

DIN EN ISO 19903

ICS 75.180.10

Entwurf

Einsprüche bis 2017-12-27
Vorgesehen als Ersatz für
DIN EN ISO 19903:2007-04

**Erdöl- und Erdgasindustrie –
Offshore-Betonkonstruktionen (ISO/DIS 19903:2017);
Englische Fassung prEN ISO 19903:2017, nur auf CD-ROM**

Petroleum and natural gas industries –
Concrete offshore structures (ISO/DIS 19903:2017);
English version prEN ISO 19903:2017, only on CD-ROM

Industries du pétrole et du gaz naturel –
Structures en mer en béton (ISO/DIS 19903:2017);
Version anglaise prEN ISO 19903:2017, seulement en CD-ROM

Anwendungswarnvermerk

Dieser Norm-Entwurf mit Erscheinungsdatum 2017-10-27 wird der Öffentlichkeit zur Prüfung und Stellungnahme vorgelegt.

Weil die beabsichtigte Norm von der vorliegenden Fassung abweichen kann, ist die Anwendung dieses Entwurfs besonders zu vereinbaren.

Stellungnahmen werden erbeten

- vorzugsweise online im Norm-Entwurfs-Portal von DIN unter www.din.de/go/entwuerfe bzw. für Norm-Entwürfe der DKE auch im Norm-Entwurfs-Portal der DKE unter www.entwuerfe.normenbibliothek.de, sofern dort wiedergegeben;
- oder als Datei per E-Mail an noeg@din.de möglichst in Form einer Tabelle. Die Vorlage dieser Tabelle kann im Internet unter www.din.de/go/stellungnahmen-norm-entwuerfe oder für Stellungnahmen zu Norm-Entwürfen der DKE unter www.dke.de/stellungnahme abgerufen werden;
- oder in Papierform an den DIN-Normenausschuss Erdöl- und Erdgasgewinnung (NÖG), 10772 Berlin, Burggrafenstr. 6, 10787 Berlin.

Die Empfänger dieses Norm-Entwurfs werden gebeten, mit ihren Kommentaren jegliche relevanten Patentrechte, die sie kennen, mitzuteilen und unterstützende Dokumentationen zur Verfügung zu stellen.

Gesamtumfang 156 Seiten

DIN-Normenausschuss Erdöl- und Erdgasgewinnung (NÖG)

Nationales Vorwort

Dieses Dokument (prEN ISO 19903:2017) wurde vom Technischen Komitee ISO/TC 67 „Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries“ in Zusammenarbeit mit dem Technischen Komitee CEN/TC 12 „Materialien, Ausrüstungen und Offshore-Bauwerke für die Erdöl-, petrochemische und Erdgasindustrie“ (Sekretariat: NEN, Niederlande) erarbeitet.

Für Deutschland hat hieran der Arbeitskreis NA 109-00-01-07 AK „Offshore Bauwerke“ im DIN-Normenausschuss Erdöl- und Erdgasgewinnung (NÖG) mitgearbeitet.

Diese Europäische Norm enthält unter Berücksichtigung des DIN-Präsidialbeschlusses 1/2004 nur die englische Originalfassung der ISO-Norm.

Für die in diesem Dokument zitierten internationalen Dokumente wird im Folgenden auf die entsprechenden deutschen Dokumente hingewiesen:

ISO 19900	siehe	DIN EN ISO 19900
ISO 19901-1	siehe	DIN EN ISO 19901-1
ISO 19901-2	siehe	DIN EN ISO 19901-2
ISO 19901-3	siehe	DIN EN ISO 19901-3
ISO 19901-4	siehe	DIN EN ISO 19901-4
ISO 19901-5	siehe	DIN EN ISO 19901-5
ISO 19901-6	siehe	DIN EN ISO 19901-6
ISO 19901-8	siehe	DIN EN ISO 19901-8
ISO 19902	siehe	DIN EN ISO 19902
ISO 19904-1	siehe	DIN EN ISO 19904-1
ISO 19906	siehe	DIN EN ISO 19906

Änderungen

Gegenüber DIN EN ISO 19903:2007-04 wurden folgende Änderungen vorgenommen:

- a) Überarbeitung des Anwendungsbereichs;
- b) Überarbeitung und Erweiterung der Normativen Verweisungen;
- c) Überarbeitung der Begriffe, Symbole und Abkürzungen;
- d) Überarbeitung von 5.3 „Overall planning requirements“;
- e) Überarbeitung von 6.2 „Environmental actions“;
- f) inhaltliche Überarbeitung der Tabellen in 6.5 „Combinations of actions“;
- g) umfangreiche Überarbeitung von 7.3.3 „Soil-structure interaction“;

- h) umfangreiche Überarbeitung von 7.4 „Types of analysis“;
- i) Löschen von 7.5.9 „Platform removal/reuse“;
- j) Löschen von 8.1 „Documentation“;
- k) umfangreiche Überarbeitung von 8.1 „Design“;
- l) Überarbeitung von 8.3.4 „Concrete production“;
- m) umfangreiche Überarbeitung von 8.5 „Quality control - Inspection, testing and actions“;
- n) Überarbeitung von 9.6 „Geotechnical design principles“;
- o) Überarbeitung von 11 „Marine operations and construction afloat“;
- p) 15.3 „Planning for decommissioning“ wurde hinzugefügt;
- q) Überarbeitung der Literaturangaben.

Nationaler Anhang NA (informativ)

Begriffe, Symbole und Abkürzungen

Die Benummerung der folgenden Begriffe, Symbole und Abkürzungen sind identisch mit der Benummerung in der englischen Fassung.

3 Begriffe

Für die Anwendung dieses Dokuments gelten die Begriffe nach ISO 19900 und die folgenden Begriffe.

ANMERKUNG Für die Anwendung dieses Dokuments maßgebende Begriffe können auch ISO 19901-2, ISO 19901-4, ISO 19901-6 und ISO 19902 entnommen werden.

ISO und IEC stellen terminologische Datenbanken für die Verwendung in der Normung unter den folgenden Adressen bereit:

- IEC Electropedia: unter <http://www.electropedia.org/>
- ISO Online Browsing Platform: unter <http://www.iso.org/obp>

3.1 außergewöhnliche Bemessungssituation

Bemessungssituation, in der die Bedingungen konventionell festgelegte Bemessungsbedingungen zur Minderung von Ereignissen entfernter Wahrscheinlichkeit überschreiten

Anmerkung 1 zum Begriff: Außergewöhnliche Bemessungssituationen werden angewendet, damit eine Robustheit gegenüber Ereignissen erreicht wird, die mit einer Wahrscheinlichkeit von üblicherweise 10^{-4} je Jahr oder weniger eintreten, indem beispielsweise eine grobe Überlastung vermieden wird.

3.2 Erdbeben mit anormaler Stärke ALE

(en: abnormal level earthquake)

intensives Erdbeben mit anormaler Stärke, dessen Einwirkung nicht zum vollständigen Verlust der Bauwerksintegrität führen sollte

Anmerkung 1 zum Begriff: Das ALE-Ereignis ist vergleichbar mit dem anormalen Ereignis in der Auslegung von Bauwerken nach ISO 19901-2 und ISO 19902. Bei Einwirkung des ALE ist vorgesehen, dass ein bemanntes Bauwerk seine tragende und/oder schwimmende Integrität für eine zur Durchführung der Evakuierung ausreichende Zeitspanne beibehält.

[QUELLE: ISO 19901-2:2004, 3.1, geändert – Verweisung auf ISO 19903 geändert zu ISO 19901-2 in Anmerkung 1 zum Begriff.]

3.3 außergewöhnliche Bemessungssituation

Bemessungssituation, die außergewöhnliche Zustände der Konstruktion oder ihrer Beanspruchung zur Folge hat

BEISPIEL Schlagwirkung, Brand, Explosion, örtliches Versagen, Verlust des vorgesehenen Differenzialdrucks (z. B. Auftrieb).

