

Irrigation and Water Resources Department

State Government of Mizoram



Officers' Manual Construction Management

January 2023



Project on Capacity Enhancement for
Sustainable Agriculture and Irrigation
Development in Mizoram



सत्यमेव जयते
State Government of Mizoram



Japan International Cooperation Agency

The cooperation between JICA and Government of Mizoram dates back to 2013 when JICA conducted a development study from 2013 to 2015 during which a 'Master Plan' for management and development of land & water resources for sustainable agricultural development in Mizoram was formulated.

In order to properly implement the approaches and projects in the Master Plan, this Technical Cooperation Project, entitled "The Project on Capacity Enhancement for Sustainable Agriculture and Irrigation Development in Mizoram" is carried out during July, 2017 to March, 2023.

It is my pleasure to acknowledge the hard work and dedication of JICA Project Team and all other officials involved in formulating the much needed Manuals viz. 1) Officer's Manual for Construction Management, 2) Manual for Strengthening of WUA for O&M of Irrigation Schemes 3) DPR Preparation Guideline, which is one of the outcomes of Technical Cooperation Project (TCP) between JICA and Government of Mizoram.

As there is neither any particular manual that is endorsed by IWRD nor any has been prepared till date for construction of irrigation projects in the state, these Manuals will be the first of their kind for the department. I am confident that these manuals will prove to be a turning point for construction management of irrigation facilities in a systematic and improved manner. I pray that these manuals will be properly utilized and the farmers will reap the benefits.



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This Officers' Manual for Construction Management was prepared with the initiatives of several line departments, namely: Irrigation and Water Resources Department (IWRD), Department of Agriculture (DOA), Department of Horticulture (DOH), and Land Resources and Soil and Water Conservation Department (LRSWCD). This manual is prepared for the officers of IWRD for the effective management of irrigation scheme construction.

The Project on Capacity Enhancement for Sustainable Agriculture and Irrigation Development (Mizo-CESAIID) not only aims to improve the agriculture scenario in the state but also improve the capacity and technical skills of the officers, technical staff, and farmers to be able to handle such kind of projects successfully in the future. For this, trainings and workshops have been held for both farmers and officers to impart the necessary technical skills needed. This officer's manual has been prepared to provide the officers of the concerned state department certain rules and guidelines to be followed, to ensure that good and quality works are executed, and to impart the necessary knowledge and skills required to execute the construction of various components of the projects successfully.



The procurement of contractor for proposed irrigation projects shall be carried out in conformity with the following government guidelines:

- Item Rate Tender & Contract, Agreement C.P.W.D Form-8, Irrigation and Water Resources Department, Government of Mizoram
- CPWD Works Manual
- CPWD Specifications
- Other guidelines prepared by the donor organizations

In the tender and contract documents, the followings shall be clearly defined and stipulated.

- Tender number and name of works
- Estimated amount
- Terms and conditions
- Earnest money
- Cost of tender form
- Performance guarantee and security deposit
- Time of completion
- Terms of payment (advance, progress, and final payment)
- Retention money
- Taxes and related charges
- Defect and liability period



Under Mizo-CESAID, community-managed construction work (community contract) was proposed and implemented. If the works and scale are suitable for the community works, there are various advantages as shown below.

Comparison between General Contract and Community Contract

Description	General Contract	Community Contract
Construction Cost	Lower than government standard (By competitive bidding)	Apply the Government standard unit price
Construction Time	Within contract period unless otherwise approved by the Employer	Within agreed period, unless otherwise approved by the Employer
Goods and Services Tax (GST)	GST imposed	GST exempt
Gaining Technical Skills	Limited	High
Gaining Management Skills	Nil	High
Sense of Ownership	Low	High
Sustainability of facility	Low (need special training)	High
Impact to Community Members	Not much or negative	Strong
Degree of Satisfaction	Low	High
Fund raising by Community Group	Nil	Possible

In addition to the exemption of the Goods and Services Tax (GST, 12% of the contract price) as above, the contractor's profits (10% of the contract amount) will be saved in the Water Users' Association (WUA)'s account, which will be utilized for maintenance in the future. This will contribute to a reduction in the construction cost and the facility maintenance support cost in the future to be paid by IWRD, which is economically advantageous.

In addition, through the community-managed construction by the WUA, the ownership of the facility is fostered and technical knowhow necessary for repair and management is accumulated. Acquiring a sense of accomplishment through collaborative work leads to the strengthening of the WUA's organizational capabilities and can contribute to better facility maintenance.

In the Memorandum of Understanding (MOU), the following responsibility of each party shall be stipulated:

Responsibilities of each Party

Division Office of IWRD shall;

- plan and design of the required works
- supervise and give necessary approval
- give guidance and training to the Community technically, financially and management,
- advise and assist to the Community on procurement of required material, tools/equipment and sub-contractor(s), if needed
- organize periodical progress meeting,
- settlement of dispute among stakeholders (e.g. land matter)
- inspect and arrange for payment
- issue the certificate on completion and defects liability, and
- give guidance for operation and maintenance

The Community shall;

- arrange and implement the agreed construction works
- keep necessary record and management
- assure accountability of the financial and organizational management
- mobilize and manage the labor contribution and other necessary contribution,
- monitor at the site, and
- be responsible in daily operation and maintenance work after completion
- keep the transparency of the Work
- update cash book daily
- keep motivation of the community to the Work

Construction Management Plan

The manual starts with the review of the construction plan prepared and submitted by the contractor. The construction plan should be submitted to the Engineer-in-charge, IWRD after award of contract and before signing the agreement.

Organization Chart for Project Implementation

The organization chart of the contractor to carry out the construction work should be prepared and attached in the construction plan. The chart should include name(s) of site engineer(s), work supervisor(s), surveyor(s), and other concerned officers with their contact numbers. The contractor should deploy a responsible site representative who will stay at the construction site on a full-time basis.



Organization Chart

Construction Schedule

- The construction schedule should be attached to the construction plan. The work items listed in the bill of quantities should be broken down into the work elements as much as possible.
- The quantity of the work elements should be clear. It is usually shown through a combination of S-Curve and bar chart.
- An S-Curve is graphical representation of cumulative progress plotted against time, which is one of the major tools used in construction management.

Review of Construction Plan

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Work Item	Cost		Unit	Qty	Year : 2018												Year: 2019														
	(INR)	(%)			Sep			Oct			Nov			Dec			Jan			Feb			Mar			Apr			May		
					1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Route Survey	10,000	1.3																													
Repairing of Existing Canal	200,000	12.0	Rm	540																											
Rehabilitation of Water Harvesting Ponds	400,000	18.0																													
Construction of Main Channel	350,000	17.5	Rm	1000																											
Distribution Channel -I	480,000	20.0	Rm	600																											
Distribution Channel -II	560,000	25.0	Rm	600																											
Om Training, Final Inspection etc.	:	:																													
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**Cumulative Work
Volume Curve**
calculated based on
schedule of construction
cost with ten days basis

Manpower, Machinery and Material Schedule

The machinery used for construction work should be specified in the construction plan with numbers/quantity. The construction material such as cement, coarse and fine aggregate, filling materials should be listed in the plan with tentative volume and the name of supplier or name of quarry site should also be written in the plan. In most cases, civil construction works in the state depends on labors coming from other states. In such cases, the contractor shall make agreement with some agents which provide labors. In cases where the contractor has made an agreement with those agents, the name and details of the agents should be submitted. Labors who are not resident of Mizoram may be asked to furnish or produce necessary permit if they are to be engaged. Relevant labor law should be adhered to.



Quality Control Plan

The quality control plan for concrete works of intake and canal with related structures should be prepared by the contractor. The quality control plan including the methodologies and frequency of test will be specified in the construction plan.

The Engineer-in-charge, IWRD should confirm whether it meets the required norms and conditions of irrigation works. This construction plan will help in the quality control in the checking and evaluation of works by the department as well as the contractor himself, thereby proceeding the works with a well thought out plan and schedule which will make the task easier and ensure that time and quality are maintained.

Awareness Meeting to the Stakeholders

Irrigation project aims at improving the livelihood of the farmers by increasing their crop production through introduction of better facility and better crop cultivation methods. For introducing and carrying out any new facility development or construction work, there must be good support from the farmer's side; otherwise, the proper implementation of the plan cannot materialize. In order to acquire effective collaboration and constant support from farmers, awareness meetings with farmers, contractors and IWRD officers should be held at the beginning of the construction works. The awareness meeting will also create sense of ownership of the irrigation facilities created by the scheme.



Introduction of Contractor to the Villagers

These awareness meetings should be used to introduce certain personnel involved in the project. Firstly, the contractor who is going to carry out the construction works should be introduced and he should familiarize himself with the farmers and villagers to avoid any problems that may disturb the smooth implementation of the construction work. This will also ensure good support and enable collaboration between farmers and the contractor to achieve good work results. The department officers should also familiarize themselves with the farmers and villagers so that grievances and feedback about the construction work can be heard and taken care of properly.

