

# DIN EN ISO 19902:2008-07 (E)

Petroleum and natural gas industries - Fixed steel offshore structures (ISO 19902:2007); English version EN ISO 19902:2007

---

<b>Contents</b>		Page
Foreword.....		10
Introduction.....		11
1 Scope .....		12
2 Normative references .....		12
3 Terms and definitions.....		13
4 Symbols .....		20
5 Abbreviated terms .....		24
6 Overall considerations .....		26
6.1 Types of fixed steel offshore structure .....		26
6.2 Planning.....		28
6.3 Service and operational considerations.....		28
6.4 Safety considerations.....		29
6.5 Environmental considerations .....		30
6.6 Exposure levels.....		31
6.7 Assessment of existing structures .....		33
6.8 Structure reuse .....		33
7 General design requirements .....		34
7.1 General.....		34
7.2 Incorporating limit states .....		34
7.3 Determining design situations .....		34
7.4 Structural modelling and analysis .....		35
7.5 Design for pre-service and removal situations .....		35
7.6 Design for the in-place situation .....		35
7.7 Determination of resistances .....		35
7.8 Strength and stability checks.....		36
7.9 Robustness .....		37
7.10 Reserve strength.....		37
7.11 Indirect actions .....		37
7.12 Structural reliability analysis.....		38
8 Actions for pre-service and removal situations .....		38
8.1 General.....		38
8.2 General requirements.....		39
8.3 Actions associated with lifting .....		41
8.4 Actions associated with fabrication .....		44
8.5 Actions associated with loadout.....		44
8.6 Actions associated with transportation .....		45
8.7 Actions associated with installation.....		46
8.8 Actions associated with removal .....		47
9 Actions for in-place situations .....		47
9.1 General.....		47
9.2 Permanent actions ( $G$ ) and variable actions ( $Q$ ).....		47
9.3 Extreme environmental action due to wind, waves and current .....		49
9.4 Extreme quasi-static action due to wind, waves and current ( $E_e$ ).....		50
9.5 Extreme quasi-static action caused by waves only ( $E_{we}$ ) or by waves and currents ( $E_{wce}$ ) .....		52
9.6 Actions caused by current.....		57
9.7 Actions caused by wind.....		58

9.8	Equivalent quasi-static action representing dynamic response caused by extreme wave conditions .....	59
9.9	Factored actions .....	61
9.10	Design situations .....	62
9.11	Local hydrodynamic actions.....	64
10	Accidental situations .....	65
10.1	General .....	65
10.2	Vessel collisions .....	69
10.3	Dropped objects .....	70
10.4	Fires and explosions .....	70
10.5	Abnormal environmental actions .....	70
11	Seismic design considerations .....	71
11.1	General .....	71
11.2	Seismic design procedure .....	71
11.3	Seismic reserve capacity factor .....	72
11.4	Recommendations for ductile design.....	72
11.5	ELE requirements .....	74
11.6	ALE requirements .....	75
11.7	Topsides appurtenances and equipment .....	77
12	Structural modelling and analysis .....	78
12.1	Purpose of analysis .....	78
12.2	Analysis principles .....	79
12.3	Modelling.....	79
12.4	Analysis requirements.....	86
12.5	Types of analysis .....	92
12.6	Non-linear analysis .....	94
13	Strength of tubular members .....	97
13.1	General .....	97
13.2	Tubular members subjected to tension, compression, bending, shear or hydrostatic pressure .....	98
13.3	Tubular members subjected to combined forces without hydrostatic pressure .....	105
13.4	Tubular members subjected to combined forces with hydrostatic pressure.....	107
13.5	Effective lengths and moment reduction factors .....	110
13.6	Conical transitions .....	112
13.7	Dented tubular members.....	122
13.8	Corroded tubular members.....	129
13.9	Grouted tubular members .....	129
14	Strength of tubular joints .....	134
14.1	General .....	134
14.2	Design considerations.....	135
14.3	Simple circular tubular joints.....	143
14.4	Overlapping circular tubular joints .....	149
14.5	Grouted circular tubular joints .....	150
14.6	Ring stiffened circular tubular joints .....	150
14.7	Other circular joint types.....	150
14.8	Damaged joints .....	150
14.9	Noncircular joints.....	151
14.10	Cast joints .....	151
15	Strength and fatigue resistance of other structural components.....	151
15.1	Grouted connections .....	151
15.2	Mechanical connections.....	158
15.3	Clamps for strengthening and repair.....	162
16	Fatigue.....	166
16.1	General .....	166
16.2	General requirements .....	167
16.3	Description of the long-term wave environment .....	170

