

**QUALITY MANAGEMENT FOR TAUNSA BARRAGE
REHABILITATION PROJECT**

S.M.A. Zaidi, Malik Ahmad Khan & Javed Asad

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1. SYNOPSIS

The safety and durability of any constructed product depends on the efforts made to ensure the conformance of the finished product to the design and technical requirements prescribed for the product. This ensures quality which in general terms is defined as “The totality of features and characteristics of a product or service, that bears on its ability to satisfy a given need”. In brief quality can be defined as “The degree to which the project fulfills the requirements.

Quality Management

Quality management is the process of creating and following policies and procedures in order to ensure that a project meets the defined needs that it was intended to meet.

In construction processes, the quality of constructed structures has to be properly managed to achieve safe and durable structures.

Quality management has the following general attributes:

- i. Quality Planning
- ii. Quality Assurance
- iii. Quality Control
- iv. Compliance of Non Conformance Report (NCR's)
- v. Quality Audits

This paper presents the Quality Management system used for construction of Taunsa Barrage Rehabilitation Project works, for sharing the quality aspects of the project works with our professional community. This presentation can also be considered as a case study.

2. INTRODUCTION

Taunsa Barrage is one of the most important diversion structures built across the Indus River and its tributaries. The Barrage serves a gross commanded area of about 2.351 million acres through the Muzaffargarh and D. G. Khan Canals, off-taking from left and right flanks of the Barrage respectively and also diverts water

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into the Chenab River through the Taunsa Panjad (T-P) link Canal on the left for mitigating serious shortages in Panjnad Canals.

In addition to regulation of irrigation supplies and flood flows, Taunsa Barrage also provides an arterial road bridge, a railway bridge, oil and gas pipelines and EHV transmission lines crossings over Indus River.

The barrage soon after its construction in 1958 ran into multiple problems of:

- i. Tendency of river to revert to its old course on the right with a severe curvilinear approach causing excessive sedimentation in the DG Khan canal;
- ii. Excessive retrogression of d/s water levels caused:-
 - ripping off skin concrete of the downstream floor
 - damage to friction blocks thereby adversely affecting the hydraulic efficiency of the structure,
 - limitation on pond level;
 - choking and malfunctioning of large number of pressure pipes, i.e. breakdown of subsurface flow monitoring system, and
 - defects in the hoisting mechanism and mechanical installations.

Works done under this project were aimed at mitigating the serious threats posed by above elements to the safety of the structure and ensuring sustainability of the canal systems being fed from this Barrage and to provide protection to the other vital national assets

3. THE PROJECT

The project comprised two International Competitive Bidding (ICB) Contracts, first Contract was for Civil Works (ICB-01) and 2nd Contract for M&E works (ICB - 02).

ICB-01 Contract included:

- i. Construction of a subsidiary weir (sub-weir).
- ii. Rehabilitation/strengthening of existing barrage and its components
- iii. Construction of guide banks
- iv. Construction of silt excluder
- v. Construction of a diversion channel
- vi. Remodeling of D.G. Khan canal Head Regulator
- vii. Gate Equipment for Sub Weir
- viii. Remodeling of existing Fish Ladders

ICB-02 Contract covered M&E works for Taunsa Barrage Emergency Rehabilitation and Modernization Project financed by the World Bank. It comprised:

- Renovation of the Barrage gates and hoists and improvements in the operating and control system for the Barrage and canal headworks as under:
 - o Rehabilitation of 31 gates of the main weir, (bay Nos. 31-61), plus 4 right undersluice gates No. 62-65 (replacement), plus Gate No. 8 in the navigation bay.
 - o 19 gates for the three canals off taking from the Barrage (Replacement of 7 gates each of D.G. Khan Canal and T.P. Link Canal and rehabilitation of 5 gates of Muzaffargarh canal.
- Procurement of necessary equipment for operation and maintenance. and
- Automation of gates operation and communication

4. DEFINITIONS

4.1 Quality Planning

Quality planning is basically the process of identifying the quality standards that are relevant to the project and determining how to satisfy them.

4.2 Quality Assurance

Quality Assurance constitutes all steps and actions taken and specifications/standards prescribed to set the requirements of the capabilities of the product required for acceptance.

4.3 Quality Control

Quality control constitutes the action and steps taken to ensure that the standards and specifications prescribed under quality assurance programme are achieved. Such steps are inspections, field and laboratory tests and submission of necessary reports.

4.4 Non Conformance Reports (NCR)

A non conformance report (NCR) is the intimation of the occurrence of non conformance of a product/process with reference to the capability standards set under quality assurance programme which has to be mitigated by carrying out instructions under quality assurance and rectification of the non conformance.

4.5 Quality Audit

Quality audit process constitutes monitoring, reporting and review of quality assurance and control report to assess the extent of success of quality assurance / quality control efforts and compliance reports of NCR's.

4.6 Project Quality Management System

Taunsa Barrage Rehabilitation Project established and maintained a documented Quality Management System to the requirements of the ISO 9001-2000 Standards.

Quality System basically consists of

- Organization resources;
- Taunsa Barrage Rehabilitation Project Quality Plan and management procedures;
- The Supervision Consultant's Quality Assurance Program;
- Approved Specifications;
- Approved Method Statements and Quality Inspection Plans (QIP) for permanent works
- Approved Health, Safety and Environment (HSE) Programme
- Quality Control and Quality Assurance records.

The quality management system procedures are listed as Annex-A.

5. REFERENCES AND QUALITY ASSURANCE (QA) STANDARDS

5.1 Standard References

Indicated in the Contract Documents for the Taunsa Barrage Emergency Rehabilitation and Modernization Project Contracts ICB-01 & ICB-02.

5.2 Contract References

- Employer's participation for review, approval, monitoring and other QA activities were indicated in the contract documents.
- Supervision Consultants participation in review, approval, monitoring and other QA activities is indicated in the Particular Conditions of the Contract and the Contract for Consultancy Services.

5.3 Quality System References

For ICB-01 Contract:-

- i. General Conditions of Contract Part 1 (FIDIC) Clauses 36 & 37.
- ii. Technical Specifications
 - a. SP-9 Approval of Materials and Equipment.
 - b. SP-10 Contractor's Quality Assurance Plan.

For ICB-02 Contract

- i. General Conditions of Contract Part 1 (FIDIC) Clauses 36 & 37.
- ii. Method of Performing the Work – volume-I of Contract Agreement.

- iii. SP-9 Approval of Materials and Equipment.
- iv. SP-10 Contractor's Quality Assurance Plan.
- v. Technical Specifications items
 - o 1.6 Standards
 - o 1.7 Materials
 - o 1.8 Test of Materials
 - o 1.18 Inspection and Testing
 - o 2.5 Commissioning Tests and Inspection

6. QUALITY PLANS

Taunsa Barrage Rehabilitation Project was a large project involving very heavy qualities of earthwork, stones, concrete, sheet piling, regulating gate works and other allied works.

Naturally the quality management had a very important role in the sustainability of the project works.

To ensure a proper quality management, the Engineer and Contractor both prepared their quality assurance programme and plan respectively and implemented with honesty and zeal. The details of these programmes/plans are too bulky/voluminous to form a part of this paper. However a brief introduction to the contents of Engineer's quality assurance plan (EQAP) and construction project quality plan (PQP) appears below and is followed by the actual steps and actions taken for ensuring good quality management by honouring the engineer and contractor's programme and plan. The project was executed under two Contracts ICB-01 and ICB-02.

7. PROJECT ORGANIZATION

The hierarchical interrelationships between the Employer, the Consultants and Contractor are identified in Annex-B.

Synthesis of the tasks and responsibilities between staff are defined in the Project Responsibilities Matrix (Annex-C)

7.1 Operative Modalities

7.1.1 General

The elements described in the following paragraphs addressed the role of the Supervision Consultants in relation to the requirements of the project contracts.

7.2 Management Responsibility

The Supervision Consultants being the Engineer were made responsible for Quality Assurance / Control. The Consultants Chief Resident Engineer was responsible for Quality activities performed in support of the Employer at the site.

The Supervision Consultant's QA Specialist provided supervision and support in relation to QA/QC tasks at site.

7.3 Authorization and Project Quality Policy

The Employer was authorized to exercise the duties and authorities as owner of the Project.

The Supervision Consultant monitored, reviewed and provided a detailed resume of the contractor's engineering, procurement, Contract Administration and construction activities during implementation of the project. Major tasks undertaken are as follows:

7.4 Engineering

- Review the contractor's planning documents, data and verify his basis of preparation;
- Monitor submission of documents and review in a timely manner the contractor's documents and compliance with the contract specifications;
- Provide timely notice to PMO of events or trends, which could have potential negative impacts on the project and proposed solutions;
- Be cognizant of and pro-active in continued review of the project for design improvements, which may result in long term benefits including cost reductions, schedule improvements and/or better operability, maintainability, etc.

7.5 Procurement

- Respond to any major design or plan change requests submitted by the contractor;
- Attend any model tests or final workshop inspections for the plants to be installed in the project;
- Monitor procurement and expediting activities performed by the contractor;
- Witness In-works performance, Commissioning and reliability tests for major items of plant. Assess, approve/reject final test reports.

7.6 Construction

- Maintain the necessary presence until the site is cleared by the contractor.
- Develop an effective working relationship with the contractor, so that clear and appropriate lines of communication are established and maintained throughout the construction, commissioning and testing phase of the project;

- Review, comment and monitor the contractor's performance with respect to the prescribed procedures, for example:
 - o Project Execution Management Plan,
 - o Traffic Management Plan
 - o Environmental Management Plan.
 - o Canal Closure Programme
 - o Monitor and make the contractor ensure compliance with design specifications and standards.
 - o Communication Plan

In order to provide PMO with documentation that shows work was performed in accordance with adequate quality control procedures:

- Certify on satisfaction the contractor's requests for payment with reference to the contract requirement;
- Review and comment on the contractor's. 'As Built' Documentation before final acceptance;

To provide products, which meet the Employer's valid requirements on time a management system policy, was implemented by the Engineer with the following objectives:

- i. Monitor quality compliance with the standards prescribed in the Contract, codes and statutory regulations;
- ii. Satisfy the appropriate requirements of ISO 9002 Standards;
 - Promote quality and service standards as being the responsibility of each and every employee in accordance with the contractor's approved PQP;
 - Establish and maintain a high degree of quality awareness at every level in the Organization, and encourage individual initiative in achieving performance and quality project delivery;
 - Respond in a timely and constructive manner to Contractors quality issues and monitor that appropriate remedial action is taken;
 - Monitor observance of the Project Schedules;
 - Revise the allocated Budgets where necessary and advise the Employer of overruns that may occur due to additional quality requirements for the project;
 - Monitor compliance with safety plan in relation to the establishment of a safe work site in accordance with the approved HSE plan;

1. Monitor resolution of environmental issues such as:
 - Disposal of waste materials such as oil, rubber tires, batteries, wood cardboard and paper, among others,
 - Implementation of sanitary facilities and disposal of sanitary waste,
 - Availability of potable drinking water,
 - Contamination of off project water sources,
 - Control of dust and noise,
 - Others related to the environments as prescribed in the Environment Management Plan of the project.
2. Monitor training and performance of contractor's QA/QC personnel;
3. Monitor and measure quality performance and provide appropriate feed back to relevant employees;
4. Ensure that where quality control and audit process were established, their operation was always supportive of the construction activities while fulfilling their special assurance role;

To meet these objectives a systematic method of managing requirements of the contract was established.

It was ensured that personnel concerned with quality, safety, productivity, environment and management were fully familiar with the EQAP, PQP and associated procedures.

All personnel employed on this project performed their duties in accordance with the requirements of quality plans and in compliance with the Taunsa Barrage Rehabilitation Project QA/QC procedures and any specific project instructions.

7.6.1 Quality Management Representative

The contractor with concurrence of the Engineer appointed a Quality Assurance Manager (QAM) as Contractor's Representative for the project quality system implementation.

The contractor's QA Manager was represented and supported by Field Engineers/ Inspectors who assumed responsibilities in his temporary absence or when overtime or shift work was involved.

Consultant's Chief Resident Engineer interfaced directly with the Contractor's QAM for QA issues that developed, and generated reports to keep PM informed of major issues and trends that developed and needs for correction through periodical reports.

7.7 Design Control

The basic, conceptual, tender level and detailed design of all the component structures was done by the Consultants design office at Lahore and all the

construction drawings were also prepared and issued for construction from Lahore. Necessary quality standards were maintained.

However some supplementary and shop drawings etc were initiated prepared by the contractor and submitted to the Engineer for approval.

Supervision Consultant's Project Manager at Lahore reviewed all submittals by the contractor relating to the design and construction activities, as required for compliance with the applicable technical standards and Employer's Requirements for the Taunsa barrage Rehabilitation Project. Principal submittal categories are:

Conceptual Design:

- Construction Schedule,
- General layout Drawings of major project features,
- Project Procedures manual,
- Project Quality Assurance Manual

Detailed Design / Drawings

- Construction Drawings,
- Shop Drawings,
- Fabrication drawings,
- Method Statements,
- Catalogue clips.

During Construction

- Progress reports and Schedule updates,
- Monitor inspection and documentation of construction activities: Excavation, placement of fill, concrete work, foundation preparation and treatment, erection and testing of electrical and mechanical equipment,
- Approve milestones for the purposes of payment,
- Monitor quality control testing and results,
- Approve sources of materials,
- Approve waste disposal locations,
- Approve details for quality control of water
- Approve outline of Environmental Management plan and monitor implementation,
- Organize and document reports of weather station,
- Project signs,
- Monitor HSE arrangements

Project Completion

- Monitor and certify Substantial Completion,
- Approve request for moving out of site and final cleanup,
- Final Inspection and certification of final completion,
- Review closeout submittals,
- Review Taking over submittals.

7.8 Document and Data Control

Supervision Consultant monitored implementation of the document and data control procedures for the project established in the Project Quality Plan, and appropriate control of its own documents, data and correspondence based on the specific coding established for the project.

7.9 Construction Process Control

Supervision Consultants' chief Resident Engineer and assigned staff at site monitored implementation of the EQAP, during the different stages of construction in accordance with the approved and updated PQP & PIP. It was ensured that the contractor's operations personnel are thoroughly aware and committed to the quality requirements involved in each part of the work and that the appropriate hold points for verification of the QC and testing personnel are being followed, as established in the approved applicable specifications, work method statements and QIPs.

Supervision Consultant's staff was fully involved during construction as part of the Quality Assurance process, in addition to QA and QC activities by the Contractor, for verification that appropriate quality related procedures are implemented. The Consultant's Chief Resident Engineer interfaced closely with the Contractor's QA Manager, as needed, in the execution of the work and the Employer was kept informed of the quality of the work. The Supervision Consultant's Chief Resident Engineer and staff performed the following main tasks:

- i. Review of the Construction Schedule and monthly evaluation of physical, economic and financial progress against the established schedule and budgets;
- ii. Attend weekly meetings with the Contractor regarding progress of the work;
- iii. Monitor the Quality of all the Permanent Works and verification of compliance with the Employer's Technical Requirements, Drawings, Specifications, Work Method Statements and that the work is carried out by the Contractor in a healthy, safe and appropriate manner in accordance with highest international engineering standards and practices;

- iv. Prepare and issue Non Conformance Report (NCR) to Contractor when necessary;
- v. Monitor implementation of QC procedures and test results and quality of workmanship and that the materials used in the Works are in accordance with the Contract requirements, including environmental protection requirements;
- vi. Ensure that the equipment and staff provided and used by the Contractor are adequate to construct the Works and maintain the program;
- vii. Participate in field verification activities and monitor results of testing related to Taking-Over Certificate Performance Certificate and Final Acceptance of the Works.
- viii. Supervision Consultant's Resident Staff prepared the following reports as follows:
 - a. Daily reports of the work performed by the Contractor at each location. Reports were submitted to the Supervision Consultant's Chief Resident Engineer on the following day and remained in the project files as documentation for the project. The daily reports included information regarding resources used and work performed at each location, and comments regarding quality measures and Contractor's personnel observed and any difficulties encountered.
 - b. A weekly report was prepared by the Supervision Consultant's Chief Resident Engineer with respect to progress and other quality related issues and sent by email or fax to the Supervision Consultant's Project Manager at Lahore, with copy to the Employer. The report included weekly summary of progress versus weekly schedule presented by the Contractor and summary of the quality control testing results presented by the Contractor's quality control unit.
 - c. The monthly report summarized the activities performed by the Contractor in each area, progress of the work with respect to the approved schedule and summary of the quality attained on the project during each period, including actions taken to recover delays and status of resolution of NCR and quality control summaries.

7.10. Inspection and Testing

A specific Project Procedure "Inspection and Testing" was developed for this project and included in the Contractor's PQP.

Supervision Consultant's resident staff at the site ensured that appropriate Quality Control Plans – QCP, Operating Procedures (Method Statements) and work instructions were established to define the responsibilities and the methods necessary to carry out inspection and tests for verification of conformance of the works to the requirements and were known to the contractor's operations personnel.

All the inspectors and testing process was not only witnessed by the Engineer's staff, all the tests were performed jointly by the quality staff of engineer and contractor in a common laboratory.

Conformance was verified through the QCP and documented inspection and testing of:

- i. Goods, equipment, materials purchased or supplied by the Contractor received at Site before incorporating permanent works.
- ii. Verification, identification and recording of information in order to allow the immediate recall and replacement in the event of non compliance to specified requirements;
- iii. Materials and products, during the construction activities (in-process), according to the quality control plans. The Contractor's QC staff provided the Supervision Consultant's staff with weekly and monthly summaries of QC test results on concrete and earthwork materials, including statistical controls, tables and graphs of test results. Supervision Consultant's staff had full access to all the QC testing information as required for quality audits. The Contractor presented weekly and monthly summaries of the materials test results, which were discussed in weekly meetings held by Supervision Consultant's Resident Staff with contractor's QA/QC personnel. Two types of Quality Control and Quality Assurance reports were presented by the Contractor to the Supervision Consultant's resident staff as follows:
 - a. Monthly Quality Control and Quality Assurance Reports: The Contractor provided a written quality control and quality assurance report each month using summary formats decided upon to adequately document the quality control and quality assurance process.
 - b. Periodic Quality Control and Quality Assurance Reports: The Contractor also prepared written quality control and quality assurance reports at the end of each quarter;
- iv. The Employer with support from the Supervision Consultant's Chief Resident Engineer reviewed the monthly reports of test results presented by the Contractors QC staff. He also monitored testing performed in the field by the QC staff to verify that they were following acceptable standard practices. He monitored that test results were reported timely and that appropriate forms were used to record all inspection and/ or testing activity and that records of inspections and

testing of the works were collected, filed and maintained by the Contractor's QAM in the Site Office and in the Laboratory.

