

Procon-Technip

ANALYSE

DIRECTION INDUSTRIELLE	BASIC ENGINEERING SPECIFICATION	PAGE	REV.	DATE
5377.V.BES.1780.1	CONCRETE FOUNDATIONS & CONSTRUCTION (MATERIAL & CONSTRUCTION)	A	6	3/9/75

CUSTOMER : PETROSUL

UNIT : SINES REFINERY

SUMMARY

Pages	rev. 0	rev. 1	rev. 2	rev. 3	rev. 4	rev. 5	rev. 6
A	27/5/74	21/6/74	2/9/74	5/11/74	3/12/74	17/1/75	3/9/75
B	2/9/74	-					
1	27/5/74	21/6/74	2/9/74				
2	"	"					
3	"	"	2/9/74	5/11/74	3/12/74	17/1/75	
3 bis	17/1/75	"		5/11/74			
4	27/5/74	"					
5	"	"	17/1/75				
6	"	"					
7	"	"					
8	"	"					
9	"	"	3/12/74	17/1/75	3/9/75		
10	"	"					
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15	"	"					

Appendix : 5 sheets

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This specification is in accordance with LUMMUS Job Specifications and U.O.P. specifications.
With the only exception agreed with PETROSUL in previous meeting or by any other written way.

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1.00 - SCOPE -

The purpose of this specification is to define the general conditions for execution of civil work to be carried out on the site of SINES refinery (units and off-sites) for PETROSUL.

The following civil work constructions are covered in this specification

- rev.2
- surface foundations
 - roads and access-ways. (if made of concrete). Roads bridges.
 - paving
 - concrete structures
 - main structure of buildings
 - ponds, basins, sumps, various pits and inspection chambers
 - trenches (other than those for roads)
 - underground piping anchor blocks
 - buried water tanks
 - stack foundation

Placing and embedment of steel items such as anchor bolts, bolt sleeves, insert plates, slide plates and cable or pipe sleeves, are also included in the work covered by this specification.

2.00 - GENERAL -

2.01 - Regulations -

The execution of concrete work shall be carried out in compliance with all provisions herein and Lummus requirements A 101, provided that they do not conflict with Portuguese regulations listed below

- regulamento de estruturas de betão armado
- regulamento de solicitações em edificios e pontes
- regulamento de betões de ligantes hidraulicos
- regulamento de segurança das construções contra os sismos

2.02 - PROCON/TECHNIP specifications -

- 5377.V.BES.1780.2 checking of concrete design
- 5377.V.BES.1730.1 concrete foundations and constructions (calculati
- 5377.V.BES.1410.1 soils data
- 5377.V.BES.1770.1 roads bridges

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2.03 - Design drawings -

PROCON/TECHNIP shall specify, for guidance, on its drawings :

- lay-out and dimensions of the foundations and other concrete works
- vehicle traffic areas
- paved areas
- position and dimension of anchor bolts
- position of catch basins, manholes and belltraps
- concrete class and, when required, grade of steel to be used,
- load diagrams for foundations and other concrete works, together with all information required for the design and proper execution of the works for which Contractor is responsible.

Approval of a drawing by TECHNIP/PROCON will in no case diminish contractor's responsibility as far as stability and life of works and compliance with rules and regulations in force are concerned.

2.04 - Dimensions -

All dimensions specified herein shall apply to finished works including plates supporting equipment, structures and coatings, if any.

All drawings shall be orientated and dimensioned in relation to reference lines and data. These references and data shall be marked on the drawings.

