

# DIN EN ISO 19903:2020-07 (E)

Petroleum and natural gas industries - Concrete offshore structures (ISO 19903:2019); English version EN ISO 19903:2019, only on CD-ROM

---

<b>Contents</b>		Page
<b>Foreword</b>		<b>viii</b>
<b>Introduction</b>		<b>ix</b>
<b>1</b>	<b>Scope</b>	<b>1</b>
<b>2</b>	<b>Normative references</b>	<b>1</b>
<b>3</b>	<b>Terms and definitions</b>	<b>2</b>
<b>4</b>	<b>Symbols and abbreviated terms</b>	<b>8</b>
4.1	Symbols	8
4.2	Abbreviated terms	10
<b>5</b>	<b>General requirements</b>	<b>10</b>
5.1	General	10
5.2	Overall planning requirements	11
5.2.1	General	11
5.2.2	Quality system	11
5.2.3	Qualifications of personnel	11
5.2.4	Documentation	11
5.3	Functional requirements	12
5.3.1	General	12
5.3.2	Position on site	12
5.3.3	Environmental considerations	12
5.3.4	Platform operational requirements	13
5.4	Structural requirements	13
5.4.1	General	13
5.4.2	Structural concept requirements	13
5.4.3	Materials requirements	14
5.4.4	Execution requirements	14
5.4.5	Temporary phases requirements	14
5.5	Design requirements	14
5.5.1	General	14
5.5.2	Design actions	14
5.5.3	Design resistance	14
5.5.4	Characteristic values for material strength	15
5.5.5	Partial factors for structural materials	15
5.5.6	Design by testing	15
<b>6</b>	<b>Action and action effects</b>	<b>16</b>
6.1	General	16
6.1.1	Classification of actions	16
6.1.2	Determination of action effects	16
6.2	Environmental actions	17
6.2.1	General	17
6.2.2	Wave actions	17
6.2.3	Current actions	20
6.2.4	Seismic actions	21
6.2.5	Ice actions	21
6.3	Other actions	22
6.3.1	Permanent actions	22
6.3.2	Variable actions	22
6.3.3	Actions from imposed deformations	22
6.3.4	Accidental actions	23

6.4	Partial factors for actions.....	26
6.5	Combinations of actions.....	27
6.6	Exposure levels.....	28
<b>7</b>	<b>Structural analyses.....</b>	<b>29</b>
7.1	General.....	29
7.2	General principles.....	29
7.2.1	Planning.....	29
7.2.2	Extent of analyses.....	30
7.2.3	Analysis requirements.....	30
7.2.4	Calculation methods.....	31
7.2.5	Verification of analysis results.....	31
7.2.6	Documentation.....	32
7.3	Physical representation.....	32
7.3.1	Geometrical definition.....	32
7.3.2	Material properties.....	33
7.3.3	Soil-structure interaction.....	34
7.3.4	Other support conditions.....	34
7.3.5	Actions.....	35
7.3.6	Mass simulation.....	36
7.3.7	Damping.....	37
7.4	Types of analysis.....	37
7.4.1	Static linear elastic analysis.....	37
7.4.2	Dynamic analysis.....	37
7.4.3	Non-linear analysis.....	39
7.4.4	Probabilistic analysis.....	40
7.4.5	Reliability analysis.....	40
7.4.6	Discontinuity region analysis.....	40
7.5	Analysis requirements.....	40
7.5.1	General.....	40
7.5.2	Analysis of construction stages.....	40
7.5.3	Transportation analysis.....	41
7.5.4	Installation and deck mating analysis.....	41
7.5.5	In-service strength and serviceability analysis.....	41
7.5.6	Fatigue analysis.....	42
7.5.7	Seismic analysis.....	42
7.5.8	Analysis of accidental or abnormal design situations.....	44
<b>8</b>	<b>Concrete works.....</b>	<b>45</b>
8.1	Design.....	45
8.1.1	Reference standard for design.....	45
8.1.2	Design principles for shell members.....	45
8.1.3	Design principles for transverse shear.....	45
8.1.4	Design principles for fatigue.....	45
8.1.5	Design principles for durability.....	46
8.1.6	Design principles for liquid tightness.....	46
8.1.7	Design principles for prestressed concrete.....	46
8.1.8	Design principles for second order effects.....	47
8.1.9	Principles for handling water pressure in pores and cracks.....	47
8.1.10	Design principles for discontinuity regions.....	47
8.1.11	Design principles for imposed deformations.....	47
8.1.12	Increase in strength of concrete with time.....	47
8.1.13	Design for fire resistance.....	47
8.1.14	Design for earthquakes.....	47
8.1.15	Design of embedments.....	48
8.1.16	Treatment of early-age and drying shrinkage effects.....	48
8.1.17	Partial factors for material.....	48
8.2	Materials requirements.....	48
8.2.1	General.....	48
8.2.2	Concrete constituents.....	49
8.2.3	Concrete.....	52

