QUALITY CONTROL OF ROAD CONSTRUCTION

IN DHAKA SOUTH CITY COPORATION

By

MD: RIPON HOSSAIN
MD: MOULIK AHMED
RIADUL ISLAM
MD: HANIF MAHMUD
MD: ARIF HOSSAIN

A thesis submitted to the Department of Civil Engineering in partial fulfillment for the degree of Bachelor of Science in Civil Engineering

Department of Civil Engineering

Sonargaon University

147/I, Green Road, Dhaka-1215, Bangladesh

Section: (15B)

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By

Name	Student ID
MD. RIPON HOSSAIN	BCE1803015067
MD. MOULIK AHMED	BCE1803015105
RIADUL ISLAM	BCE1803015043
MD. HANIF MAHMUD	BCE1803015095
MD. ARIF HOSSAIN	BCE1803015038

Supervisor

Md. Lutfor Rahman
Assistant Professor
Department of Civil Engineering
Sonargaon University

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The thesis titled "Quality Control of Road Construction in Dhaka South City Corporation" submitted by Md. Ripon Hossain, Id No.: BCE1803015067, Md. Moulik Ahmed, Id No.: BCE1803015105, Riadul Islam, Id No.: BCE1803015043, Md. Hanif Mahmud, Id No.: BCE1803015095 and Md. Arif Hossain, Id No.: BCE1803015038 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Civil Engineering. Date: 19/05/2022.

……

1. Md: Lutfor Rahman — Supervisor
   Assistant Professor

   Sonargaon University

……

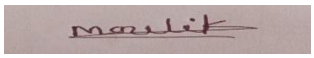
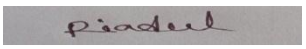
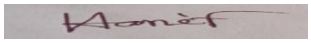
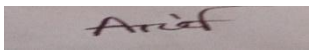
2. Internal / External Member — Member

……

3. Internal / External Member — Member

DECLARATION

It is hereby declared that this thesis/project or any part of it has not been submitted elsewhere for the award of any degree or diploma.

STUDENT NAME	STUDENT ID.	SIGNATURE
MD. RIPON HOSSAIN	BCE1803015067	
MD. MOULIK AHMED	BCE1803015105	
RIADUL ISLAM	BCE1803015043	
MD. HANIF MAHMUD	BCE1803015095	
MD. ARIF HOSSAIN	BCE1803015038	

Dedicated

to

"We dedicate this thesis to Our Parents. We would also like to dedicate this thesis to our mentors Md. Lutfor Rahman, Assistant professor, Department of Civil Engineering, Sonargaon University."

ACKNOWLEDGEMENTS

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ABSTRACT

The title of the thesis presented herein, refers the primary objectives that underpin the research work. As a high growing metropolitan city with high population density and increased rate of transportation needs, the Roadway pavement of Dhaka city has to sustain more traffic load than any other cities in Bangladesh. Moreover poor drainage system in most of the city roads accelerates the deterioration of the pavements. For these reasons, regular periodic maintenance has been adopted to keep the roads functional. This study deals with the investigation and identification of road construction faults and cracks before and after reconstruction and compare the results to evaluate the effectiveness of the reconstruction. The pavements are visually assessed and four assessment methods: DSCC, RHD, LGED Method and Texas Innovation Group Method are used. Road construction are selected throughout the Dhaka city to evaluate the effectiveness of reconstruction and increment of life span of the pavements. Before reconstruction, most of the roads were in poor to fair to poor condition. But later a periodic reconstruction after a specific interval, most of them promoted into fair or good condition.

Finally, it can be said that, this assessment may prove itself useful for future planning and implementation to ensure effective, comfortable, safe and efficient traffic movement which may lead to a better transportation system throughout the city.

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CHAPTER 1

INTRODUCTION

1.1 Background and Motivations

As the market economy has developed, market competition has had an important role of the law of survival of the fittest in every corner. The pressure of construction enterprises from the market and competitors will be greater and greater, as well as the increasing requirements of customers of quality assurance, which require the construction companies to improve their internal quality, strengthen management, in particular, pay close attention to quality control. [1]

Quality is the symbol of human civilization, and with the progress of human civilization, quality control will play an incomparable role in the business. It can be said that if there is no quality control, there is no economic benefit. Construction projects are an extremely complex process, involving a wide range. There are plenty of factors affecting the quality of construction, such as design, materials, machinery, topography, geology, hydrology, meteorology, construction technology, methods of operation, technical measures, management systems, and so on. Because of the fixed project location, large volume and different location of different projects, the poor control of these factors may produce quality problems. During controlling the whole process of construction, only accord with the required quality standards and user promising requirements, fulfilling quality, time, cost, etc., construction companies could get the best economic effects. Construction companies must adhere to the principle of quality first, and insist on quality standards, with the core of artificial control and prevention, to provide more high quality, safe, suitable, and economic composite products. [2]

The construction quality of city corporation road works is often influenced by various factors, which leads to a certain gap between the quality of corporation road works and the expected effect. Therefore, relevant units and staff must make clear the importance of quality control of corporation road construction. Comprehensively understand the testing and testing procedures and methods, and make reasonable use

of them in order to achieve effective control of the construction quality of corporation roads. [3]

1.2 Research Objectives and Overview

It is an important part of the road engineering quality assurance system that the test of road engineering can form a complete system from construction materials to construction control to completion acceptance. More and more attention is paid to city corporation road construction, and test detection has become a necessary condition for road construction. The test data becomes a necessary part of the engineering data. On the one hand, the test data can comprehensively reflect the quality of project construction, and on the other hand, it can be used to guide construction, timely detect problems and timely fix them. At the same time, the construction unit clearly defines the construction unit, material supplier and other parties to provide the basis for quality responsibility.

1.3 Research Objectives

The study was carried out with the following objectives:

- To analyze Quality Control and Testing procedure for road Construction Dhaka South City Corporation.
- To Compare Road Construction Quality Control and Testing procedure of DSCC with standard procedure (RHD, LGED).

1.4 Organization of the thesis

The study has been organized in five chapters, which comprise different elements of the study.

Chapter 1: Introduction and Objective. A brief introduction of the study with the background and research significance, objective, scope and limitation of the study.

Chapter 2: Literature Review. A brief Literature Review of the study.

Chapter 3: Methodology. A Research Methodology of the study.

Chapter 4: Results and Discussion. Results based on the Study and further Discussions are included in chapter four.

Chapter 5: Conclusions and Future Work. This chapter summarizes the conclusions and major contributions of this study and provides recommendations for future studies.

CHAPTER 2
Literature Review

2.0 Introduction

Quality control can be defined as "a collective term for activities and techniques, within the process, that are intended to create specific quality characteristics". In other words, it will assure that the organization's quality objectives are being met, by using certain techniques such as continually monitoring processes and statistical process control. Quality control of construction materials and finished product is essential requirement for obtaining improved and uniform standard of road construction. [4]

Basically, road construction specifications and estimates provide basis for effective quality control. In addition, organizations set up quality management systems, adequately trained staff and good monitoring system for implementing quality control. A number of lab and field tests are conducted on the materials used and the finished product on road construction projects. A few important ones are briefly explained below. The lab tests should be carried out by approved/certified labs and the field test should be conducted by the responsible supervising staff by the client or client's representatives. The frequency and extent of tests should be adhered to the standard criteria. [5]

2.1 Various Researches

Alford, R. A. and J. Richards. 1999 [6]. Global amphibian's declines: a problem in applied ecology. Annual Review of Ecology and Systematics 30: 133-165. Andrews, K. M. 2004 [7]. Interspecific comparisons of behavioral responses of southeastern snakes to roads. M.S. Thesis. University of Georgia. Athens, GA. Andrews, A. 1990 [8]. Fragmentation of habitat by roads and utility corridors; a review. The Australian Zoologist 26: 130-141. Aresco, M. J. 2003 [9]. Highway mortality of turtles and other herpetofauna at lake Jackson, Florida, USA, and the efficacy of a temporary fence/culvert system to reduce roadkills. Pp. 433-449 In: Proceedings of the International Conference on Ecology and Transportation, edited by C. Leroy Irwin, Paul Garrett, and K. P. McDermott, Raleigh, NC: Center for Transportation, and the Environment, North Carolina State University, 2003. Ashley, [10]

2.2 Types of Quality Control

Process Quality Control - the designer makes the decisions regarding the type of equipment, the procedure of construction and the amount of work required to obtain the desired result. In the 'End result' type of specification, the field engineering personnel carry out tests on finished work at regular intervals to evaluate whether it meets the specification requirements or not whereas in the 'Process type control', the responsibility of field personnel is to make sure that the work is carried out as per laid down specifications.

2.3 Road Pavement Types

The following are two major pavement types used in road construction,

- Rigid Pavement
- Flexible Pavements

2.3.1. Rigid Pavement

The rigid characteristic of the pavement are associated with rigidity or flexural strength or slab action so the load is distributed over a wide area of subgrade soil. Rigid pavement is laid in slabs with steel reinforcement. [11]

2.3.2. Composition and structure Rigid Pavement

Rigid pavements support loads through rigidity and high modulus of elasticity of concrete slab. The loads will distribute to natural soil layer through different layers of rigid pavement. The Composition and structure of rigid pavement tells us about the function of each layer of rigid pavement as explained below. [12]

2.3.3. Composition of Rigid Pavement

In general, Portland cement concrete is used as primary structural element for rigid pavement. The reinforcement is provided in the slab depending upon the soil strength and loading conditions. Pre-stressed concrete slabs can also be used as surface course. The concrete slab usually lies on a compacted granular or treated sub-base, which is supported, in turn, by a compacted sub-grade. Better results of pavement are obtained when the support layers under the pavement are uniform. The strength of rigid pavement is Rigid pavement is mostly depends upon the concrete slab so, it

should be laid strongly while the bottom layers are constructed using low cost materials to make it economical.

2.3.4 Structure of Rigid Pavement

The structure of a rigid pavement consists following layers.

- Concrete slab or surface course
- Granular base or stabilized base course
- Granular sub-base or stabilized sub-base course
- Frost protection layer
- Sub-grade soil

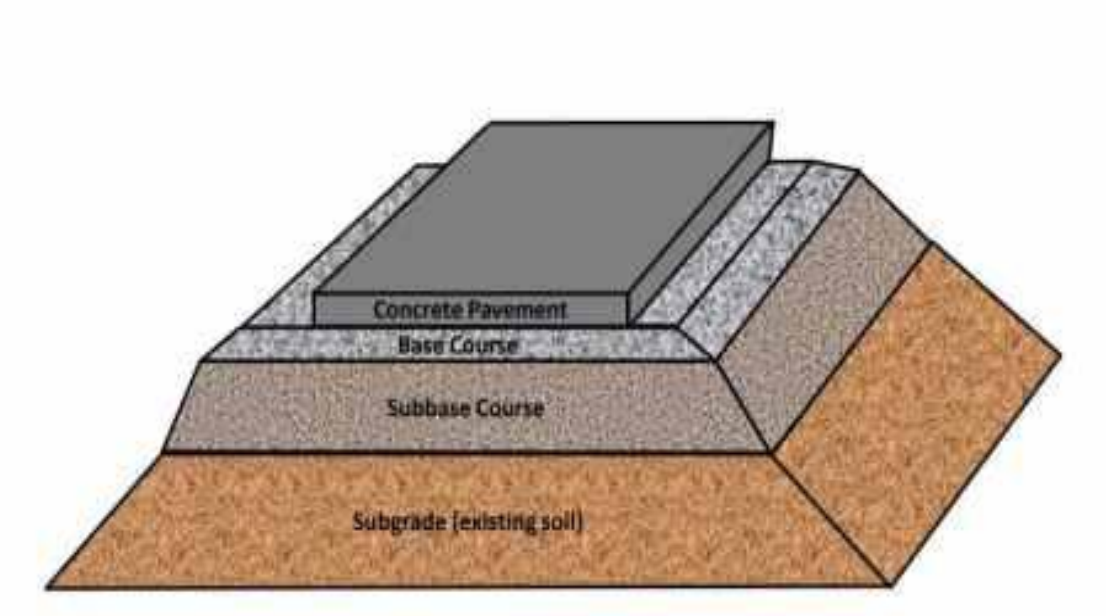

Fig 2.1: Typical Rigid Pavement Structure [13]

2.3.5 Concrete slab or surface course

The concrete slab is the top most layer of rigid pavement which is in direct contact with the vehicular loads. This is also called as surface course. It is water resistant and prevents the water infiltration into the base course. It offers friction to the vehicles to provide skid resistance. The thickness of concrete slab is kept between 150 mm to 300 mm.

Fig 2.2: Concrete Slab Laying [14]

2.3.6 Granular base or stabilized base course

The base course or granular base or stabilized base is the second layer from the top and is constructed using crushed aggregates. This course helps the surface course to take additional loads. It provides stable platform to construct rigid pavement It is also useful to provide sub surface drainage system. In frost areas, the frost action can be controlled by the stabilized base course. It helps to control swelling of subgrade soil. The base course thickness should be minimum 100mm.

