
**Cranes — Design principles for loads
and load combinations —**

**Part 5:
Overhead travelling and portal
bridge cranes**

*Appareils de levage à charge suspendue — Principes de calcul des
charges et des combinaisons de charges —*

Partie 5: Ponts roulants et ponts portiques

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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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).

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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 96, *Cranes*, Subcommittee SC 9, *Bridge and gantry cranes*.

This second edition cancels and replaces the first edition (ISO 8686-5:1992), which has been technically revised. It has been adapted to technical progress and new requirements and changes in the International Standards referenced by it. The main changes are

- the normative references to ISO 8686-1, ISO 20332 and ISO 12488-1 have been updated, and
- a calculation method for loads caused by skewing for bridge and gantry cranes with rigid or flexible characteristics has been added.

A list of all parts in the ISO 8686 series can be found on the ISO website.

Cranes — Design principles for loads and load combinations —

Part 5: Overhead travelling and portal bridge cranes

1 Scope

This document establishes the application of ISO 8686-1 to overhead travelling and portal bridge cranes as defined in ISO 4306-1 and gives specific values for the factors to be used.

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 4301-1:2016, *Cranes — Classification — Part 1: General*

ISO 4302:2016, *Cranes — Wind load assessment*

ISO 4306-5:2005, *Cranes — Vocabulary — Part 5: Bridge and gantry cranes*

ISO 8686-1:2012, *Cranes — Design principles for loads and load combinations — Part 1: General*

ISO 12488-1:2012, *Cranes — Tolerances for wheels and travel and traversing tracks — Part 1: General*

ISO 20332:2016, *Cranes — Proof of competence of steel structures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4306-5 and ISO 8686-1 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

Table 1 — Symbols and abbreviated terms

Symbol	Description
a	acceleration or deceleration value
a	term used in determining the value of ϕ_1
b_j	distance in travel direction from wheel j
C_H	elasticity factor of crane structure and rope system at the load suspension point
d_j	distance in travel direction from the front guide means to wheel j
e	base of natural logarithms, 2,718

Table 1 (continued)

Symbol	Description
$F_{\max,L}$	maximum force
f_{uc}	ultimate strength of the chain steel
g	gravity constant
h_M	flexibility of the portal in angle per moment
l	span of crane
l_r, l_c	length of rope/chain fall
m	mass
m_T	total mass of the loaded crane
M	moment turning the floating end carriage by forces Y_j applied to the wheels of that carriage
M	moment between the portal and the unguided carriage
m_H	mass of the hoist load (gross load)
m_{RC}	mass of the rated hoist load
R_r	rope grade
$S_{(f)}$	final load effect
$S_{(i)}$	initial load effect
sgn	signum function
s_j	selection factor
t_{br}	reaction time of the braking
t_{IAL}	response-time of the indirect acting lifting force limiter
t_{st}	time to stop the mechanism in stall condition by effects of the braking and increasing rope force
v_h	maximum hoisting speed
$v_{h,max}$	maximum steady hoisting speed
W	resulting wheel force
Y_F	lateral force at the guide means (F_y in ISO 8686-1:2012)
Y_j	lateral force at the contact point of wheel j (F_{yij} in ISO 8686-1:2012)
Z_{1i}	wheel load of the 1st wheel of shaft i
Z_{2i}	wheel load of the 2nd wheel of shaft i
Z_a	actual coefficient of utilization of the rope/chain
Z_j	vertical wheel force of wheel j
Z_j	wheel load of wheel j , ($Z_j \geq 0$), ($j = 1, 2 \dots n$ with n = number of wheels) The trolley carries maximum load. The trolley should be positioned on the crane's side, which has no guide means.
α	skewing angle in radian
α	triggering-factor [-]
α_g	skew component due to track clearance
α_w	component due to wear
α_t	component due to alignment tolerances of rail/wheel
$\Delta\alpha$	additional skewing angle due to flexible deformation
$(\dot{\alpha} / \dot{x})$	portal turning speed per travel speed
ϕ_{DAL}	force-limit factor for direct acting lifting force limiters
ϕ_{IAL}	force-limit factor for indirect acting lifting force limiters
ϕ_5	amplification factor for dynamic loads arising from acceleration of crane drives
ϕ_p	factor for effect of sequential positioning movements
μ_0	adhesion factor

