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## **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 charge —*

*Partie 5 : Ponts roulants et ponts portiques*



Reference number  
ISO 8686-5 : 1992 (E)

## Foreword

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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.

International Standard ISO 8686-5 was prepared by Technical Committee ISO/TC 96, *Cranes*, Sub-Committee SC 9, *Bridge and gantry cranes*.

ISO 8686 consists of the following parts, under the general title *Cranes — Design principles for loads and load combinations*:

- *Part 1: General*
- *Part 2: Mobile cranes*
- *Part 4: Jib cranes*
- *Part 5: Overhead travelling and portal bridge cranes*

*The design principles for loads and load combinations of tower cranes will form the subject of ISO 8686-3.*

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# Cranes — Design principles for loads and load combinations —

## Part 5:

## Overhead travelling and portal bridge cranes

### 1 Scope

This part of ISO 8686 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 standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 8686. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 8686 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 4302 : 1981, *Cranes — Wind load assessment*.

ISO 4306-1 : 1990, *Cranes — Vocabulary — Part 1: General*.

ISO 4310 : 1981, *Cranes — Test code and procedures*.

ISO 8306 : 1985, *Cranes — Overhead travelling cranes and portal bridge cranes — Tolerances for cranes and tracks*.

ISO 8686-1 : 1989, *Cranes — Design principles for loads and load combinations — Part 1: General*.

### 3 Definitions

For the purposes of this part of ISO 8686, the definitions given in ISO 8686-1 apply.

### 4 Symbols

The symbols used in this part of ISO 8686 are defined in ISO 8686-1.