Fig 2.3: Providing Base Course (WBM)

Site visit of Dhaka south city corporation

Location: sham bag Icon mondir road doyagonj main ,Date:15/02/22

2.3.7 Granular sub-base or stabilized sub-base course

It is the third layer from the top and is in contact with the subgrade soil and base course. It is constructed by using low quality aggregates than the base course but they should be better quality than subgrade. Generally subbase course is not required when the traffic loading is light. When the loading exceeds 100000 pounds it should be constructed. Its primary function is to provide support for the top layers and it serves as frost action controller and prevents the intrusion of fines from subgrade to top layers. The drainage facility will also improve when there is a subbase course.

Fig 2.4: Laying of Sub base Course [15]

2.3.8 Sub-grade soil

Soil compaction is one of the most important aspects of any earthwork construction. Compaction improves the engineering properties of the fills. Nearly all compaction specifications are based on achieving a certain value of dry unit weight (γd). During construction, the geotechnical engineers measure the unit weight of compacted soil in the field to verify the contractor's compliance with the requirement. This paper is a project study of road construction project "Jatarabari to staffquater". Soil samples were collected from five different locations. In situ dry density was obtained by Sand Cone Test from each location. The laboratory tests (Standard Proctor Test) were carried out to find out the dry density for each sample. The maximum dry density in relation to moisture content was obtained. Relative compaction (CR) of soil at each location was then calculated to the soil compaction of the said road project.

Fig2.5: Soil compaction of road construction [16]

2.4 Test Methods and Specifications

- ASTM C31 / AASHTO T 23 - Making and Curing Concrete Test Specimens in the Field
- ASTM C192 / AASHTO R 39 - Making and Curing Concrete Test Specimens in the Laboratory
- ASTM C470 / AASHTO M 205 - Molds for Forming Concrete Test Cylinders Vertically
- ASTM C511 / AASHTO M 201 - Moist Curing Rooms & Water Storage Tanks for Curing
- ASTM C617 / AASHTO T 231 - Capping Cylindrical Concrete Specimens
- ASTM C 1231 – Un-bonded Caps for Cylindrical Concrete Specimens
- ASTM C39 / AASHTO T 22 - Compressive Strength of Cylindrical Concrete Specimen

At to Dhaka South City Corporation Cylinder test, tension test of deformed reinforcement bar report Submitted.

2.5 Flexible Pavements

Flexible pavement can be defined as the one consisting of a mixture of asphaltic or bituminous material and aggregates placed on a bed of compacted granular material of appropriate quality in layers over the subgrade.

Table 2.1: Aggregate Gradation for Mss.

IS Sieve mm	Cumulative % by wt. of total aggregate passing	
	Type A	Type B
13.2	-	100
11.2	100	88-100
5.6	52-88	31-52
2.8	14-38	5-25
0.09	0-5	0-5

2.5.1 Quantity of Aggregates and Bitumen

- The total quantity of aggregates used shall be 0.27 cum per 10 m2 area
- The quantity of binder shall be 22.0 kg and 19.0 kg for 10m2 area for Type A and Type B surfacing respectively.

2.5.2 Bituminous Concreate (BC)

- BC is a Dense Graded Bituminous Mix used as Wearing Course for Heavily Trafficked Roads.
- BC Mix consists of Coarse Aggregates, Fine Aggregates, Filler and Binder blended as per Marshall Mix Design.

Table2.2: Grading Requirement of BC

Sieve Size mm	I	II
	50-65 mm	30-45 mm
26.5	100	-
19	79-100	100
13.2	59-79	79-100
9.5	52-72	70-88
4.75	35-55	53-71
2.36	28-44	42-58
1.18	20-34	42-58
0.60	15-27	26-38
0.30	10-20	18-28
0.15	5-13	12-20

0.075	2-8	2-8
Bitumen content percent by mass of total mix	5.0-6.0	5.0 – 7.0

2.5.3 Bituminous Concrete (BC)

Quality control operations involved are:

- ❖ Design of mix in laboratory, and control of mixing, laying and rolling temperatures
- ❖ Density, Marshall Stability, Flow, Air Voids, Retained Stability, Bitumen Content, Gradation of aggregates are controlled
- ❖ Riding quality is a control.

Table 2.3: Design Requirements for BC

Minimum Stability (KN at 60°C)	9.0
Flow	2-4
Compaction Level (Number of blows)	75 on each face
Per cent air voids	3-6
Per cent voids in mineral aggregate (VMA)	VMA Table
Per cent voids filled with bitumen (VFB)	65-75
Loss of stability on immersion in (ASTM D 1075)	Minimum 75 %

2.5.4 Dense Bituminous Macadam (DBM)

- ❖ DBM is Closely Graded
- ❖ DBM is used as a Binder Course for pavements subjected to heavy traffic
- ❖ Hydrated Lime or Cement shall be used as filler, if the mix fails to meet the water sensitivity requirement

Table 2.4: Physical Requirement of Coarse Aggregates for DBM

Test	Test Method	Requirement
Los Angeles Abrasion Value*	IS: 2386 (Part-4)	35 % Max
Aggregate Impact Value *	IS: 2386 (Part-4)	27 % Max
Flakiness and Elongation Indices (Total)	IS: 2386 (Part-1)	30 % Max
Coating and Stripping of Bitumen Aggregate Mixture	IS: 6241	Min Retained Coating 95%
Soundness Loss with Sodium Sulphate Loss with Magnesium Sulphate	IS: 2386 (Part-5) 5 Cycle 5 Cycle	 12 % Max 18 % Max
Water Absorption	IS: 2386 (Part-3)	2 % Max
Retained Tensile Strength	AASHTO T283	Min 80 %

Table 2.5: Design Requirements for DBM

Minimum Stability (KN at 60°C)	9.0

Flow	2-4
Compaction Level (Number of blows)	75 on each face
Per cent air voids	3-6
Per cent voids in mineral aggregate (VMA)	VMA Table
Per cent voids filled with bitumen (VFB)	65-75

2.5.5 Granular Sub-Base

- Laying and compacting well-graded material on prepared sub-grade
- Material shall be laid in one or more layers
- The material to be used for the work shall be natural sand, moorum, gravel, and crushed stone.

Table 2.6: Grading for Coarse-Graded Granular Sub-Base Materials

IS Sieve Destination	Percent by WT passing the IS sieve		
	Grading I	Grading II	Grading III
75.0 mm	100	-	-
53.0 mm	-	100	-
26.5 mm	55-75	50-80	100
9.50 mm	-	-	-
4.75 mm	10-30	15-35	25-45
2.36 mm	-	-	-
0.075 mm	-	-	-

0.425 mm	<5	<5	<5
CBR Value (Min)	30	25	20

2.5.6 Wet Mix Macadam

- Laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on prepared sub-grade or existing pavement
- Thickness of single compacted Wet Mix Macadam layer shall not be less than 75 mm
- Coarse aggregate shall be crushed stone
- If crushed gravel is used, not less than 90% by Wt. of gravel pieces retained on 4.75 mm sieve shall have at least two fractured faces
- If water absorption value of coarse aggregate is greater than 2%, the soundness test shall be carried out as per IS:2386 [17]

Table 2.7: Grading Requirement for WMM

IS Sieve Destination	Percent by Wt. Passing IS Sieve Destination the IS Sieve
53.00 mm	100
45.00 mm	95-100
26.50 mm	N/A
22.40 mm	60-80
11.20 mm	40-60
4.75 mm	25-40

2.36 mm	15-30
600 micron	8-22
75 micron	0-8

Materials finer than 425 micron shall have Plasticity Index (PI) not exceeding 6.

2.6 Quality Control Related test: Quality control related tests are listed below

- Penetration Test on Bitumen
- Softening Point Test on Bitumen
- Viscosity of Bitumen
- Moister Condition value(MCV) Test
- Los Angle Abrasion value Test
- Flakiness Index Test
- Elongation index Test
- Sulphate Soundness Test
- Ten Percent Fine Value (TFV)
- Percentage Refusal Density
- Polished Stone value (PSV)
- Sand patch Test

[18]

2.6.1 Penetration Test on Bitumen

Its basic principle is to determine the depth to which a needle pen etrated as asphalt sample under specified condition of load, time and temperature.
The test is conduction under following conditions:
Load=100 kg
Temperature=25c
Time=5 sec
The depth of penetration is measured in units of 0.1mm and repo rted in penetration units (e.g. if the needle penetrates 8mm the asphalt penetration number is 80).Penetration grading is based on penetration test.

2.6.2 Softening Point Test on Bitumen

The softening point is defined as the temperature at which a bitumen sample can no longer support the weight of a 3.5g steel ball. Ball and ring apparatus is used. Water is used for bitumen with a softening point of 80c or below. The temperature is raised at the rate of 5c per minute.

2.6.3 Viscosity of Bitumen

Shear stress is applied to a film of bitumen sandwiched between 2 flat plates and the rate of strain is measured. The viscosity in Pascal is given by shear stress divided by the rate of strain.

2.6.4 Moister Condition value (MCV) Test

There is relationship between compacting effort, moister content and density. The MCV test involves testing a soil a fixed moisture content and by increasing, the number of below of a rammer determining the compaction effort beyond which on further increase in density occurs. As a general guide MCV of 8.5 is recommended as the lower limits of acceptability of a soil for compaction at its natural moisture content and difficulties in earth working con, be expected when MCV drops significantly below this value.

2.6.5 Los Angle Abrasion value Test

The loss angle abrasion value test is to indicate the resistance to abrasion to abrasion. Percentage of fines passing through the 1.7mm sieve is measure of Los Abrasion value .If its value is over 40% then the moisture is quite soft. If it is 25% then material is hard.

2.6.6 Flakiness Index Test

This test eliminates aggregates unsuitable for bituminous spray and chip seal.
Flakiness Index is the percentage by weight of particles, whose least dimension is less than three-fifth of its mean dimension. Max Flakiness Index is 25% .It should not be greater than 35%.

2.6.7 Elongation index Test

Elongation Index is the percentage by weight of particles dimension (i.e. length is greater than one and four-fifths times its mean dimension.

2.6.8 Sulphate Soundness Test

This test is for checking resistance to disintegration after immersion in a 20% solution of sodium Sulphate .This test is used for assessing weather susceptibility.

2.6.9 Ten Percent Fine Value (TFV)

A test specimen is compacted in a standardized manner into a steel cylinder fitted, which a freely moving plunger .The specimen is then subjected to a load applied through the plunger. This action crushes the aggregate to a degree, which is dependent on the crushing resistance of the material. The degree of crushing is assessed by a sieving test on the crushed specimen. The procedure is repeated with various load to determine the maximum force which generates a given sieve analysis. This is taken as the ten percent fines value .TFV should not less than 180KN (dry).

2.6.10 Percentage Refusal Density

This is measure of relative stage of compaction of a site sample of laid DBM or asphalt concrete to that of a similar sample compacted to refusal(i.e. It will not compact further even though it may still contain)lab conditions.

2.6.11 Polished Stone value (PSV)

Micro texture is quantified by the PSV. The test assesses an aggregate will polish under traffic, as this will be major determinant of the pavement skid resistance .It involves posing aggregate specimen with a pneumatic type coated with an abrasive paste.

2.6.12 Sand patch Test

Macro texture is measure by sand patch test. It is measure of resistance to aqua planning .A specific volume (25ml)complying with specific grading of sand is spread over the surface with use of the wooden disc with its face kept flat, in a circular motion so that the sand is spread into a circular patch with the surface depression filled to the level of the peaks. Measure either the radii of the dividers on the sand patch or practically the diameters at every 45 and calculate the mean of the 4 individual diameter (d) to nearest1mm.

2.7 Quality Control Tests Category:

Different quality control tests are required by the RHD General Specification. Where works are to be undertaken that are not covered by the RHD General Specification then the Contract must include a Particular Specification for such works, including the tests, frequencies and required results for those tests, both for the materials and workmanship for these works.

In addition to these tests, where the Contract requires particular materials to be used but the specification does not require tests to be carried out on those materials, then it will be the responsibility of the Engineer (through his support staff) to ensure that the Contractor provides those materials to the requirements of the specification. For example, where the Contract requires thermoplastic paint to be used the contractor must use a proprietary brand of thermoplastic paint and not simply road paint.

Quality control tests fall into three categories:

- Tests on materials prior to and during construction
- Tests on the quality of workmanship during construction
- Tests on the finished works after construction

In the event that the quality control tests demonstrate that the materials or workmanship do not meet the requirements of the specification, the Engineer's Representative has no alternative but to reject them and instruct the Contractor to replace them at his own cost. All quality control tests must be carried out at the earliest opportunity both to avoid delays to the Contractor and to minimize any abortive works. [19]

2.7.1 Quality control tests on material samples

Prior to the commencement of the Works, tests must be carried out by the Zonal laboratory on material samples (or mix designs) submitted to the Engineer for his approval by the Contractor in advance of them being taken on to the site. Given that

the Zonal laboratory may be testing samples from a number of different contracts at the same time, it follows that within the laboratory itself there must be a management system to ensure that samples arecorrectly registered, tagged, tested and recorded for the separate contracts.

