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Structures for mine shafts —

Part 4:
Conveyances

Structures de puits de mine —

Partie 4: Moyens de transport

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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.

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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of 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 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.

This corrected version of ISO 19426-4:2018 incorporates the following correction:

— in 11.4.3.3, a), paragraph below Formula (33), the wording and value have been corrected to read "but the rock size shall not be taken as less than 0,02 m^3.".

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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 recognised 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 4:
Conveyances

1 Scope

This document specifies the loads, the load combinations and the design procedures for the design of the steel and aluminium alloy structural members of conveyances used for the transport of personnel, materials, equipment and rock in vertical and decline shafts. The conveyances covered by this document include personnel or material cages (or both), skips, kibbles, equipping skeleton cages, inspection cages, bridles, crossheads and counterweights.

This document is not intended to be used for the design of ropes, sheaves or attachments. Rope sizes are determined in accordance with other standards.

This document does not cover chairlifts.

This document does not cover matters of operational safety or layout of conveyances.

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 2394, *General principles on reliability for structures*

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 19426-2, *Structures for mine shafts — Part 2: Headgear structures*

ISO 19426-5, *Structures for mine shafts — Part 5: Shaft system structures*

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

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*

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

A_o	operating winder system acceleration/deceleration load (N)
A_t	trip-out winder deceleration load (N)
a_D	maximum permitted deceleration of the conveyance when the dogging system activates (m/s^2)
a_o	operating winder system peak acceleration/deceleration (m/s^2)
a_t	trip-out winder system peak deceleration (m/s^2)
C	impact load during loading of the conveyance (N)
C_h	horizontal impact load from rolling stock (N)
C_v	vertical impact load from rolling stock (N)
C_y	conveyed load (P, ΣM, U or R, as appropriate) (N)
D	dogging system load (N)
d_i	deformation of the skip door (m)
E_j	emergency dropback load (N)
E_r	rope emergency load (N)
e	maximum moving beam misalignment of the guide (m); lateral flare dimension (see Figure 1)
F	design load, or load effect (N, Nm)
F_v	friction induced vertical load (N)
G_1 and G_2	are the permanent loads, including the self-weight of the structure and the structural components, in newtons (N)
G_c	conveyance self-weight load (N)
g	acceleration due to gravity (m/s^2)
H	lateral imposed load (N)
H_r	rubbing block load (N)
H_s	lateral slipper plate load (N)
h_d	length through which the rock falls (m)
h_h	height to which the skip is filled above the lowest point of the skip door (m)
K	station-mounted holding device engagement load (N)

K_c	conveyance-mounted holding device load (N)
K_g	lateral stiffness of the steelwork at the guide mid-span or at the end of the flare (N/m)
K_s	buffer spring stiffness (N/m)
L	guide span, bunton to bunton or the length of the flare guide (m)
L_1	distance between the pivot and the centre of gravity of the skip, or the radial door (m)
L_2	distance between the pivot and the return-stop (or the tipping roller) (m)
L_T	length of the crawler track (m)
M	load from each item of rolling stock or equipment (N)
M_1	heavier axle load (N)
m_c	conveyance mass including all attachments, excluding rope attachments (kg)
m_r	mass of largest rock that will be loaded into the skip (kg)
P	load from personnel (N)
p_o to p_3	skip pressures (N/m^2)
Q_1	dominant imposed load or load effect (N, Nm)
Q_2 to Q_n	are the additional independent imposed loads, or load effects (N, Nm)
Q_e	emergency load or load effect (N, Nm)
R	static rock or slurry load (N)
R_d	bridle and top transom load during filling (N)
R_f	friction load on the skip door (N)
R_i	single rock impact vertical load on the skip door (N)
R_k	single rock impact horizontal load on the skip sides (N)
R_s	load on skip return-stops (N)
R_t	load on tipping rollers (N)
T	load due to the tail rope (N)
U	load due to underslung equipment (N)
z	maximum depth of rock or slurry contained in the conveyance (m)
Z_i	impact energy of the falling rock (J)
α_d	dynamic impact factor
α_h	horizontal load impact factor
α_k	holding device impact factor
α_p	rock impact factor

α_t tipping impact factor.

α_v vertical load impact factor

β rope emergency factor

γ_e partial load factor for emergency loads.

