PART-II

MONITORING AND EVALUATION (M&E) MANUAL ON CONSTRUCTION WORKS (Roads, Bridges and Culverts)

Prepared by: Nisar Ahmad Khan

Monitoring and Evaluation Consultant, SMECI Project

November, 2015

Table of Contents

ACKNOWLEDGEMENTS

I like to convey my heartfelt thanks and sincere gratitude to a number of people who help me in completing this guidebook/manual. First, words cannot convey my gratitude to Md. Shahid Ullah Khandaker, Secretary, IMED, Ministry of Planning and Md. Habibul Islam, Project Director, SMECI Project, IMED whose untiring patience and attention to detail enabled me to complete this manual and get it into its present form. Despite their busy schedule they gave unstintingly of their time. Apart from the administrative side, the honour and care I received from them were invaluable, which I deeply acknowledge. I would extend my thanks and gratitude to the other officials of IMED and SMECI Project as well for allowing me to formulate this document time to time. Needless to say, without the cooperation of my fellow colleague Mr. Javed, Mr. Raihan, Mr. Rahman, Mr. sanjoy and Shahina Sultana the study would have been impossible. I feel honored to express my deep sense of gratitude to all the stakeholders for their cordial response and cooperation. I also thank them most sincerely for the hours they spent talking to us and the hospitality they offered. I am extremely grateful to Md. Sefaul Alam, Director General (Addl. Secretary), Communication Sector of IMED and his officers Engr. Momit and Engr. Ashraf for going through the documents and help in improving the technical aspect of the manual. Last but not the least, I am thankful to all the authors from home and abroad whose publications have helped me to design my manual more scientifically and with strong foundation. All limitations within this document are absolutely mine and I am solely responsible for errors and omissions in this manual.

EXECUTIVE SUMMARY

The role of IMED was limited to only monitoring of projects till 1982 when project evaluation responsibility was added to its portfolio. IMED made a humble effort in this direction by initially evaluating few completed projects. Within a short period, it started evaluating all the completed projects during a particular fiscal year. Of late, it has started outsourcing consultants every year to carry out evaluation of few important completed projects/programs and this policy is continuing till date.

Encadrement of IMED's posts in 1982 in the BCS Economic Cadre is considered as a milestone, when its door was opened up with an objective to bring more agility and dynamism in its function through continuous induction of new blood in the system. IMED's job being a bit different than the job of the other Ministries and Divisions, it demands a bit different training and attitude to accomplish it professionally. Monitoring and Evaluation being two very important functions of IMED, each one of it requires special attention and treatment.

So long, on the basis of 'learning by doing', newly posted or recruited officers have been carrying out their responsibilities of monitoring and evaluation. Of course, a small 05 page inspection guideline followed by a 06 page format of Project Inspection Report was prepared in 1995 and was practiced till 2004 when Project Inspection Report format was revised and reduced to a 02 page format and was named as IMED 06/2003. Both these guidelines contain number of instructions to the intending field inspecting officials. These instructions cover almost all aspects of project activities. It directs only what to be inspected, and not how to be inspected and check quality of construction work. Therefore, necessity of a comprehensive manual/guideline on monitoring & evaluation is felt by everybody including the newcomers in the IMED. To facilitate and enhance skill of the officers and to strengthen the capability of the organization, Monitoring & Evaluation Manual for Civil Works (Buildings, Roads, Bridges and Culverts) is prepared. The manual consists of two parts. Part-I relates to 'Building' construction whereas Part-II deals with construction of 'Roads, Bridges and Culverts'.

The manual is based on less theoretical deliberations and more practical oriented questions in the form of checklists on various aspects of project implementation. The checklists are supposed to lessen the burden of inspecting officials of going through various documents like DPP/TPP, procurement etc. this will help save valuable time and concentrate more on collecting useful data/information from the field.

There are as many as 28 Checklists (Part-I contains 23 nos. and Part- II contains 5 nos.) in this manual. Some are quite elaborate and some are short. These checklists are basically divided into 2 categories. One category relates to the DPP/TPP and Public Procurement Rules and Acts and the others belong to quality checks for civil construction work in the field. As many of the checklists of Part-I cover the construction areas of the Part-II, these are not annexed with Part-II of the manual.

The checklists in the form of questionnaires are given for the purpose of strengthening an inquisitiveness related to the technical subject and also develop confidence in oneself. The questionnaires will help know and learn the technicalities involved in checking the quality and workmanship in the construction works.

Delay in procurement of goods, works and services is nationally identified as a major cause in project execution. To overcome the situation, government, with the assistance of the World Bank has initiated many steps through CPTU of IMED. One of them being, developing PPA-2006 and PPR-2008. Recently CPTU has developed 45 key indicators for monitoring procurement contracts of few selected organizations for monitoring their procurement performances.

However, the Consultant has developed a comprehensive checklists for procurement of construction works appended as **Annexure**-3 in the manual, where 45 key indicators mentioned in the above paragraph have also been taken care of. This Annexure will help IMED officials to analyse various contracts thoroughly, pin point specific steps where inordinate delays have occurred and suggest measures to contain them effectively.

Checklists of the manual are quite exhaustive and have covered almost all areas of construction that an IMED official would be interested to look into.

ABBREVIATION AND ACRONYMS

AA	**Approving Authority**
ACV	**Aggregate Crushing Value**
BCR	**Benefit Cost Ratio**
BCS	**Bangladesh Civil Service**
C.C.	**Cement Concrete**
C.B.R. Test	**California Bearing Ratio Test**
CONTASA	**Convertible Taka Special Account**
CPTU	**Central Procurement Technical Unit**
DOSA	**Dollar Special Account**
DP	**Development Partner**
DoFP	**Delegation of Financial Power**
DPP	**Development Project Proforma**
ECNEC	**Executive Committee for National Economic Council**
EOI	**Expression of Interest**
FDD	**Field Dry Density**
GCC	**General Conditions of Contract**
HOPE	**Head of Procuring Entity**
HRD	**Human Resource Development**
IFB	**Invitation for BID**
IFT	**Invitation for Tender**
IMED	**Implementation Monitoring and Evaluation Division**
IRR	**Internal Rate of Return**
LD	**Liquidated Damage**
LOI	**Letter of Intent**
LTM	**Letter Tender Method**
MDD	**Maximum Dry Density**
MDG	**Millennium Development Goal**
M&E	**Monitoring and Evaluation**
NA	**Not Applicable**
NOA	**Number of Application**

NPV	**Net Present Value**
NEC	**National Economic Council**
OMC	**Optimum Moisture Content**
OTM	**Open Tender Method**
PCC	**Particular Conditions of Contract**
PC Girder	**Pre-stressed Concrete Girder**
PE	**Procuring Entity / Project Engineer**
PEC	**Project Evaluation Committee**
PIB	**Project Implementation Bureau**
PO	**Purchase Order**
PPA	**Public Procurement Act**
PPR	**Public Procurement Rules**
PIC	**Project Implementation Committee**
PRS	**Poverty Reduction Strategy**
PWD	**Public Works Department**
RHD	**Roads and Highways Department**
R.C.C.	**Reinforcement Cement concrete**
REOI	**Request for Expression of Interest**
RPA	**Reimbursable Project Aid**
RFP	**Request for Proposal**
PSC	**Project Steering Committee**
SAFE	**Special Account for Foreign Exchange**
SMECI	**Strengthening Monitoring and Evaluation Capabilities of IMED**
STD	**Standard Tender Document**
SPD	**Standard Prequalification Document**
SRFQ	**Standard Request for Quotation**
TFV	**Ten Percent Fine Value**
TEC	**Tender Evaluation Committee**
TOC	**Tender Opening Committee**
TPP	**Technical Project Proforma**
TEC	**Technical Evaluation Committee**

1. Background:

As background to the work an overview of the existing system of project planning and approval, monitoring and evaluation in Bangladesh is given in the diagram below that in general illustrates the main steps of the project cycle. Under this study 5th and 7th stage of the project cycle, namely 'Project Monitoring/Ongoing Evaluation and Post-Project Evaluation' is covered.

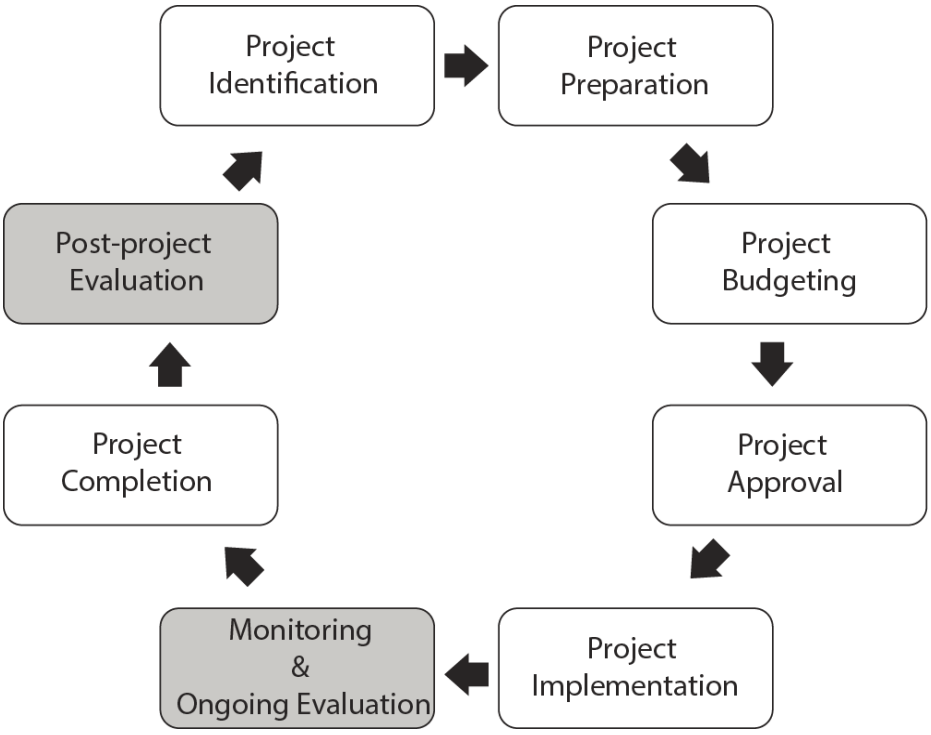


Fig. **Project Cycle**

1.1 Monitoring is defined as collection of data prior to and during the project implementation. These data, when analyzed, pinpoint progress or constraints as early as possible, allowing project managers to adjust project activities as needed. It also provides basis for undertaking evaluation.

