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Petroleum and natural gas industries — Concrete offshore structures

Industries du pétrole et du gaz naturel — Structures en mer en béton

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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).

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).

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For an explanation of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 7, *Offshore structures*.

This second edition replaces the first edition (ISO 19903:2006). The main changes compared to the previous edition are:

— udpate of the document to reflect the updated editions of the International Standards on offshore structures prepared by TC 67;

— clarifications on the use of reference standards for design;

— extension of scope to design of floating concrete offshore structures, including removing “fixed” from the title of this document;

— clarfications on the selection of soil parameters for soil-structure interaction in 7.3.3;

— Additional information on the dynamic aspects pertaining to floating concrete structures in 7.4.2.1.

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

The International Standards on offshore structures prepared by TC 67 (i.e. ISO 19900, the ISO 19901 series, ISO 19902, ISO 19903, ISO 19904-1, the ISO 19905 series and ISO 19906) constitute a common basis covering those aspects that address design requirements and assessments of all offshore structures used by the petroleum and natural gas industries worldwide. Through their application, the intention is to achieve reliability levels appropriate for manned and unmanned offshore structures, whatever the type of structure and nature or combination of the materials used.

It is important to recognize that structural integrity is an overall concept comprising models for describing actions, structural analyses, design rules, safety elements, workmanship, quality control procedures and national requirements, all of which are mutually dependent. The modification of one aspect of design in isolation can disturb the balance of reliability inherent in the overall concept or structural system. The implications involved in such modifications, therefore, need to be considered in relation to the overall reliability of all offshore structural systems.

The International Standards on offshore structures prepared by TC 67 are intended to provide wide latitude in the choice of structural configurations, materials and techniques without hindering innovation. Sound engineering judgement is therefore necessary in the use of these documents.

This document was developed based on experience gained from the design, execution and use of a number of fixed concrete platforms, in particular from more than 40 years of experience with such structures in the North Sea. The background documents used for developing this document are from the following types:

— national regulations and other requirements from the authorities;

— regional standards;

— national standards;

— operator's company specifications;

— scientific papers and reports;

— reports from inspection of structures in use.

This document applies the concept of a reference standard for design. The text that previously referred to NS 3473.E, the former Norwegian standard for concrete design that was widely used for the design of fixed offshore concrete platforms, has been amended in this document, since, as part of the Eurocode programme, NS 3473.E has been withdrawn and is no longer maintained.

This document now draws on the experience gained with fixed and floating concrete offshore structures. This experience shows that concrete offshore structures perform well and are durable in the marine environment. These structures are all unique, one-of-a-kind structures, purpose-made for a particular location and a particular set of operating requirements. This document reflects, in particular, the experience and the conditions in the North Sea and the east coast of Canada, and the design rules and practices used there, but is intended for worldwide application.

In order to provide a standard that will be useful to the industry, a comprehensive treatment of some topics is provided where there is currently no other relevant reference. For such well-known topics as the design formulae for concrete structural members, this document is intended to be used in conjunction with a suitable reference standard for basic concrete design (see 8.1.1). The designer can use suitable national or regional design standards that provide the required level of safety.

Petroleum and natural gas industries — Concrete offshore structures

1 Scope

This document specifies requirements and provides recommendations applicable to fixed, floating and grounded concrete offshore structures for the petroleum and natural gas industries and for structures supporting nationally-important power generation, transmission or distribution facility. This document specifically addresses

— the design, construction, transportation and installation of new structures, including requirements for in-service inspection and possible removal of structures,

— the assessment of structures in service, and

— the assessment of structures for reuse at other locations.

This document is intended to cover the engineering processes needed for the major engineering disciplines to establish a facility for offshore operation.