3.4

Last

Einwirkung

externe Last, die (als direkte Einwirkung) auf das Bauwerk aufgebracht wird oder dem Bauwerk (als indirekte Einwirkung) auferlegte Verformung oder Beschleunigung

BEISPIEL Eine Verformung kann durch die Herstellungstoleranzen, durch Setzung, durch Veränderung der Temperatur oder durch Feuchtigkeitsschwankungen verursacht werden.

Anmerkung 1 zum Begriff: Ein Erdbeben führt im Allgemeinen zu Beschleunigungen.

[QUELLE: ISO 19900:2013, 3.3]

3.5

Einfluss der Einwirkung

Effekt von (Last-)Einwirkungen auf tragende Bauteile

BEISPIEL Innere Kräfte, Momente, Spannungen oder Dehnungen.

[QUELLE: ISO 19900:2013, 3.4]

3.6

Zusatzstoff

fein verteilter Stoff, der im Beton verwendet wird, um bestimmte Eigenschaften zu verbessern oder um bestimmte Eigenschaften zu erreichen

Anmerkung 1 zum Begriff: Dieses Dokument behandelt zwei Arten von anorganischen Zusatzstoffen:

- nahezu inaktive Zusatzstoffe (Typ I);
- puzzolanische oder latenthdraulische Zusatzstoffe (Typ II).

3.7

Zusatzmittel

Stoff, der während des Mischvorgangs des Betons in kleinen Mengen, bezogen auf den Zementgehalt, zugegeben wird, um die Eigenschaften des Frischbetons oder Festbetons zu verändern

3.8

Gesteinskörnung

für die Verwendung in Beton geeigneter, gekörnter, mineralischer Stoff

Anmerkung 1 zum Begriff: Gesteinskörnungen können natürlich oder künstlich sein oder aus vorher beim Bauen verwendeten, rezyklierten Stoffen bestehen.

3.9

Luftkissen

Luftpolster

Luftpuffer

in die Kammern / Zellen des Anlagenunterbaus hineingepumpte Luft

Anmerkung 1 zum Begriff: Diese Vorrichtung wird üblicherweise angewendet, um den Tiefgang zu verringern und das Freibord des Bauwerks zu erhöhen und/oder die statische Belastung zu verändern.

3.10

atmosphärische Zone

Teil des Tragwerks, der oberhalb der Spritzwasserzone liegt

3.11

Caisson

Senkkasten

großer Teil der Offshore-Betonkonstruktion, der Auftrieb während Schwimmphasen sowie die Möglichkeit der Erdöllagerung innerhalb des Bauwerks bietet

Anmerkung 1 zum Begriff: Der Senkkasten ist gewöhnlich in wasserdichte Kammern unterteilt, welche zu konstruktiven Zwecken wiederum in miteinander verbundene Zellen unterteilt werden können. Der Senkkasten kann auch ganz oder teilweise mit Wasser- oder Feststoffballast gefüllt werden.

3.12

kritischer Schubbereich

Bereich, in dem die Schubspannung auf einem Höchstwert im Verhältnis zur Schubfestigkeit ist

3.13

Beton

Baustoff, der durch Mischen von Zement, grober und feiner Gesteinskörnung und Wasser, mit oder ohne Zugabe von Zusatzmitteln und Zusatzstoffen, hergestellt wird und seine Eigenschaften durch Hydratation des Zements erhält

3.14

Zustandsüberwachung

Bewertung von Zustand und Verhalten des / der Tragwerke(s) während des laufenden Betriebs unter Verwendung von Daten aus Bemessung, Prüfung und technischer Ausrüstung

3.15

schwimmende Herstellung

Konstruktion im schwimmenden Zustand

Herstellung, Konstruktion und verwandte Tätigkeiten, die an einem schwimmenden Bauwerk erfolgen, das sich gewöhnlich an einem küstennahen Ort befindet und mit einem vorübergehenden Verankerungssystem in Position gehalten wird

3.16

Deckübernahme

Zusammenpassen an Deck

mariner Betrieb, bei dem die Aufbauten der Plattform in Position schwimmen und mit der Unterkonstruktion verbunden werden

Anmerkung 1 zum Begriff: Dieser Vorgang erfolgt üblicherweise durch Ballasten und Entballasten des Tragwerks.

3.17

Tiefwasser-Baustelle

Baustelle für die Konstruktion des Bauwerks im schwimmenden Zustand

Anmerkung 1 zum Begriff: Der Einsatz einer Tiefwasser-Baustelle ist je nach Konstruktionsverfahren möglicherweise nicht immer erforderlich. Dabei könnte es sich um denselben Ort handeln, an dem das Zusammenpassen der Aufbauten und der Unterkonstruktion erfolgt, oder nicht.

3.18

Konstruktionsregel

Regel in Übereinstimmung mit der gewählten Bezugsnorm für die Auslegung von Beton

Anmerkung 1 zum Begriff: Siehe 8.2.

3.19

Bemessungswelle

deterministische Welle, die zur Auslegung einer Offshore-Anlage verwendet wird

Anmerkung 1 zum Begriff: Die Bemessungswelle ist eine technische Abstraktion. Meist handelt es sich um eine periodische Welle mit geeigneten Kennwerten (z. B. Höhe H , Periodendauer T , Steilheit, Wellenkammhöhe). Die Auswahl einer Bemessungswelle ist abhängig von:

- dem / den jeweiligen Auslegungszweck(en);
- der Wellenumgebung;
- den geometrischen Bedingungen der Anlage;
- der Art der ausgeübten Einwirkung(en) oder des ausgeübten Einflusses dieser Einwirkungen.

Anmerkung 2 zum Begriff: Üblicherweise ist eine Bemessungswelle nur mit den Bemessungssituationen kompatibel, in denen der Einfluss einer Einwirkung bezüglich der zugehörigen Welleneinwirkungen auf die Anlage quasistatisch ist.

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

3.20

dynamischer Verstärkerfaktor

Verhältnis des dynamischen Einwirkungseinflusses zum entsprechenden statischen Einwirkungseinfluss

Anmerkung 1 zum Begriff: Ein entsprechend ausgewählter dynamischer Verstärkerfaktor kann auf statische Einwirkungen angewendet werden, um die Einflüsse dynamischer Einwirkungen zu simulieren.

3.21

Erdbeben mit extremer Stärke

ELE

(en: extreme level earthquake)

Erdbeben mit einer Stärke, welcher das Bauwerk ohne wesentliche Beschädigung widerstehen sollte

Anmerkung 1 zum Begriff: Das ELE-Ereignis ist vergleichbar mit dem extremen Umweltereignis in der Auslegung von Bauwerken nach ISO 19901-2 und ISO 19902. Bei Einwirkung eines ELE ist vorgesehen, dass ein Bauwerk seine volle Leistungsfähigkeit für alle nachfolgenden Bedingungen beibehält.

[QUELLE: ISO 19901-2:2004, 3.5, geändert – Verweisung auf ISO 19903 geändert zu ISO 19901-2 in Anmerkung 1 zum Begriff.]

3.22

Bauausführung

alle Tätigkeiten für die physische Erstellung eines Gebäudes oder Ingenieurbauwerks einschließlich Beschaffung von Baustoffen, Überwachung und Erstellung der Herstellungsunterlagen

Anmerkung 1 zum Begriff: Der Begriff beinhaltet die Arbeiten auf der Baustelle; er kann auch die Herstellung von Bauteilen außerhalb der Baustelle sowie ihren anschließenden Einbau auf der Baustelle bezeichnen.