	8.2.4	Reinforcement.....	54
	8.2.5	Prestressing steel.....	55
	8.2.6	Embedded materials.....	55
8.3		Execution.....	55
	8.3.1	Falsework and formwork.....	55
	8.3.2	Reinforcement.....	58
	8.3.3	Pre- and post-tensioning.....	59
	8.3.4	Concreting.....	62
	8.3.5	Execution with precast concrete elements.....	66
	8.3.6	Embedded components.....	68
8.4		Geometrical tolerances.....	68
	8.4.1	General.....	68
	8.4.2	Reference system.....	69
	8.4.3	Tolerances of structural members.....	69
	8.4.4	Cross-sectional tolerances.....	70
	8.4.5	Embedments and penetrations.....	70
8.5		Quality control — Inspection, testing and corrective actions.....	71
	8.5.1	General.....	71
	8.5.2	Inspection of materials and products.....	71
	8.5.3	Inspection of execution.....	71
		<b>Foundation design.....</b>	<b>74</b>
9.1		General.....	74
9.2		Principal elements.....	75
9.3		Marine site investigation.....	75
	9.3.1	Purpose of investigation.....	75
	9.3.2	Soil investigation.....	75
	9.3.3	Laboratory investigation.....	75
9.4		Characteristic soil parameters.....	75
9.5		Partial factors for actions and materials.....	76
	9.5.1	General.....	76
	9.5.2	Partial factors for actions.....	76
	9.5.3	Partial factors for materials.....	76
9.6		Geotechnical design principles.....	76
	9.6.1	General.....	76
	9.6.2	Dynamic analysis for action effects.....	77
	9.6.3	SLS.....	77
	9.6.4	FLS.....	77
	9.6.5	ULS.....	77
	9.6.6	ALS.....	78
9.7		Bearing capacity.....	78
9.8		Soil reactions on structures.....	78
9.9		Installation and removal.....	79
	9.9.1	Sea floor preparation.....	79
	9.9.2	Installation.....	79
	9.9.3	Removal.....	79
9.10		Scour.....	79
<b>10</b>		<b>Mechanical systems.....</b>	<b>80</b>
	10.1	General.....	80
	10.2	Permanent mechanical systems.....	80
	10.2.1	General.....	80
	10.2.2	Crude oil storage system.....	81
	10.2.3	Other storage systems.....	83
	10.2.4	Refrigerated gas storage systems.....	83
	10.2.5	Permanent ballast water system.....	83
	10.2.6	Sea water systems.....	84
	10.2.7	Drains, sumps and bilge.....	84
	10.2.8	Vents.....	84
	10.2.9	Safety systems.....	84
	10.2.10	Decks.....	85
	10.2.11	Elevators.....	85