Reference level 100.000 indicated on PROCON drawings shall correspond top of foundation, equivalent offsite elev. 42.900 NGP

2.05 - State of the site -

The site shall be available at the following levels :

- grade elevation of product storage area (41,90 NGP)
- grade elevation of process area (42,65 NGP)
- grade elevation of crude storage area (44,30 NGP)

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3.00 - CONCRETE SPECIFICATION -

3.01 - Concrete strength -

Type	Class	compression (kg/cm ²)			tension (kg/cm ²)		
		7 d	28 d	90 d	7 d	28 d	90 d
B	180	122	180	216	13	17	20
B	225	154	225	270	16	20	23
B	300	205	300	360	20	25	30

3.02 - Type of concrete -

Type	Class	Quality		Class of durability	Quality	
		workshop	central		workshop	central
B	180	3	1	BD 2	2	1
B	225	2	1			
B	300	1	1			
B	180	3	1	BD 2	2	1
B	225			BD 2	2	1
B	300			BD 2	2	1

Generally concrete quality will be of quality 1

Designation of concrete type shall be indicated on PROCON/TECHNIP drawing
Example;

B.300.1 : for B type concrete class 300 quality 1

B.225.BD2.1 : for B type concrete class 225 of the BD class 2 quality 1

3.03 - Using different concrete type -

B.180.1 : concrete shall be used for construction of paving (with air entrainment)

B.180.BD2.1 : concrete shall be used for secondary anchor blocks of under ground piping, levelling concrete, blocking or filling concrete.

B.225.1 : concrete shall be used for all foundations above the paving and all elevate concrete structure

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B.225.BD2.1 : concrete shall be used for all foundations below the paving

B.300.1 : concrete shall be used for piece of work above the paving, basins, high concrete structures

B.300.BD2.1 : concrete shall be used for piece of work below the paving, underground basins, separators, cooling tower basin

Note : concrete for cooling tower basin shall be used with super-sulphated cement.

4.00 - REINFORCING STEEL -

Reinforcing shall be class A 40 T, ribbed type steel, or smooth steel class A 24.

Reinforcing shall consist of formed up reinforcing bars : the use of welded wire mesh or expanded metal is permitted for thin walls not subject to heavy loads.

Unless otherwise stated from portuguese regulation, thickness of concrete cover to the main reinforcing bars shall be :

- for foundations :

. 75 mm for concrete poured directly on ground for concrete poured in forms.

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- . 50 mm for bars larger than 16 mm dia
- . 40 mm for bars less than and including 16 mm dia.

- for above ground structures :

- . 40 mm for beams and columns
- . 25 mm for walls and paving not exposed to weather.

This concrete thickness is the net thickness. The above thicknesses should be increased by a half-diameter when measuring from longitudinal bar center line.

Minimum bar diameter for reinforcing bars shall be :

- . 10 mm (A 40T)
- . 12 mm (A 24) for column main reinforcing bars
- . 6 mm for paving reinforcing and for stirrups.

5.00 - CONSTRUCTION - DETAILS -

5.01 - Paving, trenches

- Joints :

The following joints shall be provided in concrete paving and shall be formed using an approved compressible material

- . there shall be construction shrinkage joints in the paving every 7,5 meters in both directions,
- . free expansion joints 15 mm wide every 15 m max.
- . free expansion joints 15 mm wide shall also be provided :
 - around foundations
 - around walls of buildings
 - around basins
 - around trenches

Expansion joint shall be 25 mm wide around foundations of vibrating machines.

Filling compound shall consist of a product not liable to be dissolved or attacked by hydrocarbons.

As far as possible expansion joints shall be located at high point of paving.

Reinforcing steel shall in no case traverse expansion joints.

- Paving thickness -

- . ordinary access areas : thickness 100 mm reinforced by welded wire in 1 layer 4 x 150 x 150
- . vehicle circulation areas : thickness 150 mm reinforced by welded wire in 2 layers 6 x 150 x 150.

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The different types of paving will be shown on drawings.

Trench slab covers shall be at same level as surrounding paving.

Trenches for electric cables shall be filled with sand (by other)

Slope of paving towards run off drainage points shall be at least equal to 10 mm per meter (1,0 %). Maximum level variation between high and low points of paving shall be 100 mm.

Where paving covers underground piping and/or electric cables, the path should be carefully identified on the surface of the paving, either by colored paving or by grooves.

Unpaved areas in the off-sites shall remain bare provided that drainage requirements are met.

