



OGDCL PAKISTAN:
OIL & GAS DEVELOPMENT
COMPANY LIMITED

KPD-TAY Compression Project (Phase-II)

ISSUED FOR TENDER

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ENAR Petrotech Services (Pvt.) Limited ,
7-B , Sector 7-A , Korangi Industrial Area ,
Karachi Pakistan

TITLE:

SPECIFICATION FOR PLAIN AND REINFORCED CONCRETE WORKS

PROJECT NO.
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OGDCL (PAKISTAN)
KPT-TAYCOMPRESSION PROJECT
SPECIFICATION FOR PLAIN AND REINFORCED
CONCRETE WORKS

DOC NO: 0258-CA-7002

PAGE: 2 of 20

REV: 0

DATE: 6-Jan-2022

C O N T E N T S

<u>SECTION NO.</u>	<u>DESCRIPTION</u>	<u>PAGE NO.</u>
1.0	GENERAL	3
2.0	MATERIAL	3
3.0	WATER	5
4.0	CLASSIFICATION OF CONCRETE	5
5.0	PROPORTIONING OF CONCRETE MIXES	5
6.0	MAXIMUM ALLOWABLE WATER CONTENT	6
7.0	SLUMP TESTS	6
8.0	BATCHING & MIXING	6
9.0	PROTECTIONS & CURING	11
10.0	PVC RUBBER SEAL JOINT / WATER STOPPER	13
11.0	FORMWORK	13
12.0	ANCHOR BOLTS & BASE PLATE/ EMBEDDED PARTS	15
13.0	SAMPLES & TESTING	16
14.0	REINFORCEMENT STEEL	18



OGDCL (PAKISTAN)
KPT-TAYCOMPRESSION PROJECT
SPECIFICATION FOR PLAIN AND REINFORCED
CONCRETE WORKS

DOC NO: 0258-CA-7002

PAGE: 3 of 20

REV: 0

DATE: 6-Jan-2022

1.0 **GENERAL**

All information pertaining to plain and reinforced concrete shown and noted on the construction drawings shall be considered part of this specification.

2.0 **MATERIAL**

2.1 **Cement**

- i) Grey Portland cement shall be normal setting cement of the specific gravity, fineness and chemical composition fully conforming to British Standard Specifications B.S. No. 12:1958 and shall be capable of satisfying all tests such as the tensile strength tests contained therein. Standard test briquettes prepared with 1:3 cement sand mortar shall give the following tensile strengths:

At 3 days not less than 300 lbs/in² (2.1 N/mm²)

At 7 days not less than 400 lbs/in² (2.8 N/mm²)

- ii) Sulphate Resistant Cement where required shall be sulphate resistant cement type 'A' fully conforming to British Standard Specification B.S. No. 4027, Part 2, 1972 and satisfying the requirements for fineness, chemical composition, strength, setting time and soundness, etc.
- iii) The cement shall be delivered to the site, by the Contractor, in the original sealed and branded bags of manufacturer in batches. Each batch shall be stacked separately and used in order of delivery. No cement shall be used, which has been manufactured more than twelve months prior to its proposed use on site.
- iv) Delivery challan or batch certificate should be provided at the time of delivery of cement.

2.2 **Aggregates**

- i) Aggregates shall conform to the test requirements of British Standard 882 or equivalent.
- ii) Fine aggregates, shall be approved sand having specific gravity in the region of 2.65 and shall be clean, sharp, free from clay, earth, vegetable and organic



OGDCL (PAKISTAN)
KPT-TAYCOMPRESSION PROJECT
SPECIFICATION FOR PLAIN AND REINFORCED
CONCRETE WORKS

DOC NO: 0258-CA-7002

PAGE: 4 of 20

REV: 0

DATE: 6-Jan-2022

matters, alkaline or acid reactions or other deleterious matter or impurities and conforming to British Standard BS 812.

- iii) Fine aggregates shall conform to British Standard Specifications BS No. 882 "Natural Aggregates for Concrete" and shall be graded as follows:

BS SIEVE NUMBER	PERCENTAGE (BY WEIGHT) PASSING	
	GRADING ZONE-1	GRADING ZONE-2
$\frac{3}{8}$ " (9.5 MM)	100	100
$\frac{3}{6}$ " (4.8 MM)	90-100	90-100
No. 7	60-95	75-100
No. 14	30-70	55-90
No. 25	15-34	35-59
No. 52	5-20	8-30
No.100	0-10	0-10

- iv) Coarse aggregates shall be approved hard crushed stone with specific gravity of 2.66 and shall be clean free from sand, dust, salt, lime, chalk, clay, organic impurities or other deleterious matter and conforming to BS 812.

