



# Himachal Pradesh Agriculture Development Society GOVERNMENT OF HIMACHAL PRADESH

# HIMACHAL PRADESH CROP DIVERSIFICATION PROMOTION PROJECT (Phase-II) JICA-ODA LOAN ID - P290

# FUNDED BY Japan International Cooperation Agency (JICA)

# **Quality Assurance and Quality Control Manual**

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### LIST OF ABBREVIATION

B:C ratio	Benefit Cost ratio
BOQ	Bill of Quantities
BPM	Block Project Manager
BPMU	Block Project Management Unit
BHP	Break Horsepower
CE	Construction Engineer
CI	Cast Iron
CQC	Construction Quality Control
Cu. m.	Cubic meter
DI	Ductile Iron
DPD	Deputy Project Director
DPM	District Project Manager
DPMU	District Project Management Unit
GI	Galvanized Iron
GoHP	Government of Himachal Pradesh
Н	Head in meter
HDPE	High Density Polyethylene pipe
HPCDP	Himachal Pradesh Crop Diversification Promotion Project
JE	Junior Engineer
JICA	Japan International Cooperation Agency
Kwh	Kilo watt hour
L	Liter
LPS	Liter per sec
MS	Mild Steel
PD	Project Director
PM	Project Manager
РМС	Project Management Consultant
PMU	Project Management Unit
PVC	Polyvinyl Chloride Pipe
Q	Discharge
QA	Quality Assurance
QA&QC	Quality Assurance and Quality Control
QAP	Quality Assurance Plan
OC OC	Quality Control
RCC	Reinforcement Cement Concrete
SEM	Site Environment Management
SPMU	State Project Management Unit
S&WC	Soil and Water Conservation
η	Efficiency

#### 1. Introduction

Himachal Pradesh Crop Diversification Promotion (HPCDP) Project (Phase-II) is being implemented in the state of Himachal Pradesh with the financial support from Japan International Cooperation Agency (JICA). The Projects aims to promote agricultural productivity, sustainable crop diversification to high value crops and improvement of farmer's income by development of production infrastructures such as irrigation facilities and access farm roads, farmers support and institutional development as well as strengthening farmer's sales force with marketing development, thereby contributing to economic and social development in all districts of Himachal Pradesh.

The Standard Operating Procedure (SOP) after preparation of DPR is being followed in the sequential manner. Major responsibility of DPMU /BPMU is as under:

- Manage and do the necessary preparation before bidding and commencement of work.
- Plan and get the required consents / permissions for the works.
- Collect necessary information of site conditions such as topography, hydrology, soil type, cropped area, cropping pattern, etc., and share with the bidders / contractors.
- Ensure access to the site including working area.

The DPM / BPM should not transfer the above responsibility to the contractor.

On the other hand, the contractor should maintain:

- Quality of material •
- Quality of equipment
- Quality of works
- Skilled manpower
- Quality of completed works as specified in contract
- Health and safety plan
- Environmental and social safeguards •

#### **Quality Assurance and Quality Control** 1.1

Quality Assurance (QA) and Quality Control (QC) are two terms that ultimately provide essential services to construction projects and ensure the final outputs as stipulated by the project. This step is essential to ensure the desired quality results. QA is the maintenance of a desired level of quality in a service or product, especially by means of attention to every stage of its process. Its main goal is to ensure that the completed project meets all requirements and is free of any defects or issues. It is proactive as it helps to understand the requirements for the project and determine all the major documents and tests that the project will encounter during the construction phase.

QC refers to the techniques and tasks used to determine whether the project fulfills its expectations. Quality tests are conducted on the project and scheduled check-point examinations indicates the quality issues and ensure the outputs meet its quality and deadline. If a project does not meet its demands, or if QC discovers a major issue or defect, corrective actions are taken to help create a solution. After fixing the issue, QC can communicate it to QA so they can take preventative measures to make sure the defect or problem doesn't occur again. Quality Control Manual

It is very important constituent of the quality management system. It is a document encompassing specific requirements, which if fulfilled, shall help in effectively implementing the quality control system to achieve the objective of good construction quality. It broadly covers tests on materials, important specifications, standards to be adopted for materials and works, inspections etc.

#### **1.2** QA/QC in the context of HPCDP

The objective of quality control management is to collect process and then communicate the data related to the quality of inputs and outputs as well as finished item of work to those who are responsible for the quality. Any program of quality control seeks to ensure adequacy and uniformity of quality through the following operations.

- 1. To ensure that the works are being executed in conformity with the prescribed specifications.
- 2. Rejecting, where warranted, the material or the product at any intermediate or final stage in case acceptance criteria is not satisfied. The rejected material should be removed from work site.
- 3. Site Order Book pages should be certified by the BPM & should be kept at site round the clock. Any discrepancy noticed during execution should invariably recorded in the site order book compliance of this should be strictly followed.
- 4. Concrete works should be strictly under the supervision of junior engineer/construction supervision team.

#### **1.3** Construction Work Program

The Contractor is required to submit a detailed work program for execution of the works. This program preferably must show the following, as a minimum:

- Itemized work activities to be executed, based on the Contract's Bill of Quantities, indicating start and finish dates and scheduled achievement (progress) each month.
- Sequencing of work and activity inter dependence.
- Calendar day estimates for submittal/invoices approvals.
- Calendar dates for achievement of various milestones, and for completion of works by section and of the project as a whole, within the time periods provided for in the Contract.

The Contractor's program has to be approved by the Project Manager/Engineer/District Project Manager DPMU, as stipulated in the Contract. Once approved, the program cannot be modified except with the prior approval of the DPM- DPMU. The PM's approval of the program does not relieve the Contractor of his obligation to complete the works or sections of work within the time periods stipulated in the Contract.

#### 1.4 Work Progress Control

The Contractor is required to undertake its activities in accordance with the approved work program. Each month the Contractor shall indicate the actual work completed as compared to work scheduled. In the event portions of the work are in danger of being delayed, or actually are delayed, the Contractor is to come up with a plan for remedial action.

Various circumstances may justify the changing of contract requirements for completion of the project on a specific date. Among these circumstances items not within the control of the Contractor,

such as: changes to contract requirements (modification of Contract); suspensions of work; delays in providing access; force majeure, etc. Generally, such occurrences will justify a delay in completion if they affect activities on the critical path of the program. However, each instance must be carefully evaluated and fully documented before a decision can be made.

The following are guidelines for controlling work progress:

- There should always be a baseline program. If changes to the baseline program are required, an updated baseline program should be created.
- The Project Director-SPMU/DPM-DPMU or representative must monitor the progress of works, and the BPM-BPMU and the Contractor should update their completion percentages using mutually agreed-upon information.

### 2. QA/QC Standards for Construction Materials and Equipment

The purpose of inspection and quality control is to assure that the requirement and intentions of the contract document are faithfully accomplished. The inspection in concrete construction includes not only visual observation and field measurements, but also laboratory testing and evaluation of test data. Careful inspection in all operations of concrete relating to the selection of the materials, the design of the mix, water cement ratio, mixing, transporting, placing, consolidating, finishing, protection and curing is required. Hence, OK Card System is recommended for the purpose of enforcement of specification during the construction of various categories of works.

#### 2.1 Constituents of Concrete

The common ingredients of concrete are:

- Cement
- Fine aggregate
- Coarse aggregate
- Water
- Admixtures (sometimes)

To make good concrete, it is necessary to know the qualities of the ingredients, the proportions and methods of mixing, the manner of laying the wet concrete in position and curing (aftercare to ensure strength).

#### 2.1.1 Quality of Cement

Cement is by far the most important constituent of concrete as it forms the binding medium for discrete ingredients. Cement is a standard product of factories. It must be protected during storage from moisture, which will prematurely set it. Set cement with hard lumps that cannot be powered by hand pressure should be rejected. Cement should be used in the order in which consignments are received.

Cement shall comply with one of the following IS codes:

- IS 269 33 Grade ordinary Portland cement
- IS: 8112 43 Grade ordinary Portland cement
- IS 12269 53 Grade ordinary Portland cement
- IS 1489 (Part 1) Portland pozzolana cement (fly ash based)
- IS 1489 (Part 2) Portland pozzolana cement (fly ash based)

The properties of cement are as follows-

1. Compressive Strength shall be as under:

S.	Time	Compressive strength		
No.		OPC IS: 8112	<b>PPC IS:1489 (Part 2)</b>	
a.	3 days	23 N/mm2	16 N/mm2	
b.	7 days	33 N/mm2	22 N/mm2	
c.	28 days	43 N/mm2	33 N/mm2	

- 2. Unit weight of cement shall be 1.44 T/m3. Average net mass of cement per bag shall be 50 Kg.
- 3. Cement shall have normal setting time. The initial setting time shall not be less than 30 minutes and final setting time not more than 600 minutes.
- 4. Cement shall be dry and shall not contain any lumps or cakes of dampened cement.
- 5. Pozzolana cement requires curing for longer periods.

#### Tests:

- 1. Manufacturer of cement shall furnish, on demand, a certificate to indicate that cement conforms to the requirements of IS: 8112 or IS: 1489 regarding chemical constituents, fineness, soundness, setting time and compressive strength.
- 2. Average weight of cement bag (IS: 8112,)

The number of bags in a sample for calculating the average net mass of a cement bag shall be as under:

S. No.	Batch size	Sample size
1	100-150 bags	20 bags
2	151-280 bags	30 bags
3	281-500 bags	50 bags
4	501-1200 bags	80 bags

Compressive strength Ref. IS: 4031 (Part 7) Consistency Ref. IS: 4031 (Part 4) Setting time Ref. IS: 4031 (Part 5)

#### Storage:

- 1. The cement shall be stored in such a manner so as to prevent deterioration due to dampness / water.
- 2. It shall be stored in a waterproof building and on wooden floor which will prevent the absorption of moisture from ground.
- 3. The cement shall be stacked in rows having two bags in width and 8 bags in height. Bags shall be arranged length wise and cross wise in alternate layers.
- 4. The rows shall be separated by sufficient space to provide easy access for inspection.

- 5. Cement shall be used on first-in first-out basis i.e. cement received first shall be used first.
- 6. Cement loses strength with storage period. Cement older than 90 days shall be used only after testing its properties.
- 7. The development of strength in pozzolana cement is slow. However, the heat of hydration is low and surface cracks are less.
- 8. 53 grade cement requires more curing.

#### 2.1.2 Quality of Fine Aggregate

- Sand shall conform to IS 383:2016. Sand shall consist of clean, hard, strong and durable pieces
  of crushed stone, crushed gravel or a suitable combination of natural sand, crushed stone or
  gravel. They shall not contain dust, lumps, soft or flaky particles, mica, silt or other deleterious
  substances like soil etc.
- 2. Presence of mica (Muscovite & Biotite) in sand will reduce considerably the durability and compressive strength of concrete.
- 3. Sand shall be washed off all the mixed earth before use.

#### **Properties**

1. Gradation- The sand shall be well graded and shall have the following gradation for concrete, masonry, and plaster works.

IS Sieve Size	%age passing by weight for grading zone				
	Ι	II	III	IV	
10 mm	100	100	100	100	
4.75mm	90-100	90-100	90-100	95-100	
2.36mm	60-95	75-100	85-100	95-100	
1.18mm	30-70	55-90	75-100	90-100	
600 microns	15-34	35-59	60-79	80-100	
300 microns	5-20	8-30	12-40	15-50	
150 microns	0-10	0-10	0-10	0-15	

Sand conforming to zone I &II shall be used for concrete works. Sand conforming to zones III and IV may also be used for concrete works but concrete mix shall be properly designed. Sand conforming to zone IV shall not be used for reinforced concrete works.

If grading falls outside the limits of particular zone of sieves, except 600-micron sieve, by a total amount of not more than 5%, it shall be taken as conforming to that zone %age (by weight) passing through 600-micron sieve as specified in the table gives the grading zone of the sand.

#### Tests:

- 1. One test for each consignment of sand shall be conducted.
- 2. The supplier on demand shall supply a certificate to indicate that the material complies with the requirements of IS: 383:2016.

S. No	Maximum size present in substantial proportion (mm)	Minimum weight of sample for sieving (kg)
1	4.75	0.2
2	2.36	0.1

- 3. Gradation: weight of the samples for gradation shall not be less than that given below:
- 4. Sample for sieving shall be prepared from larger sample by quartering.
- 5. Sample shall be brought to an air-dry condition by drying it at room temperature before sieving. Air dry sample is weighed and sieved successively on the appropriately sized sieves, starting with the largest sieve. Each sieve shall be shaken separately over a clean tray until not more than a trace passes but for a period of not less than 2 minutes. Material shall not be forced through the sieve openings by hand pressure. If sieving is carried out with a nest of sieves on a machine, not less than 10 minutes sieving shall be done.
- 6. Fineness Modulus is a numerical index of fineness that gives an idea about the mean size of particles in sand and aggregate. It is an empirical figure obtained by adding the total percentage of the sample of a sand retained on each of a specified series of sieves and dividing the sum by 100.
- 7. Sand having a fineness modulus greater than 3.2 is not considered to be suitable for the preparation of concrete. Range of F.M is given below-
  - Fine sand 2.2-2.6
  - Medium sand 2.6 -2.9
  - Coarse sand 2.9-3.2

#### 2.1.3 Quality of Coarse Aggregates

About three quarters of the volume of concrete is occupied by aggregates. Therefore, its quality is of considerable importance. The coarse aggregates not only determine the strength of the concrete, the aggregate properties also greatly affect the durability and structural performance of the concrete.

Coarse aggregate shall conform to IS: 383. It shall consist of clean hard, strong, dense, nonporous and durable pieces of crushed stone, crushed gravel, river borne material, or a combination thereof or other approved inert material. The aggregate shall not contain disintegrated stones, soft, flaky, elongated particles, vegetative matter, or other deleterious materials soil etc. It should either be rounded or cubical in shape. The unloading and stacking of the aggregates shall be done in such a manner that segregation is avoided. Coarse aggregate shall be washed of all the mixed earth before use.