5.02 - Anchor bolts -

Generally, minimum distance to be maintained between centerline of anchor bolt and edge of concrete shall be :

- | | | |
|--|-------------|--------|
| - ordinary bolts : up to and including | 1 1/4" dia. | 100 mm |
| more than | 1 3/8" dia. | 150 mm |
| - sleeved bolts : up to and including | 1 1/4" dia. | 150 mm |
| more than | 1 3/8" dia. | 200 mm |

Anchor bolts shall be located inside the reinforcing cage.

5.03 - Grouting of equipment -

Grout shall consist of CPA, fine clean sand, carefully mixed.

For critical installations such as compressors, a ready-for-use mortar may be used. Embecco or similar type product is recommended. Mortars whose volume changes during the different phases of application (placing, complete setting) are not acceptable.

For installations such as pumps, a homogeneous mortar (1 part cement, 3 parts sand) may be used.

Preparation of surface -

Foundation blocks for equipment shall be cleaned of all traces of slurry, debris, oil or grease.

It shall be carefully moistened so as to avoid any puddles of water before placing the mortar.

Underside of equipment baseplate shall be clean and de-greased before installation.

* Embecco 636 grout

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Installation and levelling of equipment -

Shims or slide plates may be left in position or removed according to manufacturer's instructions on client's requirements. If shims or slide plates are left in position after bolting down, they must be in perfect contact with the foundation block and bolts shall be constantly blocked during embedment operations.

Embedment -

Grout or mortar shall completely fill all the sleeves, bed plates and spaces ; its original volume shall remain unchanged after placing. All anchor bolt sleeves shall be filled with grout. After 5 days, if the shims or slide plates are to be removed; all the spaces will be completely filled with mortar. Then the anchor bolts will be blocked.

Surface temperature should not descend below 7 °C for a period of 7 days after equipment installation.

5.04 - Trenches and sumps -

No open trench will be allowed in the area of the units. Where a trench for electric cables must be left open for a fairly long time during which foundations and erection of nearby equipment is being carried out, lateral sheeting shall be provided.

5.05 - Earthwork for unit and off-sites foundations -

a) unit area (previously prepared ground,)

Bottom of all foundations shall be in accordance with the depth shown on PROCON drawings.

Depending on the number, proximity and level of foundations to be constructed, single or general, excavations may be carried out.

b) off-sites -

All constructions in the off-sites area shall be founded on compacted sand from the site or in the case of vegetal or silty soil, by substitution from the fill material dump on the site.

c) general requirements

Contractor shall take all necessary steps to ensure the stability of slopes, either by sheeting or by reducing slope angle. Foot of slope shall be at least 30 cm from the foundation.

If compressible materials are encountered, they shall be removed down to an agreed specified level.

Before concrete foundation is placed, bottom of excavation shall be carefully compacted with a heavy vibrating roller or any other similar equipment.

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Otherwise, prior to concrete pouring, excavation bottom shall not be disturbed.

If the undisturbed state is obtained at a level lower than that of the project, the Contractor shall be responsible for restoring to this level with lean concrete.

Backfill

Fill material shall be sand from the site.

Fill shall be placed in single layers of 20 to 30 cm before compacting.

Compacting shall be carried out in accordance with the following criteria :

- cohesive fills shall be compacted to 90 % or 95 % of Normal or Modified Proctor Optimum depending on their destination,
- non cohesive fills shall be compacted to minimum relative density of 70 %

$$= \frac{e_{\max} - e}{e_{\max} - e_{\min}} \quad e = \text{void index}$$

As gravel or coarse material is not suitable for this type of test, their compacting will be submitted to the approval of TECNIP/PROCON job-site Manager. A lower compacting rate will be allowed (90 % Normal Proctor or 60 % relative density) at the position of constructions liable to be affected by heavy compacting.

These are mainly buried piping and fills for the bottom of excavations.

These compacting rates shall only be applied after approval of TECNIP/PROCON jobsite manager.

Backfills shall not be placed against newly constructed walls until they have obtained sufficient strength allowing them to withstand the loads.

Fills shall be placed in the dry, taking into account continuous de-watering of the excavation throughout the backfill phase.

6.00 - MATERIALS -

Contractor shall comply with one or more of the following compulsory requirements :

- compulsory requirements of this specification
- Portuguese standards

No derogations of the following requirements shall be made without the prior approval of TECNIP/PROCON.