γ_{fi} partial load factor for imposed loads

γ_{g1} and γ_{g2} partial load factors for permanent loads

γ_{f1} to γ_{fn} partial load factors for imposed loads

γ_{gi} partial load factor for permanent loads

μ friction factor between the skip payload and the door

ρ bulk density of rock (kg/m^3)

Ψ_2 to Ψ_n load combination factors

5 Materials

5.1 Steel

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

5.1.1 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.

5.1.2 Cold temperature operation

Where necessary due to possible brittle fracture in cold operating temperatures, bridles, top transom and bottom transom members and fall back arrestors and their supports should have a minimum Charpy V-notch impact value of 27 J at 0 °C.

5.2 Aluminium alloys

The materials used for aluminium alloy members should comply with:

a) for extrusions: the requirements of EN 515, EN 573-3, EN 755-1, EN 755-2, EN 755-3, EN 755-4, EN 755-5, EN 755-7, or EN 12020-1 and EN 12020-2;

b) for rolled products: the requirements of EN 485-1, EN 485-2, EN 485-3 or EN 485-4 or IEC 60079.

In addition, extrusions and rolled products used for the fabrication of bridles and top transom and bottom transom members should be individually identified and should be the subject of quality systems.

6 Nominal operating loads

The nominal operating loads shall be as given in Clauses 7 to 10. The nominal emergency load shall be as given in Clause 11.

7 General operating loads

7.1 Permanent loads

Permanent loads shall be as defined in ISO 22111.

The permanent load, G_c, shall be taken as the total self-weight of the conveyance structure and all attachments, excluding rope attachments. The permanent load, G_c (N), shall be calculated using the following Formula:

$$G_c = g\, m_c \tag{1}$$

where

g is the acceleration due to gravity (m/s^2);

m_c is the conveyance mass including all attachments, excluding rope attachments (kg).

7.2 Vertical imposed loads due to holding devices

7.2.1 Holding device engagement load

The holding device engagement load, K (N), shall be calculated using the following Formula:

$$K = \alpha_k \left(G_c + C_y + T\right) \tag{2}$$

where

α_k is the holding device impact factor, which may be taken as 1,5 in the absence of better information, and provided the conveyance is not travelling at more than creep speed (0,5 m/s) when the devices are engaged;

C_y equals P, $\sum M$, U or R, as appropriate (N);

T is the load due to the tail rope or ropes (N).

NOTE Some holding devices are only applied after the conveyance has stopped completely. In this case the load specified here does not apply.

7.2.2 Holding devices securing load

The holding device securing load, K_c (N), shall be calculated using the following Formula:

$$K_c = \alpha_k\, C_y \tag{3}$$

where

α_k is the holding device impact factor, which in the absence of better information may be taken as:

1,0 for personnel loading;

2,0 for materials loading;

1,5 for rock loading;

C_y equals P, $\sum M$, U or R, as appropriate (N).

7.3 Lateral imposed loads

7.3.1 Fixed guide systems in vertical shafts

The lateral loads imposed on conveyances running on fixed guide systems in vertical shafts shall be taken as equal to the lateral loads imposed on shaft steelwork, as defined in ISO 19426-5.

7.3.2 Rope guide systems

7.3.2.1 Only one of the loads given in 7.3.2.2 to 7.3.2.4 shall be engaged at any one time.

7.3.2.2 Whilst running in rope guides, the rubbing block load, H_r, may, in the absence of better information, be taken as:

$$H_r = 0{,}01\,(G_c + C_y) \tag{4}$$

This load may be distributed amongst all the rubbing blocks.

7.3.2.3 While entering the fixed flare guides or spear guides near stations, the slipper plate load, H_s, shall be calculated in accordance with ISO 19426-5, for fixed guide systems, but with the following modifications:

L is the length of the flare (see Figure 1) (m);

e is the lateral flare guide or spear guide dimension (see Figure 1), unless a rational analysis shows otherwise (m);

K_g is the steelwork stiffness at the end of the flare (N/m).

7.3.2.4 While running in fixed guides at stations, the slipper plate load, H_s, shall be as defined in ISO 19426-5, for fixed guide systems.

7.3.3 Decline shaft conveyance wheel loads

The loads imposed on conveyances in the direction normal to the rail and transverse to the rail in decline shafts shall be taken as equal to the loads imposed on shaft rails in decline shafts, as defined in ISO 19426-5.