Gradation. Ref. 15: 2500 (Fart 1)				
Gradation: Coarse aggregate for use in concrete	Percentage passing by weight for graded			
shall be well graded and shall conform to the	aggregate of nominal size			
following gradation IS Sieve Size	40 mm	20 mm		
80 mm	100	-		
40 mm	95-100	100		

1. Gradation: Ref. IS: 2386 (Part 1)

20 mm	30-70	95-100
10 mm	10-35	25-55
4.75 mm	0-5	0-10

- 2. Aggregate impact value- As an alternative to crushing value, the aggregate impact value may be determined which gives a relative measure of the resistance of an aggregate to sudden shock or impact. This shall not exceed 45% by weight for general concrete and 30% by weight for concrete in wearing surfaces. **Ref. IS: 2386 (Part 4).**
- 3. Water absorption of aggregates when submerged for 24 hours in water shall not exceed 2%. Water absorption is an indication of porosity of the aggregate. **Ref. IS: 2386 (Part 3)**
- 4. Flakiness index: This is the %age (by weight) of particles in the aggregates passing through various thickness gauges or sieves whose least dimension (thickness) is less than 3/5 of their mean dimension. The index shall not exceed 25% by weight **Ref. IS: 2386 (Part 1).**

#### 2.1.4 Quality of Water

Compared to other ingredients of concrete, the quality of water usually receives less attention. However:

- a) Water used for mixing & curing shall be clean & free from injurious elements like oils, alkalis salts, sugar, organic material or other substances that may be deleterious to concrete or steel.
- b) The pH value of water should not be less than 6 & more than 8.
- c) Saline water shall not be used.
- d) Water used for curing should not produce any objectionable stain on concrete surface.
- e) It is generally observed that potable water is safe for mixing and curing of concrete. Natural waters that are slightly acidic are harmless but waters containing organic acids may adversely affect the hardening of concrete.

#### 2.1.5 Quality of Admixtures

Admixtures are added to the concrete mix immediately before or during mixing to modify one or more of the specific properties of concrete in the fresh or hardened state. The different types of admixtures are:

- Accelerating admixtures
- Retarding admixtures
- Water reducing admixtures
- Air entraining admixtures

#### 2.1.6 Quality Control of Concrete

Among many properties of concrete, its compressive strength is the most important and thus has been adopted as an index of its quality. The strength of a particular concrete depends upon many factors like:

- Quality of cement
- Quality of aggregates

- Quality of mixing
- Water cement ratio
- Compaction
- Curing etc.

Therefore, instead of indicating proportion of concrete constitutions, concrete grades are a better way of prescription. Some of the concrete grades commonly used in works are:

Group	Grade designation	28 days 150 mm cube compression strength N/ mm2 as per IS 456
Ordinary Concrete	M-10	10
	M-15	15
	M-20	20
Standard Concrete	M- 25	25
	M- 30	30
	M- 35	35

#### Workability of Concrete:

Concrete must have satisfactory properties both in the fresh and hardened states. While workability is the cardinal desirable property of fresh concrete, strength and durability are the most important properties of concrete in the hardened state. Satisfactory properties of concrete in the fresh and hardened states may often bring conflicting requirements in the materials and mix proportions; the aim of the rational mix design is to reconcile these factors. The diverse requirements of stability, mobility, compatibility, place ability and finish ability of fresh concrete mentioned above are collectively referred to as "workability".

The optimum workability of concrete varies from situation to situation and concrete which can be termed as workable for pouring into large sections with minimum reinforcement may not be equally workable for pouring in thin sections with heavier concentration of reinforcement. Concrete may not be workable when compacted by hand but may be satisfactory when mechanical vibration is used.

#### Slump Test for Concrete:

Slump cone test for concrete, is the test performed on the fresh concrete to check the workability. It is done before the placing of concrete, so the quality of control is high as rejected mix can be discarded before pouring into the scaffolding or structural member. So, dismantling, repair of defective concrete members can be avoided. It is most economical because it is done at site and does not require any laboratory or expensive testing machine. It is most popular due to its use and its simplicity of procedure and simple apparatus.

#### Method of Slump Test for Concrete:

- The mould for the slump cone test is a hollow frustum of a cone, 300 mm of height, dia. 200 mm at and dia. 100 mm at top as shown in figure.
- The base is firstly placed on smooth surface and then the container is filled with concrete in 3 layers (concrete whose workability is to be test)
- Each layer should be uniformly temped 25 times with a standard 600 mm long 16 mm dia. steel rod, rounded at the end.

• When the mold is completely filled with concrete, the top surface is leveled (leveled with mold top opening) by means of screening and rolling motion of the temping rod.



Slump cone apparatus

#### **Recommended Values of Slump**

Use for which concrete is suitable	Degree of Workability	Slump (mm) as per IS 456
Mass concrete: Lightly reinforced sections in slabs, beams, walls, columns; floors; hand placed pavements; canal lining; strip footings	Low	25 - 75
Heavily reinforced sections in slabs, beams, walls, columns;	Medium	50 - 100
Slip formwork; pumped concrete	Medium	75 - 100

#### Compressive strength of concrete

The compressive strength of hardened concrete is considered to be the most important properly. It can be measured easily on standard sized cube or cylindrical specimens and is often taken as an index of the overall quality of concrete. Among the materials and mix variables, water- cement ratio is the most important parameter governing compressive strength. Besides water-cement ratio, the following factors also affect the compressive strength of concrete.

a) the characteristics of cement,

- b) the characteristics and proportions of aggregates,
- c) the degree of compaction,
- d) the efficiency of curing,
- e) the temperature during the curing period,
- f) the age at the time of testing, and

g) the condition of test.

To determine the compressive strength concrete cubes are taken and are tested.

Sampling and Testing of Concrete Cubes

- 1. In order to get a relatively quicker idea of the quality of concrete, compressive strength tests at 7 days may be carried out in addition to 28 days compressive strength test.
- 2. In all cases, the specified 28 days compressive strength shall alone be the criterion for acceptance or rejection of concrete.
- 3. A random sampling procedure shall be adopted, that is, the sampling should be spread over the entire period of concreting.
- 4. The minimum frequency of sampling of concrete of each grade shall be as under:

S. No.	Quantity of concrete in the work (cum)	Number of samples as per IS 456
1	1-5	1
2	6-15	2
3	16-30	3
4	31-50	4
5	51 & above	4 plus 1 additional for each additional
		50 cum or part thereof

- 5. Three test specimens shall be made for each sample for testing at 28 days. Additional samples may be made for 7 days strength.
- 6. The size of the cube specimens shall be 150 x 150 x 150 mm.

#### Curing of Concrete:

- 1. The test specimen shall be stored on the site at a place free from vibrations under damp matting or sacks for  $24 \pm 0.5$  hours from the time of adding water to the ingredients of concrete.
- 2. Temperature of the place of storage shall be within 22°C 32°C.
- 3. After 24 hours of casting, specimens shall be stored in clean water at a temperature within 24°C- 30°C until they are transferred to the laboratory.
- 4. The specimens shall be transported to laboratory after well packing them in damp sand or damp sacks so that the specimens reach there in a wet condition.
- 5. On arrival in the lab, the specimens shall be stored in water at a temperature of  $27^{\circ}C \pm 2^{\circ}C$ .

#### Testing of Concrete:

- 1. Separate tests shall be made on specimens for 7 and 28 days compressive strength.
- 2. Testing machine shall be equipped with two steel bearing platens with hardened faces.
- 3. Specimens stored in water shall be tested immediately on removal from water while they are in wet condition. Surface water shall be wiped off.

- 4. The dimensions of the specimen to the nearest 0.2 mm and their weight shall be noted before testing.
- 5. The cubes shall be placed in the machine in such a manner that the load shall be applied to the opposite sides of the cube as cast & not to the top and bottom.
- 6. Axis of the specimen shall be carefully aligned with the center of thrust of the spherically seated platen.
- 7. No packing shall be used between the faces of the test specimen and the steel plates.
- 8. Load shall be applied on the specimen without shock and increased continuously at a rate of approximately 140 Kg. / sq. cm. / min. until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained.
- 9. The maximum load applied shall be recorded along with the appearance of concrete and any unusual features in the type of failure.

#### Test Results of Concrete tests:

- 1. The compressive strength of the cube specimen shall be calculated by dividing the maximum load applied to the specimen by the cross-sectional area of the specimen.
- 2. The compressive strength shall be expressed to the nearest Kg. / sq. cm.
- 3. The test results of the sample shall be the average of 3 specimens.
- 4. The individual variation should not be more than  $\pm 15$  % of the average. If more, the test results of the sample are invalid.

#### Batching and mixing of Concrete:

To make good concrete, it is necessary to use specified qualities & proportions of ingredients, methods of mixing, manner of laying wet concrete in position and curing (aftercare to ensure hardening).

#### Proportioning of Concrete

- 1. Cement concrete shall be composed of cement, fine aggregate, coarse aggregate, an air entertaining admixture, if considered necessary by the Engineer-in-Charge.
- 2. The determination of proportions of cement, aggregates and water to attain the required compressive strength shall be made as under.
- 3. By designing the concrete mix (Design mix concrete).
- 4. By adopting nominal concrete mix (Nominal mix concrete). It involves higher cement content.
- 5. Design mix shall be done only for specified materials to be procured for works at site as per
- 6. Specifications and shall be approved by Engineer-in-Charge.

- 7. Mix design done earlier, not prior to one year, may be considered adequate for works provided there is no change in source and the quality of the materials.
- 8. Design mix concrete should be preferred to nominal mix. If design mix concrete cannot be used or quantity of concrete is small, nominal mix concrete of grade not greater than M20 may be used with permission of Engineer-in-Charge.
- Temperature control of concrete has to be kept in view in extreme weather conditions. Concreting shall not be done when atmospheric temperature falls below 4.5 °C or rises above 35 °C.
- 10. The various ingredients of different nominal concrete mixes for one cement bag of 50 Kg shall be as under (for guidance only)

Quality of Ingredients required for concrete									
	Nominal	Agg. Size	20 mm	Nominal Agg. Size 40 mm					
Ingredients of concrete	M-10	M-15	M-20	M-10	M-15	M- 20			
	(1:3:6)	(1:2:4)	(1:1.5:3)	(1:3:6)	(1:2:4)	(1:1.5:3)			
Weight of Coarse Aggregate	320 kg	220 kg	165 kg	345 kg	235 kg	180 kg			
Weight of Fine Aggregate	160 kg	110 kg	85 kg	135kg	95 kg	70 kg			
Quantity of Water	34 liter	32 liter	30 liter	34 liter	32 liter	30 liter			

The cement contents of the above nominal mixes shall be proportionately increased if quantity of water in the mix is to be increased to facilitate placement and compaction of concrete, so that specified water cement ratio is not exceeded.

Grade of concrete	Cement Level (Kg/M <sup>3</sup> of concrete with Coarse Aggregate of nominal size)						
	40 mm(A40)	20 mm (A20)					
M10	207	221					
M15	259	288					
M20	329	366					

11. Cement level to be used in various design concrete mixes will be as under:

#### Batching of Concrete:

- 1. Smallest practical no. of concrete mixes shall be used on a work to avoid error in batching.
- 2. The contractor shall provide all necessary equipment and plant to determine and control the actual amount of materials entering into each batch.
- 3. The coarse & fine aggregates, water and cement shall be batched and measured by weight. Specified air entraining agent / water proofing compound, if any, shall be measured by weight & added separately to the mix, as directed by Engineer-in-Charge.
- 4. The weigh batchers should be capable of weighing, controlling and determining accurately the prescribed amount of various materials for each batch of mix.

- 5. Batching boxes of suitable size shall be used for measuring sand and coarse aggregate. The internal dimensions of the boxes shall generally be 35x25 cm with 40 cm depth or as otherwise approved by the Engineer-in-Charge.
- 6. The accuracy of measuring boxes shall be within  $\pm 2\%$  of the quantity of cement being measured and within  $\pm 3\%$  of the quantity of rest of the constituents of concrete mix.
- 7. One batching box, completely filled with sand or coarse aggregate shall be weighed to determine the number of boxes required to complete the quantity of aggregates in the concrete mix. The unit of measurement for cement shall be a bag of 50 kg.
- 8. The contractor shall maintain a record of the number of batches mixed and other details required for checking the correctness of the mix as per directions of the Engineer-in-charge.

#### Water Cement Ratio in Concrete:

- 1. This is one of the most important factors in the strength of concrete. Assuming full compaction, strength of concrete can be taken as inversely proportional to water cement ratio.
- 2. At a given degree of hydration, water cement ratio determines the porosity of concrete. More the water cement ratio, more porosity and less the strength.
- 3. For proper chemical action, amount of water required is only 25% of the weight of the cement used. Additional water is added to increase the workability of concrete.
- 4. The water-cement ratio in the concrete should be such that the concrete is of adequate workability for the placing conditions of the concrete and can be compacted with the means available.
- 5. To maintain the specified water cement ratio, the moisture contents of fine and coarse aggregate shall be determined for a batch of concrete according to weather conditions and as directed by Engineer-in-charge. The amount of water to be added to the mix shall be adjusted to compensate any observed variation in the moisture contents.
- 6. Water cement ratio for concrete is kept between 0.4 0.6.

#### Mixing of Concrete:

- 1. Mixing shall be done in mechanical mixer. Mixing by hand shall not be allowed.
- 2. Fine and coarse aggregates, before use, shall be washed with water to remove dirt, dust or any other foreign materials.
- 3. Suitable mixers, preferably tilting type with hopper and of adequate capacity to handle desired quantity of ingredients of concrete should be used to mix uniformly the various ingredients and discharging the prepared mix without segregation.
- 4. The mixer drum shall be flushed with clean water. Measured quantity of dry coarse and fine aggregates shall be placed first in the rotating drum of mixer & mixed thoroughly. This shall be followed by mixing with measured quantity of cement.

- 5. The time for obtaining uniform mix for a particular type of job shall be initially prescribed by the Engineer-in-Charge which shall be adhered to thereafter for all subsequent batches unless revised by the Engineer-in-Charge.
- 6. The dry materials shall be mixed for at least 4 turns of the drum, after which the measured quantity of water shall be added gradually while the drum is in motion, to ensure even distribution with the dry materials. The total quantity of water to be mixed for achieving the specified water cement ratio shall be introduced before 25% of the mixing time has elapsed.
- 7. The materials shall be mixed for a period of not less than 2 minutes (normally 25 turns of drum) and until a uniform color and consistency of concrete are obtained. The time shall be counted from the moment all the materials have been put into the drum.
- 8. The complete contents of the mixed concrete shall be emptied before recharging. When the mixer is closed down for the day or for any time interval exceeding 20 minutes, the drum shall be flushed clean.

#### Durability of Concrete

- 1. Durable concrete is one that performs satisfactorily in the working environment during its anticipated exposure conditions during designed life span of structure.
- 2. Durability of concrete is mainly influenced by its permeability to the ingress of deleterious substances such as water, chloride etc.
- 3. With normal weight aggregates, a suitably low permeability is achieved by having an adequate cement content, sufficiently low free water cement ratio, by ensuring complete compaction of concrete and by adequate curing.