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6.01 - Aggregates -

Aggregates shall consist of fine particles or small gravel and stones.

Sand and small gravel grain size curves shall be forwarded to TECH PROCON at the same time as the complete analysis results for approval of quarries. grain size curve 0/25.

Characteristics

Sand shall be natural siliceous type, with hard resistant clean particles.

Small gravel and stones shall be either rolled material from alluvial banks or de-dusted crushed material.

Flat particles in sand shall be avoided and also flat slabs and needle-like material in gravel, when their average volume coefficient is less than 0.15 for small gravel and 0.20 for stones. Aggregates shall not include any clay, alkali, feldspar or mica liable to decompose in air or water and in general any organic material.

Sand equivalent shall be ≥ 75 .

1 % weight of SO₃ will be tolerated for sulfates and sulfurs. Porosity of aggregates shall be less than 3 % for foundation concrete and 5 % for above ground constructions.

Use of sea and dune sand

The use of un-washed sea sand is authorized only for :

- small pump or vessel footings
- secondary anchor blocks of underground piping
- blinding concrete
- lean concrete
- anchor block concrete

Dune sand is prohibited if grains size is $\leq 0,25$ mm.

Dune sand will be tolerated only for some cement coatings after prior approval of TECHNIP / PROCON.

Sand from granite decay

Granitic grit sand, from granite decomposition, may be used insofar as this material is not liable to change towards clay due to deterioration of feldspars.

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6.02 - Mixing water -

Mixing water containing acids, alkalis, oil and especially organic matter shall not be used.

Mixing water shall in no case contain more than 2 g/liter of matter in suspension and not more than 15 g/liter of dissolved salts.

Quantity of water shall be in accordance to items 15 & 16, tables X and XI of R.B.L.H.

rev. 3

6.03 - Cement -

Quality of cement, incorporation and percentage of additives supply and application of cement, shall comply with the requirements of Portuguese regulations "Regulamento de betões de ligantes hidráulicos".

A chemical analysis of the ground water from the L.N.E.C. is enclosed.

Cement to be used will be as follows :

- normal Portland cement for concrete type B
- normal Portland cement for concrete type BD with percentage of cement in accordance to items 15 and 16, tables X and XI of RBLH

rev. 2

Generally, if the Contractor proposes to incorporate any additive to the concrete, he must have the prior approval of TECHNIP/PROCON

rev. 3

- Air entrainment shall be used for concrete for paving.

Cement quality shall be in accordance with the following Portuguese regulations :

- Caderno de Encargos e seu anexo para o fornecimento e recepção "Portland" normal (décreto n° 40 870 de 22.11.56
41 127 de 24.05.57)
e da portaria n° 18 189 de 5.01.61.
- Supersulphated cement shall be used for concrete cooling tower basin.

Adjuvant for paving

For the concrete of paving, air entrainment shall be added at account of 0.6 % weight of cement.

For avoid a overconcentration, the product shall be used in the shape of diluted solution at account of 10 times his weight of water (let 6 % be).

This quantity of water shall be deduce of the total quantity of water mix.

rev. 4

6.04. - Selection of concrete -

Before construction is started, specialized laboratory tests will be carried out to determine the granular size mixtures to be used on the basis of sand and aggregate samples supplied by the Contractor (see 5377.V.BES.1780.2).

Concrete strength given by the composition formulae shall be such that they comply with the requirements specified in paragraph 3.00

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7.00 - JOBSITE REQUIREMENTS -

7.01 - Material storage -

Aggregates : storage of aggregates shall be ensured so as to prevent any contamination from the ground or run-off water, and also mixing between sand, gravel and stones.

Cement : cement may be delivered in bulk or in bags. If in bulk, silos must be perfectly waterproof. If in bags, they shall be stored in enclosed damp-proof building.

Conditions for delivery at the jobsite are per the Portuguese regulations.

Cement stock at jobsite shall be sufficient for normal work requirements.

Reinforcing bars : reinforcing bars shall be perfectly clean with no trace of paint, grease, dirt or rust.