7.10.1. Control of Inspection, Measuring & Test Equipment (IMTE)

A specific Project Procedure, "Inspection, Measuring and Test Equipment Control", was developed for the Project as part of the PQP. Supervision Consultant's Chief Resident Engineer through his quality control staff monitored implementation of these procedures as approved and in accordance with the established standard practice. He ensured that the testing equipment was calibrated regularly and that the Checks/ Calibrations were performed by skilled personnel of QC staff.

7.10.2. Inspection and Test Status

Supervision Consultant's Chief Resident Engineer ensured that the inspection and test status of each part of the work were identified by suitable means, indicating the conformance or non-conformance of the product with regard to inspection and test performed, as established in the PQP.

7.11. Control of NCR

Supervision Consultants Chief Resident Engineer monitored Contractor's activities to verify that corrective actions were taken to resolve quality issues in accordance with the procedures indicated in the PQP. A specific Project Procedure, "Control of Non-Conformances" developed and implemented.

Two types of NCR were considered:

- i. Management System NCRs, regarding deficiencies in the implementation/ application of the procedures;
- ii. NCRs related to products, materials, equipment, sections of work etc.

The NCRs were identified by the Consultant's QA/QC staff, during the internal System Inspection and Audits. Non conformances were notified to the Contractor's QA Manager, who reported directly to the Contractors Project Manager supported with the technical staff's investigation report on the potential problems and proposed solutions to resolve the situation in each case. The Supervision Consultants reviewed the proposed solutions to NCRs and ensured that appropriate actions were implemented to correct the deficiencies and to prevent their recurrence.

7.11.1. Corrective and Preventive Actions

Supervision Consultant's Chief Resident Engineer ensured that the corrective and preventive actions for non conformances were implemented and recorded in accordance with the approved PQP.

7.11.2. Handling, Storage, Packaging, Preservation and Delivery

Supervision Consultant's Chief Resident Engineer ensured that adequate care was exercised by the contractor to control the activities related to handling,

storage and preservation of the materials/ products at the Site in order to prevent damages or deteriorations and to avoid dispatch of non conforming materials from the storage areas.

7.12 Control of Quality Records

A quality record is an item of objective evidence generated during the construction process on a project which demonstrates that the specified quality has been achieved for that work activity to which the record relates. A documented procedure is prepared to ensure that the identification, collation, indexing, access, filing, storage, retrieval, maintenance and disposition of quality records is undertaken at all project stations/offices.

Supervision Consultant's Chief Resident Engineer ensured that the Contractor's personnel used adequate care for the management (identification, collection, record, and maintenance) of the quality records originated by the QA/QC personnel or by external testing units.

The Project Quality records and Internal/ external audit reports were filed in the Site office and summaries and reports were prepared in accordance with acceptable standard practice to demonstrate conformance to the Contract Specifications and effective operation of the Quality System.

7.13. Personnel Training and Management / Competency, Awareness for Training

The Project Manager ensured that the following were implemented:

- Determine the necessary competence for personnel performing work affecting quality;
- Provide training for satisfying these requirements;
- Evaluate effectiveness of the training given at suitable intervals;
- Ensure that all personnel of the Consultant are aware of the relevance and importance of their actions for achieving quality objectives; and
- Maintain records of education, training, skills and experience of all personnel. Documented Procedures were prepared for the foregoing items.

Supervision Consultant's Resident Engineer managed implementation of the training program for all personnel performing activities affecting quality by the Contractor.

7.14. Statistical Techniques

Supervision Consultant's Chief Resident Engineer reviewed the Contractors QA/QC reports, summarized results of testing using statistical evaluation of the processes/ works, materials supplied, NCR, materials incorporated in the works in accordance with acceptable standard practice.

The concrete manual lays down a confidence level of 85% on quality tests. Considering the importance, sensitivity and complexity of the project, a 100% confidence limit was prescribed and ensured. In the case of uncertainties, core testing and NDE method were resorted to.

7.15. Internal Quality Audits

The Consultant prepares a documented Procedure for the conduct of Internal Quality Audits, at planned intervals, by the Quality System Manager! Quality Assurance Engineer to verify that all activities in various departments of the Consultants are being carried out in accordance with the QMS and approved guidelines and procedures. Any deviations and nonconformities are identified and suitable Corrective Action Requests (CARs) are raised. An Audit Report is prepared, signed, and distributed to all concerned. After a reasonable interval of time the QSM/QAE makes a follow-up visit to verify that the required corrective actions and preventive actions were taken by the concerned department/section. Similarly, periodic Quality Audits of the Contractor's organization are carried out to verify that his work activities are all in compliance with the Contract Specifications, approved Method Statements and Procedures and his own Project Quality Assurance Plan duly approved by the Consultant.

7.16. Equipment / Plants Management

Supervision Consultant's Chief Resident Engineer monitored Contractor's implementation of equipment maintenance program and efficiency of availability of the equipment for the project work and required corrective actions and gave specific advice to the Contractor as needed.

8. SOURCE APPROVALS

8.1 For Civil Works

The first step in the quality assurance/control (QA/QC) activities exercised on the project was the source approval of the materials intended to be used on the project by the Contractor. Source approval was granted for construction materials including steel reinforcement, aggregates, stone, cement, PVC water stops, and admixtures etc on the basis of prescribed tests, factory capabilities and will tests conducted by factory laboratory. After the source approval, regular tests were conducted in the laboratory established at the site for aggregates, concrete, bricks. For materials such as cement, steel reinforcement, samples were taken periodically from the consignments delivered at site as provided in the technical specifications of the project. These materials were got tested from Central Materials Testing Laboratory (CMTL) WAPDA, University of Engineering & Technology, Lahore, PITAC, Lahore and Deptt of earth sciences Punjab University Lahore. List of source approvals is presented in the following Table.

SOURCE APPROVAL OF CONSTRUCTION MATERIALS FOR CIVIL WORKS

| S.# | Material | Approved Source /Name of the Supplier |
|------------|---|---|
| 1 | Ordinary Portland Cement (OPC) | Maple Leaf, Askari, D.G Khan, Fauji, Kohat and Bestway Cement Factories |
| 2 | Fine & Coarse Aggregates | Sakhi Sarwar, Sanghar and Kohar Quarries, DG Khan District |
| 3 | Steel Reinforcement | 1. M/S Fazal Steel (PVT) Ltd, Islamabad 2. M/S Pak Steel, Islamabad |
| 4 | PVC Water Stops | M/S Decora Industries, Lahore |
| 5 | Admixtures for Concrete Water Reducing Agent (SIKA) Curing Compound (SIKA) Super Plasticizer (SIKA) Non Shrink Grout Joint Filler Bonding Compound Air Entraining Agents | M/S Imporient Chemical (PVT) Ltd, Lahore (SIKA Distributors) and FosRoc |
| 6 | Interlocks Sealants(Igas-R Black) for Sheet Piles | M/S Imporient Chemical (PVT) Ltd, Lahore (SIKA Distributors) |
| 7 | PVC Water Stops | M/s Khawaja Rubber Store, Lahore |
| 8 | Vibrating wire piezometer | M/s Roctest, Canada |
| 9 | Epoxy for Rawl Bolts (Lokfix) | M/s FOSROC, USA through Local Distributors |
| 10 | Joint Sealant for Construction Joints (Thioflex 600) | M/S FOSROC, USA through Local Distributors |
| 11 | Sheet Piles Interlocks Sealant (BELTAN) | M/S ARCELOR, |
| 12 | Joint Filler | M/s Mughal Brothers |
| 13 | Granulated Ground Slag | Thatta Cement Company, Attock Cement and Zeel Pak Cement factories |
| 14 | Slag Cement | Thatta Cement Company |
| 15 | Filter Blanket Material | Zinda Pir Quarry |
| 16 | Steel Reinforcement | M/s Hyundai Corporation Korea (INI Steel Company, Pohang) |

9. FREQUENCY OF TESTS FOR CONSTRUCTION MATERIALS PRESCRIBED FOR QUALITY ASSURANCE

9.1 For Civil Works

The testing frequency for various construction materials prescribed and used under the Project are contained in the following tables:

TESTING FREQUENCY FOR SOILS/EARTHWORK

| Sr. No. | Test | Designation | Testing Frequency |
|---------|---------------------------------------|------------------------|-------------------|
| 1 | Grain Size Analysis / Gradation Tests | ASTM C-136 & D-422 | 1 per 10,000 cft |
| 2 | Hydrometer | ASTM D-442 | 1 per 50,000 cft |
| 3 | Liquid Limit | ASTM D-4318 | 1 per 50,000 cft |
| 4 | Plastic Limit | ASTM D-4318 | 1 per 50,000 cft |
| 5 | Shrinkage Limit | ASTM D-427 | 1 per 50,000 cft |
| 6 | Specific Gravity | ASTM D-854 | 1 per 50,000 cft |
| 7 | Moisture Density Relationship | ASTM D-1557 | 1 per 50,000 cft |
| 8 | Moisture Density Relationship | ASTM D-698 | 1 per 50,000 cft |
| 9 | Field Density: Compacted Fill | ASTM D-1556 | 1 per 20,000 cft |
| 10 | Field Density: Structural Back fill | ASTM D-1556 | 1 per 2,000 cft |
| 11 | Field Density: Gravel Base | ASTM D-1556 | 1 per 5,000 cft |
| 12 | Relative Dry Density | ASTM D-4253 and D-4254 | 1 per 5,000 cft |

TESTING FREQUENCY FOR CEMENT

| Sr. No. | Test | Designation | Testing Frequency |
|---------|--|----------------------|---|
| 1 | Compressive Strength | ASTM C 348 and C 349 | 1 per 200 tons or 1 per month if consumption is < 200 tons |
| 2 | Initial and Final Setting Time (on Pure Paste) | ASTM C 191 | 1 per 200 tons or 1 per month if consumption is < 200 tons |
| 3 | Autoclave Expansion | ASTM C 151 | 1 per 200 tons or 1 per month if consumption is < 200 tons |
| 4 | Blaine's Specific Surface Area | ASTM C 204 | 1 per 200 tons or 1 per month if consumption is < 200 tons |
| 5 | Chemical Analysis | ASTM C 114 | 1 per 1000 tons or 1 after 3 months if consumption is < 1000 tons |

TESTING FREQUENCY FOR STEEL REINFORCEMENT

For each delivery of steel the supplier's certificate was submitted.

In addition six (6) samples per diameter were taken at random for determining the mechanical properties for a given lot or for 200 ton if the lot exceeded 200 tons. of the same type and from the same factory/source.

If any characteristic gave an unsatisfactory result, a new set of six (6) samples from the same lot or batch was put to tests on the characteristic in question. If the results of the new tests were all satisfactory, the reinforcing bars were accepted. If this was not the case, the bars were considered defective and were not allowed to be incorporated in the project works.

| Sr. # | Tests | Designation | |
|-------|-------------------------------------|-------------|--|
| 1 | Size and weight | ASTM A 615 | |
| 2 | Elongation | ASTM A 615 | |
| 3 | Bending test | ASTM A 615 | |
| 4 | Tensile strength and yield strength | ASTM A 615 | |

TESTING FREQUENCY FOR FINE AGGREGATE

| Sr. No. | Test | Designation | Testing Frequency |
|---------|--------------------------------|-------------|---|
| 1 | Sieve Analysis | ASTM C-136 | 1 for 5,000 cft |
| 2 | Materials Passing # 200 Sieve | ASTM C-117 | 1 for 5,000 cft |
| 3 | Unit Weight | ASTM C-29 | 1 for 10,000 cft |
| 4 | Specific Gravity | ASTM C-128 | 1 for 10,000cft |
| 5 | Absorption | ASTM C-128 | 1 for 10,000cft |
| 6 | Moisture Content | ASTM C-566 | 1 for 10,000 cft |
| 7 | Soundness | ASTM C-88 | 1 for 50,000 cft |
| 8 | Clay Lumps & Friable Particles | ASTM C-142 | 1 for 20,000 cft |
| 9 | Sand Equivalent | ASTM C-2419 | 1 for 20,000 cft |
| 10 | Organic Impurities | ASTM C-40 | 5 per source for initial approval. 1 per month after approval per source or 50,000cft |
| 11 | Light Weight Particles | ASTM C-123 | 1 for 50,000 cft |

| Sr. No. | Test | Designation | Testing Frequency |
|---------|--|-------------|---|
| 12 | Petrographic Analysis | ASTM C-295 | 3 no. per source for initial approval. Once every 3 months after approval per source if and as required by the Engineer |
| 13 | Mortar Bar Test for Potential Alkali Silica Reactivity | ASTM C-227 | As required by the Engineer. |

TESTING FREQUENCY FOR COARSE AGGREGATE

| Sr. No. | Test | Designation | Testing Frequency |
|---------|--|-------------|--|
| 1 | Sieve Analysis | ASTM C-136 | 1 for 5,000 cft |
| 2 | Materials Passing # 200 Sieve | ASTM C-117 | 1 for 5,000 cft |
| 3 | Unit Weight | ASTM C-29 | 1 for 10,000 cft |
| 4 | Specific Gravity | ASTM C-127 | 1 for 10,000cft |
| 5 | Absorption | ASTM C-127 | 1 for 10,000cft |
| 6 | Moisture Content | ASTM C-566 | 1 for 5,000 cft |
| 7 | Soundness | ASTM C-88 | 1 for 50,000 cft |
| 8 | Clay Lumps & Friable Particles | ASTM C-142 | 1 for 50,000 cft |
| 9 | Los Angeles Abrasion | ASTM C-131 | 1 for 20,000 cft |
| 10 | Light Weight Particles | ASTM C-123 | 1 for 50,000 cft |
| 11 | Petrographic Analysis | ASTM C-295 | 3 no. per source for initial approval. Once every 3 months after approval per source if and as required by the Engineer. |
| 12 | Mortar Bar Test for Potential Alkali SILICA Reactivity | ASTM C-227 | As required by the Engineer. |

TESTING FREQUENCY FOR CONCRETE

| | | |
|----------------------|-------------|---|
| Compressive Strength | ASTM C-39 | 1 for 2,000 cft per class per batch plant |
| Slump | ASTM C-143 | 1 for 2,000 cft per class per batch plant |
| Air Content | ASTM C-231 | 1 for 2,000 cft per class per batch plant |
| Temperature | ASTM C-1064 | 1 for 2,000 cft per class per batch plant |
| Field Density | ASTM C-138 | 1 for 2,000 cft per class per batch plant |

A set of minimum three cylinders was moulded from each pour of concrete irrespective of the above volumes and tested at prescribed periods.

TESTING FREQUENCY FOR ADMIXTURES

| | | |
|--|------------|-------------|
| Air Entrainment | ASTM C-260 | As required |
| Admixtures (water reducing) | ASTM C-494 | As required |
| Admixtures plasticizers/ retarders, accelerators | ASTM C-494 | As required |
| Curing Compound | ASTM C-309 | As required |

9.2 For Mechanical and Electrical Works

Technical Specifications of the project prescribed that materials shall be new and of first class quality, suitable for the purpose, free from defects and imperfections, and of the grades and types listed in the Contract Agreement, or their equivalents. However, while selecting the materials the Contractor shall keep in view the water analysis results and may propose materials having better qualities to resist the chemicals present in water.

Certified material test reports were furnished in triplicate to the Engineer as soon as possible after the tests were made. The test certificate identified the component for which the material was to be used and contained all information necessary to verify compliance with the Specifications.

M/s China National Electric Wire & Cable Import & Export Corporation (CCC) with Jiajiang Hydraulic Machinery Works (JHMW) as their nominated sub contractor were allotted the ICB-02 contract for rehabilitation and modernization of gates. According to the Contract, items manufactured by the Contractor had to under go a pre-shipment inspection by the Employer's Representative.

9.2.1 Jiajiang Hydraulic Machinery Works

As a specialized hydroelectric equipment manufacturer in China, JHWM has contracted with over 30 national hydro-power projects of large to medium size in China including three gorges dam. The Factory possesses "CERTIFICATE OF CONFORMITY OF QUALITY SYSTEM CERTIFICATION" according to STANDARD "GB/T 19001-1994 IDT ISO9001-1994".

JHWM is also an international supplier of gate equipment and cranes, The JHWM has successfully completed following International Contracts.

- Masjed Hydropower Project in Iran, 1997-1999;
- Pak Phanang Water Conserveyed in Thailand 1995-1997.
- Ghazi Barotha Hydropower Project. Pakistan 1997-2002.
- AITEK dam of SYNAS Project in Kazakhstan, 2002-2004.
- Merowe dam in Sudan, 2004 to date.
- Myanmar Paunglaung HPP, 1999-2002

Quality Policy of JHWM

- To satisfy customer with every product;
- To abide by standards and enforce principles rigorously;
- To upgrade all members' quality is crucial to quality improvement.

1. Testing at Source

As part of QA arrangement following three pre-shipment inspection visits to JHWM in Sichuan Province of China were made by project teams.

- i. November 07 to 12, 2006
- ii. January 09 to 19, 2007
- iii. July 12 to 20, 2008

A list of items inspected during these visits is given below

- i. Items inspected during first visit
 - a. Gate leaf for under sluices gate (1)
 - b. Embedded parts for Bulkhead gate for # 62 under sluice gate (1)
 - c. Embedded parts for Bulkhead gate for standard weir gate (1)
 - d. Side beam of weir gate (1)
 - e. Weir gate roller guard details (1)
 - f. Slide sealing place details for weir gate (1)
 - g. Under sluice gate roller guard details (1)

- h. Under sluice gate rocker assembly (1)
- i. T.P. Link fixed wheel gate (1)
- j. Under sluice gate roller train detail (1)
- ii. Items inspected during third visit were mainly related to electrical systems and other equipments. Being too large in number, details are not being included.
 - a. Hoist Assembly for under sluice gates (1)
 - b. Roller Trains (6)
 - c. Rocker Assembly (1)
- iii. Items inspected during third visit were mainly related to electrical systems and other equipments. Being too large in number, details are not being included.