3.23

Beanspruchungsklasse

Klassifizierungssystem zur Festlegung der Anforderungen an ein Bauwerk unter Beachtung des Schutzes des Lebens und der Folgen eines Ausfalls

Anmerkung 1 zum Begriff: Das Verfahren zur Bestimmung von Beanspruchungsklassen ist in ISO 19900 festgelegt. Eine Plattform der Beanspruchungsklasse 1 ist die kritischste Plattform, und eine Plattform der Beanspruchungsklasse 3 ist die ungefährlichste Plattform. Eine üblicherweise besetzte Plattform, die vor einer die Tragfähigkeit beeinflussenden Einwirkung nicht zuverlässig evakuiert werden kann, ist eine Plattform der Beanspruchungsklasse 1.

[QUELLE: ISO 19900:2013, 3.20]

3.24

Finite-Elemente-Methode

Analysenverfahren, bei dem ein Bauwerk oder ein Teil davon in kleine Elemente mit bekanntem oder angenommenem Verhalten unterteilt und anschließend in numerischen Matrixverfahren zur Bestimmung statischer oder dynamischer Einwirkungseinflüsse analysiert wird

3.25

feststehende Offshore-Betonkonstruktion

FCS

(en: fixed concrete offshore structure)

Betonbauwerk, das für die Auflagerung auf dem Meeresgrund vorgesehen ist

Anmerkung 1 zum Begriff: Ausreichende konstruktive Standsicherheit kann durch Eigengewicht oder in Kombination mit Saugwirkung in Schürzenkammern oder Gründung des Bauwerks auf Pfählen im Meeresgrund erreicht werden. Das schließt die mechanische Ausrüstung des Bauwerks ein.

3.26

feststehende Plattform

Bauwerk, das am Boden fest verankert ist und alle Lastenwirkungen vom Bauwerk auf den Meeresboden überträgt

[QUELLE: ISO 19900:2013, 3.22]

3.27

Aufschwimmen

Überführung einer größeren Assemblage von einer Trockenbaustelle in einen schwimmenden Zustand

Anmerkung 1 zum Begriff: Gewöhnlich handelt es sich um die Überführung des unteren Teils einer Betonkonstruktion aus einem gefluteten Trockendock.

3.28

globale Analyse

Ermittlung einer einheitlichen Reihe von entweder inneren Kräften und Momenten oder Spannungen in einer Konstruktion, die sich im Gleichgewichtszustand mit einer festgelegten Reihe von Einwirkungen auf die Gesamtkonstruktion befinden und die geometrischen und konstruktiven Merkmale sowie die Werkstoffeigenschaften berücksichtigen

Anmerkung 1 zum Begriff: Bei einer Tragwerksberechnung im Hinblick auf eine vorübergehende (z. B. seismische) Einwirkung ist die innere Reaktion Teil des Gleichgewichts.

3.29

Prüfung

Konformitätsbewertung durch Sichtprüfung und Beurteilung, gegebenenfalls in Verbindung mit Messung (mit oder ohne Lehre) und Prüfung, um die Übereinstimmung der Ausführung mit der Spezifikation der Projektarbeiten zu verifizieren

3.30

Einbau

mariner Betrieb, bei dem die Plattform in ihre Offshore-Position gebracht und auf dem Meeresboden abgesetzt wird

3.31

technische Ausrüstung

Ausrüstung einer Offshore-Betonkonstruktion mit Geräten für die Messung und Aufzeichnung von Daten

3.32

Schnittstellenhandbuch

Dokument, dass alle Schnittstellen zwischen den verschiedenen an der Auslegung und Konstruktion beteiligten Parteien und Fachdisziplinen definiert und sicherstellt, dass Verantwortungen, Berichtserstattungs- und Informationsabläufe, sofern zutreffend, festgelegt und eingehalten werden

3.33

leichte Gesteinskörnung

Gesteinskörnung mineralischen Ursprungs mit einer Kornrohichte im ofentrockenen Zustand von 2 000 kg/m³ oder eine Schüttdichte im ofentrockenen Zustand von 1 200 kg/m³

3.34

lokale Analyse

Ermittlung einer einheitlichen Reihe von inneren Kräften und Momenten oder Spannungen im Querschnitt eines tragenden Bauteils, oder in einer Teilmenge von tragenden Bauteilen, die Teil des Tragwerks sind, die sich im Gleichgewichtszustand mit den Randbedingungen befinden

3.35

mariner Betrieb

Arbeiten auf See

geplante und kontrollierte vertikale oder horizontale Bewegung einer Anlage oder eines Bestandteils dieser Anlage über das, im oder auf dem Wasser

3.36

Verfahrensbeschreibung

Dokument, das die bei der Ausführung der Bauarbeiten angewendeten Verfahren und Vorgehensweisen festlegt

3.37

normale Gesteinskörnung

Gesteinskörnung mit einer Kornrohichte im ofentrockenen Zustand zwischen 2 000 kg/m³ und 3 000 kg/m³

3.38

Offshore-Baustelle

Offshore-Lage, in der das Bauwerk für seine Betriebslebensdauer einzubauen ist

3.39

Betriebshandbuch

Dokument, das die Anforderungen und Einschränkungen in Zusammenhang mit dem sicheren Betrieb der Betonkonstruktion und aller ihrer Systeme enthält

3.40

Eigentümer

Vertreter derjenigen Unternehmen, die das Bauprojekt besitzen

Anmerkung 1 zum Begriff: Üblicherweise ist der Eigentümer der Betreiber, der im Namen von Mit-Lizenznehmern handelt.

3.41

Primärkonstruktion

alle wesentlichen tragenden Bauteile (Beton oder Stahl), die wesentlich zur Festigkeit und Steifigkeit der Konstruktion beitragen

3.42

Verfahren

Dokument, das eine festgelegte Art und Weise der Durchführung einer Tätigkeit oder eines Prozesses, den detaillierten Ablauf und Wechselbeziehungen enthält, welche(r) für die Ausführung einer bestimmten Aufgabe erforderlich ist

3.43

Projektspezifikation

Dokument, das die gesamten technischen Anforderungen enthält und vom Eigentümer bereitgestellt wird

3.44

Spezifikation der Projektarbeiten

sämtliche für die Ausführung der Arbeiten erforderlichen Angaben und technischen Anforderungen, einschließlich Dokumenten und Zeichnungen usw., sowie Verweisungen auf maßgebende Vorschriften, Spezifikationen usw.

3.45

Qualitätsmanagementplan

Dokument, das festlegt, welche Verfahren und zugehörigen Ressourcen wann und durch wen anzuwenden sind, und das gesamte Projekt oder festgelegte Teile davon sowie alle maßgebenden Produkte, Prozesse oder Verträge abdeckt

3.46

Sekundärkonstruktion

tragende Bauteile, die nicht wesentlich zur Festigkeit und Steifigkeit der Gesamtkonstruktion beitragen, aber einzelne Ausrüstungsteile stützen, indem sie die Einwirkungen darauf auf die Primärkonstruktion übertragen

3.47

Schacht

Kammer, die vom Senkkasten der Offshore-Betonkonstruktion bis zu den Aufbauten reicht

Anmerkung 1 zum Begriff: Ein Schacht dient gewöhnlich zur Aufnahme von Bohrungen (Bohrschacht), mechanischen Systemen (Betriebsmittelschacht) sowie Risern und Schutzrohren (Riserschacht). Der Teil eines Schachts, der sich oberhalb des Senkkastens befindet wird häufig auch als Bein („Leg“) bezeichnet.

3.48

Schürzen

tragende Bauteile aus Beton und/oder Stahl, die Teil der Gründung sind und in den Meeresgrund hineinreichen

Anmerkung 1 zum Begriff: Schürzen dienen dazu, die Fähigkeit der Gründung zu erhöhen, vertikalen und horizontalen Lasten zu widerstehen, und dazu, den Erosionswiderstand zu verbessern. Schürzen können auch erforderlich sein, um Kammern zu bilden, welche das Verdämmen des Unterbaus ermöglichen.

3.49

Feststoffballast

nichttragendes Material, das zu einer Konstruktion hinzugefügt wird

Anmerkung 1 zum Begriff: Feststoffballast wird gewöhnlich eingesetzt, um das Eigengewicht der Konstruktion zu erhöhen oder den Schwerpunkt für die Schwimmstabilität tiefer zu setzen.