The primary objectives of monitoring are to:

- Reveal if there is any impending problem to avoid disaster/delay;

- Assess the progress of the project with respect to the proposed timeline;
- Make necessary adjustments in resources, if necessary;
- Ensure quality of the ongoing work;
- Learn weakness and strength of the project management.
- Redesign or readjust project implementation strategies or project components to achieve desired objective.

1.2 Evaluation is defined as a structured process of assessing the success of a project in meeting its goal and to reflect on the lessons learned. It is carried out mostly at the end of a project work. Evaluation is not just about demonstrating success, it is also about learning why things went wrong. As such, identifying and learning from mistakes is one of the key aspects of evaluation.

The primary objectives of evaluation are to:

- Understand how the project has achieved its intended purpose, or why it may not have done so;
- Identify how efficient the project was in converting resources into activities, objectives and goals;
- Assess how sustainable and meaningful the project was;
- Inform decision-makers on how to build on or improve future projects.

The key difference between monitoring and evaluation is that evaluation is about placing a value judgment on the information gathered during a project, including the monitoring data. The assessment of a project's success (its evaluation) can be different based on whose value judgment is used. For example, a project manager's evaluation may be different to that of the project's participants, or other stakeholders.

2. Why is monitoring and evaluation important?

Monitoring and evaluation are critical tools for identifying and documenting successful projects and approaches and tracking their progress. This is especially more relevant and essential in resource poor countries like Bangladesh, where difficult decisions need to be made with respect to resource allocation priorities.

At the program level, the purpose of monitoring and evaluation is to track implementation and outputs systematically. Monitoring and evaluation forms the basis for modification and interventions and assessing the quality of work done.
Monitoring and evaluation can be used to demonstrate whether project has achieved the expected outcomes or not. It is essential in helping managers, planners, implementers, policy makers and funding agencies acquire the information and generate informed decisions about project implementation.

Monitoring and evaluation helps identify the most efficient use of resources and provide the necessary information to guide strategic planning, design and implementation of projects, and to allocate, and re-allocate resources in better ways.

3. Monitoring and Evaluation practice in Bangladesh:

Project Implementation Bureau (PIB) was created in 1975 through an executive order as a central project monitoring organization of the Government of Bangladesh. The PIB latter upgraded, renamed Implementation Monitoring and Evaluation Division (IMED) and was reorganized in 1982 to perform its function in a better way.
In 1986, Terminal Evaluation of completed projects was started by the IMED. Impact Evaluation activity was initiated with the attachment of Population Development and Evaluation Unit (PDEU) (Before it was placed under IMED, it was functioning as a project in the Planning Commission to carry out evaluation study of Health Sector programs) to the IMED in 1992.
Initially, project monitoring activities were mostly limited to financial performance reporting of projects. Although, physical progress reporting formats were also in place, IMED's data analysis activities and reports were limited mostly to observations. The reports based on those observations were prepared from (project) reports received from the ministries/agencies.

According to The Rules of Business of the government allocated the following functions or activities to the IMED:

- Monitoring and Evaluation of the implementation of development projects included in the Annual Development Program.

- Collection and compilation of project-wise data for preparing quarterly, annual and periodical progress reports for information of the President, NEC, ECNEC, Ministries and other concerned.
- Rendering such advisory or consultancy services to Ministries/Agencies concerned on implementation of projects as and when necessary.
- **Field inspection** of projects for on the spot verification of implementation status and such other Co-ordination works as may be necessary for the removal of implementation problems, if any, with the assistance of related Ministries/Agencies.
- Submission of project inspection reports to the President and Ministers concerned when attention at such levels are considered necessary.
- Matters relating to Central Procurement Technical Unit (CPTU).
- Matters relating to The Public Procurement Rules (PPR), 2008.
- Such other functions as may be assigned to the Division by the Prime Minister from time to time.

4. Emphasis on field/ site inspection:

Field inspection is one of the important tools of monitoring and evaluation, and that is being carried out by the IMED in Bangladesh with the available resources. Field inspection of the projects is one of the duties and responsibilities of the IMED enshrined in its Rules of Business. And it is being religiously executed by the organization from its very beginning to fulfil its obligation.

Emphasis given on the field inspection by the IMED can be understood by the fact that every officer of the organization is required to visit at least 3 projects every month and submit its inspection reports to the government for necessary action. This practice was made mandatory for every officer, including the DGs through an internal order and that is being followed by the organization for about 25 years.

IMED also involves itself in investigative inspection reporting, whenever and wherever it is necessary or it is desired by the higher authority to do so for the benefit of the project implementation.

5. Site inspection of Civil Works (RHD) related projects:

Field inspection gives an on the spot impression of project performance in its implementation phase. Since most of the investment projects have civil construction/ physical work component, the overall physical progress of work of any project can only be assessed properly through site visits. Site visits gives an opportunity to see whether the works are being carried out as per the approved plan document or there are deviations from the approved DPP. Besides, the rate of progress of work vis-a-vis the utilization of funds can also be assessed as to whether there are possibility of time and cost overruns. Through project inspection early forecast of the likely problems/hazards in the implementation phase can be made in advance and the remedial/corrective measures can be suggested.

Inspection and quality assurance of project implementation is the ultimate responsibility of the respective Ministry/Agency, though it is contractor's responsibility to guarantee quality of works as per terms of the contract. However, in order to have an impartial/unbiased view of the project performance inspection by the independent and higher body like IMED becomes pertinent. Field inspection gives an opportunity to see whether the works are being carried out as per the approved plan and design standards/specifications or there are deviations from the approved DPP. Besides the rate of progress of work vis-a-vis the utilization of funds can also be assessed as to whether there are possibility of time and cost overruns. These findings and recommendations form the core of the report.

There was a time when all the construction materials (like bricks cement, MS rod, sanitary fittings etc.) used to be supplied by the Roads and Highways Department (RHD) and the contractor has to take delivery of the materials from the store, carry it to specific site/s and complete the job in time. This practice was inherited from pre-independence days. But in late seventies, the flaw in the whole system was detected by an investigating teams constituted by the government. It was revealed that different construction materials and construction related equipment worth millions of Taka were lying in different RHD stores scattered all over Bangladesh. Some of the equipment and materials were even

continuing in the inventory of the store from Pakistan days. In some cases these materials and equipment were purchased to block funds allocated to the departments each Fiscal Year. This led to corruption and misuse of fund as well.

However, this position changed dramatically after revelation and government decided to put the responsibility of supplying the needed construction materials and equipment, for constructing roads and other civil works etc., on the shoulder of the contractor, leaving only the supervisory role to be played by the indenting agency. In short, the agency required to look intensely to ensure quality of material supplied by the contractor and supervise the construction work to ensure quality of work done by him (the contractor) as per specifications of the contract and also determine its completion within the specified time frame.

5.1 Attitude/approach of the inspector:

The inspecting officer may or may not be an engineer but the person sitting in front of him/her (Project Director) probably is; who is also likely to be senior in age and is supposed to know his job well. Therefore, approach of the visiting official has to be nice, positive and friendly with him. The visitor should not hurt him by his behavior. Because an inspector needs his/her office's 100% cooperation for collecting project information from the field. His/her non-cooperation may lead to unproductive visit, resulting in wastage of time, money and energy. Achievement of project's target is attributed to a team efforts and not to an individual, therefore a Project Director (PD) alone should not be put in the dock for failure to achieve the target of project. A Project Director does not live in isolation. He does not have absolute control on the entire risk and assumptions of the project activities.

An inspector should encourage PD to speak freely about the impediments project is encountering in its implementation. Negative attitude of an inspector towards PD may discourage PD to divulge any information that may, in his perception, harm him or his superior in hierarchy. In short, the atmosphere of collecting information from the field should be kept lively and cool to the extent it is possible from inspecting official's side.

As this manual/guideline deals with the highly technical engineering subjects, it would be advisable to IMED officials in general, whether engineer or non-engineer, to avoid

entering into debate or arguments on the matter of ‘design’, whether it is a building design or bridge design or any other structural design. It is a specialized area and the matter should always be left to those who have specialization in the subject. Debate or arguments on the subject may not be helpful rather it can prove to be counterproductive.

6. M & E manual for civil works:

This M&E manual is a reference document which provides— step-by-step guidance on how to perform a specific task. It contains many sets of instructions containing DOs and DON’Ts. This M&E manual includes specific steps/ instructions to be followed by the inspecting/investigating officials of the IMED.

The purpose of the manual is as follows:

- To provide an operational framework for achieving the IMED’s M&E goals.
- To explain its working procedures
- To provide clear inspection/investigation guidance for the IMED’s officials
- To establish standard internal reporting system
- To improve quality of project monitoring and evaluation
- To ensure consistency in M&E within the sectors/sub-sectors
- To enhance inspection skill of the IMED’s official
- To improve quality of reporting.

This manual will require periodic updating for keeping pace with the development strategy of the government as well as the monitoring and evaluation policy of the IMED.

7. Preparation for project inspection by using M& E Manual:

Before embarking on project inspection a number of preparatory works are necessary to be taken to make it more effective and meaningful. In brief, these steps are:

- Having knowledge about the stages of construction of a roads, bridges and culverts will be helpful in understanding the project activities and it’s efficient management.

- Holding a pre-inspection meeting with the Project Director/Project Management, preferably in the IMED, to get an overall impression of the project progress and the impediments centering round the project implementation.
- Preparing inspection schedule in consultation with the project officials, so that inspection is completed within a reasonable time period.
- Studying yearly, quarterly and monthly reports (by using IMED's 01/2003, 02/2003, 03/2003 , 04/2003 and 05/2003 formats or newly developed two formats, 2015) of the project received in the IMED and filling in part of the inspection report with static data/information before going to the field or by using online PMIS.
- Studying Development Project Proforma (DPP)
- Studying procurement plan provided in the DPP in the light of PPA-2006 and PPR-2008

8. Inspection of Roads, Bridges and Culverts:

Road is constructed on the earthen embankment. Earth is compacted in layers and raised to a specified height. On the top of the embankment pavement is constructed for movement of the traffic. The lower part of the pavement is called sub-grade. On this sub-grade two or more layers of base Course are constructed as per requirement of the design. Surface Course is done on this Base Course. On both sides of the pavement naked surface used by the pedestrians or light transports is called shoulder. As per design requirement every embankment has slopes on its both sides. At the end of the slope earth is specially treated to ensure durability of the embankment. This portion is known as 'Berm'. From the middle of the road, pavement has slopes on both sides. This slope is known as 'Camber' or 'Cross fall'. Camber is maintained as per design requirement, and it helps drain out rain water quickly and protect the road from getting damaged.