#### Surface Preparation for Concrete:

- 1. In case of foundation concrete, the prepared earth surface at the bottom of formation trench to receive the concrete may be laid with 2 cm thick layer of 1:4 cement sand mortar or a polythene sheet of adequate thickness to avoid any loss of moisture of concrete by underneath earth bed.
- 2. In case of concreting over previously laid concrete, old surface shall be roughened by thoroughly cleaning it of all the loose material, unsound concrete and cement slurry etc. by using a wire brush or air / water jet and slightly wetting the surface.

#### Placement of Concrete:

- 1. The concrete shall be mixed and deposited as nearly as practicable to its location of placement to avoid any re-handling.
- The entire concrete to be used in the work shall be laid gently (not thrown) to avoid segregation. Generally, the maximum permissible freefall of concrete may be restricted to 1.5 m. The chutes may be used for greater heights.
- 3. The concrete shall be placed and compacted before initial setting of concrete commences and should not be subsequently disturbed.

- 4. The whole quantity of prepared concrete shall be used within 30 minutes of its mixing.
- 5. Placement shall be done in layers not exceeding 30 cm in thickness. The thickness may vary as per directions of Engineer in charge. While placing whole quantity of concrete of a batch, the layer of concrete shall be so placed that the previously placed layer does not finally set before the top layer is placed.
- 6. During cold weather, concreting shall not be done when temperature falls below 4.5  $^{\circ}$ C & in summer, when temperature rises above 35  $^{\circ}$ C.

#### Compaction of Concrete

- 1. The concrete shall be thoroughly compacted by using mechanical vibrators till a dense concrete is obtained. Concrete shall be fully worked by vibrator around the reinforcement, any embedded fixtures and into the corners of the form work.
- 2. Fresh concrete should be thoroughly vibrated near all the construction joints so that mortar of new concrete flows between large aggregates and develop proper bond with old concrete.
- 3. Care should be taken, while placing concrete or using vibrator for compaction, to avoid any displacement of reinforcement or movement of form work.
- 4. Over or under vibration of concrete are harmful and should be avoided. Over vibration causes segregation of cement slurry, resulting in its deposition over the concrete surface. Under vibration causes honey combing in the concrete.
- 5. Over working the surface and addition of water / cement to aid in finishing should be avoided as the resulting laitance will have impaired strength and durability of concrete.
- 6. Suitable type of mechanical vibrators shall be used for compaction. Plate type vibrators will be used for shallow depth of concreting such as in wearing coat over slab. Needle vibrators will be used where depth of concreting is more than 20 cm.
- 7. At the end of compaction, the vibrator shall be withdrawn out of compacted concrete gradually and not suddenly.

#### Curing of Concrete:

- 1. Curing is the process of preventing the loss of moisture from the concrete and promoting the hydration of cement while preventing high temperature gradient within the concrete.
- 2. The object of curing is to keep the concrete saturated or as nearly saturated as possible until the originally water filled space in the fresh cement paste has been occupied, to the desired extent, by the products of hydration of cement.
- 3. The necessity of curing arises from the fact that hydration of cement can take place only in water filled capillaries in concrete. Thus, loss of water by evaporation from the capillaries must be prevented. Curing also reduces the permeability of concrete.
- 4. After 6 hours of laying of concrete, the surface of freshly laid concrete shall be suitably protected with moist gunny bags, or any other methodology approved by Project Manager

against quick drying for next 24 hours. After that, the surface shall be cured by flooding it with water in a minimum depth of 25 mm. The curing shall be done for a minimum period of 14 days.

#### Concrete Measurements

Measurements of all categories of concrete for payment will be made only to neat lines of the structures as indicated in the drawing. In measuring concrete for payment, the volume of all recesses, passageways openings, cavities and depressions, chambers and embedded pipes except reinforcement bars, metal works and anchor bolts etc. will be deducted.

The cement used in the slurry or cement mortar construction and lift joints will be considered as bonafide use on the works and the slurry of cement mortar in construction joints shall be treated as part of concrete and shall not be paid for additionally.

#### 2.2 Quality of Form Works

- 1. Forms shall be used wherever necessary to confine the concrete and to shape it to the required lines. Normally all exposed concrete surfaces having a slope steeper than 2H:1V shall be formed.
- 2. The condition of forms influences appearance as well as quality of the concrete in the structure.
- 3. Form work shall be designed and constructed to the shape, lines and dimensions shown in the drawing.

#### Workmanship, cleanliness and strength of form work

- 1. The form work and its supports shall be of steel/timber.
- 2. All rubbish particularly chippings, shavings, cement mortar and grout etc. shall be removed from the interior faces of the forms. Cleaned faces will be checked before use. Inner faces of forms in contact with concrete shall be oiled / greased to provide a thin uniform coating to the forms, without coating reinforcement, before concreting.
- 3. Forms shall have sufficient strength to withstand all pressures during placement and vibration of concrete including all dead and live loads in construction without any deflection from the prescribed lines. Forms shall be made sufficiently rigid by use of adequate supports.
- 4. The joints in the formwork shall be made watertight to prevent loss of slurry from the concrete.
- 5. The forms required to be used more than once shall be maintained in a good condition, thoroughly cleaned & repaired if required before re-use. All forms shall be checked for proper shape, cleanliness and strength before re-use.
- 6. The contractor shall inform Engineer-in-Charge well in time before starting placement of concrete in the forms to enable him to inspect the formwork for its adequacy, alignment, strength & overall fitness.
- 7. The holes / recesses in the concrete resulting from removal of the end of the she-bolts, ties in the forms and any damage to concrete surface caused by removal of forms shall be filled /

repaired in accordance with the provisions for Repair of Concrete and shall be finished flush with concrete surface by contractor at his own cost.

- 8. A very common blemish on formed concrete surfaces is the off set found at horizontal construction joints at the bottom of new lift. Such off-sets shall be prevented by setting the forms to fit snugly against the top of concrete in previous lift and securing them so as to remain in tight contact during the placement of the concrete to prevent any leakage of cement slurry / mortar.
- 9. The following common deficiencies resulting in failure of form work shall be inspected and addressed.
  - Inadequate cross / horizontal bracings.
  - Unequal horizontal filling of forms with concrete.
  - Abnormal displacement in the forms during and after placement of concrete.
  - Lack of adequate inspection of form work.

#### **2.3 Quality Control in Earthwork**

All works shall be carried out according to the related Indian Standards, Technical Specifications attached with the bid document and as directed by Project Manager where necessary.

All works shall be carried out in accordance with the drawings approved by the competent authority.

#### 2.3.1 Preparation of ground surface

Before beginning the construction or repair of structure, the surface area of ground to be occupied shall be cleared off all roots and vegetable matter of any kind and stripped to a suitable depth up to 300 mm as directed by the Project Manager. The depth to which top soil is removed shall be adequate to remove all perishable material and any soil which may become unstable on saturation or may interfere with development of proper bond between the existing surface and new embankment.

#### 2.3.2 Excavation

Before commencement of the excavation in any reach, the contractor shall obtain in writing from the Project Manager instruction and schedule of quantities in regard to the disposal and utilization of the excavated materials.

All material thus excavated shall be property of the Government. Excavation to be carried out shall strictly conform levels to the plans and level shown on the profile of excavation in the Cross-sections/Longitudinal sections.

Excavations shall be kept free from water, and it shall be the Contractor's responsibility to construct and maintain temporary diversion and drainage works and to carry out pumping and to take all measures necessary to comply with this requirement.

#### 2.4 Quality Control in Brick Masonry

• The category of work shall include structures constructed with bricks jointed together by cement mortar in accordance with the details shown on the drawings, such as bridges, culverts, siphons, building external walls, partition walls, road parapets etc.

- Bricks shall be table / hand moulded. Bricks shall have a uniform deep cherry red or copper colour and regular in shape. The bricks shall be thoroughly burnt but not over burnt. The edges of a brick must be straight & square and the bricks must emit a clear ringing sound when struck. They must be free from cracks, chips, flaws, nodules of free lime and stones or lumps of any kind.
- Bricks should not break into pieces when dropped flat on a hard ground from height of 1.5m approximately.
- Before the carriage of bricks to site, they shall be got approved at the kiln site by the Engineerincharge of the work. Any substandard brick carried to site shall be rejected and the contractor shall have to remove the rejected bricks at his own cost within 24 hours of their rejection.
- The bricks shall be molded with a frog 10 or 20 mm deep on one of its flat sides. The width and length of the frog will be 40mm & 100mm.
- Each brick shall be marked in the frog with an indication of source of manufacture of the brick.

#### Classification & Compressive Strength

The common burnt clay bricks shall be classified on the basis of average compressive strength as given below:

Class designation	Minimum Average compressive strength			
	N/mm <sup>2</sup>	Kg/cm <sup>2</sup>		
15	15	150		

Water absorption

The bricks shall be tested as specified, after immersion in cold water for 24 hours. The average water absorption shall not be more than

15 percent by weight - as per IS: 1077

#### Efflorescence

With the bricks containing soluble salts, the water used in construction invariably leaves the salts dissolved from the brick work on the surface. When the structure dries up, there is a powdery encrustment of salts on the surface left by evaporation. The bricks shall be tested as specified. The rating of effloresces shall be

Not more than slight - as per IS: 1077

#### 2.4.1 Cement Plastering

- The cement mortar mix, to be used for plastering, shall be as shown in the drawings.
- The joints of the brick work shall be squarely raked to a depth of 12 mm for providing key to plaster and all raked cement mortar or loose material be removed by brushing and washing. The surface shall then be kept wet for 2 days before plastering. If the surface becomes dry in spots, such areas shall be moistened again to ensure uniform bond.
- The plaster over brick work shall be 20mm thick (12mm thick as per IS: 2212) and shall be done in two layers.
- To ensure fairly even thickness and truly plane surface (Vertical in the case of walls and pillars and horizontal in the case of top of walls) small patches of plaster about 150 x 150 mm or narrow

strip of plaster about 100 mm wide, shall be first applied about 3 meter apart to serve as gauges. The surface of these gauges areas shall be truly in the plane of the finished plaster surface.

- The plaster shall then be applied and brought to a true smooth surface in the level of gauges by means of proper trowels as approved by Engineer-in-Charge. The plaster shall be floated with wooden / steel templates to produce sandy granular / smooth surface.
- Corners and junctions must be neat straight lines, truly horizontal, vertical or inclined as in plan.
- In suspending work at the end of the day, the plaster shall be left, cut clean to line both vertically and horizontally. When re-commencing the plaster, the edge of the old work shall be scraped, cleaned and wetted with cement slurry, before plaster is applied to the adjacent areas, to enable the two to join together.
- The plaster shall not be closed on the bends, corners or cornices. No portion of the surface shall be left out initially to be patched up later on.
- Any cracks in the plaster or any parts which sound hollow when tapped or are found to be soft or otherwise defective shall be cut out and re plastered at the contractor's expenses.

#### 2.4.2 Cement Pointing

- Generally, the finish of pointing is "Flush" or "Struck". However, pointing shall be done as shown in the drawings. The cement mortar mix, to be used for pointing, shall be as shown in the drawings.
- Pointing shall be done while the mortar in the joints of brick work is still green.
- For struck pointing, the vertical / horizontal joints shall be struck semi-circular by means of an iron tool 6 mm in diameter.
- When the mortar in the joints is insufficient or is not sufficiently green, the joints are raked out to a depth of 18 mm (15 mm as per IS: 2212). The racked out or loose mortar in the joints is removed and joints are cleaned & washed. The surface of wall is kept wet for at least 2 days. The joints are then finished with fresh mortar as described above.
- For flush pointing, the procedure for struck pointing shall be adopted except that the joints shall be finished flush with the upper and lower edges of the bricks forming the joint. The pointing shall be thoroughly smoothened off in the plane of the wall face.
- In no case mortar shall be spread over the outer faces of the bricks. The edges of the bricks above and below the joist shall be clearly defined.
- After pointing is completed, all the superfluous mortar shall be removed on the face of the wall.
- The wall shall be kept wet for at least 7 days.

#### 2.5 Pumps

Pumping Machinery is used for transfer of water from one place to another and pumping of water from water source. Pumping is required for:

- a) Lifting water from the source (surface or ground) to purification works or the service reservoir.
- b) Transfer of water from source to distribution system.
- c) Pumping water from sump to elevated/ground surface tanks.

Pump house (civil works) is constructed for installation of pumping machinery. It is designed for life of at least 30 years, while pumping machinery is designed for at least 15 years lifespan.

#### 2.5 .1 Classification of Pumps

For water supply system, three main types of pumps are used:

#### 2.5.1.1 Centrifugal Pumps

Centrifugal pumps are pumps used for pumping water from well/sump. They are a type of velocity pumps where water is moved through continuous application of power. They are used widely in water supply schemes containing sand, silt etc.

#### 2.5.1.2 Monoblock Pumps

Monoblock pumps are centrifugal pumps in which fluid enters suction port and agitated inside the impeller and discharged through the large or small volute casing based on the head and discharge requirement (high speed Monoblock or slow speed Monoblock).

#### 2.5.1.3 Submersible pump

Submersible pumps are air-tight sealed motor close-coupled to the pump body. The main advantage of this type of pump is that it prevents pump cavitation, a problem associated with a high elevation difference between pump and fluid surface. It is designed such that it can be introduced into well casing and lowered to the bottom of the well. It is highly used for pumping from bore well and underground sumps.

#### 2.6 Type of Pipe Material for Pipelines for Water Distribution System

Various types of pipes are used for water supply system including metallic and non-metallic pipes. Most common types of pipes used for water distribution system are:

- 1. Mild Steel Pipes- metal pipe
- 2. Galvanized Iron Pipes metal pipe
- 3. Ductile Iron Pipes
- 4. Poly Vinyl Chloride pipes (PVC PIPES) non- metal pipe (IS: 4985)
- 5. High Density Polyethylene Pipes (HDPE PIPE) nonmetal pipe (IS:4984)
- 6. Medium Density Polyethylene Pipes (MDPE PIPE) nonmetal pipe (ISO: 4427)
- 7. OPVC Pipes nonmetal pipe (ISO: 16422)

For Rising mains, mainly GI and MS pipes or High Pressure Class of HDPE pipes are used, while for Distribution line (Main/Submain/Lateral) pipes, most commonly used are HDPE/PVC pipes. DI pipes are used for conveyance of heavy discharge of water

#### 2.6.1 Mild Steel Pipes

- Number of joints are less as they are available in longer length.
- Pipes are durable and can resist high internal water pressure and highly suitable for longdistance high-pressure piping.
- Flexible to lay in certain curves.
- Light weight and easy to transport. Damage in transportation is minimal.
- Pipes are prone to rust and require higher maintenance.
- Require more time for repairs and not very suitable for distribution piping.

