INTERNATIONAL STANDARD

ISO 11662-2

First edition
2014-11-01

Mobile cranes — Experimental determination of crane performance —

Part 2: Structural competence under static loading

Grues mobiles — Détermination expérimentale des performances des grues —

Partie 2: Compétence structurale sous le chargement statique

Reference number
ISO 11662-2:2014(E)

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).

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

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 96, *Cranes*, Subcommittee SC 6, *Mobile Cranes*.

ISO 11662 consists of the following parts, under the general title *Mobile cranes — Experimental determination of crane performance*:

— *Part 1: Tipping loads and radii*

— *Part 2: Structural competence under static loading*

Introduction

When design calculations are made for mobile cranes, they are based on an ideal model in which all members and components are perfectly straight and fabrication has been exact. For tension members and members subjected to bending, the difference between the real crane and the ideal model is usually not significant. But, for compression members subject to column buckling, an allowance for deviation in straightness and fabrication is necessary.

When mobile cranes are tested non-destructively by means of strain gauges, the stresses determined intrinsically include these effects of deviations in straightness and accuracy of fabrication.

This test method is intended to describe the approximate maximum loading conditions to which any component of the entire load-supporting structure of a crane is subjected (See Annex D). In some cases, a more severe loading condition(s) can be indicated by analysis. In these cases, the more severe condition(s) can be added to or substituted for the specified test loading condition(s). This test method also classifies stress areas as Types I (Uniform Stress Areas), II (Stress Concentration Areas), III (Column Buckling Areas), and IV (Local Plate Buckling Areas; see Clause 10), and defines limits for each class. Results can be used to correlate boom system calculation results for Class III stress areas as given by boom system calculations. Test results for Class I stress areas throughout the structure can be used to check any available calculations. This test method evaluates Class II stress areas for which calculations are seldom available. Class IV stress areas, where disproportionately high stress readings can occur, can be reviewed for better insight by calculation methods.

A production boom system that has been rated by the methods of this part of ISO 11662 can be used on another machine without re-testing by the methods specified herein, provided the same analytical procedure shows its stress levels will be less than or equal to the stress levels in the original application, and provided that the supporting structure is as rigid as the original mounting. Rigidity of the supporting structure is determined by the change in the slope of the jib foot axis as test loads are applied.

Mobile cranes — Experimental determination of crane performance —

Part 2:
Structural competence under static loading

1 Scope

This part of ISO 11662 applies to mobile construction-type lifting cranes utilizing

a) rope supported, lattice boom attachment or lattice boom, and fly jib attachment (see Annex E, Figure E.3),

b) rope supported, mast attachment and mast mounted boom, and fly jib attachment (see Annex E, Figures E.1 and E.2), or

c) telescoping boom attachment or telescopic boom and fly jib attachment (see Figure E.4).

Mobile crane manufacturers can use this part of ISO 11662 to verify their design for the mobile crane types illustrated in Figures E.1 through E.4.

This test method is to provide a systematic, non-destructive procedure for determining the stresses induced in crane structures under specified conditions of static loading through the use of resistance-type electric strain gauges, and to specify appropriate acceptance criteria for specified loading conditions.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9373:1989, *Cranes and related equipment — Accuracy requirements for measuring parameters during testing*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
strain
relative elongation or compression of material at any given point with respect to a specific plane passing through that point, expressed as change in length per unit length (m/m)

3.2
stress
S
internal force per unit area resulting from strain, expressed in pascals (Pa) or newtons/square meter

Note 1 to entry: For this document, megapascals (Mpa) will be used for brevity.

3.3
yield point
S_y
stress at which a disproportionate increase in strain occurs without a corresponding increase in stress

Note 1 to entry: For purposes of this code, yield point is to be considered as the minimum 0,2 % offset tensile yield point or yield strength specified by the appropriate standard for the material used.