Awareness on IWRD Construction Management Plan

After introducing the contractor to the villagers, the officers of IWRD shall explain the construction management plan specified in the manual to the contractor and villagers with some handout. Progress monitoring and quality control method should be explained to the contractor, WUA and villagers by IWRD officers at the beginning of the project execution. It is very important to involve villagers in the construction management, especially in quality control of the facilities since they will be the main user of the facility and will take responsibility of the operation and maintenance after completion of the facilities.

In the awareness meeting, the following matters should also be discussed and confirmed, as they will affect the quality and progress of the contractor's works:

Cropping schedule and canal closure period: In most cases, construction works of irrigation facilities will be affected by the existing crop in the field. Construction schedule should be planned so as to not disturb the farm activities. Especially, the rehabilitation or upgrading works of canals and related structures can only be executed during canal closure period. In the meeting with the WUAs, the canal closure schedule based on their cropping schedule should be discussed and concluded before the start of cropping season.

Land acquisition and compensation: IWRD should be responsible for land acquisition for the permanent works and any compensation for the land for temporary works. In the awareness meeting, IWRD should conduct joint walk-through survey with WUA members as well as the land owners to show and explain the designed facility at site. If land acquisition is required, it should be settled before starting the contractor's works.

Job-opportunity for the villagers: The construction works will create job opportunity for the villagers, as the contractor may employ skilled and unskilled workers in the village. The IWRD staff should recommend and mediate between the WUA and the contractor in the meeting.

General Requirements:

- The ESHS Plan should be prepared by the contractor according to the guideline and submit it to the Engineer-in-charge, IWRD after the award of contract and before signing the agreement.
- The ESHS Compliance Report should be submitted monthly by the contractor.
- The contractor shall take all precautions for safeguarding the environment during the construction of the works. He shall abide by all rules, regulations and laws in force governing pollution and environmental protection that are applicable to the area where the works are situated.
- All construction materials such as aggregates and timbers shall be procured from authorized quarries and vendors (provided approved vendor for particular material is available at the nearby city / town). Information on the authorized quarries and vendors shall be mentioned in Construction Plan
- All sites including labour camp and construction site shall be restored to their original condition, if not improved, upon completion of the works.
- Asbestos containing material shall not be used in any construction-related activity.
- The contractor should appoint an EHS Officer who will be in-charge of the activities mentioned below.



Construction & Demolition Waste Management:

- Uprooted vegetation : It should be disposed of at an appropriate location approved by the Engineer-in-charge and concerned land owner if it is to be disposed in private land.
- Earthwork: Top soil should be deposited in agricultural lands for use by farmers if it is within 100 m from the excavation site. The rest should be used for landfill or disposed of at an appropriate location approved by the Engineer-in-charge and concerned landowner.
- Empty cement bags, broken bricks, etc., should either be distributed to farmers or disposed of at an appropriate site approved by the Engineer-in-charge and concerned landowner if not reusable.
- Plan for disposal of C&D wastes should be mentioned in the construction plan and should not be disposed of in any water body.
- Oil and lubricant wastes should be disposed of at an appropriate location approved by the Engineer-in-charge and concerned land owner.

Construction Workers Camp Management:

- Selection of camp site:
Camp should not be constructed near community water source
Deforestation for the construction of camp should be avoided as much as possible.
- Facilities to be provided:
Potable drinking water should be available at all times.
The camp should have required facilities such as bed roll and mosquito nets for workers, water supply, lighting arrangements and cooking equipment.
- Hygiene and sanitation:
Facilities for bathing, washing clothes and utensils (soap, bucket, mug etc) should be provided with arrangements for proper draining of waste water. Washing and bathing place should be allocated.
Temporary latrines should be constructed and open defecation must be avoided. The latrines should be filled after the project work is completed.

Organization, Role and Responsibility for Construction Management

All construction and rehabilitation works of irrigation projects shall be implemented under the management of the Divisional Office (Executive Engineer (EE)'s Office). The Divisional Officer (EE) shall be the "Engineer-in-charge", who shall sign the contract on behalf of the President of India and shall supervise and be in charge of the work. The concerned personnel's role and responsibilities are summarized as below.

Name of Office	Position	Role and Responsibility
Office of the Executive Engineer	Engineer-in-charge (Divisional Officer, EE)	<ul style="list-style-type: none"> ✓ Responsible for bidding ✓ Sign contract ✓ Approve and issue the concerned drawings ✓ Approve the estimated quantities and cost ✓ Instruct and Supervise the SDO and other Engineers in the divisional office ✓ Issue Completion Certificate ✓ Approve payment request ✓ Endorse necessary document to the Chief Engineer's Office
	SDO (TC)	<ul style="list-style-type: none"> ✓ Check drawings ✓ Check estimated quantities and cost ✓ Check bills for payment ✓ Check any other technical papers
Office of the SDO	SDO	<ul style="list-style-type: none"> ✓ Prepare bid documents ✓ Prepare design drawings ✓ Prepare estimates of quantities and cost ✓ Prepare documents for payment ✓ Supervise JE & SA in their day-to-day works ✓ Check the measurement and billing documents prepared by JE/SA
	JE, SA	<ul style="list-style-type: none"> ✓ Responsible for measurement at site, and compilation of measurement books ✓ Day-to-day construction supervision ✓ Monitoring of ongoing works

The quality control of the construction work should be carried out by the contractor on a daily basis as per the quality control plan. IWRD should check and monitor at the specific time and it should not miss the critical stage.

Field Inspection by IWRD and Stakeholders

To ensure that the quality of materials and quality of the works meet the correct specifications and guidelines, periodical inspection is a must. This will help in regulating the work of the contractors, and check the progress and quality of work. IWRD site officer should visit the construction site and check the conditions of the work. This site inspection may include checking the safety measures implemented, condition of labours, quality control measures, quality of materials, and quality of completed and ongoing construction work.

If any problem, mistake, or improper use of machinery and materials is found, the officers should discuss with the contractor and give instructions to correct such mistake in the instruction slip. This slip can be used not only for correcting mistakes but for suggesting a more efficient method that can be implemented in the field for better work quality.



Key Points for Quality Control

Quality is required to be maintained in the construction of facilities, as per the drawings and specifications. Key points to be considered and items to be checked are:

General	
Material	<ul style="list-style-type: none"> ✓ Cement, sand, aggregates, water, bricks, boulders, etc. should conform to the specifications. ✓ As for the reinforcement bar and other metal works - mill sheet and/or manufacture's certificate should be provided if required. ✓ In case of pipe - checking of diameter, length and thickness
Storage	<ul style="list-style-type: none"> ✓ Stacked directly on the ground? ✓ Is it covered with a sheet etc, if it is outside in the rainy season? ✓ (Re-bar, cement bags, valve, etc.)
Setting-out	<ul style="list-style-type: none"> ✓ Canal alignment after topo-survey for longitudinal profile with temporary peg installed. ✓ Location of proposed structure
Canal Works	
Earth work	<ul style="list-style-type: none"> ✓ Is excavation done according to the design? ✓ Pay line is confirmed? And measurement done for payable amount ✓ Is excavated material placed at temporary place? ✓ Backfill soil is compacted.
Brick work	<ul style="list-style-type: none"> ✓ Are they uniform in color, size and shape? ✓ Are they free from cracks and other flaws, with sharp and square edges? ✓ Joint mortar, plastering and workmanship
Structure Works	
Shuttering/formwork	<ul style="list-style-type: none"> ✓ Are formworks properly cleaned (garbage / mud inside)? ✓ Inside formwork is watered sufficiently? ✓ Support to formwork is sufficient? ✓ Thickness per design is maintained?
Reinforcement	<ul style="list-style-type: none"> ✓ Type (deformed or plain), size, diameter and length ✓ Bending and joint's overlap is ensured

	<ul style="list-style-type: none"> ✓ Spacing of reinforcement is followed as per design? ✓ Assembled reinforcement is ensured with the necessary cover of concrete? ✓ (sufficient spacer? (concrete cover block)) ✓ Are reinforcement bars tied, against any movement ?
Concrete	<ul style="list-style-type: none"> ✓ Is concrete mix proportion properly formulated? ✓ Is concrete mixed well? ✓ Do not add water during placing of concrete. ✓ Is the concrete clear from foreign materials (wooden pieces, grass, plastic bags small steel, etc.) ✓ Ensure vibrator is operated properly. ✓ Has compaction been done adequately? (If it has not been done adequately, honeycombing and construction joint shall appear.)
Curing	<ul style="list-style-type: none"> ✓ Is concrete surface covered with wet gunny bags sheet for watering? (During curing period, concrete surface should not be allowed to dry) ✓ At least seven days in case of ordinary Portland Cement (IS 456 – 2000)
Stone works	<ul style="list-style-type: none"> ✓ Gabion -size, shape and hardness of boulders ✓ Size of wire and woven mesh with joints formed by twisting each pair ✓ Masonry- size, shape and hardness of boulders, ✓ Joint mortar and workmanship
Gate	<ul style="list-style-type: none"> ✓ Size and thickness of skin plate ✓ Hoisting mechanism ✓ Painting and greasing
Pipeline	
Dismantling	<ul style="list-style-type: none"> ✓ Without damaging the dismantled pipe ✓ Storing dismantled pipe
Fitting	<ul style="list-style-type: none"> ✓ Cutting, threading, and alignment ✓ Supporting pillar ✓ Joint and valve

Check Survey

Quality control for the canal and related structures includes confirming the shape, dimensions, and elevation of the completed or ongoing facilities. All the check surveys should be carried out to determine whether the construction of the works is within the specified tolerances. All surveys are to be carried out to determine / verify interim or final quantities.

