

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

Contents		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

	Page
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

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