

STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 1 of 36

S. No	Description of Activity	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
				Agency	Extent		
1.	Detailed Soil Investigation a) Bore log	1. Depth of bore log 2. SPT Test 3. Collection of samples	As per POWERGRID Specification	Contractor (Soil testing agency approved by POWERGRID)	100% at Field	To witness 20% at Field by site engineer	Site in charge
	b) Tests on samples	As per tech. Specs.	As per POWERGRID Specification	Contractor (Testing in Laboratory of soil testing agency approved by POWERGRID)	100% by testing lab (Reports to be signed by Testing person & Checking person)	Review of lab test results (All soil reports to have signature of POWERGRID executive reviewing the report)	Site In-charge based on the guideline issued by CC Engg. as Annexure-9
2.	Earth Work (site leveling)						
	1. Mandatory testing for filling						
		1. Proctor compaction test for maximum dry density	IS:2720 (latest Revision) & POWERGRID Specification	Contractor from POWERGRID approved Lab.	One sample per 25000 Cum. or part thereof for each type & source of filling material.	100% review of lab test results	Site In charge
		2. Optimum Moisture Content	do	Contractor from POWERGRID approved Lab.	do	do	do
	2. Field Compaction Test	1. Field dry density & Moisture content test for each layer of compaction.	IS:2720 (latest Revision) & POWERGRID Specification	Contractor Field lab./ POWERGRID approved Lab.	One sample for every 2500 Sqm. or part there of for compacted soil for each compacted layer.	100% review of lab test results	Site In charge
3.	Checking of foundation Material						
	A. Materials	1. Brand approval	Cement of approved brands according to the COV in POWERGRID	Contractor	As proposed by Contractor	Any new brand cement proposed by Contractor shall be assessed by RHQ-FQA and approved by Regional Head with BIS License, validity.	FOA-RHQ 

STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 2 of 36

S. No	Description of Activity	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
				Agency	Extent		
			web Site may be procured.			After approval, details shall be forwarded to CC-FQA for uploading in COV	
		2. Physical tests	As per document at Annexure-I of this FQP	Contractor Samples to be taken jointly with POWERGRID and tested at POWERGRID approved Lab.	(i) No testing is required in case of cement procured directly from the main producer/manufacturer/ authorized dealer with traceability and if cement (in good condition without setting) is used within three (3) months from the manufacturing date based on MTC. MTC shall be reviewed. (ii) Testing (Physical & Chemical) shall be done in case storage of cement is more than three (3) months from the manufacturing date.	100% review of lab test results and MTC. Test results shall be sent by the Lab by E-mail directly to POWERGRID. Further, hard Copy of Test Certificate shall also be sent by the Lab directly to POWERGRID by Postal Address.	Site in charge
		3. Chemical Tests Chemical composition of Cement	-do-	Contractor to submit MTC	Review of all MTC's	100% review of MTC results	Site In charge
	2. a) Reinforcement Steel	1. Source approval	May be procured either from producers directly or through the authorized dealers who can produce MTC from producers with	Contractor	As proposed by contractor.	Material shall be supplied from producers / authorized dealers.	Site in charge. 

STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 3 of 36

S. No	Description of Activity	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
				Agency	Extent		
			traceability. Refer COV in POWERGRID web site for list of producers of reinforcement steel. Also refer approved list of Cut & Bend suppliers				
		2. Physical and Chemical analysis test	As per Annexure-2 of this FQP	Contractor to submit MTC	i) No testing is required for steel procured directly from POWERGRID pre-approved producers as per COV under CAT-I or their notified authorized dealers with full traceability (only MTC shall be reviewed) as no failure in physical and chemical testing observed in last decade by POWERGRID. (CAT-I: Approved Vendor List in COV). ii) For other vendors under CAT-II or their notified dealers / new vendors, frequency testing of Reinforcement steel is to be done at regular intervals as per the existing SFQP i.e. One sample* / 300MT / Manufacturer shall be jointly sealed by POWERGRID and	100% review of MTC and embossing. 1) Review of lab test results. Test results shall be sent by the Lab, by E-mail directly to POWERGRID; further, hard Copy of Test Certificate shall also be sent by the Lab directly to POWERGRID by Postal Address. 2) Unit weight of three samples to be witnessed. #	Site In charge Site Engineer



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 4 of 36

S. No	Description of Activity	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
				Agency	Extent		
					tested at POWERGRID approved Lab. Based on the supply, experience and performance up to one-year, further decision on exemption of testing for these vendors shall be taken by FQA dept. (CAT-II: New Vendors listed in COV/ New Vendors).		
		Note:- In case of steel vendors under CAT-II or their notified dealers / new vendors, i) All sizes of 10 mm and above shall be taken for testing in every 300 MT. ii) ## Three samples of each size of Reinforcement steel (all sizes of 10mm & above) out of 100MT steel Lot need to be physically weight at site in presence of POWERGRID to ascertain their acceptance as per technical specification. The weighted samples at site may be kept under custody for three months for further examination by any auditing authority (if required).					
	2. b) Miscellaneous structural steel excluding cable trench, transformer & reactor foundation.	Source to be proposed by contractor.	Source with material meeting POWERGRID Specification	contractor	As proposed by contractor	To verify documents.	Site In charge
		1. Dimensional check 2. Visual check for Damages, rusting, pitting etc.	POWERGRID specification and approved drawing.	Contractor	100%	random	Site Engineer
	2. c) Structural steel used in cable trench, transformer & reactor foundation.	Source to be proposed by contractor.	POWERGRID Specification	Contractor	As proposed by contractor	To verify documents.	Site in charge
		1. Dimensional check	POWERGRID specification and approved	Contractor	100%	random	Site Engineer



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 5 of 36

S. No	Description of Activity	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
				Agency	Extent		
			drawing				
		2. Visual check for damages, rusting, pitting etc.	POWERGRID specification and approved drawing	Contractor	100%	random	Site Engineer
		3. Visual check for welding defects primer coating and painting/ galvanizing as applicable	POWERGRID specification and approved drawing	Contractor	100%	Random	Site Engineer
		4. Physical properties of Structural steel	IS 2062 (Latest Revision) & POWERGRID specification and approved drawing	Contractor	01 sample per lot of 40MT or part thereof for tensile tests and 1 sample per lot of 20MT or part thereof for bend test of each size.	Review of lab test results by POWERGRID.	Site in charge
	3.Coarse Aggregates	1. Source approval	Source meeting POWERGRID Specification	Contractor	Proposed by the Contractor, indicating the location of the quarry & based on the test results of Joint samples tested in POWERGRID approved lab.	To review the proposal based on the documents	Site In-charge. Once approved, the particular source shall be used for all the running contracts under various Packages.
		2. Physical tests	As per document at Annexure-3 of this FQP	Samples to be taken jointly and tested in POWERGRID approved lab.	One sample per 500 cum or part thereof per source, Samples to be tested by Contractor in POWERGRID approved lab.	100% review of lab test results.	Site In charge
	4.Fine aggregate	1. Source approval	Source meeting POWERGRID Specification	Contractor	Proposed by the Contractor, indicating the location of the quarry and based on the results of Joint samples tested in POWERGRID approved lab.	To review the proposal based on the documents.	Site In-charge. Once approved, the particular source shall be used for all the running contracts under various Packages.
		2. Physical test	As per	Samples to be taken jointly	One sample per 500cum or	100% review of lab test	Site In charge

STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 6 of 36

S. No	Description of Activity	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
				Agency	Extent		
			Annexure-4 of this FQP	and tested in POWERGRID approved lab	part thereof per source, Samples to be tested by Contractor in POWERGRID approved lab.	results.	
	5.Water	1. Cleanliness	POWERGRID Specification (Water shall be fresh and clean)	Contractor	100% visual check at Field	Verification at random	Site Engineer
		2. PH Value	- do -	Contractor	One sample per source	100% review of the test results Ph value not less than 6	Site Engineer
		3. Chloride Content	IS 456:2000	Samples to be take jointly and tested in POWERGRID approved lab	One sample per source	100% review of the test results	Site Engineer
		4.Sulphate Content	IS 456:2000	Samples to be take jointly and tested in POWERGRID approved lab	One sample per source	100% review of the test results	Site Engineer
	6. Finishing materials of building	Physical verification of Different items as per specification	As per Specification.	Contractor	100%	MTC/Manufacturer catalogue to be reviewed by POWERGRID.	Site In charge.
	B. Concrete Works						
	a) Before concreting	Dimension & Depth of foundation	Approved Drawing.	Contractor	100% at Field	100% check by POWERGRID	Site Engineer
	1. Dimensions of excavation						
	2.Setting of Foundation Bolts, Embedment etc.	1) Centre Line	Approved Drawing.	Contractor	100% at Field	100% check by POWERGRID	Site Engineer
		2) Diagonals	-do-	-do-	-do-	-do-	-do-
		3) Level of foundation bolts	-do-	-do-	-do-	-do-	-do-
	3. Reinforcement steel	Placement	Bar bending schedule	-do-	-do-	-do-	Site Engineer At least 5% locations

STANDARD FIELD QUALITY PLAN

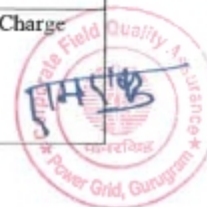
Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 7 of 36