- v) Coarse aggregates shall conform to the relevant British Standard Specifications BS No. 882.

Coarse aggregate shall be graded as follows:

FOR CONCRETE CLASSES A, B & C (NOMINAL SIZE OF GRADED AGGREGATE $\frac{3}{4}$ " TO $\frac{3}{16}$ " (19 MM TO 4.8 MM))

<u>BS SIEVE</u>	<u>PERCENTAGE (BY WEIGHT) PASSING</u>
1" (25.4 MM)	100
$\frac{3}{4}$ " (19 MM)	90-100
$\frac{3}{8}$ " (9.5 MM)	20-55
$\frac{3}{16}$ " (4.8 MM)	0-10

FOR CONCRETE CLASSES D & E (NOMINAL SIZE OF GRADED AGGREGATE $1\frac{1}{2}$ " TO $\frac{3}{16}$ " (38 MM TO 4.8 MM))

<u>BS SIEVE</u>	<u>PERCENTAGE (BY WEIGHT) PASSING</u>
$1\frac{1}{2}$ " (38 MM)	100
1" (25.4 MM)	95-100
$\frac{3}{4}$ " (19 MM)	35-70



OGDCL (PAKISTAN)
KPT-TAYCOMPRESSION PROJECT
SPECIFICATION FOR PLAIN AND REINFORCED
CONCRETE WORKS

DOC NO: 0258-CA-7002

PAGE: 5 of 20

REV: 0

DATE: 6-Jan-2022

$\frac{3}{8}$ " (9.5 MM)

10-33

$\frac{3}{16}$ " (4.8 MM)

0-5

- vi) Sieve analysis and other necessary tests of all aggregates shall be carried out as and when required

3.0 **WATER**

Unless otherwise authorized in writing, only water from potable supply system will be used for mixing concrete. Similarly only potable water shall be used for curing of concrete. The source of water for construction purposes based on the satisfactory results of test for pot ability of water.

No water shall be added to the mix after leaving the batch plant.

4.0 **CLASSIFICATION OF CONCRETE**

Classes of concrete to be used in various parts of the works shall be as indicated on the drawings. The concrete of various grades shall be proportioned as set out in **Table - 1** appended hereto:

TABLE - 1

Showing minimum required crushing strengths of $150 \times 150 \times 150$ mm ($6" \times 6" \times 6"$) test cubes and minimum quantity of cement required per cubic meter or 100 cft. of finished concrete for various mixes and under various conditions.

Nomina l Mix.	Class of Concret e	Min. Qty. of Cement		Preliminary Cube Strength				Work Cube Strength			
				at 7 days		at 28 days		at 7 days		at 28 days	
		lbs. for 100 cft.	kg/m ³	lbs/ Inch ²	N/ mm ²	lbs/ Inch ²	N/ mm ²	lbs/ Inch ²	N/ mm ²	lbs/ Inch ²	N/ Mm ²
1:1:2	A	3395	544	4000	28	6000	42	3000	21	4500	31.5
1:1½:3	B	2470	396	3350	23.4	5000	35	2500	17.5	3750	26.2
1:2:4	C	2000	311	2700	18.9	4000	28	2000	14	3000	21
1:3:6	D	1358	218	1300	9.1	2000	14	1000	7	1500	10.5
1:4:8	E	1045	167	820	5.9	1350	9.4	650	4.5	1000	7

5.0 **PROPORTIONING OF CONCRETE MIXES**

All concrete shall be proportioned by weight for concrete mixes, unless specifically directed to proportion them by volume. Laboratory test shall be carried out, for each



OGDCL (PAKISTAN)
KPT-TAYCOMPRESSION PROJECT
SPECIFICATION FOR PLAIN AND REINFORCED
CONCRETE WORKS

DOC NO: 0258-CA-7002
PAGE: 6 of 20
REV: 0
DATE: 6-Jan-2022

class of concrete, to determine the proportion of cement, aggregates and water in the concrete conforming to the quality and strength requirements specified herein. However, the amount of cement for any class of concrete shall not be less than that indicated in the above table. Preliminary test results of at least three different mixes of each class of concrete with varied water cement ratios shall be submitted. The results of 7 days and 28 days cube tests shall be used to establish the ratio between 7 days and 20 days strengths. The proportion of voids in the coarse aggregate shall be controlled and if it exceeds 45% than sand and consequently the cement content shall be increased by the Contractor without any charge. If the proportion is less than 40%, sand shall be decreased but not the cement.

