INTERNATIONAL STANDARD

ISO 22986

First edition
2007-04-15

Cranes — Stiffness — Bridge and gantry cranes

Appareils de levage à charge suspendue — Rigidité — Ponts et portiques roulants

Reference number
ISO 22986:2007(E)

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 22986 was prepared by Technical Committee ISO/TC 96, *Cranes*, Subcommittee SC 9, *Bridge and gantry cranes*.

Cranes — Stiffness — Bridge and gantry cranes

1 Scope

This International Standard gives recommendations and requirements for the stiffness properties of the structures for bridge and gantry cranes in terms of deflections and natural frequencies.

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 4306-1, *Cranes — Vocabulary — Part 1: General*

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

3 Terms and definitions

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

4 Requirements

4.1 General

The effect of flexibility is demonstrated as elastic deformations under load and as vibrations induced by motion or force transients.

Excessive flexibility of structures and mechanical components of cranes can affect their safe use; therefore, elastic deformations and vibrations should be limited so that they do not cause dangerous situations, nor prevent the crane from being used in the intended manner.

The requirements concerning the elastic deformations and vibrations depend upon the configuration of the crane and stem from the required accuracy of load handling, type and performance of the control system and location of the control station. However, the increased stiffness means increased investment costs and possibly larger space requirements, which may not be worthwhile in all applications. Furthermore, possibilities to eliminate flexibility depend very much on the type and configuration of the crane. Therefore, no exact limits are given for the deflections or the vibrations.

4.2 Basic requirements for elastic deformation

The elastic deformations of the crane structure shall not

a) cause collision of the crane or crab/trolley with other surrounding objects and structures,

b) prevent the crab/trolley from moving and braking with the designed drive/braking system with any load not exceeding the dynamic test load,

c) prevent the crab/trolley from remaining safely at a position with any load not exceeding the static test load,

d) cause excessive transverse forces to the crane rails and tracks or prevent the crane from moving,

e) cause misalignment of the mechanical drives in such a way that would cause, for example, unacceptable life of components, excessive vibration, wear or brake failure.

Guidance on recommended maximum deflection of simply supported girders is given in Annex A.

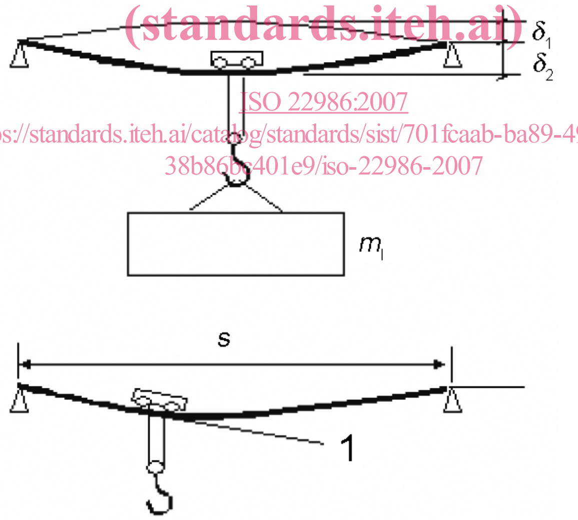
5 Recommendation for pre-camber of girders

Since pre-cambering has no effect on the strength of the girder, no specific requirements are given.

In order to assist in meeting the requirement of 4.2 b), the crane girder may be pre-cambered in such a way that the range of slope (difference of the maximum and minimum slopes) is divided into approximately equal positive and negative parts or so that the extreme values of slopes are decreased (see Figure 1).

The slope of the girder should be considered in the position where it has maximum value, with the crab on the same position, taking into account other possible crabs and their loads.

Other possible reasons for pre-cambering are the appearance of the crane or compensation of some permanent deformation of a welded girder after test loading.