S. No	Description of Activity	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
				Agency	Extent		
							shall be cross verified by immediate officer/ Site In charge, at Random with respect to foundation bolt and reinforcement steel placement.
	4. Use of Steel Jointing Coupler	In addition to present TS Provisions, Reinforcement couplers for mechanical splices of bars in concrete may be used as per IS 16172: 2023	IS 16172: 2023	-do-	-do-	-do-	-do-
	5. Concrete mix proportion (Applicable for Design Mix)	Ratio of mix proportion	Approval of Design Mix submitted by contractor based on inputs furnished by POWERGRID as per Annexure- 10 of this FQP.	-do-	-do-	-do-	Site In charge in consultation with Regional engineering department
	b) During concreting 1. Workability	Slump test	Range 25 mm to 75 mm refer document at Annexure-5 of this SFQP.	Contractor	Minimum Two per day, preferably one at the start of concreting.	20% check at random	Site Engineer
	2. Use of admixtures in concreting both in nominal and design mix	Admixtures in concreting both in nominal and design mix may be used as per IS 9103 to		Contractor	Use as per IS 9103:1999 (Reaffirmed 2018) to achieve workability.	20% check at random*	Engineer-in-Charge

* Corrected Content



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 8 of 36

S. No	Description of Activity	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
				Agency	Extent		
		achieve workability as per site requirements, with approval of Engineers in Charge.					
	3.Concrete Strength	Cubes Compressive Strength	As per POWERGRID Specifications & Annexure-5 of this FQP	Contractor Casting of cubes at site. Cubes to be tested for 28 days strength at POWERGRID In-house Lab/At site (if testing machine installed by contractor is duly calibrated by NABL Lab.)/ POWERGRID approved Lab Cubes at 100% location are to be taken in presence of POWERGRID officials.	Nominal Mix One sample of 3 cubes for every 20 cum or part thereof for each day of concreting and 28 days compressive strength shall be tested. Design Mix Sampling for concrete strength should be one set of 3 nos. of cubes for every 20 cum or part thereof for each day of concreting and 28 days compressive strength shall be tested. Concrete Cube collection & testing in case of RMC: Ready Mix Concrete (RMC) may be allowed and testing/acceptance documentation to be maintained shall be as per as per IS: 4926:2003 (Reaffirmed 2022). Concrete cube sampling should be done at site. However, in case cube samples cannot be taken at site, taking of cube samples at RMC is	Normally testing shall be carried out at the POWERGRID in-house cube testing facility. Alternatively, samples shall be tested at cube testing facility installed by contractor at POWERGRID premises, in the witness of POWERGRID. Lastly, POWERGRID approved Labs, in this case, test results shall be sent by the Lab, by E-mail directly to POWERGRID; further, hard copy of Test Certificate shall also be sent by the Lab directly to POWERGRID by Postal Address. NOTE: The efforts shall be made to carry out 100% cube testing in the in-house cube testing facility.	Site Engineer. All cubes shall be tested at In-house testing facilities. However, in case of breakdown of CTM or other force majeure conditions, cubes may be tested at approved TPL. Out of testing on 10% samples to be witnessed at TPL by POWERGRID Site Engineer and at least 5% samples at random, shall be witnessed by Site In-charge. In-case of Site/ POWERGRID Lab, 100% witness by POWERGRID Representative.



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 9 of 36

S. No	Description of Activity	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
				Agency	Extent		
					acceptable. Concrete composition and batch record for each and every lot shall be maintained as per IS: 4926:2003 (Reaffirmed 2022). The raw material in the RMC bins must be from approved sources/ brands make.		
	4. Use of PVC Block in place of Concrete Cover Blocks:	PVC cover blocks may be used as an alternative to concrete cover blocks as per clause no.12.3.2 of IS 456	IS 456:2000 (Reaffirmed 2021)	Contractor	100 %	100%*	Engineer-in-Charge
	c) After Concreting Back filling	a) Watring & Ramming for compaction	POWERGRID Specification	Contractor	100%	Random	Site Engr.
		b)Compaction Test	POWERGRID Specification	Contractor At Site/ POWERGRID Accepted Lab	a) One Sample of three specimen for 50% of tower location b) One Sample of three specimen for 20% of Equipment Foundation location c) 3 Samples (three specimen for one sample) for every Building (The depth of sampling and the locations shall be decided by Site Engineer).	Physically at Random & 100% review of Test results	Site In charge
	Membrane Curing	In addition to the moist curing of casted concrete	IS 456: 2000 (Reaffirmed 2021) and as	Contractor	100%	100%	Site Engineer

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STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 10 of 36

S. No	Description of Activity	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
				Agency	Extent		
		structures, membrane curing can also be used as per IS 456: 2000(Reaffirmed 2021) Cl. no. 13.5.2	per Specification /manufacturer's catalogue				
	NDT/Core Tests	UPV and Rebound Hammer /Core test	Refer POWERGRID's Standard procedure for Testing/Assessment of compressive strength of casted Concrete, Revision-I as per Annexure-11 of SFQP. ## Accepting Authority: (i) For NDT/Core tests results, if not meeting the acceptance criteria, Regional Head is the Accepting Authority. (ii) CGM (Projects) will be the accepting authority for NDT (UPV & RHT) and core testing done on failed concrete cube test results or not meeting the acceptance criteria in a third party approved lab as per Standard procedure for Testing / Assessment of compressive strength concrete in casted foundations and test results are found satisfactory or meet the acceptance criteria laid down in IS Codes. A quarterly report in this regard will be submitted to Regional ED.				##
4.	Pile foundations		REFER SFQP OF SWITCHYARD PILE WORK				
5.	1) Brick Masonry						
	a) Clay Bricks	1.Dimensional tolerance	POWERGRID Specification/ enclosed Annexure 6	Contractor (samples to be taken jointly and tested in POWERGRID accepted lab)	Enclosed Annexure 6	Review 100% of test results	Site Engineer
		2.Compressive strength	POWERGRID Specification/en closed Annexure 6	-Do-	-Do-	-do-	Site Engineer
		3.Water Absorption	POWERGRID Specification/en closed Annexure 6	-Do-	-Do-	-do-	Site Engineer
		4.Efflorescence	POWERGRID Specification/en	-Do-	-Do-	-do-	Site Engineer



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 11 of 36

S. No	Description of Activity	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
				Agency	Extent		
			closed Annexure 6				
	b) Fly Ash Bricks	1.Dimensional tolerance	POWERGRID Specification/en closed Annexure 6	Contractor (samples to be taken jointly and tested in POWERGRID accepted lab)	Enclosed Annexure 6	Review 100% of test results	Site Engineer
		2.Compressive strength	POWERGRID Specification/en closed Annexure 6	-Do-	-Do-	-do-	Site Engineer
		3.Water Absorption	POWERGRID Specification/en closed Annexure 6	-Do-	-Do-	-do-	Site Engineer
		4.Efflorescence	POWERGRID Specification/en closed Annexure 6	-Do-	-Do-	-do-	Site Engineer
	c) Concrete Blocks	Tests as per IS:2185 Cement Sand Proportion	Tests as per IS:2185 As per POWERGRID Specification	Contractor	Sampling as per IS:2185	Random	Site Engineer
	d) Mortar Mix for brick/concrete works	Tests as per IS:2185 Cement Sand Proportion	Tests as per IS:2185 As per POWERGRID Specification	Contractor	100%	Random	Site Engineer
	2) Stone Masonry	IS: 1121 (Part-I)-2023 & CPWD Specification clause 7.1 Stone with round surface shall not be used	Contractor (samples to be taken jointly and tested in POWERGRID accepted lab)	One sample pre source	100%	Random	Site Engineer
	1.Compressive Strength						
	2. Water Absorption	IS: 1124-1974 (Reaffirmed 2017)	Contractor (samples to be	One sample pre source	100%	Random	Site Engineer



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 12 of 36

S. No	Description of Activity	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
				Agency	Extent		
		& CPWD Specification clause 7.1 Stone with round surface shall not be used	taken jointly and tested in POWERGRID accepted lab)				
6.	P.C.C Grade , thickness, plan dimension	Completeness	IS 456: 2000, reaffirmed 2021 and POWERGRID approved foundation drawings & specification	Joint Inspection by POWERGRID and CONTRACTOR	For all locations	Joint Inspection by POWERGRID and CONTRACTOR	Site Engineer
7.	PLASTERING						
	1.Plastering	thickness and evenness	As per POWERGRID Spec.	Contractor	100%	Random	Site Engineer
	2. ingredients	Mortar Mix/ Proportion	As per POWERGRID Spec.	Contractor	100%	Random	Site Engineer
8.	Switchyard earthing						
	1. Check for dimension of earth mat	Physical check	POWERGRID spec & approved drawings	contractor	100%	Random	Site Engineer
	2. Depth of excavation and Electrode	Physical check	POWERGRID spec & approved drawings	Contractor	100%	Random	Site Engineer
	3. Check for weld joints and anti-corrosion treatment	Physical check	POWERGRID spec & approved drawings	Contractor	100%	Random	Site Engineer
9.	Site surfacing						



