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Petroleum and natural gas industries — Fixed concrete offshore structures

Industries du pétrole et du gaz naturel — Structures en mer fixes 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.

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 19903 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*.

ISO 19903 is one of a series of standards for offshore structures. The full series consists of the following International Standards.

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

— ISO 19901 (all parts), *Petroleum and natural gas industries — Specific requirements for offshore structures*

— ISO 19902, *Petroleum and natural gas industries — Fixed steel offshore structures* [1)]

— ISO 19903, *Petroleum and natural gas industries — Fixed concrete offshore structures*

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

— ISO 19904-2, *Petroleum and natural gas industries — Floating offshore structures — Part 2: Tension leg platforms* [2)]

— ISO 19905-1, *Petroleum and natural gas industries — Site-specific assessment of mobile offshore units — Part 1: Jack-ups* [2)]

— ISO/TR 19905-2, *Petroleum and natural gas industries — Site-specific assessment of mobile offshore units — Part 2: Jack-ups commentary* [2)]

— ISO 19906, *Petroleum and natural gas industries — Arctic offshore structures* [2)]

1) To be published.

2) Under preparation.

Introduction

The series of International Standards applicable to offshore structures, ISO 19900 to ISO 19906, constitutes 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 modifications, therefore, need to be considered in relation to the overall reliability of all offshore structural systems.

The series of International Standards applicable to the various types of offshore structure is 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 International Standards.

International Standard ISO 19903 was developed based on experience gained from the design, execution and use of a number of fixed concrete platforms, in particular from more than 30 years of experience with such structures in the North Sea. The background documents when developing this International Standard are from the following types of documents:

— 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 International Standard draws on the experience gained with fixed concrete offshore structures. This experience shows that fixed 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 is reflected in ISO 19903 by the fact that the standard gives guidance rather than detailed prescriptive rules. This International Standard 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.

Petroleum and natural gas industries — Fixed concrete offshore structures

1 Scope

This International Standard specifies requirements and provides recommendations applicable to fixed concrete offshore structures for the petroleum and natural gas industries, and specifically addresses

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

b) the assessment of structures in service, and

c) the assessment of structures for reuse at other locations.

This International Standard is intended to cover the engineering processes needed for the major engineering disciplines to establish a facility for offshore operation. It can also be used for the design of floating concrete structures as specified in ISO 19904-1 [11] (and the future ISO 19904-2 [12] when published) and for arctic structures (as specified in the future ISO 19906 [7] when published).

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 relevant reference. For such well-known topics as the design formulas for concrete structural members, this International Standard is intended to be used in conjunction with a suitable reference standard for basic concrete design (see 8.2.1). The designer can use suitable national or regional design standards that provide the required level of safety. Only other ISO documents will be referenced directly in the text.

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 1920-3, *Testing of concrete — Part 3: Making and curing test specimens*

ISO 1920-4, *Testing of concrete — Part 4: Strength of hardened concrete*

ISO 2394, *General principles on reliability for structures*

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

ISO 6934 (all parts), *Steel for the prestressing of concrete*

ISO 6935 (all parts), *Steel for the reinforcement of concrete*

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 19901-4, *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*[3)]

ISO 19902, *Petroleum and natural gas industries — Fixed steel offshore structures* [3)]

3 Terms and definitions

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

NOTE Terms and definitions relevant for the use of this International Standard are also found in ISO 19901-1, ISO 19901-2, ISO 19901-4 and ISO 19901-6 and in ISO 19902.

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 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.

[ISO 19901-2]

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

NOTE The ALE event is comparable to the abnormal event in the design of fixed structures which are described in ISO 19902 and ISO 19903. 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.

[ISO 19901-2]

3.3
accidental design situation
design situation involving exceptional conditions of the structure 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 (direct action) or an imposed deformation or acceleration (indirect action)

NOTE 1 An imposed deformation can be caused by fabrication tolerances, settlement, temperature change or moisture variation.

3) To be published.

NOTE 2 An earthquake typically generates imposed accelerations.

[ISO 19900]

3.5
action effect
effect of action on structural components

EXAMPLE Internal force, moment, stress or strain.

[ISO 19900]

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

NOTE This International Standard 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 in small quantities related to the mass of cement to modify the properties of fresh or hardened concrete

3.8
after-damage design situation
design situation for which the condition of the structure reflects damage due to an accidental design situation and for which the environmental conditions are specially defined

3.9
aggregate
granular mineral material suitable for use in concrete

NOTE Aggregate can be natural, artificial or recycled from material previously used in construction.

3.10
air cushion
air pumped into underbase compartments of the structure

NOTE Normally applied in order to reduce the draft and increase the freeboard of the structure and/or to alter the structural loading.