### 5 Application of $\phi$ factors

**5.1** The numerical values for different  $\phi$  factors are given in table 1.

Table 1 — Loads and load combinations

| 1                                           | 2                                                                                | 3                                          |          |          |          | 4                   |                                 |          |          | 5                   |          |      |                                 |    |          |          |    | 6        |    |          |    |      |    |    |
|---------------------------------------------|----------------------------------------------------------------------------------|--------------------------------------------|----------|----------|----------|---------------------|---------------------------------|----------|----------|---------------------|----------|------|---------------------------------|----|----------|----------|----|----------|----|----------|----|------|----|----|
| Categories of loads                         | Loads, $f_i$                                                                     | Load combinations A                        |          |          |          | Load combinations B |                                 |          |          | Load combinations C |          |      |                                 |    |          |          |    | Line No. |    |          |    |      |    |    |
|                                             |                                                                                  | Partial load factors $\gamma_p$            | A1       | A2       | A3       | A4                  | Partial load factors $\gamma_p$ | B1       | B2       | B3                  | B4       | B5   | Partial load factors $\gamma_p$ | C1 | C2       | C3       | C4 |          | C5 | C6       | C7 | C8   |    |    |
| Regular<br>(see ISO 8686-1 : 1989, 6.1)     | Gravitation, acceleration, impacts                                               | 1,16                                       | $\phi_1$ | $\phi_1$ | 1        | —                   | 1,1                             | $\phi_1$ | 1        | —                   | —        | 1,05 | $\phi_1$                        | 1  | $\phi_1$ | 1        | 1  | 1        | 1  | 1        | 1  | 1    | 1  |    |
|                                             | Mass of the gross load                                                           | 1,34                                       | $\phi_2$ | $\phi_3$ | 1        | —                   | 1,28                            | $\phi_2$ | $\phi_3$ | 1                   | —        | 1,22 | $\eta$                          | —  | 1        | 1        | 1  | 1        | 1  | 1        | 1  | 1    | 2  |    |
|                                             | Masses of lifting appliance and hoist load, travelling on an uneven surface      | 1,16                                       | —        | —        | —        | $\phi_4$            | 1,1                             | —        | —        | $\phi_4$            | $\phi_4$ | 1,05 | —                               | —  | —        | —        | —  | —        | —  | —        | —  | —    | 3  |    |
|                                             | Acceleration from drives                                                         | Masses of lifting appliance and gross load | 1,55     | $\phi_5$ | $\phi_5$ | —                   | —                               | 1,48     | $\phi_5$ | $\phi_5$            | —        | —    | 1,41                            | —  | —        | $\phi_5$ | —  | —        | —  | —        | —  | —    | —  | 4  |
| —                                           |                                                                                  |                                            |          | —        | $\phi_5$ | $\phi_5$            | —                               |          | —        | $\phi_5$            | $\phi_5$ | —    |                                 | —  | —        | —        | —  | —        | —  | —        | —  | —    | —  | —  |
| Occasional<br>(see ISO 8686-1 : 1989, 6.2)  | Displacements                                                                    | 1,16                                       | 1        | 1        | 1        | 1                   | 1,1                             | 1        | 1        | 1                   | 1        | 1,05 | 1                               | 1  | 1        | 1        | 1  | 1        | 1  | 1        | 1  | 1    | 1  | 6  |
|                                             | Effects of climate                                                               | 1) In-service wind loads                   |          |          |          |                     | 1,16                            | 1        | 1        | 1                   | 1        | 1    | 1,1                             | —  | —        | —        | 1  | —        | —  | —        | —  | —    | —  | 7  |
|                                             |                                                                                  | 2) Snow and ice loads                      |          |          |          |                     |                                 | 1,34     | 1        | 1                   | 1        | 1    | 1,28                            | —  | 1        | —        | —  | —        | —  | —        | —  | —    | —  | 8  |
|                                             |                                                                                  | 3) Temperature variations                  |          |          |          |                     |                                 | 1,1      | 1        | 1                   | 1        | 1    | 1,05                            | —  | 1        | —        | —  | —        | —  | —        | —  | —    | —  | 9  |
| Exceptional<br>(see ISO 8686-1 : 1989, 6.3) | Skewing                                                                          |                                            |          |          |          |                     | 1,16                            | —        | —        | —                   | —        | —    | —                               | —  | —        | —        | —  | —        | —  | —        | —  | —    | 10 |    |
|                                             | 1) Hoisting a grounded load<br>(see ISO 8686-1 : 1989, 6.1.2.2.2)                |                                            |          |          |          |                     |                                 |          |          |                     |          | 1,22 | $\hat{\phi}_2$                  | —  | —        | —        | —  | —        | —  | —        | —  | —    | 11 |    |
|                                             |                                                                                  | 2) Out-of-service wind loads               |          |          |          |                     |                                 |          |          |                     |          |      | 1,22                            | —  | 1        | —        | —  | —        | —  | —        | —  | —    | —  | 12 |
|                                             |                                                                                  | 3) Test loads                              |          |          |          |                     |                                 |          |          |                     |          |      | 1,22                            | —  | —        | $\phi_6$ | —  | —        | —  | —        | —  | —    | —  | 13 |
|                                             | 4) Buffer forces                                                                 |                                            |          |          |          |                     |                                 |          |          |                     |          | 1,41 | —                               | —  | —        | $\phi_7$ | —  | —        | —  | —        | —  | —    | 14 |    |
|                                             | 5) Tilting forces                                                                |                                            |          |          |          |                     |                                 |          |          |                     |          | 1,41 | —                               | —  | —        | —        | 1  | —        | —  | —        | —  | —    | 15 |    |
|                                             | 6) Emergency cut-out                                                             |                                            |          |          |          |                     |                                 |          |          |                     |          | 1,41 | —                               | —  | —        | —        | —  | $\phi_5$ | —  | —        | —  | —    | 16 |    |
|                                             | 7) Failure of mechanism or components                                            |                                            |          |          |          |                     |                                 |          |          |                     |          | 1,41 | —                               | —  | —        | —        | —  | —        | —  | $\phi_5$ | —  | —    | 17 |    |
|                                             | 8) External excitation of the lifting appliance foundation                       |                                            |          |          |          |                     |                                 |          |          |                     |          | 1,41 | —                               | —  | —        | —        | —  | —        | —  | —        | —  | —    | 18 |    |
|                                             | Strength coefficient $\gamma_f$                                                  |                                            |          |          |          | 1,48                |                                 |          |          |                     | 1,34     |      |                                 |    |          |          |    |          |    |          |    | 1,22 | 19 |    |
|                                             | Resistance coefficient $\gamma_m$                                                | 1,1                                        |          |          |          |                     | 1,05                            |          |          |                     |          |      | 1                               |    |          |          |    |          |    |          |    |      | 20 |    |
|                                             | Coefficient for high-risk applications $\gamma_n$ (see ISO 8686-1 : 1989, 7.3.6) |                                            |          |          |          |                     |                                 |          |          |                     |          |      |                                 |    |          |          |    |          |    |          |    |      | 21 |    |

5.2 The  $\phi_n$  factors for dynamic effects which are used for load combinations shown in table 1 are given in table 2.