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 13 of 36

S. No	Description of Activity	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
				Agency	Extent		
	1. Leveling, Level & Height & evenness	Physical Check	POWERGRID spec & approved drawings	Contractor	100%	Random	Site Engineer
	2. Soil sterilization : spraying of chemicals	Physical Check	POWERGRID spec & manufacturers recommendations	Contractor	100%	random	Site Engineer
	3. P.C.C (Grade, thickness & Size) a) PCC 1:5:10 (1 cement:5 coarse/fine sand:10 coarse aggregate /burnt brick aggregates)	Completeness	POWERGRID specifications	Joint Inspection by POWERGRID and Contractor	100%	Random	Site Engineer
	b) Burnt brick aggregate of nominal size 40 mm	Grading	As per Annexure-8	Samples to be taken jointly & tested in POWERGRID accepted lab.	1 sample per 500 cm	100% review of lab test results	Site In-charge
	4. 40mm stone aggregate	Grading	IS 383: 2021, IS: 2386: Part 1, reaffirmed 2021 and POWERGRID Specification. The grading shall be as per single sized nominal size	Contractor (POWERGRID accepted lab)	1 sample per lot of 500 Cubic Meter or part thereof from each source for each size.	100% review of test report	Site Engineer
	5. Resistivity of 40 mm stone aggregate	Electrical Check	POWERGRID Technical Specification. (Resistivity of the stone for	Contractor	1 sample of stone from each source (in case stones are supplied from more than one source)	100% review of test report.	Site Engineer



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 14 of 36

S. No	Description of Activity	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
				Agency	Extent		
			spreading over the ground shall be minimum 3000 ohm-m under wet condition)				
	6. Compacted thickness of 40mm stone layers as applicable	Physical	POWERGRID specification & approved drawings	Contractor	100%	Random	Site Engineer
10	Road (WBM/WMMM Layers)						
	1. Alignment & Level	Physical check	POWERGRID specification & approved drawings	Contractor	100%	100%	Site In charge
	Material A. Coarse Aggregates	1. Source approval	Source with materials meeting POWERGRID Specification	Contractor	Proposed by the Contractor, indicating the location of the quarry and based on the test results of Joint samples tested in POWERGRID approved lab.	To review the proposal based on the documents	Site In charge
		2. Physical tests	As per document at Annexure-7 of this FQP	Samples to be taken jointly and tested in POWERGRID approved lab	One sample per lot of 500 cum or part thereof per source	100% review of lab test results	Site In charge
	B) Stone Screening						
		1. Source approval	Source with materials meeting POWERGRID Specification	Contractor	Proposed by the Contractor, indicating the location of the quarry and based on the test results of Joint samples tested in POWERGRID accepted lab	To review the proposal based on the documents	Site In charge

STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 15 of 36

S. No	Description of Activity	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by POWERGRID	Accepting authority in POWERGRID
				Agency	Extent		
		2. Grading	As per document at Annexure-7 of this FQP	Samples to be taken jointly and tested in POWERGRID approved lab	One sample per lot of 200 cum or part thereof	100% review of lab test results	Site In charge
	C) Binding Material	Plasticity index	As per document at Annexure-7 of this FQP	Contractor	One sample per lot of 100 cum or part thereof	100% review of lab test results	Site In charge
	D) Laying of sub base Course	Physical check	As per CPWD spec clause 17.7.2	Contractor	100%	Random	Site Engineer
	E) Laying of base Course	Physical check	As per CPWD spec clause 17.8.1	Contractor	100%	Random	Site Engineer
11	Drain Alignment and invert level	Dimension	POWERGRID spec and approved drawing	Contractor	100%	Random	Site Engineer
12	Cable trench Alignment and Section	Dimension	POWERGRID spec and approved drawing	Contractor	100%	Random	Site Engineer
13	Storage of materials 1) Storage of Tower parts, Conductor drums, Insulators, Hardware fittings, Bolts/Nuts, RF Steel 2) Cement Storage 3) Indoor/Outdoor Equipment	Visual & Physical check	POWERGRID specifications	Contractor	100%	Random check	Site Engineer



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 16 of 36
Annexure-1
(Sheet 01 of 03)

ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR CEMENT

ORDINARY PORTLAND CEMENT					
S. No.	Name of the test	Ordinary Portland Cement 33 grade as per IS 269: 2015 (Reaffirmed 2020)	Ordinary Portland Cement 43 grade as per IS 269: 2015 (Reaffirmed 2020)	Ordinary Portland Cement 53 grade as per IS 269: 2015 (Reaffirmed 2020)	Remarks
a)	Physical tests				To be conducted in Appd. Lab
(i)	Fineness	Specific surface area shall not be less than 225 sq.m. per kg. or 2250 cm ² per gm.	Specific surface area shall not be less than 225 sq.m. per kg or 2250 cm ² per gm.	Specific surface area shall not be less than 225 sq.m. per kg or 2250 cm ² per gm.	Blaine's air permeability method as per IS 4031 (Part-2):1999, Reaffirmed 2018
(ii)	Compressive strength	72 ± 1 hour : Not less than 16 Mpa (16 N/mm ²) 168 ± 2 hour : Not less than 22 Mpa (22 N/mm ²) 672 ± 4 hour : Not less than 33 Mpa (33 N/mm ²), Not more than 48Mpa (48 N/mm ²)	72 ± 1 hour : Not less than 23 Mpa (23 N/mm ²) 168 ± 2 hour : Not less than 33Mpa (33 N/mm ²) 672 ± 4 hour : Not less than 43 Mpa (43 N/mm ²), Not more than 58Mpa (58N/mm ²)	72 ± 1 hour : Not less than 27Mpa (27 N/mm ²) 168 ± 1 hour : Not less than 37Mpa (37 N/mm ²) 672 ± 1 hour : Not less than 53 Mpa (53 N/mm ²)	As per IS 4031 (Part-6): 1988, Reaffirmed 2019
(iii)	Initial & Final setting time	Initial setting time : Not less than 30 minutes Final setting time : Not more than 600 minutes	Initial setting time : Not less than 30 minutes Final setting time : Not more than 600 minutes	Initial setting time : Not less than 30 minutes Final setting time : Not more than 600 minutes	As per IS 4031 (Part-5): 1988, Reaffirmed 2019. -do-
(iv)	Soundness	Unacrated cement shall not have an expansion of more than 10mm when tested by Le Chatlier and 0.8% by Autoclave test.	Unacrated cement shall not have an expansion of more than 10mm when tested by Le Chatlier and 0.8% by Autoclave test	Unacrated cement shall not have an expansion of more than 10mm when tested by Le Chatlier and 0.8% by Autoclave test.	Le Chatlier and Autoclave test as per IS 4031 (Part-3): 1988, Reaffirmed 2019.



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 17 of 36

Annexure-1
(Sheet 02 of 03)

S. No.	Name of the test	Ordinary Portland Cement 33 grade as per IS 269: 2015 (Reaffirmed 2020)	Ordinary Portland Cement 43 grade as per IS 269: 2015 (Reaffirmed 2020)	Ordinary Portland Cement 53 grade as per IS 269: 2015 (Reaffirmed 2020)	Remarks
b)	Chemical composition tests				Review of MTC only
		a) Ratio of percentage of lime to percentage of silica, alumina & iron oxide 0.66 to 1.02%	a) Ratio of percentage of lime to percentage of silica, alumina & iron oxide 0.66 to 1.02%	a) Ratio of percentage of lime to percentage of silica, alumina & iron oxide 0.80 to 1.02%	
		b) Ratio of percentage of alumina to that of iron oxide Minimum 0.66%	a) Ratio of percentage of alumina to that of iron oxide Minimum 0.66%	a) Ratio of percentage of alumina to that of iron oxide Minimum 0.66%	
		c) Insoluble residue, percentage by mass, Max. 5.00%	c) Insoluble residue, percentage by mass, Max. 5.00%	c) Insoluble residue, percentage by mass Max. 5.00%	
		d) Magnesia percentage by mass Max. 6%	d) Magnesia percentage by mass Max. 6%	d) Magnesia percentage by mass Max. 6%	
		e) Total sulphur content calculated as sulphuric anhydride (SO ₃), percentage by mass not more than 3.5%.	e) Total sulphur content calculated as sulphuric anhydride (SO ₃), percentage by mass not more than 3.5%.	e) Total sulphur content calculated as sulphuric anhydride (SO ₃), percentage by mass not more than 3.5%.	
		f) Total loss on ignition shall not be more than 5 percent	f) Total loss on ignition shall not be more than 5 percent	f) Total loss on ignition shall not be more than 4 percent	
		g) Chloride content, percent by mass, max 0.1%	g) Chloride content, percent by mass, max 0.1%	g) Chloride content, percent by mass, max 0.1%	



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 18 of 36

Annexure-1
(Sheet 03 of 03)