Following Pre-shipment Inspection tests were conducted:

Pre-shipment Inspection Tests

ICB-02 contractor has conducted following Inspection test in Jiajiang (JHMW), China.

| Sr.No | Description of Inspection | Carried out | Date | Results | Remark | |
|--------------------------------|---|-------------------------------|-----------------------------|--------------|--------------|--------------|
| 1 | Dimension Inspection | | | | | |
| | T.P Link Canal Gates | Manufaturer/Jiajiang, China | 2006.11.07 | Pass | Page 2-17 | |
| | Undersluice Gates | | | | | |
| | Gate leaves | Manufaturer/Jiajiang, China | 2006.11.08 | Pass | Page 67-76 | |
| | Roller train | Manufaturer/Jiajiang, China | 2006.11.08 | Pass | Page 111-115 | |
| | Rocker Assembly | Manufaturer/Jiajiang, China | 2006.11.08 | Pass | Page 158-160 | |
| | Roller guard | Manufaturer/Jiajiang, China | 2006.11.08 | Pass | Page 165-168 | |
| | Side sealing plate | Manufaturer/Jiajiang, China | 2006.11.08 | Pass | Page 174-176 | |
| | Guide frame for bulk head gate | Manufaturer/Jiajiang, China | 2006.11.07 | Pass | Page 206-211 | |
| | Weir Gates | | | | | |
| | End beam/gate leaves | Manufaturer/Jiajiang, China | 2006.11.08 2007.01.06 | Pass | Page 3-19 | |
| | Roller train | Manufaturer/Jiajiang, China | 2006.11.08 2007.01.06 | Pass | Page 51-53 | |
| | Rocker Assembly | Manufaturer/Jiajiang, China | 2006.11.08 2007.01.06 | Pass | Page 79-80 | |
| | Roller guard | Manufaturer/Jiajiang, China | 2006.11.08 2007.01.06 | Pass | Page 87-109 | |
| | Side sealing plate | Manufaturer/Jiajiang, China | 2006.11.08 2007.01.06 | Pass | Page 117-121 | |
| Guide frame for bulk head gate | Manufaturer/Jiajiang, China | 2006.11.07 2007.01.06 | Pass | Page 197-206 | | |
| 2 | Material Inspection | | | | | |
| | T.P Link Canal Gate | Manufaturer/Jiajiang, China | 2006.11.07 | Pass | Page 46-62 | |
| | Undersluice Gates | | | | | |
| | Gate leaves/Roller train | Manufaturer/Jiajiang, China | 2006.11.08 | Pass | Page 120-141 | |
| | Roller guard/Side sealing plate /Rocker Assembly | Manufaturer/Jiajiang, China | 2006.11.08 | Pass | Page 181-200 | |
| | Guide frame for bulk head gate | Manufaturer/Jiajiang, China | 2006.11.07 | Pass | Page 215-222 | |
| | Hoist | Manufaturer/Jiajiang, China | 2007.01.07 | Pass | Page 264-295 | |
| | Weir Gates | | | | | |
| | End beam/gate leaves | Manufaturer/Jiajiang, China | 2006.11.08 2007.01.06 | Pass | Page 33-49 | |
| | Roller train | Manufaturer/Jiajiang, China | 2006.11.08 2007.01.06 | Pass | Page 60-77 | |
| | Roller guard/Side sealing plate /Rocker Assembly | Manufaturer/Jiajiang, China | 2006.11.08 2007.01.06 | Pass | Page 128-149 | |
| | Guide frame for bulk head gate | Manufaturer/Jiajiang, China | 2006.11.08 2007.01.06 | Pass | Page 216-222 | |
| Hoist | Manufaturer/Jiajiang, China | 2007.01.07 | Pass | Page 264-307 | | |
| 3 | Purchased Products Certificate and test report | | | | | |
| | T.P Link Canal Gate | Manufaturer/Jiajiang, China | 2006.11.07 | Pass | Page 63-64 | |
| | Undersluice Gates | Manufaturer/Jiajiang, China | 2006.11.08 | Pass | Page 142-156 | |
| | Rubber Sealing | Manufaturer/Jiajiang, China | 2006.11.08 | Pass | Page 201-204 | |
| | Hoist | Manufaturer/Jiajiang, China | 2007.01.07 | Pass | Page 301-383 | |
| | Weir Gates | Manufaturer/Jiajiang, China | 2006.11.08 2007.01.06 | Pass | Page 153-195 | |
| | Rubber Sealing | Manufaturer/Jiajiang, China | 2006.11.08 2007.01.06 | Pass | Page 150-152 | |
| Hoist | Manufaturer/Jiajiang, China | 2007.01.07 | Pass | Page 312-425 | | |
| 4 | Welding Inspection | | | | | |
| | Weir Gates | | | | | |
| | End beam/gate leaves | Manufaturer/Jiajiang, China | 2006.11.08 2007.01.06 | Pass | Page 20-30 | |
| | Roller train | Manufaturer/Jiajiang, China | 2006.11.08 2007.01.06 | Pass | Page 54-58 | |
| | Rocker Assembly | Manufaturer/Jiajiang, China | 2006.11.08 2007.01.06 | Pass | Page 81-85 | |
| | Roller guard | Manufaturer/Jiajiang, China | 2006.11.08 2007.01.06 | Pass | Page 111-114 | |
| | Side sealing plate | Manufaturer/Jiajiang, China | 2006.11.08 2007.01.06 | Pass | Page 122-126 | |
| | Guide frame for bulk head gate | Manufaturer/Jiajiang, China | 2006.11.08 2007.01.06 | Pass | Page 207-213 | |
| | Hoist | Manufaturer/Jiajiang, China | 2007.01.07 | Pass | Page 243-257 | |
| | T.P Link Canal Gate | Manufaturer/Jiajiang, China | 2006.11.07 | Pass | Page 18-38 | |
| | Undersluice Gates | | | | | |
| | Gate leaves | Manufaturer/Jiajiang, China | 2006.11.08 | Pass | Page 77-100 | |
| | Roller train | Manufaturer/Jiajiang, China | 2006.11.08 | Pass | Page 116-118 | |
| | Rocker Assembly | Manufaturer/Jiajiang, China | 2006.11.08 | Pass | Page 161-163 | |
| | Roller guard | Manufaturer/Jiajiang, China | 2006.11.08 | Pass | Page 169-171 | |
| | Side sealing plate | Manufaturer/Jiajiang, China | 2006.11.08 | Pass | Page 177-179 | |
| | Guide frame for bulk head gate | Manufaturer/Jiajiang, China | 2006.11.07 | Pass | Page 209-211 | |
| | Hoist | Manufaturer/Jiajiang, China | 2007.01.07 | Pass | Page 231-244 | |
| | 5 | Performance Inspection | | | | |
| | | Hoist of Undersluice Gates | Manufaturer/Jiajiang, China | 2007.01.07 | Pass | Page 225-229 |
| Hoist of Weir Gates | Manufaturer/Jiajiang, China | 2007.01.07 | Pass | Page 226-230 | | |
| 6 | Anti-corrosion Inspection | | | | | |
| | T.P Link Canal Gate | Manufaturer/Jiajiang, China | 2006.11.07 | Pass | Page 41-45 | |
| | Undersluice Gates | | | | | |
| | Gate leaves | Manufaturer/Jiajiang, China | 2006.11.08 | Pass | Page 101-109 | |
| | Guide frame for bulk head gate | Manufaturer/Jiajiang, China | 2006.11.07 | Pass | Page 212-214 | |
| | Weir Gates | | | | | |
| End beam/gate leaves | Manufaturer/Jiajiang, China | 2006.11.08 2007.01.06 | Pass | Page 31-32 | | |
| Guide frame for bulk head gate | Manufaturer/Jiajiang, China | 2006.11.08 2007.01.06 | Pass | Page 214-215 | | |
| 7 | Heat treatment Inspection | | | | | |
| | Hoist of Weir Gates | Manufaturer/Jiajiang, China | 2007.01.07 | Pass | Page 259-262 | |
| | T.P Link Gates | Manufaturer/Jiajiang, China | 2006.11.07 | Pass | Page 39-40 | |
| Hoist of Undersluice Gates | Manufaturer/Jiajiang, China | 2007.01.07 | Pass | Page 260-262 | | |

10. QUALITY CONTROL DATA FOR CIVIL WORKS

10.1 Quality Control Manual

To support and stream line/facilitate the implementation of quality control activities, the project consultants prepared a Quality Control Manual and issued it for use by the supervisory staff on September 19, 2005, as the quality of constructed project structures had to be maintained to the prescribed Quality Assurance standards to achieve safety and durability of the constructed works.

This manual was prepared with an aim to provide a brief and handy compendium of technical provisions for construction of civil works under the project along with some explanatory additions, for reference and use by the supervisory staff who were expected to keep this manual with them, when on duty, which was possible because of its small volume.

However, contents of this manual were only for guidance and were not to vitiate the Contract provisions original or amended, i.e. this manual was not to be considered as legal instrument.

The inspection personnel were advised to keep the following famous quotes in view while performing their duties.

- A structure is as strong as its weakest point or for that matter as eye-leasing as its most ugly part.
- A job is as good or as bad as the consciousness or lousiness of the craftsman doing it.
- A lousy inspector gets a lousy job.

10.2 Summary of Quality Tests

Following Table depicts an abstract of tests conducted on various construction materials used for project works, jointly by the quality staff of the Engineer and the Contractor in the field and a common laboratories.

| Test Conducted in Field Laboratory | | | |
|---|---------------------------------|---------------------------|---------------------|
| Sr. # | Tests | Actually conducted | No. Required |
| 1 | Gradation of Coarse Aggregate | 1186 | 1012 |
| 2 | Gradation of Fine Aggregate | 587 | 518 |
| 3 | Unit Weight of Coarse Aggregate | 680 | 516 |
| 4 | Unit Weight of Fine Aggregate | 449 | 324 |
| 5 | Sp. Gravity of Coarse Aggregate | 537 | 494 |

| Test Conducted in Field Laboratory | | | |
|---|--------------------------------|---------------------------|---------------------|
| Sr. # | Tests | Actually conducted | No. Required |
| 6 | Sp. Gravity of Fine Aggregate | 329 | 278 |
| 7 | Sand Equivalent | 370 | 329 |
| 8 | Los Angles Abrasion | 410 | 292 |
| 9 | Absorption of Coarse Aggregate | 537 | 494 |
| 10 | Absorption of Fine Aggregate | 329 | 278 |
| 11 | Brick Testing | 214 | As per Requirement |
| 12 | Cylinder Testing | 31593 | 31050 |
| 13 | Cylinder Casting | 32256 | 31800 |
| 14 | Soundness of Coarse Aggregate | 63 | 85 |
| 15 | Soundness of Fine Aggregate | 69 | 66 |
| 16 | Atterberg Limits | 71 | As per Requirement |
| 17 | Temperature | 9182 | 9106 |
| 18 | Slump of Concrete | 8084 | 8007 |
| 19 | Cylinder Moulding | 32592 | 31800 |
| 20 | Field Density/Compaction Tests | 3986 | As per Requirement |

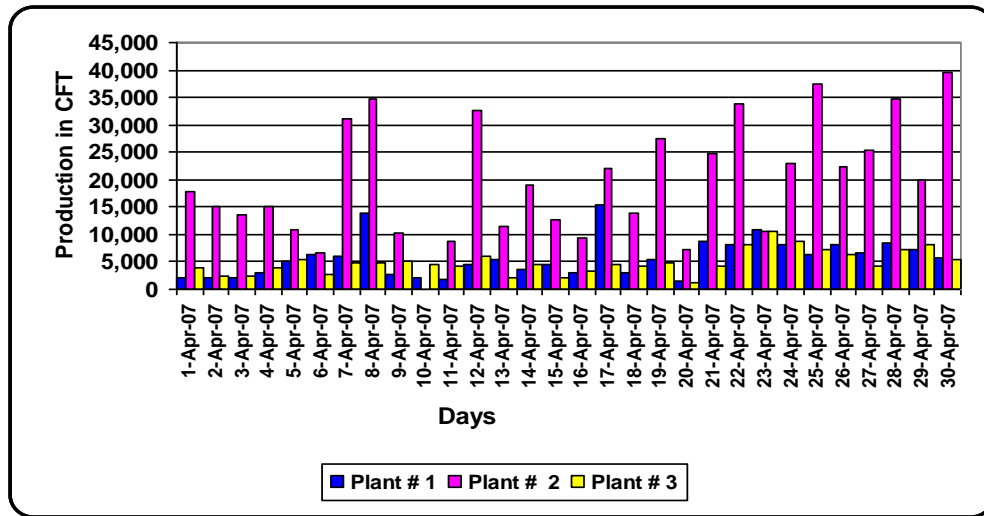
10.3 Weather Data

TAUNSA BARRAGE EMERGENCY REHABILITATION AND MODERNIZATION PROJECT MONTHLY WEATHER REPORT (A SAMPLE PAGE)

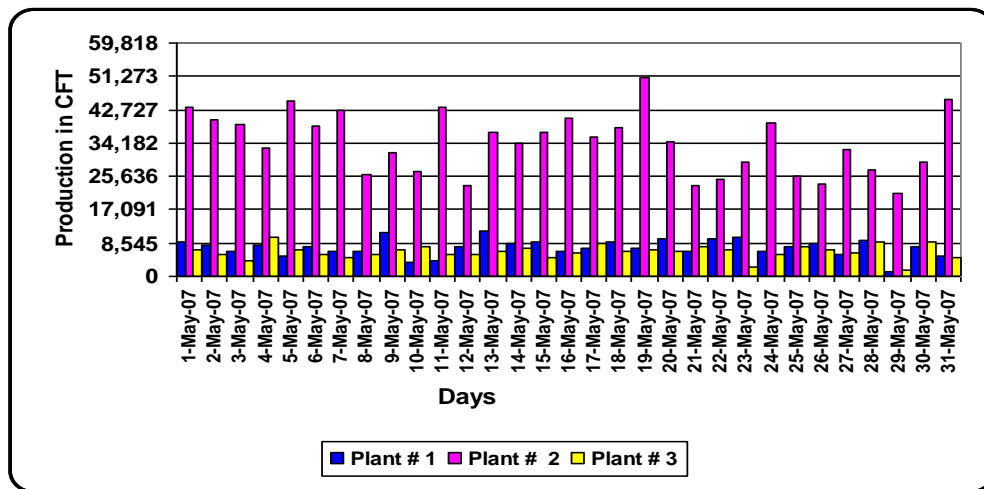
| Sr. No. | Date | Temperature | | Weather Condition | Humidity % | Remarks | | |
|---------|-------------|-------------|----------|-------------------|------------|----------------|----------------|-------------------|
| | | Max (C°) | Min (C°) | | | | | |
| 1 | 1-Apr-2007 | 36 | 17 | Sunny | 66 | | | |
| 2 | 2-Apr-2007 | 35 | 19 | Sunny | 87 | | | |
| 3 | 3-Apr-2007 | 37 | 18 | Rainy | 89 | | | |
| 4 | 4-Apr-2007 | 35 | 18 | Rainy | 87 | | | |
| 5 | 5-Apr-2007 | 37 | 20 | Rainy | 88 | | | |
| 6 | 6-Apr-2007 | 37 | 18 | Sunny | 86 | | | |
| 7 | 7-Apr-2007 | 38 | 22 | Sunny | 74 | | | |
| 8 | 8-Apr-2007 | 37 | 22 | Sunny | 76 | | | |
| 9 | 9-Apr-2007 | 40 | 21 | Cloudy/Sunny | 87 | | | |
| 10 | 10-Apr-2007 | 42 | 21 | Sunny | 85 | | | |
| 11 | 11-Apr-2007 | 44 | 22 | Sunny | 74 | | | |
| 12 | 12-Apr-2007 | 44 | 22 | Fog, Clear | 84 | Max. Temp. C°: | Min. Temp. C°: | Average Temp. C°: |
| 13 | 13-Apr-2007 | 43 | 24 | Fog, Clear | 87 | | | |
| 14 | 14-Apr-2007 | 46 | 24 | Sunny | 74 | | | |
| 15 | 15-Apr-2007 | 46 | 28 | Sunny | 74 | | | |
| 16 | 16-Apr-2007 | 47 | 29 | Sunny | 78 | | | |
| 17 | 17-Apr-2007 | 45 | 23 | Sunny | 74 | | | |
| 18 | 18-Apr-2007 | 41 | 24 | Sunny | 80 | | | |
| 19 | 19-Apr-2007 | 42 | 24 | Sunny | 86 | | | |
| 20 | 20-Apr-2007 | 44 | 24 | Sunny | 81 | | | |
| 21 | 21-Apr-2007 | 45 | 24 | Sunny | 83 | | | |
| 22 | 22-Apr-2007 | 46 | 25 | Sunny | 79 | | | |
| 23 | 23-Apr-2007 | 44 | 25 | Sunny | 82 | | | |
| 24 | 24-Apr-2007 | 46 | 23 | Fog, Clear | 76 | | | |
| 25 | 25-Apr-2007 | 47 | 25 | Sunny | 80 | | | |
| 26 | 26-Apr-2007 | 49 | 22 | Fog, Clear | 83 | | | |
| 27 | 27-Apr-2007 | 48 | 25 | Sunny | 86 | | | |
| 28 | 28-Apr-2007 | 49 | 22 | Fog, Clear | 89 | | | |
| 29 | 29-Apr-2007 | 49 | 25 | Sunny | 93 | | | |
| 30 | 30-Apr-2007 | 48 | 27 | Sunny | 91 | | | |

10.4 Production of Concrete

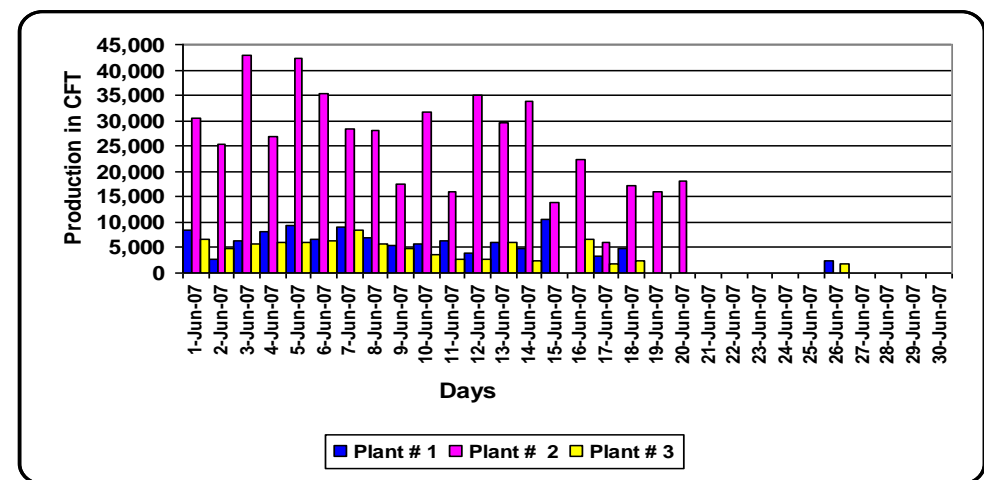
April 2007



May 2007



June 2007



The sample histograms shown above, present the monthly production of batching plants during the quarter Apr- Jun 2007. The total production of three Batching plants during the quarter (April to June 2007) stood at 3,025,514 Cft. The maximum daily production of three batching plants was recorded 64,777Cft on 19 May, 2007. Average daily production of these plants was 33,740 cft. The above record is for a sample quarter. Similar records were produced and are available for the whole construction period.


