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Oil and gas industries including lower carbon energy — Bulk material for offshore projects — Monorail beam and padeye

Industries du pétrole et du gaz, y compris les énergies à faible teneur en carbone — Petits matériels pour projets Offshore — Poutres et oeilletons des monorails

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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This document was prepared by Technical Committee ISO/TC 67, *Oil and gas industries including lower carbon energy*, in collaboration with Technical Committee ISO/TC 8, *Ships and marine technology*, SC 8, *Ship design*.

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

This document aims to reduce the number and variations in requirements to the minimum necessary to reflect a common and global best practice based upon existing standards and regulations.

The main benefit of standard shapes and dimensions for monorail beams and padeyes is to gain a reduced delivery time, more streamlined and efficient engineering and construction as well as improved cross use of standardized monorail beams and padeyes between projects. The specified test methods are provided to verify by proof load test that the monorail beams and padeyes including foundation structures have the required load carrying capacity. The detailed test methods provided in this document aim to reduce overall testing time by early stage test and inspection, and to provide a consistent and proven approach to ensure structural strength of monorail beams and padeyes.

Oil and gas industries including lower carbon energy — Bulk material for offshore projects — Monorail beam and padeye

1 Scope

The purpose of this document is to provide a uniform standard for monorail beams and padeyes when these structures are designed and constructed in offshore projects.

This document specifies the design and material requirements for mechanical handling including monorail beams and padeyes during operations of offshore facilities. This document specifies the standard shapes and dimensions of monorail beams and padeyes and provides material requirements for these bulk materials.

This document is applicable to the structures of monorail beams and padeyes for topside systems for fixed or floating offshore projects.

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 2566-1, *Steel — Conversion of elongation values — Part 1: Carbon and low-alloy steels*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 7452, *Hot-rolled steel plates — Tolerances on dimensions and shape*

ISO 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

ISO 10474, *Steel and steel products — Inspection documents*

ISO 19902, *Petroleum and natural gas industries — Fixed steel offshore structures*

ANSI/AISC 360-10, *Specification for Structural Steel Buildings*

ASTM A370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

EN 10163-2, *Delivery requirements for surface condition of hot-rolled steel plates, wide flats and sections — Part 2: Plate and wide flats*

EN 10163-3, *Delivery requirements for surface condition of hot-rolled steel plates, wide flats and sections — Part 3: Sections*

EN 10204, *Metallic products — Types of inspection documents*

3 Terms, definitions and abbreviated terms

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 Terms and definitions

3.1.1
monorail beam
beam designed to support trolley hoists or other devices rolling directly on its bottom flange

3.1.2
padeye
lift point consisting essentially of a plate, reinforced by cheek plates if necessary, with a hole through which a shackle can be connected

Note 1 to entry: Padeye only covers material handling as repair and maintenance activity during operation and not construction activities, such as module lifting and block lifting.

[SOURCE: ISO 19901-6:2009, 3.63, modified — Note 1 to entry has been added.]

3.1.3
proof load test
production load test performed to validate the structural strength of *monorail beams* (3.1.1) and *padeyes* (3.1.2) including supporting structures

3.1.4
sampling test
conservative selection of *monorail beam* (3.1.1) or *padeye* (3.1.2) to ensure structural strength check considering variable design parameters, such as safety working load, size, shape and span

Note 1 to entry: To reduce actual load test, design verification is required to verify structural strength of monorail beams and padeyes.

3.2 Abbreviated terms

ASD	allowable stress design
CJP	complete joint penetration
DF	design factor
DAF	dynamic amplification factor
DLF	design load factor
LRFD	load and resistance factor design
MPI (MT)	magnetic particle inspection (magnetic particle test)
NDT (NDE)	non-destructive test (non-destructive examination)
PJP	partial joint penetration
PVC	polyvinyl chloride
SWL	safety working load
UT	ultrasonic test
VT	visual test
WPG	welded plate girder

4 Requirements and specifications for monorail beams

4.1 General

This clause specifies requirements for design and test of monorail beams made from rolled or built-up section as per material data sheets in Annex A. This specification applies to monorail beams and their components only; it does neither apply to supporting structures, to travelling trolleys and lifting appliances operating on the beams nor to crane gantries or rails.

Monorail beams should be designed to sufficiently support the loads from lifting equipment considering SWL and arrangement of supporting structures. The design shall be based on the loads and load effects, which are described by the manufacturer of the specific lifting equipment or described in 4.2, that are to be suspended by the monorail beams.