6.0 MAXIMUM ALLOWABLE WATER CONTENT

All concrete specimens shall be made, cured and tested in accordance with British Standard or ASTM Standard. A curve representing the relation between the water content and the average 28 days Crushing Strength or earlier strength at which the concrete is to receive its full working load shall be established for a range of values, including all the crushing strengths shown on the plans. The curve shall be established by at least four points each point representing average values for at least four specimens. The maximum allowable water content for the concrete shall be as determined from this curve and shall correspond to a strength 15% greater than indicated on the plans. No substitution shall be made in the materials used in the work without additional tests in accordance with this procedure to indicate that the quality of the concrete is satisfactory.

7.0 SLUMP TESTS

The slump for concrete, determined in accordance with BS No. 1880:1952 "Slump Test for Concrete" shall be minimum of 25mm (1") and a maximum of 75mm (3") provided the requisite strength is obtained.

8.0 BATCHING & MIXING

- 8.1 Concrete can be mixed by a mechanical batch type mixing plant with adequate facilities for accurate measurements and control of each material entering the mixer and for changing the proportions to conform to varying conditions of the work. Water shall be measured for every batch with due allowance made for water already present in aggregates. The mixing plant assembly, if used, shall permit ready inspection of operations at all times.



OGDCL (PAKISTAN)
KPT-TAYCOMPRESSION PROJECT
SPECIFICATION FOR PLAIN AND REINFORCED
CONCRETE WORKS

DOC NO: 0258-CA-7002

PAGE: 7 of 20

REV: 0

DATE: 6-Jan-2022

8.2 **Batching**

Units where used shall be supplied with the following items:

- i) Weighing unit shall be provided for each type of material to indicate the scale load at convenient stages of the weighing operations.
- ii) Water mechanism shall be tight with the valve interlocked so that the discharge valve cannot be opened before the filling valve is fully closed and shall be fitted with graduated gauge.
- iii) Discharge gate shall control the mix to produce a ribboning and mixing of cement with aggregates. Delivery of materials from the batching equipment to the mixer shall be accurate within the following limits:

<u>MATERIAL</u>	<u>PERCENTAGE BY WEIGHT</u>
Cement	½
Water	¼
Fine Aggregate	1
Coarse Aggregate	2

8.3 **Mixing Unit**

Operations

- i) Mixers shall not be charged in excess of noted capacity nor be operated in excess of noted speed. In general not more than 20 revolutions per minute are necessary for adequate mixing. Excessive mixing requiring addition of water to preserve required consistency shall not be permitted. The entire batch shall be discharged before recharging.
- ii) Mixing time shall be measured from the instant water is introduced into the mixer drum containing before one fourth of the mixing time has elapsed. Mixing time for mixers of one cubic yard or less shall be between 1 minute and 1½ minute; for larger than one cubic yard capacity mixers time shall be increased 15 seconds for each additional cubic yard or fraction thereof. If an air-entraining agent is used, additional mixing time shall be allowed such as to provide the specified air content.



OGDCL (PAKISTAN)
KPT-TAYCOMPRESSION PROJECT
SPECIFICATION FOR PLAIN AND REINFORCED
CONCRETE WORKS

DOC NO: 0258-CA-7002
PAGE: 8 of 20
REV: 0
DATE: 6-Jan-2022

- iii) The batch shall be so charged into the mixer that some water (about 10 percent) enters the drum in advance of the cement and aggregates. Water shall then be added gradually while the drum is in motion such that all required water shall be in the drum by the end of the first quarter of the mixing time. The concrete shall be mixed until a mixture of uniform colour and consistency is obtained.
- iv) The amount of concrete mixed in any batch is not to exceed the rated capacity of the mixer. The whole of the batch is to be removed before materials for a fresh batch enters the drum.

Discharge Lock

Device to lock the discharge mechanism, until the required mixing time has elapsed, shall be provided on each mixer.

8.3.1 Trial Mix / Mix Design

- i. The Contractor, having knowledge of the source and types of cement, aggregate, plant and method of placing, he intends to use, shall allow for the aggregate/cement ratio and water/cement ratio, which he considers will achieve the strength requirements specified and will produce a workability which will enable the concrete to be properly compacted to its full depth and finished to the dimensions and within the tolerances shown on the drawings and required by the particular specifications. In any event, the aggregate/ cement ratio and the water/cement ratio shall not exceed the upper limits specified in Table-1 for each type of concrete. Furthermore, the quantity of cement per cubic meter of concrete shall in no case be less than the minimum specified in Table-1.
- ii. The Contractor shall prepare such trial mixes as required, that the specified concrete strengths, will be obtained using the materials and mix proportions in accordance with the above clauses. The proportion of cement shall be increased, if necessary, to obtain the strengths required.
- iii. From each trial mix, six preliminary test cubes shall be made. Out of which, 2 cubes shall be tested at 7 days and four at 28 days, the test at 7 days being intended to give an early indication of possible variation from the required strength. If the test results falls below required strength, test is to be discarded and a further trial mix made, unless all test results so obtained are above the required strength. Separate trial mixes are required for each type of concrete.