10.5 Tests Conducted on concrete

Sample data sheets of cylinder tests conducted on various grades/types of concrete used for construction of project follow:

10.6 Results of Tests Conducted on Soil for Earthwork Excavation and Filling

Sample data sheet for Field Density Test Results at various locations are presented below

April 2007

| PBC | | IRRIGATION AND POWER DEPARTMENT GOVT. OF PUNJAB | | | | | | | | | |  | |
|---|----------|---|------|---------|-------------------------|---------------------|----------|-------|------------|-------|------------|---|---------|
| Taunsa Barrage Emergency Rehabilitation And Modernization Project | | | | | | | | | | | | | |
| SUMMARY OF FIELD DENSITY TESTS FOR SUB-WEIR LEFT SIDE | | | | | | | | | | | | | |
| Sr. No. | Date | Area | | Layer # | Location | Description of Soil | Field | | Laboratory | | Compaction | | Remarks |
| | | From | To | | | | FDD g/cc | % M.C | MDD g/cc | % OMC | Obtd. | Reqd. | |
| 470 | 2/4/2007 | 2233 | 2313 | Final | Panel C Flat Portion | Sand | 1.596 | 11.7 | 1.75 | 13.6 | 91.2 | 90 | Pass |
| 471 | 2/4/2007 | 2233 | 2313 | Final | Panel C Flat Portion | Sand | 1.586 | 10.9 | 1.75 | 13.6 | 90.6 | 90 | Pass |
| 472 | 2/4/2007 | 2233 | 2313 | Final | Panel C Flat Portion | Sand | 1.612 | 12.8 | 1.75 | 13.6 | 92.1 | 90 | Pass |
| 473 | 31/03/07 | 2383 | 2453 | Final | Panel C Slope | Sand | 1.609 | 11 | 1.75 | 13.6 | 92 | 90 | Pass |
| 474 | 31/03/07 | 2383 | 2453 | Final | Panel C Slope | Sand | 1.58 | 10 | 1.75 | 13.6 | 90.3 | 90 | Pass |
| 475 | 31/03/07 | 2383 | 2453 | Final | Panel C Slope | Sand | 1.469 | 10 | 1.75 | 13.6 | 83.9 | 90 | Fail |
| 476 | 1/4/2007 | 2383 | 2454 | Final | Panel C Slope | Sand | 1.635 | 13.2 | 1.75 | 13.6 | 93.4 | 90 | Pass |
| 477 | 1/4/2007 | 2383 | 2454 | Final | Panel C Slope | Sand | 1.593 | 11.4 | 1.75 | 13.6 | 91 | 90 | Pass |
| 478 | 1/4/2007 | 2383 | 2454 | Final | Panel C Slope | Sand | 1.607 | 12.6 | 1.75 | 13.6 | 91.8 | 90 | Pass |
| 479 | 1/4/2007 | 2383 | 2454 | Final | Panel C Slope | Sand | 1.618 | 14.2 | 1.75 | 13.6 | 92.5 | 90 | Pass |
| 480 | 1/4/2007 | 2313 | 2380 | Final | Panel C Flat Portion | Sand | 1.629 | 13.4 | 1.75 | 13.6 | 93.1 | 90 | Pass |
| 481 | 1/4/2007 | 2313 | 2380 | Final | Panel C Flat Portion | Sand | 1.661 | 12 | 1.75 | 13.6 | 94.8 | 90 | Pass |
| 482 | 1/4/2007 | 2383 | 2453 | Final | Panel C Slope | Sand | 1.624 | 13.4 | 1.75 | 13.6 | 92.8 | 90 | Pass |
| 483 | 1/4/2007 | 2383 | 2453 | Final | Panel C Slope | Sand | 1.634 | 11.2 | 1.75 | 13.6 | 93.4 | 90 | Pass |
| 484 | 2/4/2007 | 2173 | 2233 | Final | Panel F | Sand | 1.546 | 8.9 | 1.75 | 13.6 | 88.3 | 90 | Fail |
| 485 | 2/4/2007 | 2173 | 2233 | Final | Panel F | Sand | 1.547 | 10.7 | 1.75 | 13.6 | 88.4 | 90 | Fail |
| 486 | 2/4/2007 | 2173 | 2233 | Final | Panel F | Sand | 1.567 | 15.7 | 1.75 | 13.6 | 89.5 | 90 | Pass |
| 487 | 2/4/2007 | 2173 | 2233 | Final | Panel F | Sand | 1.609 | 12.4 | 1.75 | 13.6 | 91.9 | 90 | Pass |
| 488 | 2/4/2007 | 2173 | 2233 | Final | Panel F | Sand | 1.463 | 18.9 | 1.75 | 13.6 | 83.6 | 90 | Fail |
| 489 | 2/4/2007 | 2173 | 2233 | Final | Panel F | Sand | 1.543 | 15.7 | 1.75 | 13.6 | 88.2 | 90 | Fail |
| 490 | 2/4/2007 | 2173 | 2233 | Final | Panel F | Sand | 1.582 | 17 | 1.75 | 13.6 | 90.4 | 90 | Pass |
| 491 | 2/4/2007 | 2173 | 2233 | Final | Panel F | Sand | 1.61 | 14.3 | 1.75 | 13.6 | 92 | 90 | Pass |
| 492 | 2/4/2007 | 2173 | 2233 | Final | Panel F | Sand | 1.606 | 13.4 | 1.75 | 13.6 | 91.8 | 90 | Pass |
| 493 | 2/4/2007 | 2453 | 2513 | Final | Panel C Slope | Sand | 1.544 | 16.4 | 1.75 | 13.6 | 88.2 | 90 | Fail |
| 494 | 2/4/2007 | 2453 | 2513 | Final | Panel C Slope | Sand | 1.533 | 10.8 | 1.75 | 13.6 | 87.6 | 90 | Fail |
| 495 | 2/4/2007 | 2453 | 2513 | Final | Panel C Slope | Sand | 1.474 | 16.4 | 1.75 | 13.6 | 84.2 | 90 | Fail |
| 496 | 2/4/2007 | 2453 | 2513 | Final | Panel C Slope | Sand | 1.506 | 14.2 | 1.75 | 13.6 | 86.1 | 90 | Fail |
| 497 | 3/4/2007 | 2446 | 2523 | Final | Panel C Slope | Sand | 1.549 | 11 | 1.75 | 13.6 | 88.5 | 90 | Fail |
| 498 | 3/4/2007 | 2446 | 2523 | Final | Panel C Slope | Sand | 1.503 | 12 | 1.75 | 13.6 | 85.9 | 90 | Fail |
| 499 | 3/4/2007 | 2446 | 2523 | Final | Panel C Slope | Sand | 1.515 | 12.4 | 1.75 | 13.6 | 86.5 | 90 | Fail |
| 500 | 3/4/2007 | 2446 | 2523 | Final | Panel C Slope | Sand | 1.442 | 11 | 1.75 | 13.6 | 82.4 | 90 | Fail |
| 501 | 3/4/2007 | 2453 | 2520 | Final | Panel C Slope | Sand | 1.447 | 16 | 1.75 | 13.6 | 82.7 | 90 | Fail |
| 502 | 3/4/2007 | 2763 | 2843 | Final | Panel A | Sand | 1.615 | 12.7 | 1.75 | 13.6 | 92.3 | 90 | Pass |
| 503 | 3/4/2007 | 2763 | 2843 | Final | Panel A | Sand | 1.605 | 11.9 | 1.75 | 13.6 | 91.7 | 90 | Pass |
| 504 | 3/4/2007 | 2233 | 2380 | Final | Panel C D/S Sheet Piles | Sand | 1.631 | 14.6 | 1.75 | 13.6 | 93.2 | 90 | Pass |
| 505 | 3/4/2007 | 2233 | 2380 | Final | Panel C D/S Sheet Piles | Sand | 1.612 | 13.2 | 1.75 | 13.6 | 92.1 | 90 | Pass |
| 506 | 3/4/2007 | 2193 | 2233 | Final | Panel A | Sand | 1.597 | 16.6 | 1.75 | 13.6 | 91 | 90 | Pass |
| 507 | 3/4/2007 | 2743 | 2853 | Final | Panel B | Sand | 1.643 | 13.4 | 1.75 | 13.6 | 94 | 90 | Pass |


June 2007


| Sr. No. | Date | Area | | Layer # | Location | Description of Soil | Field | | Laboratory | | Compaction | | Remarks |
|---------|----------|------|--------|---------|-------------------|---------------------|----------|-------|------------|-------|------------|-------|---------|
| | | From | To | | | | FDD g/cc | % M.C | MDD g/cc | % OMC | Obtd. | Reqd. | |
| 1066 | 1/6/2007 | 4273 | 4300 | 404.17 | Panel D, E, F | Sand | 1.605 | 13.9 | 1.729 | 13.6 | 92.6 | 90 | Pass |
| 1067 | 1/6/2007 | 4273 | 4300 | 404.17 | Panel D, E, F | Sand | 1.624 | 14.2 | 1.729 | 13.6 | 93.7 | 90 | Pass |
| 1068 | 1/6/2007 | 4273 | 4300 | 404.17 | Panel D, E, F | Sand | 1.612 | 13 | 1.729 | 13.6 | 93 | 90 | Pass |
| 1069 | 1/6/2007 | 3343 | 3583 | 404.75 | D/S Curtain Wall | Sand | 1.584 | 13 | 1.729 | 14.2 | 91.6 | 90 | Pass |
| 1070 | 1/6/2007 | 3343 | 35883 | 404.75 | D/S Curtain Wall | Sand | 1.611 | 14.2 | 1.729 | 14.2 | 93.2 | 90 | Pass |
| 1071 | 1/6/2007 | 3343 | 3583 | 403.75 | D/S Curtain Wall | Sand | 1.628 | 16 | 1.729 | 14.2 | 94.2 | 90 | Pass |
| 1072 | 1/6/2007 | 3343 | 3583 | 403.75 | D/S Curtain Wall | Sand | 1.618 | 14 | 1.729 | 14.2 | 93.6 | 90 | Pass |
| 1073 | 2/6/2007 | 3553 | 3673 | 401.53 | Panel D 123 ~ 124 | Sand | 1.584 | 13 | 1.714 | 13.8 | 92.4 | 90 | Pass |
| 1074 | 2/6/2007 | 3553 | 3673 | 401.53 | Panel D 123 ~ 124 | Sand | 1.611 | 14.2 | 1.714 | 13.8 | 94.4 | 90 | Pass |
| 1075 | 3/6/2007 | 4243 | 430.5 | 414.75 | Panel A 144, 145 | Sand | 1.629 | 13 | 1.734 | 13.6 | 94 | 90 | Pass |
| 1076 | 3/6/2007 | 4243 | 4300.5 | 414.75 | Panel A 144, 145 | Sand | 1.586 | 13 | 1.734 | 13.6 | 91.5 | 90 | Pass |
| 1077 | 3/6/2007 | 4243 | 4300.5 | 414.25 | Panel A 144, 145 | Sand | 1.612 | 13.5 | 1.734 | 13.6 | 93 | 90 | Pass |
| 1078 | 3/6/2007 | 4243 | 4300.5 | 414.25 | Panel B 144, 145 | Sand | 1.628 | 12.4 | 1.729 | 14.2 | 94.2 | 90 | Pass |
| 1079 | 3/6/2007 | 4243 | 4300.5 | 402.13 | Panel B 144, 145 | Sand | 1.588 | 14.8 | 1.729 | 14.2 | 91.9 | 90 | Pass |
| 1080 | 3/6/2007 | 3493 | 3613 | 402.13 | Panel E & D | Sand | 1.485 | 11 | 1.729 | 14.2 | 85.9 | 90 | Fail |
| 1081 | 3/6/2007 | 3493 | 3613 | 402.13 | Panel E & D | Sand | 1.507 | 10.2 | 1.729 | 14.2 | 87.2 | 90 | Fail |
| 1082 | 3/6/2007 | 3493 | 3613 | 402.13 | Panel E & D | Sand | 1.629 | 14 | 1.734 | 13.6 | 94 | 90 | Pass |
| 1083 | 3/6/2007 | 3493 | 3613 | 402.13 | Panel E & D | Sand | 1.638 | 14.5 | 1.734 | 13.6 | 94.5 | 90 | Pass |
| 1084 | 3/6/2007 | 3493 | 3613 | 402.13 | Panel E & D | Sand | 1.647 | 13.7 | 1.734 | 13.6 | 95 | 90 | Pass |
| 1085 | 3/6/2007 | 4243 | 4300.5 | 409.25 | U/S Curtain Wall | Sand | 1.598 | 10.8 | 1.729 | 14.2 | 92.4 | 90 | Pass |
| 1086 | 3/6/2007 | 4243 | 4300.5 | 409.25 | U/S Curtain Wall | Sand | 1.618 | 12.8 | 1.729 | 14.2 | 93.6 | 90 | Pass |
| 1087 | 3/6/2007 | 3673 | 3733 | 397.25 | Panel C 125, 126 | Sand | 1.6 | 13.5 | 1.734 | 13.6 | 92.3 | 90 | Pass |
| 1087A | 3/6/2007 | 3673 | 3733 | 397.25 | Panel C 125, 126 | Sand | 1.621 | 12.7 | 1.734 | 13.6 | 93.5 | 90 | Pass |
| 1088 | 3/6/2007 | 3673 | 3733 | 397.25 | Panel D 125, 126 | Sand | 1.599 | 14 | 1.714 | 14.2 | 93.3 | 90 | Pass |
| 1089 | 3/6/2007 | 3673 | 3733 | 397.25 | Panel D 125, 126 | Sand | 1.576 | 12.3 | 1.714 | 14.2 | 92 | 90 | Pass |
| 1090 | 3/6/2007 | 3333 | 3513 | 404.75 | D/S Curtain Wall | Sand | 1.569 | 14 | 1.734 | 13.6 | 90.5 | 90 | Pass |
| 1091 | 3/6/2007 | 3333 | 3513 | 404.75 | D/S Curtain Wall | Sand | 1.569 | 14.5 | 1.734 | 13.6 | 90.5 | 90 | Pass |
| 1092 | 3/6/2007 | 3333 | 3513 | 404.75 | D/S Curtain Wall | Sand | 1.577 | 13.9 | 1.734 | 13.6 | 91 | 90 | Pass |
| 1093 | 3/6/2007 | 3333 | 3573 | 403.75 | D/S Curtain Wall | Sand | 1.586 | 12.5 | 1.734 | 13.6 | 91.5 | 90 | Pass |
| 1094 | 3/6/2007 | 3333 | 3573 | 403.75 | D/S Curtain Wall | Sand | 1.605 | 10.5 | 1.734 | 13.6 | 92.6 | 90 | Pass |
| 1095 | 3/6/2007 | 3333 | 3573 | 403.75 | D/S Curtain Wall | Sand | 1.56 | 13 | 1.734 | 13.6 | 90 | 90 | Pass |
| 1096 | 4/6/2007 | 3628 | 3745 | 412 | B/W Panel & C/W | Sand | 1.649 | 15.2 | 1.729 | 14.2 | 95.4 | 90 | Pass |
| 1097 | 4/6/2007 | 3628 | 3745 | 412 | B/W Panel & C/W | Sand | 1.628 | 14 | 1.729 | 14.2 | 94.2 | 90 | Pass |
| 1098 | 5/6/2007 | 3474 | 3628 | 412 | B/W Panel & C/W | Sand | 1.621 | 13.5 | 1.734 | 13.6 | 93.5 | 90 | Pass |
| 1099 | 5/6/2007 | 3474 | 3628 | 412 | B/W Panel & C/W | Sand | 1.595 | 13 | 1.734 | 13.6 | 92 | 90 | Pass |
| 1100 | 5/6/2007 | 3474 | 3628 | 412 | B/W Panel & C/W | Sand | 1.586 | 12.5 | 1.734 | 13.6 | 91.5 | 90 | Pass |
| 1101 | 5/6/2007 | 3697 | 3733 | 403.25 | Panel D, E | Sand | 1.603 | 12.5 | 1.734 | 13.6 | 92.5 | 90 | Pass |
| 1102 | 5/6/2007 | 3697 | 3733 | 403.25 | Panel D, E | Sand | 1.612 | 12 | 1.734 | 13.6 | 93 | 90 | Pass |

10.7 Summary of Inspection Requests

Sample summarized data for inspection requests for guide banks, sub weir and curtain walls are contained in the following tables:

| PBC | | IRRIGATION AND POWER DEPARTMENT GOVT. OF PUNJAB | | | | | | | | | |
|---|----------|---|----------|-------|-------|-------------|------------|---------|--|--|--|
| | | Taansa Barrage Emergency Rehabilitation And Modernization And Modernization Project | | | | | | | | | |
| SUMMARY OF INSPECTION REQUESTS FOR GUIDE BANK LEFT SIDE | | | | | | | | | | | |
| Req. No | Date | Time | Location | | Layer | Description | Level (ft) | Remarks | | | |
| 5006/GBL/67A | 1/6/2007 | 6:00 | 0+000 | 0+250 | 9 | Guide Bank | 428 | O.K | | | |
| 5006/GBL/494B | 1/6/2007 | 9:15 | 0+209 | 0+230 | 26 | Guide Bank | 437 | O.K | | | |
| 5006/GBL/666 | 27/06/07 | 17:30 | 0+000 | 0+250 | 20 | Guide Bank | 439 | O.K | | | |
| 5006/GBL/667 | 27/06/07 | 20:30 | 0+000 | 0+057 | 33 | Guide Bank | 440.5 | O.K | | | |
| 5006/GBL/668 | 27/06/07 | 20:30 | 01000 | 01250 | 33 | Guide Bank | 440.5 | O.K | | | |
| 5006/GBL/669 | 28/06/07 | 17:30 | 0+000 | 0+057 | 34 | Guide Bank | 441 | O.K | | | |
| 5006/GBL/670 | 28/06/07 | 17:30 | 01000 | 01250 | 34 | Guide Bank | 441 | O.K | | | |
| 5006/GBL/671 | 29/06/07 | 10:30 | 0+000 | 0+057 | 21 | Guide Bank | 440 | O.K | | | |
| 5006/GBL/672 | 29/06/07 | 10:30 | 01000 | 01250 | 21 | Guide Bank | 440 | Not O.K | | | |
| 5006/GBL/673 | 29/06/07 | 17:45 | 0+000 | 0+057 | 35 | Guide Bank | 441.5 | O.K | | | |
| 5006/GBL/674 | 29/06/07 | | 01000 | 01250 | 35 | Guide Bank | 441.5 | O.K | | | |
| 5006/GBL/672A | 29/06/07 | 20: | 0+000 | 0+250 | 21 | Guide Bank | 440 | O.K | | | |
| 5006/GBL/675 | 30/06/07 | 2:40 | 01000 | 01057 | 36 | Guide Bank | 442 | O.K | | | |
| 5006/GBL/676 | 30/06/07 | 2:10 | 0+000 | 0+250 | 36 | Guide Bank | 442 | O.K | | | |
| 5006/GBL/677 | 30/06/07 | 04: | 01000 | 01057 | 2 | Guide Bank | 441 | O.K | | | |
| 5006/GBL/678 | 30/06/07 | 04: | 0+000 | 0+250 | 22 | Guide Bank | 441 | O.K | | | |
| 5006/GBL/679 | 30/06/07 | 17:30 | 01000 | 01057 | 37 | Guide Bank | 442.5 | O.K | | | |
| 5006/GBL/680 | 30/06/07 | 17:40 | 0+000 | 0+123 | 7 | Guide Bank | 442.5 | O.K | | | |
| 5006/GBL/681 | 30/06/07 | 22: | 01000 | 01250 | 23 | Guide Bank | 442 | O.K | | | |
| 5006/GBL/682 | 30/06/07 | 10:00 | 01000 | 01057 | 23 | Guide Bank | 442 | O.K | | | |
| 5006/GBL/683 | 30/06/07 | 21:50 | 0+000 | 0+057 | 38 | Guide Bank | 443 | O.K | | | |
| 5006/GBL/684 | 30/06/07 | 21:30 | 01000 | 01127 | 38 | Guide Bank | 443 | O.K | | | |

