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TECHNICAL SPECIFICATION

Doc No: DSF-SPC-CIV-006

Rev. 1

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HIGH PRESSURE (HP) TRANSMISSION SYSTEMS

CONCRETE WORKS

JUNE 2021

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1. SCOPE AND OBJECTIVES

The scope of the document is the elaboration of the minimum requirements which refer to the concrete material, construction, performance and inspection of the civil works for the Natural Gas Pipelines.

2. REFERENCES

- EN 197 -1 [Cement – Composition, specifications and Conformity criteria for common cements]
- EN 206 [Concrete – Specification, Performance, production and conformity] EN 480 [Admixtures for concrete, mortar and grout – test methods]
- EN 932 [Test for General Properties of aggregates]
- EN 933 [Test for Geometrical Properties of aggregates] EN 934-2 [Admixtures for Concrete, mortar and grout – Part 2: Concrete admixtures –Definitions, requirements, conformity, marking and labeling]
- EN 1008 [Mixing water for concrete]
- EN 10080 [Steel for the reinforcement of concrete - Weldable reinforcing steel – General]
- EN 1097-5 [Tests for mechanical and physical properties of aggregates]
- EN 12620+A1 [Aggregates for concrete] Determination of the water content by drying in a ventilated oven
- EN 12350 [Testing fresh concrete]
- EN 12390 [Testing Hardened concrete]
- EN 12794+A1 [Precast concrete products. Foundation piles] EN 13670 [Execution of concrete structures]
- EN 1991 [Eurocode 1: Actions on structures]
- EN 1992 [Eurocode 2 - Design of concrete structures]



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- EN 1993-5 [Eurocode 3: Design of steel structures - Part 5: Piling]
- EN 1994 [Eurocode 4: Design of composite steel and concrete structures]
- EN 1996 [Eurocode 6: Design of masonry structures]
- EN 1997 [Eurocode 7: Geotechnical design]
- EN 1998 [Eurocode 8: Seismic design]
- ΕΑΚ 2000 - ΦΕΚ 2184/Β/20.12.1999 "Greek Seismic Design Code" (Ελληνικός Αντισεισμικός Κανονισμός)
- ΕΑΚ-2003 ΦΕΚ 781Β/18.06.2003 «Τροποποίηση και συμπλήρωση Ελληνικού Αντισεισμικού Κανονισμού ΕΑΚ 2000» [Hellenic Seismic Code]
- "ΦΕΚ 1154/Β'/12-8-2003 Δ17α/115/9/ΦΝ275
- ΚΤΣ Τεύχος Β' 1561/02.06.2016 «Ελληνικός Κανονισμός Τεχνολογίας Σκυροδέματος» - [Hellenic Concrete Technology Regulation]
- ΦΕΚ 4007/Β/14.12.2016.
- ΦΕΚ 1839/Β/25.5.2017.
- ΚΤΧ-2008 - ΦΕΚ 1416Β & ΦΕΚ 2113Β: Hellenic Reinforcement Technology Regulation
- TP 1501-01-02-01-00: Steel reinforcement for concrete
- ΕΚΩΣ – 2000 ΦΕΚ 1329Β «Ελληνικός Κανονισμός Οπλισμένου Σκυροδέματος» [Hellenic Reinforced Concrete Code]

3. ACRONYMS

DN	Nominal Diameter
PN	Nominal Pressure Rating
NG	Natural Gas



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PED Pressure Equipment Directive

4. MATERIALS

4.1 Cement

Cement used for the manufacture of concrete shall be in compliance with EN 197-1 and has to bear the CE marking in accordance with this standard and the provisions of Article 9 of Regulation (EU) 305/2011. Cement used for the concrete production shall be of the same brand and type for each mix design throughout the duration of the Project.

The Contractor shall retain manufacturer's monthly test Certificates for each batch of cement and shall make these available for inspection by the Engineer, at his request. Cement shall not be used after 6 months from manufacture date or after it has been held store for more than 3 months. Cement affected by moisture shall be rejected.