7.02 - Execution of concrete constructions

Forming -

Shape and size of concrete work and formwork shall conform to that indicated on construction drawings. Lay-out and levels of all constructions should be checked by the Contractor before placing concrete.

Formwork and supports shall be arranged so that when it is removed, steel reinforcing will have a protection less than that specified in paragraph 4.00.

Formwork shall be sufficiently rigid to withstand, loads and shocks to which it will be subjected during construction until its removal. It shall also be sufficiently water tight to prevent any slurry leakage.

Formwork for concrete surfaces remaining untouched after removal of forming, shall be carefully fitted. It may consist of standard steel panels, dressed timber or ply-faced panels. All joints shall be fitted so as to obtain an even smooth concrete surface.

Where excavations are carried out without sheeting, foundation footings may be poured directly against the sides of the excavation.

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Formwork and formwork supports shall not be removed until concrete has reached sufficient strength. Voids left in concrete after formwork removal shall be immediately and carefully filled in with cement and any form ridges or other projections shall be immediately removed and smoothed.

The following formwork removal times are for an average temperature of 15 °C (for Portland cement concrete) :

- walls and vertical surfaces	2 days min.
- columns	3-4 days min.
- beam and joist cheeks	3-4 days min.
- beam struts	21 days min.
- underface of wide floors	21 days min.
- underface of narrow floors	8-10 days min.

If construction loads are expected, removal times of formwork for beam struts shall be increased to 30 days.

The above-mentioned time limits shall be increased by the number of days during which the temperature falls below + 5 °C.

In order to reduce these formwork removal times, additional supports shall be provided, especially in the case of beams and slabs.

In this case, preliminary formwork removal shall only be commenced 6 days after concrete pouring. Intermediate supports shall remain in place so that for example, a slab is supported every 2.10 m in both directions.

Equipment shall not be installed on foundations until concrete has acquired sufficient strength. Under no circumstances shall hydrostatic tests of equipment be carried out before 28 days after concrete pouring.

- erection of steel structures	7 days
- columns and vertical drums	10 "
- horizontal tanks	10 "
- compressors and equipment where maximum load is placed on foundation in single operation	28 "
- loads on upper floors	28 "
- grade paving : light loads	10 "
heavy concentrated loads	28 "

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7.03 - Shaping and securing of reinforcing bars -

Reinforcing bars and their accessories, including splices, elbows, hooks, etc., shall be fabricated in accordance with Portuguese regulations "regulamento de Estruturas de betao armado".

Reinforcing bars shall be shaped and positioned in accordance with requirements on construction drawings.

Positioning tolerances of each bar shall not be more than half bar diameter, up to a maximum of 6 mm.

Securing of reinforcing bars at intersections shall be either with annealed wire, diameter at least 1.2 mm, in the form of a cross and securely tightened, or by special attachments of approved type.

For mild steel bars, all hooks shown on the drawings shall be bent into a complete half-circle with an average radius at least equal to 3 times the bar diameter and extending beyond at least twice the bar diameter (normal type hooks).

Bending of high strength bars shall be in accordance with the appropriate regulations.

Wire mesh reinforcing shall be lapped three welds for bearing mesh and two welds for distribution mesh.

Overlap of bar joints shall be at least 30 times largest bar diameter if there are hooks, and 50 times if there are no hooks.

The clean bars, free of paint, mud, grease, scale or loose rust shall be secured and interconnected so that their position, in conformity with the construction drawings, cannot be modified during concrete pouring.

Steel or concrete packers shall be located at suitable intervals between the horizontal steel bases. Similar concrete packers shall be located between the reinforcing steel and formwork. The use of wood or stones as packers is prohibited. The rigidity of upper bars of reinforcing steel should be checked and corrected if necessary.

Embedment and reinforcing bars taking the tensile stress acting on bolts shall be calculated for a stress of 8.4 hectobars increased by 20 %, whatever the actual design stress on the bolts.

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7.04 - Embedded items -

Items to be embedded in the concrete such as brackets, anchors, angle bars, studs, etc... shall be installed and securely fixed before concrete pouring.