S. No.	Name of the test	Remarks
2.	POZZOLANA PORTLAND CEMENT AS PER IS 1489 (Part 1) Reaffirmed 2020	
a)	Physical tests	To be conducted in POWERGRID approved Lab
	i) Fineness	Specific surface area shall not be less than 300 m ² /Kg. or 3000 cm ² /gm. IS 4031 (Part-II)
	ii) Compressive strength	a) 72 ± 1 hour : Not less than 16 Mpa (16 N/mm ²) b) 168 ± 2 hour : Not less than 22 Mpa (22 N/mm ²) c) 672 ± 4 hour : Not less than 33 Mpa (33 N/mm ²) IS 4031 (Part-VI)
	iii) Initial & Final setting time	Initial setting time : Not less than 30 minutes Final setting time : Not more than 600 minutes IS 4031 (part-V)
	iv) Soundness	Un aerated cement shall not have an expansion of more than 10mm Le chatlier test and 0.8% by Autoclave test as per IS 4031 (Part-3):1988 (Reaffirmed 2019)
b)	Chemical composition tests	
	a) Magnesia percentage by mass Max. 6%	Review of MTC only
	b) Insoluble residue, percent by mass, (a) Maximum $\{x + 4 (100-x)/100\}$ (b) Minimum 0.6x, where x is the declared % of fly ash in the given Portland pozzolana cement.	-do-
	c) Total sulphur content calculated as sulphuric anhydride (SO ₃), percentage by mass not more than 3.5	-do-
	d) Total loss on ignition shall not be more than 5 percent	
	e) Chloride content, percent by mass, max 0.1%	



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 19 of 36

Annexure-2

ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR REINFORCEMENT STEEL AS PER IS 1786 -2008 (Reaffirmed 2018)

S. No.	Name of the test	Fe 500	Fe 500D	Fe 550	Fe 550D
i)	Chemical analysis test				
	Carbon	0.30 Percent Maximum	0.25 Percent Maximum	0.30 Percent Maximum	0.25 Percent Maximum
	Sulphur	0.055 Percent Maximum	0.040 Percent Maximum	0.055 Percent Maximum	0.040 Percent Maximum
	Phosphorus	0.055 Percent Maximum	0.040 Percent Maximum	0.055 Percent Maximum	0.040 Percent Maximum
	Sulphur & Phosphorus	0.105 Percent Maximum	0.075 Percent Maximum	0.10 Percent Maximum	0.075 Percent Maximum
	Carbon Equivalent	0.42 percent Maximum	0.50 percent Maximum	0.50 percent Maximum	0.61 percent Maximum
ii)	Physical tests				
	a) Tensile Strength/Yield stress ratio,	≥1.08, but tensile strength not less than 545.0 N/mm ²	≥1.10, but tensile strength not less than 565.0 N/mm ²	≥1.06, but tensile strength not less than 585.0 N/mm ²	≥1.08, but tensile strength not less than 600.0 N/mm ²
	b) 0.2% of proof stress/Yield stress Minimum, N/mm ²	500	500	550	550
	c) Elongation percent , Minimum	12	16	10	14.5
	d) Total elongation at maximum force, percent, Minimum	--	5	5	5
iii)	Bend & Rebend tests	Pass	Pass	Pass	Pass



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 20 of 36

Annexure-3

ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR COARSE AGGREGATES AS PER IS 383:2016 (Reaffirmed 2021)

3.	Coarse Aggregates										
i)	Physical Tests										
	a) Determination of particles size	a. IS Sieve Designation	%age passing for Single-Sized Aggregate of nominal size					Percentage Passing for grades Aggregate of nominal size			
			40 mm	20 mm	16 mm	12.5 mm	10 mm	40 mm	20 mm	16 mm	12.5 mm
		63 mm	100	-	-	-	-	-	-	-	-
		40 mm	85 to 100	100	-	-	-	90 to 100	100	-	-
		20 mm	0 to 20	85 to 100	100	-	-	30 to 70	90 to 100	100	100
		16 mm	-	-	85 to 100	100	-	-	-	90-100	-
		12.5 mm	-	-	-	85 to 100	100	-	-	-	90 to 100
		10 mm	0 to 5	0 to 20	0 to 30	0 to 45	85 to 100	10 to 35	25 to 55	30 to 70	40 to 85
		4.75 mm	-	0 to 5	0 to 5	0 to 10	0 to 20	0 to 5	0 to 10	0 to 10	0 to 10
		2.36 mm	-	-	-	-	0 to 5	-	-	-	-
	b. Combined Flakiness and Elongation index	Not to exceed 40%									
	c. Crushing Value	Not to exceed 30%									
	d. Presence of deleterious material	Total presence of deleterious materials not to exceed 5% for uncrushed, 2% for crushed and manufactured coarse aggregates as per Annexure- 3A.									
	e. Hardness	Abrasion value not more than 50%, Impact value not more than 45%									
	f. Soundness test (for concrete work subject to frost action)	12% when tested with sodium sulphate and 18% when tested with magnesium sulphate									



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 21 of 36

Annexure-3A

Deleterious Substance	Percentage by Mass, Max		
	Uncrushed	Crushed	Manufactured
a) Coal and lignite	1.0	1.0	1.0
b) Clay lumps	1.0	1.0	1.0
c) Materials finer than 75 micron	1.0	1.0	1.0
d) Soft fragments	3.0	--	3.0
e) Shale	--	--	--
f) Total of percentages of all deleterious materials (except mica) including S. No. a) to e) for uncrushed and crushed aggregates	5.0	2.0	2.0



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 22 of 36

Annexure-4

ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR FINE AGGREGATES AS PER IS 383:2016 (Reaffirmed 2021)

4.	Fine aggregates				
i)	Physical Tests		Percentage passing for graded aggregate of nominal size		
	a) Determination of particle size	IS Sieve Designation	F.A. Zone I	F.A. Zone II	F.A. Zone III
		10 mm	100	100	100
		4.75 mm	90-100	90-100	90-100
		2.36 mm	60-95	75-100	85-100
		1.18 mm	30-70	55-90	75-100
		600 microns	15-34	35-59	60-79
		300 microns	5 to 20	8 to 30	12 to 40
		150 microns*	0-10	0-10	0-10
	b) Presence of deleterious material	Total presence of deleterious materials not to exceed 5% for uncrushed, 2% for crushed/Mixed and manufactured fine aggregates as per Annexure- 4A.			
	c) Soundness Applicable to concrete work subject to frost action	10% when tested with sodium sulphate and 15% when tested with magnesium sulphate			

*For crushed stone sand the permissible limit on 150 microns IS Sieve is increased to 20 %.



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 23 of 36

Annexure-4A

Deleterious Substance	Percentage by Mass, Max		
	Uncrushed	Crushed/Mixed	Manufactured
a) Coal and lignite	1.0	1.0	1.0
b) Clay lumps	1.0	1.0	1.0
c) Materials finer than 75 micron	3.0	15.0 (for crushed sand) 12.0 (for mixed sand)	10.0
d) Soft fragments	--	--	--
e) Shale	1.0	--	1.0
f) Total of percentages of all deleterious materials (except mica) including S. No. a) to e) for uncrushed aggregates and a) & b) for crushed/mixed and manufactured aggregates	5.0	2.0	2.0



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 24 of 36
Annexure-5

ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR CONCRETE WORK

1)	Concrete	a) Workability	Slump shall be recorded by slump cone method and it shall be between 25-75 mm. depending upon workability requirement as per IS 456:2000 (Reaffirmed 2021).
		b) Compressive strength	For Design mix as per IS 456:2000 (Reaffirmed 2021) for Grade M15 or above For nominal (volumetric) concrete mixes compressive strength for 1:1.5:3 (Cement : Fine aggregates : Coarse aggregates) concrete 28 days strength shall be min 265Kg/cm ² (26N/mm ²) and for 1:2:4(Cement: Fine Aggregate: Coarse aggregate) nominal mix concrete 28 days strength shall be min 210Kg/cm ² (20.60N/mm ²).

Notes :

- 1) **ACCEPTANCE CRITERIA BASED ON 28 DAYS COMPRESSIVE STRENGTHS FOR NOMINAL MIX CONCRETE:** As per clause 5.4.10.4 of CPWD Specifications, Volume 1
 - (a) The average of the strength of three specimen be accepted as the compressive strength of the concrete provided the strength of any individual cube shall neither be less than 70% nor higher than 130% of the specified strength.
 - (b) If the strength of any individual cube exceeds more than 30% of specified strength, it will be restricted to 130% only for computation of strength.
 - (c) If the actual average strength of accepted sample is equal to or higher than specified strength upto 30% then strength of the concrete shall be considered in order and the concrete shall be accepted at full rates.
 - (d) **If the actual average strength of accepted sample is less than specified strength but not less than 70% of the specified strength, the concrete may be accepted at reduced rate.**
 - (e) In case cube strength is less than 70% of specified strength, then structure shall be rejected (to be dismantled and recast) and thus no payment shall be made.

If, however the Engineer-in-Charge so desires, on critical/ urgent work, additional tests such as UPV, RHT, Core etc. shall be done at the cost of contractor in consultation with FQA to ascertain the quality of casted concrete. On the basis of proposal of site, FQA shall put up their recommendations to Regional-Head regarding acceptance / non-acceptance of concrete based on test results. Regional head shall take further decision on nonaccepted works whether the said concrete structure to be retained (with / without strengthening measures) or rejected (to be dismantled and recast).

If strengthening measures are chosen, a strengthening proposal with detailed reasons / justification for not rejecting the concrete shall be submitted to CC -Engg. CC, Engg will review the strengthening proposal and communicate their approval or revised drawing accordingly.

If structures are retained after strengthening/ rectification measures, All the charges in connection with these additional tests and /or strengthening / rectification work shall be borne by the contractor. In case such structure is retained, part payment shall be paid as indicated in payment procedure in SOP.