OGDCL (PAKISTAN)
KPT-TAYCOMPRESSION PROJECT
SPECIFICATION FOR PLAIN AND REINFORCED
CONCRETE WORKS

DOC NO: 0258-CA-7002

PAGE: 9 of 20

REV: 0

DATE: 6-Jan-2022

The trial mix or mixes agreed by the OGDCL / OGDCL's Representative shall be designated job mixes and used as a basis for actual concrete production.

8.4 Batching Aggregate by Volume

- i) When batching aggregates by volume is allowed, as and when required, the cement shall be batched by weight and the water by weight or volume. Each size of aggregate shall be measured in metallic containers the depth of which is 1'-0" \times 1'-0" \times 1.25'. The containers shall be of such shape that their volume can be easily checked by measurement.
- ii) Concrete shall be mixed in a (Full Load) batch mixer (half load or hand operated mixers will not be allowed) of an approved type and in good condition having a drum rotating about a horizontal or inclined axis.
- iii) Continuous mixers shall not be used.
- iv) No hand mixing under any circumstances even with extra cement shall be permitted. If during concreting, the mixing plant fails, the concrete already poured shall be removed, unless directed otherwise.

8.4.1 Work in Cold or Hot Weather

- i. Concrete is not to be mixed or placed at a shade air temperature below 2 °C on a rising thermometer or at a shade air temperature below 3 °C on a falling thermometer.
- ii. When the shade air temperature is 37 °C and rising, special precautions shall be taken during concreting operations, such as shading of the aggregates and plant, cooling of the mixing water or other methods approved by the OGDCL/OGDCL's Representative, so that the temperature of the concrete when placed shall not be in excess of 32 °C.
- iii. Fresh concrete placed at these temperature shall be shaded from the direct rays of the sun for a period of at least 24 hours.
- iv. Concrete is not to be mixed and placed when the shade air temperature is 43 °C or above unless suitable precautions are taken.
- v. When the temperature of the steel is greater than 50 °C, steel forms and reinforcement shall be sprayed with water just prior to placing the concrete.



OGDCL (PAKISTAN)
KPT-TAYCOMPRESSION PROJECT
SPECIFICATION FOR PLAIN AND REINFORCED
CONCRETE WORKS

DOC NO: 0258-CA-7002

PAGE: 10 of 20

REV: 0

DATE: 6-Jan-2022

8.5 Transporting & Placing Concrete

- a) Concrete shall be conveyed and deposited as quickly as possible after mixing and shall proceed so that, as far as possible a complete section of the work is done in one operation.
- b) Transport of concrete shall be in a manner so as to avoid segregation or loss of ingredients of concrete.
- c) All forms and reinforcement and embedded items shall be completed, cleared inspected and approved before pouring of concrete.
- d) Placing of concrete shall not be permitted when the sun, heat, wind, cold, snow or limitations or facilities furnished prevent proper placing finishing and curing of concrete.
- e) All concrete shall be thoroughly compacted and consolidated by means of pneumatic or mechanical vibrators or other approved compacting method. Care shall be taken to avoid segregation due to excessive vibration.
- f) Concrete shall not be dropped freely from a height of more than 2.0 meters. In cases where an excessive drop is inevitable, spouts, down pipes, chutes, or side parts to forms with pockets shall be provided to protect concrete from segregation. The discharge of the spouts, down pipes or chutes shall be controlled so that the concrete may be effectively compacted into horizontal layers not more than 200 mm (8") thick.
- g) Concrete which has attained its initial set or has contained its mixing water for more than 20 minutes shall not be allowed to be placed in the work.
- h) When concrete is laid on hard core, such as sub grade for floor slabs, or other absorbed material, the surface is to be watered, consolidated and, where specified, blinded before the concrete is deposited.
- i) Fresh concrete shall not be placed on previously laid concrete or on old concrete surfaces until the later has been cleaned of dirt, scrub and laitence by wire brushes. The clean surface shall then be thoroughly wetted and grouted with cement slurry.