3.11
atmospheric zone
part of the load-bearing structure that is above the splash zone

3.12
caisson
major portion of fixed concrete offshore structure, providing buoyancy during floating phases and the possibility of oil storage within the structure

NOTE 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.

3.13
characteristic value of a material property
value of a material or product property having a prescribed probability of not being attained in a hypothetical unlimited test series, a nominal value being used as the characteristic value in some circumstances

NOTE The characteristic material property generally corresponds to a specified fractile of the assumed statistical distribution of the particular property of the material or product. Characteristic strength is normally defined as the value of the strength below which 5 % of the population of all possible strength determinations of the material under consideration are expected to fall or, alternatively, 95 % if an upper value is more severe.

3.14
critical shear zone
zone in which the shear stress is at a maximum in relation to the shear strength

3.15
concrete
material formed by mixing cement, coarse and fine aggregate and water, with or without the incorporation of admixtures and additions, which develops its properties by hydration of the cement

3.16
condition monitoring
evaluation of the condition and behaviour of the load-bearing structure(s) in service using data from design, inspection and instrumentation

3.17
construction afloat
fabrication, construction and related activities taking place on a structure that is afloat, normally at an inshore location and restrained by a temporary mooring system

3.18
deck mating
marine operation in which the platform topsides is floated into position and connected to the substructure

NOTE This operation is normally conducted by ballasting and deballasting of the substructure.

3.19
deep water construction site
site for construction of the structure while afloat

NOTE 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 to the substructure takes place.

3.20
design rules
rules in accordance with the chosen reference standard for concrete design

NOTE See 8.2.

3.21
dynamic amplification factor
DAF
ratio of a dynamic action effect to the corresponding static action effect

NOTE An appropriately selected dynamic amplification factor can be applied to static actions to simulate the effects of dynamic actions.

3.22
extreme level earthquake
ELE
earthquake with a severity which the structure should sustain without major damage

NOTE The ELE event is comparable to the extreme environmental event in the design of fixed structures which are described in ISO 19902 and ISO 19903. When exposed to an ELE, a structure is supposed to retain its full capacity for all subsequent conditions.

[ISO 19901-2]

3.23
execution
all activities carried out for the physical completion of the work including procurement, inspection and documentation thereof

NOTE The term covers work on site; it might also signify the fabrication of components off-site and their subsequent erection on site.

3.24
exposure level
classification system used to define the requirements for a structure based on consideration of life safety and of environmental and economic consequences of failure

NOTE The method for determining exposure levels is described in ISO 19902. An exposure level 1 platform is the most critical and exposure level 3 the least. A normally manned platform which cannot be reliably evacuated before a design event will be an exposure level 1 platform.

[ISO 19900]

3.25
finite element analysis
FEA
analysis method whereby a structure or a part thereof is subdivided into small elements of known or assumed behaviour, then analysed by numerical matrix methods to determine action effects, static or dynamic

3.26
fixed concrete offshore structure
FCS
concrete structure designed to rest on the sea floor

NOTE 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.

3.27
fixed structure
structure that is bottom founded and transfers all actions on it to the seabed

[ISO 19900]

3.28
float-out
transfer of a major assembly from a dry construction site to a self-floating condition

NOTE Typically, it is the transfer of the lower part of the concrete structure from a flooded drydock.

3.29
global analysis
determination of a consistent set of either internal forces and moments or of stresses in a structure that are in equilibrium with a defined set of actions on the entire structure and which depend on geometrical, structural and material properties

NOTE For a global analysis of a transient situation (e.g. seismic), the internal response is part of the equilibrium.

3.30
inspection
conformity evaluation by observation and judgement accompanied, as appropriate, by measurement, testing or gauging to verify that the execution is in accordance with the project work specification

3.31
installation
marine operation in which the platform is positioned and set down on the sea floor at the offshore site

3.32
instrumentation
outfitting of a fixed concrete offshore structure with instruments for data measurement and recording

3.33
interface manual
document defining all interfaces between the various parties and disciplines involved in the design and construction, ensuring that responsibilities, reporting and information routines, as appropriate, are established and maintained

3.34
lightweight aggregate
aggregate of mineral origin having an oven-dry particle density $\leqslant$ 2 000 kg/m^3 or a loose oven-dry bulk density $\leqslant$ 1 200 kg/m^3

3.35
local analysis
determination of a consistent set of internal forces and moments, or stresses, in a cross-section of a structural component, or in a subset of structural components forming part of the structural system, that are in equilibrium with the boundary conditions

3.36
marine operation
planned and controlled vertical or horizontal movement of a structure or component thereof over, in or on water

3.37
method statement
document stating the methods and procedures to be used to perform the work

3.38
normal-weight aggregate
aggregate with an oven-dry particle density between 2 000 kg/m^3 and 3 000 kg/m^3

3.39
offshore site
offshore location where the structure is to be installed for its operational life

3.40
operations manual
document giving the requirements and restrictions related to a safe operation of the concrete structure and all its systems

3.41
owner
representative of the companies which own a development

NOTE The owner will normally be the operator on behalf of co-licensees.