* Corrected content



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 25 of 36

- 2) 53 Grade cement shall be used after obtaining specific approval of the Engineer in charge.
- 3) Portland slag cement conforming to IS 455:2015 (Reaffirmed 2020) may be used as per Technical Specification.
- 4) All Design Mix concrete shall be as per IS 456: 2000, reaffirmed 2021
- 5) ACCEPTANCE CRITERIA BASED ON 28 DAYS COMPRESSIVE STRENGTHS FOR DESIGN MIX CONCRETE: As per Table-11 IS 456 as given below:

Table 11 Characteristic Compressive Strength Compliance Requirement
(Clauses 16.1 and 16.3)

Specified Grade	Mean of the Group of 4 Non-Overlapping Consecutive Test Results in N/mm^2	Individual Test Results in N/mm^2
(1)	Min (2)	Min (3)
M 15 and above	$\geq f_{ck} + 0.825 \times \text{established standard deviation}$ (rounded off to nearest $0.5 N/mm^2$) or $f_{ck} + 3 N/mm^2$, whichever is greater	$\geq f_{ck} - 3 N/mm^2$

NOTES

1. In the absence of established value of standard deviation, the values given in Table 8 may be assumed, and attempt should be made to obtain results of 30 samples as early as possible to establish the value of standard deviation.
2. For concrete of quantity up to $30 m^3$ (where the number of samples to be taken is less than four as per the frequency of sampling given in 15.2.2), the mean of test results of all such samples shall be $f_{ck} + 4 N/mm^2$, minimum and the requirement of minimum individual test results shall be $f_{ck} - 2 N/mm^2$, minimum. However, when the number of sample is only one as per 15.2.2, the requirement shall be $f_{ck} + 4 N/mm^2$, minimum.

- 6) The test results of the sample shall be the average of the strength of the three specimens. The individual variation shall not be more than $\pm 15\%$ of the average.



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 26 of 36

Annexure- 6

SAMPLING PLAN FOR BRICK-WORK

Scale of sampling and permissible number of defectives for visual and dimensional characteristics.

No of Bricks in the lot	For characteristics specified for individual bricks		For Dimensional characteristics for group of 20 bricks
	No of bricks to be selected	Permissible no of defective in the sample.	No of bricks to be selected
(1)	(2)	(3)	(4)
2001-10000	20	1	40
10001-35000	32	2	60
35001-50000	50	3	80

Note: In case the lot contains 2000 or less bricks the sampling shall be as per decision of the Engineer – in- charge.

Scale of sampling for physical characteristics

Lot size	Sampling size for compressive strength, water absorption and efflorescence	Permissible No of defectives for efflorescence
(1)	(2)	(3)
2001-10000	5	0
10001-35000	10	0
35001-50000	15	1

ACCEPTABLE CRITERIA FOR BRICK WORK

1) Dimensional Tolerances: The dimensions of modular/ Non modular bricks when tested shall be within the following limits per 20 bricks.

S. No	DESCRIPTION	MODULAR BRICKS	NON-MODULAR BRICKS
1	LENGTH	372 to 388 cm (380± 8 cm)	452 to 468 cm (460 ± 8 cm)
2	WIDTH	176 to 184 cm (180± 4 cm)	216 to 224 cm (220 ± 4 cm)
3	HEIGHT	176 to 184 cm (180± 4 cm)	136 to 144 cm (140 ± 4 cm)

2) Compressive strength: the bricks shall have a minimum average compressive strength as specified in POWERGRID specification. The compressive strength of any individual brick tested shall not fall below the min. average compressive strength specified for the corresponding class of brick by more than 20%. in case compressive strength of any individual brick tested exceeds the upper limit specified for the corresponding class of bricks, the same shall be limited to upper limit of the class as specified for the purpose of calculating the average compressive strength.

3) Water Absorption: The average water absorption of bricks shall not be more than 20% by weight.

4) Efflorescence: The rating of efflorescence of bricks shall not be more than moderate.



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 27 of 36

Annexure-7
Page 1 of 2

PHYSICAL, REQUIREMENT OF COARSE AGGREGATE W.B.M.

S.No.	Type of Constn.	Type of W.B.M Test	Test Method	Requirements
1.	Sub-base	Los Angeles Abrasion Value or Aggregate Impact value	IS 2386 (Part-IV) IS 2386 (Part-IV) IS 5640***	60% max. * 50% max
2.	Base	a) Los Angeles Abrasion Value or Aggregate Impact value b) Flakiness Index	IS 2386 (Part-IV) IS 2386 (Part-IV) IS 5640*** IS 2386 (Part-I)	50% max. * 40% max **15% max
3.	Surface Course	a) Los Angeles Abrasion Value or Aggregate Impact value b) Flakiness Index	IS 2386(Part-IV) IS 2386 (Part-IV) IS 2386 (Part-I)	40% max. 30% max **15% max
4	Binding Material	Plasticity index	IS 2720 (Part-V)	Less than 6

* Aggregates may satisfy requirements of either of the two tests

** The requirements of flakiness index shall be enforced only in case of crushed/broken stone and crushed slag.

*** Aggregates like brick metal, kankar and laterite which get softened in presence of water, shall be tested for impact value under wet conditions in accordance with IS 5640.



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 28 of 36

Annexure-7
Page 2 of 2

GRADING REQUIREMENTS OF COARSE AGGREGATE FOR W.B.M

Grading No.	Size Range	Sieve designation	% by weight passing the sieve
1	90mm to 45mm (Suitable for sub base courses of compacted layer of not less than 90mm thickness).	125mm 90mm 63mm 45mm 22.4mm	100 90-100 25-60 0-15 0-5
2.	63mm to 45mm	90mm 63mm 53mm 45mm 22.4mm	100 90-100 25-75 0-15 0-5
3.	53mm to 22.4mm	63mm 53mm 45mm 22.4mm 11.2mm	100 95-100 65-90 0-10 0-5
4	Screening		
	A) 13.2 mm	13.2 mm 11.2 mm 5.6 mm 180 micron	100 95-100 15-35 0-10
	B) 11.2 mm	11.2 mm 5.6 mm 180 micron	100 90-100 15-35



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 29 of 36

Annexure-8

Requirement of grading of broken Burnt Brick Coarse aggregate

IS Sieve Designation	Percent Passing
75 mm	100
37.5 mm	95-100
19.0 mm	45-75
4.75 mm	0-5

General Notes:

- 1) This standard Field Quality Plan is not to limit the supervisory checks which are otherwise required to be carried out during execution of work as per drawings/Technical specifications etc.
- 2) All materials under supply contract should have Cat-A CIP before they are erected.
- 3) Contractor shall be responsible for implementing/documenting the SFQP. Documents shall be handed over by the contractor to POWERGRID after the completion of the work.
- 4) Project incharge means over all incharge of work. Site Incharge means incharge of the Site. Site Engineer means in charge of the section. Site Engineer's responsibility may be allocated to Site JE, with the approval of Regional Head, only in such cases where, Site Engineer is not in position.
- 5) In case of deviation the approving authority will be one step above the officer designated for acceptance in this quality plan subject to minimum level of Site incharge.
- 6) Acceptance criteria and permissible limits for tests are indicated in the Annexures. However for further details/tests POWERGRID specification and latest relevant Indian standards shall be referred.
- 7) Tests as mentioned in this FQP shall generally be followed. However E.I.C. reserves the right to order additional tests wherever required necessary at the cost of the agency.
- 8) All counter checks/tests by POWERGRID shall be carried out by POWERGRID's officials' at least at the level of Site Engineer. .
- 9) The authorized dealer of reinforcement steel means the dealer whose names are listed in the steel producer's web site or certified by the producers.
- 10) Accepting Authority for testing Laboratory shall be Regional Head.



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 30 of 36

- 11) READYMIX CONCRETE (RMC) IS ACCEPTABLE FOR USE. HOWEVER, SITE INCHARGE SHALL APPROVE THE SOURCE OF MATERIALS TO BE USED FOR RMC. The documentation to be maintained shall be as per IS 4926:2003 (Reaffirmed 2022) i.e.
- i) Information to be supplied by the purchaser (clause 7)
 - ii) Information to be supplied by the producer (clause 8)
 - iii) Sampling for concrete strength should be one set of 3 nos. of cubes for every 50 cum or part thereof for each day of concreting and 28 days compressive strength shall be tested in line with IS 456:2000 (Reaffirmed 2021).
- 12) The preference shall be given to batching/RMC plants approved by Quality Council of India.
- 13) Epoxy coating on reinforcement steel wherever required shall be done as per IS 13620:1993 (Reaffirmed 2020).
- 14) Cement is to be used in the order; it is delivered (i.e. First in First Out). In case the cement remains in storage for more than 3 months, the cement shall be retested before use and shall be rejected, if it fails to conform to any of the requirements given in the relevant Indian Standard. Cement shall be packed in bags and stored in accordance with the provisions in IS 4082:1996 (Reaffirmed 2018).
- 15) Three samples of each size of steel (all sizes of 10mm & above) out of 100MT steel Lot need to be physically weighted to ascertain their acceptance as per technical specification. The weighted samples at site may be kept under custody for three months.
- 16) If e-mail facility is not available in POWERGRID approved Lab, report may be collected directly by POWERGRID /Speed Post / Register Post / UPC.
- 17) In case any Laboratory refuses to allow POWERGRID representative for witnessing the test, same shall be taken in writing and approved by Regional Head.
- 18) Latest IS codes shall be followed.
- 19) Standard marking of ISI mark along with license number (Seven digit no., represented as CM/L-----) should be verified for construction materials.
- 20) The mix design shall be approved in line with standard format for mix design concrete and final approval of mix design shall be done in consultation with Regional engineering department.
- 21) Tolerance of cement weight shall be governed by IS 269: 2015 (Reaffirmed 2020) for OPC and by IS 1489 (Part 1) Reaffirmed 2020 for PPC.
- 22) Digital Photographs during major construction activities shall be taken and kept in record.
- 23) All the charges in connection with NDT/ Core tests shall be borne by the contractor.
- 24) The cube testing in in-house Cube testing machine shall be carried out by POWERGRID employee not directly associated with construction activities. The employees associated with O&M works should be preferred for carried out cube test.
- 25) Wherever reference to BIS Codes is made, it shall be the latest edition/revision of the same.