Especially for newly constructed canals, check survey should be done by preparing longitudinal profile to check that the gradient of the canal is correctly maintained as per the design. Check survey report should be prepared and submitted to the Engineer-in-charge, before proceeding for payment.

In this regard, temporary benchmarks installed during the design stage for the preparation of the Detailed Project Report (DPR) should be well maintained to be utilized during construction period. These benchmarks must be used for the check surveys by the contractor while setting out to determine as to whether the location of all structures, alignment and elevation, gradient of the canal works and related structures are in the correct position in relation to the actual design or not.

Proportion of the Material

Three types of concrete are used mainly for irrigation and drainage work. The officers in IWRD should check in the field whether these proportions are kept as specified and whether the field supervisor or field worker who is involved in the concrete work knows the proportion. The proportion for each concrete type and expected compressive strength are as follows:

Type of Concrete		Use	Aveg. Compressive Strength (28 days) (N/mm ²)	Proportion in Volume		
				Cement	Sand	Stone
Type A	Reinforced	Walls and pillars	20	1	1.5	3
Type B	Reinforced Mass	Canal	15	1	2	4
Type C	Mass	Floor or base	10	1	3	6

Slump Test

Slump test is one of the methods to measure the liquidity of fresh concrete. It is a widely employed method to determine the workability of concrete. In structures such as buildings, in which reinforcement bars are densely placed, concrete with high slump offers better workability. If the liquidity is too low, it may result in concrete failing to seep through to all gaps between reinforcement bars and therefore produce defects. Too high liquidity, however, means low strength. The contractor should measure the slump in every batch of concrete. The staff of IWRD will check the slump regularly in the field.



During concrete placing after the slump test, laborers tend to add water when workability becomes low. However, it is strictly prohibited to put additional water to the concrete already mixed. Concrete and mortar which have partially hardened shall not be re-tempered or remixed with additional water.

Compressive Strength Test (Cube Test)



Compression Testing Machine



15 cm Cube Mould



Concrete Cube

The compressive strength of concrete done by cube test determines whether concreting has been done properly or not. The compressive strength of concrete depends on many factors such as water-cement ratio, cement strength, quality of concrete material, quality control during production of concrete, etc.

For small concrete structures of MIP, the quality control of concrete should be carried out by checking the quality of each material such as cement, sand, aggregate, and water and their proportion on the field. However, several samples of concrete should

be taken for compressive strength test during the placing of concrete for each project site. The contractor should be instructed to test a sample from a batch of concrete selected by the IWRD officer.

Strength Test After It Hardened

The strength of placed concrete should be checked by Schmidt Hammer in the field. Schmidt Hammer test is a non-destructive testing method of concrete which provides a convenient and rapid indication of the compressive strength of the concrete. The test is conducted in order to estimate strength

and quality distribution of concrete, using measurements of surface rebound tested by a Schmidt Hammer or other test hammers. The strength calculated from rebound is of different nature to the compressive strength determined by destructive compression of a specimen and therefore called a test hammer strength.



Periodical Monitoring and Progress Meeting

After the construction works are started, the department has to monitor the works carefully based on its own observation and progress report submitted by the contractor. For proper monitoring, the contractor has to enter the details and progress as well as the work items to be implemented in the next reporting period of the progress report. The EE's office will check and inspect the progress report and if any problems are found, the officers will discuss the matters with the contractor and find ways to rectify the problems. These problems can be mismatch of the work items proposed and actual work done, slow execution of work, etc.

After that, the site officer will crosscheck whether the schedule is followed as planned or not, and if any problems are found, the matter may be discussed with the other officers of the department and the contractor and find ways they can follow through with the planned schedule. If there are any hindrances from the villagers or farmers' side which prevent the contractors from maintaining the proper schedule, then this matter should be discussed by the contractors and IWRD officers with the Village Council and Farmer's Organization leaders and should be rectified as early as possible to prevent any major interruption to the work flow.

This meeting should make the stakeholders aware of the approaches taken to achieve different portions of the construction works, methods implemented for quality control, safety measures followed, etc. Further plans on how they intend to proceed, where they will continue with the construction works, and how they will procure materials should also be informed in the meeting, so that the stakeholders can anticipate the next plans for the construction and make items for inspection accordingly. These progress meetings will also get the farmers involved and interested in the project and will motivate them to support the project.

Based on the monitoring of the works, schedule control shall adjust and manage the construction to proceed as planned in order to complete as per the construction period. If the original plan differs from the actual plan, the cause should be investigated and removed.

There are two ways of progress monitoring and control. One is on milestone basis (expressed in date) and the other is on progress rate basis (expressed in percentage). The milestone basis (expressed in date) of progress monitoring and control is usually used with bar chart and monitoring sheet. The bar chart shows the commencement and completion of the individual works, and the monitoring sheet shows the date of important events during the implementation of the works. Both should be evaluated through the comparison between the scheduled and actual accomplishment.



Progress Monitoring Sheet

On the progress monitoring sheet, activities should include, but not limited to:

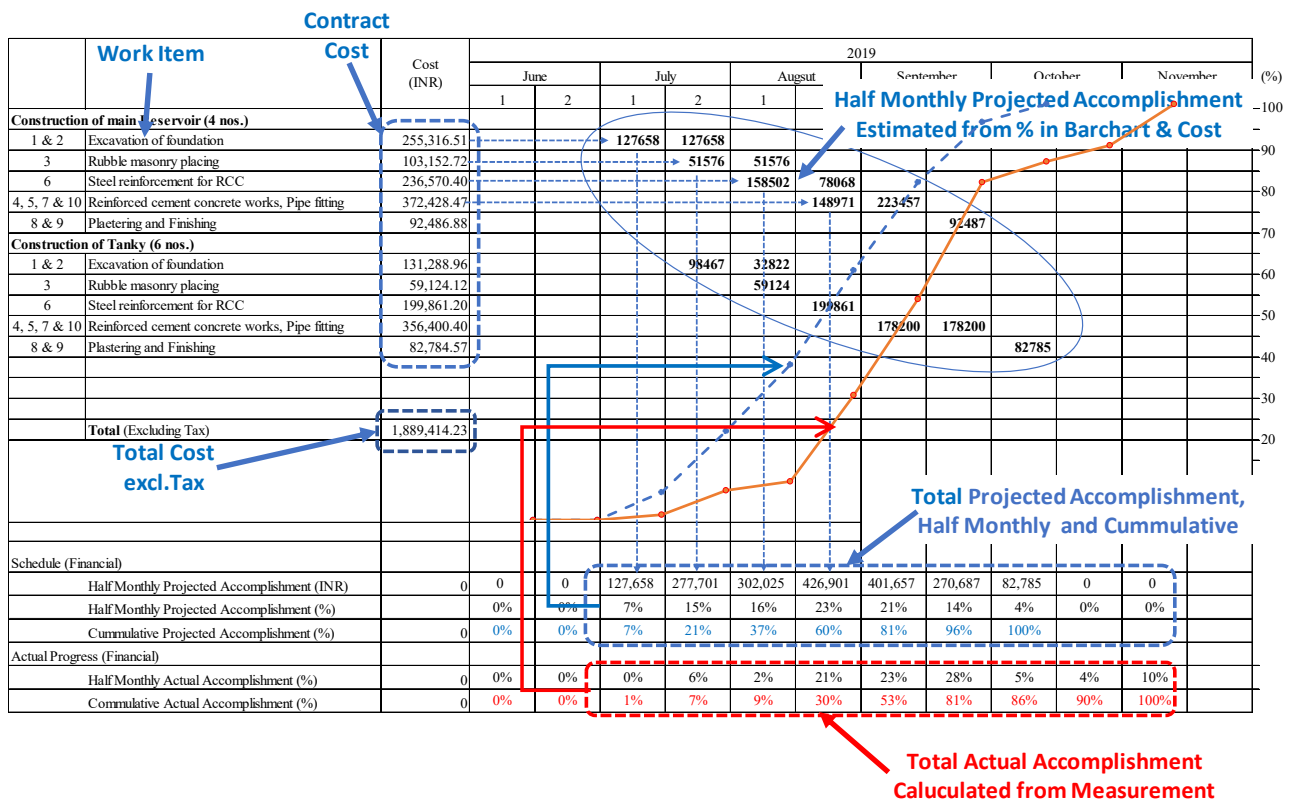
- Joint walk-through survey to confirm the site condition and instruct topographic survey points;
- Submit construction plan including organization chart by the contractor;
- Approve construction plan and organization chart;
- Conduct topographical survey by the contractor;
- Awareness meeting among IWRD, contractor and WUA;
- Submit invoice and guarantee bond by the contractor for advance payment;
- Approve the advance payment and proceed;
- Mobilization to the work site;
- Transportation of major materials;
- Commencement of each works;
- Conduct monthly progress meeting among stakeholders;
- Conduct inspection and approval of progress payment;
- Conduct final inspection by stakeholders;
- Final measurement;
- Issue of completion certificate and final payment.