Table 1 (continued)

Symbol	Description
$\mu_f(\sigma_j)$	friction coefficient of wheel j by lateral slip σ_j
μ_f	friction slip coefficient (f in ISO 8686-1:2012)
σ_j	lateral slip of wheel j
σ	slip factor

5 Loads and applicable factors

5.1 Regular loads

5.1.1 General

Regular loads, occurring during normal operation, shall be considered in proof of competence calculations against failure by yielding, elastic instability and, when applicable, against fatigue in accordance with ISO 8686-1:2012, 6.1 and the following amendments.

5.1.2 Hoisting and gravity effects acting on the mass of the crane

The gravitational force induced by the mass of the crane (dead weight) shall be multiplied by a factor ϕ_1 , as shown in [Formula \(1\)](#):

$$\phi_1 = 1 + \alpha \quad (1)$$

For masses with unfavourable gravitational load effect, the factors shall be taken as $\alpha = 0,10$ and $\phi_1 = 1,10$, and for masses with favourable gravitational load effect as $\alpha = -0,05$ and $\phi_1 = 0,95$, unless other values are obtained by measurements or calculations.

Where cranes work in atmospheres contaminated by process debris, such material accumulations deposited upon the upper surfaces of the crane shall be taken into account in the dead load computation.

5.1.3 Hoisting an unrestrained grounded load

5.1.3.1 General

The hoist load shall be multiplied by factor ϕ_2 that represents the additional dynamic force applied on the crane, when the weight of a grounded load is transferred on the hoisting medium (ropes or chains).

When assuming the most extreme conditions, the hoisting medium is slack while the hoist mechanism reaches its maximum hoisting speed. In this condition, the dynamic additional force is directly proportional to the hoisting speed, with a coefficient that depends upon the stiffness properties and mass distribution of the crane (β_2 in ISO 8686-1:2012, 6.1.2.1.1).

In physical crane operation, there are other factors that influence the actual dynamic effect, such as control systems, dampening and flexibility of other than main components (e.g. hoist slings, other lifting devices, load itself, crane foundation). These dependencies and determination of factor ϕ_2 are represented by hoisting classes in ISO 8686-1:2012, 6.1.2.1.2.

For determination of ϕ_2 , the following principles shall be used:

- calculation by selection of a hoisting class;
- determination by alternative methods, see [5.1.3.5](#).

The hoisting class and the factor ϕ_2 shall be calculated either

- in accordance with ISO 8686-1:2012, 6.1.2.1.2, or
- in accordance with 5.1.3.2 to 5.1.3.4.

The hoisting speed used for the determination of the dynamic coefficient shall reflect the actual use and possible exceptional events of the crane in a realistic way. Two events shall be considered as follows:

- crane in normal use where hoisting commences at a mechanism controlled speed from a slack rope condition — load combination A and B as per ISO 8686-1:2012, Table 2b;
- exceptional case where hoisting commences at mechanism maximum speed from slack rope condition — load combination C as per ISO 8686-1:2012, Table 2b.

5.1.3.2 Determination of a dynamic factor, ϕ_{2t}

The determination of a hoisting class as defined in ISO 8686-1 shall be selected by the theoretical dynamic factor, ϕ_{2t} . It shall be estimated in one of the following ways.