3.42
primary structure
all main structural components (concrete or steelwork) that provide the structure's main strength and stiffness

3.43
procedure
document that describes a specified way to carry out an activity or a process, the detailed sequence and inter-relationships required for the completion of a particular task

3.44
project specification
document giving the overall technical requirements provided by the owner

3.45
project work specification
all information and technical requirements necessary for the execution of the works, includes documents and drawings, etc. as well as references to relevant regulations, specifications, etc.

3.46
quality plan
document specifying which procedures and associated resources shall be applied by whom and when, covering the entire project or defined parts of the project and all relevant products, processes or contracts

3.47
secondary structure
structural components that do not contribute significantly to the overall strength and stiffness of the structure but which support individual items of equipment, transferring the actions thereon onto the primary structure

3.48
shaft
compartment extending from the caisson of the fixed concrete offshore structure to the topsides

NOTE A shaft is generally used to house and support the wells (drill shaft), mechanical systems (utility shaft) and risers and J-tubes (riser shaft). The part of a shaft extending above a caisson is also often referred to as a leg.

3.49
skirts
structural components constructed in concrete and/or steel that extend from the foundation downwards and penetrate into the seabed

NOTE Skirts are used to increase the capacity of the foundation to resist vertical and horizontal actions and improve erosion resistance. Skirts can also be needed to form compartments facilitating the under-base grouting.

3.50
solid ballast
non-structural material added to a structure

NOTE Solid ballast is normally applied in order to increase the self weight of the structure or to lower the centre of gravity for floating stability purposes.

3.51
splash zone
area of a structure that is frequently wetted due to waves and tidal variations

[ISO 19900]

3.52
structure
organized combination of connected parts designed to withstand actions and provide adequate rigidity

[ISO 19900]

3.53
submerged zone
part of the structure that is normally submerged and exposed to the constant influence of sea water

3.54
subsidence
that part of the settlement of the structure that results from extraction of reservoir hydrocarbons and factors other than the weight of the structure

3.55
summary report
document including the most important assumptions on which the design, construction and installation work is based with regard to the load-bearing structure

3.56
topsides
structures and equipment placed on a supporting structure (fixed or floating) to provide some or all of a platform's functions

NOTE A separate fabricated deck or module support frame is part of the topsides.

[ISO 19900]

3.57
tow to field
marine operation in which the complete platform or structure is moved from the dry dock or inshore construction site to the offshore site

3.58
works
construction work described in the project work specification

3.59
works certificate
mill certificate
document issued by the manufacturer or a testing institute certifying the materials delivered, and giving

— test method, specifications and criteria (e.g. test standard used),

— all relevant test data,

— certification that the tests have been carried out on samples taken from the delivered products, and

— all necessary information for identification of product, producer and purchaser.

NOTE A works certificate is normally required for construction materials that are not subject to an accepted certification scheme.

4 Symbols and abbreviated terms

4.1 Symbols

A accidental action

A_c actual surface area to be protected

C_a total current capacity of the anodes

D	action due to imposed deformation
E	environmental action
E^{o}_{a}	design closed-circuit anode potential
E^{o}_{c}	design protective potential
G	permanent action
I_{a}	anode current output
$I_{a,initial}$	initial current output
$I_{a,final}$	final current output
I_{c}	current demand
$I_{c,average}$	average current demand
$I_{c,initial}$	initial current demand
$I_{c,final}$	final current demand
L	lap length
M_x, M_y, M_{xy} N_x, N_y, N_{xy}	six force components giving stresses in the plane of the member
R	radius
R_a	anode resistance
Q	variable action
a	mass content of the active addition (type II)
c	cement mass content
c_a	current capacity of an anode
f_c	coating breakdown factor for any coated surfaces (f_c = 1 for bare steel)
f_{cd}	design compressive strength of concrete
f_{ck}	characteristic compressive strength of concrete
f_{cn}	nominal compressive strength of concrete
f_{yk}	characteristic strength of steel
i_c	design current density
k	factor which takes into account the activity of a type II addition
m	effective water/cement ratio
m_T	total net anode mass