4.2 Design loads

Unless otherwise agreed or stated by the manufacturer of the lifting equipment, the following design loads apply:

a) The safety working load (SWL) for monorail beams shall be designed equal to or larger than the selected trolley hoist SWL.

b) Design load factor (DLF) shall be taken as per Table 1.

c) The information on trolley hoist self-weight provided by manufacturer shall be used for design.

d) The horizontal load shall be taken as minimum 10 % of the design load in longitudinal direction and 20 % of the design load in transverse direction acting in the lowest suspension point including DLF. Horizontal loads in both directions shall be applied simultaneously to the vertical design load.

Table 1 — Design load factor depending on SWL

SWL	DLF for LRFD	DLF for ASD
SWL ≤ 5 t	2,52	1,74
SWL > 5 t	2,18	1,51
NOTE 1 DLF for LRFD is based on DAF and DF.		
NOTE 2 DLF for ASD is converted from DLF for LRFD considering safety factor (0,6) and material resistance factor (1,15).		
NOTE 3 In the proposed DLF, the value of the dynamic amplification factor (DAF) has been taken as 1,5 for SWL up to and including 5 t, and 1,3 for SWL above 5 t.		
NOTE 4 Design factor (DF) is defined as partial load factor multiplied with consequence factor. For design of monorail beams, DF 1,68 is considered as single critical elements.		

4.3 Deflection

Vertical deformation, δ_{ver}, of a monorail beam shall be calculated under the SWL with trolley hoist self-weight as single load at middle of simple support or at end of cantilever (excluding load factors and self-weight of monorail beam). δ_{ver} shall conform to the following allowable values:

a) for simple support member with both side boundary as shown in Figure 1: $\delta_{ver} \leq L / 500$

b) for cantilever member: $\delta_{ver} \leq L / 250$

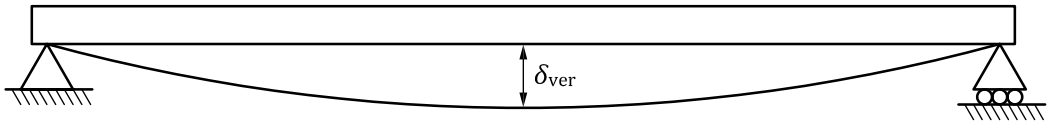


Figure 1 — Vertical deformation

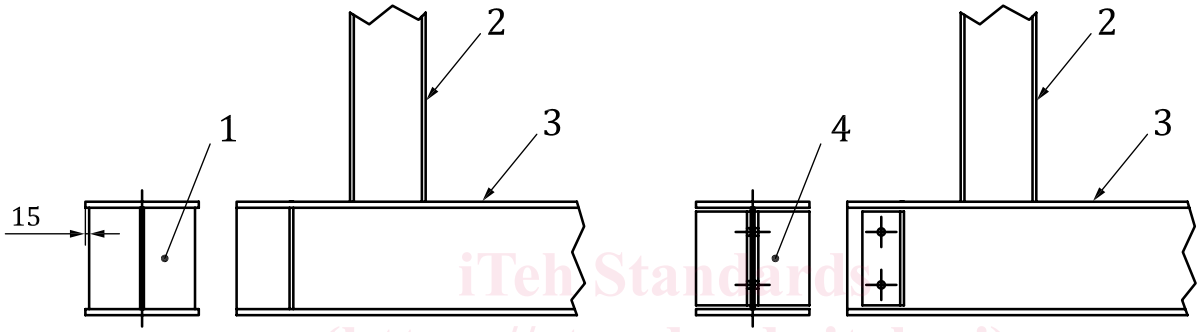
Any deformation requirement by manufacturer shall be additionally considered.

4.4 End stoppers

Monorail beam shall be provided with end stoppers on all open ends where the lifting equipment can become detached from the monorail beam. Either welded closed end or bolted type for maintenance shall be considered as end stoppers. The contact area of the end stoppers shall align with the part of the lifting equipment which is designed for such contact.

End stopper width shall be extended to the edge of the load bearing flange to prevent trolleys of any dimension, under any operating condition, from inadvertently passing the end stopper. For welded closed end stopper, end stopper width can be located at typically 15 mm from edge of flange as shown in Figure 2 a). The end stopper is generally installed as bolted type for easy installation and removal of trolley as shown in Figure 2 b).

Dimensions in millimetres



a) Closed type end stopper by welding **b) Bolted type end stopper**

Key

1 welded type end stopper
2 supporting structure
3 monorail beam
4 bolted type end stopper

Figure 2 — Example of end stopper

4.5 Fabrication

The detailed specification of dimensions and tolerances for monorail beams shall be as specified in Annex A.

Welded joints on the rolling surface of monorail beam shall be ground flush.

4.6 Painting and marking

Monorail beams shall be permanently marked with unique identification with any limiting conditions and SWL visible from floor level with font letters to be minimum 100 mm high. Monorail beams may be painted yellow, yellow with black stripe, white or any other colour which is noticeably different than the structural steel.