Key

δ_1 pre-camber plus deflection due to girder weight

$\delta_1 + \delta_2$ maximum static deflection due to crab/trolley weight plus gross hoist load

s span

m_l hoist load mass

1 maximum slope

Figure 1 — Deflections and slope

6 Recommendations on vibrational frequencies of crane girders

6.1 Effects on operator

In order to avoid uncomfortable vibrations for the operator in cabin, the natural frequency of the structure carrying the cabin should not be less than 2 Hz for vertical vibration. For long spans this limit might be too difficult to meet with economically feasible stiffness. Therefore, lower frequencies are permitted, but amplitude and duration of vibrations should be minimized by using stepless controls and smooth speed transitions. Informative guide values of lowest frequencies are given in Annex B.

For gantry cranes in process duty the frequency of horizontal vibrations should be not less than 0,50 Hz for vibrations caused by the main operating movement of the crane (e.g. trolley travel direction of ship unloaders and ship-to-shore container cranes).

6.2 Effects on structure and operation

The effect of vibration on bridge crane structures and crane operation can be reduced by controlling the stiffness of the girder.

Typical values representing current experience on bridge crane installations are given in Annexes A and B.

NOTE Damping at higher frequencies is greater than at lower ones.

6.3 Guideline for proportions of welded box girders

The dimensional proportions of the box girders of bridge cranes should meet the following limits:

— $s/h < 25$;

— $s/b < 65$ for step control of travel;

— $s/b < 80$ for stepless control of travel.

Where

s is the span;

h is the height of girder (to flange midline) (see Figure 2);

b is the width of girder (to web midline) (see Figure 2).

The proportions should also be applied to the spans of gantry cranes.

For gantry cranes with cantilevers, the s/b limits should be applied so that s represents the whole length of the girder, including cantilevers, unless the legs provide adequate stiffening effect.

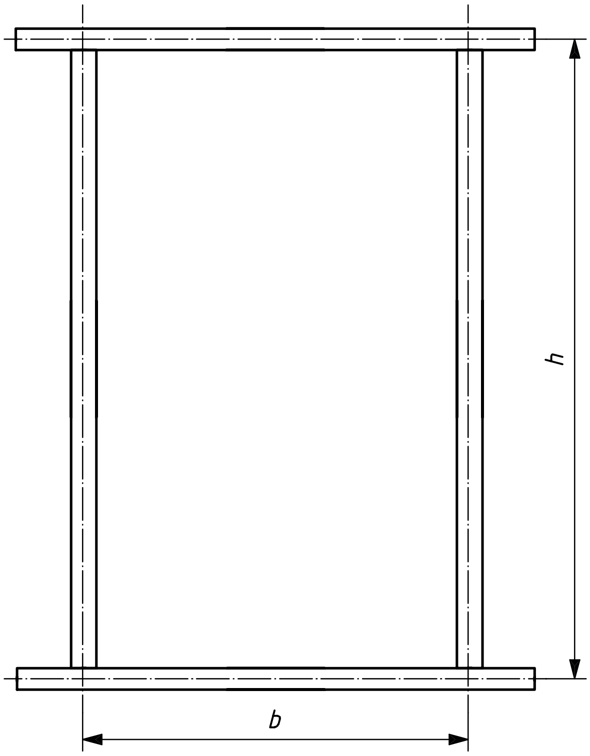


Figure 2 — Girder dimensions b and h

Annex A
(informative)

Guidance on maximum deflection of girders

The crane design should be characterized by a stiffness index, I_s, which is the span (s) divided by the maximum static deflection, δ_{stat}, due to the trolley and the hoist load:

$$I_s = \frac{s}{\delta_{stat}}$$

Table A.1 presents the range of stiffness index values considered acceptable for various operating regimes.

Table A.1 — Range of acceptable stiffness index values

Stiffness index I_s		
1 500		
	Zone A ↑	Zone A — Characteristic of cranes needing high positioning accuracy.
1 000		
	Zone B	Zone B — Characteristic of normal workshop cranes with medium positional accuracies which can use simple control systems.
750		
500	Zone C ↓	Zone C — Suitable for low positioning accuracies or with special features such as stepless control; low hoisting speeds and accelerations may be used to achieve acceptable positioning accuracies.
250		