- Make a complete dynamic simulation taking into account the elastic, inertial and dampening properties. The maximum force in the hoisting medium during time of the first 3 s represents the hoist load multiplied by factor ϕ_{2t} .
- Use one of the simplified [Formulae \(2\)](#) applicable to the hoist.

a) for a crane with a rope hoist

$$\phi_{2t} = 1 + \frac{2,8 \times v_{h,max}}{0,45 + \left(\frac{R_r \times l_r}{1500 \times Z_a} \right)^{1/2}}$$

b) for a crane with a chain hoist

$$\phi_{2t} = 1 + \frac{2,8 \times v_{h,max}}{0,45 + \left(\frac{f_{uc} \times l_c}{150 \times Z_a} \right)^{1/2}} \quad (2)$$

where

$v_{h,max}$ is the maximum steady hoisting speed in metres/second;

R_r is the rope grade, in N/mm²;

f_{uc} is the ultimate strength of the chain steel, in N/mm²;

l_r, l_c is the length of rope/chain fall in metres;

Z_a is the actual coefficient of utilization of the rope/chain (total breaking force of the rope/chain reeving system/hoist load).

The length, l_r/l_c , shall be taken as the typical distance between the upper and lower rope sheaves/chain sprockets, when hoisting a grounded load. Where a loaded part or all of the hoist media deviates from the vertical, the length of the rope/chain fall shall be adjusted to give the equivalent flexibility in vertical direction.

NOTE This simplified formula takes into account the rigidity and the masses of the crane parts and load.

The hoisting class shall be determined in accordance with [Table 2](#).

Table 2 — Selection of hoisting class

Condition for calculation result			Hoisting class of ISO 8686-1:2012
	$\phi_{2t} \leq$	$1,07 + 0,24 \times v_{h,max}$	HC1
$1,07 + 0,24v_{h,max}$	$< \phi_{2t} \leq$	$1,12 + 0,41 \times v_{h,max}$	HC2
$1,12 + 0,4v_{h,max}$	$< \phi_{2t} \leq$	$1,17 + 0,58 \times v_{h,max}$	HC3
$1,17 + 0,58v_{h,max}$	$< \phi_{2t}$		HC4

5.1.3.3 Selection of hoisting speed

The hoisting speed representing the normal use in load combinations A and B, and an exceptional occurrence in load combination C, shall be selected according to the hoist drive class, HD, provided by the system and ISO 8686-1:2012, Table 2b.

5.1.3.4 Calculation of factor, ϕ_2

The factor ϕ_2 shall be calculated in accordance with ISO 8686-1:2012, 6.1.2.1.2, using the selected hoisting class and speed determined in 5.1.3.2 and 5.1.3.3.

5.1.3.5 Determination of ϕ_2 by testing

The dynamic factor, ϕ_2 , can also be determined by measurement from an equivalent crane. The values measured with different hoisting speeds shall be directly used in calculations, without reference to a hoisting class.

The dynamic increment of deflections found by measurement or dynamic simulation may include the dynamic effects from the mass of the crane including the trolley; see 5.1.2. The portion represented by the factor a could be removed from the evaluation of the final ϕ_2 to avoid it being considered twice in ϕ_1 and also in ϕ_2 .

5.1.4 Loads caused by travelling on an uneven surfaces

The dynamic effects on the crane by travelling, with or without hoist load, on or off roadway or on rail tracks shall be considered by the specific factor, ϕ_4 .

For continuous rail tracks or welded rail tracks with finished ground joints without notches (steps or gaps) the specific factor $\phi_4 = 1,0$.

For roadways or rail tracks with notches (steps or gaps), the specific factor, ϕ_4 , shall be calculated according to ISO 8686-1. For rubber tyred cranes, the flexibility of the tyre shall be taken into account.

5.1.5 Loads caused by acceleration of drives

For crane drive motions, the change in load effect, ΔS , caused by acceleration or deceleration is presented by Formula (3):

$$\Delta S = S_{(f)} - S_{(i)} \quad (3)$$

where

$S_{(f)}$ is the final load effect;

$S_{(i)}$ is the initial load effect.

NOTE The change in load effects, ΔS , is caused by the change of drive force, ΔF , given by the formula: $\Delta F = F_{(f)} - F_{(i)}$, where $F_{(f)}$ is the final drive force and $F_{(i)}$ is the initial drive force.