Progress Control with S-Curve

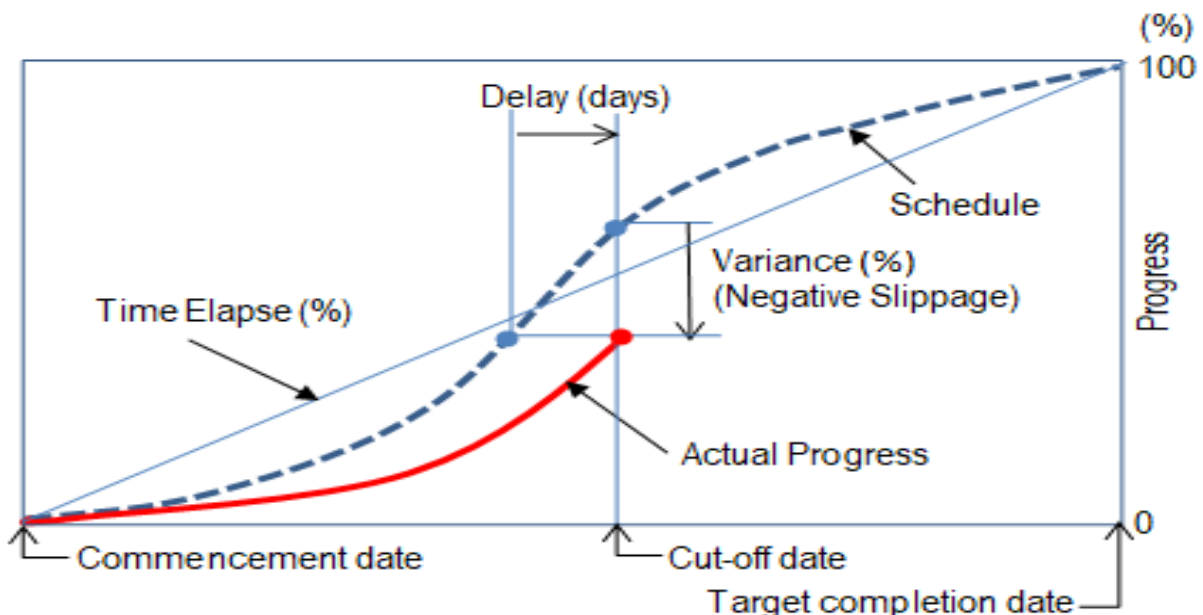
The monitoring on progress rate (%) basis is usually evaluated with an S-Curve. The S-Curve is a graphical representation of the cumulative progress plotted on the vertical axis against time on the horizontal axis, which is usually shown with a comparison between the scheduled and actual accomplishment. Hence, all the project stakeholders, especially the contractor and IWRD always demand to have these S-Curves in the progress reports as these help them to understand the project status. The preparation of S-Curve is summarized below.

Progress Control and Monitoring

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Actual progress should be calculated on the contract Schedule of Quantities (SOQ) based on the field inspection, which is indicated in percentage against the contract amount. The actual progress in percentage (%) should be compared with the scheduled progress. Referring to the prepared S-Curve, the delay in the works (schedule slippage shown in days) and variance of the progress (negative slippage, if it is minus) should always be noted by all the stakeholders.



Warning System and Measures in Case of Delay

Based on certain values of negative slippage, IWRD should warn the contractor and the necessary actions should be taken. The sample action is shown as below.

Warning Level	Condition	Action Required
Warning Level 1	<ul style="list-style-type: none">Negative slippage exceeds 10%	<ul style="list-style-type: none">Instruction by IWRD in the periodical meeting and/or in a letter.Instruction letter to the Project Manager of the contractor,
Warning Level 2	<ul style="list-style-type: none">Negative slippage exceeds 30%No improvement is observed/expectedCatch-up plan is not prepared or not realistic	<ul style="list-style-type: none">Show cause letter to the contractor issued by EEObtain contractor's explanationIssue direction to contractor by EE
Warning Level 3	<ul style="list-style-type: none">Negative slippage exceeds 50%No improvement is observed/expected after previous warning	<ul style="list-style-type: none">Project Management Meeting (PMM) organized at the Chief Engineer's Office, IWRD in AizawlFinal notice issued by EE (if decided by PMM) to the contractor to inform his intention or possibility of contract termination
Final decision by the CE		<ul style="list-style-type: none">Termination of the contract



Catch up Plan

In case of serious delay in the works, the contractor should prepare his revised construction schedule as per the instruction of IWRD to catch up the schedule. Generally, the following measures are required in order to catch up:

- Increase working group
- Increase working shift (2~3 working shift operation in a day)
- Review and improve material supply schedule in order to minimize idling of machinery and manpower.

However, night shift should be avoided as much as possible and if unavoidable, it should be carried out only under the supervision of IWRD official, on the condition that enough lighting system and safety measures are provided by the contractor. Catch-up plan shall be prepared in the following sequence:

- Confirm calculation of completed quantities of each work item, and estimate the remaining quantities of each work item.
- Estimate the workable days based on confirmed workable period (canal closure period and estimated rainy days).
- Consider most effective formation of working group based on estimated unit productivity of one working group.
- Estimate the required number of working groups and related equipment according to the available workable days.
- Prepare detailed construction time schedule for each work item at individual work sites (not SOQ basis) based on the above arrangement of working groups.
- Prepare schedule of manpower, equipment and material supply.
- Prepare revised bar chart, S-Curve and other schedule, and manpower.

The original bar chart should be revised according to the catch-up plan proposed by the contractor and approved by IWRD, on which both original and revised schedules should be shown for the purpose of comparison. (see figure below).



Measurement and Payment

The Contractor may submit a request for payment for the work accomplished at the time stipulated in condition of the contract. Such request for payment shall be verified and certified by the Engineer-in-charge, IWRD. The Engineer-in-Charge shall ascertain and determine by measurement, the value of work done in accordance with the contract.

All measurement of items shall be entered in Measurement Books so that a complete record is obtained for all works performed under the contract. All measurements and levels shall be taken jointly by the IWRD engineer and by the contractor from time to time during the progress of the work and such measurements shall be signed and dated by the Engineer-in-charge and the contractor or their representatives as token of their acceptance. If the contractor objects to any of the measurements recorded, a note shall be made to that effect with reason and signed by both the parties.

Except as otherwise stipulated in the contract, materials and equipment delivered on the site but not completely put in place shall not be included for payment.

Especially, the length of different diameter reinforcement bars including authorized spacer bars and overlaps, as actually (not more than specified in the drawings) used in the work, shall be measured to the nearest centimeter, and their weight calculated on the basis of standard weight given in the table below, while the quantity is estimated as below during the preparation of DPR.

Actual Measurement for Payment

Nominal Size (mm)	Cross sectional area (mm ²)	Mass per R.M (kg)
6	28.3	0.222
8	50.3	0.395
10	78.6	0.617
12	113.1	0.888
16	201.2	1.580

Ref. CPWD Specifications

Estimate during Preparation of DPR

Members	Requirement of steel per cum. of concrete
Foundation	100 kg
Columns	310 kg
Beams	270 kg
Slabs	100 kg
Stairs	120 kg
Fins, chajjas, etc.	80 kg

Wastage and unauthorized overlaps shall not be paid. Annealed steel wire required for binding or tack welding shall not be measured, its cost being already included in the rate of reinforcement.

The following shall be deducted from the certified gross amounts to be paid to the contractor as progress payment:

- Cumulative value of the work previously certified and paid for.
- Portion of the advance payment to be recouped
- Retention money in accordance with the conditions of contract.