4.2 Aggregates

Aggregate shall be clean, hard, firm, durable, chemically or physically sound and not contain a harmful amount of dust, mud, organic impurities, chlorides, etc..

Aggregates used for concrete production shall be crushed aggregates fully complying with the detailed of EN 12620 and has to bear the CE marking in accordance with this standard and the provisions of Article 9 of Regulation (EU) 305/2011. Also Aggregates should comply with ELOT EN 206 Serie "Concrete part 1: specification, performance, production and conformity", ΕΚΤΣ - Τεύχος Β' 1561/02.06.2016 "Hellenic Concrete Technology Regulation" (Ελληνικός Κανονισμός Τεχνολογίας Σκυροδέματος) - ELOT TP 150101-01-01-00: Concrete production and transportation. The composition of fine and coarse aggregates shall be within the "favorable range" of the grading curves of ELOT EN 206 and ΕΚΤΣ. The maximum size of coarse aggregate for beams and columns shall be 32 and for foundations shall be 63 mm.

Maximum particle size shall be 32 mm. For concrete which will be situated above ground in the completed structure and which may be exposed to frost, hard- stone aggregates (granite chippings or similar) shall be used.



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For concrete below ground the combined content of chalk and porous flint with a dimension greater than 4 mm, shall not exceed 5% by weight.

4.3 Water

Water used in mixing concrete shall be clean and free from injurious amounts of coils, acids, alkalis, salts, organic materials, or other deleterious substances and shall be in accordance with ELOT EN 1008.

4.4 Additives

Chemical admixtures and mineral admixtures used for concrete shall comply with EN-206 and additionally the provisions of Par B1.5 of KTΣ-2016. Additives may only be used by agreement of the OWNER's Representative and the Contractor shall submit for approval technical data sheets of additives which clearly indicate their trade-name, properties, scope of use, mix proportions, for each concrete type. Where simultaneously use two or more admixtures is required these shall be obtained from the same admixture manufacturer.

4.5 Steel Reinforcement

Steel reinforcing bars shall be grade B500c according to the Hellenic Reinforced Concrete Code and the Hellenic Reinforcement Technology Regulation.

The Contractor shall ensure that each batch of reinforcing steel arriving on site shall be accompanied of KTX. The documents shall be submitted to the OWNER's Representative for approval. Steel reinforcement not accompanied by the quality certificates or not complying with the above requirements shall be rejected. Reinforcement shall be clean and free from any material that may cause corrosion of the reinforcement.

Reinforcement shall be stored on site in a manner that will maintain its good condition.

Reinforcement bars shall be placed and securely tied in position as it is shown on the design drawings.



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Finally, appropriate plastic or cement spacers shall be used in order to secure the minimum absolute values of reinforcing covering mentioned on the design drawings.

All symbols shall be in accordance with the Hellenic Reinforced Concrete Code.

4.6 Formwork

Formwork shall be constructed to provide the correct shape, openings, finished surface, lines and dimensions of each structure as specified in the detail design drawings.

The formwork shall be sufficiently rigid and tight to prevent loss of paste or mortar from the fresh concrete.

Formwork shall be constructed by wood or steel panels/boards in good condition and of sufficient thickness to prevent any deflection which may occur during concrete placing in the forms. Formwork shall be securely braced, supported and wedged so as to retain its position, without displacement or deflection during placing and compaction of concrete.

The formwork shall be designed to withstand the worst combination of self-weight, reinforcement weight, wet concrete weight, concrete pressure, construction and wind loads, together with all incidental dynamic effects caused by placing, vibrating and compacting the concrete. In the case of formwork supported by scaffolding, all necessary stability calculations will be evaluated by an appointed engineer and submitted to the Engineer for review, before the commencement of any concrete works.

All rubbish and debris shall be removed from the interior of the forms before the concrete is placed. Also concrete shall not be placed in forms until such forms have been inspected and approved by OWNER's Supervision.