Anchor bolts shall be positioned by means of a template, constructed and securely fixed to prevent any movement of the bolts during concrete pouring.

Tolerance allowed for anchor bolt positioning shall be :

- for sleeved bolts, one tenth of bolt nominal diameter
- for bolts without sleeves, one twentieth of bolt nominal diameter

Inspection of correct distances between anchor bolts for the same equipment will be especially strict.

Sole plates shall be 12 mm thick and have a surface area such that the stress transmitted to the foundation blocks does not exceed the maximum value allowed by the regulations in compression only.

7.05 - Concrete mixing -

Concrete shall be mechanically mixed with fresh water immediately before use.

Proportioning of materials shall be as specified, with an allowable tolerance of 3 % weight.

All materials for a batch shall be mixed together for at least 1 1/2 minutes for a volume of 1 m³ and increased by 0.25 minute per additional volume of 0.500 m³ or fraction of this volume, with the mixer revolving at its designed speed (recommended 20 r.p.m. for tipping concrete mixers, 15 r.p.m. for horizontal mixers).

TP/P reserve the right to have the optimum mixing time investigated and then applied, so that a uniform mass is obtained where all the aggregates are covered with the binder.

Contractor shall use, after TP/P approval, all means to prevent commencement of setting and any segregation of materials, such as :

- choice of method and distance of transport
- use of additive up to maximum proportion of 3 % of weight of cement etc,

Any concrete which has commenced to set before being placed shall be discharged outside the jobsite by the Contractor.

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7.06 - Placing of concrete -

Placing of concrete shall in no way effect its homogeneity or allow any segregation of materials.

Concrete not poured in position within 30 min. of mixing shall be rejected and shall be transported outside the jobsite by the Contractor at his expense.

Where concrete is transported by revolving concrete carriers or trucks fitted with agitators, this time is increased to 1 1/2 hours for temperatures below 20 °C and 1 hour for temperatures above 20 °C.

During concreting, stoppages shall be reduced as much as possible. Before recommencing after interruption, joining surfaces shall be cleaned and chipped 1 cm deep to bring gravel to the surface and remove any trace of slurry. Old concrete shall be wetted long enough so that it is thoroughly soaked before fresh concrete is poured.

It is essential that the Contractor calculates in advance all construction joints so that reinforcing is provided at these positions.

The use of cement slurry (cement mixed with water) is prohibited.

However, the proportion of cement in the first batches of concrete placed on old concrete surface shall be increased and quantity of large aggregate used shall be reduced.

For concrete which has to be of monolithic construction, arrangements must be made (e.g. concrete mixing at 3 positions) so that once concreting has started, it shall be continued without interruption until pouring is completed. Joints in non-monolithic constructions shall be jointly decided by the Contractor and TECHNIP. In the case of large constructions or those which required special design, the problem will be dealt with by the Design Office.

Concrete shall be poured uniformly in the forms and vibrated, either by surface vibration (paving and footings) in 15 cm layers, so that mixing water returns to the surface, or by means of concrete vibrator equipment in the concrete itself. For this reason, adequate spaces (at least 50 mm) should be left at uniform distances between the reinforcing bars to allow entry of vibrators.

Further, formwork vibration is recommended for concrete surfaces remaining untouched after removal of forming.

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Vibrating equipment shall be of a size and type suitable for the work required. High frequency vibration shall be provided so that maximum settling takes place without segregation :

- 8.000 pulsations per minute for pervibrator or vibroplat equipment
- 3.000 pulsations per minute for formwork vibrating equipment

Concrete shall be without voids and in perfect contact with formwork sides and whole surface of reinforcing bars.

Aggregates, water, reinforcing steel, formwork and ground under foundations shall be free of frost and ice when mixing and pouring are carried out.

Concrete shall be sheltered from rain and sun until it is sufficiently cured. Constructions in regions where climate is particularly dry and sunny, shall be wetted as necessary for at least 15 days after placing of concrete to ensure that concrete sets in proper conditions.

Freshly placed concrete shall be protected against any possibility of damage, if necessary, by tarpaulins.

Underwater concreting may be carried out provided that water temperature is 7 °C or above.