OGDCL (PAKISTAN)
KPT-TAYCOMPRESSION PROJECT
SPECIFICATION FOR PLAIN AND REINFORCED
CONCRETE WORKS

DOC NO: 0258-CA-7002

PAGE: 11 of 20

REV: 0

DATE: 6-Jan-2022

- j) Care shall be taken not to disturb newly placed concrete by vibrator, indirect loading or otherwise. No traffic or loading shall be allowed on the concrete until it has thoroughly set and hardened.
- k) Construction joints in concrete shall only be given at locations indicated on the drawings. At the end of the day's work the concrete shall be finished off against a temporary shutter stop which shall be vertical and securely fixed. Such stops shall be removed within 24 hours of placing of concrete.
- l) Should any part of the exposed surface present a rough uneven or imperfect appearance when the shuttering is removed, it shall be picked out to honeycomb depth and refilled and properly re-surfaced or entirely redone.

All exposed surfaces and lines of the concrete work are to be true and fair without cracks, bends, windings and distortions of all kinds. All unplastered concrete works is to be fair face, smooth and pleasing.

- m) Concrete of any one part or section of the work shall be carried out in one continuous operation and no interruption of concrete work will be allowed without approval. Where beams and slabs together form and integral part of the structure, they shall be poured in one operation unless provision is made to form a construction joint, in accordance with the code, or as specified on drawing.

n) Joints

Expansion joints shall be formed in the positions indicated and to the details shown on the Drawings.

The expansion joints shall be filled with bitumen-impregnated fibreboard to its full depth and width. The filling will be permitted to be used as permanent formwork only for the second casting. Where the fibre-board is exposed it shall be cut back for a depth of at least 10 mm from the chamfered edge, filled and pointed with a resilient liquid polysulphide polymer sealant or any other approved sealant.

Whenever the placing of concrete is discontinued other than at the expansion faces, this discontinuity shall form a construction joint. Construction joints are to be made only along a horizontal or vertical plane except that in the case of inclined or curved members they shall be at right angles to the principal axis. Care shall be taken to prevent off-setting of the joint and to ensure water-



OGDCL (PAKISTAN)
KPT-TAYCOMPRESSION PROJECT
SPECIFICATION FOR PLAIN AND REINFORCED
CONCRETE WORKS

DOC NO: 0258-CA-7002

PAGE: 12 of 20

REV: 0

DATE: 6-Jan-2022

tightness. The joints shall in every way satisfy the requirements of, and be in accordance with the Drawings.

Unless otherwise shown on the Drawings, construction joints will not be allowed in the unsupported portions of slabs, beams and beamlike members. At construction joints the laitance film and porous layer of the already set concrete shall be removed and the surface keyed by hacking and then wire-brushed and thoroughly cleaned. Immediately before adding the new concrete, the surface is to be thoroughly wetted and a 10 mm thick coating of a fresh cement / sand mortar (having the same proportion of cement / sand as concrete in the mix) applied to the surface. The next concrete is then to be well compacted into the old.

o) Admixtures

No admixtures of any type shall be used in the preparation of concrete or concrete products unless so required by the Particular Specification.

p) Unless otherwise indicated, the minimum cover to the reinforced bars is to be as listed below or equal to the diameter of the bar, whichever is the greater.

Position	Minimum cover – mm
Main bars in internal faces of columns and beams	25
Main bars in external faces of columns and beams	35
Main bars in floor slabs and soffits of roof slabs.	15
Main bars in top of roof slabs	20
Outermost bars in internal faces of walls	20
Outermost bars in external faces of walls	25
Bars in top of ground slabs	20

9.0 PROTECTION & CURING

All exposed concrete shall be cured. Curing shall be accomplished by preventing loss of moisture, rapid temperature change and mechanical injury or injury from rain or flowing water for a period of at least 7 days. Curing shall be started as soon as the concrete has hardened sufficiently for the surface not to be marked. Curing shall be done either by continuous sprinkling of water on the surface or by covering with sand, hessian, canvas or other approved fabrics mats, which shall be kept continually wet. As an alternative, curing of concrete, on all exposed surfaces which could not be kept



OGDCL (PAKISTAN)
KPT-TAYCOMPRESSION PROJECT
SPECIFICATION FOR PLAIN AND REINFORCED
CONCRETE WORKS

DOC NO: 0258-CA-7002
PAGE: 13 of 20
REV: 0
DATE: 6-Jan-2022

covered, such as sides of the beams, under side of the slabs, may also be done by sealing concrete surfaces with curing compounds.

Minimum period of curing for any concrete shall be 12 days or more. All concrete components of concreted structures shall be clearly marked with non-washable paints to indicate the date of placing concrete. During hot weather, curing shall be done even at night.

