loads (the position of which are shown in Figures C.1 and C.2) should be taken as follows:

a) a vertical load, P_{LV} (N), being the greater of:

$$P_{LV} = \alpha_{V1} (W_G + W_{PL}), \text{ and} \quad (C.1)$$

$$P_{LV} = \alpha_{V2} (W_W) \quad (C.2)$$

and

b) a horizontal load, P_{LH} (N):

$$P_{LH} = \alpha_L P_{LV} \quad (C.3)$$

where

α_L is a horizontal impact factor, which may be taken as 0,35 in the absence of better information;

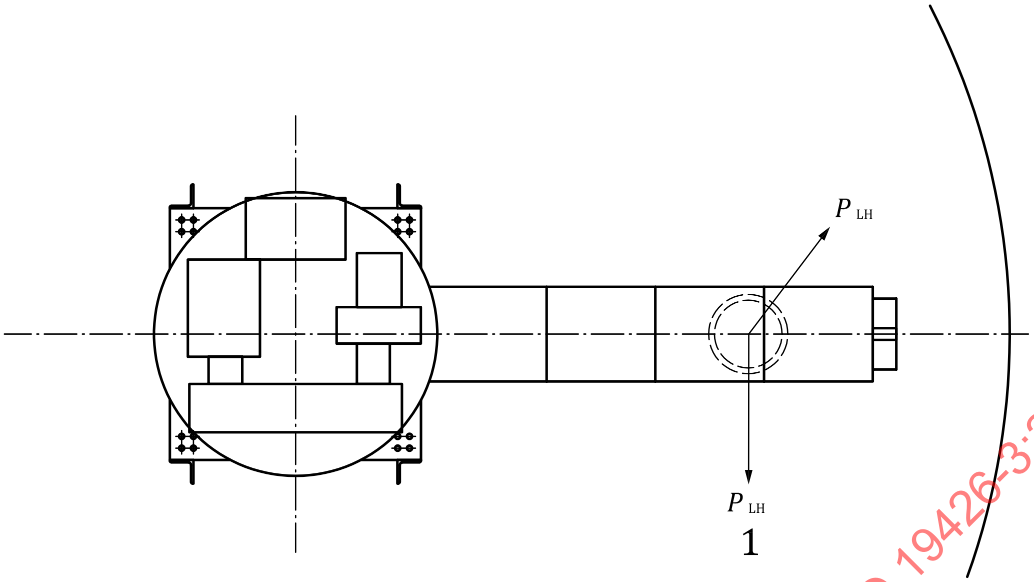
α_{V1} is a vertical impact factor, which may be taken as 3,0;

α_{V2} is a vertical impact factor, which may be taken as 1,5;

W_G is the weight of the cactus grab including the grab cross-head (N);

W_{PL} is the weight of rock in the lashing unit grab (N);