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 31 of 36

Annexure-9

ENGINEERING GUIDE LINE FOR CHECKING / ACCEPTING SOIL INVESTIGATION REPORT:

Following are the guide line for checking and accepting the soil investigation report:

The soil investigation shall be carried out in line with the Technical Specification. The detailed soil Investigation Report should be signed by the soil investigating agency, Line Contractor and POWERGRID's Site Engineer/RHQ Engineer and following points should be checked in the soil investigation report:

- Soil investigation report should contain the bore Log sheet indicating the variation of different soil strata.
- The Bearing capacity, Bulk density (γ) , Submerged Density(γ_{Sub}) , angle of repose (δ) in dry as well as wet condition and Angle of internal friction (ϕ) for different soil layers including at 3m depth shall be indicated in the Soil investigation report.
- Present water table and history of variation of water table at the tower location shall be indicated in the soil investigation report.
- Classification of foundation should be indicated based on the water table , Bearing capacity, Swelling Index, Soil type and the value of angle of repose (δ) in line with parameters indicated in the standard foundation drawings.



STANDARD FIELD QUALITY PLAN

Item	Switchyard Civil works
Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

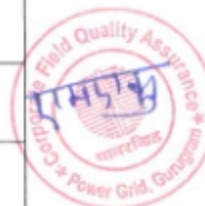
SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 32 of 36

Annexure-10

CONCRETE MIX PROPORTIONING-MIX DESIGN

S. No.	Design Stipulations	Specified Criteria for Mix Proportion
A	CONCRETE DETAILS:	M20 M25 M30 M35 M40
1.	Grade of Concrete (M 20 to M 60- 28 days compressive Strength of 150mm cubes)	
2.	Type of Concrete- Structural Classification	PCC RCC PSC Others
3.	Placing Conditions of Concrete (Structural Elements)	Building TL Pile S/S Pile S/S Structure Road
B	MIX DESIGN LIMITS:	0.30 0.35 0.40 0.45 0.50 Others
4.	Max. Water-Cement Ratio (W/C)- Optional	
5.	Min Cement Content- Optional- Kg/m3	300 320 340 360 380 Others
C	EXPOSURE CONDITIONS:@	Mild Mod. Severe V. Severe Extreme
6.	Type of Environmental Exposure	
7.	Whether Exposed to Sulphate attack from Soil, Water & Containment.	Yes No Not Known
8.	Whether Exposed to Chloride attack from Soil, Water & Containment.	Yes No Not Known
D	CONCRETE INGREDIENTS:	Ground River Pond Others
9.	Source of Water for Construction	
10.	Type of Cement & Strength Grade.	OPC OPC OPC PPC PPC PSC



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SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 33 of 36

		Gr.33	Gr.43	Gr.53	BFS	FAB	
		☐	☐	☐	☐	☐	☐
11.	Brand, Batch No./Week/Year of Cement(Test Certificate to be sent to Lab)						
12.	Cementitious Materials Proposed for Improvement of Density & Permcability.	Microsilica/ Silica Fume	Slag	Fly Ash	Other Pozzolona		
		☐	☐	☐	☐		
13.	FRESH CONCRETE Properties: Desired Slump of Concrete (mm)#	25-55	25-75	100-150	Others		
		☐	☐	☐	☐		
14.	QUALITY CONTROL AT SITE: Degree of Quality Control at Project Site (For Standard Deviation)	V.Good	Good	Fair	Std.Lab.		
		☐	☐	☐	☐		
15.	Max. Size of Coarse Aggregate (MSA)-mm	63	40	20	12.5	4.75	Other
		☐	☐	☐	☐	☐	☐
16.	Source of Coarse Aggregate	Name of Quarry			Location		
17.	Type of Fine Aggregate	River Sand	Crushed Sand	Others Specify			
		☐	☐	☐			
18.	Source of Fine Aggregate (Sand)	Name of Quarry			Location		
19.	Admixture proposed to be Used (Batch MTC to be Submitted to Lab)	Brand Name:			Batch No.:		



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Applicability	POWERGRID Projects
Date of Issue	10-07-2024
Validity	Till next revision

SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 34 of 36

20.	Type of Compaction Equipment	Plate Vibrator ☐ Needle Vibrator ☐ Vibro Hyd. Pressure ☐ Piling Concrete ☐
21.	Type of Concrete Placement Facility at Project	Manual Lift ☐ Hudraulic Bucket ☐ Concrete Pump ☐
22	Maximum/Minimum temp. envisaged during placing of concrete	

Slump Value as per SFQP;

- i. For Switchyard civil works – 25 to 75mm
- ii. For Switchyard pile foundations- 150-180mm
- iii. For Transmission line open cast foundations- 25 to 75mm
- iv. For Transmission line pile foundations- 150-180mm



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SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 35 of 36

ENVIRONMENT	EXPOSURE CONDITIONS
MILD	• Concrete surfaces protected against weather or aggressive
MODERATE	• Concrete exposed to condensation and rain • Concrete continuously under water • Concrete surfaces sheltered from rain or freezing whilst wet • Concrete in contact or buried under non-aggressive soil/ground water
SEVERE	• Concrete surfaces exposed to severe rain, alternate wetting and drying or occasional freezing whilst wet or severe condensation • Concrete completely immersed in sea water • Concrete exposed to coastal environment
VERY SEVERE	• Concrete surfaces exposed to sea water spray, corrosive fumes or severe freezing conditions whilst wet. • Concrete in contact with or buried under aggressive subsoil/ ground water
EXTREME	• Surface of members in tidal zone, Members in direct contact with liquid/solid aggressive chemicals



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SFQP No.	DOC No.C/FQA/SFQP/SCW
REV.	07

Page 36 of 36

Annexure-11

**Standard procedure for Testing/Assessment of compressive strength of cast Concrete
(Revision-I)
issued vide**

IOM No: CC:FQA:SOP:2024 dated 05-07-2024





पावर ग्रिड कॉर्पोरेशन आफ इंडिया लिमिटेड
कारपोरेट एफ. क्यू.ए. विभाग
अंतर कार्यलाय ज्ञापन

प्रेषक: मुख्य महाप्रबंधक, एफ. क्यू.ए.
केंद्रीय कार्यालय

सेवा में : As per Distribution

संदर्भ संख्या: CC:FQA:SOP:2024

दिनांक: 05-07-2024

विषय: Revised (Revision 1) Standard procedure for Testing / Assessment of compressive strength of cast Concrete for nominal and design mix.

Please find enclosed herewith the Revised (Revision 1-SOP) Standard procedure for Testing / Assessment of compressive strength of cast Concrete, duly approved by competent authority. These guidelines are being issued both for nominal mix and design mix concrete. Henceforth, this standard operating procedure (Revision 1-SOP Annexure I) shall be applicable for all future projects of POWERGRID.

This issues with the approval of the Competent Authority.

Encl: Revision 1-SOP Annexure I (08 pages)

एम अशोक कुमार
05/07/2024
(एम अशोक कुमार)

वितरण/Distribution:

- 1) **कार्यपालक निदेशक :** उत्तरी क्षेत्र-1/उत्तरी क्षेत्र-2/उत्तरी क्षेत्र-3 /पश्चिमी क्षेत्र-1/पश्चिमी क्षेत्र-2/ दक्षिण क्षेत्र-1/दक्षिण क्षेत्र-2/ पूर्वी क्षेत्र-1 /पूर्वी क्षेत्र-2/ उत्तर पूर्वी क्षेत्र/ Arunachal comprehensive T&D/एन. ई. आर .पी.एस. आई. पी./ ओड़िसा प्रोजेक्ट्स./टी.बी.सी.बी./ उप मुख्य सतर्कता अधिकारी/संविदा सेवाए/ अभियांत्रिकी /अभियांत्रिकी एच वी डी सी / एफ. क्यू.ए.
- 2) ES/PS of CMD/Director (Projects)/Director (Operation)/Director (Fin)/CVO
- 3) समस्त एफ. क्यू.ए. कार्यपालक

Standard procedure for Testing/Assessment of compressive strength of cast Concrete

Structural Elements

(A) Foundation shall be divided into two structural elements:

- a) Foundation Pad(s)
- b) Chimney/Column

(B) Pile foundation shall be divided into three structural elements:

- a) Piles
- b) Pile cap (s)
- c) Pedestal
- d) Tie Beam

(C) Building shall be divided into four structural elements:

- a) Foundation pad(s)
- b) Column
- c) Beam
- d) Slab

(D) Miscellaneous infrastructure works - cable trench, Fire wall, Boundary wall Panels, RCC roads , RCC drains

1.0 Acceptance Criteria:

For all RCC structures (such as Foundation Pad, Pile Cap & Pedestal, Roads/Drains/ Column / Chimney/ Cable Trenches/ Firewall/ Boundary wall panels, Beams, Columns & Slabs of Buildings.