This is being a purely technical subject, it requires a monitor to have some acquaintance with technical terminologies of civil construction work and some basic knowledge of the subject. This manual is prepared with that purpose. It tries to provide a monitor with knowledge and knowhow of construction of different stages of Roads, Bridges and Culverts.

9. Steps in construction of road:

9A. Road construction equipment:

Before introducing to road construction activities it is desirable to get acquainted with the equipment that are usually used in road construction:

Sl.	Name of the equipment	Images of the equipment
1.	**Excavator:** **Excavators** are heavy construction equipment consisting of a boom, stick, bucket and cab on a rotating platform known as the "house". The house sits atop an undercarriage with tracks or wheels. A cable-operated excavator uses winches and steel ropes to accomplish the movements. They are a natural progression from the steam shovels and often called power shovels. Excavators are also called Diggers. It is used for various purposes, like: • Digging of trenches, holes, foundations • Road construction work • Material handling • Forestry work • Demolition • General grading/landscaping • Mining, especially, but not only open-pit mining • River dredging • Driving piles, in conjunction with a pile driver etc.	 ***Fig**: Excavator*

Sl.	Name of the equipment	Images of the equipment
2.	**Pay loader:** A **loader** (bucket loader, front loader, front-end loader, pay loader, scoop, shovel, skip loader, or wheel loader) is a heavy equipment machine used in construction and sidewalk maintenance to move aside or load materials such as asphalt, demolition debris, dirt, snow, feed, gravel, logs, raw minerals, recycled material, rock, sand, woodchips, etc. into or onto another type of machinery (such as a dump truck, conveyor belt, feed-hopper, or railroad car).	  ***Fig:*** *Pay Loader*

Sl.	Name of the equipment	Images of the equipment
3.	**Roller: Drum, Pneumatic:** A **road roller** (sometimes called a roller-compactor, or just roller) is a compactor type engineering vehicle used to compact soil, gravel, concrete, or asphalt in the construction of roads and foundations, similar rollers are used also at landfills or in agriculture. In some parts of the world, road rollers are still known colloquially as steam rollers, regardless of their method of propulsion. This typically only applies to the largest examples (used for road-making).	  ***Fig:*** *Road Rollers*
4.	**Soil Compactor:** A C**ompactor** is a machine or mechanism used to reduce the size of waste material or soil through compaction. A Trash Compactor is often used by a home or business to reduce the volume of trash. Normally powered by hydraulics, compactors take many shapes and sizes. In landfill sites for example, a large bulldozer with spiked wheels called a landfill compactor is used to drive over waste deposited by Waste Collection Vehicles (WCVs).	

Sl.	Name of the equipment	Images of the equipment
	WCVs themselves incorporate a compacting mechanism which is used to increase the payload of the vehicle and reduce the number of times it has to empty. This usually takes the form of hydraulically powered sliding plates which sweep out the collection hopper and compress the material into what has already been loaded. Different compactors are used in scrap metal processing, the most familiar being the car crusher. Such devices can be of either the "pancake" type, where a scrap automobiles flattened by a huge descending hydraulically powered plate, or the baling press, where the automobile is compressed from several directions until it resembles a large cube.	  ***Fig:*** *Soil compactors*

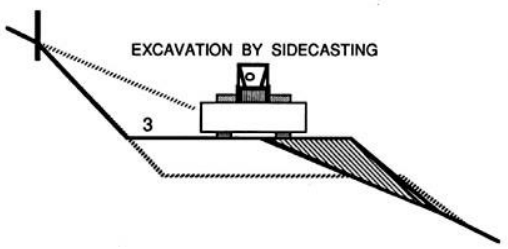
Sl.	Name of the equipment	Images of the equipment
5.	**Dump Truck/Pickup:** A **Dump Truck** (or, UK, dumper/tipper truck) is a truck used for transporting loose material (such as sand, gravel, or dirt) for construction. A typical dump truck is equipped with an open-box bed, which is hinged at the rear and equipped with hydraulic pistons to lift the front, allowing the material in the bed to be deposited ("dumped") on the ground behind the truck at the site of delivery. In the UK and Australia the term applies to off-road construction plant only, and the road vehicle is known as a **tipper**, **tipper lorry** (UK) or **tip truck** (AU).	  ***Fig:*** *Dump truck and Dump Trailer*
6.	**Water Tanker:** Water hauling services have always placed an important part in the construction industry. From dust control for haul roads and work sites to base compaction and road building, Rebel. Water trucks range in a variety of tank sizes from 7600L Single Axles which are great for smaller projects/ buildings to 19,500L Tri-axles for the large scale jobs requiring maximum water volumes. Water trucks are equipped with in cab operator controls, rear fantail sprayers, spray bars, 2" fire nozzles, tank mounted water cannons, rear flooding dump valves, and pump through valves.	  ***Fig:*** *Water tankers*

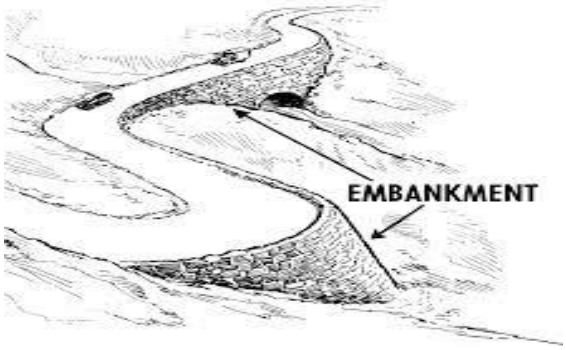
Sl.	Name of the equipment	Images of the equipment
	Water trucks are GPS equipped and dispatched. This allows for effective fleet management with quicker response times, assists in accurate billing and provides up to the minute information to our customers.	
7.	**Asphalt plant:** An **Asphalt Plant** is a plant used for the manufacture of asphalt, macadam and other forms of coated road stone, sometimes collectively known as blacktop or asphalt concrete. The manufacture of coated road stone demands the combination of a number of aggregates, sand and a filler (such as stone dust), in the correct proportions, heated, and finally coated with a binder, usually bitumen based or, in some cases, tar. The temperature of the finished product must be sufficient to be workable after transport to the final destination. A temperature in the range of 100 - 200 degrees Celsius is normal. Increasingly, recycled asphalt pavement (RAP) is used as part of the mix. The binder used is flammable, and the heaters are large liquid or gas fired burners. RAP is introduced after the heating process and must be accounted for in the overall mix temperature calculations.	 

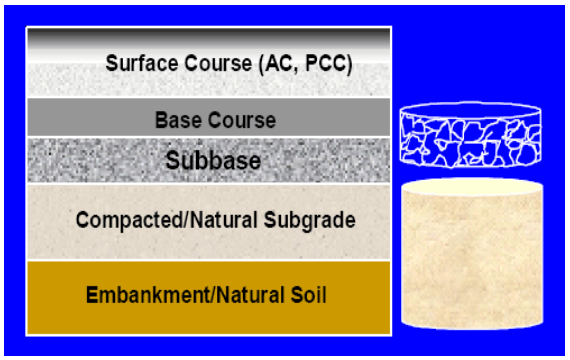
Sl.	Name of the equipment	Images of the equipment
	There are three main classes of plant: batch heater, semi-continuous (or "asphalt plant"), and continuous (or "drum mix"). The batch heater has the lowest throughput, the continuous plant the highest at up to around 500 Tones per hour. Supply of road stone for large contracts is generally by tender with considerable pressure on price. A faulty batch of road stone must be planed up and re-laid, often with additional lane rental charges, at a cost which may be orders of magnitude higher than the original price, so sophisticated control systems are a necessity.	 ***Fig:*** *Asphalt plants for road construction*
8.	**Bitumen Sprayer:** A **Bitumen Spray** seal is usually a two-coat system. Liquid bitumen is sprayed onto a prepared road base surface via a computerized application. A 14mm aggregate is spread in a uniform layer and rolled with a rubber tyred roller. A second coat of bitumen is sprayed, followed by a layer of 7mm aggregate (which fills the voids between the aggregate of the previous coat) and then rolled. The surface texture of a spray seal is coarse with an amount of excess (or loose) stone on the surface. This is usually left and will bed in over time. Bitumen spray seals are suitable for country areas or longer driveways, marshalling yards, etc.	  ***Fig:*** *Bitumen Sprayer*

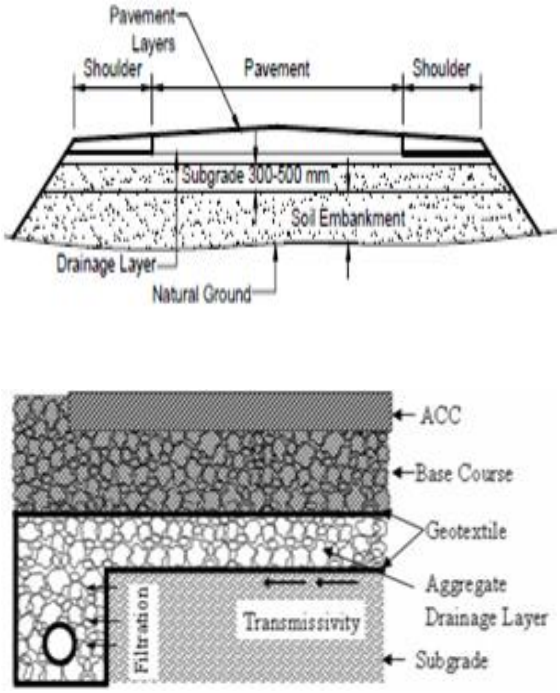
9B. Steps in construction of road segments:

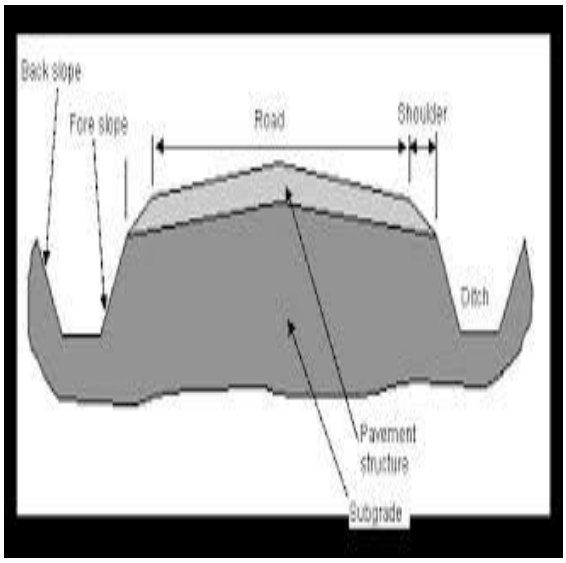
Sl.	Activities	Images of activities
1.	**Clearing and grubbing:** **1.1** Road alignment should be cleared from tree roots, shrubs, grass and grass roots, structures below or above the ground etc. before start of any work. **1.2** Pre-work measurement of original form of land should be taken so that the earth measurement can be done finally.	  ***Fig:*** *Clearing and grubbing*

Sl.	Activities	Images
2.	**Road way Excavation:** **2.1** Soil test shall be carried out along the road alignment to ascertain bearing capacity of the soil. **2.2** Whether material of the place can be used in road construction or not, shall be assessed before starting excavation. **2.3** Measurement of useable materials should be taken beforehand.	  ***Fig:*** *Road way excavation*
3.	**Borrow pit:** **3.1** The engineer shall decide and approve the location of the borrow pit. **3.2** Borrow pit shall be located away from the site of construction to ensure the safety and stability of the structure. **3.3** Borrow pit shall be located at such places that it does not hinder the natural or artificial flow of water.	  ***Fig:*** *Borrow pit*

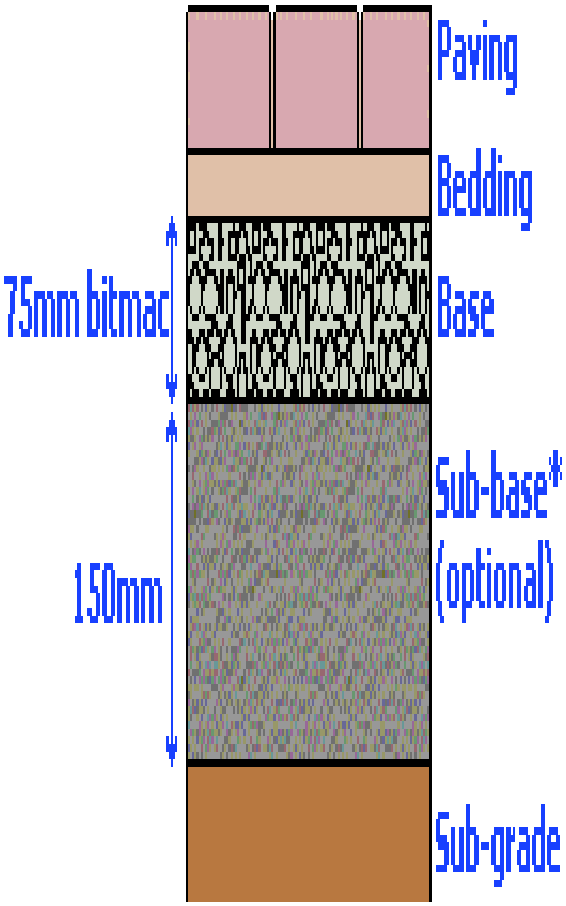
Sl.	Activities	Images
4.	**Road embankment materials:** **4.1** Earth fill materials shall be free from roots, shrubs, grass and grass roots, structures etc. **4.2** Shall be approved by the Engineer as a suitable material for the purpose. **4.3** CBR of embankment material shall be more than 3%. **4.4** Embankment materials, when compacted shall achieve 95% maximum dry density (MDD) determined in accordance with Standard Testing Procedure (STP). **4.5** One compaction test shall be carried out for each 1000 sq. meters of completed layer according to STP.	  ***Fig:*** *Road embankment materials*
5.	**Road embankment:** **5.1** After clearing the area cross section of the original land, its approval should be taken before start of work. **5.2** Embankment should be constructed in 150mm compacted layers and it should be parallel to the last compacted layer. This will remove water from the embankment easily. **5.3** Before spreading a new layer, the engineer must approve the last compacted layer. **5.4** Spongy materials should be removed from the embankment to get the desired compaction result. **5.5** Places like ponds, marshes and canals in the alignment should be cleared and sand-filled, to strengthen the embankment. When this filled land shall be raised to a designed height level, it shall be compacted.	  ***Fig:*** *Road embankment*

Sl.	Activities	Images
6.	**Subgrade:** **6.1** 150mm layer above the earth layer or just below the pavement is known as Subgrade. **6.2** Subgrade preparation with suitable soil and proper compaction. **6.3** Subgrade is spread through entire breadth of the embankment including shoulder. **6.4** During construction of embankment on an existing road, entire earth up to 150mm depth should be removed so that new materials are completely mixed with the old materials. **6.5** Subgrade layers should be compacted to achieve 98% of maximum dry density (MDD). **6.6** Subgrade should have LL<50%, PI<15% and CBR>5%or as specified in the contract document **6.7** The depth of upper part of the prepared subgrade should be at least 50mm everywhere. The variation in subgrade at any place should not exceed ±20mm. **6.8** The contractor must take approval of the subgrade before starting work of the pavement.	    ***Fig:*** *Subgrade preparation*

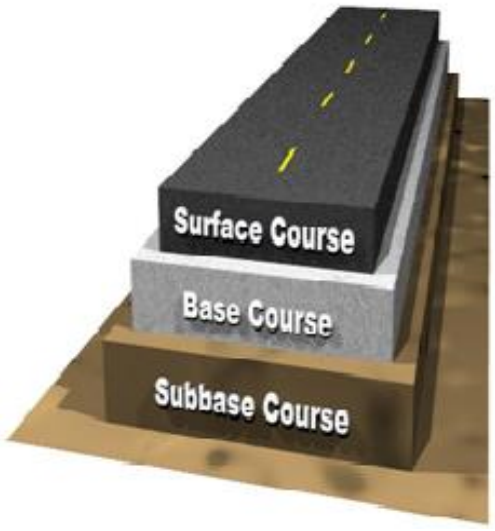
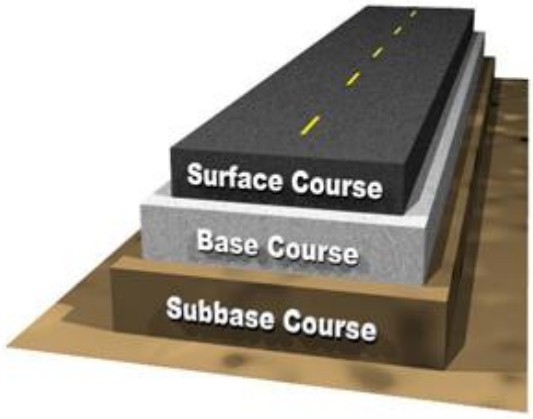
Sl.	Activities	Images
7.	**Subgrade drain:** **7.1** To consolidate the embankment, it is required to construct subgrade drain layer. It will let water pass through easily without damaging the embankment. **7.2** Subgrade drain should be constructed 200mm in width and 300mm in depth and should be made across the whole length of the embankment. **7.3** Clean sand and gravel mix should be used to fill it and compacted as per specifications **7.4** Geotextile membrane should be placed on the drain to protect small particles from being washed away.	 ***Fig:*** *Subgrade drain*
8.	**Improved subgrade:** **8.1** Improved subgrade materials should be natural or artificial mixture of sand or other mineral aggregates free from vegetation, soft particles and excess clay. **8.2** Improved subgrade shall be compacted in 150mm layers or as per specification of the design, with vibratory roller to achieve 95% compaction. At this stage, optimum moisture content should be ±2% or as specified in the contract. **8.3** The material should have a soaked CBR value not less than 8% when compacted to 95% of maximum dry density (MDD) or as specified in the contract document.	 ***Fig:*** *Improved subgrade*

Sl.	Activities	Images
9.	**Earthen shoulder:** **9.1** Before shoulder filling work, subgrade preparation and subgrade drainage work shall be completed. **9.2** Shoulders shall be constructed in layers approximately parallel to the finished grade of the roadbed. The layers should not exceed 150mm in thickness on completion of compaction. **9.3** Shoulder fill material should be free from roots, sods, etc. **9.4** Each 150mm layer should be compacted to achieve not less than 98% MDD with ±2% optimum moisture content (OMC) or as specified in the contract document. **9.5** Compaction test (Field Dry Density) shall be carried out for every 500 sq. meter area of constructed shoulder or as specified in the contract document.	  ***Fig:*** *Earthen shoulder*

Sl.	Activities	Images
10.	**Sub base material:** **10.1** Sub-base construction with well graded brick aggregates (with various shape and sizes) and sand mixed shall be done and compacted or it shall be done as specified in the contract. **10.2** Sub-base materials should be natural or artificial aggregate material, free from vegetation, soft particles and excess clay. The material shall fully conform to the specifications and must have approval of the Engineer. **10.3** The material should have 4-day soaked in water and CBR value>25%when compared to 98% MDD or it shall have value as specified in the contract. **10.4** Aggregate crushing value (ACV) <38% and ten percent fine value (TFV)> 75kN or shall have value as specified in the contract. **10.5** Contractor Shall submit all the test results for the engineer's approval	   ***Fig:*** *Sub base material*

Sl.	Activities	Images
11.	**Sub base** **11.1** Sub-base is the middle load bearing layer of the pavement. **11.2** Sub-base materials are spread over engineer-approved sub-grade and compacted to desired specification. **11.3** Sub-base materials should be spread mechanically or manually in more thickness so that after compaction, 150mm thickness or as per specification of the approved design is achieved. It shall be done by sprinkling water as required in the contract. **11.4** Every layer shall be compacted by vibrating roller to achieve 98% compaction of MDD with optimum moisture content (OMC) ±2%or as specified in the contract. **11.5** Three field dry density (FDD) tests shall be carried out for every 1000 sq. meter of compacted layer or as per specifications. **11.6** At any place of the sub-base, the thickness shall be more or less than 10% of the required thickness or as specified in the contract document.	 ***Fig:*** *Sub base*