Table 2 —  $\phi_n$  factors

| Table 1 line No. | $\phi_n$       | Reference to ISO 8686-1:1989 | Values for factors $\phi_n$ , or values for loads, or relevant International Standards                                                                                                                                                                                                                                              |
|------------------|----------------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                | $\phi_1$       | 6.1.1                        | $\phi_1 = 1 \pm a$ , $a = 0,1$                                                                                                                                                                                                                                                                                                      |
| 2                | $\phi_2$       | 6.1.2.2                      | ISO 8686-1:1989, hoisting classes                                                                                                                                                                                                                                                                                                   |
|                  | $\phi_3$       | 6.1.2.3                      | ISO 8686-1                                                                                                                                                                                                                                                                                                                          |
| 3                | $\phi_4$       | 6.1.3.2 and annex D          | The value of $\phi_4$ shall be estimated as shown in ISO 8686-1:1989, annex D, if there are steps or gaps between the rails                                                                                                                                                                                                         |
| 4 and 5          | $\phi_5$       | 6.1.4 and annex E            | When using rigid body kinetic models:<br>$\phi_5 = 1,2$ if the acceleration and braking forces are changed with stepless control systems without backlash<br>$\phi_5 = 1,5$ in other control systems where the drive forces are acting on the crane practically free of backlash<br>$\phi_5 = 2$ where considerable backlash exists |
| 6                |                | 6.1.5                        | When a displacement remains within the limiting value specified in ISO 8306, its effect can be neglected in the stress analysis                                                                                                                                                                                                     |
| 7                |                | 6.2.1.1                      | ISO 4302                                                                                                                                                                                                                                                                                                                            |
| 8                |                | 6.2.1.2                      | Regional snow- and ice-load conditions                                                                                                                                                                                                                                                                                              |
| 9                |                | 6.2.1.3                      | Ambient and localized temperature variations                                                                                                                                                                                                                                                                                        |
| 10               |                | 6.2.2                        | ISO 8686-1:1989, annex F, may be used for guidance                                                                                                                                                                                                                                                                                  |
| 11               | $\hat{\phi}_2$ | 6.1.2.2.2                    | ISO 8686-1:1989, hoisting classes                                                                                                                                                                                                                                                                                                   |
| 12               |                | 6.3.1                        | ISO 4302                                                                                                                                                                                                                                                                                                                            |
| 13               | $\phi_6$       | 6.3.2                        | ISO 8686-1 and ISO 4310                                                                                                                                                                                                                                                                                                             |
| 14               | $\phi_7$       | 6.3.3                        | ISO 8686-1                                                                                                                                                                                                                                                                                                                          |
| 15               |                | 6.3.4                        | ISO 8686-1                                                                                                                                                                                                                                                                                                                          |
| 16               | $\phi_5$       | 6.3.5                        | $\phi_5 = 2$                                                                                                                                                                                                                                                                                                                        |
| 17               | $\phi_5$       | 6.3.6                        | $\phi_5 = 2$                                                                                                                                                                                                                                                                                                                        |
| 18               |                | 6.3.7                        | ISO 8686-1                                                                                                                                                                                                                                                                                                                          |

## 6 Hoisting classes

Some examples for the selection of hoisting classes according to ISO 8686-1:1989, 6.1.2.1, are given in table 3.

Table 3 — Examples

| Type of crane                                                                                      | Hoisting class                                              |
|----------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| Manual cranes                                                                                      | HC <sub>1</sub>                                             |
| Power station cranes<br>Erection cranes<br>Workshop cranes                                         | HC <sub>2</sub> /HC <sub>3</sub>                            |
| Ship unloaders<br>Stockyard cranes                                                                 | } with lifting beams, hooks or spreaders<br>HC <sub>3</sub> |
| Ship unloaders<br>Stockyard cranes                                                                 |                                                             |
| Ship unloaders<br>Stockyard cranes                                                                 | } with grabs or magnets<br>HC <sub>3</sub> /HC <sub>4</sub> |
| Ladle cranes<br>Open-hearth furnace charging cranes<br>Ingot charging cranes<br>Soaking pit cranes |                                                             |
| Stripper cranes<br>Forge cranes                                                                    | HC <sub>4</sub>                                             |

The examples given in table 3 represent typical applications, structural designs and hoist control systems. More flexible load bearing systems and more sophisticated speed control systems may allow the selection of a lower hoisting class than indicated in table 3. There may be cases where a higher hoisting class is appropriate.

## 7 Combination of acceleration effects

In the case of overhead travelling and portal bridge cranes, the load is moved by hoisting (H), travelling (Lt), traversing (Ct) and, possibly, by slewing (Sl) mechanisms. (See figure 1.)