After installation of equipment, bolt holes or sleeves shall be filled with small gravel concrete, and space left for adjustment shall be packed with grout.

All exposed horizontal surfaces of concrete foundations shall be finished smooth with trowel.

Exposed surfaces of concrete shall be maintained wet for 7 days after pouring, either by watertight forms or water-soaked forms replaced later by tarpaulins, or by an approved setting agent, or by continuous light watering or any other similar process.

Intermittent watering is not considered a satisfactory method.

Exmo Senhor
 Director da Procon-Tecnia
 232, Avenue Napoléon Bonaparte
 92500 Rueil-Malmaison

FRANCE

Sua referência: Sua comunicação de: Nossa referência: Data: 53/1/5370 7716 - 30.01.1974

Assunto: Prospecção complementar dos terrenos da Refinaria de Sines.
Agressividade das águas para o betão

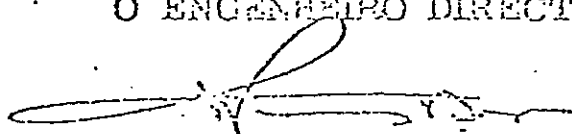
Junto remeto a V.Ex.as os resultados dos ensaios das águas colhi-
 das em furos de sondagens com o fim de estudar a sua agressividade pa-
 ra o betão.

Para o estudo da composição do betão e natureza do ligante a utili-
 zar consultar o Regulamento dos Betões de Ligantes Hidráulicos (Decre-
 to nº 404/71, 23 de Setembro) Artigos 15 e 16 e Quadros 10 e 11.

Como se poderá verificar pode-se em geral usar cimento Portland,
 desde que com dosagem adequada, e não serão necessárias precauções es-
 peciais para proteger o betão das fundações.

Sem outro assunto aproveito a oportunidade para apresentar a V.Ex.as
 os meus melhores cumprimentos.

O ENGENHEIRO DIRECTOR



J. Ferry Borges

Anexo: Resultados dos ensaios da
 Agressividade das águas

CC/LBR

... para mais entrar as referências deste offício e ser dirigida ao Sr.

QUADRO 2 - TEOPES EM IÕES AGRESSIVOS PARA O BETÃO E EM HALOGENETOS DE VÁRIAS AMOSTRAS DE ÁGUA

Amostras referentes à refinaria de Sines	Iões agressivos para betão, mg/dm ³					Halogenetos
	SO ₄ ²⁻	Mg ²⁺	S ²⁻	NH ₄ ⁺	Total	Cl ⁻ mg/dm ³
ST-1	131,9	15,3	0,00	0,07	147,27	142,6
ST-6	69,2	16,1	0,00	0,05	85,36	86,3
ST-16	21,2	25,2	0,00	0,13	45,53	431,3
ST-20	118,0	25,4	-	0,20	144,20	270,1
ST-24	70,8	21,5	-	0,13	92,43	223,3
ST-27	290,9	39,3	-	0,22	330,42	940
CR-41	59,34	25,7	-	0,06	85,10	160,8
OPT 419	39,4	20,4	-	0,23	60,03	192,8
Refrigerante	59,5	20,1	-	0,66	80,26	206,9

Continuação

QUADRO 3 - CONCLUSÕES EM FACE DO QUADRO III.
REGULAMENTO DE BETÕES DE LIGAN-
TES HIDRÁULICOS (DEFINIÇÃO DA AGRES-
SIVIDADE QUÍMICA DAS ÁGUAS EM CON-
TACTO COM O BETÃO).

Amostra	Poder Incrustante	Teor em iões agressivos (1) (mg/dm ³)	Agressividade
ST-1	- 12 < 0	147,27 < 300	Não agressiva
ST-6	+ 19 > 0 < 25	85,36 < 300	Moderada
ST-16	+ 7 > 0 < 25	45,53 < 300	Moderada
ST-20	- 39 < 0	144,20 < 300	Não agressiva
ST-24	- 7 < 0	92,43 < 300	Não agressiva
ST-27	+ 3 > 0 < 25	330,42 > 300	Elevada
CR-41	+ 12 > 0 < 25	85,10 < 300	Moderada
OPT 419	+ 24 > 0 < 25	60,03 < 300	Moderada
Refrigerante	- 12 < 0	80,26 < 300	Não agressiva

(1) Soma dos teores em iões SO_4^{2-} , S^{2-} , NH_4^+ e Mg^{2+} .