Sl.	Activities	Images
12.	**Base material (Aggregate):** There are two type of aggregate bases that are constructed. These bases are classified as Base Type I and Base Type II, depending on the basis of materials used. These are as follows: **Base Type I** - It is constructed with crushed stone fragments with proportionate mix of sand or stone dust. **Base Type II**- It is constructed with crushed brick fragments with proportionate mix of sand or stone dust. **12.1** Base materials shall be mixed of all size and shapes of aggregates i.e. it shall be well graded. **12.2** When tested in accordance with STP, the material shall have a minimum soaked CBR value at a compaction of 98% of MDD as determined by STP as follows: Base Type I - 80% Base Type II - 50% **12.3** Aggregate Crushing Value (ACV) shall be less than 30% for Base Type I and 35% for Base Type II or other test values as specified in the contract. **12.4** Contractor shall obtain approval of all the test results of Base materials from the Engineer.	  ***Fig**: Aggregate base material*

Sl.	Activities	Images
13.	**Aggregate base (laying):** **13.1** Aggregate and sand shall be mixed thoroughly to obtain homogenous mix and water shall be added to keep mixed material moist and spread over the surface. Each layer shall be compacted (by vibrating hammer) to at least 98% of the MDD as determined by STP. **13.2** Density of the compacted aggregate base course shall be determined in accordance with STP (150 mm or 200 mm depending on layer thickness of design) with at least 3 tests to be carried out for each 1000 square meters **13.3** Final shaping and rolling of the shoulder to the full width shall be made after the base course is completed	 ***Fig:*** *Aggregate base*
14.	**Pavement Construction:** **14.1** Pavements are generally of two types. These are: **a. Rigid Pavement and** **b. Flexible Pavement** **a. Rigid pavement:** This pavement is made of R.C.C. or C.C. Although it is considered ideal in the weather condition like Bangladesh where rainy season is long and flooding is quite common phenomena. But very small portion of total KM of road is made of rigid pavement. Normally roads in hat and bazar where water logging is common and roads	 ***Fig:*** *Pavement (surface course)*

Sl.	Activities	Images
	that remain submerged during rainy season are made of R.C.C. or C.C. Construction cost per KM of this type of road said to be a bit higher compare to the cost of flexible pavement, but its (rigid pavement) maintenance cost is very low. **b. Flexible pavement:** Different types of surfacing are done for the subgrade, improved subgrade and base. Popular flexible pavements are bituminous or asphalt. Sometimes on top of the pavement, sealing is done by bituminous seal coat. Generally a bituminous wearing course is applied on the top of asphalt concrete. Depending on requirement of the design, top surface of the road pavement is made. Construction of road pavement involves various parameters of highly technical nature. Before starting work, the contractor shall submit in writing to the engineer a job-mix formula for each type of proposed asphaltic mixture. This shall state the sources and types of various materials to be used, the mixing proportions of the various constituents, the method of mixing, the method of heating bitumen and aggregate sand the means of transportation, laying and compaction. The formula so submitted shall stipulate a single definite temperature for the emptying of the mixture from the mixer, and for mixture to be laid hot, a single definite	 ***Fig:*** *.Earth work during Laying pavement works*  ***Fig:*** *.Laying geo-grid before placing earthen layers during pavement woks.*

Sl.	Activities	Images
	temperature at which the mixture is to be delivered on the road. The job-mix formula for the mixture shall indicate the percentage of aggregate passing each required sieve size and the percentage of bitumen to be added to the aggregate. **The contractor shall not commence bitumen surfacing work until the job-mix formula has been approved in writing by the Engineer, including any adjustment to the job mix formula which the Engineer considers are necessary**. A checklist on construction of bituminous pavement is developed and attached as C**hecklist Annexure-5, page-58** at the end of the chapter that may be useful for IMED for the purpose of inspection of pavement construction. Apart from this, a short illustration of frequently used terms in bituminous pavement work is also given below: **Prime Coat:** The principal function of prime coat in bituminous pavement is to protect the subgrade from moisture and weathering. Since the presence of moisture affects the strength of subgrade, the prevention of water entry during construction is essential to avoid the failure of the pavement. Prime coat is an asphalt which, when applied evenly to the surface of sub-base or subgrade, serves to seal the surface to hinder the penetration of moisture into subgrade. Vehicular traffic should be avoided on the	  ***Fig:*** *Bitumen Spraying*

Sl.	Activities	Images
	surface sprayed with prime coat because the traction and tearing action of vehicles would damage this asphalt layer. Following steps shall be taken before spreading bituminous layer over the surface: • The Prime Coat layer shall be sprayed on completely dried and cleaned surface as per specifications or as per instruction of the engineer. • Bitumen mix shall not be spread until Prime Coat layer is completely dried. • The surface area shall be thoroughly cleaned before applying bitumen or bituminous layer. • When upper surface is completely dried, possibility of rain is remote and condition of Road Bed is satisfactory then only bitumen mix layer shall be spread as per instruction of the engineer. • Bituminous surfacing layer shall be compacted quickly by a specified roller to achieve result as per specifications. The work shall consists of cleaning of the surface to be Prime Coated and applying bituminous material in accordance with the specifications or as directed by the engineer **Tack Coat:** Tack coat is applied after the prime coat, to form an adhesive bond between the tack coat and the next layer of coating. The tack coat prevents slippage and may sometimes function as a more long-term sealer. The work shall consists of applying bituminous material to a previously prepared Road Bed, in accordance with the specifications and to the width and the area required by the engineer.	 ***Fig:*** *Laying of pavement work*

10. Stages of Bridge Construction

10.1 Essential tests and equipment required to ensure quality

It has been mentioned earlier that quality achievement is not an easy outcome or an accident; it is the product of determined effort. The PD/PE is the key person who must play an important role to get the works done true to the standards and specifications so as to ensure desired quality of work. The contractor is obligated under the contract for testing of the quality of work to ensure compliance as stipulated in the specifications. It is the standard practice for the engineer's site staff to supervise and witness such testing of the works. However, the site engineer should also carry out some testing separately, for the purpose of validation of tests done by the contractor as well as for the auditing purposes. In case of construction of bridges and culverts following tests and steps are required to be followed:

- **Tests of Materials:** In case of materials **Particle Size Distribution (PSD), Aggregate Crushing Value (ACV), Flakiness Index tests** and **Elongation/Tensile strength/Bend tests for MS bar** or any other tests as instructed by the engineer shall be carried out and approval of the engineer shall be obtained by the contractor for the source of supply of materials and the Brand (if any).

- **Tests of Concrete:** During different stages of construction of bridges and culverts frequent tests of concrete mix like **Workability-Slump/Cylinder test and Compressive Strength tests** shall be performed by the contractor as required by the contract document or as instructed by the engineer and shall obtain approval of the engineer and then proceed further as per instruction of the authority.

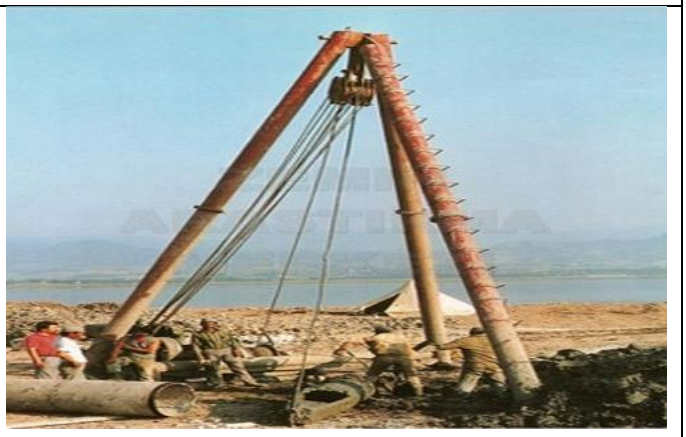
- **Test of Pile:** A **Pile Integrity Test** (also known as **low strain dynamic test**, **sonic echo test**, and **low strain integrity test**) and **Load Test** shall be carried out by the contractor to determine its length, designed strength and other required features and obtain approval of the engineer before commencing the **Service Pile** work.

- **Curing:** Curing shall be started immediately after thumb set of the concrete laid. Hessian clothe /Plastic shall be covered over the set concrete to reduce moisture evaporation from the concrete during hardening and thus to minimize shrinkage crazy cracks. These cracks are inheriting property of the concrete that appears during casting of flat surfaces.

  Curing water should be as per specification and curing shall be carried out as specified in the contract.

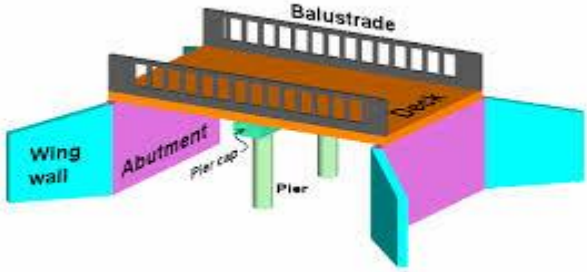
- **Use of Equipment:** Depending on the volume of work and requirement of the contract construction equipment like M**ixer Machine**, **Batching Plant** etc. shall be made available by the contractor prior to start of work. **Vibrator machine** shall be used in concreting work to ensure proper compaction and achieve desired result as per specifications of the contract.