Similar tests must be carried out by the Contractor on all such materials subsequently Delivered to site in the site laboratory (supervised by the Materials Engineer) with additional tests on those materials carried out on a sampling basis at the Zonal laboratory as a quality control check. [20]

2.7.2 Quality Control Tests on Workmanship

Largely, these tests are required to ensure that the approved construction materials are correctly mixed, placed and compacted during the works. With respect to road pavements, it is essential that each layer is tested and approved before the Contractor is allowed to place the next layer, since failure of an underlying layer will inevitably result in failure of the layers above it.

Accordingly, the Contractor may only be permitted to commence work on a particular layer when the underlying layer has been approved in writing by the Engineer's Representative. Standard forms for this are included.

2.7.3 Mixing of Materials

Whether mixed on-site or off-site, the ER's support staff must take samples of all bituminous and concrete mixes for testing at the Zonal laboratory in accordance with the requirements of the Specification. Inevitably, the results of these tests will not be known until a considerable period has elapsed after the materials have been placed and compacted. Where the results of these tests demonstrate that the materials do not comply with the Specification further intrusive and /or non-destructive tests must be carried out on the completed works for the Engineer to decide whether to reject the works.

Concrete target strengths are to be calculated using the statistical approach set out in the Contract.

2.7.4 Placing and Compacting of Materials

Premature failure of the works will occur unless the materials are correctly placed and Compacted (where appropriate) in accordance with the specifications. In the case of road widening work, premature failure will also occur if required cross drainage structures or drainage layers are not provided. With respect to road pavements, this essentially means the compaction of each layer to the required dens it (typically 98% of MDD) to achieve the necessary CBR to support the next layer.

Accordingly the ER must ensure that field density measurements are taken by the Contractor at the appropriate times to demonstrate that the underlying layers are properly compacted (or corrective measures taken if not), and that rolling of the bituminous surfacing is undertaken within the correct temperature range.

2.7.5 Quality Control Audit of Completed Works

The RHD General Specification requires cores to be taken from completed bituminous surfacing work and for laboratory tests to be undertaken on these samples to determine whether they comply with the requirements of the specification. Amongst other things, these tests will include Marshall Stability, determination of bitumen content and the grading of aggregates in each sample. In addition to this, the laboratory will measure the compacted thickness of the bituminous layer for compliance with the design or relevant BQ item in the Contract. The taking of cores is to be undertaken by the Contractor and all tests on those cores are to be undertaken by an off-site laboratory approved by the Engineer, with all costs associated with this testing being borne by the Contractor.

Where cores have been taken from road pavements Dynamic Cone Penetration (DCP), tests are to be undertaken for the underlying layers through to the sub-grade to determine both the thickness of these layers and their respective CBR values. These tests are to be undertaken by the ER or his support staff.

In the event that the DCP tests show that the underlying pavement layers do not have the required thickness or CBR or if the bituminous cores do not meet the requirements of the specification or thickness required by the Contract, the Engineer will immediately notify CE/RHD requesting that an inquiry be held to determine what course of action should be taken.

CHAPTER 3
Methodology

3.1 Introduction

At first we have selected a road and collected material report (which in appendix -C) from selected zone of Dhaka South City Corporation (DSCC).

For study, we had to perform inventory, final field study, data collection and analysis of the data. A define method compatible with standard practices was used to perform the thesis work.

Map:

A site vicinity Google map closer image:

Fig 2.1: Location map

3.2 Methodology Overview

1. Data Collection

At first, we have collected report from selected zone of DSCC and basis on this report we try find out the Quality Control of Road Construction

2. Information about the availability and cost of the required foundation material. All of the materials are available and cost of the materials has nearly limited range to develop this project.

3. Quality Control soft this study is very negligible other them.

3.3 Methods for Pavement Evaluation

It is better to use software evaluation of pavement, but in its absences, there are various methods to visually evaluate road condition. Visual methods are less accurate but are effective for surveying overall road network condition. We used the following methods for evaluation:

1. RHD Method
2. DRM Method

3.3.1 RHD Methods

In order to identify the condition of the road, we have to first identity the cracks, distress, surface defects and deformation. We should also know the possible reasons behind these defects. To identify, RHD provide a characteristics table

Table 3.1: RHD Methods

Defects	Rating Scale Limit	Rating
Transverse Crack	0-5	
Longitudinal Cracking	0-5	
Alligator Crack	0-10	
Shrinkage Crack	0-10	
Rutting	0-5	
Corrugations	0-10	
Raveling	0-5	
Shoving	0-10	
Pot Holes	0-10	

Excess Bitumen	0-10	
Polished Aggregates	0-5	
Deficiency in drainage	0-10	
Overall riding Quality	0-10	
	Sum of Defects	

From the above table we get the value of total of the total defects of a road. By subtracting sum of defects from the total value, we have the condition rating for the particular road. Now for pavement condition rating recommended treatment below:

Table 3.2: Table for Road assessment on RHD Method [21]

Recommended Treatment	**Rating**	**Pavement Condition**
Reconstruction within 2 years	0-20	Pavement is in poor to very poor condition with extensive severe cracking, alligator and channeling. Ride ability and the surface is very rough.
Reconstruction or recycle in 2 years	20-30	Pavement in poor condition with moderate alligator and extensive severe cracking and channeling. Riding ability is poor and surface is very rough and even.
Recycle or reconstruction within 3-4 years	30-40	Pavement in poor to fair condition with frequent moderate alligator and extensive severe cracking and channeling. Riding ability is poor and surface is very rough and even.
Reconstruction in 4-5 years or resurface within 2 years	40-50	Pavement in fair condition with moderate alligator and extensive severe cracking and channeling. Riding ability is poor and surface is very slightly and uneven.

Resurface within 3 years	50-65	Pavement in good condition with moderate alligator and moderate severe cracking and channeling. Riding ability is poor and surface is slightly rough and uneven.
Resurface in 3-5 years	65-80	Pavement in good condition with frequent alligator and slight severe cracking and channeling. Riding ability is good and surface is intermittent rough and uneven.
Normal maintenance only	80-90	Pavement in good condition with frequent alligator very slight severe cracking and channeling. Riding ability is good and surface is slightly rough and uneven.
No maintenance required	90-100	Pavement is in excellent condition with few cracks. Ride ability is excellent with few areas of slight distortion.

3.3.2 Evaluating Pavement with DRM Method

DRM method includes various distresses various for rigid, flexible and composite pavements and sets a standard for establishing severity and extent. The method used to compute PCR is based upon the summation of deduct point for each types of observable distress. Deduct values are a function of type, severity and extent. Deduction for each distress type is calculated by multiplying distress weight times the weights for severity and extent of the distress. Distress weight is the maximum number of deductible points for each different distress type. The mathematical expression for PCR is as follow:

Table 3.3: Table for Road assessment on DRM Method

PCR	**Condition**
100	Very Good
90	Very Good
75	Good
65	Fair

55	Fair to Poor
40	Poor
0	Very Poor

PCR= 100 - ∑Deduct

A PCR scale has been developed to describe the pavement condition using the PCR numbers.

However, RHD and LGED have Different Quality Manual for Road Construction.

3.4 Selection of the study area

Selection of the study area is very important for any kind of dissertation and research study. According to the title and objectives, a part of the main arterial thoroughfare of DSCC was taken for study, which extends from selected express on Jatarabari-Staff Quarter Road.

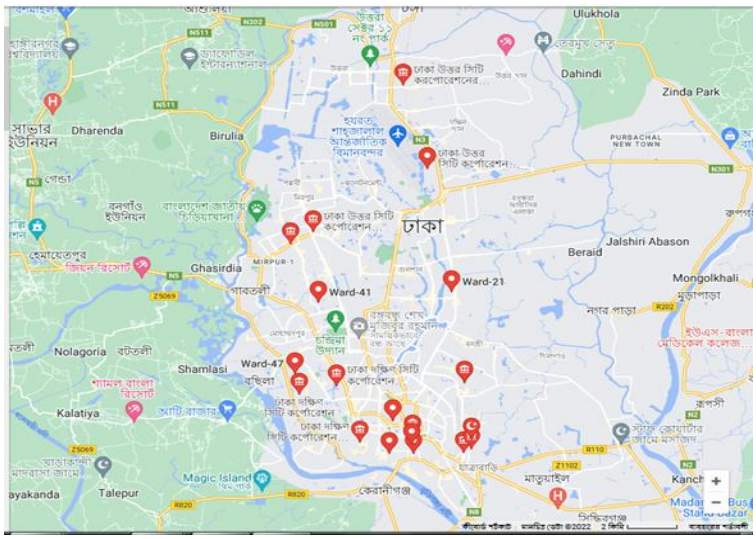

Figure: 3.2: Location Map

The quality of the road construction has been maintained according schedule of activities of DSCC (Appendix-E). Some of concerned test report has been attached in Appendix-C.

3.5 Summary:

The present chapter summarizes the methodology of the entire study elaborately. We have worked here on road quality control in DSCC.

CHAPTER 4

Results and Discussion

4.1 Introduction

Analysis on Quality Control of Road Construction in DSCC shows that the Quality Control process of Road Construction has a little variation depending local standards like LGED, DSCC or RHD. However, the table gives a comparison of RHD standard procedure with that of DSCC.

Table 4.1: Testing Requirements for Materials and Underlying Layers [22]

RHD Procedure				**DSCC**
Layer	**Standard Test Procedure**	**Required Result**	**Frequency**	Same as Procedure RHD
Earthworks	Liquid Limit	LL of material passing 0.425 sieve not to exceed 50%	1/2000m3	
	Plasticity Index	PI of material passing 0.425 sieve not to exceed 25%	1/2000m3	
	Moisture Content	MC to be within ± 2% of optimum	1/2000m3	
	Lab CBR	Minimum 3%CBR (soaked) at 95% MDD	1/2000m3	
	Compacted density	95% of MDD verified by STP 6.2	1/1000m2	
	(DCP Test)	Not greater than 45mm / blow	1/500m	
Subgrade	Liquid Limit	LL of material passing 0.425 sieve not to exceed 50%	3/1000m2	
	Plasticity Index	PI of material passing 0.425 sieve not to exceed 15%	3/1000m2	
	Moisture Content	MC to be within □□2% of optimum	3/1000m2	

	Lab CBR	Minimum of 5% CBR (soaked) at 98% MDD	3/1000m2	
	Compacted density	98% of MDD verified by STP 6.2	1/500m2	
	(DCP Test)	Not greater than 30mm / blow	1/1000m3	
Improved Subgrade	Grading	Particle size distribution to comply with specified grading envelope	1/1000m3	
	Liquid Limit	LL of material passing 0.425 sieve not to exceed 30%	1/1000m3	
	Plasticity Index	PI of material passing 0.425 sieve not to exceed 9%	1/1000m3	
	Moisture Content	Material is to be free draining	3/1000m2	
	Lab CBR	Minimum of 8% CBR (soaked) at 95% MDD	3/1000m3	
	Compacted density	95% of MDD verified by STP 6.2	3/1000m3	
	(DCP Test)	Not greater than 22mm / blow	1/500m2	
Sub base	Grading	Particle size distribution to comply with specified grading envelope	1/750m	
	Liquid Limit	LL of material passing 0.425 sieve not to exceed 25%	1/750m	
	Plasticity Index	PI of material passing 0.425 sieve not to exceed 9%	1/750m	

	ACV	Not greater than 38% for material retained on 10mm sieve	1/2000m3	
	!0% Fines	Not less than 75kN for material retained on 10mm sieve	1/2000m3	
	Lab CBR	Minimum of 25% CBR (soaked) at 98% MDD	1/2000m3	
	Compacted density	98% of MDD verified by STP 6.2	1/750m	
	(DCP Test)	Not greater than 9mm / blow	1/500m	
Base Type(1)	Grading	Particle size distribution to comply with specified grading envelope	1/500m3	
	Liquid Limit	LL of material passing 0.425 sieve not to exceed 20%	1/500m3	
	Plasticity Index	PI of material passing 0.425 sieve not to exceed 5%	1/500m3	
	ACV	Not greater than 30% for material retained on 10mm sieve	1/1000m	
	!0% Fines	Not less than 125kN for material retained on 10mm sieve	1/1000m	
	Lab CBR	Minimum of 80% CBR (soaked) at 98% MDD	1/500m3	
	Compacted density	98% of MDD verified by STP 6.2	3/1000m2	

	(DCP test)	Not more than 3.5mm / blow	1/500m2	

Table 4.2: Testing Requirements for Cement Stabilized Base

RHD Procedure				**DSCC**
Item	**Standard Test Procedure**	**Required Result**	**Frequency**	Same as Procedure RHD
		Type 1		
Aggregate	grading	As per spec	1/100m3	
	Liquid Limit	< 25% passing 0.425 sieve	1/100m3	
	Plasticity Index	< 10% passing 0.425 sieve	1/100m3	
	ACV	Less than 30%	1/100m3	
	10% Fines	Greater than 125 kN	1/100m3	
	Min. 1 Fracture Face	>50% by weight if gravel	continuous	
cement	Fineness /strength	To comply with AASHTO M85	every batch	
Water	AASHTO Test T26	N/A	As directed	
CS base	Compacted Density	98% of MDD	3/1000m3	
	UCS Durability	N/A	3/day 3/day	