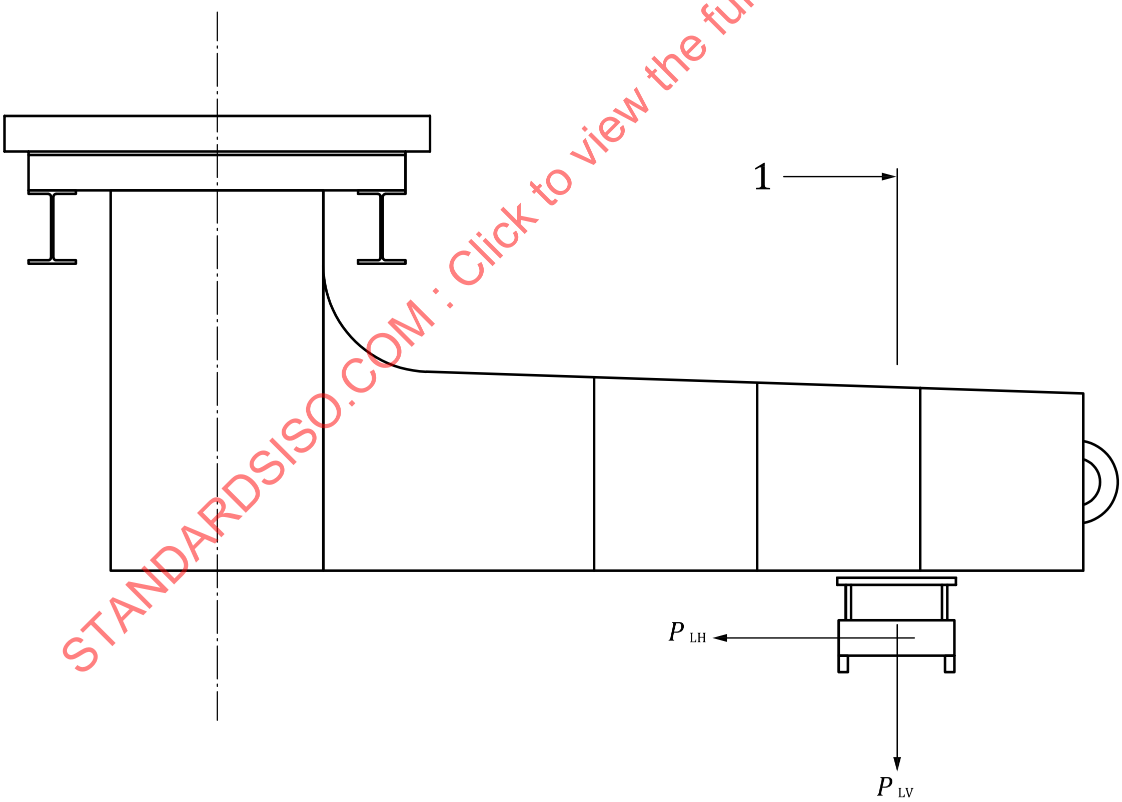
W_W is the grab winch safe working load (N).



Key

1 P_{LH} acts in any direction

Figure C.1 — Horizontal load (P_{LH})



Key

1 lashing unit loads should be determined at outer limit of lashing unit travel

Figure C.2 — Vertical load (P_{LV})

These loads should be rationally distributed to the points at which the lashing unit is supported on the stage.

C.2 VSM lashing unit

C.2.1 Operational loads

The lashing unit operational loads (the position of which are shown in Figure C.3) should be taken as follows:

a) a vertical load, P_{LV} (N), being the greater of:

$$P_{LV} = \alpha_L \left(W_{PL} + G_L\right) \tag{C.4}$$

$$P_{DV} = \alpha_H \sum W_{CVi} \tag{C.5}$$

b) a horizontal load, P_{LH} (N):

$$P_{LH} = \alpha_L \sum W_{CHi} \tag{C.6}$$

and

c) a moment, M_L (Nm), being the greater of:

$$M_L = \alpha_L \left(W_{PL} L_1 + G_L L_4\right) \tag{C.7}$$

$$M_L = \alpha_H \left(\sum W_{CVi} L_{5i} + \sum W_{CHi} L_{6i}\right) \tag{C.8}$$

where

α_H is the hydraulic cylinder unit impact factor, which may be taken as 1,5 in the absence of better information;

α_L is the lashing unit impact factor, which may be taken as 3,0 in the absence of better information;

G_L is the self-weight of the VSM lashing unit (N);

L_1 is the VSM lashing unit grab lever arm (m);

L_4 is the VSM lashing unit centre of gravity lever arm (m);