4.7 Material grade and design temperature

The design class of monorail beams shall be considered as DC4, in accordance with the design class approach of ISO 19902. The structural significance of monorail beams including supporting structures are not major structures for the global integrity of topside structures and the consequences of its

failure are locally impacted on topside structures. That means the failure of monorail beams including supporting structures will not have substantial consequences. Considering the geometrical complexity, the monorail beams mainly have biaxial stress pattern, which are mainly axial beam bending stress with transverse stress on flange.

Design temperature for material selection is –20 °C. Design temperature lower than –20 °C is not covered in this document.

4.8 Strength assessment

The strength assessment for monorail beams shall be carried out in accordance with design requirements in ANSI/AISC 360-10 using the design loads as specified in 4.2.

4.9 Fatigue assessment

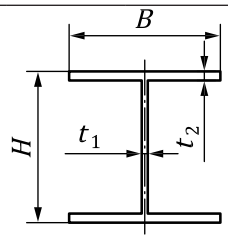
The monorail beam structure shall be verified for fatigue assessment under load combinations involving frequently applied loads and for the service life specified.

Fatigue assessment is not required for monorail beams, if the number of cycles is less than 20 000 and if the capacity load is infrequently used.

4.10 Specification of beam size and span

The specified beam size and span for each SWL as shown in Table 2 are based upon the design load specified in 4.2, the deflection requirements specified in 4.3 and the strength assessment specified in 4.8.

Table 2 — Specified beam size and span for each SWL

SWL	Type	Monorail size (mm)				Maximum span (m)		Maximum allowable "*k*"
						Simple	Cantilever	
		H	***B***	t_1	t_2			
≤ 1 t	H	200	200	8	12	6,0	1,50	2,00
	H	294	200	8	12	6,0	1,50	2,00
≤ 2 t	H	200	200	8	12	5,0	0,75	2,00
	H	294	200	8	12	5,0	1,50	2,00
	H	400	200	8	13	5,5	1,50	2,00
≤ 3 t	H	200	200	8	12	3,5	0,75	2,00
	H	294	200	8	12	4,0	1,25	2,00
	H	400	200	8	13	4,5	1,50	2,00
	H	390	300	10	16	6,0	1,50	2,00
≤ 4 t	H	200	200	8	12	2,5	0,75	1,88
	H	294	200	8	12	3,5	0,75	1,93
	H	300	300	10	15	6,0	1,5	2,00
	H	400	200	8	13	4,0	1,25	2,00
	H	390	300	10	16	6,0	1,50	2,00
≤ 5 t	H	294	200	8	12	3,0	0,75	1,60
	H	300	300	10	15	6,0	1,25	2,00
	H	400	200	8	13	3,5	1,00	1,93
	H	390	300	10	16	6,0	1,50	2,00

NOTE 1 It is also acceptable to apply welded plate girder (WPG) which has equivalent or above scantling against sectional property of beams summarized in this table. For example, if the designer uses same inertia, elastic modulus and flange thickness of the section reported in this table, it is possible to accept lower beam height.

NOTE 2 The specified sizes and spans in this table are fully conforming with the requirements of resistance of bottom flanges to wheel loads in EN 1993-6:2007 based on point loads with four wheels and distance from flange edge of 5 mm to 25 mm depending on SWL. Hoist class for EN code check is considered as "HC2" in accordance with yard practice and experience.

NOTE 3 Maximum allowable "k" is a factor for linear superimpose stresses effect on flange of monorail beam considering distance between wheels of trolley for the selection of trolley hoist or flange design of monorail beam. In accordance with flange check by EN 1993-6:2007, this table provides allowable maximum "k" factor. For maximum allowable "k" factor of 2,0, current monorail beam size in this table can be applied to any type of trolley. For maximum allowable "k" factor of 1,0, current monorail beam size in this table is not to be applied to any superimpose stresses and it is required to apply special trolley that is no superimpose stresses due to between wheels of trolley.

NOTE 4 For monorail beam with SWL above 25 t, the structural design using WPG can be performed separately.

NOTE 5 Trolley hoist self-weight for monorail design considered in the load specifications provided in this table is 15 % of SWL for up to and including 1 t and 10 % of SWL for above 1 t.

NOTE 6 Boundary conditions for the specified sizes of monorail beams are conservatively considered for maximum bending moment and shear force as simple support for both sides supporting beam and fixed end for cantilever beam.

NOTE 7 Boundary conditions for deflection check are considered for maximizing the deflection as hinged and pined boundary for simple support and fixed end for cantilever beam as shown in figures in this table.