(Note: Site trials on cement stabilized base to be undertaken in accordance with the Specification) [23]

Table 4.3: Testing Requirements for DBST [24]

RHD Procedure				
Item	**Standard Test Procedure**	**Required Result**	**Frequency**	Same as Procedure RHD
Bitumen	penetration	80 / 100 pen	continuous	
	temperature	N/A	2 / day	
	spray rate	N/A	1 / 100m3	
Aggregate	Flakiness	<25%	1 / 100m3	
	ACV	>28	1 / 100m3	
	10% fines	>175kN	1 / 100m3	
	Grading	N/A	1 / 100m3	
	Fracture face	90% > 5mm	As directed by the Engineer	
	Spray rate	N/A	2 / day	

Table 4.4: Testing Requirements for DBS and Bituminous Carpeting [25]

RHD Procedure				
Item	**Standard Test Procedure**	**Required Result**	**Frequency**	Same as Procedure RHD
Materials				
Coarse aggregate	Grading flakiness ACV 10% fines	As per Spec. Not to exceed 30% Not greater than 30% Not less than 150 kN	Every 100m3 of aggregate	
Fine Aggregate	Plasticity Index	To be less than 4	Every 100m3 of Aggregate	
Mineral Filler	Particle Size Distribution	0.600mm - 100% 0.150mm - 95-100%	As directed by the	

		0.075mm 65-100%	Engineer	
Asphalt				
Asphalt (Design)	Marshall Stability & Flow Aggregate grading	Stability of 350kg at 60□ □C Flow between 2mm - 4mm Ratio of stability/flow of 140 - 200 Air voids 3 - 7 % (base course) Air voids 3 - 5% (wearing course) As per specification requirements	Prior to commencement of Works and upon any changes to the job mix formula	
Asphalt (Mixing)	Marshall Tests Bitumen extraction Aggregate grading	Stability of 350kg at 60C Flow between 2mm - 4mm Ratio of stability/flow of 140- 200 Air voids 3 - 7 % (base course) Air voids 3 - 5% (wearing course) As per specification requirements	Three samples for Marshall testing plus two samples for bitumen extraction and aggregate grading per day	
Asphalt (Laying & Compaction)	Marshall Tests and thickness measurements on 100/150mm cores. Monitoring of mix temperature	To comply with specification and design requirements	Two cores for every 100 tons of DBS or every 50m of carpeting Laid.	

4.2 Control Charts: The following table shows the comparison of test report of RCC pipe load test and Compressive strength and Yield strength of rod for different standard.

Table 4.5: Table for laboratory test

Name of the standard	Compressive strength test(psi)	Average yield strength(psi) of MS bar	Actual applied load(psi) for 900 mm dia. Pipe	Comment
LGED	6090	75000	2917	Acceptable
DSCC	3966	81000	2810	Acceptable (Very close to 4000 psi)
RHD	3930	80000	NOT DONE	Acceptable (Very close to 4000 psi)

4.3 The findings and results described below

Quality control depend on laboratory test, which is shown in **control chart (table 4.2)**

From the result, LGED road is the most accepted. Our preferable compressive strength is 4000 psi (Appendix-D) but that of DSCC and RHD is less than 4000 psi.

Acceptable yield strength of MS bar for road construction is 60,000 psi. So result of LGED, DSCC and RHD is acceptable.

Pipe test acceptable range is 1350-1600 psi. (Appendix-E Item no 59). Result of LGED and DSCC is acceptable.

CHAPTER 5

Conclusions and Future Works

5.1 Conclusions

To conclusion up, with the increasing of urban modernization, urban economic circulation and the demand of People's Daily life in traffic is also increasing, this is for the city's south city corporation road engineering brings bigger bearing pressure. In this situation, the government also gradually increased the construction of city corporation road works to meet the urban traffic demand. In view of the practical significance of City Corporation road engineering quality control, relevant units and staff should actively carry out the quality control and inspection management of City Corporation roads. In order to improve the quality of Corporation road works, we can provide efficient and safe transportation service for urban economic development and residents' life.

In this research, we tried to present about the quality control. Manually we have do the quality control based on concrete casting plan design (Appendix-D). DSCC maintain 28 Mpa concrete material strength (Appendix A, B, C).

5.2 Limitations and Recommendations for Future Works

There are still some suggestions for the quality management and control of construction project. The mathematical methods can be used for quantitative control and management of project quality. It can make quality management more quantitative, objective and scientific, which is advantageous to constantly improving the construction quality and raise the level of construction quality management. The review of the construction organization and workers should be strengthened, and the qualification management should be strict. The quality and technical operation of workforce should be improved through training, and the continuing education of technical staff should be encouraged. The systematic quality management system should be applied. The quality of each process and project can be ensured through systematic planning, control and inspection. The waste of workforce, machinery, materials and other costs can be avoided, as well as the schedule delays. It has been found out that the scientific quality management system can ensure the rational

allocation of project resources, and make the project run on the preconcert quality objectives, so as to achieve the effect of project quality control.

The quality management of the whole process of project construction should be paid more attention, including the phase of pre-construction, construction and completion. The consciousness of quality control in the phase of project quality plan should be strengthened, and the focus on the inspection after completion should be transferred to the planning and process control of pre-construction.

This section should summarize the limitation of your studies and how these can be eliminated. Often the recommendation for future studies is based on the limitation of your study. For future study recommendations, you may mention specific activities that can help to fill up the gaps in knowledge, remedy the limitations of the current study, and/or probable extension of the current study.

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APPENDIX

Appendix A

Summary of Checklists developed for Quality Control of Concrete

Designation	Reference	Available
Quality Check-Lists		
Lowering Test (Slump Test)	QCL_CT_ST	in Annex
Vibe Test	QCL_CT_CDT	in Annex
Compactness Degree Test	QCL_CT_CDT	in Annex
Spraying Table Test	QCL_CT_STT	in Annex
Air Entrainment Test	QCL_CT_AET	in Annex

Appendix B

TITLE

Company Symbol:	QUALITY CHECK LIST - CONCRETE TEST'S Lowering Test (Slump Test)	Reference: QCL_CT_ST

IDENTIFICATION

Road: _____
Construction Owner: _____
Constructor: _____
Concrete Supplier: _____

Controller:

PROJECT REFERENCES

Specifications Book: (Pages) _____
Drawings: (Reference) _____
Norme: _____

Local of concrete aplication: _____

(image)

ACTS REGISTER

	I	II	III	IV
Localization				
Date	/ /	/ /	/ /	/ /
Hour	:	:	:	:
Weather Conditions(*)				
Concrete Type				

Note (*): A: sunny; B: clear; C: cloudy; D: rain; E: snow

CONTROL POINTS

√ Check × Not Check / Canceled

Workers

Verifications	Way of Control	Decision Criteria	Decision/Observations		
Responsible	Visual	Yes/No	I		
			II		
			III		
			IV		

Helper	Visual	Yes/No	I		
			II		
			III		
			IV		

Scope

Verifications	Way of Control	Decision Criteria	Decision/Observations		
Maximum Dimension of the Aggregate	Visual	≤ 40 (mm)	I		
			II		
			III		
			IV		
Lowering	Measure	[10,200] (mm)	I		
			II		
			III		
			IV		

Execution Times

Verifications	Way of Control	Decision Criteria	Decision/Observations		
Execute the whole operation of mold	Clock	6 to 10 seconds	I		
			II		
			III		
			IV		
Execute the whole operation	Clock	< 150 seconds	I		
			II		
			III		
			IV		

Equipment

Verifications	Way of Control	Decision Criteria	Decision/Observations		
Mold (truncated cone): Cone of Abram	Visual	Calibration Yes/no	I		
			II		
			III		
			IV		
Graduated scale from 0 to 300 (mm)	Visual	Calibration Yes/no	I		
			II		
			III		
			IV		

OBSERVATIONS

AUTHENTICATION

	I	II	III	IV
Responsible				
Controller				

TITLE

Company Symbol:	QUALITY CHECK LIST - CONCRETE TEST'S Vebe Test	Reference: QCL_CT_VT

IDENTIFICATION

Road: _____

Construction Owner: _____

Constructor: _____

Concrete Supplier: _____

Controller:

PROJECT REFERENCES

Specifications Book: (Pages) _____

Drawings: (Reference) _____

Norme: _____

Local of concrete aplication: _____

(image)

ACTS REGISTER

	I	II	III	IV
Localization				
Date	/ /	/ /	/ /	/ /
Hour	:	:	:	:
Weather Conditions(*)				
Concrete Type				

Note (*): A: sunny; B: clear; C: cloudy; D: rain; E: snow

CONTROL POINTS

√ Check × Not Check / Canceled

Workers

Verifications	Way of Control	Decision Criteria	Decision/Observations
Responsible	Visual	Yes/No	I II III IV

Appendix C

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY (BUET)

DEPARTMENT OF CIVIL ENGINEERING

Mobile: 01819557964; PABX: 55167100 Ext. 7226

http://brtc.ce.buet.ac.bd/#/home

CONCRETE LABORATORY

BRTC Bureau of Research, Testing & Consultation

BRTC No. : 1102-52609 /21-22/CE; Dt: 25/1/2022

Sent by : Executive Engineer, Zone-5 (Sayedabad)
Dhaka South City Corporation

Ref. No. : 46.207.000.21.16.19.2022; Dt: 9/1/2022

Project : Development work of Road Drains and By lane Drains at 40 no. Ward, Swamibag, Munshirtek

Sample : Concrete Cylinder [Mix proportion(as quoted): Not mentioned, Aggregate Type: Stone chips]

Location : Not mentioned [Admixture (as per letter): Not mentioned]

Test : Compressive Strength Test of Concrete Cylinder [ASTM C39]

Date of Test : 26/1/2022

TEST REPORT

SL No.	Date of Casting as per the letter	Specimen Designation/ Frog Mark	Specimen Area	Maximum Load	Crushing Strength	Average Crushing Strength	Mode of Failure
			(sq. in)	(lb)	(psi)		
1	15/12/2021 (42 days test)	-	12.18	62,273	5,113	---	Combined *
2		-	11.94	86,710	7,262		Combined *
3		-	11.70	92,091	7,871		Combined *

* Combined = Mortar and Aggregate Failure.

Note: Samples were received in sealed condition.

51

99MRZGgbN

Countersigned by:

Dr. A. B. M. Badruzzaman
Professor
Department of Civil Engineering
BUET, Dhaka-1000, Bangladesh

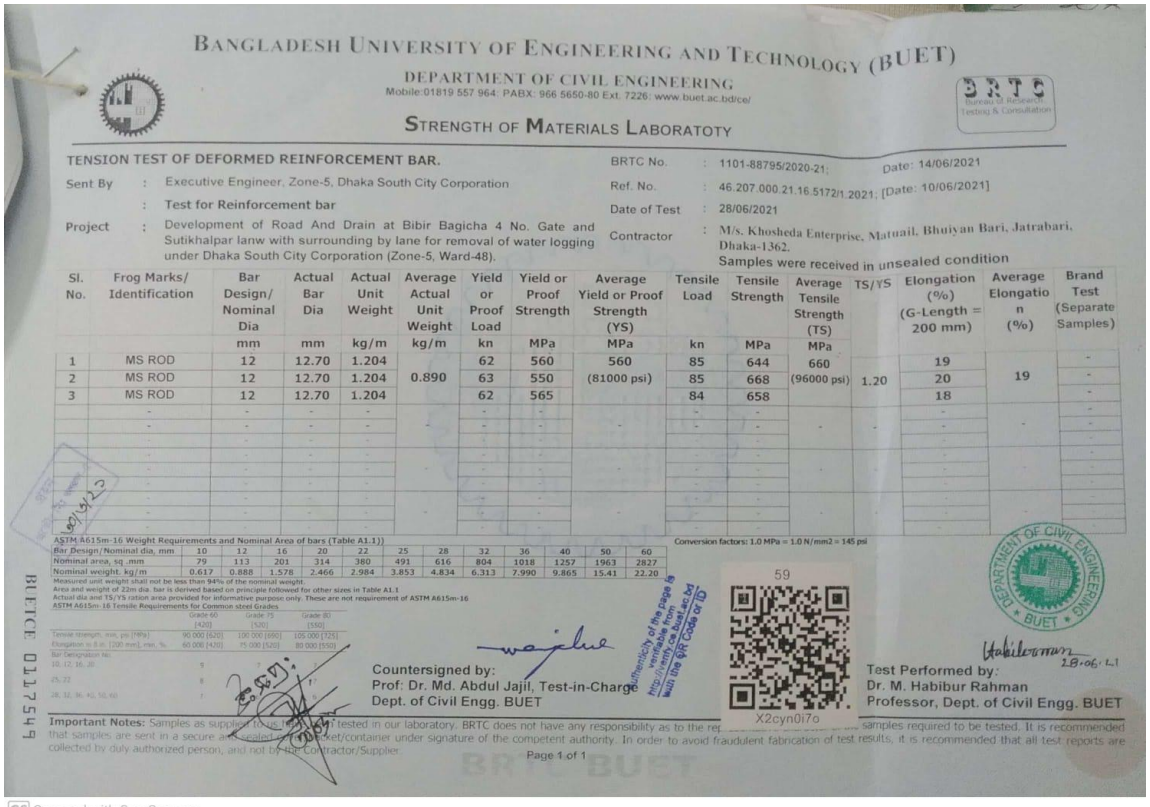
Test Performed by:

27/01/2022

Dr.Rowshan Mamtaz
Professor
Department of Civil Engineering
BUET, Dhaka-1000, Bangladesh

Important Notes: Samples as supplied to us have been tested in our laboratory. BRTC does not have any responsibility as to the representative character of the samples required to be tested. It is recommended that samples are sent in a secure and sealed cover/packet/container under signature of the competent authority. In order to avoid fraudulent fabrication of test results, it is recommended that all test reports are collected by duly authorized person, and not by the Contractor/Supplier.