10.2 Bridge construction Stages:

Sl. no	Activities	Images
1.	**Soil test:** Conducting Soil Test of a selected place is necessary to know conditions of soil beneath the surface to obtain full information on the type, size, length and capacity of the piles. Designer of the Pile takes into consideration the result of the soil test and fixes its parameters.	 *Figure: Soil Test*
2.	**Test Piling**: There are various types of piles which are designed for massive structures. These are Driven Pile, Cast in Place Piles / Board Piles, Prefabricated Piles etc. The most used types are Bored piles and Prefabricated Piles. It can be constructed using a number of methods. The simplest method for Bored Pile construction is to use an auger to remove the soil and replace it with concrete and reinforcement and Prefabricated Piles are carried to the specified place and is mechanically driven to a designed depth or as per instruction of the engineer **Pile load tests** are generally performed to either prove that piles are capable of sustaining the ultimate design load ("proof	 *Figure: Boring hole for Piles*  *Figure: Pile Reinforcement*

Sl. no	Activities	Images
	test") or to gain more detailed information that will enable a more efficient design. For a proof test, a test pile is loaded to the ultimate design load (allowable design load times the factor of safety) and the deflection is measured at the pile head. If the deflection is within allowable levels, the test has “proved” that the pile is acceptable. Proof tests are generally performed during construction as the piles are installed. Stages of pile work are as follows: a. Boring b. Reinforcement preparing and lowering in the bore hole c. Concrete pouring d. Pile load test	 *Figure: Pile reinforcement lowering in hole*  *Figure: Concrete pouring*  *Figure: Pile load test*

Sl. no	Activities	Images
3.	**Service Piling:** This piling work shall commence after getting the result of the Test Pile and as per final design and recommendations of the design expert. Pilings are used as foundations where the size of the structure, poor soil quality at shallow depths, and intense site gradients preclude the use of conventional or other foundations. Pilings are long lengths of solid or hollow steel, wood, or concrete either driven into the ground by a pile driver, placed in ready excavated cavities, or cast in situ in specially drilled holes. In the case of driven pile foundations, several piles are typically placed together in a group. A reinforced concrete slab is cast over the tops of the group to form a single structural element. This allows for the even distribution of the weight the pile group will carry so no individual member is over-stressed. Activities same as mentioned above in case of Test Piling	 ***Figure:*** *Lowering of Pile reinforcement in the bore hole*
4.	**Pile Cap:** Propping & concreting Pile Cap in the flowing river: The term "pile cap" may be used to describe a reinforced concrete slab constructed on top of a group of foundation piles to evenly displace or spread the load they are to carry.	 ***Figure*****:** *Pile Cap and Pier Reinforcement*

Sl. no	Activities	Images
	It can also refer to plastic or glass fiber caps placed over the tops of wooden pilings to protect them against rot and to stop birds nesting on the pilings. Most commonly, however, the term refers to the concrete slab that is cast on concrete or steel pilings once they have been suitably trimmed and prepared. These slabs offer a larger area for the construction of the columns they support and also help spread the weight of the structure over all pilings in a group allowing them to better support the load.	 *Figure: Pile cap in flowing river*
5.	***Abutment & Wing Wall:*** Its construction is similar to that of building construction. Abutments are designed to rest two ends of a bridge, whereas Wing Walls are designed to protect earth from sliding. It also acts as load transferring structure from the bridge to the ground.	 *Figure: Abutment & Wing Wall*
6.	**Scaffolding:** Scaffolding is used to build platform to support working men and materials. All scaffolding must be erected, dismantled and altered in a safe manner. This is achieved by following the guidance provided by the expert in the field or by following guidance provided by the manufacturers of system scaffolding.	 *Figure: Scaffolding*

Sl. no	Activities	Images
7.	**PC Girder:** Activities same as mentioned above in case of Test Piling. A **PC box girder bridge** is a bridge in which the main beams comprise girders in the shape of a hollow box. The box girder normally comprises either pre-stressed concrete, structural steel, or a composite of steel and reinforced concrete. The box is typically rectangular or trapezoidal in cross-section. Box girder bridges are commonly used for highway flyovers and for modern elevated structures of light rail transport. Although normally the box girder bridge is a form of beam bridge, box girders may also be used on cable-stayed bridges and other forms. If made of concrete, box girder bridges may be cast in place using false work supports, removed after completion, or in sections if a segmental bridge. Box girders may also be prefabricated in a fabrication yard, then transported and emplaced using cranes. Careful handling of the PC Girder shall be ensured as per instruction of the engineer.	 *Figure: PC Girder pre-fabrication*  *Figure: PC Girder in position*

Sl. no	Activities	Images
8.	**Expansion Joint**: A **Bridge Expansion Joint** is a structural component designed to provide smooth passage over the gap between adjacent sides of a deck joint and thus allow for continuous traffic between structures accommodating movement, concrete shrinkage or creep, elastic shortening due to pre-stressing, temperature variations on reinforced and pre-stressed concrete, composite and steel structures. They stop the bridge from bending out of place in extreme conditions and allow enough vertical movement to permit bearing replacement without the need to dismantle the bridge expansion joint.	 ***Figure:*** *Concrete Bridge Expansion Joint*
9.	**Deck Slab construction:** Deck slab is used for movement of traffic. It transfers traffic load to the round through piles. Its construction method is similar to that of slab casting of a building. Pouring of concrete shall be made as per instruction and guidance of the engineer. Proper walkways/platforms shall be arranged so that the supports of the pipeline and manpower do not directly stand on reinforcement. Sufficient carpenters along with supervisor shall inspect the behavior of supports below the slab during the casting. Extra Props shall be stocked below slab to provide additional supports in case of any failure of supports.	 ***Figure*****:** Deck Slab construction

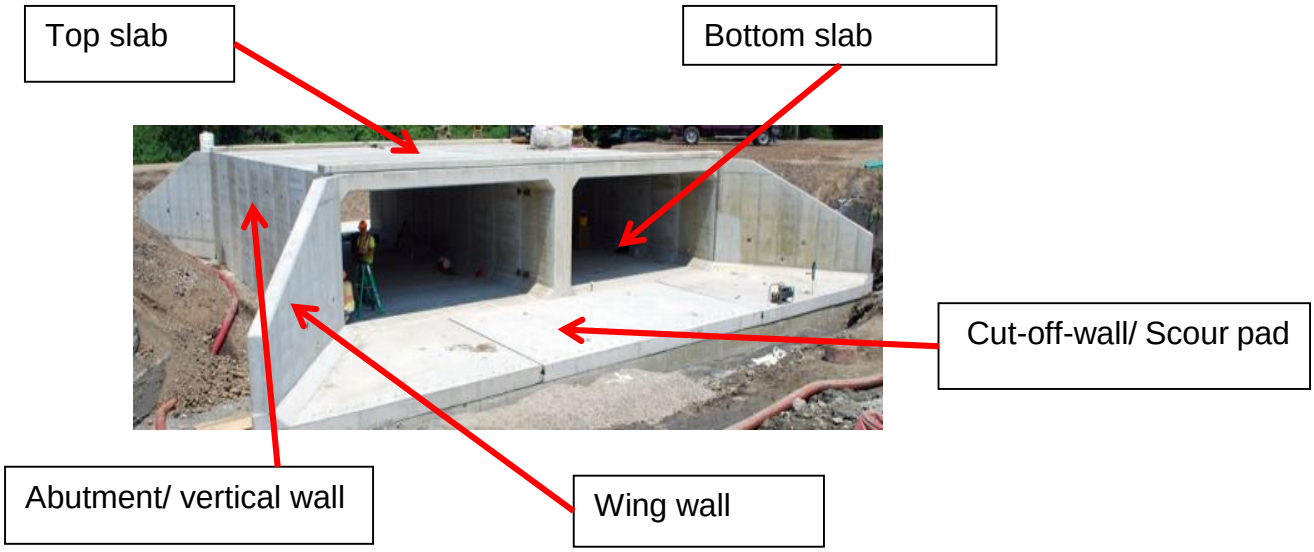
Sl. no	Activities	Images
10.	**Railing, Walkway & Drainage:** Bridge **Railings** are very important components of roadway safety systems and play an important role in preventing and mitigating crashes. Since the primary purpose of a bridge railing is to prevent penetration, it must be strong enough to redirect an impacting vehicle. A provision of slightly elevated **Walkway** alongside railing is kept for the pedestrians. **Drainage** facility is provided to avoid water stagnation on the bridge. Poor drainage may damage bridge structure and increase.	 *Figure: Railing of a bridge*  *Figure: Walkway of a bridge*  *Figure: Drainage road bridge*

Sl. no	Activities	Images
11	**Electrification:** Illumination of a bridge and its approaches through installation of electrical system is a part and parcel of the entire bridge construction/design activities. Proper illumination increases visibility of the bridge environment and safety of the commuters. It also lessens chances of traffic accidents and ensures safe movements of pedestrians on the bridge.	 *Figure: Electrification of bridge*
12	**Approach Road:** Without properly completing approach road of a bridge or culvert, the purpose of its construction remains unfulfilled. Therefore, utmost care is necessary to complete its construction along with completion of construction of bridge or culvert to ensure its benefit to the common people.	 *Figure: Approach road construction*

11. Stages of Culvert's Construction:

11A. Component of Culvert

- **Bottom slab**
- Cut-off-wall
- Vertical wall
- Wing wall
- Top slab
- Protective works (special cases)



11B. Construction steps of Culverts:

- Setting vertical and horizontal alignment.
- Box cutting.
- Concreting of base slab with cut-of-wall.
- Concreting vertical wall with wing wall.
- Backfilling

12. Study of Project Document:

An approved Development Project Proforma (DPP) is considered to be the Bible to be followed by everybody in its letter and spirit. It is the document that contains the physical and non-physical items of works along with its budgetary provisions and also its execution plan to be carried out over the project implementation period. An inspector should also have comprehensive knowledge of this approved government document as to what are the physical activities to be taken up for implementation by the project management. Study of the project document thoroughly, particularly the work components that are planned to be inspected with reference to previous inspection/progress report (**See Annexure-1; page 44-46** and **Annexure-2 page 47-48** for DPP/TPP Checklists) is necessary.

13. Study of procurement discipline:

Beside other documents, it is advisable to study in depth on the PPA 2006 and the PPR **(See Annexure-3; page 49-52** procurement discipline Checklist**)**. Without having comprehensive knowledge of this aforesaid Acts and Rules with checklists one may be misguided while visiting the project site. The documents and the checklists will give one an insight into the detail of the work awarded to the contractor.

14. Study of roads related technical discipline:

Before investigation of roads related projects which are purely known as civil works, one should remember the basic engineering roles item by item. For example rate Schedule of all kind of materials. **See Annexure-4, page 53-57;** road related technical discipline Checklist.

15. Study of Project implementation arrangements:

All the project documents have an approved provision of required number of, different categories of project personnel for execution of the project as well as for its operation after its completion. IMED's inspecting official should take stock of the whole arrangement and see whether these positions are filled up. Organizations like PWD, PDB, WDB, R & H D etc. government and autonomous bodies normally do not recruit new personnel for

the project from outside; rather it depute project personnel including PD, from within the organization. If project execution personnel are appointed from outside through open advertisement, IMED may see whether procedures for recruitment of manpower were properly followed and recruited personnel possessed requisite qualifications and experience as stipulated in the DPP/TAPP.