All concrete (concrete for blinding excluded) shall be cast in formwork unless otherwise indicated.



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Formwork shall conform to the shape, lines and elevations and dimensions shown on the design drawing and shall be constructed to as to ensure that the concrete elements will conform to the tolerances specified in § 10 of EN 13670 Annex G.

4.7 Concrete Quality

All concrete shall be ready-mixed.

A record of all control data and essential production and finishing data shall be made by the contractor and shall be handed over to the Owner Representative.

4.7.1 Lean Concrete

Concrete for blinding shall be grade C12/15 according to the Hellenic Reinforced Concrete Code and the ΚΤΣ [Hellenic Concrete Technology Regulation].

4.7.2 Concrete for Reinforced and Mass Concrete Structures

Concrete for reinforced and mass concrete structures and concrete for concrete piles shall be grade C25/30 minimum in accordance with the ΚΤΣ-2016 [Hellenic Concrete Technology Regulation].

Maximum characteristic water - cement ratio shall be 0.65.

Strengths indicated on the drawings have precedence over strengths indicated in the Specifications.

Air entrainment shall be 4-6%.

Concrete shall be vibrated according to the Hellenic Concrete Technology Regulation.

Cement content shall be minimum 280 Kg/m³ and total content of cement and filler minimum 375 Kg/m³

4.8 Cement Mortar

Cement mortar shall be mixed in proportion 1:3 (cement: sand) by weight.



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5. CONSTRUCTION

5.1 Aggregates

Quality control of the factory-made concrete shall be based upon results from the factory's running quality control tests.

This control shall be prepared and carried out in accordance with the principles mentioned in the Hellenic Concrete Technology Regulation and the factory shall be subject to quality control of an approved control organization.

Delivery notes with the data of the concrete delivered shall be handed over to the OWNER's Representative.

5.2 Reinforcement

Contractor shall prepare bending schedules showing all cutting and bending lengths. The Owner Representative may ask for copies of the bending schedules to be given.

Locations of joints in running reinforcement are not normally indicated on the drawings.

Before being assembled, the reinforcing bars shall be cleaned, and rust or any other foreign matters, which may adversely affect the bond between the bar and concrete, shall be removed.

Rebar diameter, position, number and spacing shall be strictly according to the detail design drawings. Anchoring and splicing of reinforcement shall be in conformity with clauses 17.6, 17.8 and 17.9 of EKOS.

Reinforcement in bars or in welded mesh shall be cut, bent and placed to the shape shown in the detail design drawings. All reinforcement shall be cut and bent in conformity with section 17.2 of the EKOS and paragraphs 7.1 to 7.4 inclusive of KTX.

Casting work may not be started before the reinforcement has been approved by the Owner Representative.



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5.3 Forms

Forms shall be according to the Hellenic Concrete Technology Regulation.

Formwork and framework shall be rigid so that the quality requirements for geometry and appearance can be fulfilled.

Where form clamps are used in visible surfaces, they shall be placed in a regular pattern approved in advance by the Owner Representative.

Immediately before casting, the form shall be rinsed.

All wooden surfaces of forms shall be watered thoroughly before casting. Oiling of forms may be used providing that the form oil does not cause discolouration.

Forms shall be constructed so that they can be removed easily without causing shock, vibration or damage to concrete. Following cleaning, the formwork shall be coated with an approved chloride free form release oil (indicative type SIKA SEPAROL LE) and all excess shall be carefully removed. Form release oil shall not be allowed to come into contact with hardened concrete in construction joints, reinforcement or any other embedded items. The use of mineral oils as form release oil is not permitted.

Minimum concrete cover of the reinforcing bars shall be according to the Hellenic Concrete Technology Regulation and the Hellenic Reinforced Concrete Code par.17.3, but not less than:

- 30 mm for indoor structures and
- 40 mm for outdoor structures.

5.4 Concreting

Before casting, the reinforcement and formwork shall be approved by the Owner Representative.