- Available in diameter of 150-250 mm for water supply and cut lengths of 4 7 m (2.6-4.5 mm wall thickness).
- Steel Pipes are joined with flanged joints or welding.

#### 2.6.2 Galvanized Iron (GI) Pipes

- Cheap in cost and light in weight.
- Light in weight and easy to join.
- Affected by acidic or alkaline water.
- GI pipes are highly suitable for distribution system. They are available in light (yellow color code), medium (blue color code) and heavy grades (red color code) depending on the thickness of pipe used. Normally, medium grade pipes (wall thickness 2.6-4.8 mm) are used for water supply system. Normally, 15-150 mm size pipes (nominal internal diameter) are used for distribution system. They are available in length of 6 m.
- GI pipes can be used:
  - $\circ$  in non-corrosive water with pH value greater than 6.5.
  - for rising main as well as distribution.
  - to join with lead putty on threaded end.

# Dimension and nominal Mass of Steel Tubes-Medium (IS 1239- Part I: 2004)Nominal Bore Outside DiameterThicknessMass of Table

	Outside D	lameter	1 IIICKIIE55				
	Max	Min		Plain end	Screwed and socketed		
mm	mm	mm	mm	Kg/m	Kg/m		
1	2	3	4	5	6		
80	8.95	8.80	4.00	8.36	8.53		
100	11.5	11.31	4.50	12.20	12.50		
125	14.08	13.81	4.80	15.90	16.40		
150	16.65	16.39	4.80	18.90	19.50		

#### Dimension and nominal Mass of Stel Tubes-Heavy (IS 1239- Part I: 2004)

<b>Nominal Bore</b>	Outside		Thickness	Mass of Table		
	Diameter					
	Max Min			Plain end	Screwed and socketed	
mm	mm	mm	mm	Kg/m	Kg/m	
1	2	3	4	5	6	
80	89.50	88.0	4.80	9.90	10.10	
100	115.00	113.10	5.40	14.50	14.80	
125	140.80	138.50	5.40	17.90	18.40	
150	166.80	163.90	5.40	21.30	21.90	

#### 2.6.3 Poly Vinyl Chloride (PVC Pipes)

PVC pipes are rigid pipes. They are cheap in cost and light in weight. They are economical in laying and jointing and highly durable and suitable for distribution network. They are free from corrosion and tough against chemical attack. They are good electric insulation and highly suitable for distribution piping and branch pipes. They are less resistance to heat and direct exposure to sun. Hence, not very suitable for piping above the ground. PVC pipes weigh only 1/5th of steel pipes of same diameter. Jointing of PVC can be made by solvent cement or rubber ring joint.

#### 2.6.4 HDPE Pipes

- Light in weight.
- Flexible than PVC pipes.
- HDPE pipes are black in color.
- Suitable for underground piping and can withstand movement of heavy traffic.
- Allows free flowing of water.
- Highly durable and suitable for distribution network.
- Free from corrosion.
- Good electric insulation.
- Useful for water conveyance as they do not constitute toxic hazard and does not support microbial growth.

Normally, 20-315 mm diameter pipes are used for water supply and distribution system with pressure ranging from 6 m.

#### Pressure Rating: (IS 4984 -1995)

Pressure Rating Pipes shall be classified by pressure rating (PN) corresponding to the maximum permissible working pressure at 30°C as follows:

Pressure rating of pipe	Maximum permissible working pressure
PN 2.5	0.25 Mpa (25 M head of water)
PN 4	0.40 Mpa (40 M head of water)
PN 6	0.60 Mpa (60 M head of water)
PN 8	
PN 10	1.00 Mpa (100 M head of water)
PN 12.5	1.25 Mpa (125 M head of water)
PN 16	1.60 Mpa (160 M head of water)

#### Wall Thickness of pipe for material Grade PE 63 (IS 4984 -1995)

Nominal Diameter	PN 2.5		<b>PN 4</b>		<b>PN 6</b>		PN 10	
	Min	Max	Min	Max	Min	Max	Min	Max
1	2	3	4	5	6	7	8	9
90	2.80	3.20	4.30	5.00	6.30	7.20	10.00	11.20
110	3.40	3.90	5.30	6.00	7.70	8.70	12.30	13.70
125	3.80	4.40	6.00	6.80	8.80	9.80	13.90	15.50
140	4.30	4.90	6.70	7.60	9.80	11.00	15.60	17.40
160	4.90	5.60	7.70	8.60	11.20	12.50	17.80	19.80
180	5.50	6.20	8.60	9.70	12.60	14.10	20.00	22.20
200	6.10	6.90	9.60	10.70	14.00	15.60	22.30	24.70

Nominal	PN 4		PN 6		PN 10		PN 12.5		PN 16	
Diameter										
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	2	3	4	5	6	7	8	9	10	11
90	3.50	4.10	5.10	5.90	8.20	9.30	10.00	11.20	12.50	14.00
110	4.30	5.00	6.30	7.20	10.00	11.20	12.30	13.80	15.20	17.00
125	4.90	5.60	7.10	8.10	11.40	12.80	13.90	15.50	17.30	19.30
140	5.40	6.20	8.00	9.00	12.80	14.30	15.60	17.40	19.40	21.60
160	6.20	7.10	9.10	10.30	14.60	16.30	17.80	19.80	22.10	24.60
180	7.00	7.90	10.20	11.50	16.40	18.30	20.00	22.20	24.90	27.60
200	7.70	8.70	11.40	12.80	18.20	20.30	22.30	24.80	27.60	30.60

#### Wall Thickness of pipe for material Grade PE 80 (IS 4984 -1995)

#### 2.6.5 Ductile Iron Pipes

- Ductile Iron pipes are better version of cast iron pipes with better tensile strength.
- DI pipes are prepared using centrifugal cast process.
- DI pipes have high impact resistance, high wear and tear resistance, high tensile strength, ductility and good internal and external corrosion resistance.
- DI pipes are provided with cement mortar lining on inside surface which provides smooth surface and is suitable for providing chemical and physical barriers to water. Such pipes reduce water contamination.
- The outer coating of such pipes is done with bituminous or Zinc paint.
- DI pressure pipes are available in range from 80-1000 mm diameter in lengths from 5.5-6 m.
- Available in thickness class K7 and K9 with barrel wall thickness ranging from 5-13.5 mm. Also available in pressure class (Like C25, C30, C40 etc.).
- They are about 30 percent lighter than conventional cast iron pipes.
- DI pipes lower pumping cost due to lower frictional resistance.

#### 2.7 Type of Valves for Water Flow Control

#### 2.7.1 Sluice Valve

It is used for control on water flow in pipeline. It is fixed in main line and at start of branch line. It is also used as scour valve for cleaning of pipeline. They are provided in straight pipeline at 150-200 m intervals. When two pipelines intersect, valves are fixed in both sides of intersection.

#### 2.7.2 Non-Return Valve

A non-return valve allows a medium to flow in only one direction and is fitted to ensure that the medium flows through a pipe in the right direction, where pressure conditions may otherwise cause reversed flow. These are mostly used on rising main near pumping unit to control the damage on pumping machinery due to sudden failure of electricity.

#### 2.7.3 Air Valve

Air valves are fixed in order to allow air circulation in pipeline. It is placed in pumping main line and distribution line mainly which are at higher levels. Air valves may be placed at every 1000 m for pipelines up to 600 mm dia.

#### 2.7.4 Type of Pipe Fittings

Pipe fitting are important component of pipelines as they connect pipes and control pipe leakages. Various pipefittings are used for distribution piping system. Choose the diameter of the fitting based on the size of pipe. These fitting are available with threading, mainly for metallic pipes. For PVC pipes, non-threaded fittings are normally used for smaller diameter pipes.

For HDPE pipe fitting special flanged fittings are available for joining pipes.

- a) Socket or coupling It is used to connect two straight lengths of pipes. The outer diameter of pipe will be equal to inner diameter of socket after threading.
- b) Elbow It connects two pipes of same diameter at an angle, normally 90 /45 degrees.
- c) Tee it will fit two straight pipes and will have an outlet at right angle.
- d) Union It is used for joining the ends of two pipes which cannot be rotated. They are used in long stretches of straight pipes in the beginning of a pipe system and near all appliances along stop valves.
- e) Reducer It is used to connect two pipes with different size (diameter) to reduce the size of pipe. Reducer can be a socket, elbow or a tee as per required distribution network requirement.
- f) Nipple it is tubular pipe fitting, mainly in 300 mm length. It is used for extending pipeline.
- g) End Plug It is used to plug the flow of water at dead ends.

All other items will be as specified in the contract documents.

#### 2.8 Reinforcement Steel

- Steel reinforcement is provided in concrete used in pucca works on canal/ drains such as bridges, falls, weirs & outlets etc.
- All reinforcement shall be procured from genuine manufacturers. Re- rolled steel shall not be used in any component of work.
- The contractor shall make his own arrangement to procure high yield strength deformed bars in accordance with IS: 1786 and in quantity/ size as shown in the drawing.
- The reinforcement steel shall be high strength deformed steel bars of grade Fe-415 & conforming to IS: 1786.
- Tested quality of steel reinforcement bars shall be used. Requisite IS test certificates from manufacturers are to be provided by contractor to the Engineer before use of reinforcement steel on the work.
- Steel bars shall be stored in such a manner as to avoid distortion or deterioration by rusting / corrosion.
- To protect reinforcement steel from exposure to saline atmosphere, surface of bars shall be treated with cement wash or any other suitable method shall be used.
- Nominal diameter / size of deformed bar is equivalent to the diameter of a plain round bar having the same mass per meter length as that of deformed bar.

# **3.** QA/QC for Different Types of Works

## 3.1 QA/QC in Civil Works

This section of the Quality Control Plan covers the procedures of reviewing contractor's method statements, job mix designs, inspection; and testing of works leading to approval. The works include, but not limited to earthworks, masonry, construction of cement concrete blocks and repair of hydraulic structures.

#### 3.1.1 Construction Material

It is common practice for the Contractor to submit to the BPM-BPMU suitable method statements to execute a particular task for review and approval well before the planned start of operations. Because each Contractor has different management, and resources, the methodology for each particular task could be different. The methodology will include what, why, when and how the task will be completed in accordance with the contract conditions.

The responsibilities of safety while executing any task rest on the Contractor, irrespective of approval of his methodology.

#### 3.1.2 Job Mix Design

Any recipe of one or more materials to produce a conforming product in accordance with prescribed standards and contract conditions is called job mix design. Such designs, if required by the technical specifications, must be proposed by the Contractor and approved by the Junior Engineer /Construction Engineer /Consultant.

The approval methodology will be as follows:

- The Contractor submits his proposed design, together with a Request for Inspection.
- The contractor will prepare trial mixes according to the requirements.
- The Engineer's/DPM-DPMU's Design Engineer/Construction Engineer/Junior Engineer will check, make any tests, recommend and approve.
- On approval by the BPM-BPMU, the Contractor may be instructed to demonstrate the adequacy by field trials.
- On approval, permanent works may be started.

#### 3.1.3 Construction Quality Control

This section of the Plan provides an overview of construction quality control activities, including process control, testing, site inspection and tracking of instructions.

Construction quality control (CQC) is intended to provide a comprehensive, common and consistent framework for quality control across various contract packages. CQC comprises two main elements of quality control:

- Testing
- Inspections

Testing control covers the type of tests to be carried out, frequency of testing and stage of testing. Inspection control covers the timing of inspections, what must be inspected and the inspection procedures. The contractors are responsible for the management of the construction works and in the performance of the required testing on all materials and of the various operations being carried out as per specification. The Engineer/DPM-DPMU's representative Construction Engineer or Junior Engineer of BPMU oversees the testing to ensure general compliance with the contractual stipulations. This includes laboratory and field testing. Appropriately, the Engineer's/DPM-DPMU's representative might also oversee certain specific tests at the manufacturers or other third-party facilities in accordance with the specifications and good practice.

During the course of construction, contractors will carry out all routine testing for the purposes of source screening and construction control in accordance with the project requirements. This is a continuous process. CQC for any given activity should be practiced at all stages of construction from beginning to the completion.

#### 3.1.4 Testing

Various site tests on materials and works are required to be carried out by the contractor during construction.

#### 3.1.5 Site Inspection

Site inspections shall be carried out to ensure that the materials and construction activities conform to the specifications. Site inspections can be divided into day-to-day supervision and periodic site visits, as discussed below.

#### (i) Day-to-day Supervision

The Block Project Manager BPMU, and his field Engineers and supervisor shall carry out the day-to-day site supervision of all construction activities. This includes checking of lines, levels and layouts, and inspection of materials and construction activities. The day-to-day supervisory team shall ensure that materials that have been rejected are not used in the works.

As part of construction supervision, the BPM-BPMU or his representative would issue site instructions to the Contractor, as necessary from time to time.

The Contractor shall give advance notice to the Supervision Engineers when critical activities, such as concrete pouring is proposed to be undertaken and when a stage of work has been or is expected to be completed and/or covered.

#### (ii) Periodic Site Visit

Periodic site visits by senior staff from SPMU or DPMU or Consultant, provide an external review of quality of works executed. A tentative agenda for the periodic site visits is as follows:

- Physical inspection of the works under execution and inspection of quality of workmanship.
- Review of site documentation and contractor compliance.
- Sample verification of test reports and quality certificates.
- Review of issues, constraints in quality system implementation.
- Preparation of action plans for improving the quality.
- Inspection of laboratories/plants in operation.
- Performance appraisal of the Contractor.

#### 3.2 QA/QC in Conveyance Development Works

FIS is an irrigation scheme in which water is used with the help of gravity. Routine Maintenance: Routine maintenance is the kind of maintenance that has to be repeated throughout the lifetime of an irrigation scheme to keep it functioning. In FIS where water is used with the help of gravity, the following activities are daily routines and do not require special skills:

(a). Strengthening the Upper Head weir or Intake Structure:

The headweir which is a kind of check dam is made of concrete upto a certain level of water. But upper structure of the headweir is made of mud, that and other soft materials. This upper headweir needs routine maintenance. When water is not needed for irrigation, at that time there is no need of upper headweir but during irrigation time the kohli/ farmers will be responsible for strengthening the upper headweir during the use of irrigation water.

(b). Removing Vegetation:

All members of the KVA will be responsible for removing the vegetation and other materials from embankments, water channels (*kuhals*) and drains before each crop season.

(c). Removing Silt from Water Reservoir:

Since all irrigation schemes are proposed on natural streams, therefore, the silt is likely to be deposited in the upstream of the headweir. This silt will be removed on quarterly basis. The same kind of mechanism, as mentioned above, will be developed for removing the silt.