Fig 5.1: Compressive Strength Test of concrete cylinder report (DSCC)



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DEPARTMENT OF CIVIL ENGINEERING

Mobile:01819 557 964: PABX: 966 5650-80 Ext. 7226: www.buet.ac.bd/ce/

STRENGTH OF MATERIALS LABORATOTY

TENSION TEST OF DEFORMED REINFORCEMENT BAR.

BRTC No. : 1101-88795/2020-21; Date: 14/06/2021

Sent By : Executive Engineer, Zone-5, Dhaka South City Corporation

Ref. No. : 46.207.000.21.16.5172/1.2021; [Date: 10/06/2021]

: Test for Reinforcement bar

Date of Test : 28/06/2021

Project : Development of Road And Drain at Bibir Bagicha 4 No. Gate and Sutikhalpar lanw with surrounding by lane for removal of water logging under Dhaka South City Corporation (Zone-5, Ward-48).

Contractor : M/s. Khosheda Enterprise, Matuail, Bhuiyan Bari, Jatrabari, Dhaka-1362.

Samples were received in unsealed condition

Sl. No.	Frog Marks/ Identification	Bar Design/ Nominal Dia	Actual Bar Dia	Actual Unit Weight	Average Actual Unit Weight	Yield or Proof Load	Yield or Proof Strength	Average Yield or Proof Strength (YS)	Tensile Load	Tensile Strength	Average Tensile Strength (TS)	TS/YS	Elongation (%) (G-Length = 200 mm)	Average Elongation (%)	Brand Test (Separate Samples)
		mm	mm	kg/m	kg/m	kn	MPa	MPa	kn	MPa	MPa				
1	MS ROD	12	12.70	1.204		62	560	560	85	644	660		19		-
2	MS ROD	12	12.70	1.204	0.890	63	550	(81000 psi)	85	668	(96000 psi)	1.20	20	19	-
3	MS ROD	12	12.70	1.204		62	565		84	658			18		-

ASTM A615m-16 Weight Requirements and Nominal Area of bars (Table A1.1))

Bar Design/Nominal dia, mm	10	12	16	20	22	25	28	32	36	40	50	60
Nominal area, sq .mm	79	113	201	314	380	491	616	804	1018	1257	1963	2827
Nominal weight, kg/m	0.617	0.888	1.578	2.466	2.984	3.853	4.834	6.313	7.990	9.865	15.41	22.20

Measured unit weight shall not be less than 94% of the nominal weight.
Area and weight of 22m dia. bar is derived based on principle followed for other sizes in Table A1.1
Actual dia and TS/YS ration area provided for informative purpose only. These are not requirement of ASTM A615m-16
ASTM A615m-16 Tensile Requirements for Common steel Grades

Conversion factors: 1.0 MPa = 1.0 N/mm2 = 145 psi

Countersigned by:
Prof. Dr. Md. Abdul Jajil, Test-in-Charge
Dept. of Civil Engg. BUET

Test Performed by:
Dr. M. Habibur Rahman
Professor, Dept. of Civil Engg. BUET

Important Notes: Samples as supplied to us have been tested in our laboratory. BRTC does not have any responsibility as to the representative character of the samples required to be tested. It is recommended that samples are sent in a secure and sealed container under signature of the competent authority. In order to avoid fraudulent fabrication of test results, it is recommended that all test reports are collected by duly authorized person, and not by the Contractor/Supplier.

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BUETCE 011754

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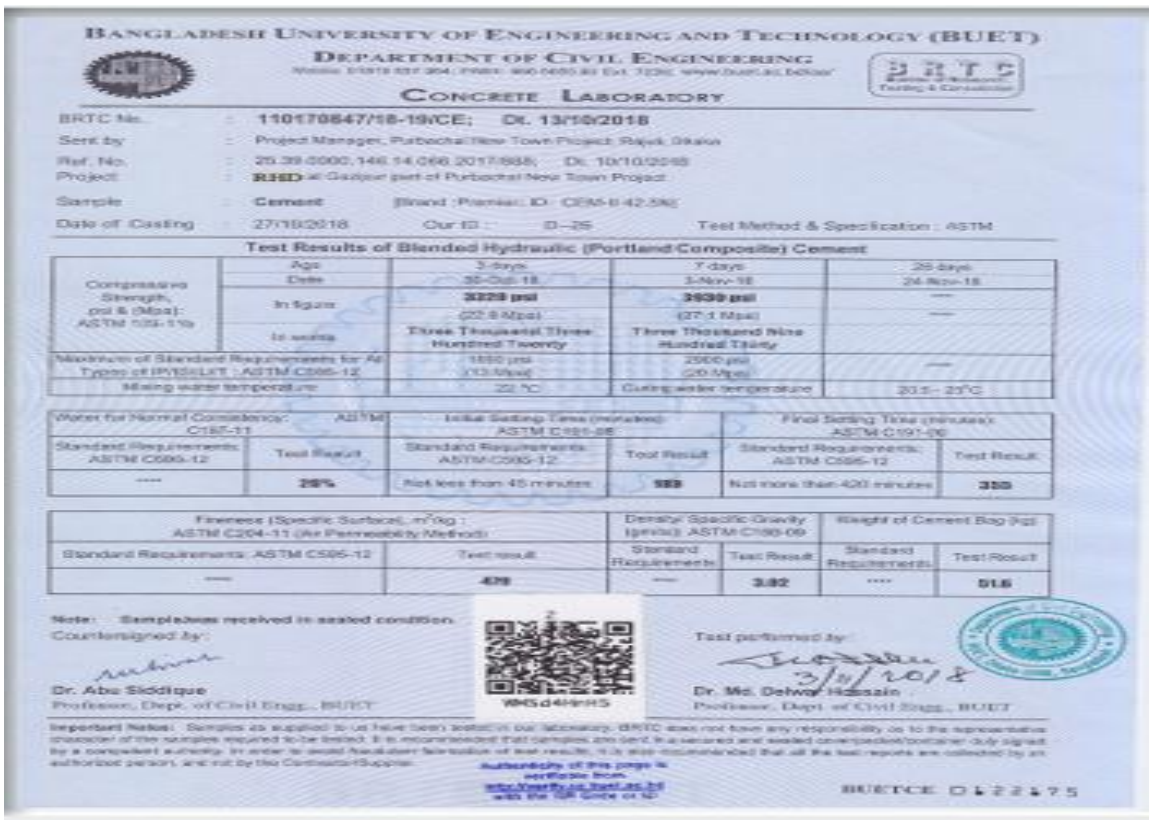
Fig5.2: Tension Test Deformed Reinforcement Bar (DSCC)



BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY (BUET)

DEPARTMENT OF CIVIL ENGINEERING

CONCRETE LABORATORY

BRTC No. : 1101708647/18-19/CE; Dt. 13/10/2018

Sent by : Project Manager, Purbachal New Town Project, Rajuk, Dhaka

Ref. No. : 20.39.0000.146.14.066.2017/885; Dt. 10/10/2018

Project : RHD at Gazipur part of Purbachal New Town Project

Sample : Cement [Brand : Premier; ID : CEM-II 42.5N]

Date of Casting : 27/10/2018 Our ID : D-25 Test Method & Specification : ASTM

Test Results of Blended Hydraulic (Portland Composite) Cement

	Age	3 days	7 days	28 days
Compressive Strength, psi & (Mpa): ASTM C39-18a	Date	30-Oct-18	3-Nov-18	24-Nov-18
	In figure	3229 psi	3939 psi	---
		(22.6 Mpa)	(27.1 Mpa)	---
	In words	Three Thousand Three Hundred Twenty	Three Thousand Nine Hundred Thirty	
Minimum of Standard Requirements for All Types of (RESULT : ASTM C595-12		1890 psi (13 Mpa)	2900 psi (20 Mpa)	---
Mixing water temperature		22 °C	Curing water temperature	20.5 - 23°C

Water for Normal Consistency: ASTM C187-11		Initial Setting Time (minutes): ASTM C191-08		Final Setting Time (minutes): ASTM C191-08	
Standard Requirements: ASTM C595-12	Test Result	Standard Requirements: ASTM C595-12	Test Result	Standard Requirements: ASTM C595-12	Test Result
---	28%	Not less than 45 minutes	183	Not more than 420 minutes	310

Fineness (Specific Surface), m²/kg : ASTM C204-11 (Air Permeability Method)		Density, Specific Gravity (grms): ASTM C188-09		Weight of Cement Bag (kg)	
Standard Requirements: ASTM C595-12	Test result	Standard Requirements	Test Result	Standard Requirements	Test Result
---	479	---	3.02	---	51.5

Note: Samples were received in sealed condition.

Countersigned by:

Dr. Abu Siddique
Professor, Dept. of Civil Engg., BUET

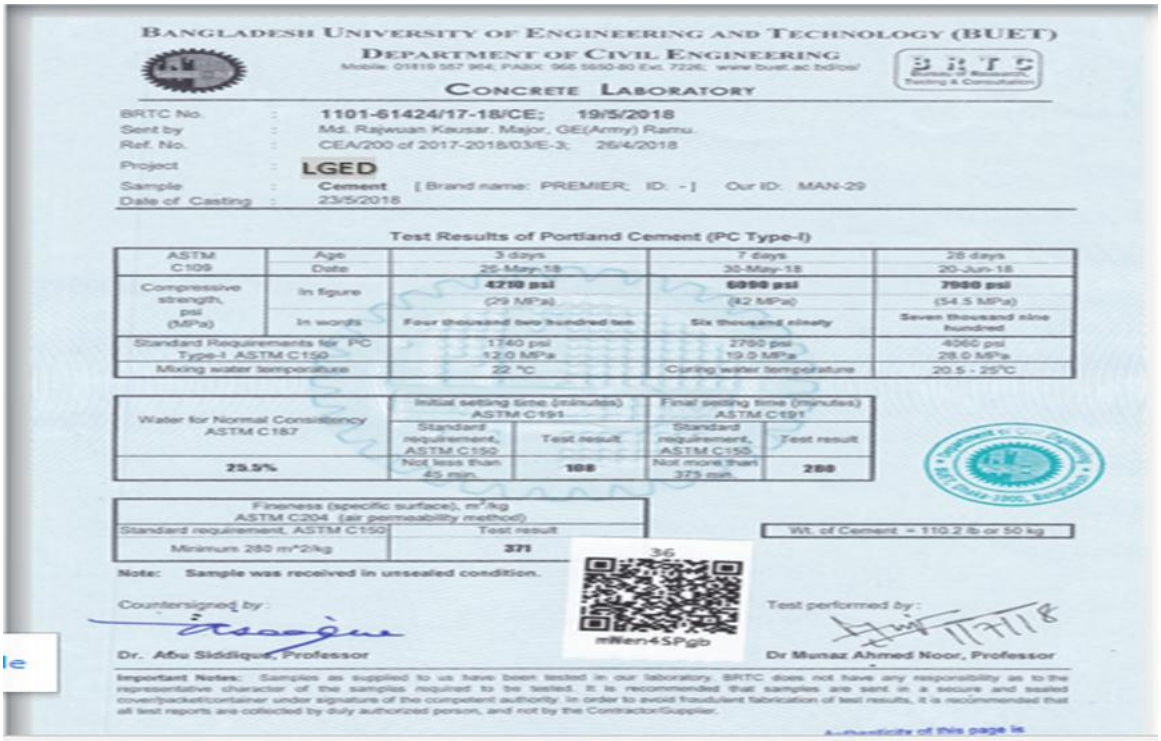
Test performed by:

Dr. Md. Delwar Hossain
Professor, Dept. of Civil Engg., BUET

Important Notes: Samples as supplied to us have been tested in our laboratory. BRTC does not have any responsibility as to the representative character of the samples required to be tested. It is recommended that samples are sent in a secure and sealed container/package duly signed by a competent authority. In order to avoid fraudulent fabrication of test results, it is also recommended that all the test reports are collected by an authorized person, and not by the Contractor/Supplier.