10.0 PVC RUBBER SEAL JOINT/WATER STOPPER

a) **Material**

All PVC water stops hydrofoil shall be central bulb type 230mm wide. The specific gravity of PVC water stop hydrofoil shall not be less than 1.07. Full stretch breakout intensity when tested at normal temperature shall not be less than 12.94 MPa.

The material shall have a modulus of rigidity of 853 psi at 106°C 72.65 MPa at 200°C.

b) **Placing & Connections**

In general all PVC water stop/hydrofoil shall be placed in the centre of the structural member. Joints at inter sections and at ends of pieces shall be made in the manner most appropriate to the material being used. Joints shall develop effective water tightness fully equal to that of the continuous water stop material and shall permanently retain their flexibility.

c) **Chemical Poor Sealer**

Floors to which an architectural finish is not applied shall, where noted, be treated with a concrete sealer/hardener, applied strictly in accordance with the manufacturer's specification. Fosroc Nitoflor FC110 or approved equivalent shall be used.

d) **Dam Proof Membrane**

Polyethylene vapour barrier shall be ICI Fortecon (200 micron) or approved equivalent placed in accordance with the manufacturer's specification below all concrete cast on grade except where blinding is specified.



OGDCL (PAKISTAN)
KPT-TAYCOMPRESSION PROJECT
SPECIFICATION FOR PLAIN AND REINFORCED
CONCRETE WORKS

DOC NO: 0258-CA-7002

PAGE: 14 of 20

REV: 0

DATE: 6-Jan-2022

11.0 FORMWORK

- i) The formwork for columns, beams, slabs and all other works whether to be precast or cast in situ shall be made-up of M.S plates for obtaining industrial finishing.
- ii) The formwork shall be inclusive of all labor, material, workmanship and alike. All formwork and supports thereto shall be designed by the Contractor and relevant drawings for approval before the work is put in hand. Such an approval shall not relieve the Contractor from all the obligations of the Contract or give rise to any claims.
- iii) Scaffolding pipes shall be used for supporting the shuttering of walls, beams, columns and slabs etc.
- iv) The formwork shall be fabricated and erected in position, perfect in alignment, levels and true to plumb and shape and securely braced so as to enable it to stand all weights, live and vibrating to be endured during placing of concrete and its subsequent hardening till the formwork is struck. It shall be so sufficiently rigid as not to loose its form and shall be so made for bulging, and deflection as to give the finished concrete the required lines, plumb, size and shape.
- v) For concrete work, where concrete surface is to be exposed for Industrial finish and left un-plastered, the formwork shall be made up of M.S. plates as approved by the OGDCL / OGDCL's Representative, so as to make a perfectly smooth surface of the finished concrete.
- vi) Where any surface defects on the exposed concrete surfaces occur and which do not impair the structural performance, being in excess of the designed surfaces, and the architectural appearance of the work in the opinion of OGDCL / OGDCL's Representative, such defects may be removed by ganting and grinding with carborandum stone or in any other approved manner, at the cost of the Contractor, otherwise the whole or part of the work may have to be removed and remade good by the PC Contractor at his own cost. For precast concrete members the forms shall be rigid, exact, smooth and made of steel.
- vii) The Contractor shall be responsible for any injury to the work and any consequential damages caused by or arising from the removal and striking of forms, centering and supports, due to striking too soon, and any advice,



OGDCL (PAKISTAN)
KPT-TAYCOMPRESSION PROJECT
SPECIFICATION FOR PLAIN AND REINFORCED
CONCRETE WORKS

DOC NO: 0258-CA-7002

PAGE: 15 of 20

REV: 0

DATE: 6-Jan-2022

permission or approval given by the OGDCL / OGDCL's Representative, relative to the removal and striking of forms, centering and supports shall not relieve the Contractor from the responsibilities herein defined.

- viii) Any minor surface honey combing or other irregularities are to be properly made good immediately upon the removal of the formwork and the surface made good to the satisfaction of the OGDCL / OGDCL's Representative.
- ix) Any small voids shall be neatly stopped with cement mortar consisting of one part of cement to two parts of sand and the whole surface rubbed over with carborandum stone and cement wash and bring the whole to a smooth a pleasing finish and uniform colour.
- ix) The formwork to vertical surface such as walls, columns and sides of beams may be remove in accordance with the table below although care must be taken to avoid damage to the concrete especially to arises and features.
- x) Vacuum periods in days for striking other formwork should be in accordance with the following table:

	Ordinary Portland / Sulphate Resisting Cement	
	Warm Season	Cold Season
Slabs (Props left under)	7	10
Beam soffits (Props left under)	16	20
Props to slabs	7	10
Props to beams	16	20
Vertical surfaces such as walls columns & sides of beams	1	1

- xi) Formwork, shuttering, props or any other means of temporary or semi permanent support shall not be remove from the concrete until the concrete is sufficiently strong to carry safely the load (dead and temporary). The Contractor shall inform the OGDCL / OGDCL's Representative when he is ready to make the formwork, or remove any form of temporary support, and shall obtain his written consent before proceeding.
- xii) The times given for the removal of props are based on the assumption that the total live plus dead weight to be supported at the time of removal is not more than one half of the total design load.