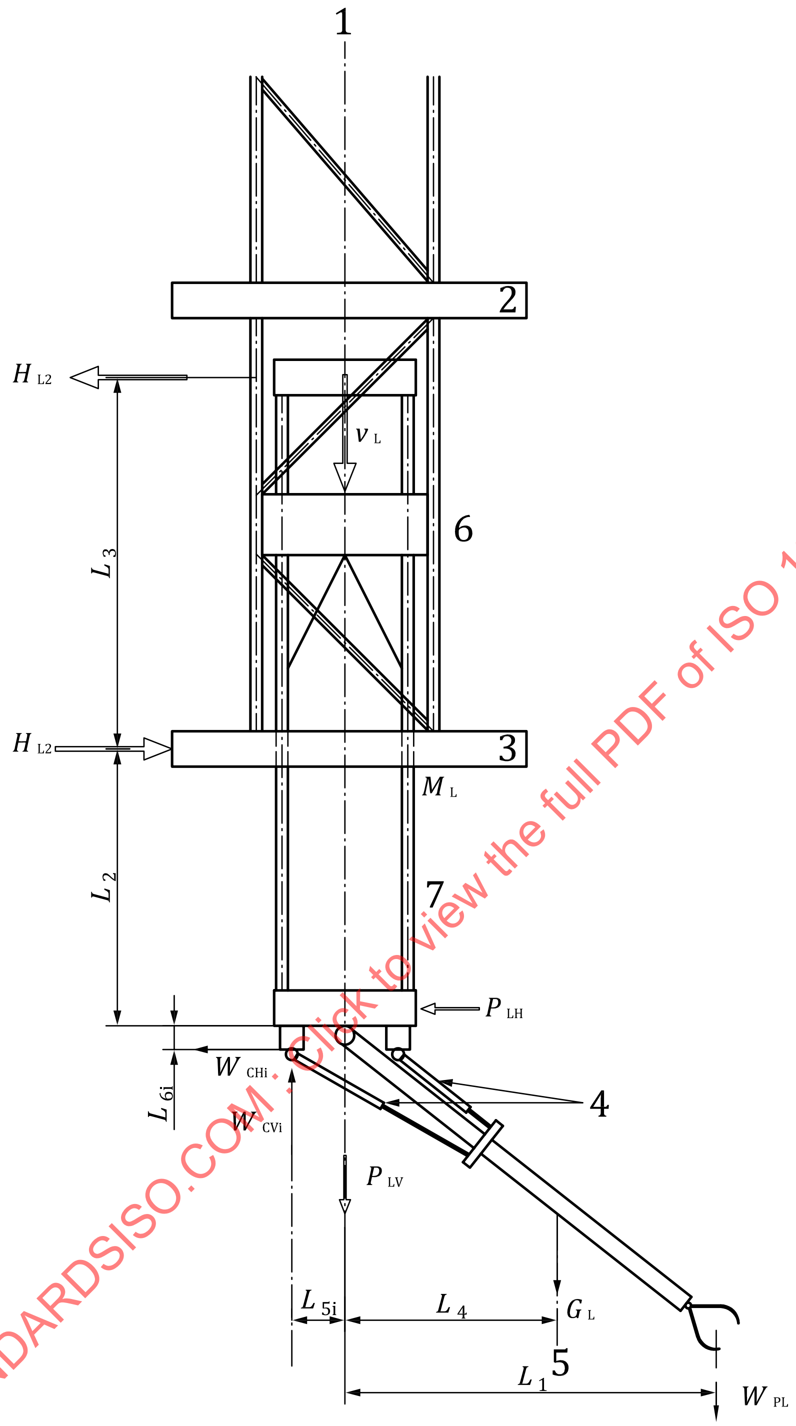
L_{5i} is the hydraulic cylinder horizontal lever arm to the boom pivot point (m);

L_{6i} is the hydraulic cylinder vertical lever arm to the boom pivot point (m);

W_{CHi} is the horizontal hydraulic cylinder loads at maximum capacity (N);

W_{CVi} is the vertical hydraulic cylinder load (N);

W_{PL} is the weight of rock in the lashing unit grab (N).



Key

1 centreline of tower
2 stage deck
3 stage bottom deck
4 hydraulic cylinders
5 VSM (vertical shaft mucker) centre of gravity
6 suspension frame
7 operator's compartment

Figure C.3 — VSM lashing unit

C.2.2 Distribution of loads onto stage structure

These loads should be rationally distributed to the points at which the VSM lashing unit is supported on the stage, i.e. the loads V_L and H_{Li} in Figure C.3.