10.2.12	Lifting devices	85
10.2.13	Risers and J-tubes	85
10.2.14	Conductors and shale chutes	86
10.2.15	Access	86
10.2.16	HVAC	86
10.2.17	Structure and foundation condition monitoring	86
10.2.18	External markings	87
10.2.19	Other	87
10.3	Temporary mechanical systems	87
10.3.1	General	87
10.3.2	Air cushion system	87
10.3.3	Temporary ballasting/de-ballasting water system	88
10.3.4	Grouting and skirt evacuation systems	89
10.3.5	Instrumentation for construction, tow and installation of the structure	90
10.3.6	Other systems	90
10.4	Attachments and penetrations	90
10.4.1	Attachments	90
10.4.2	Penetrations	91
10.4.3	Welding	91
10.4.4	Corrosion protection	91
10.5	Special considerations	91
10.5.1	Design, installation and testing of piping	91
10.5.2	Design of pipe supports	92
10.5.3	Design of steel structures	92
10.5.4	Design of equipment	92
10.5.5	Dropped object protection	93
<b>11</b>	<b>Marine operations and construction afloat</b>	<b>93</b>
11.1	General	93
11.2	Engineering and planning	93
<b>12</b>	<b>Corrosion control</b>	<b>94</b>
12.1	General	94
12.1.1	Corrosion control in concrete structures	94
12.1.2	Corrosion zones and environmental parameters affecting corrosivity	94
12.1.3	Forms of corrosion and associated corrosion rates	95
12.2	Design for corrosion control	95
12.2.1	General	95
12.2.2	Criteria for design of corrosion control	95
12.2.3	Coatings and linings	96
12.2.4	Cathodic protection	96
12.2.5	Corrosion-resistant materials	99
12.2.6	Corrosion allowance	100
12.3	Fabrication and installation of systems for corrosion control	100
12.3.1	General	100
12.3.2	Coatings and linings	100
12.3.3	Cathodic protection	100
12.3.4	Corrosion-resistant materials	101
<b>13</b>	<b>Topsides interface design</b>	<b>101</b>
13.1	General	101
13.2	Basis for design	101
13.3	Deck/shaft structural connection	102
13.4	Topsides installation	102
13.5	Transportation, tow-to-field	103
<b>14</b>	<b>Inspection and condition monitoring</b>	<b>103</b>
14.1	General	103
14.2	Objective	103
14.3	Personnel qualifications	103

14.4	Planning.....	103
14.4.1	General.....	103
14.4.2	Basis for planning of inspection and condition monitoring.....	104
14.4.3	Programme for inspection and condition monitoring.....	104
14.4.4	Inspection and condition monitoring intervals.....	104
14.5	Documentation.....	105
14.6	Important items related to inspection and condition monitoring.....	106
14.6.1	General.....	106
14.6.2	Atmospheric zone.....	106
14.6.3	Splash zone.....	107
14.6.4	Submerged zone.....	107
14.6.5	Internal.....	107
14.6.6	Concrete durability.....	108
14.6.7	Corrosion protection.....	108
14.7	Inspection and condition monitoring types.....	108
14.7.1	General.....	108
14.7.2	Structural monitoring and structural safety systems.....	109
14.8	Marking.....	109
14.9	Guidance for inspection of special areas.....	109
14.9.1	General concrete surface.....	109
14.9.2	Steel transition ring/concrete interface.....	110
14.9.3	Construction joints.....	110
14.9.4	Penetrations.....	111
14.9.5	Vertical intersections between different structural parts.....	111
14.9.6	Embedded plates.....	111
14.9.7	Repaired areas.....	111
14.9.8	Splash zone.....	111
14.9.9	Debris.....	111
14.9.10	Scour.....	111
14.9.11	Differential hydrostatic pressure (drawdown).....	112
14.9.12	Temperature of oil sent to storage.....	112
14.9.13	Sulphate reducing bacteria.....	112
14.9.14	Post-tensioning.....	112
<b>15</b>	<b>Assessment of existing structures.....</b>	<b>112</b>
15.1	General.....	112
15.2	Structural assessment initiators.....	113
15.3	Planning for decommissioning.....	113
15.3.1	Planning.....	113
15.3.2	Analysis for removal.....	113
	<b>Bibliography.....</b>	<b>115</b>