3.50

Spritzwasserzone

Bereich einer Anlage, der häufig durch Wellen und Gezeitenschwankungen benetzt wird

[QUELLE: ISO 19900:2013, 3.44]

3.51

Bauwerk

geordnete Kombination von Bauteilen, die so miteinander verbunden sind, dass sie (Last-)Einwirkungen standhalten und eine ausreichende Stabilität bieten

[QUELLE: ISO 19900:2013, 3.49]

3.52

Eintauchzone

Teil des Bauwerks, der sich gewöhnlich unter Wasser befindet und ständig dem Einfluss von Meerwasser ausgesetzt ist

3.53

Absenkung

der Teil der Setzung des Bauwerks, der aus der Förderung von Kohlenwasserstoffen aus Lagerstätten und anderen Faktoren als dem Gewicht des Bauwerks resultiert

3.54

zusammenfassender Bericht

Dokument, das die wichtigsten Annahmen enthält, auf denen Auslegung, Konstruktion und Einbauarbeiten in Zusammenhang mit dem Tragwerk beruhen

3.55

Überwasserbauten

Aufbauten

Deck

Bauten und Einrichtungen, die zur Ermöglichung einiger oder aller Funktionen einer Plattform auf einer Stützkonstruktion angeordnet sind

Anmerkung 1 zum Begriff: Ein separat hergestelltes Deck oder ein Modul-Tragrahmen ist Teil der Aufbauten.

[QUELLE: ISO 19900:2013, 3.52, geändert – Anmerkungen 1 und 2 zum Begriff wurden weggelassen.]

3.56

Bauarbeiten

in der Spezifikation der Projektarbeiten festgelegte Baumaßnahmen

3.57

Bescheinigung über Bauarbeiten

Werkzeugzeugnis

vom Hersteller oder von einem Prüfinstitut ausgestelltes Dokument zur Zertifizierung der gelieferten Werkstoffe, das Folgendes enthält:

- Prüfverfahren, Spezifikationen und Kriterien (z. B. angewendete Prüfnorm);
- sämtliche maßgebenden Prüfdaten;
- Bescheinigung, dass die Prüfungen an Proben durchgeführt wurden, die den gelieferten Produkten entnommen wurden; und
- sämtliche für die Identifizierung von Produkt, Hersteller und Käufer erforderlichen Angaben

Anmerkung 1 zum Begriff: Eine Bescheinigung über Bauarbeiten ist gewöhnlich erforderlich für Baustoffe, die keinem anerkannten Zertifizierungsprogramm unterliegen.

4 Symbole und Abkürzungen

4.1 Symbole

A	außergewöhnliche Einwirkung
A_c	tatsächliche zu schützende Oberfläche
a	Massenanteil des aktiven Zusatzstoffes (Typ II)
C_a	Gesamt-Strombelastbarkeit der Anoden
c	Zement-Massenanteil
c_a	Strombelastbarkeit einer Anode
D	Einwirkung aufgrund aufgebrachter Verformung
E	umweltbedingte Einwirkung
E^0_a	Bemessungswert des Anodenpotenzials bei geschlossenem Stromkreis
E^0_c	Bemessungswert des Schutzpotenzials
f_c	Beschichtungsreduktionsfaktor für jegliche beschichteten Oberflächen ($f_c = 1$ für blanken Stahl)
f_{cd}	Bemessungswert der Druckfestigkeit von Beton
f_{ck}	charakteristische Druckfestigkeit von Beton
f_{cn}	Nenn-Druckfestigkeit von Beton
f_{yk}	charakteristische Festigkeit von Stahl
G	ständige Einwirkung

I_a	Ausgangsstrom der Anode
$I_{a,initial}$	Anfangswert des Ausgangsstroms
$I_{a,final}$	Endwert des Ausgangsstroms
I_c	Strombedarf
$I_{c,average}$	mittlerer Strombedarf
$I_{c,initial}$	Anfangswert des Strombedarfs
$I_{c,final}$	Endwert des Strombedarfs
i_c	Bemessungswert der Stromdichte
k	Faktor, der die Auswirkung eines Zusatzstoffes vom Typ II berücksichtigt
L	Überlappungslänge
M_x, M_y, M_{xy} N_x, N_y, N_{xy}	sechs Kraftkomponenten, welche Spannungen in der Bauteilebene angeben
m	effektives Wasser / Zement-Verhältnis
m_T	Gesamtnettomasse der Anode
n	Anzahl der Anoden
Q	veränderliche Einwirkung
R	Radius
R_a	Anodenwiderstand
t	Dicke
t_f	Bemessungslebensdauer des kathodischen Korrosionsschutzsystems
u	Ausnutzungsfaktor der Anode
w	Wasser-Massenanteil im Beton
γ_A	Teilbeiwert für außergewöhnliche Einwirkungen
γ_D	Teilbeiwert für Einwirkungen aufgrund aufgebrachter Verformungen
γ_E	Teilbeiwert für umweltbedingte Einwirkungen
γ_F	Teilbeiwert für Einwirkungen, der modellbedingte und geometrische Unsicherheiten einbezieht
γ_G	Teilbeiwert für ständige Einwirkungen unter Einbeziehung von Maßschwankungen

γ_M	Teilbeiwert für werkstoffbezogene Festigkeitseigenschaften unter Einbeziehung werkstoff- und, modelbezogener sowie geometrischer Unsicherheiten
γ_Q	Teilbeiwert für veränderliche Einwirkungen
ε	elektrochemische Effizienz des Anodenwerkstoffs
ν	Poisson-Zahl

4.2 Abkürzungen

AAR	Reaktion alkalischer Gesteinskörnung (en: alkali aggregate reaction)
ALS	Grenzzustand der Unfallschäden (en: accidental limit state)
CCTV	Video-Überwachungsanlage (en: closed-circuit television)
CFD	numerische Strömungsmechanik (en: computational fluid dynamics)
FLS	Grenzzustand der Ermüdung (en: fatigue limit state)
GRP	glasfaserverstärkter Kunststoff (en: glass-fibre reinforced plastic)
HAT	höchste astronomische Tide (en: highest astronomical tide)
HAZOP	Gefährdungs- und Bedienbarkeitsanalyse (en: hazard and operability analysis)
HISC	wasserstoffinduzierte Spannungsrisskorrosion (en: hydrogen-induced stress cracking)
HVAC	Heizung, Lüftung und Klimatechnik (en: heating, ventilation and air conditioning)
IC	Prüfklasse (en: inspection class)
LAT	niedrigste astronomische Tide (en: lowest astronomical tide)
MIC	mikrobiologisch beeinflusste Korrosion (en: microbiologically induced corrosion)
ROV	ferngesteuertes Fahrzeug (en: remotely operated vehicle)
SCC	selbstverdichtender Beton (en: self-compacting concrete)
SLS	Grenzzustand der Gebrauchstauglichkeit (en: serviceability limit state)
SRB	sulfatreduzierende Bakterien (en: sulphate-reducing bacteria)
ULS	Grenzzustand der Tragfähigkeit (en: ultimate limit state)

Nationaler Anhang NB (informativ)

Literaturhinweise

DIN EN ISO 19900, *Erdöl- und Erdgasindustrie — Allgemeine Anforderungen an Offshore-Bauwerke*

DIN EN ISO 19901-1, *Erdöl- und Erdgasindustrie — Spezielle Anforderungen für Offshore-Anlagen — Teil 1: Grundsätze für die Auslegung und den Betrieb auf dem offenen Meer*

DIN EN ISO 19901-2, *Erdöl- und Erdgasindustrie — Spezielle Anforderungen für Offshore-Anlagen — Teil 2: Seismische Auslegungsverfahren und -kriterien*