#### **3.3 QA/QC in Lifting Works**

LIS is an irrigation scheme in which water is lifted with the help of electric pump up to a certain height and then water is used with the gravity through distribution network.

Routine Maintenance: Routine maintenance is the kind of maintenance that has to be repeated throughout the lifetime of an irrigation scheme to keep it functioning. The following activities are daily routines and do not require special skills:

(a) Removing Vegetation and Other Materials:

All members of the KVA will be responsible for removing the vegetation and other materials from embankments, channels, drains ,outlet, inspection chamber, MDT, distribution chamber, desilting tank and intake point. This activity is needed on routine monthly basis throughout the year.

(b) Removing Silt:

Since all irrigation schemes are proposed on natural streams, therefore, the silt is likely to be deposited in the upstream of headweir. This silt will be removed on quarterly basis with the help of scour pipe. As mentioned above, the same kind of mechanism will be developed for removing the silt from other location of irrigation facilities.

(c) Lubrication Oil or Greasing the Electric Pump:

The Electric pump is needed to be lubricated or greased regularly. As per the maintenance book of electric pump, the KVA will make arrangement for this task. The activity will be accomplished and inspected as per schedule. It is to be performed on quarterly basis. It will be recorded as well.

#### (d) Pump Station Inspection and Pump Test:

Evaluation includes a visual inspection of the Starter Panel, Electric Motor, Pump, and related pump system components. Running tests include Amp/Voltage readings and system pressure checks. Machinery will not be run whenever voltage & electric current is very low.

#### **3.4 QA/QC in Pumping Works**

The Tube wells are of two types (1) Shallow Tube well and (2) Deep Tube well. The operation and maintenance of both types of tube wells is almost similar; and, hence, explained below collectively.

#### (a). Routine Maintenance:

Routine maintenance is the kind of maintenance that has to be repeated throughout the lifetime of an irrigation scheme to keep it functioning. The following activities are routine activities of TWIS schemes:

#### (b). Removing Vegetation and Silt:

All the members of the KVA will be responsible for removing the vegetation and other materials from open channels/drains (kuhal). This activity is needed on routine monthly basis throughout the year.

#### (c). Inspection of Submersible Electric Pump:

This includes pump inspection and measurement of the flow and/or pressure at different rates. This can be used to determine the overall performance of the pump. This task will be performed on monthly basis (even during the off-season) by the pump operator and inspected by one member of the Management Committee and recorded. Machinery will be run at rated voltage and current.

#### (d). Electric Wiring Repairing:

The pump operator will check the electricity wiring system. The record of this task will be prepared on quarterly basis by the operator. The task will be monitored, inspected and recorded by the Management Committee.

#### (e). Inspection of Water Hydrants:

The hydrants are used for diverting water for use of water by different farmers in different direction, it will be inspected by the operator on monthly basis. On an average there could be around 40 hydrants in an irrigation scheme. The inspection will be duly recorded as per standard procedure.

### 4. QA/QC Procedures in the Implementation of Construction Works

The Quality Assurance and Control Plan (QA&QC Plan) is to support the execution of civil works at field by the contractors in the sub-project level. The Construction Supervision work must be carried out in accordance with the QA&QC Plan. The plan defines the roles of the construction supervision team of the project and other stakeholders. This document is expected to be improved during the execution of the project based on the experience during the implementation of sub-projects in coming years. It is expected that the members of the project team including SPMU, DPMU, BPMU and the Consultant will provide inputs for updating this document once they gain experience in coming years.

The execution of sub-project construction is expected to begin in May 2023. In any quality control system, the crucial task and role to be fulfilled is documentation. The habit of writing down events and field observations must be internalized and so become a routine reflex of thinking and doing of all supervisors.

The main objective of the plan is to establish a system of quality assurance and quality control that fits into the greater framework of monitoring of the physical and financial progress of the project/sub-project. In view of the role existing construction supervision arrangement, the plan aims to

provide the sequence of checking, and measuring of works and materials during sub-project implementation.

The plan prescribes specific quality practices, resources and sequences of activities relevant to the project. To be more specific, this document provides sequence of activities, quality checks and tests, type of inspection tools, quality records etc. with the purpose of defining how the quality system requirements will be met.

For the QA&QC Plan to be a working document, it must be a practical and useful tool that is flexible enough to incorporate changes. In view of the large number of contracts spread over state of Himachal Pradesh, the Plan has to be simple. Therefore, use of standard forms has been adopted as a working tool. During field visits by team members of the supervision team, quality control forms will be filled in. They will provide a well-documented overview on the quality of the work done and facilitate the DPMU and BPMU to monitor all construction sites. The Quality Control Forms will be reviewed by the BPM-BPMU at first in order to assess whether the quality of work is maintained as per the specifications, work schedules and approved design drawings and to act for reports if the documents show poor quality of a specific item in a row.

The plan does not attempt to copy or paraphrase sections of technical specifications, codes or standards since these are stated in the contract documents. Its aim is to ensure that the works are executed as per specifications, i.e. it is looked at as a means to achieve the end results. Quality control and test results shall be interpreted as applicable in accordance with the contract specifications. The subsequent sections of this Plan shall describe the above-mentioned aspects.

#### 4.1 Quality Assurance System

The Quality Assurance System does not attempt to display any details of construction or project work. That is the role of the Contractor and his approved methodology. It shows how the contractor's work will be inspected and tested, leading to approval. The SPMU, DPMU, BPMU as per their roles and responsibilities in accordance with the Contract Documents and its Clauses, and Contractor's systems merged to form the Project Quality Assurance System.

The main objective of the Quality Assurance System is to establish a standard procedure of quality assurance and quality control that fits into the greater framework of monitoring of the physical and financial progress of the project.

#### 4.2 Site Environment Management (SEM)

The environmental and social aspects on the sub-project site should be monitored by the DPMU and BPMU on regular basis.

The Contractor shall appoint an Environmental Monitor to follow the day-by-day monitoring procedures. The general objectives of the environmental management for the implementation of the Project are:

• Implementation of measures to prevent or reduce negative impacts to acceptable levels or to enhance environmental conditions.

- Implementation of measures to deal with risks that arise during implementation and Defects Liability Period: occupational health and safety, accidents.
- Implementation of measures that help ensuring that the environmental actions are in phase with engineering and other project activities throughout implementation.
- Supervising and monitoring significant issues during installation and operation.

The following potential risks *inter alia* should be addressed through the SEM:

- **Management of pollution incidents:** Care should be taken to avoid contaminating the canal system during construction.
- **Hazardous materials:** Storing and handling of hazardous material during construction. In India, facilities are available for the reuse / recycling of residues and wastes from petroleum products. Effective procedures shall be implemented under the Contract for the use of such facilities.
- **Construction wastes:** Collection and safe disposal of hazardous residues and dismantled material: The disposal of dismantled material shall be coordinated with local administration. Agreement for disposal site(s) should also include the collection and disposal of any existing waste material.
- Quarry and Borrow Areas: Management of quarries and borrow areas, if any
- **Traffic movements:** The sites are located in rural areas. Most are some distance from main roads along narrow tracks. Careful control and supervision of movements of lorries and other construction traffic may be required to minimize the impact on crops and other vegetation etc. bordering the roads.
- Air pollution: All reasonable measures should be taken to avoid dust and other forms of air pollution.
- **Sewage:** Currently mains sewerage is not available at any of sites. It will therefore be necessary for the contractor to provide suitable facilities during the construction period for his staff.
- **Construction materials:** Management of quarries and borrow areas, if any, will be required.
- Occupational safety and health: Safety and health requirements shall be covered under a separate plan prepared by the Contractor.
- **Disturbance of rare birds:** All reasonable measures should be taken to avoid disturbance of rare birds.
- Blasting: Careful management of any blasting should be undertaken at all times.

Government of India has various rules and regulations on monitoring certain environmental and social considerations during the implementation of certain projects. Taking into account the intent of government rules and regulation and the Loan Agreement, a SEM Checklist has been prepared and shown in **Form 14** in **Annexure-3**. This **Form 14** must be filled up by both the Junior Engineer of BPMU and the Contractor's representative.

#### 4.3 Health and Safety Plan

The health and safety plan should include or address the following topics, where they are relevant to the work proposed. The Contractor shall observe high standards of safety for men and machines at all times and regarding safety, and shall comply with following local laws and ensure strict adherence to the following:

- Labor Contract Regulation Act 1970
- Contract labor abolition and regulation Act 1974
- Workmen Compensation Act 1923
- Employers' liability Act 1938
- Industrial disputes Act 1947
- Maternity benefit Act 1961
- Interstate migrant workmen (regulation of employment and conditions of service) Act 1979

The Contractor shall adhere to safe construction practices and guard against hazardous and unsafe working conditions and shall comply with the owner's safety rules as set forth herein. Arrangements for Controlling Significant Site Risks

- i. Safety risks:
  - services, including temporary electrical installations;
  - working in confined spaces;
  - preventing falls;
  - work with or near fragile materials;
  - control of lifting operations;
  - dealing with services (water, electricity and gas);
  - the maintenance of plant and equipment;
  - poor ground conditions;
  - traffic routes and segregation of vehicles and pedestrians;
  - storage of hazardous materials;
  - dealing with existing unstable structures;
  - accommodating adjacent land use;
  - other significant safety risks.
- ii. Health risks:
  - removal of asbestos;
  - dealing with contaminated land;
  - manual handling;
  - use of hazardous substances;
  - reducing noise and vibration; and  $\succ$  other significant health risks.

**Form-15** in **Annexure-3** should be referred and filled in to prevent the health and safety risks in the construction site.
# 4.4 Screening of Contractors (review of documents and basic requirements)

During site inspections, the BPM-BPMU's staff should check and follow up with the documentation maintained on site by the Contractor, as follows:

- Check the Drawing Registers and ensure that the approved designs and drawings are being used during construction.
- Check the Test Report Log.
- Check the Material Register and the material test reports.
- Check the site instruction register and ensure that the Contractor, as recorded in these registers, is implementing the instructions.

# 4.5 Quality Control of Materials

Quality control of materials forms an integral part of the overall construction and supervision function. It provides the link between the design and the finished works. It is imperative therefore that proper procedure be implemented to ensure that the materials used on the sub-project meet with the project specifications.

This section hereinafter describes the general manner in which materials for the works will be handled from initial screening to acceptance of the material.

# 4.5 .1 Source Screening

The screening process basically refers to the Contractors' submittals of their proposed Suppliers seeking a "source approval". Each Contractor will contact a variety of manufacturers and distributors (Suppliers) for the various materials that will be used on for construction of the sub-project.

The Contractor shall provide complete information required for the screening process to the DPMDPMU/BPM-BPMU for review. The Contractor's letter to which the Supplier information is attached must include all details.

On receipt of the Contractor's letter, the BPM-BPMU will review the information submitted. If he is satisfied, the Contractor will be notified that the BPMU has no objections to a particular supplier as a source of material. The BPM-BPMU will notify the Contractor if additional information is required. If the additional Supplier information is acceptable, the DPM-DPMU will so inform the Contractor that the Supplier may be used. The DPM-DPMU's approval of the Supplier will be subject to the Supplier (and Contractor) meeting all the requirements and stipulations of the contract. The DPM-DPMU's approval does not relieve the Contractor of his duty to ensure that only those materials which meet the project specifications are used.

The following summarizes the screening process:

- Contractor identifies the material(s) required for the project.
- Contractor obtains all necessary information from the Supplier consistent with the project's screening requirements.
- Contractor submits his proposed Supplier for the review to DPM-DPMU/BPM-BPMU.
- BPM-BPMU reviews Contractor's submittal. Advises Contractor if additional information is needed.
- BPM-BPMU indicates his approval (no objections) of the source to Contractor if appropriate, else, advises that the Supplier is unacceptable.

- All approvals subject to supply of material in accordance with sub-project specifications and stipulations.
- Contractor is not relieved of his responsibility by the Engineer's/ DPM-DPMU approval of named proposed supplier.

The Contractor is urged to provide each of his proposed Suppliers with the sub-project requirements for the particular material.

#### **4.5.2 Certification of Material**

Acceptance of certain manufactured materials, as stipulated in the contract, shall be based on test certificate(s) from the manufacturer conforming specified standards. Upon their delivery and before their installation or incorporation in the works, the BPM-BPMU shall inspect the condition of these items. Tentative list of Materials to be certified by Manufacturer:

- Steel Reinforcement
- o Cement
- o Paints
- HDPE/PVC/GI/MS Pipes
- Reinforced Concrete Pipes
- Joint Filler Material
- Concrete Admixtures
- o Steel Channel Sections and Iron Angles
- Barbed Wire
- Gabion wire
- Sluice Valve
- o Reflux Valve
- Alfa Valve
- o Non-return valve
- Pressure release valve
- Air release valve
- Control valve
- Pressure gauge
- Water meter
- Pump set
- Prime mover (Motor)
- Foot valve
- MS Flanges
- Nut Bolts
- o Gasket
- Air Valves
- Zero Velocity valve
- MS plate
- Centrifugal pumps
- Submersible pumps
- Mono Block pumps

- o Strainer
- Casing pipe
- Hume pipe
- Transformer
- Laboratory Equipment
- Geo-synthetics

### 4.6 Testing and Maintenance of Quality Records

The supervision team particularly the BPMU team shall maintain quality records that contain sufficient information to permit verification of any report.

### 4.6.1 Code of Standards

The Codes and Standards referred to in the Technical Specifications Section of the Contract for works shall be followed. The other codes and standard which are not mentioned in the Contract Document could be accepted subject to the Engineer's/ DPM-DPMU's prior review and written <u>approval.</u>

### 4.6.2 Inspection and Testing of Works

The DPM-DPMU/BPM-BPMU will inspect and supervise the works to ensure that the works are executed using the approved materials in accordance with contract specifications. Before the commencement of concrete work, the contractor must seek permission to pour concrete work using the **Form-11** shown in **Annexure-3**. BPMU's Construction Engineer/ Junior Engineer (JE) should provide the approval for concrete work. Concrete samples will be collected using **Form-12** and any conceal works will be done only after completing process mentioned in the **Form-13**.

### 4.6.3 Sub-standard Works

Any work, in part or in whole, which Construction Supervision team including SPMU, DPMU, BPMU or their representative has determined to be of poor quality or in any way not in accordance with the contract will be regarded as sub-standard work.