Concrete shall be cast before setting begins. During casting it must be ensured that segregation does not take place as the concrete falls into the form.

Concrete shall be cast in layers not exceeding 0.3- 0.4 m in thickness and shall be compacted by vibration. Each layer of concrete shall be plastic when covered with the following layer. If new concrete is to be placed against existing hardened concrete, the



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bonding surface shall be thoroughly cleaned, chipped and roughened 100% to coarse aggregate and wetted to saturation.

The concrete shall be vibrated until it can be clearly seen to be thoroughly vibrated.

The vibrator head shall be inserted at a sufficient number of places to ensure that every part of the concrete is thoroughly vibrated. When the vibrator rod is pulled from the concrete, this shall be done slowly so that no cavities are formed where the rod has been.

Concrete may not be moved sideways due to vibrator's action. The vibrator shall be kept in good condition, and a reserve one shall be kept available so that a vibrator which fails during casting can be replaced immediately.

When casting horizontal surfaces, a beam vibrator can be used. Construction joints other than those indicated on the drawings are subject to approval by the Owner Representative. Concrete treatment at severe weather conditions shall be as per the Greek Concrete Technology Regulation ΚΤΣ- ΦΕΚ 1561B 2016.

In any case, its temperature concrete to be laid is not permitted (in any ambient temperature) to be greater than 32 ° C.

Concreting is recommended to be postponed at ambient temperatures greater than 38°C or less than 0 °C unless special measures would be taken. Concreting in ambient temperature below -5°C is strictly forbidden.

5.5 Curing

Curing shall start immediately after concreting. Surfaces shall be cured for a period of not less than 7 days according to section Δ5.1.3 of K.T.Σ 2016.

The Contractor shall prepare method statements, for approval of DESFA Quality Management Systems Division and ENGINEER, stating his proposed materials and methods for curing the different structural members.

5.6 Recesses

Recesses shown on the drawings shall be made and after installation of items to be cast-in, the concreting shall be performed.



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5.7 Surface Treatment

The concrete surface shall be smoothed to a flat and even surface, free of cavities, burrs, sharp edges, holes and slurry accumulations. Tolerance on level is ± 8 mm and tolerance on surface irregularity is max. 10 mm, measured with 3 m boring rod.

6. PILE FOUNDATIONS

6.1 Materials

Concrete for piles shall be grade C20/25 minimum in accordance with the Hellenic Concrete Technology Regulation with a water-cement ratio lower than 0.6.

Pile reinforcing bars shall be grade S500s (previous St IV).

6.2 Design

Pile design and pile reinforcement shall be according to ΕΚΩΣ-2000 – ΦΕΚ 1329B, ELOT EN 1992 (Eurocode 2) and ELOT EN 1993-5 (Eurocode 3- Part 5).

6.3 Construction

Driving of piles shall be carried out in accordance with ELOT EN 1993-5 (Eurocode 3- Part 5). For all driven piles the progress of pile-driving shall be registered in a daily record.

The driving resistance shall be recorded as a number of blows per 0.20 m of penetration.

Documentation for efficiency factor on the actual pile driver shall be presented to the Owner Representative.

The cropping and disposal of pile ends shall be included in the contract. Pile concrete shall extend minimum 50 mm up into the structure and reinforcement rods shall extend minimum 0.5 m up into the structure.

7. ENCHASING CONCRETE

Where the Contractor needs to use a concrete encasing of the pipe instead of concrete



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saddles, the thickness of the concrete shall be calculated in each case.

Minimum reinforcement material shall be two reinforcing meshes T92 (4.2 mm diameter bars placed every 150mm) of grade S500s.

Between the concrete and the pipe, one layer of 15mm minimum thickness roofing felt or rockshield mat shall be placed. The system used will be subject to approval by OWNER.

8. CONCRETE SADDLES

Saddles are to be in agreement with OWNER Standard drawing or to be of self-fixing type.

The saddles to be used will be subject to OWNER approval.