DIN EN ISO 19901-3, *Erdöl- und Erdgasindustrie — Spezielle Anforderungen an Offshore-Anlagen — Teil 3: Topsides structure*

DIN EN ISO 19901-4, *Erdöl- und Erdgasindustrie — Besondere Anforderungen an Offshore-Bauwerke — Teil 4: Geotechnische und Fundament-Auslegungsmerkmale*

DIN EN ISO 19901-5, *Erdöl- und Erdgasindustrie — Besondere Anforderungen an Offshore-Bauwerke — Teil 5: Gewichtskontrolle während der Auslegung und Konstruktion*

DIN EN ISO 19901-6, *Erdöl- und Erdgasindustrie — Spezielle Anforderungen für Offshore-Anlagen — Teil 6: Mariner Betrieb*

DIN EN ISO 19901-8, *Erdöl- und Erdgasindustrie — Spezielle Anforderungen für Offshore-Anlagen — Teil 8: Meeresbodenuntersuchungen*

DIN EN ISO 19902, *Erdöl- und Erdgasindustrie — Gegründete Stahlplattformen*

DIN EN ISO 19904-1, *Erdöl- und Erdgasindustrie - Schwimmende Offshore-Anlagen — Teil 1: Produktions- und Lagerungsanlagen außer Tension-Leg-Anlagen*

DIN EN ISO 19906, *Erdöl- und Erdgasindustrie — Offshore-Bauwerke für den Arktis-Bereich*

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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*.

This second/third/... edition cancels and replaces the first/second/... edition (), [clause(s) / subclause(s) / table(s) / figure(s) / annex(es)] of which [has / have] been technically revised.

The second edition of this document is prepared to reflect the updated edition of ISO 19900 and other revisions in the ISO 19000 series, and to clarify the use of reference standards for design. In addition, the systematic review of the document has revealed minor inconstancies and need for clarifications in the text.

No major technical issues have been subject to revision, even though the document has been revised to better explain that it is also applicable for design of floating offshore concrete structures. This is also reflected in the new title of the document in which the term “fixed” has been removed.

Subclause 7.3.3 on soil-structure interaction has been amended in order to be more precise on selection of soil parameters. Subclause 7.4.2.1 has been revised in order to better address dynamic aspects pertaining to floating concrete structures.

Introduction

The series of documents 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 such modifications, therefore, need to be considered in relation to the overall reliability of all offshore structural systems.

The series of documents 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 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, which has been widely used for design of fixed offshore concrete platforms, is amended in this document as NS 3473.E as part of the Eurocode program 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 is reflected in this document by the fact that it gives guidance rather than detailed prescriptive rules. 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 formulas 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. Only other ISO documents will be referenced directly in the text.

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:

- 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;
- c) 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 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 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 19901-3, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 3: Topsides structures*

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.

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

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

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

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 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.

[SOURCE: ISO 19901-2:2004, 3.1, modified – Reference to ISO 19903 changed to ISO 19901-2 in note 1 to entry.]

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)

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

Note 1 to entry: An earthquake typically generates imposed accelerations.

[SOURCE: ISO 19900:2013, 3.3]

3.5

action effect

effect of action on structural components

EXAMPLE Internal force, moment, stress or strain.

[SOURCE: ISO 19900:2013, 3.4]

3.6

addition

finely divided material used in concrete 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 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

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

Note 1 to entry: 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 that is above the splash zone

3.11

caisson

major portion of concrete offshore structure, providing buoyancy during floating phases 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.

3.12

critical shear zone

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

3.13

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

3.14

condition monitoring

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

3.15

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

3.16

deck mating

marine operation in which the platform topsides 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.

3.17

deep water construction site

site for construction of the structure 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 to the substructure takes place.

3.18

design rule

rule in accordance with the chosen reference standard for concrete design

Note 1 to entry: See 8.2.

3.19

design wave

deterministic wave used for design of an offshore structure

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) or action effect(s) 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 structure.

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

3.20

dynamic amplification factor

ratio of a dynamic action effect to the corresponding static action effect

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

3.21

extreme level earthquake

ELE

earthquake with a severity which the structure 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.

[SOURCE: ISO 19901-2:2004, 3.5, modified – Reference to ISO 19903 changed to ISO 19901-2 in note 1 to entry.]

3.22

execution

all activities carried out for the physical completion of the work including procurement, inspection 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.

3.23

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 1 to entry: The method for determining exposure levels is described in ISO 19900. 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.

[SOURCE: ISO 19900:2013, 3.20]

3.24

finite element analysis

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

3.25

fixed concrete offshore structure

FCS

concrete structure 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.

3.26

fixed structure

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

[SOURCE: ISO 19900:2013, 3.22]

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 structure from a flooded drydock.

3.28

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

3.29

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

3.30

installation

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

3.31

instrumentation

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

3.32

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

3.33

lightweight aggregate

aggregate of mineral origin having an oven-dry particle density 2 000 kg/m³ or a loose oven-dry bulk density 1 200 kg/m³

3.34

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

3.35

marine operation

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

3.36

method statement

document stating the methods and procedures to be used to perform the work

3.37

normal-weight aggregate

aggregate with an oven-dry particle density between 2 000 kg/m³ and 3 000 kg/m³

3.38

offshore site

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

3.39

operations manual

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

3.40

owner

representative of the companies which own a development

Note 1 to entry: The owner will normally be the operator on behalf of co-licensees.

3.41

primary structure

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

3.42

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

3.43

project specification

document giving the overall technical requirements provided by the owner

3.44

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.

3.45

quality plan

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

3.46

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

3.47

shaft

compartment extending from the caisson of the concrete offshore structure to the topsides

Note 1 to entry: 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.

3.48

skirts

structural components constructed in concrete and/or steel that are part of the foundation and penetrate into the seabed

Note 1 to entry: 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.

3.49

solid ballast

non-structural material added to a structure

Note 1 to entry: 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.

3.50

splash zone

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

[SOURCE: ISO 19900:2013, 3.44]

3.51

structure

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

[SOURCE: ISO 19900:2013, 3.49]

3.52

submerged zone

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

3.53

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

3.54

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

3.55

topsides

structures and equipment placed on a supporting structure to provide some or all of a platform's functions

Note 1 to entry: A separate fabricated deck or module support frame is part of the topsides.

[SOURCE: ISO 19900:2013, 3.52, modified – Notes 1 and 2 to entry have been omitted.]

3.56

works

construction work described in the project work specification

3.57

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 1 to entry: 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
a	mass content of the active addition (type II)
C_a	total current capacity of the anodes

c	cement mass content
c_a	current capacity of an anode
D	action due to imposed deformation
E	environmental action
E^o_a	design closed-circuit anode potential
E^o_c	design protective potential
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
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
i_c	design current density
k	factor which takes into account the activity of a type II addition
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
m	effective water/cement ratio
m_T	total net anode mass
n	number of anodes
Q	variable action
R	radius
R_a	anode resistance

t	thickness
t_f	design life of the cathodic protection system
u	utilization factor of the anode
w	water mass content in concrete
γ_A	partial factor for accidental actions
γ_D	partial factor for actions resulting from imposed deformations
γ_E	partial factor for environmental actions
γ_F	partial factor for action taking account of model and geometrical uncertainties
γ_G	partial factor for permanent actions, also accounting for dimensional variations
γ_M	partial factor for material resistance properties taking account of material, model and geometric uncertainties
γ_Q	partial factor for variable actions
ε	anode material's electrochemical efficiency
ν	Poisson ratio

4.2 Abbreviated terms

AAR	alkali aggregate reaction
ALS	accidental limit state
CCTV	closed-circuit television
CFD	computational fluid dynamics
FLS	fatigue limit state
GRP	glass-fibre reinforced plastic
HAT	highest astronomical tide
HAZOP	hazard and operability analysis
HISC	hydrogen-induced stress cracking
HVAC	heating, ventilation and air conditioning
IC	inspection class
LAT	lowest astronomical tide
MIC	microbiologically induced corrosion
ROV	remotely operated vehicle

SCC	self-compacting concrete
SLS	serviceability limit state
SRB	sulphate-reducing bacteria
ULS	ultimate limit state

5 General requirements

5.1 General

Concrete offshore structures shall be designed in accordance with ISO 19900, this document and the requirements given in the project specification.