OGDCL (PAKISTAN)
KPT-TAYCOMPRESSION PROJECT
SPECIFICATION FOR PLAIN AND REINFORCED
CONCRETE WORKS

DOC NO: 0258-CA-7002
PAGE: 16 of 20
REV: 0
DATE: 6-Jan-2022

xiii) For horizontal members where the loading is to be a higher proportion of the total design load these times may be increased

12.0 ANCHOR BOLTS & BASE PLATE/EMBEDDED PARTS

- 12.1 All sleeves, inserts, anchor bolts, and other embedded items shall be positioned accurately and supported against displacement by template wherever required.
- 12.2 Material for Anchor bolts and nuts shall be ASTM A-307 Gr.B.
- 12.3 Material for Base Plates, Embedded plates/template shall be ASTM A-36.
- 12.4 Anchor bolts shall be positioned inside vertical reinforcement by means of temporary template.
- 12.5 Special anchor bolts for machinery engines pumps, compressors shall be in accordance with equipment manufacturer recommendations.
- 12.6 Where anchor bolts or pipe sealed are to be remain isolated, sleeves shall be filled with pliable material such as Silicon Rubber moulding compound or other material shown on the drawing or approved by OGDCL / OGDCL's Representative or its representative.

13.0 SAMPLES & TESTING

13.1 General

Test cubes of concrete shall be prepared and stored by the Contractor, in accordance with PS No. 560 1965, or BS No. 1881 or ASTM C-31 as directed by the OGDCL / OGDCL's Representative or his Representative. Test cubes be tested in a laboratory and the Contractor shall bear the charges for the same. Aggregates shall be tested as prescribed.

13.2 Cement

Cement shall be tested as prescribed in the following British Standards or equivalent ASTM Standards:

- | | |
|----------------------------------|--------|
| a) Ordinary Portland Cement | BS 12 |
| b) Rapid Hardening Cement | BS 12 |
| c) Portland Blast Furnace Cement | BS 146 |



OGDCL (PAKISTAN)
KPT-TAYCOMPRESSION PROJECT
SPECIFICATION FOR PLAIN AND REINFORCED
CONCRETE WORKS

DOC NO: 0258-CA-7002

PAGE: 17 of 20

REV: 0

DATE: 6-Jan-2022

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|----|---------------------------|---------|
| d) | High Alumina Cement | BS 915 |
| e) | Low Heat Portland Cement | BS 1070 |
| f) | Sulphate Resistant Cement | BS 4027 |

13.3 Aggregates

Aggregates shall be tested as prescribed in relevant Pakistan Standard or British Standard 882. In addition fine aggregates shall be tested for organic impurities in conformity with BS 812 or equal ASTM Standard or Pakistan Standard.

13.4 Reinforcement

Reinforcing bars shall be tested as per relevant BS 785 and BS 4461: 1969 or ASTM Standard.

13.5 Testing of Concrete

- i) The Contractor shall provide for test purposes one set of mix cubes taken for each class of concrete poured on each day. The OGDCL / OGDCL's Representative may, however, order for more cube tests, if any, irregularity is found in the concrete.
- ii) All test cubes shall be 150 x 150 x 150 mm (6" x 6" x 6") size.
- iii) All test cubes of the same set shall be made from the same batch of concrete.
- iv) Three cubes of the set shall be tested at 7 days and three shall be tested at 28 days or at such ages as directed by the OGDCL / OGDCL's Representative.
- v) All test specimens shall be made and cured in accordance with Pakistan Standard PS 560: 1965 or British Standard BS 1881 or ASTM C-31.
- vi) Specimens shall be cured under laboratory conditions except that the OGDCL / OGDCL's Representative may require curing under field conditions.
- vii) All cube moulds shall be steel moulds perfectly true having all internal and the meeting faces machined to a smooth surface.
- viii) If the strength tests of the laboratory controlled specimens for any portion of the work falls below the minimum allowable compressive strength at 28 days



OGDCL (PAKISTAN)
KPT-TAYCOMPRESSION PROJECT
SPECIFICATION FOR PLAIN AND REINFORCED
CONCRETE WORKS

DOC NO: 0258-CA-7002
PAGE: 18 of 20
REV: 0
DATE: 6-Jan-2022

required for the class of concrete used in that portion, the OGDCL / OGDCL's Representative shall have the right to order replacement of the rejected work.