| PBC | | IRRIGATION AND POWER DEPARTMENT GOVT. OF PUNJAB | | | | | | | | | |  |
|---|-----------|---|----------|------|-------------|--------|-----------|-------------|----------|--|--|---|
| | | Taamsa Barrage Emergency Rehabilitation And Modernization And Modernization Project | | | | | | | | | | |
| SUMMARY OF INSPECTION REQUESTS FOR SUB-WEIR PANEL - D | | | | | | | | | | | | |
| Req. No | Date | Time | Location | | Level (ft) | | Panel No. | Description | Status | | | |
| | | | From | To | | | | | | | | |
| 5006-LSW/D-013 | 2/5/2007 | | 2413 | 2473 | 398.2 | 401.78 | 83-84 | Formwork | | | | |
| 5006-LSW/D-014 | 2/5/2007 | | 2413 | 2473 | 402.38 | 408 | 83-84 | Concrete | | | | |
| 5006-LSW/D-015 | 4/5/2007 | 1:00 | 2293 | 2413 | | | 79-82 | Formwork | O.K | | | |
| 5006-LSW/D-016 | 4/5/2007 | 10:30 | 2293 | 2413 | | | 79-82 | Concrete | O.K | | | |
| 5006-LSW/D-017 | 6/5/2007 | 16:00 | 2233 | 2293 | 401.78 | 408 | 77-78 | Formwork | Resubmit | | | |
| 5006-LSW/D-018 | 6/5/2007 | 17:00 | 2233 | 2293 | 401.78 | 408 | 77-78 | Concrete | Resubmit | | | |
| 5006-LSW/D-017A | 7/5/2007 | 5:00 | 2233 | 2293 | 401.78 | 408 | 77-78 | Formwork | O.K | | | |
| 5006-LSW/D-018A | 7/5/2007 | 6:00 | 2233 | 2293 | 401.78 | 408 | 77-78 | Concrete | O.K | | | |
| 5006-LSW/D-019 | 7/5/2007 | 16:00 | 2653 | 2713 | 398.2-401.8 | 401.78 | 91-92 | Formwork | O.K | | | |
| 5006-LSW/D-020 | 7/5/2007 | 18:00 | 2653 | 2713 | 402.38-408 | 408 | 91-92 | Concrete | O.K | | | |
| 5006-LSW/D-021 | 12/5/2007 | 1:00 | 2833 | 2893 | 398.2 | 401.78 | 97-98 | Formwork | O.K | | | |
| 5006-LSW/D-022 | 12/5/2007 | 1:00 | 2833 | 2893 | 398.2 | 401.78 | 97-98 | Concrete | O.K | | | |
| 5006-LSW/D-023 | 15/05/07 | 10:00 | 2713 | 2773 | 401.78 | 402 | 93-94 | Formwork | O.K | | | |
| 5006-LSW/D-024 | 15/05/07 | 10:00 | 2713 | 2773 | 401.78 | 402 | 93-94 | Concrete | O.K | | | |
| 5006-LSW/D-025 | 16/05/07 | 8:00 | 2533 | 2653 | 408 | 408 | 87-90 | Formwork | O.K | | | |
| 5006-LSW/D-026 | 16/05/07 | 10:00 | 2533 | 2653 | 408 | 408 | 87-90 | Concrete | O.K | | | |
| 5006-LSW/D-027 | 17/05/07 | 19:00 | 3133 | 3193 | 408 | 408 | 107-108 | Formwork | O.K | | | |

| PBC | | IRRIGATION AND POWER DEPARTMENT GOVT. OF PUNJAB | | | | | | | | | |  |
|--|----------|--|----------|------|------------|-------|-----|-------------|---------|--|--|---|
| | | Tansa Barrage Emergency Rehabilitation And Modernization And Modernization Project | | | | | | | | | | |
| SUMMARY OF INSPECTION REQUESTS FOR SUBWEIR PANEL - F | | | | | | | | | | | | |
| Req. No | Date | Time | Location | | Level (ft) | Panel | | Description | Remarks | | | |
| | | | From | To | | From | To | | | | | |
| 5006-LSW/F-0056 | 13/04/07 | 18:30 | 2233 | 2293 | 408 | 77 | 78 | Concrete | O.K | | | |
| 5006-LSW/F-0057 | 15/04/07 | 14:00 | 2653 | 2773 | 408 | 91 | 93 | Formwork | O.K | | | |
| 5006-LSW/F-0058 | 15/04/07 | 14:00 | 2653 | 2773 | 408 | 91 | 93 | Concrete | O.K | | | |
| 5006-LSW/F-0059 | 16/04/07 | 10:30 | 2353 | 2413 | 408 | 81 | 82 | Formwork | O.K | | | |
| 5006-LSW/F-0060 | 16/04/07 | 11:00 | 2353 | 2413 | 408 | 81 | 82 | Concrete | O.K | | | |
| 5006-LSW/F-0061 | 17/04/07 | 12:40 | 2473 | 2533 | 408 | 85 | 86 | Formwork | O.K | | | |
| 5006-LSW/F-0062 | 17/04/07 | 12:40 | 2473 | 2533 | 408 | 85 | 86 | Concrete | O.K | | | |
| 5006-LSW/F-0063 | 18/04/07 | 16:00 | 2543 | 2593 | 412 | 87 | 88 | Formwork | O.K | | | |
| 5006-LSW/F-0064 | 18/01/07 | 16:30 | 2543 | 2593 | 412 | 87 | 88 | Concrete | O.K | | | |
| 5006-LSW/F-0065 | 18/04/07 | 17:00 | 2893 | 2953 | 404.5 | 99 | 100 | Formwork | O.K | | | |
| 5006-LSW/F-0066 | 18/04/07 | 17:00 | 2893 | 2953 | 404.5 | 99 | 100 | Concrete | O.K | | | |
| 5006-LSW/F-0067 | 23/04/07 | 11:00 | 2668 | 2709 | 408 | 91 | 92 | Formwork | O.K | | | |
| 5006-LSW/F-0068 | 23/04/07 | 12:00 | 2668 | 2709 | 408 | 91 | 92 | Concrete | O.K | | | |
| 5006-LSW/F-0069 | 23/04/07 | 15:30 | 3013 | 3133 | 403.5 | 103 | 106 | Formwork | O.K | | | |
| 5006-LSW/F-0070 | 23/04/07 | 17:00 | 3013 | 3133 | 403.5 | 103 | 106 | Concrete | O.K | | | |
| 5006-LSW/F-0071 | 25/04/07 | 11:30 | 2709 | 2703 | 408 | 93 | 94 | Formwork | O.K | | | |
| 5006-LSW/F-0072 | 25/04/07 | 12:30 | 2709 | 2703 | 408 | 93 | 94 | Concrete | O.K | | | |
| 5006-LSW/F-0073 | 26/04/07 | 11:30 | 2653 | 2668 | 408 | 91 | 91 | Formwork | O.K | | | |
| 5006-LSW/F-0074 | 26/04/07 | 11:30 | 2653 | 2668 | 408 | 91 | 91 | Concrete | O.K | | | |
| 5006-LSW/F-0075 | 27/04/07 | 16:30 | 2773 | 2893 | 408 | 95 | 98 | Formwork | O.K | | | |
| 5006-LSW/F-0076 | 28/04/07 | 16:30 | 2773 | 2893 | 408 | 95 | 98 | Concrete | O.K | | | |

11. QUALITY AUDIT AND GRAPHICAL PRESENTATION OF DATA

The data contained in the preceding sections, indicates that the quality assurance and control tests conducted are more than the number prescribed by Specifications. Brief analysis of each type follows:

11.1 The Los Angeles Abrasion Tests Results

The Los Angeles Abrasion tests results (for a sample period) for coarse aggregates, are presented graphically in Figure 1. The plot shows that the loss of weight has always been very much less than the permissible limit of 40%. The average loss comes to only 26%, confirming the good quality of the coarse aggregate.

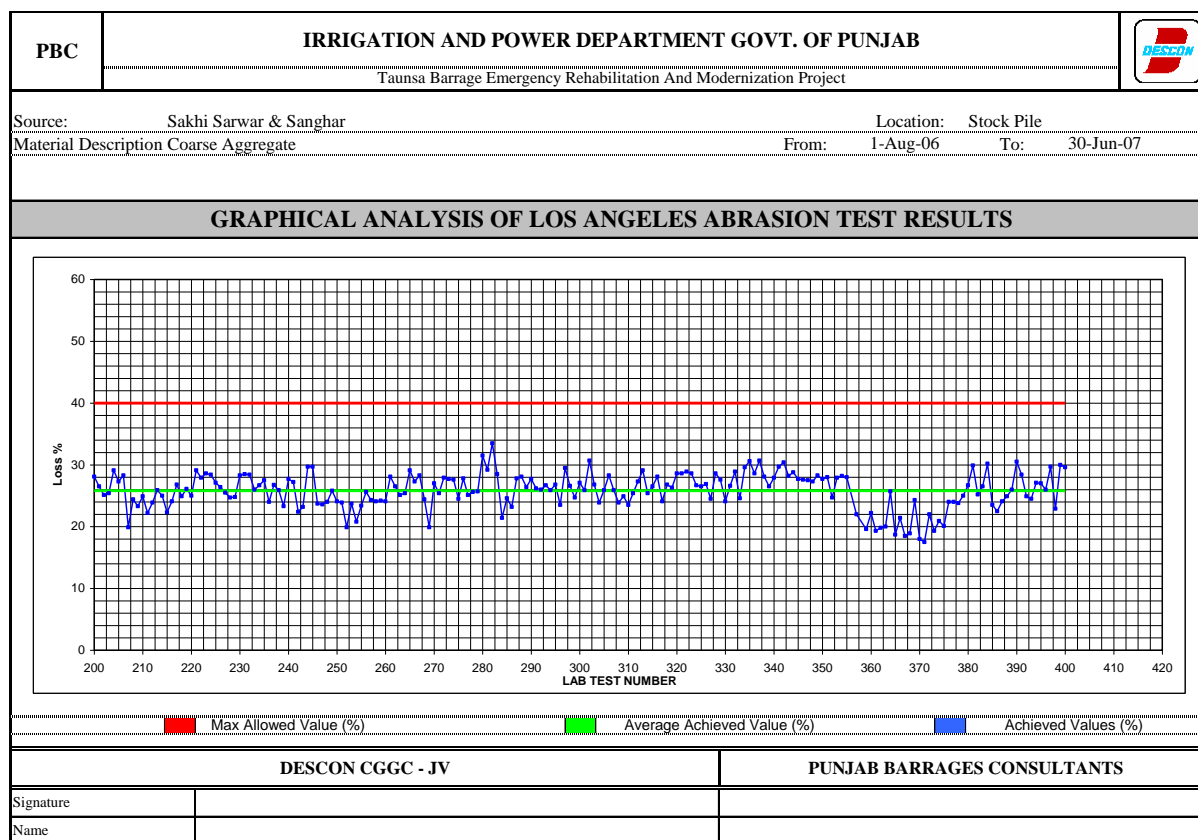


Figure 1: Los Angeles Abrasion Test Results

11.2 Sand Equivalent Tests Results for Fine Aggregate

The plot of sand equivalent tests results for fine aggregates (Figure 2) indicates that sand equivalent values for all tests have been above the permissible base value of 80% except in only 5 out of 169 tests. The average values come to 82.25%. Failing consignments were rejected and removed from the site.

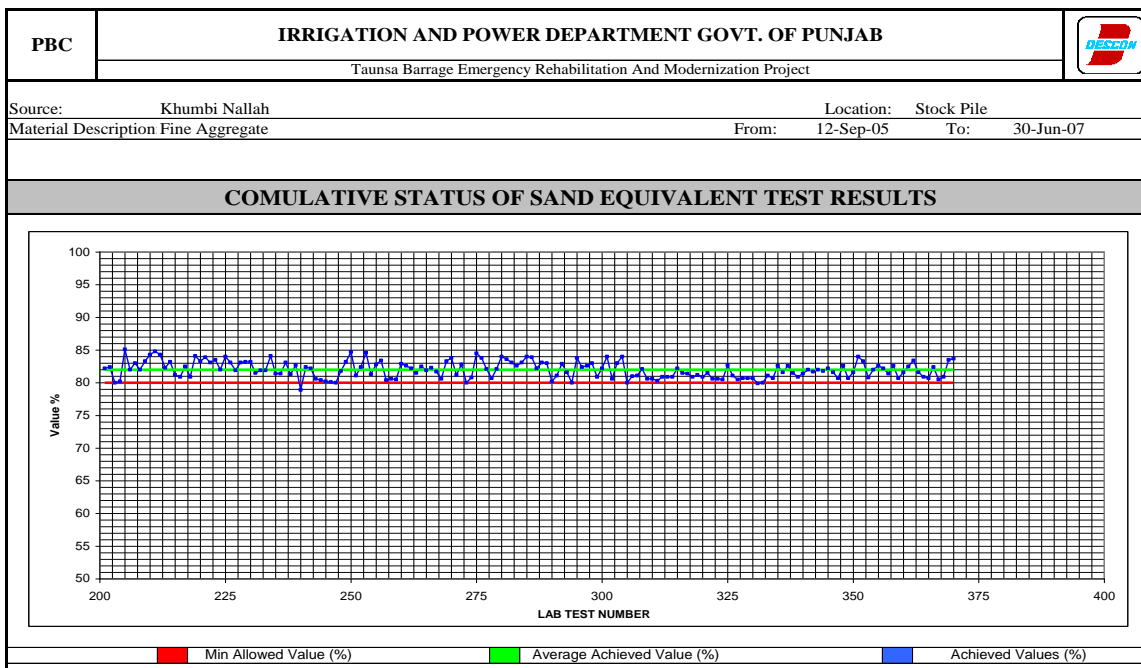


Figure 2: Sand Equivalent Test Results for Fine Aggregate

11.3 Soundness Tests for Coarse Aggregate

The values of percentage weight loss for coarse aggregate after 5 cycles of sodium sulphate treatment is only 1.1% (max), 0.2% (min) and 0.7% on the average against a permissible value of 12%, establishing the soundness of coarse aggregates used (Figure 3).

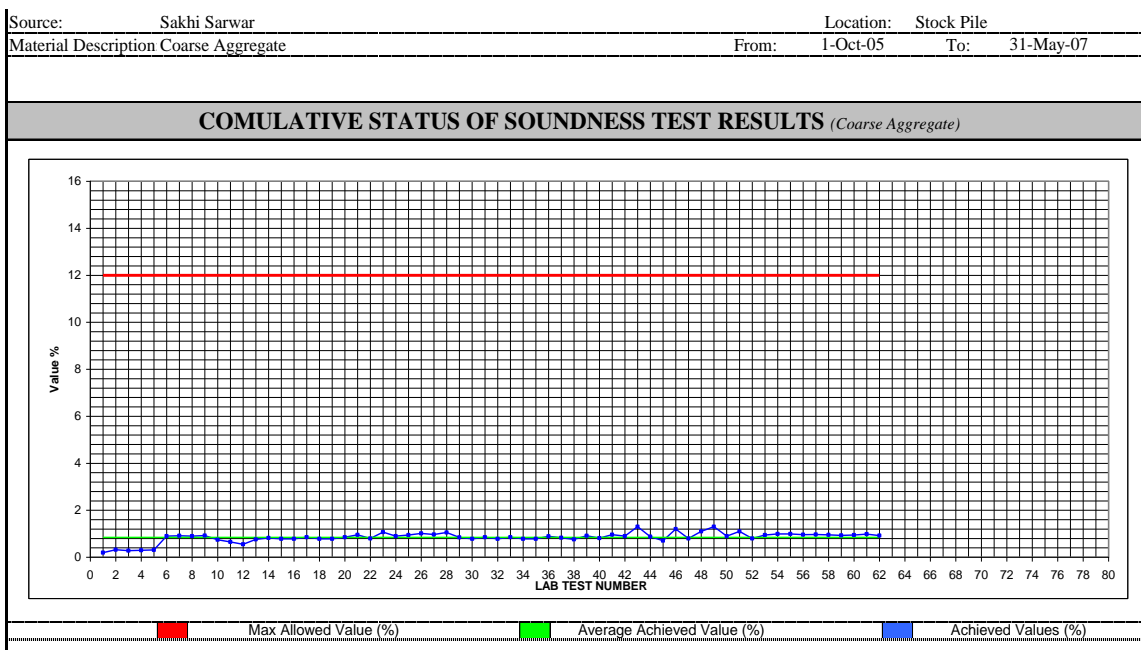


Figure 3: Soundness Tests for Coarse Aggregate

11.4 Soundness Tests for Fine Aggregate

The plot of these tests in Figure 4 indicates that the weight loss after soundness test has been 2.5% (max), 1.6% (min) and 2% on the average, against a permissible value of 12% establishing the soundness of the fine aggregates used.