The structure shall be designed, constructed, transported and installed in such a way that:

- the installed structure meets the intended reliability level;
- all functional and structural requirements are met.

General principles for the verification of the reliability of the structure shall be in accordance with ISO 19900.

This document assumes that the owners will operate an organization that supervises and monitors the project, and ensures that an appropriate level of independent verification of design and construction is performed.

This document is intended to be used in conjunction with a suitable reference standard for basic concrete design. The designer may use suitable national or regional design standards that provide the required level of safety and structural reliability.

5.2 National requirements

National regulations and standards applicable in the place where a structure will be used can be different from those given in this document. In such cases it shall be ensured that the requirements of safety, reliability and durability implicit from the requirements of this document are met. This applies to all phases of planning, design, construction, transportation, installation, service in-place and possible removal.

NOTE Regional information can be found in Annex A.

5.3 Overall planning requirements

5.3.1 General

A concrete offshore structure shall be planned in such a manner that it will meet all requirements related to its functions and use, while at the same time providing adequate levels of structural safety, reliability and durability.

All functional requirements including operational issues and environmental setting affecting the layout and design of the structure shall be established in a clear format such that these can form the basis for the engineering process and the structural design. All functional and operational requirements in temporary and in-service phases, as well as robustness against accidental situations that can influence

the layout and the structural design, shall be considered. The exposure level shall be defined according to 6.6.

Site-specific data such as water depth, environmental conditions and soil properties shall be sufficiently known and documented to serve as a basis for the design.

Investigation of site-specific data, such as seabed topography, geo-hazards (shallow gas, boulders, etc.), soil conditions and environmental conditions including ice and icebergs, as appropriate, shall be carried out in accordance with the requirements of ISO 19901-1, ISO 19901-2, ISO 19901-4, ISO 19901-8 and ISO 19906.

5.3.2 Quality system

The quality system shall comply with the requirements of ISO 19900 and specific requirements quoted for the various engineering disciplines in this document.

All work performed in accordance with this document shall be subject to quality control in accordance with an implemented quality plan. There can be one quality plan covering all activities or one overall plan with separate plans for the various phases and activities to be performed.

The quality plan shall ensure that all responsibilities are defined. An interface manual should be developed that defines all interfaces between the various parties and disciplines involved, and ensures that responsibilities, reporting and information routines are established as appropriate.

5.3.3 Qualifications of personnel

The qualifications of personnel shall comply with the requirements of ISO 19900 and specific requirements quoted for the various engineering disciplines in this document.

5.3.4 Documentation

Documentation shall be prepared for all activities that are to be performed in the engineering, design, construction, transportation, installation and possible removal of concrete offshore structures.

This documentation shall be sufficient to give complete information about the structure including the following:

- investigations establishing data on which the design is based;
- design briefs for major elements of design such as concrete, mechanical outfitting, foundation, etc.;
- engineering reports, design reports and calculations;
- drawings, specifications, etc.

Documentation shall also be prepared showing records of all inspection and control of materials used and execution work performed that has an impact on the quality of the final product. This documentation shall be in accordance with the requirements in ISO 22966. Annex A of ISO 22966:2009 provides to the project team guidance to determine the minimum list of documents and content of execution specification required from contractors and suppliers.

Necessary procedures and manuals shall be prepared to ensure that the construction, transportation, installation and in-service inspection are performed in a controlled and safe manner in full compliance with all assumptions of the design.

The assumptions on which the design, construction and installation work is based with regard to the load-bearing structures shall be presented in a summary report. The summary report shall be available and suitable for use in connection with operation, maintenance, alterations and possible repair work.

An operations manual shall be prepared giving all necessary information for the safe operation of the concrete offshore structure including all systems.

5.4 Functional requirements

5.4.1 General

The engineering of a concrete offshore structure shall be performed in such a way that all functional and operational requirements relating to its safety and its operation as an offshore platform are met.

The functional requirements affect the layout of the structure as well as the design situation that shall be considered in the design of the structure. The functional requirements are related both to the site-specific conditions and to the structure as a production or storage facility for the production of hydrocarbons, or any other activities in the operation of a field.

5.4.2 Position on site

The structure shall be positioned and oriented on site taking into account the reservoir, construction requirements, other platforms in the vicinity, operations, accessibility by ships and helicopters, and safety in case of fire or leakages of hydrocarbons. Position tolerance is to be defined by the owner.

5.4.3 Environmental considerations

There shall be a site-specific evaluation of all types of environmental conditions that can affect the layout and design of the structure, including rare events with a low probability of occurrence.

The deck elevation shall be determined such that it provides an adequate air gap, based on site-specific data, allowing the passage of wave crests higher than the design wave crest and icebergs or sea ice, in accordance with ISO 19901-1 and ISO 19906, as appropriate.

Green water effects on the deck of floating structures shall be considered in accordance with ISO 19904-1.

Due account shall be taken of wave crest modifications caused by the structure, caisson effect, local or regional features of the sea floor, storm surge, uncertainty in water depth including platform placement tolerance, wave diffraction by nearby structures, and wave run-up along the shafts.

It can be impractical to set the deck elevation to avoid impact from wave run-up along the shafts of multi-leg structures or up the sides of caissons. Potential detrimental effects of wave run up along shafts of multi-leg structures or up the sides of caissons may be mitigated by use of wave deflectors or other structural components that can resist those forces.

The water depth used in establishing layout and in design shall be based on site-specific data taking due account of potential settlements, including subsidence, etc.

A wave model test early in the design phase may be used to determine the air gap.

5.4.4 Platform operational requirements

The functional requirements related to the production system shall be determined by the owner and could include:

- a) design life;
- b) layout of production wells, risers and pipelines, etc.;
- c) storage volume, compartmentalization, densities, temperatures, etc. in case of stored products;
- d) safeguards against hydrocarbon spillage, leakage and contamination;
- e) access requirements, both internal and external, for operation, inspection and condition monitoring, etc.;
- f) interface to topsides;
- g) requirements for supply boats and other vessels servicing the platform;
- h) future tiebacks;
- i) hydrocarbon loading or offloading systems.

All hazards (fire, explosions, loss of intended pressure differentials, flooding, leakages, rupture of pipe systems, falling objects, ship impacts, etc.) that can be reasonably foreseen during operations shall be established and evaluated.

5.5 Structural requirements

5.5.1 General

Structures and structural members shall perform satisfactorily during all design situations, with respect to structural strength, ductility, durability, displacements, settlements and vibrations. The structure and its layout shall be such that it serves as a safe and functional base for all the mechanical and other installations that are needed for it to operate. Adequate performance shall be demonstrated in design documentation.

5.5.2 Structural concept requirements

The structural concept, details and components shall be such that the structure:

- a) has adequate robustness (reserve strength, ductility) where local damage (dropped objects, vessel collision) will neither impair overall structural integrity nor hydrocarbon containment;
- b) can be constructed in a controlled and efficient manner;
- c) is adequately protected from corrosion and other degradation throughout the design life;
- d) is suitable for condition monitoring, maintenance and repair, if required;
- e) fulfils requirements for decommissioning and removal, if required;
- f) maintains deflections and motions within acceptable limits both during floating conditions and at permanent location;
- g) meets water/oil leak-tightness requirements.

5.5.3 Materials requirements

The materials selected shall be suitable for the purpose and meet requirements of the design standard. The material properties and the verification that these materials fulfil the requirements shall be documented.

It shall be ensured that the specified quality of the materials, all structural components and the physical structure itself is maintained during all stages of construction.