16.4	Performing the global stress analyses.....	172
16.5	Characterization of the stress range data governing fatigue.....	175
16.6	The long-term local stress range history .....	176
16.7	Determining the long-term stress range distribution by spectral analysis .....	178
16.8	Determining the long-term stress range distribution by deterministic analysis .....	182
16.9	Determining the long-term stress range distribution by approximate methods.....	182
16.10	Geometrical stress ranges.....	183
16.11	Fatigue resistance of the material.....	185
16.12	Fatigue assessment.....	187
16.13	Other causes of fatigue damage than wave action .....	188
16.14	Further design considerations .....	189
16.15	Fracture mechanics methods.....	191
16.16	Fatigue performance improvement of existing components .....	192
17	Foundation design.....	193
17.1	General.....	193
17.2	Pile foundations .....	194
17.3	General requirements for pile design .....	195
17.4	Pile capacity for axial compression.....	196
17.5	Pile capacity for axial tension .....	201
17.6	Axial pile performance .....	201
17.7	Soil reaction for piles under axial compression.....	202
17.8	Soil reaction for piles under lateral actions .....	205
17.9	Pile group behaviour .....	209
17.10	Pile wall thickness .....	210
17.11	Length of pile sections.....	212
17.12	Shallow foundations.....	213
18	Corrosion control.....	214
18.1	General.....	214
18.2	Corrosion zones and environmental parameters affecting corrosivity .....	214
18.3	Forms of corrosion, associated corrosion rates and corrosion damage .....	215
18.4	Design of corrosion control.....	215
18.5	Fabrication and installation of corrosion control.....	220
18.6	In-service inspection, monitoring and maintenance of corrosion control .....	221
19	Materials .....	222
19.1	General.....	222
19.2	Design philosophy .....	223
19.3	Strength groups .....	225
19.4	Toughness classes .....	225
19.5	Applicable steels.....	226
19.6	Cement grout for pile-to-sleeve connections and grouted repairs. ....	227
20	Welding, fabrication and weld inspection .....	228
20.1	General.....	228
20.2	Welding .....	229
20.3	Inspection .....	235
20.4	Fabrication.....	236
21	Quality control, quality assurance and documentation.....	239
21.1	General.....	239
21.2	Quality management system .....	239
21.3	Quality control plan .....	240
21.4	Inspection of installation aids and appurtenances .....	241
21.5	Inspection of loadout, sea-fastening and transportation .....	242
21.6	Installation inspection .....	242
21.7	Documentation.....	243
21.8	Drawings and specifications .....	245
22	Loadout, transportation and installation.....	245
22.1	General.....	245
22.2	Loadout and transportation .....	246

22.3	Transfer of the structure from the transport barge into the water.....	248
22.4	Placement on the sea floor and assembly of the structure.....	249
22.5	Pile installation.....	251
22.6	Installation of conductors.....	256
22.7	Topsides installation.....	257
22.8	Grounding of installation welding equipment.....	258
23	In-service inspection and structural integrity management.....	258
23.1	General.....	258
23.2	Data collection and update.....	260
23.3	Evaluation.....	260
23.4	Inspection strategy.....	262
23.5	Inspection programme.....	264
23.6	Inspection requirements.....	264
23.7	Default periodic inspection requirements.....	267
23.8	Personnel qualifications.....	269
24	Assessment of existing structures.....	270
24.1	General.....	270
24.2	Assessment process.....	270
24.3	Data collection.....	273
24.4	Structural assessment initiators.....	274
24.5	Acceptance criteria.....	275
24.6	Structure condition assessment.....	276
24.7	Actions assessment.....	276
24.8	Screening assessment.....	277
24.9	Resistance assessment.....	277
24.10	Prevention and mitigation.....	280
25	Structure reuse.....	280
25.1	General.....	280
25.2	Fatigue considerations for reused structures.....	280
25.3	Steel in reused structures.....	280
25.4	Inspection of structures to be reused.....	281
25.5	Removal and reinstallation.....	282
25.6	In-service inspection and structural integrity management.....	282
Annex A	(informative) Additional information and guidance.....	283
A.1	Scope.....	283
A.2	Normative references.....	283
A.3	Terms and definitions.....	283
A.4	Symbols.....	283
A.5	Abbreviated terms.....	283
A.6	Overall considerations.....	283
A.6.1	Types of fixed steel offshore structure.....	283
A.6.2	Planning.....	283
A.6.3	Service and operational considerations.....	283
A.6.4	Safety considerations.....	285
A.6.5	Environmental considerations.....	285
A.6.6	Exposure levels.....	285
A.6.7	Assessment of existing structures.....	287
A.6.8	Structure reuse.....	287
A.7	General design requirements.....	287
A.7.1	General.....	287
A.7.2	Incorporating limit states.....	287
A.7.3	Determining design situations.....	287
A.7.4	Structural modelling and analysis.....	287
A.7.5	Design for pre-service and removal situations.....	287
A.7.6	Design for the in-place situation.....	288
A.7.7	Determination of resistances.....	288
A.7.8	Strength and stability checks.....	293
A.7.9	Robustness.....	293