The, BPM-BPMU or his representative must check all project works to the extent possible. On refusal of acceptance the Contractor must be given the opportunity to rectify any work. If this is not possible, or the BPM-BPMU does not approve rectification, the contractor must remove the offending item(s). The methodology to deal with sub-standard work is given below:

- The Contractor will construct the works in accordance with the contract specifications.
- The Contractor will perform required tests in accordance with the specifications, under the guidance of the BPM-BPMU/field Engineers.
- In the event that the work, or part of the work, does not meet the specifications or quality standards in accordance with the contract, the BPM-BPMU may give the contractor an opportunity to rectify the work.

• The work must again be inspected/tested and on acceptance may be approved on the request for approval on completion.

If in the opinion of the DPM-DPMU/BPM-BPMU the offending work cannot be effectively rectified, an instruction to remove the work, including any materials, detritus, and unsuitable materials will be issued. These materials must be removed from site and suitably disposed of.

### 4.7 Maintenance of Measurement Books (Annexure 2)

The payment procedure to Contractors' invoice will be as stated in section 5.3 Payment Procedure. The invoices submitted by the contractors need checking and processing in terms of measurement checking at site as well as administrative processing for the release of payments. In order to minimize the time for checking and processing of contractor's invoices and release the payment in time, the following steps are recommended.

The contractor can prepare his invoice in a format as shown in the **Annexure-1** and present to the Block Project Manager who after taking measurement as described below in Measurement Book and after examination and attestation shall forward to the District PMU for further processing, checking and approving for payment.

The Junior Engineer / Construction Engineer can make entry to the measurement book following the procedures mentioned in the **Annexxure-2**.

### 4.8 Approval Process by Concerned Authority

Because of the variability of both manufactured and other materials, source approval will be required before procuring the materials.

### 4.8.1 Material Approval

Approval of construction materials shall be based on the following:

- Test reports for materials as per specification Tests may be made at site laboratory or at manufacturer's premises or a at an independent testing laboratory; and
- Manufacturer's certificates of approved suppliers for certain materials such as- steel, cement, GI pipe, HDPE pipe, pumping machinery, admixtures etc.

### **4.8.2 Control of Material at Site**

The basic steps to proper material management are:

- Advance copy, if possible, of Factory Test Certificates or other certificates of quality (gives Contractor and BPM time to review the test results prior to the material arriving on site)
- The results of the Quality Tests (viz. the Factory Test Certificates) are checked by the Contractor (and the BPM-BPMU or his representative to confirm that the material properties meet the appropriate specifications. A copy of the Factory Test Certificate must be given to the DPM-DPMU within 7 days of the material's arrival.
- Samples may be taken to a third-party testing facility.
- All material must be stored in an approved storage area that affords protection to the material as required under the contract specifications and stipulations.
- The management of the Contractor's storage facility rests with the Contractor.
- All materials must be stored appropriately.

- No rejected material may remain at the site.
- If rejected while on the truck, it may not be unloaded and must be removed from the site.
- At the work site, the material will be inspected and confirmed that no damage has taken place during transport or unloading. If the material has been damaged in transit/on unloading, and is subject to rejection, the Contractor shall remove from the site the damaged material.
- If material is damaged during construction processes (e.g., during installation, during concreting, during launching), the Site Engineer may deem the material as unsuitable for use. In this case the material would be rejected.

### 4.9 Payments Procedures (Annexure 1)

The process of payments to Contractor should be quick, efficient and totally effective so that the contractor's due progress or cash flow is not affected in any way.

### **4.9.1 Interim Payment Procedures**

The Contractor will draw up a monthly statement, which, after due inspection and modifications as required, will result in the BPM-BPMU or his representative checking interim payment certificates. This is duly signed and forwarded to the DPM, who will issue the payment after his checking. Interim payment certificates are normally expected to be submitted monthly. When repeatedly quality of work is not up to the desired standard/level, the consideration will be made for partial payment (running bill) till the deficiencies are rectified.

### **4.9.2 Final Payment Procedures**

The Final Payment Certificate is only produced on completion of the works and after it has been verified to be in accordance with the contract.

# 5. QA/QC Provisions in HPCDP

The following sections outline some of the measures taken in terms of QA/QC in HPCDP.

### 5.1 Orientation and Training of Construction Supervision / Quality Control Staff

A capable and functional construction supervision (CS) and quality control / quality assurance team is needed to ensure implementation of contract specifications. To achieve this object intensive training will be given to all related staff of construction / quality control in suitable batches covering specifications for the works to be executed and the procedure to be followed to conduct the various tests in the field and laboratories. Recommendation of I.S. codes will be explained in the training workshops as to cover key construction and QC/QA aspects.

### 5.2 Meetings with Stakeholders

During the course of the Project, meeting will be initiated and attended by various parties. It is imperative that minutes be recorded during each meeting using **Form 5** depicted in **Annexure-3**. The transcribing of the minutes should take place within a few days after the meeting has taken place. After review, minutes of meetings should be sent out to all parties in attendance at the meeting.

It is recommended that formal progress review meetings be held once in 15 days, if possible, between the client and the Contractor. The agenda for these meetings should include a review of

compliance with various commitments made during the previous meeting, a review of progress and quality of works, discussion of various problems, and preparation of a list of actions to be taken.

### 5.3 Cross checking for Quality Control

In this project, the process of supervision and monitoring by multiple parties has been arranged for quality control. The construction supervision is done just from the PMU side but also from the KVAs. Moreover, PMC experts also visit the sites during its milestones to assure that the quality has been maintained.

### 5.4 O.K. Card System

It provides a systematic approach towards assuring quality construction and has proved to be practical mechanism for enforcement of technical specifications. For the purpose, each work is divided in various activities in proper sequence / order of construction and is listed in chronological order of occurrence in O.K. card. The O.K. Cards should be made available on the site in regular manner. Approval of the component of work in progress at the times of inspection should be maintained properly and recorded by the Block Project Manager.

### Himachal Pradesh Crop Diversification Promotion Project Phase (II)

### O.K. Card

### <u>O.K Card S. No.</u>-<u>Detail of work item for which O.K. card is required: -</u>

Sub Project Name:-	BPMU:-	
Structure Name:-	DPMU:-	
Date of Submission of O.K. card:-	Concrete Qty:-	
Name of Contractor: -	Concrete Grade:-	

Location for which O.K. card submitted: -

<b>S.</b>		Description	Remarks	<b>Remarks</b> of
No.			of	Department
			Contractor	J.E./C.E
1	Pre pou	r inspection details at site:-		
	1.1	Dewatering arrangements		
	1.2	Surface measurement		
	1.3	Availability of loose material		
	1.4	Checking of survey/layout		
	1.5	Checking of R.L		
	1.6	Arrangement for center line		
	1.7	Checking of formwork plumb/support		
	1.8	Checking of reinforcement details as per drawing		
2	Observ	ations during concreting work:-		
	2.1	Type of concrete mixer used		
	2.2	Availability of Slump test apparatus		
	2.3	Availability of molds for casting of cubes		
	2.4	Availability of proper compaction arrangements		
3	Arrange	ements for post-concreting activities planned: -		
	3.1	Type of concrete curing arrangements		
	3.2	Concrete specimen strength test planned		

Note: - O.K. card should be issued after performing the relevant tests & Manufacturer Test Certificates.

### Signature with name & Designation of Contractor's representative

	Name	Signature
Reported by -		
J.E./C.E BPMU		
O.K. given by-		
Block Project Manager		

The Quality System requirements will specify which Quality Control Forms or other routine forms should be completed for which tasks and when they are necessary. Typical Quality Control Forms are given in the **Annexure-3**.

Form Nos.	Name of Form
Form -1	Site Order Book
Form -2	Weekly Site Report
Form -3	Site Inspection Report
Form – 4	Physical Progress Report (Monthly)
Form -5	Minutes of Progress Review Meeting
Form -6	Reinforcement Check out Form /checklist
Form -7	Monthly Financial Progress Report
Form -8	Field Visit Report (as and when the visit is made)
Form -9	Concrete Cube Register Form
Form-10	Site Environmental Management Checklist
Form-11	Health and Safety Checklist
Form-12	Completion Certificate
Form -13	Hindrance Register
Form -14	Handing Over/Taking Over Certificate.

The following forms are proposed for progress and quality monitoring purpose.

The suggested forms and format as shown in the **Annexure-3** should be updated during the course of project implementation based on the experience and requirement. Additional forms and formats may be included if required.

### 5.6 Documentation and Data System

### 5.6.1 Contract Documents

All formally written correspondence to contractor, client, suppliers or any other official parties including letters, memorandums, forms, minutes of meetings, site instructions, change orders, payment certificates, approvals, drawings, schedules, quantities, changes, variations etc. is collectively known as 'contract documents'. They are official and legal records of the project and must be handled and stored carefully. They could be subject to future litigation in the event of any claims etc.

### 5.6.2 Taking Over Certificates

On substantial completion of a section, the PM-BPMU or his representative will inspect and list any deficiencies that need to be corrected before advising to DPMU to issue a meaningfully partial Taking Over Certificate. On Final Completion a Final Completion Certificate is issued after joint inspection by the PMDPMU or his representative and the Contractor.

# 6. Role of Stakeholders in QA/QC.

There are four main organizations responsible for sub-project implementation in relation to the execution of sub-project. They include:

- The Employer / accepting Authority Project Director, SPMU
- The Project Manager / Engineer District Project Manager (DPM), District Project Management Unit (DPMU)
- Engineer's Representative Block Project Manager (BPM) and his staff, Block Project Management Unit (BPMU)
- The Contractors

# 6.1 Role of SPMU

The Project Director (PD), SPMU will have central authority for the overall control of entire execution of all sub-projects in the DPMUs. DPD and all the DPM-DPMU and BPM-BPMU will report to PD-SPMU on monthly basis regarding progress achieved and quality issues if any in the construction implementation of the ongoing sub-projects. PMC construction engineers will assist PD-SPMU and his staff at DPMU and BPMU to check the quality assurance and quality control on periodic basis. The District Project Manager, DPMU will have overall control of entire execution of sub-project implementation in his jurisdiction. The Construction Engineer other relevant staff at District level PMU and Block Project Manager of Block Level PMU and his/her associates are to be made responsible to ensure that the quality system activities are being conducted by project staff in the manner specified in this Quality Assurance Plan and the Contract. The Block Project Manager at BPMU and key persons designated by him shall supervise the ongoing construction and implementation works, and check and review the quality system on daily basis. The district level PMU will supervise the quality system on weekly/monthly basis or as and when needed. The State level PMU will check and review the quality system on periodic or quarterly basis together with the support from PMC. Figure 1 portrays the Organization Chart for Construction Supervision showing the responsibility of the concerning level PMU and their frequency of quality control check.





## 6.1.1 Project Director – PD-SPMU

PD-SPMU will be overall responsible for the entire construction implementation, quality assurance and quality control of the sub-projects in the HPCDP (Phase-II) Project area. PD will report to the JICA and DOA about the monthly and quarterly progress achieved by the Project.

### 6.1.2 Deputy Project Director (Soil and Water Conservation) - SPMU

DPD will be responsible for technical matters especially, quality assurance and quality control of the sub projects in the HPCDP (Phase-II) Project area. DPD will follow up on major and specific issues on quality control and non-conformance issues. He will seek the reports and progress achieved from all DPMUs on the ongoing sub-projects in the state. On the necessity basis, he will also visit to concerning sites with the PMC construction engineers to check and ensure the quality control following the guidelines set in this Manual and the Contract Technical Specification. He will report to the PD-SPMU on monthly or required basis.

### 6.2 Role of DPMU

The roles and responsibilities of the Supervision Team particularly the District Project Manager of DPMU during the implementation of sub-project will mainly focus to ensure the followings:

- Works are executed in accordance with the General and Particular Conditions of the Contract, the Technical Specifications and Engineering Drawings or any amendments thereto.
- Optimal use of available material resources has been made to minimize the costs to the Employer or to maximize the quality of the Works or to expedite construction; and.
- Works have been completed within the Contract price and specified time schedule as allowed by the contract or any agreed amendments thereto.

### 6.2.1 District Project Manager – DPMU

The DPM-DPMU will act as the Project Manager / Engineer for all the contracts to the subprojects in his jurisdiction. He will be overall responsible for the construction implementation and quality control and act like the nucleus for communication between the Contractors and the sub-project construction and quality control issues. He will check the twenty percent (20%) of works done by the Contractors and the measurement as per the contract document. For the amount allocated in the subproject contract, he will issue the approval for the payment of the contractor's invoice, partial and final completion certificate. DPM-DPMU will report to PD, SPMU on monthly basis.

### 6.2.2 Design Engineer / Construction Engineer – DPMU

Similar responsibility as mentioned in BPMU level but check/record on weekly/monthly or periodic basis. Design Engineer / Construction Engineer will check the quality control, other related matters. They/he will assist to check the twenty percent (20%) of works done by the Contractors and the measurement as per the contract document and invoice submitted by the BPMU and forward to the DPM-DPMU for payment after getting improvement/correction.

## 6.3 Role of BPMU

## 6.3.1 Block Project Manager – BPMU

The BPM-BPMU will be overall responsible for the construction implementation, quality, cost and time control of the sub-project and interact with the Engineering section on day-to-day activities. All the measurements of any type of work executed will be entered into Measurement Book (MB) with hundred percent (100 %) test check responsibility. He will report to DPM-DPMU on fortnightly basis for the progress achieved and quality control status and issues if any.

## 6.3.2 Construction Engineer / Junior Engineer - BPMU

Construction Engineer/Junior Engineer are responsible for all day-to-day site supervision works, construction activities, checking of contractor's construction schedule and work plan. They/he will mark or check the lines, levels and layout of the sub-project on the basis of survey work done by the surveyor. They/he will help in preparing construction drawing and quantity estimate, or they/he will check and make corrections to the working drawings submitted by the Contractors. Collection of samples of concrete works and testing at the stipulated laboratory will be their responsibility. They/he will take the support from supervisor and check quality system in construction activities on daily basis. They/he will check the test result of materials and construction activities. They/he will control the entire labor either departmental or the work to be executed by the Contractors. All the measurements of any type of work executed will be entered into Measurement Book (MB) with hundred percent (100%) check responsibility. For any delay in works, they/he will check the invoice submitted by the contractors. They/he will prepare reports using the progress and quality control forms attached in **Annexure-3**.

## 6.3.3 Supervisor – BPMU

Supervisor assists the Construction Engineer/Junior Engineer in supervising works like labor supervision, material supervision and construction supervision. He will check the quality of proposed works under respective sub-component like concreting, wooden, pipe placement etc. under the guidance of Construction Engineer/Junior Engineer. He will be responsible for maintaining the record at site.