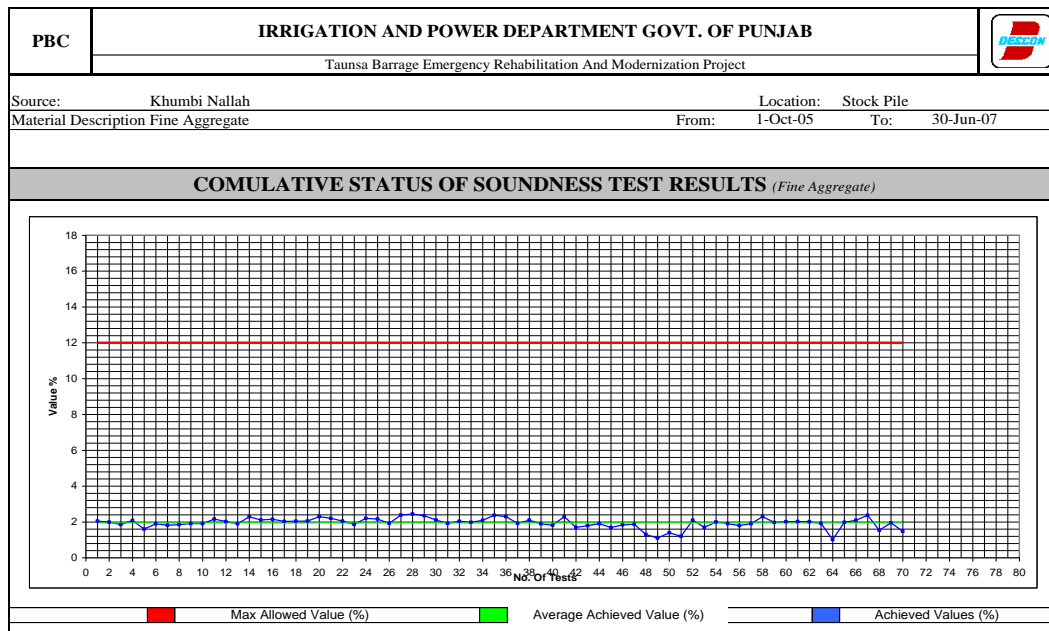
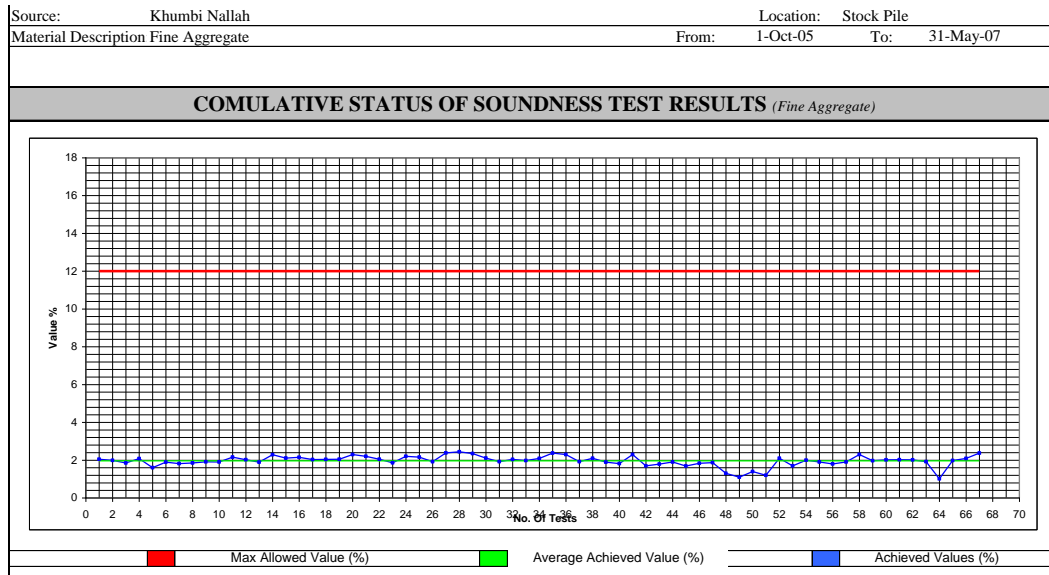


Figure 4: Soundness Tests for Fine Aggregate

11.5 Gradation Charts of Fine Aggregate

The gradation charts (for a sample period) prepared from the sieve analyses of fine aggregates plotted in Figures 5 indicate that the aggregates used were well graded. The red lines in the figures 5 to 7 represent maximum and minimum envelope curves while the actual gradation of sand is in between these two envelopes.

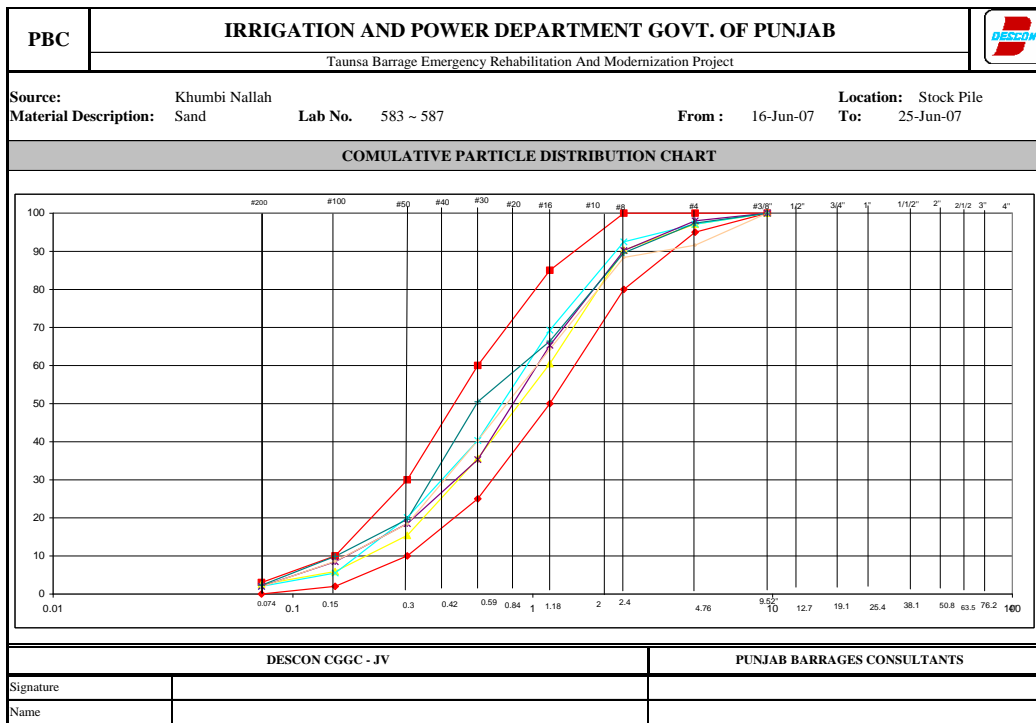
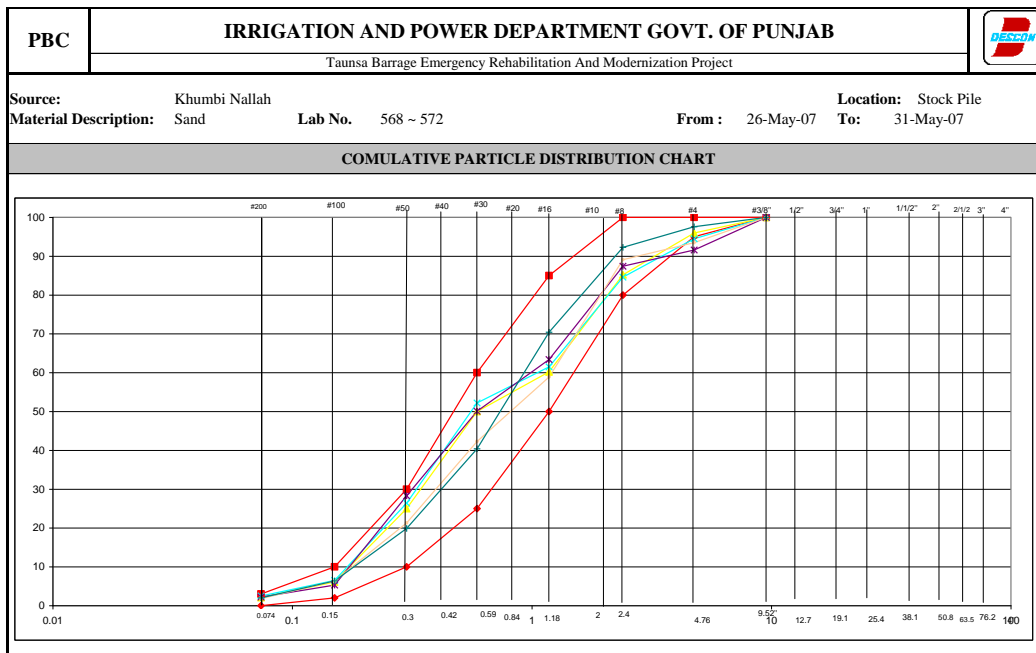


Figure 5: Gradation Chart of Fine Aggregate

11.6 Specific Gravity Tests for Coarse and Fine Aggregates

The results for 328 tests plotted in Figure 6 indicate that the specific gravity of the coarse aggregates was observed to be 2.70 (max), 2.610 (min) and 2.650 on the average against a prescribed value of 2.60 establishing the denseness of the aggregates. Similarly the results for 166 tests plotted in Figure 8 indicate that the

specific gravity of the fine aggregates has been observed to be 2.73 (max), 2.59 (min) and 2.65 on the average against a prescribed value of 2.60 establishing the denseness of the aggregates.

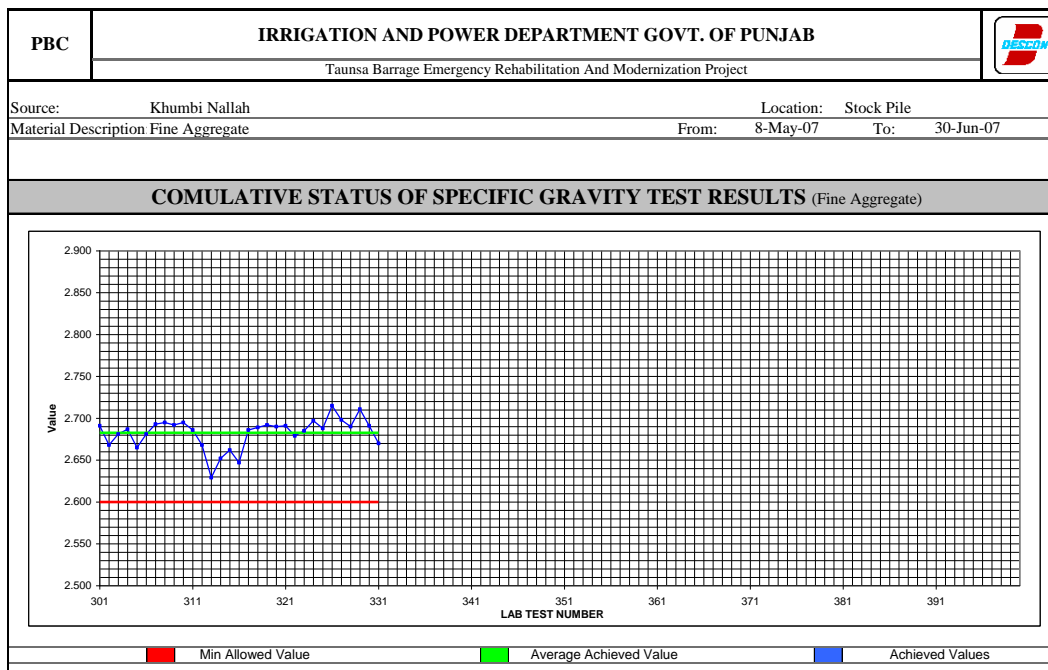
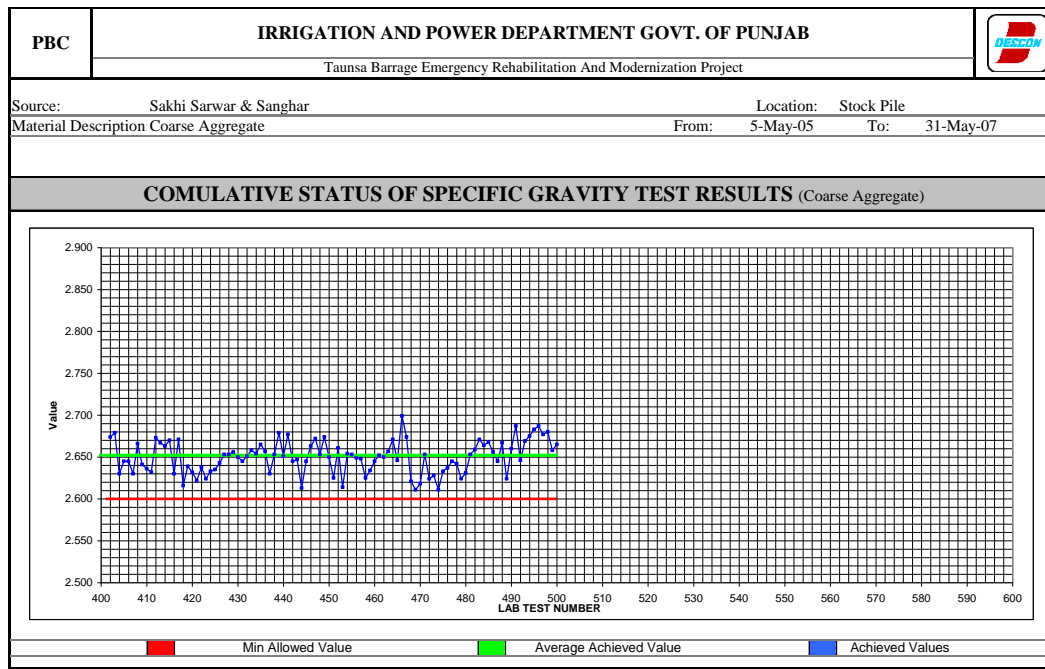


Figure 6: Specific Gravity Tests for Coarse and Fine Aggregates

11.7 Compressive Strength Results for Class D Concrete

The graphical presentation of compressive strength results for 28 days for class D concrete in Figure 7 are always higher than the prescribed values, thus

showing the good quality of concrete. Due to lean mix, the 7 days strength of some samples is a bit less but after 28 days more than required strength was achieved.

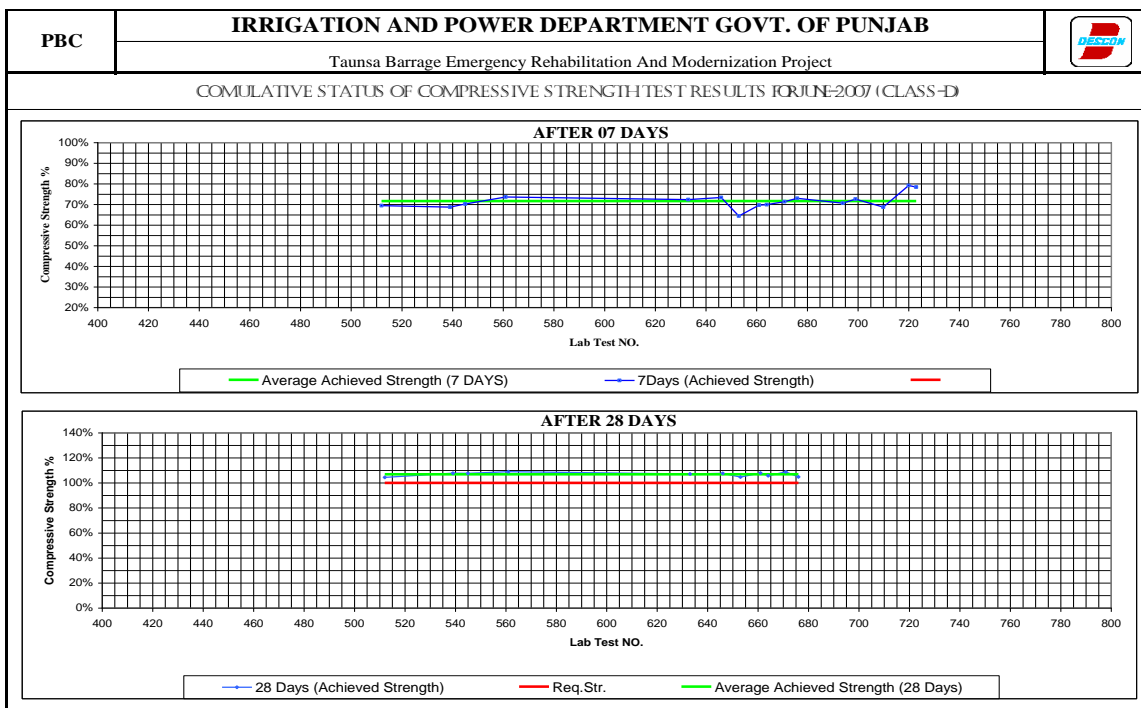
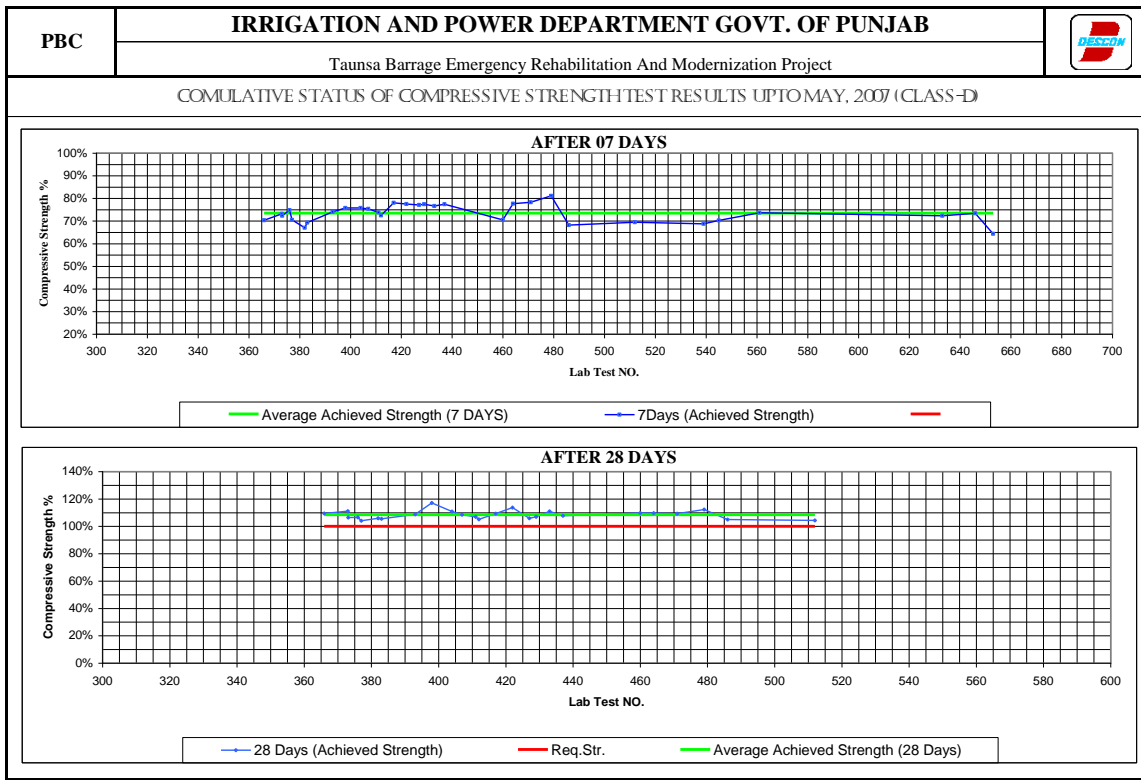


Figure 7: Compressive Strength Results for Class D Concrete

11.8 Compressive Strength Results for Class AA Concrete

Graphical presentation of compressive strength results for 7 and 28 days for class AA concrete in Figure 8 shows higher than the prescribed strength values, thus establishing the good quality of concrete.