Variation of the Works

The Engineer-in-charge shall make or obtain permission to make any variation of the form, quality or quantity of the works or any part thereof that may, in his opinion, be necessary and for that purpose, or if for any other reason it shall, in his opinion, be appropriate, he shall have the authority to instruct the contractor to do and the contractor shall do any of the following:

- increase or decrease the quantity of any work included in the contract,
- omit any such work,
- change the character or quality or kind of any such work,
- introduce new work items that are not included in the original contract,
- change the levels, lines, position and dimensions of any part of the works,
- execute additional work of any kind necessary for the completion of the works, and
- change any specified sequence or timing of construction of any part of the works.

Except for ordered variation in writing by the Engineer-in-charge, the contractor shall not alter any of the work. The power to sanction extra/substituted/deviated items will be as per the prevailing CPWD Manual.

All variations and any additions to the contract price shall be valued at the rates and prices set out in the original contract if the same shall be applicable. If the contract does not contain any rates or prices applicable to the varied work, the rates and prices in the contract shall be used as the basis for valuation so far as may be reasonable, failing which, suitable rates stated in the SOR shall be agreed upon between the Engineer-in charge and the contractor.

Time Extension

During the course of the warning to the contractor regarding serious delay in the works, the contractor reserves the right to claim an extension of the contract duration. If the reason of the delay given by the contractor is considered acceptable that it was beyond the control of the contractor, the duration of the time extension should be evaluated and approved in due course.

Reason of Delay Beyond the Control of the Contractor Extension Accepted	Reason of Delay Default of the Contractor Extension Not Accepted
<ul style="list-style-type: none">• Force majeure• Abnormal bad weather condition, heavy rainfall• Conflict with individual farmer on land acquisition, stopping work• Civil commotion, local commotion of workmen, strike or lockout affecting any of the trades employed on the work• Delay on the part of other contractors or tradesmen engaged by IWRD in executing work not forming part of the contract• Additional work• Delay in issuing variation order or submission of revised drawings	<ul style="list-style-type: none">• Poor management during construction work• Insufficient manpower.• Delay in material supply• Insufficient machinery/equipment• Insufficient running budget

In case additional work of any kind or other special circumstances of any kind whatsoever occur so as to fairly entitle the contractor to an extension of the contract time, the Engineer-in charge shall determine the amount of such extension.

If the time extension has been approved by the IWRD, the contractor should prepare/re-schedule milestones and construction time schedule appropriately for

the remaining work. It should be noted that in the event of an extension of the time for completion of the contract, the Engineer-in-charge would need to request an extension of the bank guarantee.

Contract Amendment

Contract amendment is the written documents that defines the amendment of the parties' roles, responsibilities, and detailed description of the work under the original contract such as drawings, specifications, procedures, any other conditions, etc, and is legally binding on the parties.

Amendment of the contract may be required to add provisions or modify the conditions of contract at any time but should be done before closing the contract, and the final amendment should be made according to the amended contract price. The amendment of contract includes any variation of the required works, addition and omission, extension of the contract period, intended completion date, additional pay item and unit price, contract amount, etc. In the amendment, all provisions of the original contract other than the amended parts shall remain in full force and effect.

The amendment comprises the followings:

- Amendment to the original contract.
- Schedule of Quantities if revised.
- Additional drawings, if needed.
- Referred letters and documents as above.

The amendment shall be effective subject to the following conditions:

- That it is signed by both parties, same signatories as the original contract.
- Effective date is specified.

The amendment can be established only by mutual agreement of both parties. If not agreed, the other may elect to terminate the agreement.

Field Inspection by IWRD and Stakeholders

After the construction works are completed, certain aspects of the works need to be assessed before it is handed over to WUA. The first action to be taken up is to conduct final inspection of the construction works by the stakeholders including the officers of IWRD (Executive Engineer, the Engineer-in-charge, or his representative), the beneficiaries, and the contractors.

This inspection should mainly focus on:

- Checking that all the works were constructed in conformity with the contract (drawings, specification, and conditions of the contract), guidelines, and site instructions given by IWRD,
- Checking the quality of structures (elevation, dimension, concrete quality, stability, crack, leakage, etc.),
- Checking whether the structure will be operational or not,
- Any defects in the structure, and
- Checking for any disturbances to nearby forest area, water source, dwellings, and other protected areas.

During inspection, farmers should be given awareness and knowledge regarding the different components and functions of the structures, and weak spots or the sections of the structure susceptible to damage. The operation and maintenance of the facilities should also be taught. If any defects are detected during inspection, they should be immediately reported to the higher officers of IWRD. The department should discuss the matter with the contractor for rectification before issuing the completion certificate and final payment or during the defects liability period.



Issue of the Completion Certificate and Handling Over of Facility

After inspection is completed, IWRD should issue the completion certificate to the contractor provided that the works have been completed satisfactorily and up to the standard. The certificate is a confirmation that the works were well executed under the guidance and instruction of IWRD and that the contractor employed is a reliable one.

On issuing the completion certificate, the facility is ready to be handed over to the WUA. Handing over of facility to WUA should be done by concerned IWRD officers in the presence of other officers of related departments, leaders of Farmers' Association and the Village Council members. Agreement should be made and signed by the officers as well as leaders of the WUA; this agreement will highlight the responsibilities and activities to be taken up by both WUA and IWRD regarding the operation and maintenance of irrigation facilities. (For details on the role of WUA and IWRD in the operation and maintenance of irrigation projects, please refer to the "Officer's Manual and Training Material for Strengthening of WUA for O&M of Irrigation Scheme".)

Defects Liability Period

After the completion certificate is issued, a defects liability period is provided to the contractor which is calculated from the completion date (date of entering in MB) as stipulated in the conditions of contract. During this period, the facilities should be operational. IWRD officers and WUA (farmers) should conduct regular site visits to check the working quality and inspect whether the structures are working at expected capacities. A thorough check should also be done for any damage or defect while the structure is in use. If any defects or damages are found in the structures or the structure fails due to the bad quality of the work within the defects liability period, the contractor is liable to return to the site and repair the defects.

The retention money shall be due for release upon final acceptance of the works on completion of repair and/or improvement works during the defects liability period. If the contractor has not corrected a defect within the time specified in the notice by IWRD, the IWRD shall assess the cost of having the defect corrected, and this cost would be deducted from the retention money.

In this provision, “defect” means any part of the works not completed in accordance with the contract including damages, collapse, and any structural failure due to the contractor’s faults, flaws, and deficiencies. However, the defects liability period usually does not include an obligation to repair defects which occur as a result of the following reasons:

- damages which occur due to the mistake in operation by users;
- damages which occur due to other reasons beyond the contractor’s responsibilities; and
- defects which occur as a result of wear and tear

Evaluation of Contractors' Performance

After the facility has been handed over to the beneficiaries for operation, IWRD officers should evaluate the work of the contractor based on the different information collected from the inspection during the construction work. Points may be awarded based on the criteria summarized below. Based on the cumulative points, the contractor can be given an award of recognition by the department on certain aspects of his good works. This will encourage the contractors to achieve better quality works in the future.

In case the evaluation shows poor quality of the works and management, the concerned contractors would be disqualified and dropped from the list of capable contractors.

This evaluation may be conducted based on different aspects like:

- Detailing of responsible engineer(s) stationed at the site
- Proper maintenance of construction time schedule, and timely completion of the works
- Quality of the works
- Efficient management of work flow
- Safety management practiced
- Environment and social considerations
- Compliance to instructions
- Labour management

Preparation of Completion Report

A completion report is a formal document of closing a project, which should be prepared even if the government and/or supporting agency does not indicate the obligation. The report should provide the process and actions undertaken by IWRD from the beginning to the end of the project implementation. This will reflect the results achieved through the project interventions. The main purposes of the report are to promote accountability, reflect on performance and elicit lessons learned, and to define an appropriate post-project strategy.

A well-managed project completion process is of key importance for identifying the ways and means to enhance the sustainability of project interventions. It provides all stakeholders with the opportunity to reflect on overall project performance and generate useful lessons learned from implementation.

The objectives, plan of work, and other items laid out in the DPR and the contract for construction have been completed, and the final task is to document the results of the project. The completion report responds to the request for information, and it explains how the plan of the work was carried out and what conclusions and recommendations can be drawn from the project.