A.7.10	Reserve strength .....	305
A.7.11	Indirect actions .....	306
A.7.12	Structural reliability analysis.....	306
A.8	Actions for pre-service and removal situations .....	306
A.8.1	General .....	306
A.8.2	General requirements .....	307
A.8.3	Actions associated with lifting.....	307
A.8.4	Actions associated with fabrication .....	309
A.8.5	Actions associated with loadout .....	309
A.8.6	Actions associated with transportation .....	309
A.8.7	Actions associated with installation .....	310
A.8.8	Actions associated with removal.....	310
A.9	Actions for in-place situations .....	311
A.9.1	General .....	311
A.9.2	Permanent actions ( $G$ ) and variable actions ( $Q$ ).....	311
A.9.3	Extreme environmental action due to wind, waves and current .....	312
A.9.4	Extreme quasi-static action due to wind, waves and current ( $E_e$ ).....	312
A.9.5	Extreme quasi-static action caused by waves only ( $E_{we}$ ) or by waves and currents ( $E_{wce}$ ).....	313
A.9.6	Actions caused by current .....	327
A.9.7	Actions caused by wind.....	327
A.9.8	Equivalent quasi-static action representing dynamic response caused by extreme wave conditions.....	327
A.9.9	Factored actions .....	332
A.9.10	Design situations.....	335
A.9.11	Local hydrodynamic actions .....	336
A.10	Accidental situations .....	338
A.10.1	General .....	338
A.10.2	Vessel collisions.....	338
A.10.3	Dropped objects .....	339
A.10.4	Fires and explosions .....	339
A.10.5	Abnormal environmental actions .....	339
A.11	Seismic design considerations.....	340
A.11.1	General .....	340
A.11.2	Seismic design procedure.....	340
A.11.3	Seismic reserve capacity factor.....	340
A.11.4	Recommendations for ductile design .....	340
A.11.5	ELE requirements .....	340
A.11.6	ALE requirements.....	340
A.11.7	Topsides appurtenances and equipment .....	341
A.12	Structural modelling and analysis .....	341
A.12.1	Purpose of analysis.....	341
A.12.2	Analysis principles .....	341
A.12.3	Modelling.....	342
A.12.4	Analysis requirements .....	347
A.12.5	Types of analysis.....	349
A.12.6	Non-linear analysis.....	352
A.13	Strength of tubular members .....	354
A.13.1	General .....	354
A.13.2	Tubular members subjected to tension, compression, bending, shear or hydrostatic pressure .....	355
A.13.3	Tubular members subjected to combined forces without hydrostatic pressure .....	364
A.13.4	Tubular members subjected to combined forces with hydrostatic pressure .....	366
A.13.5	Effective lengths and moment reduction factors.....	371
A.13.6	Conical transitions .....	376
A.13.7	Dented tubular members .....	378
A.13.8	Corroded tubular members .....	383
A.13.9	Grouted tubular members .....	383
A.14	Strength of tubular joints.....	387
A.14.1	General .....	387
A.14.2	Design considerations .....	387