# 6.4 Role of PMC

In terms of QAQC, the PMC has the monitoring role as well as technical assistance providing role. In terms of monitoring, the major tasks of PMC include reviewing the Detailed Project Reports (DPRs) to assure sound sub-project proposals, assurance of proper tendering process and subsequent visits during construction to monitoring the quality of the construction works. The supervision efforts for real time rectification/ adjustments shall be conducted both for the design as well as in the construction process. The technical assistance is in terms of providing feedback on technical matters.

Apart from the above, the PMU also has the role of ensuring that the contractor complies with the social and environmental requirements of the project. PMC shall also confirm the Contractor's construction work, health and safety plans, so that the infection prevention measures/requirements set forth in the applicable laws, regulations site operating procedures, the specification or other parts of the contract related to epidemic, pandemic, plague or other similar diseases including COVID-19, are duly

respected to ensure the safety of the Contractor's personnel including subcontractor. In case of any accidents during the construction, the PMC shall assist the Employer in reporting to JICA the details of such accidents in a manner reasonably by JICA and prepare and submit the required reports to the SPMU.

### 6.5 Role of Contractors

Construction contractors are responsible for the execution of the works in conformance with the requirements of the contract documents both in terms of quantity and quality. Contractors are responsible for arranging the followings:

- All necessary plant, labor, equipment and construction materials to be used in the permanent works;
- All plant, equipment, materials and labor for temporary and auxiliary works;
- Transportation and storage facilities for all materials and equipment.
- Office and accommodation for staff and labor;
- Facilities for the construction supervision teams as required by the contract; (if any)
- Sanitation facilities at the site;
- All necessary facilities for testing and quality control as required by the contract; and
- Environmental protection/enhancement measures as required by the contract.

In addition, the Contractors are responsible for executing and completing the works in accordance with the specified standards and specifications, within the contractual time allowed, and within the contract price for the works. Contractors will be responsible for preparing working drawings for all civil works and obtaining their approval before the commencement of construction works, if required by the Contract Condition. Any damage caused to any structure during the execution of work by the firms will be restored to its original conditions by the firm/contractor at its own cost.

### 6.5.1 Quality Control Duties of Contractors

The contractor's main QA/QC duties are summarized in **Table 1**. Other duties shall be performed as stipulated in the contract documents or directed by the Project Manager-DPMU/BPMU/ their representatives.

Activity/Item	Contractor's QA/QC Duties		
Designs and drawings	•	Maintain design/drawing register(s) at site	
	Use only approved drawings for construction		
	٠	Replace drawings that have been modified with new ones	

### List of Contractor's Main QA/QC Duties-Table 1.

Test laboratory and	• Following labs are existing in the vicinity of the Project area		
equipment	Contractors have to make inquiry whether these labs provide services		
equipment	on commercial basis or not. Accordingly, they have to arrange and		
	perform tests preferably in any of the following laboratories, if possible		
	perform tests preferably in any of the following faboratories, it possible		
	or take approval from DPM for any proposed commercial authentic rab.		
	1. Office of Chief Engineer, HPPWD Shimla/Mandi/Hamirpur/		
	Dharmshala.		
	2. N.I.T. Hamirpur		
	3. Office of Superintending Engineer, HPPWD, Bilaspur		
	4. Bhakra Beas Management Board, Nangal		
	5. Other Govt. of H.P or notified labs / institutes		
Activity/Item	Contractor's QA/QC Duties		
Material receipts	• Enter receipts in material register showing the date of arrival, quantity,		
	any manufacturer's certificate if applicable etc.		
Materials testing	• Take test samples from the working mix/material in presence of		
8	Supervision staff		
	• Perform materials tests as per contract requirements		
	• Maintain test log		
	• Prepare mix designs if required by contract and submit test results to		
	the BPM- BPMU		
Material Storing/stock	<ul> <li>Make sure that materials are stored properly in the stores or demarked</li> </ul>		
niling	areas		
pining	<ul> <li>No contamination should be allowed</li> </ul>		
	<ul> <li>Hazards/noisonous material if any should be stored and handled in safe</li> </ul>		
	manufer manufer and manufer in any should be stored and nandred in safe		
D: (1 ( 1			
Rejected materials	• Enter in material register at site		
	Remove rejected material from site		
Material consumption	• Enter daily consumption of materials in material register and indicate		
	balance quantity		
Construction	<ul> <li>Maintain equipment in good working condition</li> </ul>		
equipment			
Construction	• Intimate BPM-BPMU or his representative when construction is going		
	to commence, and other benchmark activities are proposed to be		
	undertaken.		
Daily work progress	Maintain record		
Testing of works in	Perform tests as per contract requirements		
progress	• Submit test reports to BPM- BPMU		
F8	Maintain test log		
Rejected /Defective	Rectify defective work and invite the RPM-RPMU or his		
work items	representative for re-inspection		
WOIK ICHIS	<ul> <li>Safe and proper disposal of rejected and unusable material</li> </ul>		
Instructions from	Enter change orders, site instructions, letters and minutes of meetings		
DM/Enginger	· Enter change orders, site instructions, fetters and minutes of meetings		
r wi/Engineer	issued by BPM-BPMU in the instruction log		
Construction	• Prepare and update construction programs and schedules and undertake		
scheduling and control	work in accordance with approved schedule		
	• Submission of revised program as and when needed to recover slippage		
	from the planned program and to set the works back on schedule.		

Records	Maintain the following records on site:	
Records	waintain the following feedbas on site.	
	• site instruction book	
	<ul> <li>signed copies of approved drawings</li> </ul>	
	design/drawing register	
	• test reports and test log	
	materials register	
	• equipment register	
	Note- All register/book/reports should be numbered properly.	

#### 6.6 Role of KVA

Formation of Krishak Vikas Associations (KVAs) is an essential activity of Himachal Pradesh Crop Diversification Promotion Project (HPCDP). Under HPCDP, KVAs are being formed with a mandate to have technical, management and business skills required to manage the irrigation facilities developed under this Project.

In accordance with the terms of HPCDP, irrigation systems developed under this Project shall be handed over to the KVAs after final inspection and issuance of completion certificate by the Project Management Unit (PMU).

The KVAs shall be responsible for operation, maintenance and management of the handed over irrigation systems, and for equitable distribution of water among the farmers to facilitate cultivation and promotion of crop diversification. Besides operation and maintenance, the KVAs shall build awareness among farmers regarding agricultural development techniques, including judicious use of irrigation water, and promote crop diversification and high value crops on sustainable basis. Also, the KVAs shall be responsible for water management and resolution of disputes among members in regard to sharing and use of irrigation water and other related matters.

**Annexure 1: Contractor's Invoice** 

## Format A1-1: Contractor's Invoice (Running Account Invoices)

(For contractors: - this form provides for (1) Advance Payments (2) Payments for measured works) The form of Account secured advance which has been printed separately should be attached where necessary.

Division: DPMU:
Sub-Division:BPMU:
Cash Book Voucher NoDated
Name of Contractor
Name of work
Serial No. of the invoice
No. & Date of his previous invoice for this work
Reference to agreement No
Date of written order to commence work
Date of actual completion of work

### Account of Work Executed

Unit	Qty. executed up to	Item of work under	Rate	Payment on the basis of actual		Remarks
	date as per	sub-head and sub		measurements		
	measurement book	works of estimate		Up-to date Since previous		
				invoice	invoice	
1	2	3	4	5	6	7
C/o						
			Rupees	Rupees	Rupees	

Total value of work done to date (A)		
Deducted value of work shown on previous invoice		

Unit	Qty. executed up to date as per	Item of work ground under "—sub-head" and	Rate	Payment based on actual measurements		Remarks
	measurement book	"—sub works" of		Up-to-date	Since previous	
		estimate		invoice	invoice	
1	2	3	4	5	6	7
Net Va Rupee In wo	lue of work since preves	vious invoice (f) figure (F)				

**NB.** When there are two or more entries in column 6 relating to each sub head of estimate these should in case of works the amount of which are kept by sub heads be totaled and the total recorded in column 6 for posting of the work abstract.

### **Certificates and Signature**

- 2. Certified that in addition to and quite apart from the quantities of work actually executed as shown in column 6 of Account I, Some work has actually been done in connection with several items and the value of such work (after deducting there from the proportionate amount of secured advances, if any, ultimately recoverable on account of quantities of material used therein) is in no case, less than the advance payments as per item 2 of the memorandum of payments made or proposed to be made for the convenience of contractor, in anticipation of and subject to the result of detailed measurements which will be made as soon as possible.

Dated Signature of officer Preparing the invoice .....

Rank .....

Dated Signature of contractor

.....

Dated Signature of the officer authorized payments ...... Rank..... **Annexure 2: Measurement Book** 



### **Measurement Book**

The Measurement Book in **Format A3-1** is the basis of all accounts of quantities of work done. The processes of completing the Measurement Book are as follows:

- 1. Entries at Commencement of Measurements
- 2. Writing of Abstract
- 3. Nomenclature of Item
- 4. Cross Reference in case of Running Account Bill
- 5. Recording of Date of Completion 6. Neat Recording of Measurements
- 7. Signature of the Contractor
- 8. Measurements in Ink
- 9. Making corrections in Measurements
- 10. Page Numbering
- 11. Recording of Measurements only by Authorized Persons
- 12. Certification of Measurements
- 13. Responsibility for Quality of Work
- 14. Test Checking of Measurements
- 15. Test Check by the District Project Manager

#### 1. Entries at Commencement of Measurements

Each set of measurements to be recorded shall commence with entries stating:

- A. In case of bills for work done:
  - a. Full Name of work as given in the Agreement/Estimate;
  - b. Location of work;
  - c. Name of Contractor;
  - d. Number and Date of Agreement;
  - e. Date of written order to commence work;
  - f. Date of actual completion of work;
  - g. Date of recording measurements
  - h. Reference to previous measurements.
- B. In case of bills for supply of materials:
  - a. Name of Supplier
  - b. Number and date of Supply Order/Agreement
  - c. Purpose of Supply in one of the following forms as applicable to the case:
    - (i) Stock (for all supplies for stock purpose).
    - (ii) Purchase for direct issue to the work (full name of the work as given in the estimate shall be mentioned).
    - (iii) Purchase for (full name of work as given in estimate) for issue to contractor.... on ..... :

- a. Date of written order to commence the supply
- b. Date of actual supply
- c. Date of recoding measurements

# 2. Writing of Abstract

A suitable abstract shall then be prepared which should collect in the case of measurements for work done, the total quantities of each distinct item of work relating to each sanctioned sub-head. The measurement books meant for this purpose shall contain pages in singleton. Details of quantities, rate, and amount of each item for every bill shall be entered in this Measurement Book in a tabular form.

## 3. Nomenclature of Item

- a) For recording measurements and for preparing abstract, the agreement item number, both in words as well as in figure, shall be given neatly along with description of the item in full or in abbreviated form.
- b) In case of extra/substituted item of work that is not covered in the agreement, the full nomenclature shall be reproduced in the Measurement Book.

## 4. Cross Reference in case of Running Account Bill

If the measurements are taken in connection with a running contract, a reference to the last set of measurements, if any, shall be given.

## 5. Recording of Date of Completion

- a) If the entire job or contract has been completed, the date of completion shall be duly recorded;
- b) If the measurements taken are the first set of measurements on a running account, or the first and final measurements, this fact shall be suitably noted against the entries in the Measurement Book, and in the latter case, the actual date of completion shall be recorded.

## 6. Neat Recording of Measurements

All measurements shall be recorded neatly in the Measurement Book.

# 7. Signature of the Contractor

The signature of the contractor or his authorized representative shall be obtained in the Measurement Book for each set of measurements.

## 8. Measurements in Ink

The measurements shall be recorded in ink.

# 9. Making corrections in Measurements

a) No entry shall be erased or overwritten. If a mistake is made, it shall be corrected by crossing out the incorrect words or figures and inserting the correction. The correction thus made shall be initialed and dated by the officer recording/checking measurements.



b) When any measurements are cancelled or disallowed, these must be endorsed by the dated initials of the officer ordering the cancellation or by a reference to his orders, initialed by the officer who made the measurements, the reasons for cancellation being also recorded.

#### 10. Page Numbering

- a) The pages of the Measurement Books shall be machine numbered.
- b) Entries should be recorded continuously and no blank page left or torn out. Any pages or space if left out blank inadvertently shall be cancelled by diagonal lines, the cancellation being attested and dated.

#### 11. Recording of Measurements only by Authorized Persons

All items of work irrespective of their cost shall be measured and recorded by the Construction Engineer/Junior Engineer of the work. It is, however, open to the Block Project Manager to record measurements for any particular item of work himself.

#### **12. Certification of Measurements**

The person recording the measurements shall record a dated certificate —Measured by mell over his full signature in the Measurement Book.

#### 13. Responsibility for Quality of Work

- a) The officer who records/tests checks the measurements for an item of work will be responsible for the quality, quantity and dimensional accuracy of the work.
- b) The Construction Engineer /Junior Engineer shall make special efforts to be present at site when work is going on and must ensure quality of the work through appropriate checks.

### 14. Recording and Test Checking of Measurements

Block Project Manager is required to check measure the works in his charge as below:

- a. All items of work in a project irrespective of their cost, shall be measured and recorded by the Construction Engineer/ Junior Engineer. It is, however, open to the Block Project Manager to record measurements for any particular item of work himself. In case of absence of Construction Engineer/ Junior Engineer, Design Engineer may be asked to record measurements.
- b. The officer accepting the tender for any work, may stipulate and require the Block Project Manager to record measurements himself or exercise **100% check** on the measurements recorded by his subordinate for any item including those, which, owing to their situation, cannot subsequently be check measured or which have very high unit rates or which in the opinion of the officer are important.

Items of work which owing to their situation cannot subsequently be checked. These items are classified generally as below:

i. All work below ground level such as Concrete, Masonry, Steel work, etc. in foundation; and ii. Lines of pipes buried in floor or masonry in water supply or drainage installations; iii. Earthing installation, cable laying, etc.

### 15. Test Check by the District Project Manager

- a) The District Project Manager (DPM) shall test check **20%** of the measurements recorded. Measurements selected by DPM shall be independent of measurements test checked by BPM.
- b) The individual items checked shall be clearly shown in the Measurement Book, and the result recorded by the officer concerned. The items thus checked shall be attested by the dated initials of the Checking Officer.
- c) Consolidated record of checks/test checks:
  - (i) A collective record of all the checks carried out from time to time will be prepared in each Measurement Book in the following form:
    - i Date of Check
    - ii Page recording measurements subject to test check;
    - iii Value of measurements checked;
    - iv Result of the check exercised;
    - v Dated initials and designation of the checking officer.
  - (ii) The result will be indicated by the word —Satisfactory or —Unsatisfactory as judged at the time on merits of each case. Unsatisfactory result will be communicated to the Construction Engineer/ Junior Engineer or both the Construction Engineer/ Junior Engineer and BPM as the case maybe.