The acceleration effects of these mechanisms acting simultaneously on the crane depend on the control systems and service conditions of the crane and whether a load is hoisted from the ground or a suspended load is hoisted.

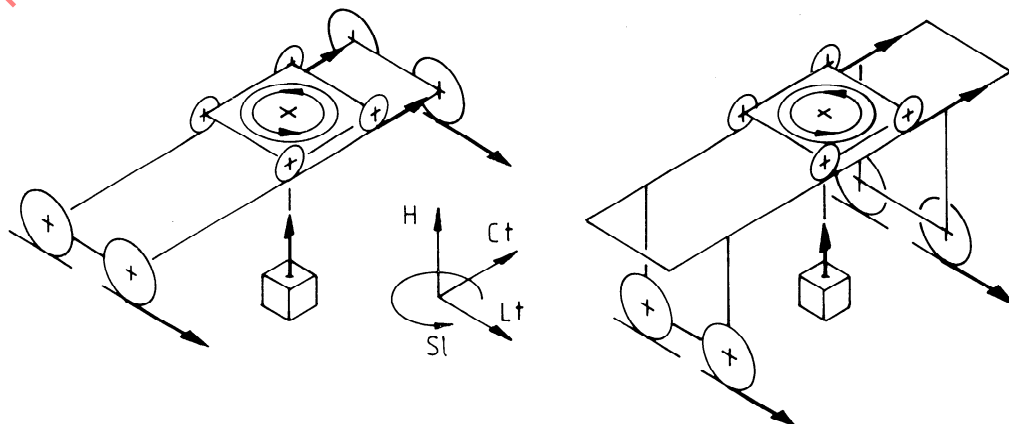


Figure 1

Taking the above into account, the accelerations given in table 4 are assumed to be acting simultaneously.

The gross loads shall be multiplied within the individual load combinations by the following factors:

- load combinations A1 and B1:  $\phi_2$
- load combinations A2 and B2:  $\phi_3$
- load combinations A3 and B3:  $\left(1 + \phi_5 \times \frac{\Delta F}{mg}\right)$
- load combinations A4 and B4:  $\phi_4$
- load combination C3:  $\phi_6$

Drive forces can change significantly in a short time interval. Thus the accelerations shall be calculated

- a) for starting the movement,

- b) for braking the steady-state movement, and

- c) for braking the movement during the starting process, or

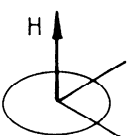
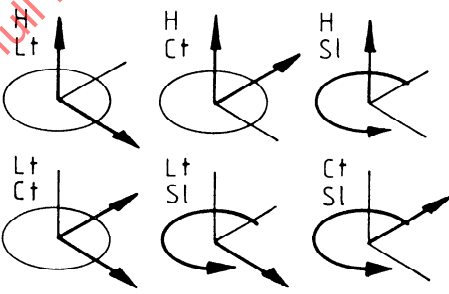
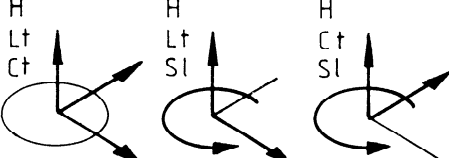
- d) for accelerating the movement during the braking process (positioning).

Thus the calculated rigid body acceleration forces shall be multiplied by the factor  $\phi_5$  in accordance with ISO 8686-1:1989, 6.1.4.

When considering the positioning effects, only one such effect is combined with other movements.

In load combination C6 or C7, only the dynamic effects of the "emergency cut-out" or of the "failure of mechanism or components" shall be considered without other dynamic effects, assuming the case of starting during steady-state motion.

Table 4 — Combination of acceleration effects

|                                                               | Hoisting a grounded load<br>Load combinations A1, B1, C1                                                                                                                   | Hoisting a suspended load<br>Load combinations A2 to A4, B2 to B4, C3                |
|---------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Control by push-button panel or bi-directional control levers |                                                                                         |   |
| Control by multi-directional control levers                   | Power station cranes<br>Erection cranes<br>Workshop cranes                                                                                                                 | Power station cranes<br>Erection cranes<br>Workshop cranes                           |
|                                                               | Ship unloaders<br>Stockyard cranes<br>Steel mill cranes                                                                                                                    | Ship unloaders<br>Stockyard cranes<br>Steel mill cranes                              |
|                                                               | <br> |  |