BUETCE 022575

Fig5.3: Compressive Strength Test of concrete cylinder report (RHD)



BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY (BUET)

DEPARTMENT OF CIVIL ENGINEERING

Mobile: 01819 557 964; PABX: 966 5650-80 Ext. 7226; www.buet.ac.bd/ce/

CONCRETE LABORATORY

BRTC No. : 1101-61424/17-18/CE; 19/5/2018
Sent by : Md. Rajwuan Kausar, Major, GE(Army) Ramu.
Ref. No. : CEA/200 of 2017-2018/03/E-3; 26/4/2018
Project : LGED
Sample : Cement [Brand name: PREMIER; ID: -] Our ID: MAN-29
Date of Casting : 23/5/2018

Test Results of Portland Cement (PC Type-I)

ASTM C109	Age	3 days	7 days	28 days
	Date	25-May-18	30-May-18	20-Jun-18
Compressive strength, psi (MPa)	In figure	4250 psi (29 MPa)	6090 psi (42 MPa)	7900 psi (54.5 MPa)
	In words	Four thousand two hundred ten	Six thousand ninety	Seven thousand nine hundred
Standard Requirements for PC Type-I ASTM C150		1740 psi 12.0 MPa	2760 psi 19.0 MPa	4060 psi 28.0 MPa
Mixing water temperature		22 °C	Curing water temperature	20.5 - 25°C

Water for Normal Consistency ASTM C187	Initial setting time (minutes) ASTM C191		Final setting time (minutes) ASTM C191	
	Standard requirement, ASTM C150	Test result	Standard requirement, ASTM C150	Test result
25.5%	Not less than 45 min.	108	Not more than 375 min.	280

Fineness (specific surface), m²/kg ASTM C204 (air permeability method)	
Standard requirement, ASTM C150	Test result
Minimum 280 m^2/kg	371

Wt. of Cement = 110.2 lb or 50 kg

Note: Sample was received in unsealed condition.

Countersigned by:

Dr. Abu Siddique, Professor

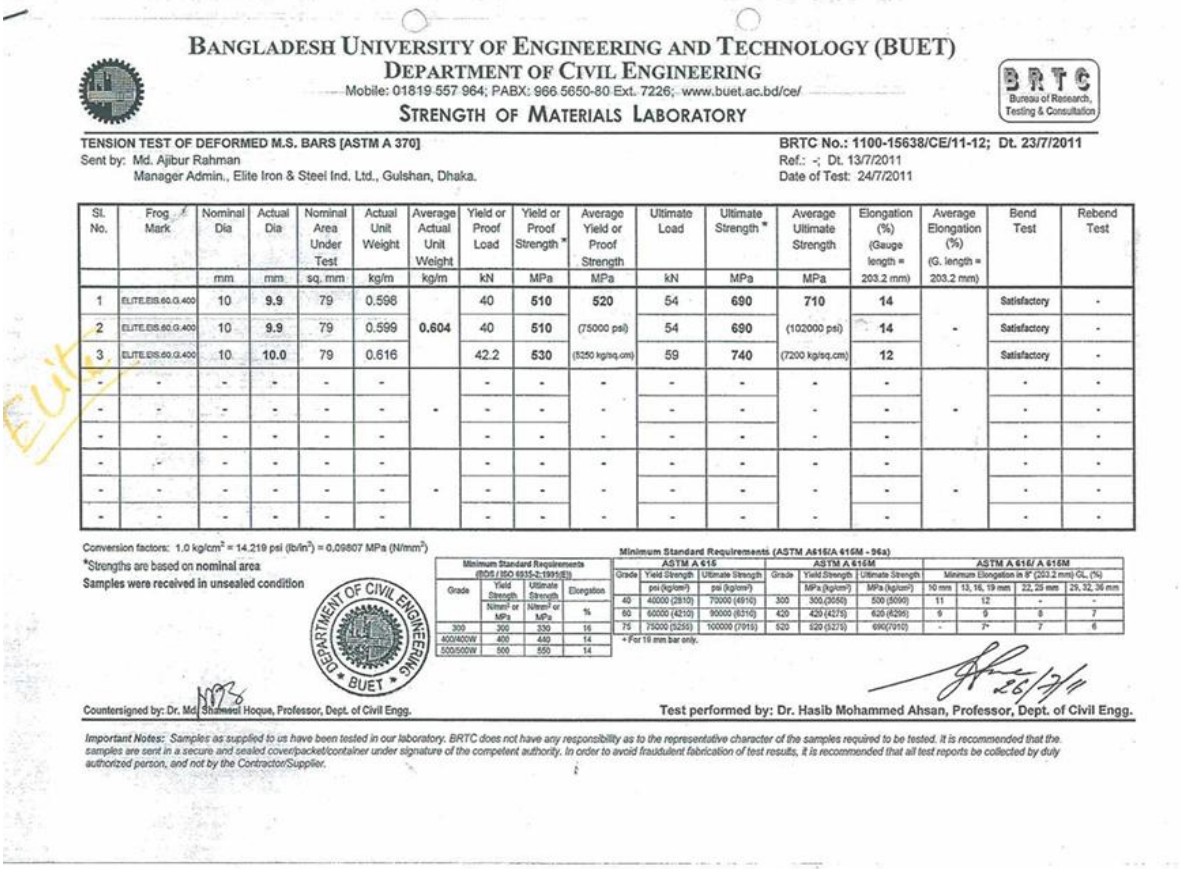
Test performed by:

Dr Munaz Ahmed Noor, Professor

Important Notes: Samples as supplied to us have been tested in our laboratory. BRTC does not have any responsibility as to the representative character of the samples required to be tested. It is recommended that samples are sent in a secure and sealed cover/packet/container under signature of the competent authority. In order to avoid fraudulent fabrication of test results, it is recommended that all test reports are collected by duly authorized person, and not by the Contractor/Supplier.

Authenticity of this page is

Fig5.4: Compressive Strength Test of concrete cylinder report (LGED)



BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY (BUET)

DEPARTMENT OF CIVIL ENGINEERING

Mobile: 01819 557 964; PABX: 966 5650-80 Ext. 7226; www.buet.ac.bd/ce/

STRENGTH OF MATERIALS LABORATORY

BRTC Bureau of Research, Testing & Consultation

TENSION TEST OF DEFORMED M.S. BARS [ASTM A 370]

BRTC No.: 1100-15638/CE/11-12; Dt. 23/7/2011

Sent by: Md. Ajibur Rahman
Manager Admin., Elite Iron & Steel Ind. Ltd., Gulshan, Dhaka.

Ref.: -; Dt. 13/7/2011
Date of Test: 24/7/2011

Sl. No.	Frog Mark	Nominal Dia	Actual Dia	Nominal Area Under Test	Actual Unit Weight	Average Actual Unit Weight	Yield or Proof Load	Yield or Proof Strength *	Average Yield or Proof Strength	Ultimate Load	Ultimate Strength *	Average Ultimate Strength	Elongation (%) (Gauge length = 203.2 mm)	Average Elongation (%) (G. length = 203.2 mm)	Bend Test	Rebend Test
		mm	mm	sq. mm	kg/m	kg/m	kN	MPa	MPa	kN	MPa	MPa				
1	ELITE.EIS.60.G.400	10	9.9	79	0.598		40	510	520	54	690	710	14		Satisfactory	-
2	ELITE.EIS.60.G.400	10	9.9	79	0.599	0.604	40	510	(75000 psi)	54	690	(102000 psi)	14	-	Satisfactory	-
3	ELITE.EIS.60.G.400	10	10.0	79	0.616		42.2	530	(5350 kg/sq.cm)	59	740	(7200 kg/sq.cm)	12		Satisfactory	-
-	-	-	-	-	-		-	-	-	-	-	-	-		-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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Conversion factors: 1.0 kg/cm² = 14.219 psi (lb/in²) = 0.09807 MPa (N/mm²)

*Strengths are based on nominal area

Samples were received in unsealed condition

Minimum Standard Requirements (ASTM A615/A 615M - 96a)

Grade	Minimum Standard Requirements (BDS / ISO 6935-2:1995(E)) Yield Strength N/mm² or MPa	Ultimate Strength N/mm² or MPa	Elongation %
300	300	330	16
400/400W	400	440	14
500/500W	500	550	14

Grade	ASTM A 615 Yield Strength psi (kg/cm²)	ASTM A 615 Ultimate Strength psi (kg/cm²)	Grade	ASTM A 616M Yield Strength MPa (kg/cm²)	ASTM A 616M Ultimate Strength MPa (kg/cm²)	ASTM A 616/ A 616M Minimum Elongation in 8" (203.2 mm) GL, (%) 10 mm	13, 16, 19 mm	22, 25 mm	29, 32, 36 mm
40	40000 (2810)	70000 (4910)	300	300 (3050)	500 (5090)	11	12	-	-
60	60000 (4210)	90000 (6310)	420	420 (4275)	620 (6295)	9	9	8	7
75	75000 (5255)	100000 (7015)	520	520 (5275)	690(7010)	-	7*	7	6

+ For 16 mm bar only.

Countersigned by: Dr. Md. Shaheed Hoque, Professor, Dept. of Civil Engg.

Test performed by: Dr. Hasib Mohammed Ahsan, Professor, Dept. of Civil Engg.

Important Notes: Samples as supplied to us have been tested in our laboratory. BRTC does not have any responsibility as to the representative character of the samples required to be tested. It is recommended that the samples are sent in a secure and sealed cover/packet/container under signature of the competent authority. In order to avoid fraudulent fabrication of test results, it is recommended that all test reports be collected by duly authorized person, and not by the Contractor/Supplier.

Fig5.5: Tension Test Deformed Reinforcement Bar (LGED)