- ix) All test cubes cast at site shall bear distinguishing mark showing serial number, date of casting, quality of concrete and place from where sample was taken and where that batch of concrete was placed in the structure. A proper daily record of test specimens made, test results obtained shall be maintained by the Contractor and weekly test results shall be submitted to the Contractor.
- x) The OGDCL / OGDCL's Representative may require load tests for the part of the structure from where test specimens have shown unsatisfactory results at the cost of the Contractor. In the event that load tests indicate bad quality of concrete, measures as prescribed by the OGDCL / OGDCL's Representative shall be taken to correct the deficiency at no additional cost to the OGDCL / OGDCL's Representative. The nature, descriptions and details of load test shall be determined by the OGDCL / OGDCL's Representative and shall be binding on the Contractor.

13.6 Permissible deviation (PD) on in-situ concrete and on erection only for pre-cast concrete are as follows:

a) **Foundations:**

Mass concrete with or without reinforcement:

- 1) Position on Plan ± 38 mm
- 2) Dimensions on Plan ± 50 mm

13.7 **Concrete Repair**

In the event of cavities, honeycombing or other defects due to misalignment, segregation, poor compaction, grout loss or any other reason then the Contractor shall propose remedial work that will be subject to the approval of the OGDCL / OGDCL's Representative prior to being carried out.

No patching or repairs shall commence prior to the approval of OGDCL / OGDCL's Representative.

All products approved to be used for repair work shall be used in accordance with manufacturer's specification, & application procedure.



OGDCL (PAKISTAN)
KPT-TAYCOMPRESSION PROJECT
SPECIFICATION FOR PLAIN AND REINFORCED
CONCRETE WORKS

DOC NO: 0258-CA-7002

PAGE: 19 of 20

REV: 0

DATE: 6-Jan-2022

14.0 REINFORCEMENT STEEL

14.1 Materials

- a) Reinforcing steel to be new billet stock of mild steel (plain bar), hard grade (deformed bar) and ribbed tor steel as specified on the drawings and shall confirm to British Standard Specifications or equivalent ASTM or Pakistan Standard.
- b) Maximum requirement for reinforcing steel shall be as follows:
- i) Mild Steel plain bars confirming to BSS 15 or BSS 4449 or PS-231-1962.
- Tensile Strength - 438 to 517 N/mm² (63500 to 75000 lbs/in²)
 - Yield Strength - 250 N/mm² (36000 lbs/in²)
 - Elongation - 16% to 24% (average 20%)
- ii) Ribbed Tor Steel confirming to BS 4461.
- Tensile Strength - 490 N/mm² (70,000 lbs/in²).
 - Yield Strength - 420 N/mm² (60,000 lbs/in²)
 - Elongation - 14.5%
- iii) Deformed Steel bar confirming to BS 4449.
- Tensile Strength - 506 N/mm²
 - Yield Strength - 460 N/mm²
 - Elongation - 12% (min)
- c) All steel to be true to the Standard Specifications with regard to bend ability specially the hard grade deformed bars under Ø19mm (¾") shall be capable of being bent cold through 90 degrees round a bar of four times its own diameter without fractures or injury of any kind. In case of deformed bars over Ø19mm and under Ø28mm round a bar of 6 times its own diameter shall be capable of being bent cold.
- d) 20 gauge galvanized wire shall be used for binding the steel reinforcement.

14.2 Testing

Samples shall be tested for above specification in an approved laboratory.



OGDCL (PAKISTAN)
KPT-TAYCOMPRESSION PROJECT
SPECIFICATION FOR PLAIN AND REINFORCED
CONCRETE WORKS

DOC NO: 0258-CA-7002

PAGE: 20 of 20

REV: 0

DATE: 6-Jan-2022

14.3 **Placing Approval**

The Contractor shall be notified at least 24 hours prior to any proposed cast in order that inspection of formwork, reinforcement and related works can occur. A written record of permission to commence placing concrete shall be maintained for all casts. Permission to place concrete may be withheld, if in the opinion of the OGDCL / OGDCL's Representative, insufficient preparation has been made, for example if no spare vibrator or power float is available or if in poor repair.