The recommended contents of the report are summarized below:-

Contents of Completion Report

1. Outline of the project and summary of plan and design in DPR
2. Procurement of the contractor
 - Process of bidding
 - Results of bidding
 - Awarding and contract signing
3. Construction record
 - Contractor's program of works and actual accomplishment on S-Curve
 - Major contractual events
 - Time extension and suspension of the contract
 - Design modification during construction
 - Contract amendment
 - Completion and handing over to the community

- Activities during defects liability period and final acceptance
 - Quality control record
 - Final work quantity and cost
 - Record of payment to the contractor
4. Issues and action taken
5. Attachment
- Facility layout map (final)
 - Irrigation flow diagram
 - Inventory of canals and related facilities
 - As-built drawings
 - Photo album

Recording and Data Keeping

Managing records on a construction project is an essential activity that creates a framework for running project activities and procedures and for analysis, lessons learned, historical reviews, etc. It is the responsibility of the Engineer-in-charge, IWRD to ensure that every document, file and drawing is properly stored, secured, communicated, archived and updated.

As a process, project records to be managed are listed as the following items:

1. DPR including:
 - Project plan and design
 - Cropping information
 - Data on CCA and beneficiaries
2. Tender documents
3. Contract documents on general contract, and MOU on community contract
4. Project completion report, including:
 - Implementation record
 - As-built drawings
 - Inventory list of facilities
 - Financial statement
 - Photos
 - Fiscal statement and related accounting documents
 - Correspondences

ENVIRONMENT, SOCIAL HEALTH & SAFETY PLAN

(The contractor should modify the plan as required)

1. Name of Project :
2. Name of Work :
3. Tender No. :
4. ESHS Officer & Contact No. :

The ESHS Officer will be responsible for compliance of all the activities in the ESHS plan mentioned below. Monthly ESHS compliance report will be prepared and submitted to the Engineer-in-charge by last week of each month.

5. **Non-Permissible Activities:** Any construction material containing Asbestos will not be utilized.
6. **Construction & Demolition Waste Management Plan.**

Sl No	Anticipated waste material	Disposal site	Remarks
1	Uprooted vegetation		
2	Earthwork	<i>Top soil:</i>	
		<i>Remaining:</i>	
3	Broken bricks		
4	Empty cement bags		
5	Oil & Lubricant waste		
	...etc etc		

7. Construction Workers Camp Management Plan

Issues	Plan
Selection of camp site	
Facilities to be provided	
Hygiene and sanitation	
Arrangements for waste disposal	

8. Health Care and Safety Management Plan

(Example)

- i. Health and safety instructions will be given to workers by ESHS Officer before starting construction work.
- ii. First-aid box will be made available in the camp at all times. Workers will be taught how to use it.
- iii. Fire extinguisher will be provided in the camp and instruction will be given to workers regarding the purpose and usage.
- iv. In case of any eventuality that demands hospitalization, project vehicle will be used to transport patients to hospitals.

ESHS COMPLIANCE REPORT FOR THE MONTH OF				
Name of Project:				
Name of work:				
SL NO	Activity	Complied	If 'No', Reason for non-compliance	Remarks
1	Disposal of C&D Wastes to disposal site approved by Engineer-in-charge			
	i. Uprooted vegetation	Yes/No		
	ii. Earthwork	Yes/No		
	iii. Broken bricks	Yes/No		
	iv. Empty cement bags	Yes/No		
	v. Oil & lubricant wastes	Yes/No		
2	Workers camp management plan			
	i. Is it constructed away from community water source	Yes/No		
	ii. Is deforestation avoided?	Yes/No		
3	Facilities to be provided			
	i. Is drinking water available at all times?	Yes/No		
	ii. Are workers provided with bed rolls & mosquito nets?	Yes/No		
	iii. Is enough basic food items provided and stored?	Yes/No		
	iv. Are cooking utensils provided?	Yes/No		
	v. Is lighting facility provided?	Yes/No		
4	Hygiene and sanitation			
	i. Are bathing and washing facilities provided	Yes/No		
	ii. Is temporary drain constructed	Yes/No		
	iii. Is temporary latrine constructed	Yes/No		
5	Arrangements for camp waste disposal			
	i. Pit (1cum) is dug for disposal of kitchen and decomposable wastes	Yes/No		
	ii. Waste bin with lid is provided for collecting plastic wastes	Yes/No		
	iii. Are plastic wastes disposed to disposal site approved by Engineer-in-charge	Yes/No		
6	Health care and safety			
	i. Are workers given health & safety instructions?	Yes/No		
	ii. Is first-aid box provided?	Yes/No		
	iii. Is fire extinguisher provided?	Yes/No		
	iv. Is project vehicle made available for transport of patients?	Yes/No		
	v. Any eventuality that demand hospitalization	Yes/No	-	
Date of submission:		Name of EHS Officer:		
		Signature:		

Training of Engineers on Quality Control Measures in Construction Management

VARIETIES & GRADES

Cements produced in India confirm to Indian Standard Specifications issued by Bureau of Indian Standards (BIS), the national body for the formulation & regulation of Indian Standards.

Cements can be broadly classified in 3 types :

- ☞ Ordinary Portland Cement
- ☞ Blended Cement
- ☞ Special Cement

CEMENT

CEMENT

ORDINARY PORTLAND CEMENT (OPC)

- OPC - GRADE 33 - IS : 269 (1989)
- OPC - GRADE 43 - IS : 8112 (1989)
- OPC - GRADE 53 - IS : 12269 (1987)



CEMENT

BLENDED CEMENTS

- PORTLAND POZZOLANA CEMENT - IS 1489, PART I & II (1991)
- PORTLAND SLAG CEMENT - IS :455 (1989)
- MASONRY CEMENT - IS : 3466 (1967)



CEMENT

Where OPC and PPC can be used ?



Bridges



Water Tanks



Marine Structures



Industrial Structures



Dams n Canals



Bungalows

CEMENT

Quality tests for Cement



Select high quality cement.
Examine manufacturing date for ensuring freshness.



Store it properly.
Consume as early as possible.

CEMENT

Quality tests for Cement



Ensure 50 kg in each bag by random weightment. Lumps in bag, if any, shall be screened off before use.



Concrete should be cohesive. The Ball Test is a quick and an easy site testing method.

SAND

Types of SAND



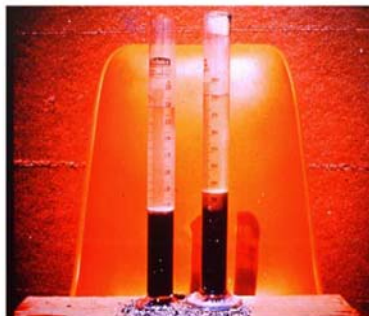
Sand should be surrounded by bricks while storing

- ☞ Fine sand (Used for filling)
- ☞ Medium sand (Best quality for Brick Masonry)
- ☞ Coarse sand (Filling, Stone masonry)

TESTS OF SAND

SAND

- ✓ Wet sand is taken in hand, the amount of clay and mud sticking to the palm determines its purity.
- ✓ Sand is poured into a glass of water and stirred with a rod, and is left for 24 hours. The amount of clay and mud settled on it should not exceed 7%.



AGGREGATE

TYPES OF AGGREGATE

Coarse Aggregate:

- > 4.75 mm
- Constitute the gravel and crushed stone



Coarse Aggregate Diameter > 4.75mm

Fine Aggregate:

- < 4.75 mm
- Constitute the natural sand or crushed stone.
- 35 to 45% by mass or volume of total aggregate



Fine Aggregate Diameter < 4.75mm

SIZES OF AGGREGATE

AGGREGATE

Generally in construction;

(Hand broken or Crusher broken)

- 0 to 6 mm
- 6 to 12.5 mm
- 20 mm down
- 25 mm
- 37.5 mm



AGGREGATE

QUALITY TESTING OF AGGREGATES

- ☛ If chips are regular or rounded then the strength is less but if irregular then strength is more.
- ☛ Porous stone or non-porous material to check ?
- ☛ Aggregates is poured into a glass of water and stirred with a rod, and is left for 24 hours. The amount of water soaked on it should not exceed 3 %.

Irregular shapes

Rounded



REINFORCEMENT

TYPES OF REINFORCEMENT BARS

The steel bars used in reinforcement cement concrete are called reinforcement bars or rebars. These are two types;

1. Plane steel bars
2. Tor steel bars

Plane steel bars;

- Round sections, which are made up of mild steel, medium tensile steel, or high yield tensile steel are used in reinforcement cement concrete.
- But the present trend in India is to go for tor steel bars.
- Plane steel bars also available in 5 mm to 32mm bars.