Appendix -D

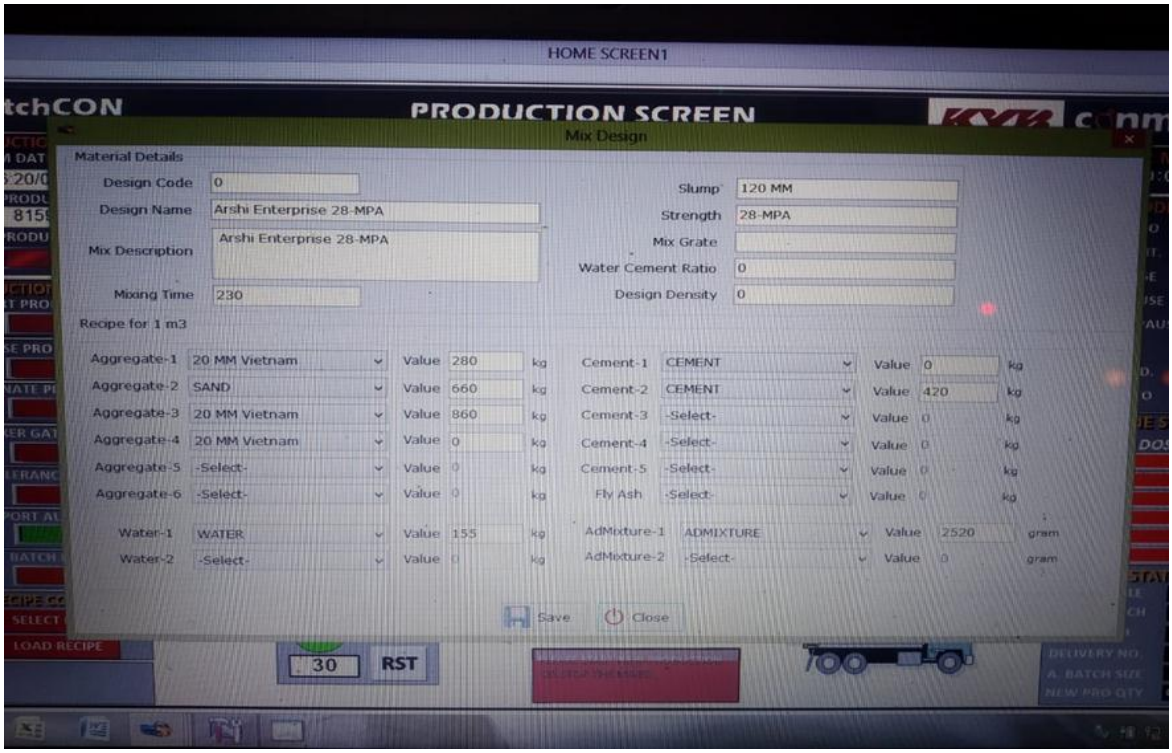

Fig5.6: proposal strength

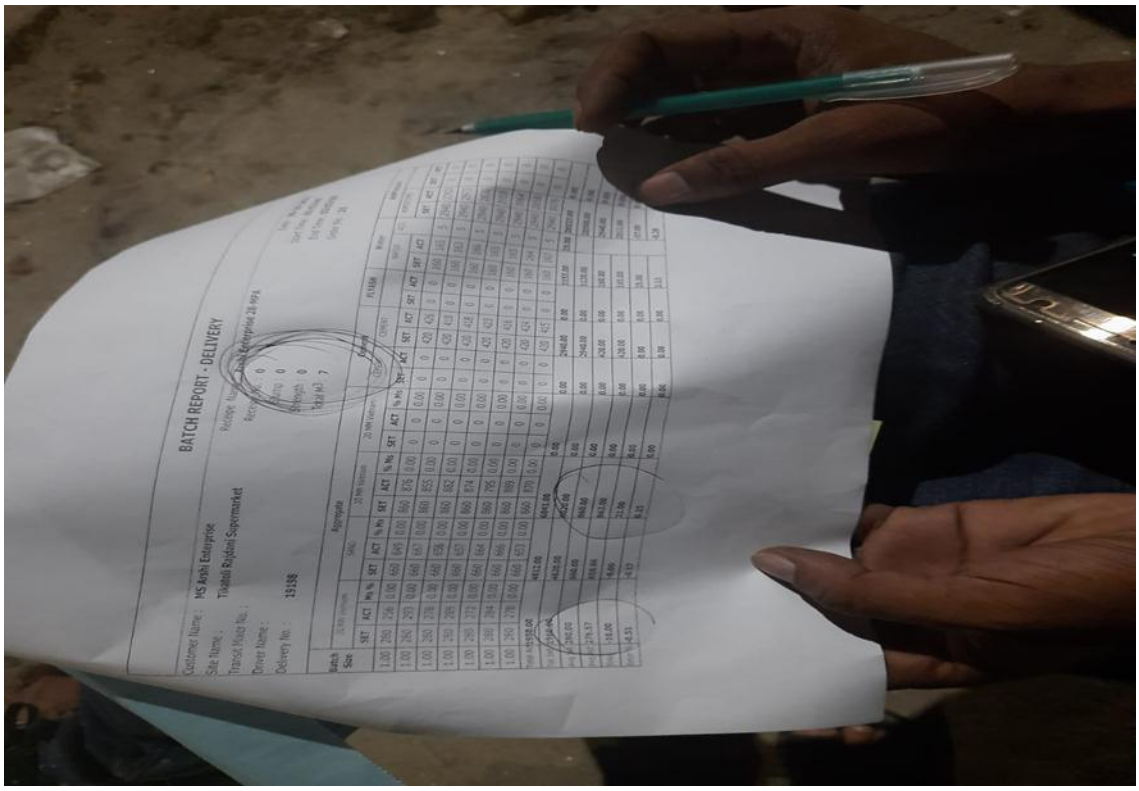

Fig5.7: Check casting plan design

Appendix-E

Schedule for Road Constructions of DSCC

Related to Road construction

Item No	Description of Item (QC Test)
8	Earth work in excavation in all kinds of soil for foundation trenches including layout, providing center lines, local bench-mark pillars, levelling, ramming and preparing the base, **fixing bamboo spikes and marking layout with chalk powder, providing necessary tools and plants, protecting and maintaining the trench dry etc.** stacking, cleaning the excavated earth at a safe distance out of the area enclosed by the layout etc. all complete and accepted by the Engineer-in-charge, subject to submit method statement of carrying out excavation work to the Engineer-in-charge for approval. However, engineer's approval shall not relieve the contractor of his responsibilities and obligations under the contract.
12	Sand Backfill for Structures: Sand material (FM= 0.8-1.0) is delivered direct to site. Assumes bulking factor of 25% means that 20cum compacted = 25cum loose. **It is also assumed that 20 cum equates to 3-4 layers (150 - 200mm thickness) therefore labor filling cannot work continuously, say, 25% down time for compacting and 75% time for filling**.
13(b)	Preparation of Subgrade 300 mm Depth Manually (Box cutting): The inset material is suitable and only requires be scarifying, **watering and compacting. Watering is by water tanker and compaction manually**.
15(a)	Improved Subgrade (F.M = 1.2 -1.5) with Manual compaction: furnishing, placing and compacting improved subgrade material on a prepared and accepted subgrade in accordance with these Specifications, and to the lines, levels, grades, dimensions and cross sections shown on the Drawings, or as required by the Engineer. Material shall be a natural or artificial mixture of sand or other mineral aggregate, free from vegetable matter, soft particles and excess clay shall have a soaked **CBR value not less than 8% when compacted to 95% of maximum dry density.**
16(a)	Subgrade Drains (using polythene & Sylhet Sand): consist of excavating, furnishing material, backfilling and finishing drains to the prepared and accepted subgrade in accordance with these specifications and the dimensions and cross sections shown on the drawings, or as required by the Engineer. The material for backfilling of subgrade drains shall be clean free draining sand and gravel, free from any vegetable matter, soft particles, silt or clay. The separator material shall consist of perforated heavy duty polythene sheeting of adequate strength to protect the drainage material The grading requirement of the drain backfill material is in detail in technical specification part.
18	Repair of Potholes on the Existing (Manual): Materials for per cum work subject to mix design: **(a) Bitumen(80/100 grade) 0.09 ton (b) Coarse Sand (F.M> = 2.5) 0.44 cum (c) Crushed boulder/gravel aggregate <25mm (25 mm to 3.35 mm size) 0.56 cum (d) Crushed (stone) dust 0.21 cum** : All damaged and

	unstable parts of the existing base and sub-base shall be excavated until sound material is reached on all sides and at the base of the excavation. Unsuitable excavated materials shall either be disposed of or stockpiled in locations as directed by the Engineer. The shape of the excavation shall then be made rectangular with vertical sides. The bottom of the excavation shall then be shaped, trimmed, watered if necessary, and compacted to the density required for the appropriate layer. The excavation shall then be filled with base material of the type directed by the Engineer in layers after compaction of not thicker than 100 mm. Each layer shall be properly leveled and watered and carefully rammed or compacted with an approved road roller (8-12 ton), shall have a minimum soaked **CBR value at a compaction of 98% of the maximum dry density.** A bituminous leveling course or bituminous surfacing will then be placed as directed by the Engineer in accordance with the procedure as described in Section 3.5.3.4. The machineries concern to the work (Dumper, water lorry and sufficient light arrangement at night will conserve) will have to be used etc. Complete as per direction of E/Ch.
19(a)	Sub-Base (WBM): Materials for per cum work subject to mix design: **Materials for per cum work: (a) Coarse Sand (F.M> = 1.0) 0.33 cum (b) Brick picket jamma <38mm (38 mm to 25 mm size) 0.74 cum (c) Water 1 cum. Specified grading a blend of typically 3:1 (Khoa: Sand) is required**. **The Khoa must be properly crushed to give a well-graded material (i.e. not single size material**). Sub-base shall be spread in layers of nearly equal thickness either by hand or by using a grader or paving machine, with an uncompacted thickness up to 150 mm, subject to the approval of the Engineer. Where sand and aggregates are combined together to meet the specified grading, care shall be taken to prevent segregation of the material into fine and coarse parts. All areas of segregated coarse or fine material shall be corrected, or removed and replaced with material, which conforms to the Specification.
20(a)	Aggregate Base Type I (Base course): Materials for per cum work subject to mix design: **(a) Crushed boulder/gravel aggregate <40 mm (40 mm to 25 mm size) 0.88 (b) Sand (F.M> = 1.0) 0.44 cum (c) Water 1 cum. A 2:1 mixture of Stone aggregate: Sylhet Sand. The fraction passing the 0.075 mm sieve shall not be greater than three quarters of the fraction passing the 0.300 mm sieve. Aggregate Crushing Value is less than 30% and Ten Percent Fines Value greater than 125 KN.** The aggregate and sand shall be mixed thoroughly to obtain a homogenous mix complying with the grading requirements as per table 12-1 in technical specification. Water shall be added during mixing to keep the mixed material moist so as to prevent segregation during transportation. Base shall be at or near the optimum moisture content at the time of placing and spread in layers of nearly equal thickness **(150 mm or 200 mm diameter depending on the layer thickness),** subject to the approval of the Engineer. Spreading may be carried out by hand or using a motor grader or using a paving machine, but machine laying is preferred. After laying all areas of segregated coarse or fine material shall be corrected, or removed and replaced with material, which conforms to the Specification. Immediately after each layer has been spread and shaped satisfactorily, each layer shall be thoroughly compacted with suitable and adequate compaction equipment approved by the Engineer.

	Each layer shall be compacted to at least 98% of the maximum dry density.
21(a)	Bituminous Prime Coat (Plant Placed) by bitumen distributor**: Materials for per sqm work: (a) Bitumen (80/100) 0.88 kg (b) Kerosene 0.44 ltr.The bituminous material shall be approved by the Engineer and may be prepared by cutting back 80/100 penetration bitumen with kerosene in the ratio 50(K):100(B) at a temperature** within the range called for in Table 13-6 in technical specification part for the particular material being used and the spray rate is 1.5Ltr/sqm. Spraying is done by a pressure bituminous distributor and when necessary, equipment for heating bituminous material is also be used. Prime coat shall be applied at a time when the surface to be treated is dry or slightly damp, when the ambient temperature is above 13ºC and rising, or above 16ºC if falling, and when the weather is dry. Immediately before applying the bituminous material, all loose dirt and other objectionable material shall be removed from the surface with a power brush. When so ordered by the Engineer, a light application of water shall be made just before the application of bituminous material.
22(a)	Bituminous Tack Coat (Plant Work): The full width of surface to be treated shall be cleaned with a power brush to remove loose dirt, sand, dust and other objectionable material. **The surface to be treated shall be dry. Cut back bitumen RC 30, RC 70 or 80/100 penetration bitumen at a temperature** within the range called for in Table 13-6 in technical specification part for the particular material being used and the spray rate is 0.45 Ltr/sqm. Spraying is done by a pressure bituminous distributor and when necessary, equipment for heating bituminous material is also be used.
23(a)	Double Bituminous Surface Treatment, 20mm aggregate followed by 10mm (Machine Method): Materials for per sqm work subject to mix design**: (a) Bitumen (80/100 grade) 0.0023 ton (b) Stone Chippings (pakur stone) 10mm size 0.007 cum (c) Stone Chippings (pakur stone) 20 size 0.016 cum. 80/100 penetration grade bitumen with rate of application 1.2ltr/sqm is required.** The equipment shall include a power brush, a self-powered bituminous material pressure distributor and, when necessary, equipment for heating bituminous material. The grading of the aggregates shall fall within the limits specified in Table 17-1 in technical specification part. Double Surface Treatment the first course may be either 20 mm or 14 mm followed by a second course of 10 mm nominal size. The aggregate shall be spread uniformly over the bituminous material by means of the approved aggregate spreader at either the rate of application of Aggregate= 16kg/sqm specified or as determined by trials. Any bare or insufficiently covered areas shall be re-run by the mechanical spreader or covered by hand as necessary to give uniform and complete coverage. Any aggregate spread in excess of the rate specified or ordered shall be scattered and evenly distributed on the road or otherwise removed and stockpiled as directed by the Engineer. Immediately after spreading to the satisfaction of the Engineer, the aggregate shall be rolled with one or more pneumatic tyred rollers and 8-12 tonne steel wheeled rollers where this shall have a load per 10 mm width of roll between 25 and 45 kg until the aggregate is firmly embedded in the bituminous material. The machineries concern to the work (Dumper, water lorry and sufficient light arrangement at night will conserve) will have to be used etc.

	Complete as per direction of E/Ch. (For user of DSCC's asphalt plant hire charge must deducted as per approved rate).
24(a)	Dense Bituminous Surfacing (Plant Method) - **Base Course (Leveling course): Approximate quantity of materials for per cum work: (a) Bitumen (80/100 grade) 0.11 tonne (b) Coarse Sand (F.M> = 2.5) 0.37 cum (c) Crushed boulder/gravel aggregate <25mm (25 mm to 3.35 mm size) 0.61 cum (d) Crushed (stone) dust 0.12 cum (the above mentioned quantity may vary depending on the mix design** and reference table 18-1 of technical specification). 80-100 grade bitumen shall be heated to a temperature between 121°C and 163°C.The mineral aggregates shall be dried and heated to a temperature between 135°C and 177°C so that the surfaces of aggregates are clean and free of carbon and unburned fuel oil. Laying of base course shall be kept clean prior to laying the surface course over a tack coat @ 0.45 ltr per sqm of road surface and no traffic except in connection with laying the surface course shall be permitted on the prepared base course. The mixture shall be compacted as soon after being placed as the material will support the roller without undue displacement or cracking and sufficient compaction plant should be deployed so that the required degree of compaction is achieved before the mat has cooled to a temperature of 107°C. Smoothing rolling may continue longer, if necessary, as long as the temperature of the mat is above 90°C. **The density of the base courses shall not be less than 97% of the Marshall density.** The air voids in the compacted courses shall not exceed 7% for base course. The thickness of a compacted layer shall not be less than twice the maximum stone size. The machineries concern to the work (Dumper, water lorry and sufficient light arrangement at night will conserve) will have to be used etc. Complete as per direction of E/Ch. The user of DCC's asphalt plant must deduct as hired charge of plant). (Excluding the cost of tack coat). Details Specification is attached in technical specification part.
26(a)	Premix Bituminous Carpeting (Manual Method): **(Crushed stone dust: Sylhet sand: 5mm crushed gravel: 12mm crushed gravel: 20mm crushed gravel blended together in a approximated ratio of 10%: 20%: 15%: 20%: 35 %): Materials quantity for per cum work: a) Bitumen (80/100 grade) 0.12 tonne (b) Coarse Sand (F.M> = 2.5) 0.31 cum (c) Crushed boulder/gravel aggregate <25mm (25 mm to 3.35 mm size) 0.76 cum (d) Crushed (stone) dust 0.12 cum (the above mentioned quantity may vary depending on the mix design** and reference table 19-1 of technical specification). A tack coat @ 0.45 ltr per sqm to an existing bituminous surface before spreading the bituminous carpet.80-100 grade bitumen shall be heated to a temperature between 121°C and 163°C.The mineral aggregates shall be dried and heated to a temperature between 135°C and 177°C so that the surfaces of aggregates are clean and free of carbon and unburned fuel oil. The heated bitumen is drawn off from the tar boiler, decanted into gauge tins and added to the aggregate in the pan on the unheated frame. As the two ingredients are at approximately the same temperature there is no risk of fire. The mixing is carried out on the unheated frame and, when satisfactorily completed, the pan is carried to the adjacent work head for placing. Laying of wearing course shall be kept clean prior to laying the surface course and no traffic except in connection with laying the surface course shall be permitted on the prepared wearing course. The mixture shall be