3.4
critical buckling stress
S_{cr}
average stress which produces an incipient buckling condition in column-type members (See Annex C)

3.5
initial reference test condition
defined no-stress or zero-stress condition of the crane structure after the “break-in” as established by

a) supporting the structure on blocking to minimize the effects of gravity, or

b) the crane structure components in an unassembled state or any alternate method that will establish the zero-stress condition. Under this condition, the initial reference reading for each gauge is obtained, N_1

3.6
dead load stress condition
completely assembled crane structure on the test site and in the position or attitude, ready to apply the specified live load at the specified radius

Note 1 to entry: Under this condition, the second reading for each gauge is obtained, N_2.

Note 2 to entry: The hook, hook block, slings, etc. are considered part of the suspended load but may be supported by the crane when this reading is taken. For dead load purposes, the hook in the “home” position – suspended from the crane without lifting the test load. This position has to be repeated after placing the load back on the ground (see 9.4.4).

3.7
dead load stress
S_1
stress computed as defined in Clause 10 by using the difference in the readings obtained in 3.6 and 3.5 for each gauge ($N_2 - N_1$)

3.8
working load stress condition
completely assembled crane structure on the test site and in the specified position, supporting the specified rated load

Note 1 to entry: Under this condition, the third reading for each gauge is obtained, N_3.

3.9
working load stress
S_2
stress computed as defined in Clause 10 by using the difference in the readings obtained in 3.8 and 3.5 for each gauge ($N_3 - N_1$)

3.10
resultant stress
S_r
stress induced in the structure as a result of dead load stress (S_1) or the working load stress (S_2), whichever is greater in absolute magnitude

3.11
column average stress
S_{ra}
direct compression stress in a column or the average stress computed from several gauges located at the section (see Annex B)

3.12
column maximum stress
S_{rm}
maximum compression stress in a column computed from the plane of buckling as established from several gauges located at the section (see Annex B)

3.13
loadings
application of weights and/or forces of the magnitude specified under the condition specified

3.14
load radius
horizontal distance between the axis of rotation of the turntable of the crane and the vertical axis of the hoist line or load block when the crane is erected on a level site

4 Symbols and abbreviated terms

E modulus of elasticity

K effective length factor for a column

L un-braced length of column

L_b length of boom

L_j length of fly jib

L_1 small arbitrary projected length of fly jib along x-axis

L_2 projected length of fly jib strut along y-axis

n strength margin

n_1 strength margin, Class I area, ratio of yield strength to resultant or equivalent stress

n_2 strength margin, Class II area, ratio of yield strength to resultant or equivalent stress

n_3 strength margin, Class III area, derived from an interaction relationship

N_1 strain reading at initial reference test condition

N_2 strain reading at dead load stress condition

N_3 strain reading at working load stress condition

r radius of gyration

RL rated load as specified by manufacturer

"R" plane (Figure 1) perpendicular to boom foot pin centreline (CL)

RR rated radius as specified by manufacturer

S stress

S_1 dead load stress

S_2 working load stress

S_{ra} column average stress computed from several gauges at a cross section

S_{cr} critical buckling stress for axially loaded columns

SL side load, i.e. 0,02 × RL;

%SL percentage of side load expressed as a percentage of rated load or %RL = Percentage of rated load

SLL side load left

SLR side load right

S_{rm} maximum compression stress in a column

S_p stress at the proportional limit

S_r resultant stress

S_{RC} maximum residual stress in compression

S_y stress at the yield point

S' equivalent uniaxial stress

t horiz. distance from the load centre to the front pad reaction centre for each box jib section

σ_0 tensile yield stress

σ_x maximum principal stress

σ_y minimum principle stress

Z' lattice boom tip slope (out of plane)

Z_b lattice boom tip deflection from plane “R”

Z_j fly jib tip deflection from plane “R”