REINFORCEMENT

SIZES OF REINFORCEMENT BARS

- ✓ All finished steel bars for reinforced work should be neatly rolled to the dimension and weights as specified.
- ✓ This should be sound, free from cracks, surface flaws, laminations, rough, jagged and imperfect edges and other defects.
- ✓ The reinforcement shall be kept little high over the ground



REINFORCEMENT

QUALITIES OF REINFORCEMENT BARS

General precautions for steel bars in reinforcement:

- Steel bars are clear, free from loose mill scales, dust and loose rust coats of paints, oil or other coatings which may destroy or reduce bond strength.
- Steel bars should be stored in such a way as to avoid distortion and to prevent deterioration and corrosion.
- Steel bars should not be clean by oily substance to remove the rust.
- The bar is bent correctly and accurately to the size and shape as shown in drawings.
- If possible, the bar of full length is used.
- Overlapping bars do not touch each other and these should be kept apart with concrete.
- The overlap if given should be staggered.
- The cranks in the bar at the end should be kept in position by using spots.
- The steel bars should not be disturbed while lying cements concrete.
- Required cover under steel bars should be given before laying the cement concrete.
- No over lap is given in the bar having a diameter more than 36 mm, if required, the bar should be welded.

REINFORCEMENT

QUALITIES OF REINFORCEMENT BARS

Self weight of steel bars per meter

Sr.No.	Dia of steel bar	Weight per meter	
		Round Bar	Square Bar
a	6 mm	0.22 Kg	0.28 Kg
b	8 mm	0.39 Kg	0.50 Kg
c	10 mm	0.62 Kg	0.78 Kg
d	12 mm	0.89 Kg	1.13 Kg
e	16 mm	1.58 Kg	2.01 Kg
f	20 mm	2.46 Kg	3.14 Kg
g	25 mm	3.85 Kg	4.91 Kg
h	28 mm	4.83 Kg	6.15 Kg
i	32 mm	6.31 Kg	8.04 Kg
j	36 mm	7.99 Kg	10.17 Kg
k	40 mm	9.86 Kg	12.56 Kg
l	45 mm	12.49 Kg	15.90 Kg
m	50 mm	15.41 Kg	19.62 Kg

BRICK

TYPES OF BRICK

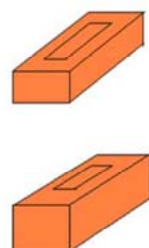
1. Burnt bricks local made
2. Mud blocks unburnt, sun-dried
3. Engineering bricks - 1st/2nd class
4. Concrete blocks, solid and hollow
5. Fly-ash clay bricks - mud blocks



BRICK

SIZES OF BRICK AND ITS USES

1. Nominal size - 19 x 9 x 9 cm
2. Modular size - 20 x 10 x 10 cm
3. One brick (250mm)
4. Half brick (125mm)
5. One half brick (375mm)



BRICK

QUALITIES OF A GOOD BRICK

- ✓ The Colour of the burnt brick should be reddish and uniform
- ✓ When soaked in water for 24 hours it should not absorb water more than 20% of its weight.
- ✓ A clear metallic ringing sound should come when two bricks strike each other.
- ✓ It should not break when dropped from a height of 3 ft
- ✓ Size of all bricks should be same.
- ✓ Edges should be sharp, straight and in right angle
- ✓ The breakage should not exceed 5%.
- ✓ The brick should not break when thrown on their flat face from a height of 90 cm.



WATER

QUALITIES OF WATER

- Never add water without measuring.
- A marked bucket is a simplest measuring tool.
- Never use salty/ drain/ contaminated water.
- Water should be potable (drinkable).
- pH value should be approximately 7 but never less than 7



CONCRETE

TYPES OF CONCRETE

- PCC – PLAIN CEMENT CONCRETE
- RCC – REINFORCED CEMENT CONCRETE

CONCRETE

QUALITIES OF CONCRETE



Concrete should not be thrown from height



Concrete should be placed from little height

Water Cement Ratio for Concrete

Grade of concrete	Proportion	Quantity of cement in Kg	Aggregate in Kg	Water in Litre
M7.5	1:4:8	50 kg	625 Kg	45
M10	1:3:6	50 kg	480 Kg	34
M15	1:2:4	50 kg	330 Kg	32
M20	1:1.5:3	50 kg	250 Kg	30

Importance of compaction in concrete

5% voids	: 30 % less strength
10% voids	: 60 % less strength
25% voids	: 90 % less strength

CONCRETE

QUALITIES OF CONCRETE

Clear cover to main reinforcement for RCC members

For mild conditions

Footing	: 50 mm
Columns	: 40 mm
Lintel, stairs and slab	: 20 mm
Beams	: 30 mm

CONCRETE

QUALITIES OF CONCRETE

Slump test :

- to measure liquidity of fresh concrete.
- to determine the workability of concrete.

The standard slump test for each concrete type is

- 10 cm for Type A,
- 8 cm for type B and
- 6 cm for Type C.

This is mandatory for each concrete casting day.



CONCRETE

QUALITIES OF CONCRETE



Shuttering props should always be vertical and braced properly in the horizontal direction. The centering plates should be placed without any gap to prevent slurry leakage. Avoid use of binding wires to tie shutters, always use wedges and nails.



Always use good quality bricks. Bricks should be soaked first and then surface dried before use.

CONCRETE

QUALITIES OF CONCRETE



Concrete should not be mixed on the ground. Avoid mixing by hand as far as possible. In case of hand mixing, 10% extra cement is to be added.



Always use the correct boxes for measuring sand and stone chips.

CONCRETE

QUALITIES OF CONCRETE



Always use good quality water. Concrete should be made workable. Mixing water should be carefully determined and should not be indiscriminately changed without consulting the engineer.



Don't dump cement bags on the ground. In case of only half bag use, add 25 kg cement by weightage.

CONCRETE

QUALITIES OF CONCRETE



Clay balls in sand, if any, shall be eliminated by screening. Size of the screen shall not be more than 5mm.



If clay / silt is more than 5 %, then sand should be washed before use. If sand is moist, proportionate quantity of sand should be added based on bulking Test

CONCRETE

QUALITIES OF CONCRETE



Different size aggregates should be stored in separate compartments.



Place concrete in front of the vibrator to ensure good compaction.

CONCRETE

QUALITIES OF CONCRETE



Ensure clearing of mixer drum before concrete mixing. Buttering has to be done before the first mix is fed. Rectify the dents in the drum before and repair the mixing blades.



For slab vibration – rammer alone is not sufficient – should be supplemented with a vibrator.

CONCRETE

QUALITIES OF CONCRETE



All types of aggregates shall not be stored together. Cubic shaped aggregates preferable. Shall be free of dust.



Make sure you are using the right vibrator. Make sure there is adequate space between the rebars for inserting the vibrator.

CONCRETE

QUALITIES OF CONCRETE



All joints shall be filled properly with mortar. Mortar should be placed all around the bricks. The vertical joint should always be staggered.



Ensure curing for concrete brickwork and plastering. Always hack/make rough and moisten the surface before plastering.



Use mortar mix should not be made in large quantities. Use mortar should be consumed within 30 minutes after mixing.

CONCRETE

QUALITIES OF CONCRETE

Cube test : Compressive strength of concrete done by cube test which provides whether concreting has been done properly or not.

1. Specimen
6 cubes of 15 cm size Mix. M15 or above

2. Mixing of Concrete for Cube Test
Mix the concrete either by hand or in a laboratory batch mixer

3. Sampling of Cubes for Test
Clean the moulds and apply oil and Fill the concrete in the moulds in layers and compacting

4. Curing of Cubes
The test specimens are stored in moist air for 24 hours and kept submerged in clear fresh water until taken out prior to test.



Cubical moulds of size 15cm x 15cm x 15cm

BRICK MASONRY

QUALITIES OF BRICK MASONRY

- Brick should be kept in a water tub for 24 hrs before using.
- Joint should not be more than 10mm.
- Joint should not be continuous.
- Water should not be poured on the masonry during laying.
- Frogs on the brick should be placed upwards and covered with mortar when raising the subsequent layer.
- Mortar should be used within 30 minutes of mixing.
- Gap should not remain in between bricks.
- Curing must be done for minimum 7 days and the wall kept moist always.