	compacted as soon after being placed as the material will support the roller without undue displacement or cracking and sufficient compaction plant should be deployed so that the required degree of compaction is achieved before the mat has cooled to a temperature of 107°C. Smoothing rolling may continue longer, if necessary, as long as the temperature of the mat is above 90oC. The depth of the finished surfacing, and the density of the material after compaction, is controlled by using mild steel angles as side shutters (32 × 32 mm for a finished 25 mm surfacing and marking on the prime or tack coat with chalk the area that each pan of mixed material should cover. The cross-fall or super elevation is controlled in a similar way using 32 mm rods for 25 mm surfacing at intermediate points between the edge of the road and the crown of the road. **The density of the base courses and the wearing courses shall not be less than 97% of the Marshall density**. The air voids in the compacted courses shall not exceed 5% for wearing course. The machineries concern to the work (Dumper, water lorry and sufficient light arrangement at night will conserve) will have to be used etc. Complete as per direction of E/Ch. (Excluding the cost of tack coat). Details Specification is attached in technical specification part.
28(a)	12 mm Compacted Premix Bituminous Seal Coat (Plant Method): 80/100 **penetration grade bitumen shall be heated in a Mechanical tar boiler to a temperature between 121oC and 163oC.** The heated bitumen is drawn off from the tar boiler, decanted into ashphalt plant and added to the aggregate in the plant in the proportion of **1.1 kg of bitumen to 0.014m3** of aggregate mixture for per sqm work (a blend of pea gravel: Sylhet sand: stone dust in the ratio of **40%:40%:20%.)** which shall be laid on 1.0m2 of road surface for 7mm thickness seal coat. The mixture shall after mixing be at a temperature within the limits of 135 oC and 163 oC.The mixed bituminous seal coat shall be placed and spread over the granular base course which has been primed or bituminous carpeting to a uniform thickness which shall be a minimum of 25% greater than the specified compacted thickness, and immediately compacted with a power driven road roller to the satisfaction of the Engineer. The machineries concern to the work (Dumper, water lorry and sufficient light arrangement at night will conserve) will have to be used etc. Complete as per direction of E/Ch. (For user of DSCC's asphalt plant hire charge must deducted as per approved rate).
31	Single Layer Brick Flat Soling: The bricks shall be laid flat over the prepared subgrade or improved subgrade surface**. Bricks shall be laid in a regular and uniform manner. Interstices of bricks shall be filled with sand, and water shall be applied by sprinkling**. No bricks shall be laid on loose earth or earth filling which has not been compacted to the required density and no bricks shall be laid on any surface which has not been inspected and approved by the Engineer.
32	Herring Bond Brick Pavement i/c 12mm sand cushion: The bricks shall be laid on edge in a single layer in a herringbone pattern to the lines, grades, levels, dimensions and cross section shown on the Drawings or as required by the Engineer. The edge of the layer shall be made with cut bricks to produce a line, which is compatible with brick edging. **The joints shall be filled with sand brushed** in and the completed layer shall be sprinkled liberally with water.

34	Concrete class -10(N/mm2): Rammed CC (1:3:6): Cement concrete work in proportion (1:3:6) in foundation of cross drain, box culvert, walls, floors with 1st class **picked Jhama brick chips (20mm drown size) sand (F.M- 1.50) and cement, mixing, screening laying, compacting to required** levels and curing for at least 7 days in/c the cost of all materials, breaking Jhama into chips, shutturing,casting and all other incidental charges etc. all complete as per direction of E/Ch
36	Concrete class-20 (1:2:4) CC with stone chips: Foundation/GL: For concrete in Foundation or at ground, the water-cement ratio shall not exceed 0.45, unless approved by the Engineer. Minimum Cement Content As indicated for the respective class in Table 23-3 in technical specification). Minimum Filler Content: (fine aggregate less than 0.25 mm, coarse aggregate with crushed stone chips shall not be 20 mm for maximum size and minimum filler content 435 kg/m3 or 350 kg/m3 (except for mass concrete). **Slumps measured in accordance with STP 9.1 shall not exceed 75 mm unless otherwise indicated on the Drawings or approved by the Engineer**. . (In/c fixing and removing of scaffolding and shuttering cost and laying, ramming, curing and other n/c labour work etc. as per direction of engineer in charge.)
41	Reinforced Concrete Class - 25 (1:1.5:3): with stone chips: Foundation: For concrete in Foundation or at ground, the water-cement ratio shall not exceed 0.45, unless approved by the Engineer. Minimum Cement Content As indicated for the respective class in Table 23-3 in technical specification). Minimum Filler Content: (fine aggregate less than 0.25 mm, coarse aggregate shall not be **less than 40 mm or 20 mm for maximum size and minimum filler content 435 kg/m3 or 350 kg/m3 (except for mass concrete).** Slumps measured in accordance with STP 9.1 shall not exceed 75 mm unless otherwise indicated on the Drawings or approved by the Engineer. . (In/c fixing and removing of scaffolding and shuttering cost and laying, ramming, curing and other n/c labour work etc. as per direction of engineer in charge.)
42	FORM WORK : Centering and shuttering, including strutting, propping etc. (The formwork must be rigid enough both in and out of plane, to make the concrete surface true to the designed shape and size by using necessary MS sheets of minimum 16 BWG, angles of minimum size 40 mm x 40 mm x 5 mm, flat bars etc.)
44	Ready mix concrete for Road, Footpath, Median (25 Mpa) Class-25: with stone chips: For complete mixing at the batch plant, mixing operations shall begin **within 30 minutes after the cement has been added to the aggregate.** After mixing, the truck mixer shall be used as an agitator, when transporting concrete, at the speed designated by the manufacturer of the equipment as agitating speed. Concrete discharge shall be completed within 45 minutes after the addition of the cement to the aggregates. Each batch of concrete delivered at the job site shall be accompanied by a time slip issued at the batching plant, bearing the time of departure therefrom. The rate of discharge of the plastic concrete from the mixer drum shall be controlled by the speed of rotation of the drum in the discharge direction with the discharge gate fully open. Each batch of concrete shall be mixed for between 70 and 100 revolutions of the drum or blades at the

	rate of rotation designated by the manufacturer of the equipment as the "mixing speed". Such designation shall appear on a metal plate attached to the mixer. The work shall consist of lobour charge for laying/ placing in required grade, head loading/unloading, watering, ramming and cost of shuttering etc. during casting at jobsite; all complete as per direction of engineer in charge.
45	Ready mix concrete for Road, Footpath and Median (28 Mpa) Class-28: with stone chips: **For complete mixing at the batch plant, mixing operations shall begin within 30 minutes after the cement has been added to the aggregate**. After mixing, the truck mixer shall be used as an agitator, when transporting concrete, at the speed designated by the manufacturer of the equipment as agitating speed. Concrete discharge shall be completed within 45 minutes after the addition of the cement to the aggregates. Each batch of concrete delivered at the job site shall be accompanied by a time slip issued at the batching plant, bearing the time of departure therefrom. The rate of discharge of the plastic concrete from the mixer drum shall be controlled by the speed of rotation of the drum in the discharge direction with the discharge gate fully open. Each batch of concrete shall be mixed for between 70 and 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment as the "mixing speed". Such designation shall appear on a metal plate attached to the mixer. The work shall consist of lobour charge for laying/ placing in required grade, head loading/unloading, watering, ramming and cost of shuttering etc. during casting at jobsite; all complete as per direction of engineer in charge
48	High Yield Deformed Steel Reinforcing Bars 60 Grade: **Supplying, fabrication and fixing to details as per shall conform to ASTM A 615 in/c straightening and cleaning rust, if any, bending & binding in position in/c supply of G.I. wires etc. All high yield steel bars shall be deformed bars with a yield stress not less than 415 N/mm².**
49	R.C.C. Pipe: Supplying and placing of machine made RCC pipe in/c construction as per direction of the E/Ch (1:1.5:3) proportionate with cement, sand (F.M- 2.50) & 12mm downgraded Aggregates. Curing shall be accomplished by keeping the pipes constantly moist for at least 14 days following manufacture. The pipes are to be sufficient crushing strength to pass the **British standard specification 556. Minimum crushing test load for 600 (75mm) dia pipe is 1350-1600 PSI. Per ft. of effective length**.The pipe must be best quality, fair uniform and free from any kind of defects. Junction of the two pipe must be protection by Jute, Chat, cement, sand and by CC work so that work cannot leak out by the joints etc. all complete as per direction of the E/Ch.
50	Manufacture and supply of 450mm, 550mm & 600mm dia perforated C.I. manhole cover with frames as per specification, terms & condition and the drawing enclosed details and the direction of the Engineer in charge. Manhole cover should be stored as per direction of the Engineer in charge, which will be use in different places in Dhaka city. The monogram with year as per drawing must be inscribed on C.I. manhole cover. The manhole cover with frames must be capable with standing a load of 5(five) tons within on area of 300mm dia in circle, otherwise it will not accepted. 1 %(one percent) of total supplied materials or calculated amount given by concerned **officers must be tested in**

	BUET/BSTI/LGED or any of the recognised testing laboratory as per direction of the Engineer in charge. Supplies must have to bear total expenses involved in testing and other all expenses (including VAT)
52	Brick works with first class bricks with cement sand (F.M. 1.2) mortar (1:6) in foundation and plinth, filling the joints/interstices fully with mortar, racking out the joints, cleaning and soaking the bricks at least for **24 hours before use and curing at least for 7 days** etc. all complete including cost of water, electricity and other charges and accepted by the Engineer-in-charge. (Cement: CEM-II/A-M)
55	Minimum 12 mm thick cement sand **(F.M. 1.2)** plaster with neat cement finishing to plinth wall **(1:4)** with cement up to 150 mm below ground level with neat cement finishing including washing of sand, finishing the edges and corners and curing at least for 7 days, cost of water, electricity and other charges etc. all complete in all respect as per drawing and accepted by the Engineer.
56	Net Cement finishing: Net Cement finishing to plinth wall up to 150 mm below ground level finishing the edges and corners and curing at least for 7 days etc. all complete as per direction of engineer in charge .(in/c the cost of all materials).
57	Supplying and laying of single layer polythene sheet weighing one kilogram per 6.5 square meter in floor or anywhere below cement concrete complete in all respect and accepted by Engineer-in-charge.
63(a)	Expansion Joint with dowell bar: Providing Expansion **joint (20mm & 100mm or 150mm) with in road of RCC work & filling up the gaps with sand (F.M-2.50) & bitumen (80 to 100 grade)** as per direction of the E/Ch**. (Using dwell bar 750mm C/C 12mm dia MS rod 600 mm long).**
65	Cleaning of RCC Pipe: Taking out mechanically or manually silted Rubbish/ Garbage/ Solid Waste from existing different sizes of RCC pipeline, removing the safe place. No depreciate of the pipe during working period.*Bamboo, Bakhary, Rope, bags, pump machine, Pressure matching and necessary tools should be used for cleaning purpose. Removing dervishes from the site instantly in the disposal site etc. all complete as per direction of Engineer in charge. (Adjacent Pit, Manhole, Connecting pipe etc. must be cleaned at the same time. Payment will be made only on the main line length). *450 mm to 1370 mm dia RCC pipe cleaning.
71	MS angle: Supplying & fitting fixing the steel plate (required thickness) over the MS angle to provide one the cross with the CC work (1:2:4 proportion) in/c the cost all materials, welding, carrying, curing etc. all complete as per direction of the E/Ch.
81	M.S Rod Grattings: Fitting, fixing of M.S Rod Gratings with hings of catch pit cover, 16mm dia MS rod both side 75 mm c/c, welding Within 40mm´40mm´6mm size angle Frame, fixing with 1:2:4 of cc work in proper place, curing at least 7 days. Painting with 2 coats of synthetic enamel paint over a prime coat of anticorrosive etc. all complete as per direction of Engineer in charge.