1.1 Nominal Mix:

(i) Acceptance of Concrete Cubes test results

If test results of Concrete cubes & Cores are in between 70%-100% of specified grade of concrete, CPWD specifications Cl.no.5.4.10.4, Vol 1 shall be followed. Accordingly, the following may be adopted to consider the acceptance criteria of nominal mix concrete.

- (a) The average of the strength of three (3) specimen be accepted as the compressive strength of the concrete provided the strength of any individual cube shall neither be less than 70% nor higher than 130% of the specified strength.
- (b) If the strength of any individual cube exceeds more than 30% of specified strength, it will be restricted to 130% only for computation of strength.
- (c) If the actual average strength of accepted sample is equal to or higher than specified strength up to 30% then strength of the concrete shall be considered in order and the concrete shall be accepted at full rates.
- (d) If the actual average strength of accepted sample is less than specified strength but not less than 70% of the specified strength, the concrete may be accepted at reduced rate. No NDT such as UPV & RHT etc. shall be carried out.
- (e) In case cube strength is less than 70% of specified strength, then structure shall be rejected (to be dismantled and recast) and thus no payment shall be made.

If, however the Engineer-in-Charge so desires, on critical/ urgent work, additional tests such as UPV, RHT, Core etc. shall be done at the cost of contractor in consultation with FQA to ascertain the quality of cast concrete. On the basis of proposal of site, FQA shall put up their recommendations to Regional-Head regarding acceptance /non-acceptance of concrete based on test results. Regional head shall take further decision on non-accepted works whether the said concrete structure to be retained (with / without strengthening measures) or rejected (to be dismantled and recast).

If strengthening measures are chosen, a strengthening proposal with detailed reasons / justification for not rejecting the concrete shall be submitted to CC -Engg. CC-Engg. will review the strengthening proposal and communicate their approval or revised drawing accordingly.

If structures are retained after strengthening/ rectification measures, All the charges in connection with these additional tests and /or strengthening / rectification work shall be borne by the contractor.

In case such structure is retained, part payment shall be paid as indicated in the payment procedure.

(ii) Acceptance of Core test results:

In case of nominal mix, Acceptance of Concrete Core test results (In case of doubt/strength



is less than 70% of specified strength/concrete cube test results not available).

Core test shall be carried out in case of doubt regarding desired compressive strength of concrete used either due to poor workmanship or based on results of cube strength tests/cube test results are not available.

The acceptability criteria adopted for concrete cube test results of Nominal Mix may also be applicable for Core test results.

1.2 Design mix: Concrete Cubes

Acceptable Compressive strength:- Acceptance of Concrete Cube test results considering average value of three specimens.

a) when mean of the group of four (4) non overlapping consecutive test results:
 $\geq f_{ck} + 0.825 \times \text{established standard deviation (rounded off to nearest } 0.5 \text{ N/mm}^2)$
or
 $f_{ck} + 3 \text{ N/mm}^2$

whichever is greater for M 15 and above and Individual test results minimum $\geq f_{ck} - 3 \text{ N/mm}^2$

Notes:

- i) In the absence of established value of standard deviation, the values given in Table -8 in IS 456-2000 may be assumed, and attempt should be made to obtain results of 30 samples as early as possible to establish the value of standard deviation.
- ii) For concrete quantity up to 30 m³ (where number of samples to be taken is less than four (4) as per the frequency of sampling given in 15.2.2 of IS 456:2000), the mean test results of all such samples shall be $f_{ck} + 4 \text{ N/mm}^2$, minimum and the requirement of minimum individuals test results shall be $f_{ck} - 2 \text{ N/mm}^2$, minimum. However, when number of sample is only one as per 15.2.2 IS 456:2000, the requirement shall be $f_{ck} + 4 \text{ N/mm}^2$, minimum.

In case cube strength is as per above, then full payment shall be released.

- b) when compressive strength value is in between f_{ck} and $f_{ck} + 4/f_{ck} + 3$ as applicable, then the payment shall be made as indicated in the payment procedure. No NDT such as UPV & RHT etc. shall be carried out.
- c) However, in invalid results cases, if there are no further samples available, the average of two (2) closest values may be considered for determination of compressive strength as per IS 516 (Part I/Sec I) 2021. The payment shall be made as indicated in the payment procedure.
- d) In cases, compressive strength is less than f_{ck} and acceptance criteria brought out above, the structure shall be rejected.

If, however the Engineer-in-Charge so desires, on critical/ urgent work, additional tests such as UPV, RHT, Core etc. shall be done at the cost of contractor in consultation with FQA to ascertain the quality of cast concrete. On the basis of proposal of site, FQA shall put up their recommendations to Regional-Head regarding acceptance/non-acceptance of concrete



based on test results. Regional head shall take further decision on non-accepted works whether the said concrete structure to be retained (with / without strengthening measures) or rejected (to be dismantled and recast).

If strengthening measures are chosen, a strengthening proposal with detailed reasons / justification for not rejecting the concrete shall be submitted to CC -Engg. CC- Engg. will review the strengthening proposal and communicate their approval or revised drawing accordingly.

If structures are retained after strengthening/ rectification measures, All the charges in connection with these additional tests and /or strengthening / rectification work shall be borne by the contractor.

In case such structure is retained, part payment shall be paid as indicated in payment procedure.

1.3 Design Mix Concrete Core Test: - Acceptance of concrete core test results:(In case of doubt/If strength is less than Fck/ Concrete cube test results are not available)

Core test shall be carried out in case of doubt regarding strength of concrete used either due to poor workmanship or based on results of cube strength tests or less than fck (Characteristic cube compressive strength of concrete)/Concrete cube test results are not available.

If Average value of core specimens is 85% of the specified Grade of concrete and no individual value is less than 75% of the specified Grade of concrete and the same is considered acceptable as per B-2.5.1 IS 516(Part4):2018.

Any compressive strength deviation from the above, the acceptance/rejection procedure has been elaborated in Payment procedure.

- 1.4** No NDT (RH & UPV testing) test is required if concrete cube strength found in between 70% to 100 % for nominal mix and in between FCK and FCK+3/FCK+4 (as applicable) for design mix. However, If applicable, the NDT (UPV & RH testing) test is to be carried out and accepted as per latest IS 516 (Part-5, Sec-1)/516 (Part-5, Sec-4).

2.0 Payment Procedure:

For all RCC structures (such as Foundation Pad, Pile Cap & Pedestal, Roads/Drains/ Column / Chimney/ Cable Trenches/ Firewall/ Boundary wall panels, Beams, Columns & Slabs of Buildings)

2.1 Payment Procedure (Other than Pile): In case of Nominal Mix

For Concrete Cubes and Cores (Core shall be extracted in case of doubt/If specified strength is less than 70%, in average and individual/ Concrete cube test results are not available)

Acceptable Compressive strength- As per specified strength of concrete.

- a) when Concrete cube or core strength equal or more than specified strength of Concrete, Full payment shall be applicable



- b) when Concrete cube or core strength lies in between 70-100% of the specified strength of Concrete then payment shall be released on prorata basis for concrete portion and full payment shall be made on other components such as excavation, PCC, Reinforcement steel, Shuttering as applicable.
- c) when Concrete cube or core strength is less than 70% of specified strength of Concrete, the Engineer-in-Charge shall reject the defective portion of work represented by sample and no payment shall be made for the rejected work inclusive of concrete, reinforcement steel, PCC, excavation etc.
- d) If, however the Engineer-in-Charge so desires, on critical/ urgent work, additional tests such as UPV, RHT, Core etc. shall be done at the cost of contractor in consultation with FQA to ascertain the quality of cast concrete. On the basis of proposal of site, FQA shall put up their recommendations to Regional-Head regarding acceptance /non-acceptance of concrete based on test results. Regional head shall take further decision on nonaccepted works whether the said concrete structure to be retained (with / without strengthening measures) or rejected (to be dismantled and recast).

If strengthening measures are chosen, a strengthening proposal with detailed reasons / justification for not rejecting the concrete shall be submitted to CC-Engg. CC-Engg. will review the strengthening proposal. and communicate their approval or revised drawing accordingly.

If structures are retained after strengthening/ rectification measures, All the charges in connection with these additional tests and /or strengthening / rectification work shall be borne by the contractor.

In case such structure is retained, no payment shall be made for concreting & full payment of other components such as excavation, PCC, Reinforcement steel, shuttering if applicable as per original approved drawing/BOQ shall be made.