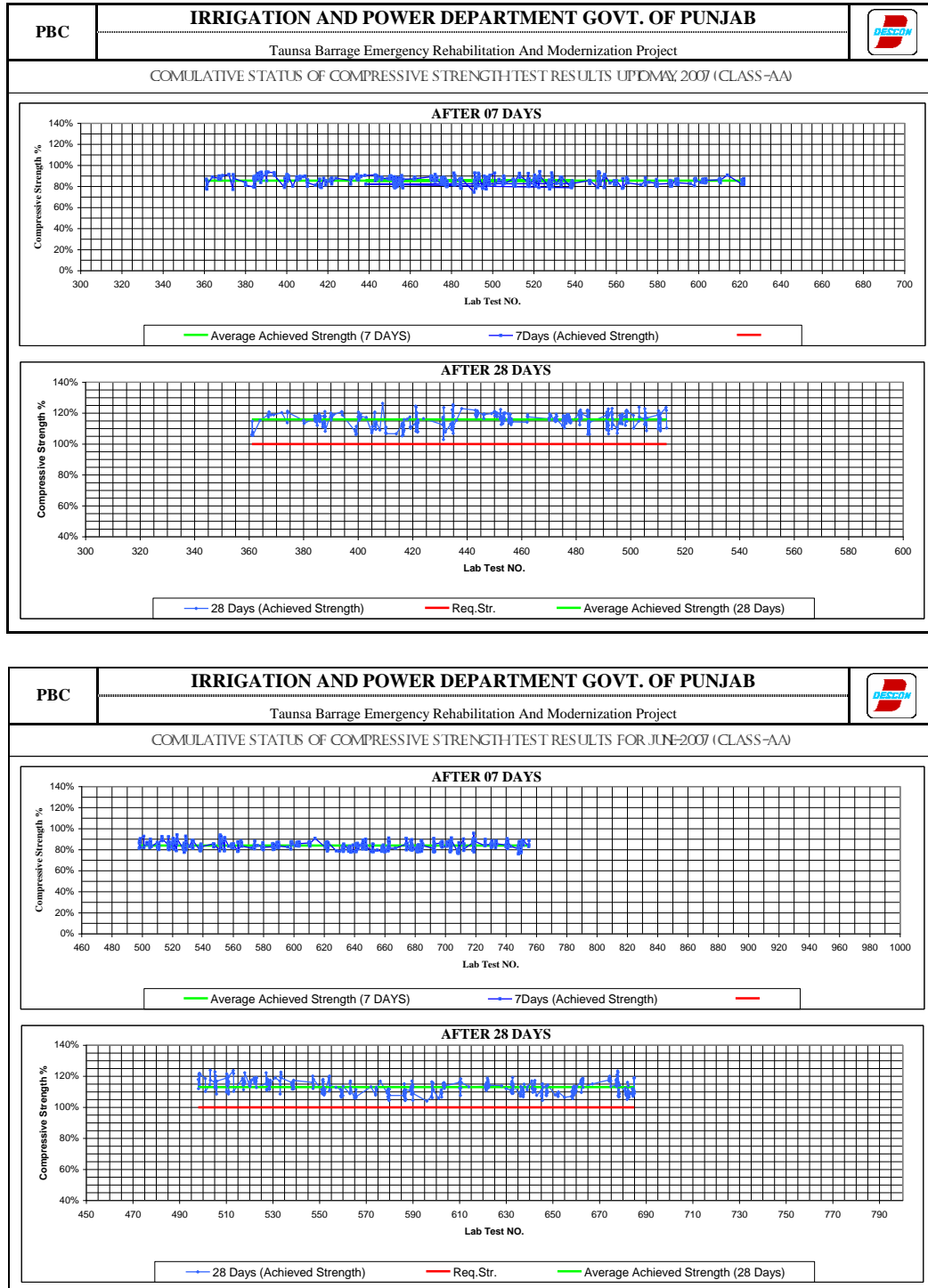


Figure 8: Compressive Strength Results for Class AA Concrete

11.9 Compressive Strength Results for Class BB Concrete

Graphical presentation of compressive strength results for 7 and 28 days for class BB concrete in Figure 9 shows higher than the prescribed strength values, thus establishing the good quality of concrete.

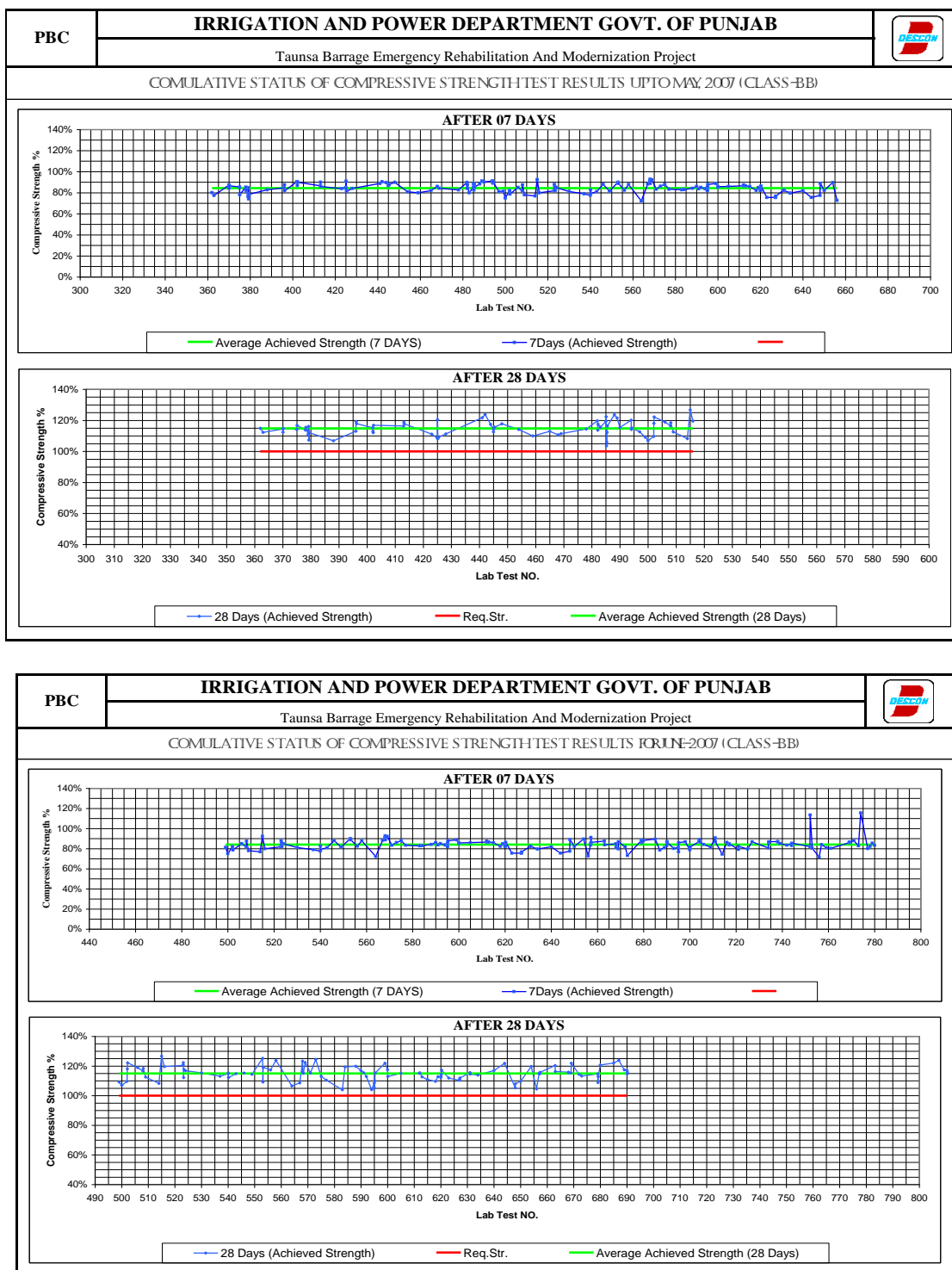


Figure 9: Compressive Strength Results for Class BB Concrete

12. QA/QC ACTIVITIES PERFORMED BY ICB-02 CONTRACTOR

Mechanical and Electrical works were covered under ICB-02 Contract. Under this contract, rehabilitation of 31 weir gates and 1 navigation lock gate including raising of gate by 1 ft., replacement and repair of Canal Gates, hoisting arrangement, counter weights and superstructure were covered. The works done at the site was put to following Quality checks by the Consultants during the reporting period:

- i. Visual & measurement checks, tensile test & chemical composition test of material.
- ii. Straightness of grooves facing, side seals plates & roller guard and gate guide shoes.
- iii. Alignment of gate leaf, rocker assembly, roller train & guide, rope drums & hoist.
- iv. Welding visual & measurement checks, dye penetrant test (DPT) & ultrasonic test (UT)
- v. Painting appearance checks & dry film thickness (DFT) test by Elecometer.
- vi. Rise in temperature measured at various parts/points of hoist.
- vii. Electrical parameters (voltage, ampere & phase sequence) & insulation test of three phase induction motor & trial test run of gates operations

Details of the quality assurance/control activities ICB-02 works for rehabilitation of main weir gates and upstream navigation lock gate no. 8 are as follows:

| Mechanical Works | | | | | |
|-------------------------|--------------|----------|----------|------------|----------|
| 1) Side sealing plate | | | | | |
| Description | Straightness | Flatness | Chipping | Concreting | Location |
| WG-31 | OK | OK | OK | OK | At site |
| WG-32 | OK | OK | OK | OK | At site |
| WG-33 | OK | OK | OK | OK | At site |
| WG-34 | OK | OK | OK | OK | At site |
| WG-35 | OK | OK | OK | OK | At site |
| WG-36 | OK | OK | OK | OK | At site |
| WG-37 | OK | OK | OK | OK | At site |
| NL-08 | OK | OK | OK | OK | At site |

| 2) Facing of rocker assembly base | | | | | |
|-----------------------------------|--------------|----------|----------------|--------------|----------|
| Description | Straightness | Flatness | Depth machined | Grinding | Location |
| WG-31 | OK | OK | OK | OK | At site |
| WG-32 | OK | OK | OK | OK | At site |
| WG-33 | OK | OK | OK | OK | At site |
| WG-34 | OK | OK | OK | OK | At site |
| WG-35 | OK | OK | OK | OK | At site |
| WG-36 | OK | OK | OK | OK | At site |
| WG-37 | OK | OK | OK | OK | At site |
| NL-08 | OK | OK | OK | OK | At site |
| 3) Assembly of rocker assembly | | | | | |
| Description | Straightness | Flatness | Movement | Junction gap | Location |
| WG-31 | OK | OK | OK | OK | At site |
| WG-32 | OK | OK | OK | OK | At site |
| WG-33 | OK | OK | OK | OK | At site |
| WG-34 | OK | OK | OK | OK | At site |
| WG-35 | OK | OK | OK | OK | At site |
| WG-36 | OK | OK | OK | OK | At site |
| WG-37 | OK | OK | OK | OK | At site |
| 4) Gate leaf | | | | | |
| Description | Dimension | Welding | Paint | Sealings | Location |
| WG-31 | OK | OK | OK | OK | At site |
| WG-32 | OK | OK | OK | OK | At site |
| WG-33 | OK | OK | OK | OK | At site |
| WG-34 | OK | OK | OK | OK | At site |
| WG-35 | OK | OK | OK | OK | At site |
| WG-36 | OK | OK | OK | OK | At site |
| WG-37 | OK | OK | OK | OK | At site |
| NL-08 | OK | OK | OK | OK | At site |

| 5) Roller guard | | | | | |
|-------------------------------|--------------|-----------|-------------|------------|----------|
| Description | Straightness | Clearance | Chipping | Concreting | Location |
| WG-31 | OK | OK | OK | OK | At site |
| WG-32 | OK | OK | OK | OK | At site |
| WG-33 | OK | OK | OK | OK | At site |
| WG-34 | OK | OK | OK | OK | At site |
| WG-35 | OK | OK | OK | OK | At site |
| WG-36 | OK | OK | OK | OK | At site |
| WG-37 | OK | OK | OK | OK | At site |
| NL-08 | OK | OK | OK | OK | At site |
| 6) Sill beam | | | | | |
| Description | Straightness | Flatness | Level | Concreting | Location |
| NL-08 (U/S) | OK | OK | OK | OK | At site |
| NL-08 (D/S) | OK | OK | OK | OK | At site |
| 7) Bracket for bulkhead gates | | | | | |
| 7.1) Installation of bracket | | | | | |
| Description | Straightness | Flatness | Verticality | Weld joint | Location |
| WG-31 | OK | OK | OK | OK | At site |
| WG-32 | OK | OK | OK | OK | At site |
| WG-33 | OK | OK | OK | OK | At site |
| WG-34 | OK | OK | OK | OK | At site |
| WG-35 | OK | OK | OK | OK | At site |
| WG-36 | OK | OK | OK | OK | At site |
| WG-37 | OK | OK | OK | OK | At site |
| 7.2) Concreting of bracket | | | | | |
| Description | Chipping | Drilling | Concreting | Pouring | Location |
| WG-31 | OK | OK | OK | OK | At site |
| WG-32 | OK | OK | OK | OK | At site |
| WG-33 | OK | OK | OK | OK | At site |
| WG-34 | OK | OK | OK | OK | At site |
| WG-35 | OK | OK | OK | OK | At site |
| WG-36 | OK | OK | OK | OK | At site |
| WG-37 | OK | OK | OK | OK | At site |

13. QUALITY REPORTS

The Contractor and Consultants generated monthly and quarterly quality reports, which contained periodical data and review of quality processes. These reports were submitted to the Government (owner) and the World Bank (Financiers).

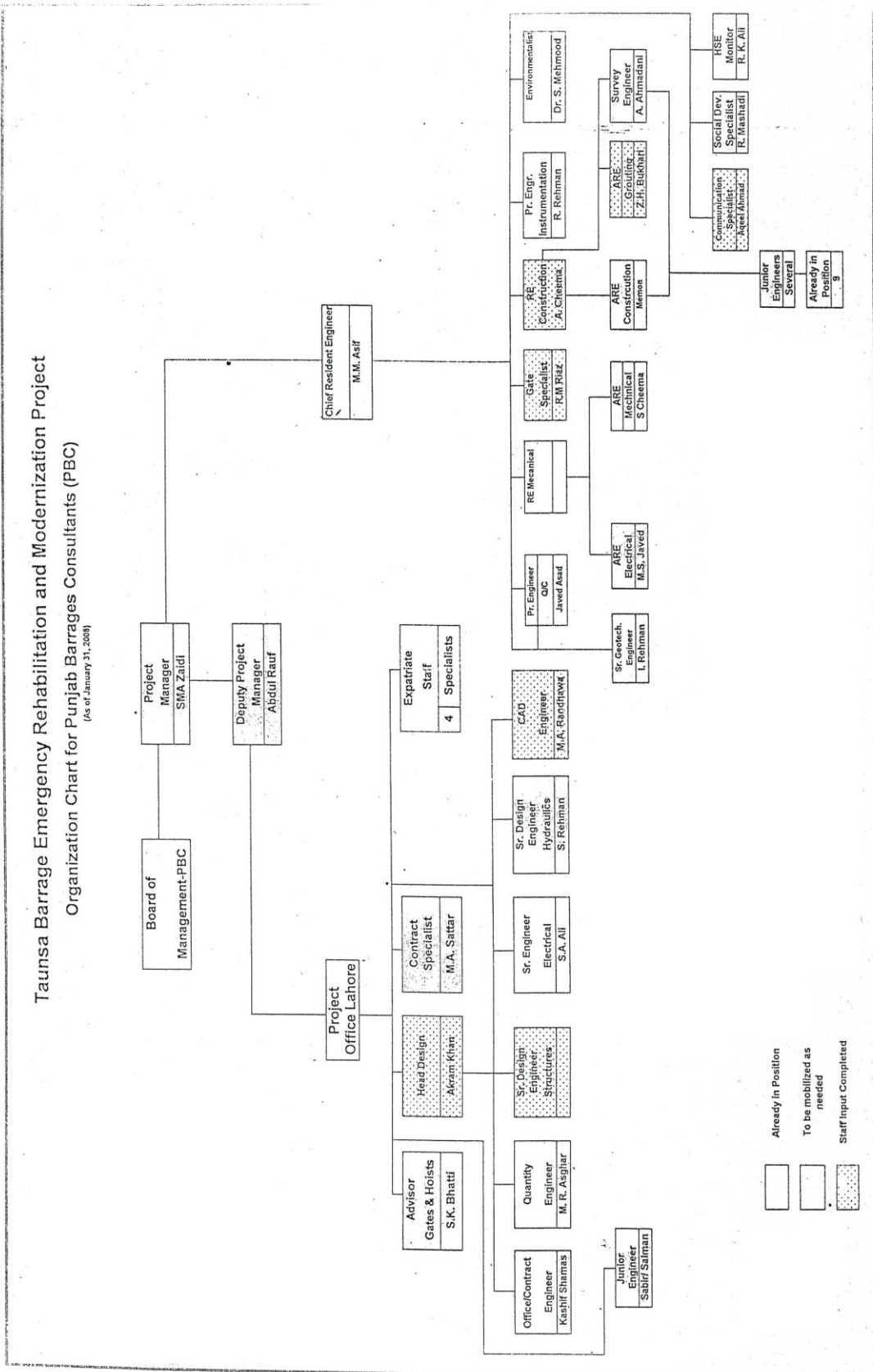
14. OVERALL ASSESSMENT

Looking at the preceding narration in an overall perspective, we find that the Quality Assurance and Quality Control planning, the plans and their implementation has been quite good and in line with International Standards (ISO 9001-2000). State of the Art systematic control has yielded high quality works.