Appointment of full time PD, though very important for timely project implementation, but government decision in this respect is often overlooked/neglected by the ministry/agency and part time PD is appointed. IMED's inspecting official may obtain detail information about the appointment of the PD and also note whether project progress or quality of work in anyway suffered due to appointment of a part time PD or shortage of manpower in this project**.**

16. Checking quality of work:

Basic responsibility of ensuring quality of work lies with the contractor. The contractor has to ensure supply of construction materials as per specifications of the contract and also to ensure its use and workmanship as mentioned in the contract document. The indenting agency/ministry has to ensure that whatever was specified in the contract document is being delivered by the contractor. IMED as an outsider can do little to ensure quality of work from the contractor, but it can certainly help agency/ministry in extracting quality work and better workmanship through regular visits to the project sites. But in most cases IMED's field inspection takes place after completion of the work that does not help ensure quality of work. Therefore, depending on the stage of progress of work in the field IMED's visits has to be planned.

16. A Establishing site office and on-site testing facilities:

To fulfill the conditions of the contract and facilitate smooth construction activities, a contractor is required to builds a site office nearest to the project location. Creation of material and quality testing facilities at site at the cost of contractor also remains part of the contract.

Site office is built by the contractor in a way that it accommodates PD's office and his staff as well. Provision of electricity and water supply is also ensured by the contractor to smoothen activities of the project without interruption. At the site office, contractor's essential men and construction materials and equipment are also located.

16. B Maintenance of site inspection register/book:

Contractor is required to maintain a 'site inspection register/book' on the site, and also preserve a copy of the 'Work Order' along with it, so that visiting project officials and other related officials can write their observations/instructions in it, regarding progress of work, mobilization of equipment and materials, quality of material as well as quality of work performed (workmanship) by the contractor. He is also required to supply construction schedule and keep a copy of it at project site for quick reference and observations. These are considered prerequisite steps for the start of construction work. Therefore, when visiting a site, take a look into this 'book'. That will give first-hand information about the frequency of visits by senior project officials and other related officials at site, instructions given to the contractor for compliance and its follow status up etc. IMED official may also record his comments/observations in the 'book' regarding his visit and other issues that deem worth mentioning and can desire to be on record for future ready reference.

16. C Use of visual aid during inspection:

Visual aid like Camera or Video Recorder may be used for recording images of project activities. These images will always be helpful in better understanding the project situation in the field. In many cases, it will complement comments/observations of the officials and confirm reliability of information and data collected from the field. Therefore, wherever possible, help of visual aid should be sought for explaining views/comments/observations. Photographs of the structure from different angles and the photographs of the construction defects like hair cracks or larger cracks in slabs, honeycombs or cracks in pillars etc. and defects in in other areas of construction will strongly complement inspecting official's views and comments.

17. Removal of temporary structures and backfilling:

After completion of the construction work, contractor is required to remove the temporary structures and make necessary backfill of earth and restore the ground to its original surrounding position. It is observed that the contractors often leave the site without properly backfilling, removing the temporary structures and leveling the ground, causing serious damage to the road embankment and concrete structures. These temporary structures include diversion road constructed for facilitating construction of small bridges and culverts or construction of temporary structures in the river to facilitate the construction of a long bridge etc. Unwanted structures in the river sometimes cause scouring and threaten stability of the bridge.

18. Conclusion:

The quality achievement is not an easy outcome or an accident; it is the product of determined effort. The PD/PE is the key person who must play an important role to get the work s done true to the standards and specifications so as to ensure desired quality of work. The contractor is obligated under the contract for testing of the quality of work to ensure compliance as stipulated in the specifications. It is the standard practice for the engineer's site staff to supervise and witness such testing of the works. However, the site engineer should also carry out some testing separately, for the purpose of validation of tests done by the contractor as well as for the auditing purposes.

The inspecting officials from the Ministry/Department and the IMED may verify whether or not the contractual obligations of the contract have been fulfilled with proper documentation of the test results and comments of the site/Project Engineer there on. This must be carefully noted and reported at the decision making level of the government.

Annexure-1

CHECKLIST FOR DPP

1. Project Title:
2. Objectives of the project:
3. Estimated cost of the project total GoB PA (RPA):
4. Mode of financing:
5. Components of the project:

Sl.	Aspects to be answered/covered	Yes/No	Remarks
6.	Whether log frame in the DPP is correctly drawn to achieve the objective of the project		
7a.	Whether required manpower as mentioned in the DPP has been deputed from existing setup, recruited directly or recruited by outsourcing		
7b.	Whether recruitment of personnel has been made following government recruitment rules and regulations		
7c.	Whether recruited/deputed personnel have requisite qualification and experience as mentioned in the DPP		
8.	Whether there is a steering committee and PIC for reviewing the progress of project (monthly/quarterly/half yearly)		
9.	Whether procurement plan of goods, works and services as mentioned in the Annex III (a), III (b) and III(c) are being executed following the PPA-2006 and PPR-2008. Make analysis of the individual contracts in the Checklist for Procurement of Construction (Building) Work -- Annexure—3,page-44		

Sl.	Aspects to be answered/covered	Yes/No	Remarks
10a.	Whether item wise physical components as approved in the project document, differ from those being executed in the field.		
10b.	Whether physical components targets and progress as reported in the 02, 03 IMED formats are consistent with the field up to last quarter.		
10c.	Whether year wise financial phasing as approved in the DPP matches with the yearly ADP allocation.		
10d.	Whether year wise fund release and expenditure are consistent with the reported figures in the IMED formats.		
11a.	Whether project authority has clearly identified the RPA expenditure items of the project and is making the RPA claims from DOSA, CONTASA, SAFE, Impressed, etc. accounts properly and timely		
11b.	Whether claims of RPA expenditures are being submitted quickly for reimbursement.		
12.	Whether benefit-cost ratio (BCR), net present value (NPV) and internal rate of return (IRR) figures provided in the approved project document are inconsistent with the present figures (for completed profit earning industries).		
13a.	Whether mitigation programs for environmental impact has been taken care of by the project authority as mentioned in the DPP.		
13b.	Whether the project in anyway is contributing to the poverty alleviation, empowerment of women and regional disparity as mentioned in the DPP.		
14.	Whether the project is contributing to the PRS and MDGs as mentioned in the DPP.		

Sl.	Aspects to be answered/covered	Yes/No	Remarks
15.	Whether any project aid conditionality mentioned in the DPP is affecting implementation of the project.		
16a.	Whether rehabilitation/resettlement of affected persons/families program is taken up by the project authority.		
16b.	Whether the cost involvement as mentioned in the DPP for rehabilitation/resettlement will remain within the approved estimate.		
17.	Whether project implementation period is likely to be extended		
18.	Whether there is a possibility of time over run and cost over run		
19.	Whether internal and external audits are being carried out. When last internal and external audit was done.		
20.	Whether site register/book is being maintained at project site and visiting supervisory officials are recording their observations on progress and quality of work etc.		
21.	Whether Annual Work Plan has been prepared by the project authority/PD.		
22.	Whether CPM/ Bar Chart, for smooth execution of the project, has been prepared and being followed.		

Annexure -2

CHECKLIST FOR TPP

1. Project Title:
2. Objectives of the project:
3. Estimated cost of the project total GoB PA (RPA):
4. Mode of financing:
5. Components of the project:

Sl.	Aspects to be answered/covered	Yes/No	Remarks
6.	Whether there is a possibility for cost and time overrun.		
7.	Whether PD/NPD is a full time or a part time appointee.		
8.	Whether financing arrangement has been finalized.		
9.	Whether loan/credit/grant and other amounts as approved in the TPP is the same		
10.	Whether TOR of the consultants adequately covers the areas related to the objective of the TPP		
11.	Whether PPR 2008 has been followed in selecting consultants		
12.	Whether adequate step have been taken by the project authority to ensure transfer of technology.		
13.	Whether consultant's performance is being monitored regularly		
14.	Whether educational qualifications and experience of the consultants are relevant to the assignments they have been engaged.		
15.	Whether the counter-part personnel attached to the consultants have required educational qualifications and experience as mentioned in the approved TPP.		

Sl.	Aspects to be answered/covered	Yes/No	Remarks
16.	Whether educational qualification and experience of the support staff matches with information provided in the approved TPP.		
17.	Whether letter of agreement with implementing agency and the development partner has been signed.		
18.	Whether project steering committee has been formed to review the progress of work.		
19.	Whether auditing of the project is being carried out. When the last audit was done?		
20.	Whether project work is progressing as per approved implementation works schedule provided in the TPP.		
21.	Whether total procurement plan as envisaged in the approved TPP is being implemented in the light of PPR 2008. Individual contracts should be analyzed in the Checklist for Procurement of Construction (Building) Work - -Annexure-3.		
22.	Whether approving authority is exercising financial authority as per Delegation of Financial Power published by ministry of finance.		
23.	Whether CPM/ Bar Chart, for smooth execution of the project, has been prepared and being followed.		

Annexure -3

CHECKLIST FOR PROCUREMENT OF CONSTRUCTION WORKS (RHD)

PART-A PROCURING ENTITY AND DESCRIPTION OF PROCUREMENT				
1. Ministry/Division				
2. Agency				
3. Procuring Entity				
4. Name of the Project	(if applicable)			
5. Source of Funds (Tick relevant boxes)	Government ☐	Development ☐	Revenue ☐	
	Project Aid ☐	Own Funds ☐		
6. Procurement Plan	Status of Annual Procurement Plan (APP)			
	Approved ☐	Unapproved ☐		
	Short Description (If necessary):			
7. Brief Description of Works				
8. Procurement Method (as in DPP or otherwise)				
9. Procurement Value (Estimated Cost)				
10. Type of Tender Document (Tick relevant one)	• SRFQ (PW 1) • STD (PW 2/PW 3/PW 4/PW 5) • SPD (PQW 4/ PQW 5)			
11. Formation of TOC/POC and TEC/PEC	• No of members in TOC/POC • No of member from TEC/PEC • No of members in TEC/PEC • No of external members in TEC/PEC • Authority approved TEC/PEC			