A.14.3	Simple circular tubular joints .....	381
A.14.4	Overlapping circular tubular joints .....	385
A.14.5	Grouted circular tubular joints .....	385
A.14.6	Ring stiffened circular tubular joints .....	386
A.14.7	Other circular joint types .....	387
A.14.8	Damaged joints .....	387
A.14.9	Non-circular joints .....	387
A.14.10	Cast joints.....	387
A.15	Strength and fatigue resistance of other structural components .....	387
A.15.1	Grouted connections.....	387
A.15.2	Mechanical connections .....	390
A.15.3	Clamps for strengthening and repair.....	407
A.16	Fatigue .....	421
A.16.1	General.....	421
A.16.2	General requirements.....	425
A.16.3	Description of the long-term wave environment .....	425
A.16.4	Performing the global stress analyses.....	431
A.16.5	Characterization of the stress range data governing fatigue.....	433
A.16.6	The long-term local stress range history .....	434
A.16.7	Determining the long-term stress range distribution by spectral analysis .....	434
A.16.8	Determining the long-term stress range distribution by deterministic analysis .....	441
A.16.9	Determining the long-term stress range distribution by approximate methods.....	443
A.16.10	Geometrical stress ranges.....	447
A.16.11	Fatigue resistance of the material.....	473
A.16.12	Fatigue assessment.....	475
A.16.13	Other causes of fatigue damage than wave action .....	477
A.16.14	Further design considerations .....	478
A.16.15	Fracture mechanics methods.....	479
A.16.16	Fatigue performance improvement of existing components.....	481
A.17	Foundation design.....	483
A.17.1	General.....	483
A.17.2	Pile foundations .....	483
A.17.3	General requirements for pile design .....	484
A.17.4	Pile capacity for axial compression.....	484
A.17.5	Pile capacity for axial tension .....	498
A.17.6	Axial pile performance .....	498
A.17.7	Soil reaction for piles under axial compression.....	501
A.17.8	Soil reaction for piles under lateral actions .....	502
A.17.9	Pile group behaviour .....	504
A.17.10	Pile wall thickness .....	504
A.17.11	Length of pile sections.....	505
A.17.12	Shallow foundations.....	505
A.18	Corrosion control.....	505
A.19	Materials .....	505
A.19.1	General.....	505
A.19.2	Design philosophy.....	506
A.19.3	Strength groups .....	508
A.19.4	Toughness classes.....	510
A.19.5	Applicable steels.....	510
A.19.6	Cement grout for pile-to-sleeve connections and grouted repairs .....	510
A.20	Welding, fabrication and weld inspection .....	511
A.20.1	General.....	511
A.20.2	Welding .....	511
A.20.3	Inspection .....	517
A.20.4	Fabrication.....	517
A.21	Quality assurance, quality control and documentation.....	518
A.21.1	General.....	518
A.21.2	Quality management system .....	518
A.21.3	Quality control plan .....	518
A.21.4	Inspection of installation aids and appurtenances.....	519

A.21.5	Inspection of loadout, sea-fastening and transportation .....	520
A.21.6	Installation inspection.....	520
A.21.7	Documentation .....	520
A.21.8	Drawings and specifications .....	521
A.22	Loadout, transportation and installation .....	524
A.22.1	General .....	524
A.22.2	Loadout and transportation.....	524
A.22.3	Transfer of the structure from the transport barge into the water .....	524
A.22.4	Placement on the sea floor and assembly of the structure .....	524
A.22.5	Pile installation .....	524
A.22.6	Installation of conductors.....	526
A.22.7	Topsides installation.....	526
A.22.8	Grounding of installation welding equipment.....	526
A.23	In-service inspection and structural integrity management.....	526
A.23.1	General .....	526
A.23.2	Data collection and update.....	529
A.23.3	Evaluation.....	530
A.23.4	Inspection strategy.....	536
A.23.5	Inspection programme.....	541
A.23.6	Inspection requirements.....	541
A.23.7	Default periodic inspection requirements .....	543
A.23.8	Personnel qualifications .....	544
A.24	Assessment of existing structures.....	545
A.24.1	General .....	545
A.24.2	Assessment process.....	545
A.24.3	Data collection .....	545
A.24.4	Structure assessment initiators.....	546
A.24.5	Acceptance criteria .....	546
A.24.6	Structure condition assessment.....	547
A.24.7	Actions assessment.....	549
A.24.8	Screening assessment.....	553
A.24.9	Resistance assessment.....	553
A.24.10	Prevention and mitigation .....	556
A.25	Structure reuse .....	556
A.25.1	General .....	556
A.25.2	Fatigue considerations for reused structures.....	556
A.25.3	Steel in reused structures .....	556
A.25.4	Inspection of structures to be reused .....	556
A.25.5	Removal and reinstallation.....	558
A.25.6	In-service inspection and structural integrity management.....	558
Annex B	(informative) CTOD testing procedures .....	559
B.1	Testing procedure requirements.....	559
B.2	Test-assembly welding.....	559
B.3	Number and location of CTOD specimens.....	559
B.4	Specimen preparation .....	560
B.5	Pre-compression.....	560
B.6	Sectioning.....	560
Annex C	(informative) Material category approach .....	564
C.1	Selection of material category (MC).....	564
C.2	Selection of toughness class .....	564
C.3	Specific steel selection .....	564
Annex D	(informative) Design class approach.....	569
D.1	General.....	569
D.2	Specific steel selection .....	570
D.3	Welding and non-destructive inspection categories .....	576