Z_1 boom deflection at a point l_1 back from the boom tip

Z_2 fly jib strut deflection at its tip

α imperfection factor

β fly jib offset angle from centreline (CL) jib

ε strain

ε_a strain recorded from leg “a” of rosette

ε_b strain recorded from leg “b” of rosette

ε_c strain recorded from leg “c” of rosette

ε_d strain recorded from leg “d” of rosette

ε_x maximum principal strain

ε_y	minimum principal strain
μ	units of strain, 10^6
θ	fly jib tip rotation about x-axis (radians)
π	Pi = 3,1416
τ_0	shear yield stress
ν	Poisson's ratio
X	relative buckling stress (= S_{cr}/S_y)
$\bar{\lambda}_0$	initial relative slenderness
$\bar{\lambda}$	relative slenderness (= λ/λ_c)
λ	slenderness ratio (= KL/r)
λ_c	reference slenderness ratio $\left(=\pi\sqrt{E/S_y}\right)$
S_k	allowable buckling stress
S_{ci}	Euler's buckling stress
S_{ck}	Jager's buckling stress

5 Limitations

5.1 This method applies to load-supporting structures as differentiated from power transmitting mechanisms. It is restricted to measuring stresses under static conditions and a general observation after overload conditions.

5.2 Personnel competent in the analysis of structures and the use of strain-measuring instruments are required to perform the tests.

6 Method of loading

6.1 Suspended load

The specified load suspended at the specified radius and held stationary a short distance above the ground. The weight of the hook, block, slings, etc., shall be included as part of the specified suspended load.

6.2 Side load (*SL*)

When the test specification requires side loading, the force displacing the suspended load should be horizontal and perpendicular to the plane containing the axis of upper structure rotation and the centreline of the undeflected boom. The side load shall be applied in each direction. Side loading is applied to simulate the various effects associated with machine operation including a 9 m/s wind loading that might be encountered.

6.2.1 Lattice boom attachment

For lattice boom attachments, the side load that is to be applied for the conditions listed in Table C2 is as follows. The side load shall be applied as 2 % (0,02 *RL*) of the rated load in each direction.

6.2.2 Mast attachments

For mast attachments, the side load percentage that is to be applied in each direction at the load attachment point for the conditions listed in Table C1 is to be a minimum of 2 % (0,02 *RL*) of the rated load in each direction.

6.2.3 Telescoping boom attachment

For telescoping boom attachments, the side load that is to be applied for the conditions listed in Table C3 is as follows. The side load shall be applied as 3 % (0,03 *RL*) of the rated load in each direction with the boom over the end of the machine.

6.3 Deflection criteria

The usability of a latticed column [i.e. lattice boom and fly jib(s) combination] or a telescoping boom attachment is sometimes affected by the elastic stability of the overall column as well as of the individual members. Incipient out of plane elastic instability is indicated by excessive boom and/or fly jib tip deflection (sideways) as the attachment is side loaded when suspending a rated load. The following lateral deflection limits are therefore imposed.

6.3.1 Lattice boom attachments

The lateral deflection criteria for the rated load and side load of Table C2 are as follows. First, the deflection of the total boom and jib combination shall be less than or equal to 2 % of the total combination length. Furthermore, the deflection of each individual boom or fly jib member shall be less than or equal to 2 % of the length of that member. To satisfy these criteria, it should be noted that the deflection of an individual member does not include the deflection, rotation, or slope of the member to which it is mounted.

For a single fly jib mounted on a boom, the following relationship is given (Figure 1):

$$Z_j \leq 0{,}02 L_j + Z_b + Z'\left(L_j \cos\beta\right) + \theta\left(L_j \sin\beta\right) \quad (1)$$

The following values are measured.

Z_j fly jib tip deflection

Z_b lattice boom tip deflection

Z_1 lattice boom deflection at a distance L_1 down from the boom tip

Z_2 fly jib strut deflection at the tip

The following values are calculated.

Slope:

$$Z' = \left(Z_b - Z_1\right) / L_1 \tag{2}$$

Rotation:

$$\theta = \left(Z_b - Z_2\right) L_2 \tag{3}$$

If slope (Z') and rotation (θ) are not measured, the last two terms of Formula (1) may be deleted.