An account of issue and receipt of Measurement Book shall be maintained in **Table A3-1**. All the Measurement Books shall be maintained serial.

Format A3-1: Measurement Book
PMU
Measurement Book No.
Name of Officer.
Designation.
Date of first entry.
Date of last entry.
N.B. This portion should be printed as a title page.
Name of work.
Situation of work.
Agency by which work is executed.
Date of measurement.
(These four lines should be repeated at the commencement of the measurements relating to each work)

Project Name: Himachal	Pradesh Crop Diversifie	cation Promotion	Project Phase-II
Document Name: Quality	y Assurance and Quality	y Control Manual	

Particulars		Details of Actual Measurement				Remarks
	No.	L	В	D or H	Q	
		Length	Breadth	Depth or Height	Contents or Area	
(1)	(2)	(3)	(4)	(5)	(6)	(7)

## Abstract

Particulars	Q'ty	Rate	Amount	Remarks

## Table A3-1: Register of Receipts and Issues of Measurement Books

PMU.....

S. No.	Number of	Name and	Date of	Date of	Date of	Date of	Remarks
	measurement	designation of	issue	completion	return	destruction	
	book	person to			to		
		whom issued			office		

Project Name: Himachal Pradesh Crop Diversification Promotion Project Phase-I
Document Name: Quality Assurance and Quality Control Manual

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

July 2023 R-1 **Annexure 3: Quality Assurance and Control Formats** 



### Form No. 1 HIMACHAL PRADESH CROP DIVERSIFICATION PROMOTION PROJECT

### Site Order Book

Name o	f Sub-F	Project:				
Name o	f BPM	U:				
S. No	Date	Instructions issued on the Inspection of work with Signature and designation	Contractor / contractor's representative acknowledgement with Signature, Name & Date	Compliance report by contractor / contractor's representative with Signature, Name & date	Final remarks of with Signature, designation & date	
					Site Incharge	BPM

### Form No. 2

### HIMACHAL PRADESH CROP DIVERSIFICATION PROMOTION PROJECT

### Weekly Site Report

Contract No: Name of Contractor: Sub-project: Reporting Period: District/Block:

Days	Excavation	Lean Concrete	Masonry	Pipe Laying	RCC	E/w in filling	Cement Concrete /Brick Blocks	Sand Filter	Other activities in site	Remarks
Sunday										
Monday										
Tuesday										
Wednesday										
Thursday										
Friday										
Saturday										
Total Quantity										
Site instructions/ comments if any										

(Please put the work activities as per the nature of the contract.....????)

Contractor's Signature:

Signature of Site Supervisor/ Junior Engineer /Construction Engineer

Signature of BPM-BPMU

### Form No. 3 HIMACHAL PRADESH CROP DIVERSIFICATION PROMOTION PROJECT

### Site Inspection Report for Structures

### Monitoring of Quality Control

#### **STRUCTURES:**

District:	Block:
Name of Sub-project:	
Contract No	
Name of Contractor:	
Name of Work with Location:	
Description of work:	
Date of Inspection:	
Reported by:	

Designation: .....

S.N.	Description of Work Activity	Work done was:				N/A	Remarks
		Good	Fair*	Poor	Not done		
01.	Setting out.						
02.							
03.							
04							
05.							
06.							
07							

\*Fair work is acceptable provided it complies with technical specification of Contract Document, but it may need improvement depending upon the type of work. Observer should decide and mention about the acceptance or improvement at remarks.

Signature /Contractor's Representative: .....

Signature/BPMU: .....

## Form No. 4

### HIMACHAL PRADESH CROP DIVERSIFICATION PROMOTION PROJECT

### **Physical Progress Report (Monthly)**

District:	Block:	Name of Sub-project:	
Contract No:			
Name of Contractor:	l	Description of Work:	
Original Contract Value:		Revised Contract Value:	
Value of Works Completed as from Form No.7	:		
Date of Contract Awarded:	Date of Completion:	Date of this Reporting:	

Item	Description of Work	Total quantity			Completed	Total	Remarks	
No.		Physical	Weighted	Target during	Complete during	Up to date	Progress	
			%	the month	this month	complete quantity	%	

Signature of Supervisor/ J.E /Construction Engineer:	Signature of BPM-BPMU	_ Date:
Name:	Designation:	

(One copy to TL, PMC)

# Form No. 5

\_% Compliance with

# HIMACHAL PRADESH CROP DIVERSIFICATION PROMOTION PROJECT

### **Minutes of Progress Review Meeting**

Meting Conducted on:	Previous Meeting on:	
Contract No:	Name of the Sub-project:	
Location (District/Block):	Name of Works:	
Name of Contractor:	Work Order Date:	
Contract Duration:	Completion Date:	
Elapsed Time: mo	onths	% Target of
Progress of Work up to the reporting month	1:	%

Actual Work Completed: \_\_\_\_\_

Commitments Made During Last Review Meeting

SI.	COMMITMENT IN LAST REVIEW MEETING			WHETHER	IF NOT, WHY & WHEN	REMARKS
NO.	Contractor	Consultant	Employer	COMPLIED	WILL BE COMPLIED	

Sl. No.	PROBLEMS, ISSUES, ACTIONS TO BE TAKEN	ACTION BY	DUE DATE

## **Revision of Progress, Quality and Coordination**

### Any Other Business / General Comments:

Signature of Contractors:

Signature of PMU/DPMU/BPMU:

*Consultant (if required):* 



### Form No. 6

### HIMACHAL PRADESH CROP DIVERSIFICATION PROMOTION PROJECT

### **Reinforcement Checkout Form**

POUR LOCATION: .....

Sl. No.	Location (Drawing)	Dia of Bar mm	Length m	No. Of Bars	Total Length m	Quantity of Concrete	Remarks

Representative of Contractor:

J.E/Construction Engineer

Design Engineer

### Form No. 7

### HIMACHAL PRADESH CROP DIVERSIFICATION PROMOTION PROJECT

### Monthly Financial Progress Report

Sl. No.	Contract No.	Name of Contractor	Name of Work	Contract Amount	Invoice During the Month	Payment during the Month	Total Payment	Financial Progress (up to date) %	Remarks
тот	AL								
Signat	Signature: Account/Office Manager								

### Form No. 8 HIMACHAL PRADESH CROP DIVERSIFICATION PROMOTION PROJECT

### **Field Visit Report**

(As and when visited by senior officials)

District:
Block:
Contract No:
Name of Contractor:
Observation made by (Name):
Designation:
Description of Work:
Location of Work:
Observed and communicated the following on (date):

A: Works completed Since last inspection	Work lagging behind	B: Works in progress	C: Works likely to start Before next inspection

#### **Observations:**

No.	Observations on Quality

#### **General Remarks:**

No.	Remarks/Instructions

#### Signature:

Original retained by: JE /Construction Engineer / BPM-BPMU

Copy to DPM-DPMU, Team Leader-PMC

### Form No. 9

### HIMACHAL PRADESH CROP DIVERSIFICATION PROMOTION PROJECT

### **Concrete Cube Register Format**

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1101	rioti
	IICI.

Sub-project Name:

Contract No.:
Name of Structures:

Name of contractor:

Site/Location	Type of structure	Date of casting	Date of testing		Date of testing		Date of testing		Grade of concrete	Obtained C strength o cubes(N	ompressive f concrete V/mm2)	Remarks
			7 Days	28 Days		7 Days	28 Days					
#### Form No. 10 HIMACHAL PRADESH CROP DIVERSIFICATION PROMOTION PROJECT

# Site Environmental Management Checklist

C:4	
211	e:

	YES	NO	Comment
WORK CAMPS/ CONSTRUCTION SITE	_		
Layout			
Suitable site: Keep clear of farmland/ properties			
Minimize disturbance to existing vegetation cover			
Site roads aligned (site access road)			
Reasonable slopes			
Construction Wastewater	-		
Concreting wastewater collection/treatment facility adequate			
Dredging wastewater collection/treatment facility adequate			
Waste Collection/Disposal			
Pollution risk to surface/groundwater	-		
Pollution risk if flooded	-		
Appropriate hazardous waste disposal			
Plant for final disposal			
Refuse/scrap areas fenced			
Fuel Storage/vehicle repair areas			
Fueling areas			
Adequate spillage capacity			
Firefighting equipment			
Public Health and Safety			
Measures to protect secure fencing around and within site			
Informal settlement outside camp			
Lighting of works			

Safe and secure electrical systems		
Water supply adequate (i.e. drinking water)		
Washing and showers		
Sanitation		
Refuse disposal plan		
Vermin, rats, cockroaches		
Accommodation/kitchens clean		
Regular public health authority inspection		
Water Quality (clean)		
Irrigation canals		
Lakes/wetlands		
Roadside drain		
Standing water near settlement/site		
Fire		
Incineration risk of waste materials		
Space between buildings		
Firefighting equipment		
Firefighting plan		
Correct storage of dry wood		
Air Pollution		
Dust control		
SOURCE OF MATERIALS/ HAULAGE		
Borrow Pits		
Acceptable site location		
Tests for contamination		
Suitable embankments (slopes)		
Topsoil stored		
Adequate drainage/silt traps		
Restoration plan including drawing		
		•

Check carried out by

Signed \_\_\_\_\_

#### Form No. 11 HIMACHAL PRADESH CROP DIVERSIFICATION PROMOTION PROJECT

#### Health and Safety Checklist

Site:			
General site Check – for all areas where work is going on	YES	NO	NOTES
Is construction area erected with barricades to protect public and workers?			
Is there safety instructions displayed on notice boards?			
Are there any measures to protect the public from machinery?			
Can the workers call for help in an emergency first aid facilities if any?			
Is there any means of fighting a fire?			
Is there enough light (for nightworks) for workers to work safely?			
Are there any measures to protect workers on foot from machines? (e.g. wearing high visibility clothing)			
Is scaffolding engaged for high level construction works?			
Are the machines working at a safe distance apart?			
Are there measures to suppress dust?			
Is there a reasonably quick access for emergency vehicles?			
Is rubbish stored/disposed of safely?			
Check list for concreting operations			<u> </u>
Do workers have proper protection for their skin?			
Is there water to wash off splashes of concrete?			
Are their safety guards on bar cutting/bending machines?			
If the rebar is being fixed in-situ, is there safe access for the workers (e.g., a ladder)?			
If the rebar is being lifted into place, is it safely tied together? Is there a risk of bars falling?			
Are cranes parked on stable foundations, not to close to the excavation? Are foot supports being used?			
Check list for Site Camps			
Are there first aid facilities?			
Is there anyone trained in first aid?			
Is there good control of vehicle movements, and separate pedestrian routes?			

Are there Protection and warning signs used? (For	
flammables, electricity, traffic etc)	
Is there adequate water supply?	
Are toilet facilities clean?	
Are there washing facilities?	
Is there electricity supply earthed?	
Are the cables safely out of the way?	
If the cables are suspended, is there a risk of them coming in contact with tall equipment?	
If the cables are on the ground, is there a risk of them being damaged by vehicles?	
In workshops, are workers using protective equipment where needed e.g.:	
Ear defenders,	
Welding masks and gloves,	
Dust masks	
Is waste stored/disposed of safely?	
Are supplies stored/stacked safely so that they cannot fall or	
be blown down?	
Check list for worker welfare	
Are workers given regular breaks?	
Are workers given safety training?	
Is there a clean drinking water supply?	
Is there somewhere for workers to rest, protected from the weather (both hot and cold)?	
Are workers provided with correct clothing (warm clothes in winter)?	
Are there trained first aid staff	
Check list for excavations for structure construction.	
Is the excavator on stable ground?	
Are the side slopes safe?	
Is water being managed safely?	
Is there a risk of sides eroding and collapsing?	
Are there safe routes for people to get in and out of the excavation?	

Is there any risk of equipment falling into the excavation?		
Is there a risk of spoil heaps falling into the excavation?		
Working on or alongside water:		
Is there a safe, stable working platform for people and plant?		
Is there flow being controlled where possible?		
Is there safety equipment to rescue someone falling in to the water?		
Protocols and plans		
Are there plans for emergency?		
Are there risk assessments?		
Are there records of staff training?		
Are there records of incidents and near misses?		

Check carried out by

Signed \_\_\_\_\_



#### Form No. 12

### HIMACHAL PRADESH CROP DIVERSIFICATION PROMOTION PROJECT

### **Certification of Completion**

Certified that <b>FIS/LIS/TWIS</b> completed as per detail given below: -
Sub-project Name:
Name of BPMU:
Name of DPMU:
Contract No.:
Date of Start:
Date of completion:

	Scope of Work									
Sl No.	As per Award Taken	As per Award Taken As per Execution at site								

Representative of Contractor:

JE /Construction Engineer:

Design Engineer:



#### Form No. 13

### HIMACHAL PRADESH CROP DIVERSIFICATION PROMOTION PROJECT

### **Hindrance Register Format**

Sub-project Name:
Name of BPMU:
Name of DPMU:
Contract No.:

Sl No.	Hindrance Mark Date	Description	Start Date	Finish Date	Date taken in issue resolve	Remarks
1	2	3	4	5	6	7

✤ Any type of hindrance resulting in stoppage of filed activity.

Representative of Contractor:

JE /Construction Engineer:

Design Engineer:



#### Form No. 14

## HIMACHAL PRADESH CROP DIVERSIFICATION PROMOTION PROJECT Handing over and Taking over Certificate

1.	That, IS/O Sh										•••
	workin		of	KVA					•••••	••••	
	have	been	authorized	by	the	KVA	in	the	meeting	held	on
					. vide r	esolution	No	to	o give this ur	ıdertakin	g for
	and on	behalf o	f the KVA.								

- 2. That, we have taken over the scheme in all respect completely working satisfactorily after it is completed and shall take responsibility of its operation and maintenance.
- 3. That, we take responsibility of equal distribution of water amongst the members by way of making a schedule of irrigation chart.
- 4. That, we shall be responsible to recover the water charges as levied by the KVA and put in the O & M fund to be maintained by KVA.
- 5. That, O & M fund shall be properly maintained/operated.
- 6. That, we take responsibility for full utilization of irrigation water and shall be deriving maximum benefit from the scheme.
- 7. That KVA shall function in tandem with the Gram Panchayat .....and GP representative shall be involved in the every meeting concerning O&M.
- 8. That, in case the KVA becomes defunct due to one or the other reason, we would have no objection if the scheme is taken over by the Gram Panchayat concerned including operation and maintenance fund.

Name and Signature of BPMU KVA With office stamp Name and Signature of President

