

DEP SPECIFICATION

ONSHORE CONCRETE DESIGN AND CONSTRUCTION

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DESIGN AND ENGINEERING PRACTICE



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The information set forth in these publications is provided to Shell companies for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual Operating Units to adapt the information set forth in DEPs to their own environment and requirements.

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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the design and execution of onshore concrete structures. This DEP applies to both in-situ work and construction using manufactured/ prefabricated concrete elements.

For concrete structures directly exposed to sea water, see DEP 35.00.10.10-Gen.

The sections in this DEP are based on American standards and are the minimum standard for design and construction of onshore concrete structures.

For acceptable equivalent European standards (EN) refer to (7). For European applications, the Euronorms are supplemented by the National Annexes of the respective European member states for their own areas of jurisdiction.

This is a revision of the DEP of the same number dated September 2011; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorized access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production, gas handling, LNG, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases, the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

The word **may** indicates a permitted option.

1.3.2 Abbreviations

Term	Definition
ITPS	Inspection and Test Plans
PTI	Post Tensioning Institute
QCR	Quality Control Records
WCR	Water Cement Ratio

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (7).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated September 2011. The following are the main, non-editorial changes:

Section/Clause	Change
3 to 5	DEP alignment with American Codes. Replication with international standards deleted.
3 and 5	Sections added on Precast, Pre-stressed, Self-compacting concrete and Fibre reinforced concrete.
4	Material requirement for grout added.
5	Section 5 on execution has been rearranged. Section on Execution document, Concrete Measuring, Mixing, Production, Transportation, deleted.
Standard Drawing	Following standard drawings have been deleted: S 19.012: Standard detail for ties/ stirrups (2 sheets) S 28.020: Anchor Bolts
Appendix A	Existing appendix on General Notes for Structural Concrete Drawings deleted and replaced with Standard details for Anchor bolts added

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
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DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://swwww.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

2. DESIGN OF CONCRETE STRUCTURES

2.1 DESIGN REQUIREMENTS OF CONCRETE STRUCTURES

1. The design and calculations of concrete structures shall be in accordance with ACI 318.
2. The loads and load combinations for all onshore concrete structures shall be in accordance with DEP 34.00.01.30-Gen.

2.2 CONSTRUCTIONAL AND MOVEMENT JOINTS

1. Constructional and movement joints shall be clearly specified and indicated in the concrete drawings.

2.3 ANCHOR BOLTS

1. Anchor bolts design and construction shall be in accordance with ASCE guideline for wind loads and anchor bolt design for petrochemical facilities and ACI 318 Appendix D.
2. For foundations supporting static equipment, the Manufacturer/Supplier shall provide anchor bolt template.
 - a. At situations where this is not provided, to allow for minor (<6 mm) field adjustment concrete pockets shall be provided.
 - b. Alternatively, anchor bolt sleeves may be provided.
3. For foundations supporting vibrating equipment, anchor bolts shall be installed using sleeves, unless otherwise specified by the Principal.
4. Anchor bolt sleeves shall be designed to accommodate the pre-tension requirements of the design anchor bolts.
 - a. Where pre tensioning is required, full length sleeves shall be provided.
5. Anchor bolts subject to uplift or vibration shall be locked with a washer and two nuts.
6. The minimum concrete edge distance, anchor bolt spacing, and embedment shall be in accordance with ACI 318 Section D.8, ASCE Guideline for anchorage design for Petrochemical Facilities and API 686.
7. The minimum edge distances for post-installed anchor bolt shall be in accordance with ACI 318 Appendix D.8.3.

2.4 LIQUID RETAINING STRUCTURES

1. Liquid retaining structures shall be designed in accordance with ACI 350/350R.
2. Crack widths shall be limited to <0.1 mm (0.004 in) in accordance with ACI 224R.
3. Crack widths for the Serviceability Limit state shall be determined in accordance with the Limit State Principles and formulae presented within Eurocode 2.
4. The location and position of construction joints shall be shown on the drawings.

2.5 PRE-STRESSED CONCRETE STRUCTURES

1. Design of pre-stressed concrete shall be in accordance of ACI 318 and PCI TR-7.
2. Anchorage device and local zone reinforcement shall meet the requirements of AASHTO "Standard Specification for Highway Bridges," Division I, Articles 9.21.7.2.2 through 9.21.7.2.4.
3. Prestressed concrete shall only be allowed for piles, bridges/culvert decks in roads and concrete LNG tanks.

2.6 PRECAST CONCRETE

1. Precast concrete members and connections shall be designed in accordance with ACI 318, ACI 550.2R and PCI TR-7.

2.7 FOUNDATIONS AND STRUCTURES SUBJECT TO VIBRATION

1. Foundations and structures subject to vibration shall be isolated from adjacent structures to prevent transmission of machinery vibrations.
2. Foundation analysis shall be performed in accordance with DEP 34.00.01.30-Gen.

2.8 FOUNDATIONS AND STRUCTURES SUBJECT TO TEMPERATURE EFFECTS

1. Foundations and structures subject to temperature effects shall be designed for any temperature difference that could occur in parts of structural members and/or the whole structure.

2.9 SKIRTED PROCESS COLUMN PEDESTALS AND TABLE TOP STRUCTURES

1. The pedestals of the foundation for skirted process vessels shall be provided with a slope and drain.
 - a. Refer to Standard Drawing S 19.014 for typical drainage details.
2. All edges of table top slabs shall have a curb of minimum 100 mm (4 in) height to enable draining of the liquid to a designated drain.

3. MATERIALS AND COMPONENTS**3.1 ADMIXTURES**

1. Concrete admixtures shall be in accordance with ASTM C494/C494M.
2. Only one Manufacturer/Supplier of each admixture shall be used throughout the course of the project.
3. Admixtures shall only be used with the Principal's written approval.
4. No admixtures shall be used that contain matter which could be harmful to the reinforcement or the durability of the concrete.
5. Calcium chloride and admixtures containing soluble chlorides shall not be permitted.

3.2 AGGREGATES

1. Aggregate used by each Manufacturer/Supplier shall be the following:
 - a. Obtained from a single source throughout the course of the project.
 - b. Aggregate in accordance with ASTM C33.
 - c. Not "gap-graded"

3.3 ANCHOR BOLTS AND EMBEDMENTS

1. Anchor bolt materials shall be based on standard bolt assemblies and hot dip galvanised according to DEP 34.28.00.31-Gen.
2. Anchor bolts and assemblies shall meet the requirements of (Appendix A).
3. Other embedded steel material shall be as per ASTM A36/A36M and hot dip galvanised (except the anchorage designed based on embedment length) in accordance with DEP 34.28.00.31-Gen.
4. Aluminium items shall not be used for concrete embedment.