<b>Annex E</b> (informative) <b>Welding and weld inspection requirements — Material category approach</b> .....	<b>579</b>
<b>E.1</b> <b>General</b> .....	<b>579</b>
<b>E.2</b> <b>Weld toughness</b> .....	<b>579</b>
<b>E.2.1</b> <b>Weld metal toughness</b> .....	<b>579</b>
<b>E.2.2</b> <b>HAZ toughness</b> .....	<b>579</b>
<b>E.3</b> <b>Inspection</b> .....	<b>581</b>
<b>Annex F</b> (informative) <b>Welding and weld inspection requirements — Design class approach</b> .....	<b>584</b>
<b>F.1</b> <b>General</b> .....	<b>584</b>
<b>F.2</b> <b>Toughness of weld and heat affected zone (HAZ)</b> .....	<b>584</b>
<b>F.2.1</b> <b>General</b> .....	<b>584</b>
<b>F.2.2</b> <b>CTOD testing</b> .....	<b>584</b>
<b>F.2.3</b> <b>PWHT alternative to CTOD testing</b> .....	<b>584</b>
<b>F.3</b> <b>Extent of NDT for structural welds</b> .....	<b>584</b>
<b>Annex G</b> (normative) <b>Fabrication tolerances</b> .....	<b>587</b>
<b>G.1</b> <b>Measurements</b> .....	<b>587</b>
<b>G.2</b> <b>Launch rails</b> .....	<b>587</b>
<b>G.3</b> <b>Global horizontal tolerances</b> .....	<b>587</b>
<b>G.4</b> <b>Global vertical tolerances</b> .....	<b>589</b>
<b>G.5</b> <b>Roundness of tubular members</b> .....	<b>590</b>
<b>G.6</b> <b>Circumference of tubular members</b> .....	<b>590</b>
<b>G.7</b> <b>Straightness and circumferential weld locations of tubular members</b> .....	<b>590</b>
<b>G.8</b> <b>Joint mismatch for tubular members</b> .....	<b>593</b>
<b>G.9</b> <b>Leg alignment and straightness tolerances</b> .....	<b>595</b>
<b>G.10</b> <b>Tubular joint tolerances</b> .....	<b>596</b>
<b>G.11</b> <b>Cruciform joints</b> .....	<b>598</b>
<b>G.12</b> <b>Stiffener tolerances</b> .....	<b>599</b>
<b>G.12.1</b> <b>Stiffener location</b> .....	<b>599</b>
<b>G.12.2</b> <b>Stiffener cross-section</b> .....	<b>599</b>
<b>G.13</b> <b>Conductor, pile guide, pile sleeve and appurtenance support tolerances</b> .....	<b>601</b>
<b>Annex H</b> (informative) <b>Regional information</b> .....	<b>603</b>
<b>H.1</b> <b>General</b> .....	<b>603</b>
<b>H.2</b> <b>North West Europe</b> .....	<b>603</b>
<b>H.2.1</b> <b>Description of region</b> .....	<b>603</b>
<b>H.2.2</b> <b>Regulatory framework in NW Europe</b> .....	<b>603</b>
<b>H.2.3</b> <b>Technical information for NW Europe</b> .....	<b>604</b>
<b>H.3</b> <b>Canada</b> .....	<b>604</b>
<b>H.3.1</b> <b>Description of region</b> .....	<b>604</b>
<b>H.3.2</b> <b>Regulatory framework in Canada</b> .....	<b>604</b>
<b>H.3.3</b> <b>Technical information for Canada</b> .....	<b>605</b>
<b>H.3.4</b> <b>Additional information and guidance for Canada</b> .....	<b>606</b>
<b>Bibliography</b> .....	<b>608</b>