5.5.4 Execution requirements

Requirements for execution, testing and inspection of the various parts of the structure shall be specified on the basis of the significance of the various parts with regard to the overall safety of the completed and installed structure as well as to the structure in temporary phases.

5.5.5 Temporary phases requirements

The structure shall be designed for all phases with the same intended reliability as for the final condition unless otherwise agreed. This applies also to temporary moorings or anchorage systems applied to those construction phases when the structure is afloat.

For all floating phases during marine operations or construction, sufficient positive stability and reserve buoyancy shall be ensured. Both intact and damaged stability shall be evaluated on the basis of an accurate geometric model for each condition. Adequate freeboard shall be provided. One-compartment damage stability should normally be provided. For short transient phases, the one-compartment damage stability may be waived, provided this can be justified by a risk analysis.

Weight control required for temporary phases should be performed by means of a well-defined, documented, robust and proven weight control method. Procedures shall be in accordance with ISO 19901-5. The system should provide up-to-date weight reports containing the necessary data for all operations.

5.6 Design requirements

5.6.1 General

The structural design of a concrete offshore structure and its foundation design shall be in accordance with this document. The design shall be performed according to the principles of limit state design as defined in ISO 19900.

The design shall provide adequate strength and tightness in all design situations such that the assumptions made are complied with.

The design of structural steel components shall be in accordance with ISO 19902 and ISO 19901-3, as applicable.

5.6.2 Design actions

The representative values of actions shall be selected according to 6.2.

The partial factors for actions shall be chosen with respect to the limit states and the combination of actions concerned. Values are given in 6.4.

5.6.3 Design resistance

The characteristic resistance of a cross-section or a member shall be derived from characteristic values of material properties and nominal geometrical dimensions.

The design resistance is obtained by amending the characteristic values by the use of appropriate partial factors for materials.

5.6.4 Characteristic values for material strength

The characteristic strength of materials shall be determined according to the relevant design standards and recognized standards for material testing.

For concrete, the 28 days characteristic compressive strength f_{ck} is defined as a 5 % fractile value (5th percentile) found from statistical analysis of testing 150 mm × 300 mm cylindrical specimens.

NOTE 1 In some standards a nominal compressive strength f_{cn} is used, which is less than f_{ck} ; this considers transition of test strength into *in situ* strength and ageing effects due to high sustained stresses. If this nominal value is used for the calculation of design strength, reduced partial factors for materials reflecting this can be applied.

NOTE 2 In some design standards, limits are placed on the upper characteristic strength, which can reflect local construction practice. Such limits may be relaxed if adequate justification can be provided, including testing of the concrete mix and aggregates, where appropriate.

For reinforcement steel, the specified minimum yield stress shall be taken as the characteristic strength f_{yk} ; for prestressing, the 0,1 % proof stress may be applied.

Values for geotechnical analyses shall be determined according to ISO 19901-4. Any deteriorating effects during the operation phase shall be taken into consideration.

For the fatigue limit state (FLS), the characteristic material strength shall be determined statistically as a 5 % fractile for reinforcement, prestressing assemblies, couplers, welded connections, etc., unless other values are specified in the reference standard for design. For concrete, normally a design reference strength shall be used. For other materials, acceptance criteria shall be specified which offer a safety level equivalent to that of the requirements in this document. The reference standard used for design should give key fatigue parameters for concrete, reinforcement and prestressing in marine environment.

Where high resistance of a member is unfavourable (e.g. in weak link considerations), an upper value of the characteristic resistance shall be used in order to give a low probability of failure of the adjoining structure. The upper value shall be chosen with the same level of probability of exceedance as the probability of lower values being underscored. In such cases, the partial factor for material shall be 1,0 for calculating the resistance that is used when actions are applied on adjoining members.

5.6.5 Partial factors for structural materials

The partial factors for the materials in reinforced concrete shall be chosen in accordance with the reference standard for the design and for the limit state considered.

For structural steel members in the mechanical outfitting, embedment, skirts, etc., the partial resistance factor shall be in accordance with ISO 19902.

5.6.6 Design by testing

Where actions acting on a structure or the resistance of materials or structural members cannot be determined with reasonable accuracy, model tests should be considered.

Characteristic resistances of structural details, structural members or parts may be verified by a combination of tests and calculations.

A test structure, a test structural detail or a test model shall be sufficiently similar to the structure to be considered representative of the actual structure. The results of the tests shall provide a basis for a reliable interpretation in accordance with a recognized standard. Scale effects shall be taken into account where relevant.

6 Action and action effects

6.1 General

6.1.1 Classification of actions

In accordance with ISO 19900, actions are classified as:

- permanent actions (G);
- variable actions (Q);
- environmental actions (E);
- accidental actions (A).

Although ISO 19900 defines actions resulting from imposed deformation (D) as permanent actions, in this document they are treated differently (see 6.3.3).

The actions shall include the corresponding external reactions. The representative actions shall be chosen according to the design situation under investigation. The following design situations are distinguished:

- normal operations;
- temporary and transient situations including construction (dry-dock and deep water site) transportation, and installation;
- accidental and abnormal situations;
- damaged situations;
- decommissioning.

6.1.2 Determination of action effects

Action effects shall be determined by means of recognized methods that take into account the variation of the action in time and space, the configuration and stiffness of the structure, relevant soil conditions and the limit state that is under consideration. For floating structures, reference may be made to ISO 19904-1 for the determination of action effects.

Simplified methods for computing actions may be applied, if it can be verified that they produce conservative results.

Dynamic or non-linear effects shall be considered where appropriate.

Hydrodynamic and aerodynamic actions, and the associated action effects, shall be determined by methods which take the kinematics of the liquid or air into account. For hydrodynamic actions the interaction between liquid, structure and soil shall be considered. For calculation of overall action effects from wind, simplified models normally suffice.

Seismic actions shall be considered in accordance with ISO 19901-2 and 7.5.7.

When determining the soil reactions used in the calculation of action effects in the structure, the soil-structure interaction shall be accounted for. An appropriate range of key parameters should be used to ensure that all realistic patterns of distribution are enveloped, considering long- and short-term effects, unevenness of the sea floor, degrees of elasticity and plasticity in the soil and, if relevant, in the structure.

6.2 Environmental actions

6.2.1 General

Wind, wave, tide and current are important sources of environmental actions (E) on many structures located offshore. In addition, seismic actions (see 6.2.5), ice actions (see 6.2.6) or both can be significant environmental actions, depending on location.

The determination of actions due to wind, wave and current requires an appropriate description of the physical environment in the form of sea state severity and direction, associated wind speed and direction, and relevant current descriptions in terms of current velocity profiles through the depth and associated directional information. The derivation of wind, wave and current combinations required for the calculation of actions is described in ISO 19901-1.

Actions from wind, wave and current occur as a result of various mechanisms. The most important sources of action are:

- viscous or drag effects, which are generally of most importance for relatively slender bodies;
- inviscid effects due to inertia of the water particles and wave diffraction, which are generally of most importance in terms of global effects for relatively large-volume bodies.

For fixed concrete offshore structures, static analyses can be adequate, but the possibility that dynamic analysis is required for local behaviour of components or for the global behaviour of the whole platform shall be investigated. In the specific case of wave action, the possibility that non-linear effects can lead to responses at frequencies either above or below the frequency range in the wave spectrum shall be investigated. This applies to the as-installed situation at the permanent location as well as to floating situations.

Possible ringing effects shall be included in the considerations of wave actions on particular types of concrete offshore structures, normally single-shafted. When a steep, high wave encounters a shaft, non-linear, higher-order frequency components of wave actions can coincide with natural frequencies of the structure causing resonant transient response. Such ringing effects are only of significance in combination with extreme first order wave frequency effects. CFD analysis procedures may be used to evaluate the magnitude of the wave actions.

Potential dynamic effects due to local or global actions shall also be investigated.