BRICK MASONRY

QUALITIES OF BRICK MASONRY

- 1 : One brick length
- 1/2 : Half brick length
- 1/4 : Quarter of a brick length
- 3/4 : Three quarters of a brick length
- 3 : Vertical reinforcement bars with concrete (1:1/2:3 nominal mix) or 1:3 mortar filling in pocket

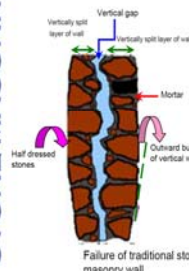
PROPORTION OF BRICK MASONRY

250 mm thick wall (10" wall) = 1:6

125 mm thick wall (5" wall) = 1:3

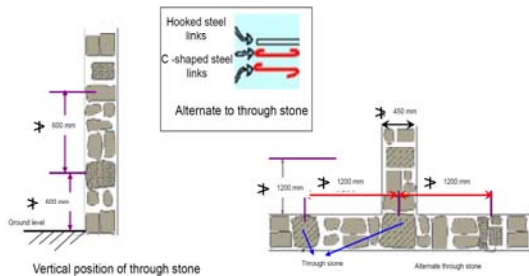
STONE MASONRY

QUALITIES OF STONE MASONRY



STONE MASONRY

QUALITIES OF STONE MASONRY

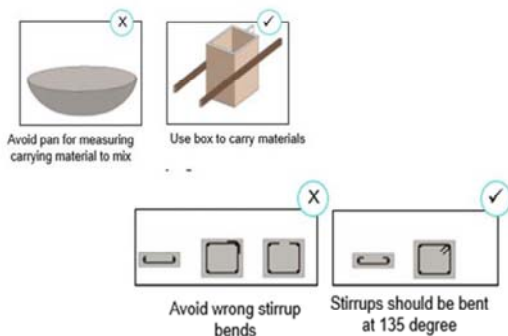


CURING

QUALITIES

- The minimum periods for curing of concrete is 14 days and it should be always moist.
- Brick Masonry for 7 days
- Stone Masonry for 7 days
- Brick / Stone Plastering for 7 days/

DO'S AND DON'TS



DO'S AND DON'TS

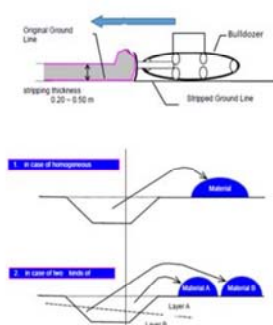


STRIPPING OF TOP SOIL

Construction materials in Earthen Embankment works

Depth of stripping of top soil carefully checked into maximum of 20cm to 50 cm and kept in a different places for further use

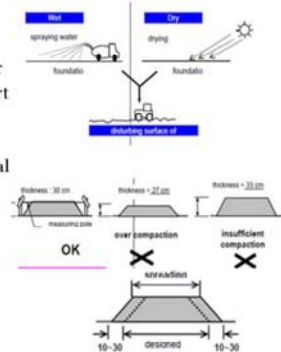
Different kind of materials needs to be kept separately for usability of soil in different purposes during filling or other uses, as shown alongside.



TREATMENT OF FOUNDATION

Construction materials in Earthen Embankment works

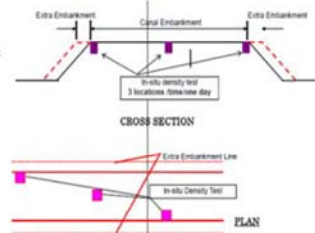
- Foundation is too dry, water to be sprayed
 - Foundation is too wet, drying or stripping shall be made for the part
 - Foundation surface shall be disturbed for securing a sufficient contact with embankment material
- Spreading **thickness** for compaction of soil shall be normally 30cm.
 - Spreading **width** shall be 10 ~ 30cm wider than the designed one.



IN-SITU DENSITY TEST

Testing of Compaction in Earthen Embankment

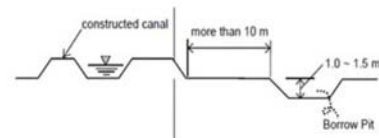
- In-situ density test shall be under taken to confirm the compaction degree of the embankment.
- It Can be done by sand compaction method.
- It can be carried out about 200mt of every compaction or every 500 cum of earthwork



BORROW-PIT

Necessity of borrow-pit

- In case of borrow-pit selected along the canal.
- Distance between canal and borrow pit must be more than 10mt.
- Depth of borrow-pit shall be 1.0 to 1.5 mt.
- Ownership of the land or Govt. land needs to be taken up
- Environment criteria needs to be followed.
- Proper documentation needs to be done prior to use borrow-pit.

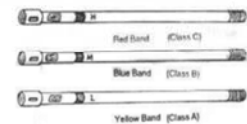


Galvanized Iron Pipe (G.I) in Water Supply Systems

- G.I pipes are made of mild steel sheet.
- G.I pipe is used to supply water, gas or any other liquid inside the building.
- These types of pipes are prepared from 12mm (0.5 inches) to 15 cm (6 inches) in diameter.
- Available in 6 meters (20 feet) length.
- The pipe is saved from rusting.
- The average age of this pipe is 10 years.
- It can be joined easily, cutting, threading, and bending.
- Joined with the help of a socket.
- These pipes are light-weighted and cheap.
- Acidic and alkaline waters affect these pipes badly

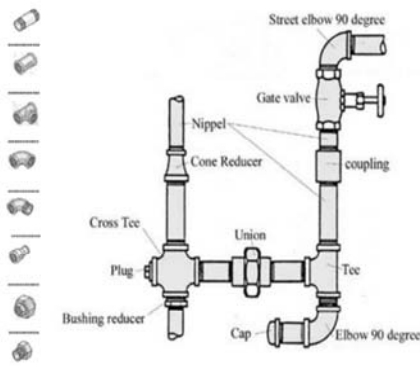
Class identification mark for G.I.Pipes

SIZE	DIAMETER OF PIPES											
	15	20	25	32	40	50	65	80	100	125	150	
In mm	15	20	25	32	40	50	65	80	100	125	150	
In inch	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	5	6	
TYPE	WEIGHT OF G.I. PIPES (KG/METRE LENGTH)											
	1.01	1.48	2.10	2.72	3.40	4.32	6.10	7.20	10.48	---	---	
Light class L mark (yellow strip)	1.01	1.48	2.10	2.72	3.40	4.32	6.10	7.20	10.48	---	---	
Medium class M mark (blue strip)	1.28	1.65	2.54	3.27	3.76	5.31	6.81	8.85	12.68	17.04	20.20	
Heavy class H mark (red strip)	1.51	1.97	3.08	3.97	4.58	6.38	8.20	10.51	14.97	18.64	22.20	



Pipe Connection

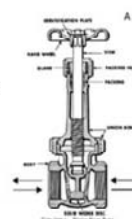
Screw and socket joints are mostly applied in GI pipes



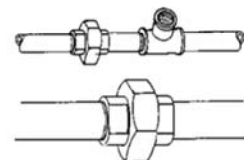
Valves and Union

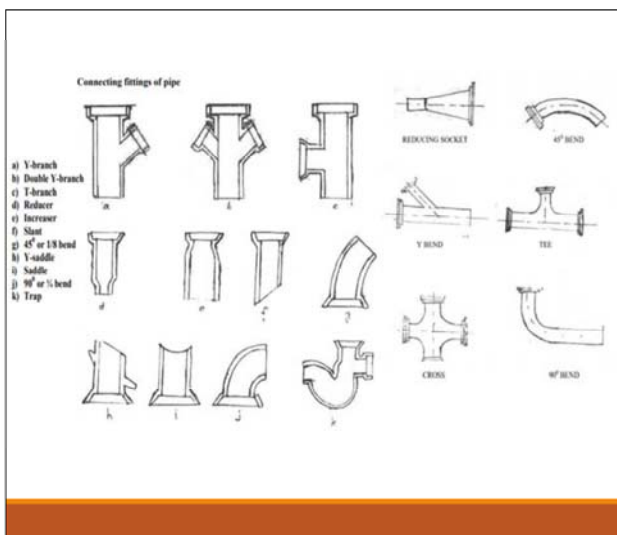
To accomplish these methods of control over the fluids within the piping system, pipe fitters install the following types of valves.

- Gate valve
- Globe valve
- Ball valve
- Check valves
- Angle valve



A union is a device used to connect pipes. It usually consists of three pieces:





Laying of GI pipe

Precautions

- Ensure that burrs around the pipes are removed before threading.
- Use oil or lubrication during threading.
- Rotate the die stock clockwise and anticlockwise while cutting threads on the pipe, so as to remove chips from the die.
- The threaded portion should not be cut with a pipe cutter; always use a hacksaw for this.

Care during work :

- Pipes should be cut to the required length.
- The cotton thread should be wrapped on threaded portion of the pipe.
- The packing material should be wrapped around the joint.
- The pipe should be properly aligned.
- Zinc oxide should be applied gently.

SAFETY

SAFETY DURING CONSTRUCTION

- Fencing, Railings of 90cm to be provided by the contractor if the height more than 3.6m, 12ft. Or above the GF.
- Precautions from electrical equipment
- Excavation and trenching – ladder shall be provided beyond 1 mt. and a step of 30cm for additional depth.
- Roads and open areas in the working areas needs to closed or suitable protected.
- All practical steps to prevent danger from risk of fire, explosion, flooding etc.

SAFETY

SAFETY DURING CONSTRUCTION

- Personal Safety equipment like helmet, fluorescent stripped jacket, fluorescent light marked on the excavation site etc. needs to be verified from the engineer in charge.
- Work place means more than 20mpersons at site.
- First-aid box facilities with red cross symbol kept for easy visible. (list enclosed in page no. 34 of item rate tender & contract agreement CPWD, form – 8.
- Drinking water facilities
- Washing facilities separately for male and female
- Latrines and Urinals, one latrine for 25 persons (Separate for male and female)