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 4463-1, *Measurement methods for building — Setting-out and measurement — Part 1: Planning and organization, measuring procedures, acceptance criteria*

ISO 16204, *Durability — Service life design of concrete structures*

ISO 19900, *Petroleum and natural gas industries — General requirements for offshore structures*

ISO 19901-1, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 1: Metocean design and operating considerations*

ISO 19901-2, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 2: Seismic design procedures and criteria*

ISO 19901-3, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 3: Topsides structure*

ISO 19901-4, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 4: Geotechnical and foundation design considerations*

ISO 19901-5, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 5: Weight control during engineering and construction*

ISO 19901-6, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 6: Marine operations*

ISO 19901-8, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 8: Marine soil investigations*

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

ISO 19904-1, *Petroleum and natural gas industries — Floating offshore structures — Part 1: Monohulls, semi-submersibles and spars*

ISO 19906, *Petroleum and natural gas industries — Arctic offshore structures*

ISO 22966, *Execution of concrete structures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 19900 and the following apply.

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

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

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

3.1
abnormal design situation
design situation in which conditions exceed conventionally specified design conditions and which is used to mitigate against very remote events

Note 1 to entry: Abnormal design situations are used to provide robustness against events with a probability of typically 10^{-4} per annum or lower by avoiding, for example, gross overloading.

3.2
abnormal level earthquake
ALE
intense earthquake of abnormal severity under the action of which the *structure* (3.51) should not suffer complete loss of integrity

Note 1 to entry: The ALE event is comparable to the abnormal event in the design of structures which are described in ISO 19901-2 and ISO 19902. When exposed to the ALE, a manned structure is supposed to maintain structural and/or floatation integrity for a sufficient period of time to enable evacuation to take place.

3.3
accidental design situation
design situation involving exceptional conditions of the *structure* (3.51) or its exposure

EXAMPLE Impact, fire, explosion, local failure or loss of intended differential pressure (e.g. buoyancy).

3.4
action
external load applied to the *structure* (3.51) (direct action) or an imposed deformation or acceleration (indirect action)

EXAMPLE An imposed deformation can be caused by fabrication tolerances, differential settlement, temperature change or moisture variation. An imposed acceleration can be caused by an earthquake

[SOURCE: ISO 19900:2019, 3.3]

3.5
action effect
result of *actions* (3.4) on structural components or on the structure

EXAMPLE Internal force, moment, stress or strain; deflection rotation

[SOURCE: ISO 19900:2019, 3.4]

3.6
addition
finely divided material used in *concrete* (3.12) in order to improve certain properties or to achieve special properties

Note 1 to entry: This document deals with two types of inorganic additions:

— nearly inert additions (type I);

— pozzolanic or latent hydraulic additions (type II).

3.7
admixture
material added during the mixing process of *concrete* (3.12) in small quantities related to the mass of cement to modify the properties of fresh or hardened concrete

3.8
aggregate
granular mineral material suitable for use in *concrete* (3.12)

Note 1 to entry: Aggregate can be natural, artificial or recycled from material previously used in construction.

3.9
air cushion
air pumped into underbase compartments of the *structure* (3.51)

Note 1 to entry: The air cushion is normally applied in order to reduce the draft and increase the freeboard of the structure and/or to alter the structural loading.

3.10
atmospheric zone
part of the load-bearing *structure* (3.51) that is above the *splash zone* (3.50)

3.11
caisson
major portion of *concrete* (3.12) offshore *structure* (3.51), providing buoyancy whilst afloat and the possibility of oil storage within the structure

Note 1 to entry: The caisson is generally divided into watertight compartments, which can be subdivided into intercommunicating cells for structural reasons. The caisson can also be filled, or partly filled, with ballast water and *solid ballast* (3.49).

3.12
concrete
material formed by mixing cement, coarse and fine *aggregate* (3.8) and water, with or without the incorporation of *admixtures* (3.7) and *additions* (3.6), which develops its properties by hydration of the cement

3.13
condition monitoring
evaluation of the condition and behaviour of the load-bearing *structure(s)* (3.51) in service using data from design, *inspection* (3.29) and *instrumentation* (3.31)

3.14
construction afloat
fabrication, construction and related activities taking place on a *structure* (3.51) that is afloat, normally at an inshore location and restrained by a temporary mooring system

3.15
deck mating
marine operation (3.35) in which the platform *topsides* (3.55) is floated into position and connected to the substructure

Note 1 to entry: This operation is normally conducted by ballasting and deballasting of the substructure.