PART-B	SCHEDULE OF ACTIVITIES (Pre-Qualification)			
Sl.	**Activity** (If not applicable indicate N/A**)**	**Planned Date** (As per procurement plan/ Flow Chart)	**Actual Date**	**Remarks**
1.	**PRE-QUALIFICATION**			
1.1	Date of Advertisement of Invitation 1.1.1 Advertisement in Newspaper Published 1.1.2 Advertisement in CPTU Website Published 1.1.3 Advertisement published in own website, 1.1.4 Tenders/Proposals followed PPA-2006/PPR, 2008 1.1.5 Tenders/Proposals followed DP's Guidelines			
	1.1.6 No of Sale/Issuance of Tender/Proposal Documents 1.1.7 No of Tenderer/Consultant participated 1.1.8 Days allowed per Rule for preparation and Submission 1.1.9 Date of Submission of Tender Doc./Applications			
1.2	Date of Pre-Qualification Meeting (if any)			
2.	**Tenders/Proposals Evaluation**			
	2.1 Days allowed per Rule between opening and completion/submission of evaluation 2.2 Days actual between opening and completion/submission of evaluation 2.3 Responsiveness of Tender/Proposal 2.4 Re-invitation of Tenders/Proposals recommended by TEC/PEC 2.5 Procurement proceedings annulled/cancelled 2.6 Date of Submission of Evaluation Report with Recommended List			
	2.7 Approving Authority (AA) as per Delegation of Financial Power (DoFP) 2.8 Date of Approval of List 2.9 Authority approval date 2.10 Evaluation report was sent directly to the AA			

PART-C	SCHEDULE OF ACTIVITIES			
Sl.	**Activity** (If not applicable indicate N/A**)**	**Planned Date** (As per procurement plan/ Flow Chart)	**Actual Date**	**Remarks**
1.	**TENDER FOR WORKS**			
1.1	Date of Advertisement of Invitation for Tenders 1.1.1 Advertisement in Newspaper Published 1.1.2 Advertisement in CPTU Website Published 1.1.3 Advertisement published in agency's own website, 1.1.4 Tenders/Proposals followed PPA-2006, PPR-2008 1.1.5 Tenders/Proposals followed Dev. Partner's Guidelines			
1.2	Date of Issue of Tender Document 1.2.1 No of Sale/Issuance of Tender/Proposal Documents 1.2.2 No of Tenderer/Consultant participated			
1.3	Date of Pre-Tender (Pre-Bid) meeting			
	1.3.1 Days allowed as per rules for preparation and Submission 1.3.2 Date of Submission of Tenders			
1.4	Date of Opening of Tenders			
1.5	Date of Submission of Technical Sub-Committee Report (if applicable)			
1.6	Date of Submission of Evaluation Report			
1.7	Procurement processing lead-time i.e. days actual between opening and issuance of NOA/PO/Contract signing/LOI			
1.8	Days actual between IFT/RFP and issuance of NOA/PO/Contract signing/LOI			
1.9	Publication of award in CPTUs website/PE's website/others			
1.10	Contract award made within the initial Tender/Proposal validity period	:		
1.11	Date of Approval for Award of Contract	:		

Part-D	Individual Contract Review				
1.	**Contract Implementation:**		**Planned Date** (As per procurement plan/ Flow Chart)	**Actual Date**	**Remarks**
1.1	Contract Reference				
1.2	Contract Amount/ Value				
1.3	Contract Signing Date				
1.4	General Conditions of Contract (GCC) should be specific				
1.5	Particular Conditions Contract (PCC) should be specific				
1.6	Terms of Reference/ Activities (Item by item)				
1.7	Work plan				
2.	**Completion of Contract**				
2.1	Days per original contract time specified for supply/Execution/Delivery	:			
2.2	Days actual for Supply/Execution/Delivery	:			
2.3	Amount of LD imposed	:			
3.	**Complaints and Appeal**				
3.1	Complaint, if any, lodged and reasons thereof	:			
3.2	Resolution of complaints per Rules	:			
3.3	Modifications resulting from resolution of complaints	:			
3.4	Appeal of Independent Review Panel	:			
3.5	Review Panel's decision and follow-on	:			
4.	**Contract Amendment**				
4.1	No of times contract time extended and days	:			
4.2	Variation/Extra Work/Repeat/Addl. Delivery Orders etc. made	:			
4.3	No and amount of such orders	:			
5.	**Contract Disputes unresolved**				
6.	**Fraudulence and Corruption**				
7.	**Procurement Management Capacity**				
7.1	HRD facilities	:			
7.2	No. of Staff trained in procurement	:			

***Annexure*-4**

Checklist for inspection of roads, bridges and culverts

Sl. No.	Aspects	Yes/No	Remarks
1.	Whether contractor is maintaining traffic flow along the existing road through its proper maintenance by providing and maintaining temporary diversions, temporary bridges, necessary barricades etc.		
2.	whether contractor is providing and maintaining signs,, markings, lights, barricades etc. as per BRTA manual		
3.	Whether contractor has constructed and provided furnished field office to the Engineer and his staff as per contract agreement		
5.	Whether necessary MLSS, computer operator, office equipment and necessary consumables have been provided for the office of the Engineer		
6.	Whether colored photographs of progress of work are being arranged every month by the contractor		
7.	Whether contractor has set up field testing laboratory and provided equipment and consumable stores at site that are necessary to carry out tests as per terms of the agreement for his use as well as for the use of the Engineer		
8.	Whether besides site testing, off site tests are also being carried out by the contractor as per instruction of the Engineer		
9.	Whether contractor has provided qualified laboratory engineers, technicians, assistants, laborers etc. to carry out sampling and testing of materials and other tests.		

Sl. No.	Aspects	Yes/No	Remarks
10.	Whether contractor is maintaining site register book and supervising officers are recording their comments/ observations in it		
11.	Whether source approval of material has been taken by the contractor		
12.	Whether compaction test of the final layers have been carried out and test results have been approved by the Engineer		
13.	Whether construction materials are being tested in the laboratory and then used by the contractor according to the instruction and approval of the Engineer		
14.	Whether subgrade drain have been constructed and covered with Geotextile Membrane as per drawings or as per instruction of the Engineer.		
15.	Whether sub base and aggregate base layers have been compacted to achieve the CBR values as per requirement of the contract		
16.	Whether sub base and aggregate base materials have been tested in the site laboratory and results have been okayed by the Engineer.		
17.	Whether report on Asphalt Concrete pavement and test reports on 'Core' sampling in respect of MIX proportion, thickness etc. matches with the requirements of the contract		
18.	Whether road 'Camber' is maintained all through the length and breadth of the road uniformly as per design		
19.	Whether contractor has carried out samples tests of all the materials in the laboratory, to be used in the road, and taken approval of the Engineer.		

Sl. No.	Aspects	Yes/No	Remarks
20.	Whether all test reports and records, including material tests and collected samples, are systematically maintained.		
21.	Whether contractor has mobilized construction equipment as per contract agreement		
22.	Whether required manpower for execution of the project as mentioned in the DPP is made available		
23.	Whether progress of work in the field matches with the project target mentioned in the Bar Chart/CPM given and approved by the project authority		
24.	Whether financial progress in the field is consistence with the physical progress		
25.	Whether there is any deviation of the contract agreement		
26.	Whether there is any deviation of the approved DPP		
27.	Whether physical and financial target and achievement as reported in the 02 and 03 IMED's formats are in line with progress in the field		

A**reas for quality checks of Bridges and Culverts:**

Sl. No.	Aspects	Yes/No	Remarks
1.	Whether equipment/machinery positioned for the construction of foundation works and sub-structures are using methods/ techniques as mentioned in the drawings/design or as instructed by the engineer.		
2.	Whether in designing the bridge Navigational Clearance has been taken into account.		
3.	Whether approval of all the construction materials in respect to its specifications and concrete mix design and its		

Sl. No.	Aspects	Yes/No	Remarks
	strength (compressive) have been taken from the competent authority.		
4.	Whether quality (Grade) of deformed M.S. bar to be used in the construction (tensile strength/ elongation test/bend test has been carried out.		
5.	Whether the test reports on compaction of road sub-grade at both ends of the bridge approaches and check the 'construction joint' with the design provision to prevent subsidence/slippage.		
6.	Check the test reports for Setting Time and Compressive Strength of Cement Brand that is being used in the construction or it is as specified in the contract.		
7.	Check whether Artificial Island/Ring Bundh/Diversion has been completely removed after completion of the work		
8.	Check whether RCC work of 'Scour Pad' or 'Cut off Wall' has been completed as per design and specification		
9.	Check whether RCC work of the foundation has been done as per design and specifications		
10.	Check whether RCC work of Vertical Wall/Pier/Pier Cap has been done as per design and specifications		
11.	Check whether RCC work of Wing Wall has been done as per specifications		
12.	Check whether RCC work of Girder has been done as per design and specifications.		
13.	Check whether RCC work of Slab/Deck Slab is done as per design and specifications		
14.	Whether work of Wheel Guard is done as per design and specifications		

Sl. No.	Aspects	Yes/No	Remarks
15.	Whether Back Filling work is done as per design ad specifications.		
16.	Whether works of bridge/culvert approach is done as per design and specifications		
17.	Whether length of Pile has been completed cast as per specifications.		
18.	Whether Curing of construction work is done as per specifications for specified duration.		
19.	Whether CC Block work has been done as per approved design and specifications		
20.	Whether Geo-Textile has been used in CC Block work as per design and specifications.		
21.	Whether Particle Size Distribution (PSD), Aggregate Crushing Value (ACV) and Flakiness Index tests of materials have been carried out		
22.	Whether workability Slump/Cylinder test and Compressive Strength test of concrete have been carried out		
23.	Whether Pile Integrity test and Load test have been carried out by the contractor before commencing the Service Pile work		

Annexure-5

Checklist for quality check of Bituminous Pavement

The contractor shall not commence bitumen surfacing work until the job-mix formula has been approved in writing by the Engineer, including any adjustment to the job mix formula which the Engineer considers are necessary.

Sl. No.	Aspects	Yes/No	Remarks
1.	Whether Core Cutting machine test confirms bituminous layer above 50 mm thickness or as specified in the contract		
2.	Whether materials use in bituminous pavement re well graded and are as per specifications		
3.	Whether materials used in the bituminous pavement are as per specifications of the contract as per job mix formula approved by the engineer		
4.	Whether bitumen content in the bituminous pavement is ensured as suggested in job mix design or as per written instruction of the engineer		
5.	Whether temperature control of the materials mixing with bitumen is done as suggested in job mix design or as per instruction of the engineer		
6.	Whether temperature of laying of bituminous mix material is controlled as per instruction of the engineer		
7.	Whether bituminous layer compaction is done as per specifications		
8.	Whether Core cutting tests have been carried out by the department concerned as per specifications of the contract		
9.	Whether road Camber during bituminous mix laying and compaction is maintained as per design		
10.	Whether bituminous layer has been laid mechanically or manually or as per instruction of the engineer		
11.	Whether use of Asphalt Plant/Bitumen mix Paver machine/Tyre Roller/ Steel Roller etc. is ensured as per contract agreement to ensure quality work		