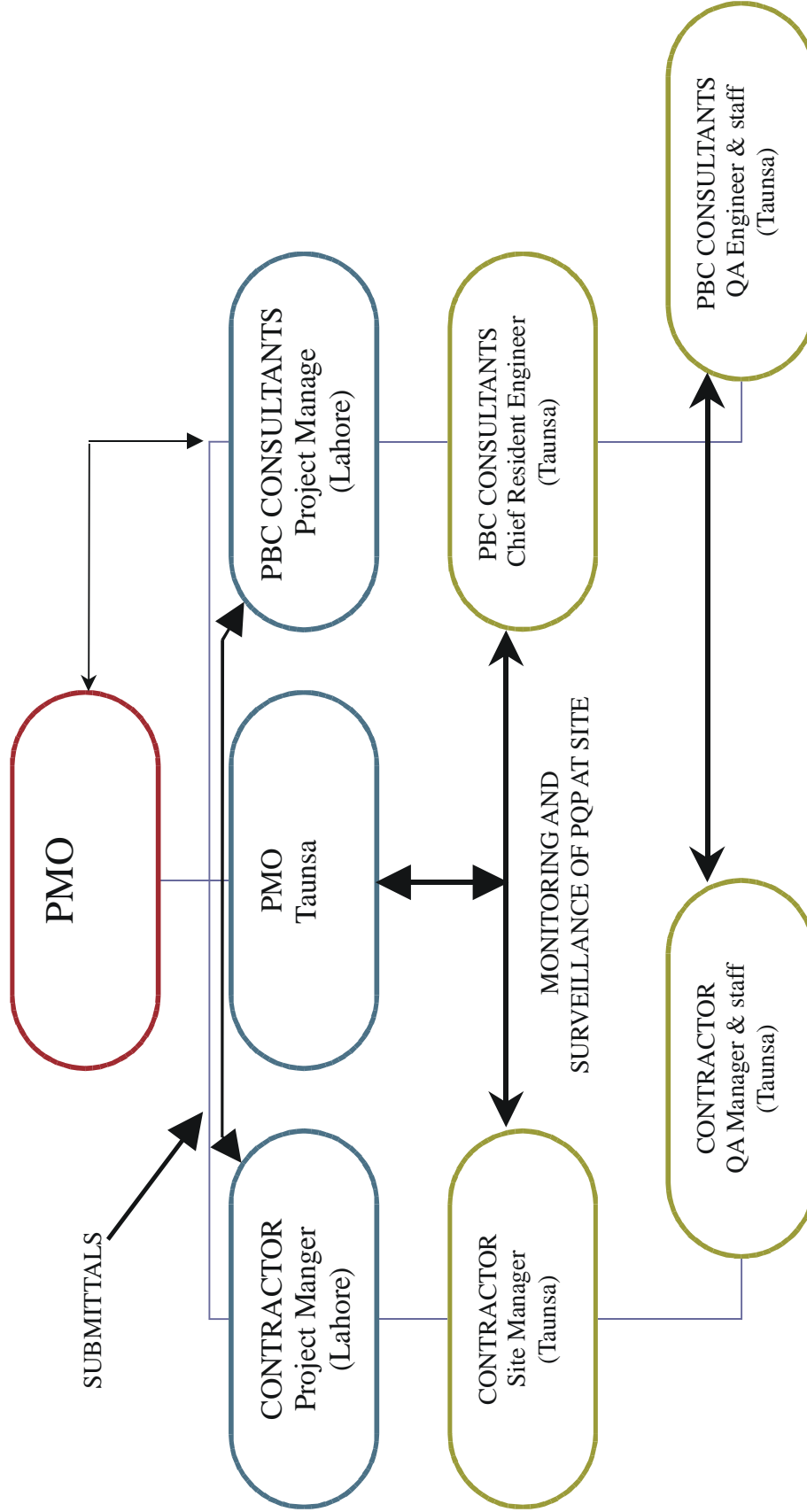
All the project works were done in full conformance with the prescribed standards, drawings and specifications and no significant quality incident occurred. However as a routine measure any deficiencies observed by the supervisory staff in preparation stage were notified through necessary field memos verbal instructions and letters and pursued till rectification to ensure quality.

The quality control data was put to internal audit and the works quality was found to be very good in all aspects.

The project works were visited by a large number of professionals from various organizations like Pakistan Engineering Congress, FWO, Engineers of 2nd Corps Multan, World Bank teams, Panel of Experts and others, who appreciated the works quality. The project also provided training and experience of this special type of works after 35 years, all through domestic resources.

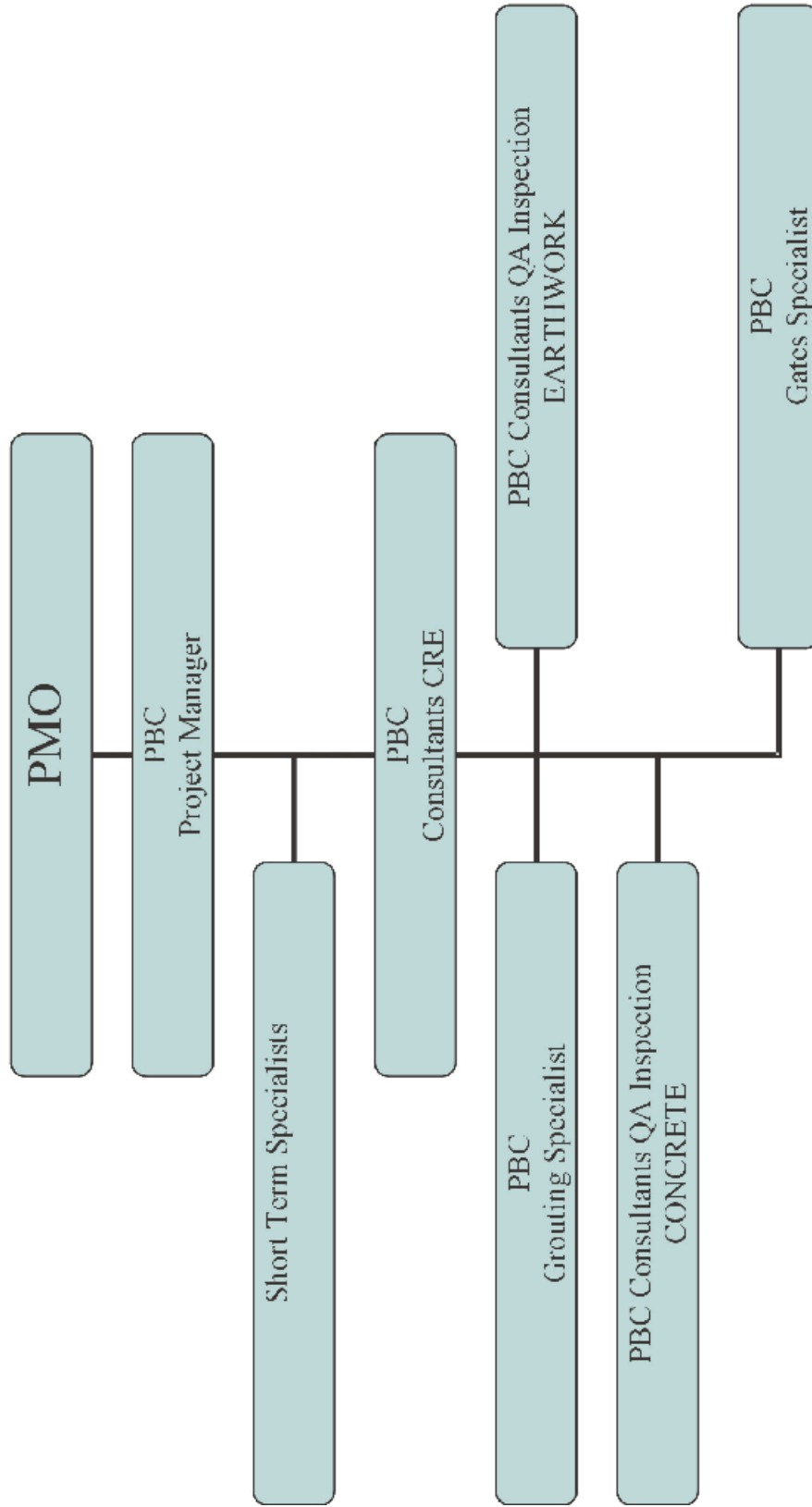


**TAUNSA BARRAGE EMERGENCY REHABILITATION AND
MODERNIZATION PROJECT ORGANIZATION AND FLOW OF**



**TAUNSA BARRAGE EMERGENCY REHABILITATION AND MODERNIZATION PROJECT
SUPERVISION CONSULTANTS QUALITY ASSURANCE AND QUALITY CONTROL PROGRAMME**

Summarized Organization Chart



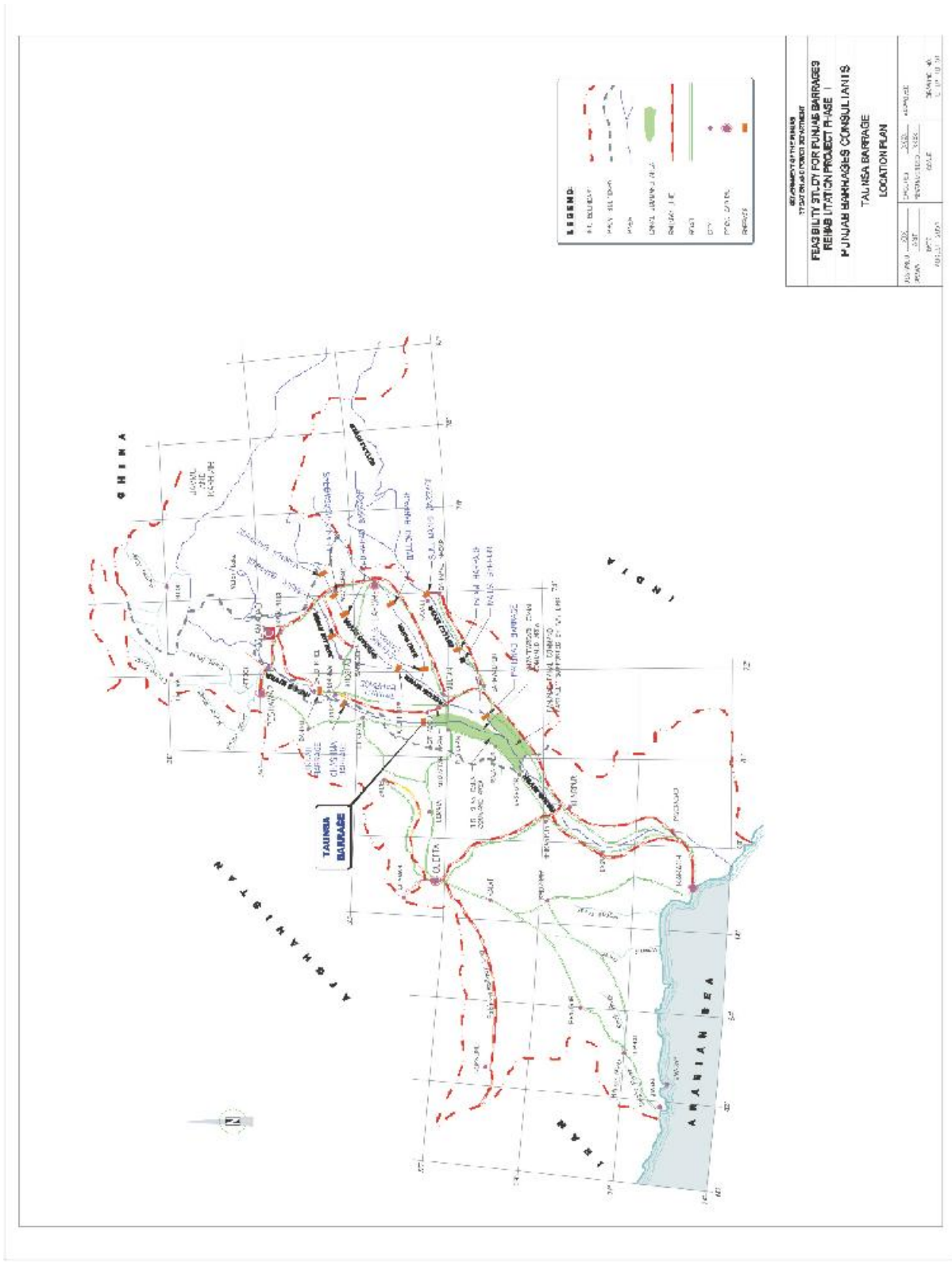


Figure 10: Location plan of the Barrage

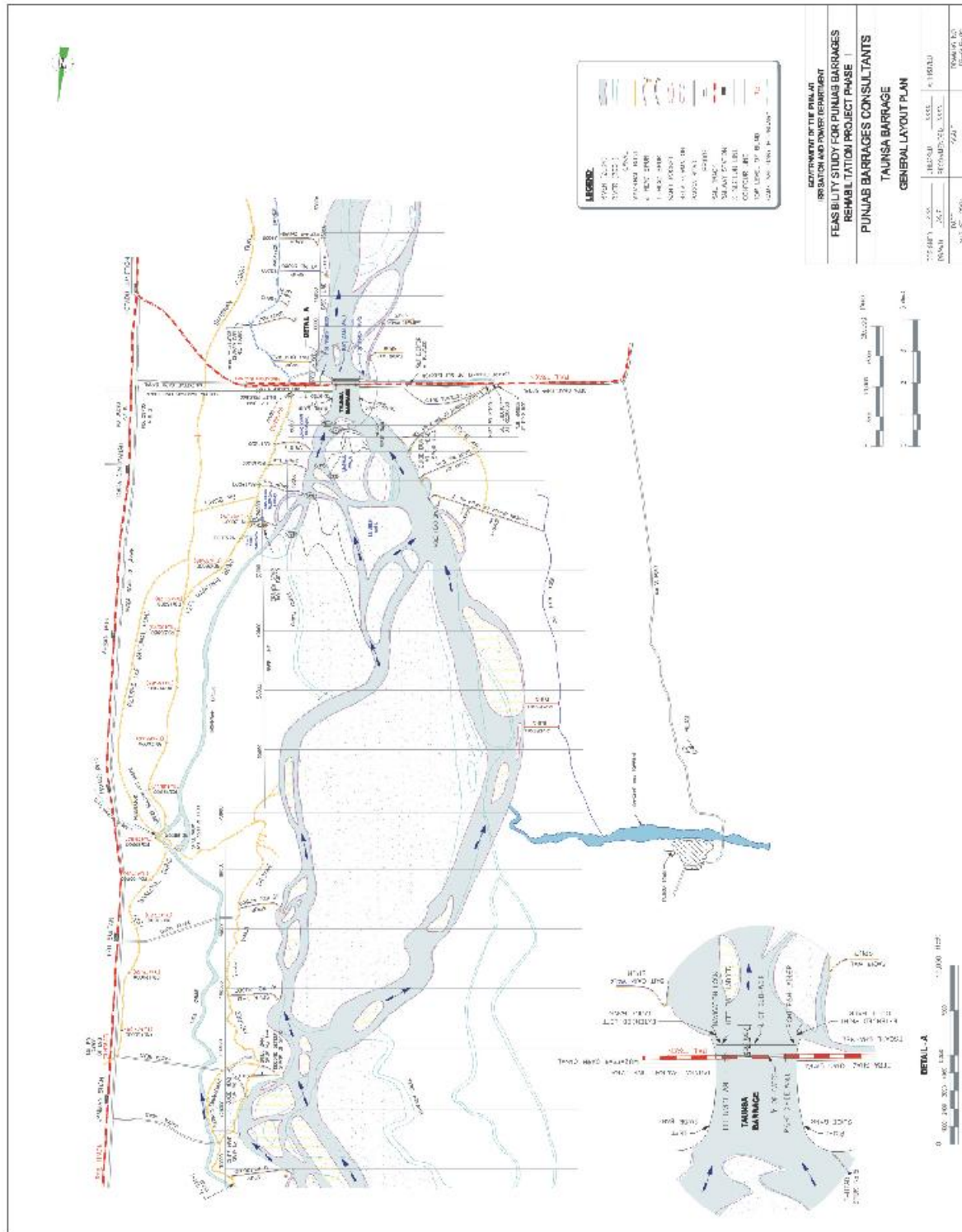


Figure 11: Layout of the Barrage



Figure 3: Upstream View of the Barrage

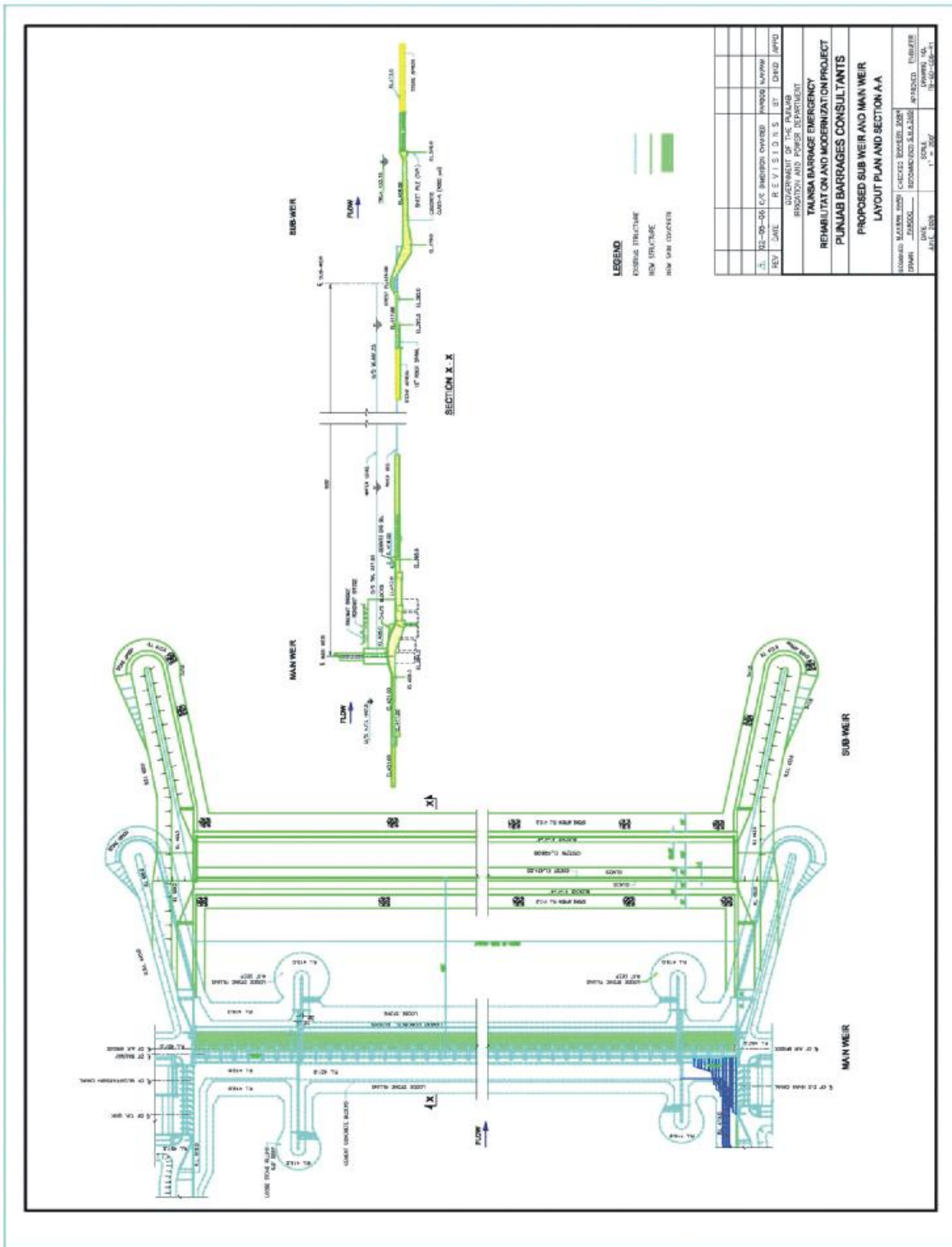


Figure 12: Main Existing Barrage and Sub-Weir - Plan and Cross Section