3.16
deep water construction site
site for construction of the *structure* (3.51) while afloat

Note 1 to entry: The use of a deep water site might not always be required, depending on the construction method. It might or might not be the same location as that where mating of *topsides* (3.55) to the substructure takes place.

3.17
design rule
rule in accordance with the chosen reference standard for *concrete* (3.12) design

Note 1 to entry: See 8.2.

3.18
design wave
deterministic wave used for the design of an offshore *structure* (3.51)

Note 1 to entry: The design wave is an engineering abstraction. Most often it is a periodic wave with suitable characteristics (e.g. height *H*, period *T*, steepness, crest elevation). The choice of a design wave depends on:

— the design purpose(s) considered;

— the wave environment;

— the geometry of the structure;

— the type of *action(s)* (3.4) or *action effect(s)* (3.5) pursued.

Note 2 to entry: Normally, a design wave is only compatible with design situations in which the action effect(s) are quasi-statically related to the associated wave action on the structure.

[SOURCE: ISO 19901-1:2015, 3.5]

3.19
dynamic amplification factor
ratio of a dynamic *action* (3.4) effect to the corresponding static *action effect* (3.5)

Note 1 to entry: An appropriately selected dynamic amplification factor can be applied to static actions to simulate the effects of dynamic actions.

3.20
extreme level earthquake
ELE
earthquake with a severity which the *structure* (3.51) should sustain without major damage

Note 1 to entry: The ELE event is comparable to the extreme environmental event in the design of structures which are described in ISO 19901-2 and ISO 19902. When exposed to an ELE, a structure is supposed to retain its full capacity for all subsequent conditions.

3.21
execution
activities carried out for the physical completion of the *works* (3.55), including procurement, *inspection* (3.29) and documentation thereof

Note 1 to entry: The term covers work on site; it might also signify the fabrication of components off-site and their subsequent erection on site.

3.22
exposure level
classification system used to establish relevant criteria for a *structure* (3.51) based on consideration of life-safety and of environmental and economic consequences of failure

Note 1 to entry: The method for determining exposure levels is described in ISO 19900. An exposure level 1 platform is the most critical and an exposure level 3 the least. A normally manned platform that cannot be reliably evacuated before a design event will be an exposure level 1 platform.

[SOURCE: ISO 19900:2019, 3.20, modified — "consideration of life-safety and of environmental and economic" has been added to the definitions and the Note 1 to entry has been added.]

3.23
finite element analysis
analysis method whereby a *structure* (3.51) or a part thereof is subdivided into small elements of known or assumed behaviour, then analyzed by numerical matrix methods to determine *action* (3.4) effects, static or dynamic

3.24
fixed concrete offshore structure
concrete (3.12) *structure* (3.51) designed to rest on the sea floor

Note 1 to entry: Sufficient structural stability can be achieved through its own weight, or in combination with suction in skirt compartments, or founding of the structure on piles into the seabed. It includes the mechanical outfitting of the structure.

3.25
fixed structure
structure (3.51) that is bottom founded and transfers most *actions* (3.4) on it to the seabed

[SOURCE: ISO 19900:2019, 3.24, modified — "all" has been changed to "most".]

3.26
floating concrete offshore structure
concrete *structure* (3.51) where the full weight is supported by buoyancy

3.27
float-out
transfer of a major assembly from a dry construction site to a self-floating condition

Note 1 to entry: Typically, it is the transfer of the lower part of the *concrete* (3.12) *structure* (3.51) from a flooded drydock.

3.28
global analysis
determination of a consistent set of either internal forces and moments or of stresses for a complete *structure* (3.51) usually resulting from the *finite element analysis* (3.23).

3.29
inspection
conformity evaluation by observation and judgement accompanied, as appropriate, by measurement, testing or gauging to verify that the *execution* (3.21) is in accordance with the *project work specification* (3.44)

3.30
installation
marine operation (3.35) in which the platform is positioned and set down on the sea floor at the *offshore site* (3.38)