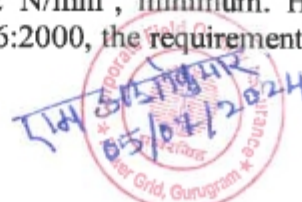
2.2 Payment procedure (Other than Pile) in case of Design Mix: Concrete Cubes

- a) when mean of the group of four (4) non overlapping consecutive test results:
 $\geq f_{ck} + 0.825 \times \text{established standard deviation (rounded off to nearest } 0.5 \text{ N/mm}^2)$
 or
 $f_{ck} + 3 \text{ N/mm}^2$

whichever is greater for M 15 and above and Individual test results minimum $\geq f_{ck} - 3 \text{ N/mm}^2$

Notes:

- i) In the absence of established value of standard deviation, the values given in Table -8 in IS 456-2000 may be assumed, and attempt should be made to obtain results of 30 samples as early as possible to establish the value of standard deviation.
- ii) For concrete quantity up to 30 m³ (where number of samples to be taken is less than four (4) as per the frequency of sampling given in 15.2.2 (Table 11) of IS 456:2000), the mean test results of all such samples shall be $f_{ck} + 4 \text{ N/mm}^2$, minimum and the requirement of minimum individuals test results shall be $f_{ck} - 2 \text{ N/mm}^2$, minimum. However, when number of sample is only one as per 15.2.2 IS 456:2000, the requirement shall be $f_{ck} + 4 \text{ N/mm}^2$, minimum.



In case cube strength is as per above, then full payment shall be released.

- b) when compressive strength value is in between f_{ck} and $f_{ck}+4/f_{ck}+3$ as applicable, then the payment shall be released on prorata basis for concrete and full payment shall be made towards excavation, PCC, Reinforcement steel, Shuttering as applicable as per drawing/BOQ. No NDT such as UPV & RHT etc shall be carried out.
- c) However, in invalid results cases, if there are no further samples available, the average of two (2) closest values may be considered for determination of compressive strength as per IS 516 (Part I/Sec I) 2021. In such cases when the compressive strength meets the specified strength of Concrete, payment for concrete portion shall be released on prorata basis and full payment on other components such as towards excavation, PCC, Reinforcement steel, Shuttering etc shall be made.
- d) In cases, compressive strength is less than f_{ck} and acceptance criteria brought out above, the structure shall be rejected.

If, however the Engineer-in-Charge so desires, on critical/ urgent work, additional tests such as UPV, RHT, Core etc. shall be done at the cost of contractor in consultation with FQA to ascertain the quality of cast concrete. On the basis of proposal of site, FQA shall put up their recommendations to Regional-Head regarding acceptance /non-acceptance of concrete based on test results. Regional head shall take further decision on non-accepted works whether the said concrete structure to be retained (with / without strengthening measures) or rejected (to be dismantled and recast).

If strengthening measures are chosen, a strengthening proposal with detailed reasons / justification for not rejecting the concrete shall be submitted to CC -Engg. CC, Engg. will review the strengthening proposal and communicate their approval or revised drawing accordingly.

If structures are retained after strengthening/ rectification measures, All the charges in connection with these additional tests and /or strengthening / rectification work shall be borne by the contractor.

In case such structure is retained, no payment shall be made for concreting & full payment of other components such as excavation, PCC, Reinforcement steel, shuttering if applicable as per original approved drawing/BOQ shall be made.

2.3 Payment procedure (Other than Pile) in case of Design Mix: Concrete Cores

Concrete Cores (Core shall be extracted In case of doubt/If specified strength is less than f_{ck} , Concrete cube test results are not available)

The payment procedure for core test results is detailed below:

- i) When equivalent cube strength is equal/more than $f_{ck}+4/f_{ck}+3$ as applicable, then full payment shall be made.
- ii) When equivalent cube strength is in between f_{ck} and $f_{ck}+4/f_{ck}+3$ as applicable/When equivalent cube strength is in between 85% f_{ck} and no individual value is less than 75% of the specified Grade of concrete, the same is considered acceptable, prorata payment for concrete portion and full payment shall be made on other components such as excavation, PCC, Reinforcement steel, Shuttering as applicable.



- iii) In case equivalent cube strength is less than 85%fck and/or an individual core has a strength less than 75%, then structure shall be rejected and thus no payment shall be made.

If, however the Engineer-in-Charge so desires, on critical/ urgent work, additional tests such as UPV, RHT, Core etc. shall be done at the cost of contractor in consultation with FQA to ascertain the quality of cast concrete. On the basis of proposal of site, FQA shall put up their recommendations to Regional-Head regarding acceptance /non-acceptance of concrete based on test results. Regional head shall take further decision on nonaccepted works whether the said concrete structure to be retained (with / without strengthening measures) or rejected (to be dismantled and recast).

If strengthening measures are chosen, a strengthening proposal with detailed reasons / justification for not rejecting the concrete shall be submitted to CC -Engg. CC, Engg. will review the strengthening proposal. and communicate their approval or revised drawing accordingly.

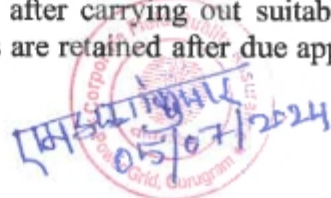
If structures are retained after strengthening/ rectification measures, All the charges in connection with these additional tests and /or strengthening / rectification work shall be borne by the contractor.

In case such structure is retained, no payment shall be made for concreting & full payment of other components such as excavation, PCC, Reinforcement steel, shuttering if applicable as per original approved drawing/BOQ shall be made.

3.0 Acceptance Criteria & Payment procedure for Pile Foundations (Design Mix)

- (i) In case of Pile foundation, when value of Average cube strength is $fck + 0.825 \times \text{Standard Deviation}$ or $fck + 4/fck + 3$ as applicable whichever higher, then Full payment shall be applicable.
- (ii) when value of Average cube strength is equal to or more than fck but less than $fck + 0.825 \times \text{Standard Deviation}$ or $fck + 4/fck + 3$ as applicable which ever greater, then payment shall be released on prorata basis for concrete portion and full payment shall be made to all other components such as boring, SPT, Reinforcement steel, MS Liner, as applicable as per drawing/BOQ.
- (iii) However, in invalid result cases, if there is no further samples available, the average of two (2) closest values may be considered for determination of compressive strength as per IS 516 (Part 1/Sec 1) 2021. In such cases when the compressive strength meets the specified strength of Concrete, payment for concrete portion shall be released on prorata basis and full payment on other components such as towards boring, Reinforcement steel, MS Liner, SPT etc as applicable shall be made.
- (iv) In case compressive strength of cubes observed is less than fck , Vertical load test (routine test) shall be carried out in Pile foundations of Switchyard / Transmission lines wherever applicable in consultation with Engineering to ascertain the capacity of pile as per IS 2911(Part IV). If the test result is meeting the codal requirement, then 50 % payment shall be made for concrete & full payment shall be made towards Boring, Reinforcement steel, SPT, MS Liner as applicable in line with original approved drawings/BOQ.

Alternatively, for Transmission Line cases, if Head of the Region so desires, the proposal may be examined by Engineering for acceptance after carrying out suitable remedial measures including strengthening/ OR if structures are retained after due approval from



Engineering without any rectification. In such cases, 50% payment shall be made for concrete & full payment shall be made towards Boring, Reinforcement steel, SPT, Liner as applicable in line with approved drawings/BOQ.

- (v) If compressive strength of cube of piles observed is less than f_{ck} & not technically meeting /cleared by Engineering as brought out above, the structure shall be rejected and then no payment shall be paid for the rejected pile inclusive of concrete, boring, reinforcement steel, MS Liner etc.

4.0 General Notes: -

- i) In case only one set of cube results are available for a location and results are found to be less than 70% of specified strength in case of Nominal Mix, all four legs of the location shall be analyzed as per the procedure as indicated in acceptance criteria.
- ii) However, in case of locations where two or more set of cube results are available and results are found less than 70% of specified strength, in case of Nominal mix, then only one pit shall be excavated at a time (utmost care shall be taken to avoid any damage to concrete surface or disturb undercut zones of foundation) and analyzed those legs as per the procedure as indicated in acceptance criteria.
- iii) The calibration certificate of the rebound hammer should be checked before commencement of a test.
- iv) NDT (UPV & Rebound Hammer Test) or Core Test shall be conducted by POWERGRID approved laboratory. The lab shall be entrusted to carry out the testing which shall be witnessed by Site/FQA executive. The laboratory shall submit the report containing the UPV & Rebound Hammer Test or CoreTest results along with the field data.
- v) Acceptance criteria of construction materials shall be as per SFQP/relevant IS codes.
- vi) For core testing at least three specimens are required as per IS:516(Part-4). While extracting cores, four to five specimens may be taken from the foundation pads (uniformly distributed) such that three sound specimen may be used for testing. Otherwise repeat test shall be made. If cores of sufficient length cannot be extracted for testing due to poor quality of concreting/workmanship etc. as per IS: 516(Part-4), the foundation shall be treated as rejected.
- vii) When core test is carried out, technical acceptance and commercial implications shall be governed solely on the basis of core test results. This shall be applicable for both nominal and design mix concrete.
- viii) For additional structures/piles if any installed in lieu of rejected structure/pile, no payment shall be made for the rejected pile and the additional pile shall be dealt as per the provisions of Contract.
- ix) Generally, Core test should not be repeated after completion and availability of test reports for the same structure of the same batch of concrete.
- x) No core extraction/test is permitted in case of pile foundations
- xi) The provision of additional 5% Core testing as mentioned in SFQP's stands deleted.

मि. अ. कुमार 05/07/2024
(म. अ. कुमार)
मुख्य मंडल अधिकारी (एफ. व्. ए.)
Power Grid, Gurugram