CBSI

LISBOA

21.01.1974

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D. B. C. - 1974 - 10

AGRESSIVIDADE DE AGUAS PARA O BETAO

ENTIDADE REQUERENTE Divisão de Fundações (SG)

REFERENCIA Mod. 4 Nº. 49 490

OPERA Petrosul - Sines

MATERIAL 9 amostras de água

IDENTIFICAÇÕES Indicadas nos quadros seguintes

ENSAIO PAGO POR D.F.

MAPA

DATA DE ENTREGA

SERIE Nº DE

QUADRO 1 - PODER INCRUSTANTE DAS VARIAS AMOSTRAS DE AGUA

Amostras referentes à refinaria de Sines	Valores iniciais obtidos no Laboratório		Valores obtidos após 48 de contacto com CaCO ₃	
	PH	Alcalinidade total expressa em CaCO ₃	PH	Alcalinidade total expressa em CaCO ₃
ST-1	7,8	322	7,6	310
ST-6	7,4	171	7,6	190
ST-16	7,7	209	7,55	216
ST-20	7,8	409	7,8	370
ST-24	7,95	216	7,95	209
ST-27	7,9	259	7,75	272
CR-41	7,55	204	7,7	216
CPT 419	7,75	176	7,7	200
Refrigerante	7,9	200	7,6	189

Continuação

Amostras referentes à refinaria de Sines	Diferença		Conclusão
	Entre valores do PH	Entre os valores da alcalinidade total	
ST-1	- 0,2	- 12	Incrustante
ST-6	+ 0,2	+ 19	Não incrustante
ST-16	- 0,15	+ 7	Não incrustante
ST-20	0,0	- 39	Indiferente
ST-24	0,0	- 7	Indiferente
ST-27	- 0,15	+ 3	Não incrustante
CR-41	+ 0,05	+ 12	Não incrustante
OPT 419	- 0,05	+ 24	Não incrustante
Refrigerante	- 0,30	- 12	Incrustante

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Anjour

DIRECTION INDUSTRIELLE	BASIC ENGINEERING SPECIFICATION	PAGE	REV.	DATE
5377.V.BES.1730.1	CONCRETE FOUNDATIONS & STRUCTURES (CALCULATIONS)	A	4	21/2/7

CUSTOMER : PETROSUL

UNIT : SINES REFINERY

SUMMARY

Pages	Rev. 0	Rev. 1	Rev. 2	Rev. 3	Rev. 4
A	7/6/74	25/6/74	2/9/74	5/11/74	21/02/75
B	2/9/74				
1	7/6/74	"	"		
2	"				
3	"				
4	"	25/6/74	21/2/75		
5	"	"	21/2/75		
5 bis	21/02/75				
6	7/6/74	"	2/9/74		
7	"	"	21/2/75		
8	"	"	21/2/75		
9	"	"			
10	"	"	5/11/74		
11	"	"	2/9/74	5/11/74	
12	"	"			
13	"	"			
14	"	5/11/74			
15	"				
16	"				
17	21/2/75				
18	"				

CONTENTS

- 1.00 - SCOPE
- 2.00 - GENERAL
- 3.00 - DESIGN DATA
- 4.00 - CALCULATIONS OF FOUNDATIONS
- 5.00 - WIND LOAD
- 6.00 - EARTHQUAKE
- 7.00 - CONSTRUCTION - DETAILS

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DIRECTION INDUSTRIELLE	BASIC ENGINEERING SPECIFICATION	PAGE	REV.	DATE
5377.V.BES.1730.1	CONCRETE FOUNDATIONS & STRUCTURES (CALCULATIONS)	B	0	2/9/74

This specification is in accordance with LUMMUS Job Specifications and U.O.P. specifications.

With the only exceptions agreed with PETROSUL in previous meeting or by any other written way.