Environmental actions shall also be considered for temporary configurations of the structure during construction, tow and installation, including any inertial actions resulting from accelerations of the structure. The complete design life cycle of the structure, from initial construction to removal, shall be considered and appropriate combinations of actions shall be determined to define design situations for all phases.

6.2.2 Wave action

6.2.2.1 General

Wave actions from hazards conditions shall be determined by means of an appropriate analysis procedure and supplemented, by a model test programme, if required. Global actions on the structure and local actions on various appurtenances, attachments and components shall be determined.

Impulsive global and local wave actions shall be considered, e.g. slamming. These effects can be significant for structures where the water level above the caisson is small compared to the wave-height.

The appropriate analysis procedure for computing wave actions generally depends on the ratio of wavelength to a characteristic dimension of the structure, such as the diameter of a cylinder or caisson. For ratios less than approximately five, a procedure such as diffraction analysis shall be applied that accounts for the interaction of the structure with the incident wave-field. For higher ratios, a slender-body theory such as the Morison equation may be used. Where drag forces are important in this regime, both methods should be applied in combination. In some cases, such as in the computation of local actions on various external attachments to a structure, both procedures can be required.

Model testing should be considered for supplementing analytical results, particularly in cases where it is anticipated that non-linear effects can be significant, or where previous experience is not directly applicable because of the configuration of the structure.

6.2.2.2 Slender-body theory

The Morison equation can be appropriate for application to determine wave actions on slender members. The local wave kinematics are considered to be unaffected by the presence of the structural component under investigation, but local kinematics can be significantly influenced by adjacent structures.

The required inertia and drag coefficients for application in the Morison equation shall be based on recognized procedures such as those given in ISO 19902.

The Morison equation shall be applied:

- with a regular (single-period) extreme wave;
- with irregular sea states in the time domain;
- with spectral representations in the frequency domain using appropriate linearization of the drag term.

The Morison equation may also be applied to calculate local actions from the kinematics around a global structure derived from diffraction theory.

The Morison equation does not account for various non-linear or higher order interactions between wave and structure such as slamming or ringing.

6.2.2.3 Diffraction analyses

6.2.2.3.1 General

Global actions on large-volume bodies shall generally be determined by applying a validated diffraction analysis procedure. In addition, the design of various appurtenances shall be evaluated, including incident kinematics, diffraction and (if necessary) radiation effects.

The fundamental assumption of diffraction analysis is that the fluid is inviscid and that the oscillatory motions of both the waves and of the structure are sufficiently small to permit the assumption of linearity. The hydrodynamic interaction between waves and a structure can then be predicted based on linearized three-dimensional potential theory.

CFD analysis procedures may be employed on shallow water structures, on surface-piercing structures that will be overtopped by the progressing wave or on structures with significantly varying cross-section near the waterline, within the likely wave-affected zone. The CFD analysis may either complement or replace the diffraction analysis.

6.2.2.3.2 Methods

Diffraction procedures shall generally be implemented through well-verified computer programs, typically based on source/sink (Green's function) panel methods or similar procedures.

6.2.2.3.3 Special considerations for panel methods

Diffraction analysis using panel methods shall be executed with an adequate grid density to provide a solution with the required accuracy.

Diffraction models shall be combined with Morison models in the assessment of various relatively slender attachments to large-volume structures. Diffraction methods provide the required kinematics field, the Morison equation may be applied to compute resulting actions on slender attachments.

The proximity of additional relatively large-volume structures shall be included in assessing actions. Disturbances to the kinematics field around two or more structures can interact and this interaction shall be accounted for in the analysis.

Careful consideration shall be given to possible pressure fluctuations on the base of a structure during the passage of a wave field. If the foundation conditions are such that pressure fluctuations are expected to occur on the base, then such pressure fluctuations shall be included in the analysis.

Diffraction analysis programs may be used to determine coefficients required in the evaluation of various non-linear effects, typically involving sum and/or difference frequencies.

6.2.2.4 Additional requirements for dynamic analysis

In cases where the structure can respond dynamically, the additional effects associated with the motions of the structure shall be determined. Typically, these additional effects shall be captured in additional inertia and damping terms in the dynamic analysis. Structures can, for example, respond dynamically in the as-installed situation due to wave or seismic actions, or in floating situations due to wave or wind actions.

The effects of motions of the structure on internal fluids such as ballast water in tanks shall also be evaluated. Sloshing in tanks generally affects the pressures, particularly near the free surface of the fluid.

6.2.2.5 Model testing

6.2.2.5.1 Role of model testing

Model test should be considered in the following circumstances:

- Verification of analytical procedures: model tests should be performed to confirm the results of analytical procedures, particularly for cases with structures of unusual shape, for structures in shallow water with steep extreme waves, for the assessment of potential for sea-bed scouring or for any other case where known limitations of analytical procedures are present.
- Complementing analytical procedures: model tests should be performed where various effects such as ringing, wave run-up, potential occurrence of slamming are suspected, or in cases where the higher order terms that are neglected in analytical procedures can be important.

6.2.2.5.2 Scaling of model tests

Froude scaling is normally appropriate for typical gravity-driven processes like waves acting on large-volume structures. However, in any decision to apply Froude scaling, the possible influence of viscosity and Reynolds number effects should be considered.

6.2.2.5.3 Validation of model tests

Actions determined by model test shall be validated by comparison with analytical solutions or with the results of prior appropriate test programmes.

6.2.2.5.4 Estimation of actions

Sufficient data shall be gathered to perform reliable statistical analysis to determine wave actions. Data can include:

- the time history of the local instantaneous air/water surface elevation at various locations;
- local particle kinematics;
- global actions, such as base shear, vertical load or overturning moment, as well as local actions in the form of the pressure distribution on individual components;
- structural response, such as displacements and accelerations, particularly if dynamic response occurs.

Model test data shall be converted to full scale by appropriate factors consistent with the physical scaling procedures applied in the test programme.

6.2.2.5.5 Limitations of model testing

Analogous with analytical procedures, model test results have inherent limitations that shall be considered in assessing the validity of resulting actions. The primary sources of inherent limitations include the following:

- Surface tension effects: these are not allowed for in model test programme definition in general and can be significant, particularly where large-scale factors are applied.
- Viscous effects: the Reynolds number is not accurately scaled in general, and these effects are important where viscosity is significant, such as in the prediction of drag or damping effects.
- Air/water mixing and air entrainment: various actions that depend on this phenomenon, such as slamming actions, will not be accurately scaled in typical Froude-scale-based model tests in general.

The influence of particular effects on actions determined in model tests shall be assessed and steps shall be taken in the testing programme to reduce or minimize them. Such effects can be:

- wave reflections from the ends of model test basins;
- scattering of waves from large-volume structures;
- reflection of spurious scattered waves from model basin sidewalls interfering with target design wave conditions;
- breakdown of wave trains representing the target design wave due to various instabilities leading to an inaccurate realization of design wave conditions;
- difficulties in the inclusion of wind or currents in association with wave fields.

6.2.3 Current action

6.2.3.1 General

Currents, including directionality over the water column, shall be combined with the design wave conditions.

The disturbance of the incident current field due to the presence of the structure shall be accounted for.

6.2.3.2 Methods

Current actions on platforms shall be determined using recognized procedures. Typical methods are based on the use of empirical coefficients accounting for area, shape, shielding, etc. Such empirical coefficients shall be validated. Model tests or analytical procedures or both shall be considered to validate computed current actions.

Analytical procedures based on CFD may be used in the evaluation of current actions or other effects associated with current. Only well-validated implementations of the CFD procedure shall be used in the computation of current effects. The method can provide a more economic and reliable procedure for predicting drag forces than physical modelling techniques.

6.2.3.3 Local effects

Disturbances of the incident current field lead to modifications in the local current velocity in the vicinity of the structure. Actions on local attachments to the structure shall be computed based on the modified current field. The possibility of vortex-induced vibrations on various attachments shall be investigated.