



Government of the People's Republic of Bangladesh

**Roads and Highways Department (RHD)
Bangladesh Road Research Laboratory (BRRL)**

**Final Report
on
Failure investigation, Design correction, Data collection,
Research resource collection etc under BRRL during the
year 2016-2017**

June, 2017

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Executive summary

Introduction

Pavements continually undergo various types of stresses that induce major/minor defect into the pavement. Traffic loading, various climatic conditions, technical inadequacy, material quality, workmanship etc contributes to premature pavement failure. An asphalt pavement can exhibit various distresses that will eventually lead to pavement failure. To prevent failure, proper treatment at proper time should be given to the pavement after proper and careful investigation. This study is an attempt to identify causes of failure of 18 important roads of RHD road network under different road divisions. Recommendations for remedial measures including rehabilitation/reconstruction of the distressed pavement sections are also covered by this study.

Background:

According to the RHD Management Plan (Volume 4), BRRL is responsible for ensuring Quality Assurance Plan (QAP) being established and implemented in all RHD works. The Director, BRRL has to ensure provision of research, testing and advisory services to various wings of the Department on the quality of construction materials, on the soil condition for road/bridge design and on required quality of construction. Chief Engineer, RHD also entrusted Director, BRRL of internal quality auditing. In FY 2016-2017, BRRL appointed 1 pavement specialist as a senior consultant for a period of 5 months and 6 days to ensure the provisions for advisory service to BRRL. Pavement specialist is responsible to investigate intended pavement distress/ problems by respective road divisions. BRRL received requests and data from different road divisions about their failure problem of roads. Among these data, Director, BRRL selected some road sections based on their priority and other convenience. Accordingly, pavement specialist visited eighteen (18) distressed road sections of RHD road network and tried to analyze the failure problems.

Road sections under investigation

Following road sections are investigated under the study

| Serial No | Rd ID | Division | Road Name |
|-----------|---------------|------------------------------|---|
| 1 | N 804 | Faridpur | Bhanga – Faridpur (Goalchamat) Road |
| 2 | Z 8404 | Faridpur | Talma-Nagarkanda Road |
| 3 | Z 8406 | Faridpur | Goalchamat – Munshibazar (Faridpur Bypass) Road |
| 4 | R 860 | Sariatpur | Mostofapur-Madaripur-Sariatpur (Monohor Bazar)- Ibrahimpur-Horina-Chandpur(Bhatialpur) |
| 5 | N8 | Madaripur | Dhaka (Zatrabari) – Mawa – Bhanga – Barisal - Patuakhali Road (Madharipur part) |
| 6 | N 805 | Madaripur | Bhanga –Bhatiapara-Mollarhat-Fakirhat-Noapara Road (Bhanga-Muksudpur part) |
| 7 | Z 8603 | Madaripur | Eterpole –Ghoshherhat-Dasher-Aguiljhora Road |
| 8 | Z 8604 | Madaripur | Madaripur-Kalkini-Bhurghata Road |
| 9 | N 805 | Gopalganj | Bhanga –Bhatiapara-Mollarhat-Fakirhat-Noapara Road (Gopalganj part) |
| 10 | N 507 | Sirajgonj | Hatikamrul - Bonpara Road (Sirajgonj part) |
| 11 | N 6 | Pabna | Kasinathpur-Pabna- Dashuria-Natore-Rajshahi (Pabna part) |
| 12 | N 6 | Natore | Kasinathpur-Pabna- Dashuria-Natore-Rajshahi (Natore part) |
| 13 | N 6 | Natore | Kasinathpur-Pabna- Dashuria-Natore-Rajshahi (Natore part) |
| 14 | N 6 | Natore | Kasinathpur-Pabna- Dashuria-Natore-Rajshahi (Natore part) |
| 15 | N 502 | Natore | Bogra (Jahangirabad)-Natore Road (Natore Part) |
| 16 | N 507 | Natore | Hatikamrul - Bonpara Road (Natore part) |
| 17 | R 548 | Natore | Naogaon Atrai-Natore(Natore part) |
| 18 | N 6 | Pabna | Kasinathpur-Pabna- Dashuria-Natore-Rajshahi (Pabna part) |
| | | Total 18 road section | |

Methodology:

The works involved a series of field and laboratory tests to document and characterize surface and subsurface materials and load-bearing conditions beneath and within the pavements. Specifically, the investigation included

- Data collection from concerned Road Division
- Pavement visual condition survey
- Thickness measurement of different pavement layer through core cutting
- Laboratory tests of pavement materials / field test of pavement materials
- Check adequacy of the test results with the requirements of RHD technical specification
- Draw conclusion about the reason and possible remedial measures for the road under investigation
- Try to generalize the problems for the whole network.

Findings:

Pavements deteriorate with time and fail prematurely for various reasons. From investigations of 15 (fifteen) road sections some common reasons of failure have been identified within RHD network.

1. Overloaded vehicle is a key factor which accelerates pavement failure. RHD road network carry traffic load that is 3 to 4 times of standard axle load. Pavements are not designed to carry that much loading of vehicles. Both the overloading need to be controlled and pavement design should incorporate this overload as well.
2. From C&B era road network was built through staged construction method. Different time different contractors are engaged in road construction and maintenance work. There was no standard elaborated technical specification for doing that work. There is a significant difference in pavement structural layers.
3. Road construction industry of Bangladesh is yet to be grown to deliver the need of road transport service. They are using conventional method and equipments for pavement construction. There is a huge scope to update construction method and equipment. Use of modern technology can improve quality of construction.

4. A significant portion of RHD network is suffering from foundation problem. In most cases, embankment of a pavement is prepared on the existing ground without proper sub-soil investigation. Most of the highways of road network are built on filled section by filling from borrow pit adjacent to the road. This process create acute problem in soft soil areas. Foundation of pavement is not good in those areas. When embankment is filled from borrow pit, this make the condition even worse. Embankment settles down there as well as the foundation.
5. During road construction, uniform compaction is applied for a road section. Uniform compaction cannot meet up the compaction requirement for all segment and results weak embankment at some areas. Whenever, a road is reconstructed, it is reconstructed up to the top of sub-grade level. As a result, foundation problem remains unresolved.
6. RHD road network have been expanded from 2500km to 21000km. At the early stage of this expansion process, limited engineering process was followed in pavement construction. Road embankment was not always compacted mechanically. It was allowed to be settled naturally. Especially zilla roads (feeder roads) are suffering from this problem. Whenever heavy/overloaded traffic is passing over these roads, pavement deflection becomes much greater. As proper soil investigation was not done during construction, localized settlements are occurring in the pavement.
7. Overlay is the most common form of periodic maintenance in RHD. But overlay design does not always follow proper engineering process. Most of the time overlaying thickness is determined from IRI value. But it should be based on the deflection value of pavement under treatment. As deflection value is not considered during overlay design, there is a huge risk factor in the design of overlay.
8. There are also drainage problem in some areas. Both pavement drainage and longitudinal drainage (water logging/ pavement submerge) problem exist in built up areas. Surface drain problem deteriorate pavement to a large extent. When a road becomes waterlogged, it should be closed for traffic. As there is no alternate route in most cases, it remains open for traffic and loses its strength.

9. Selection of appropriate grade of bitumen is another important factor. Previously 80/100 grade bitumen was used in RHD. Now 60/70 grade bitumen is also used in road construction. But quality of bitumen is again an issue.
10. National highways are in quite good condition. It seems, good engineering practice was followed during these constructions, which is not found in zilla roads. Most of the zilla roads have alignment problem. If appropriate geometric alignment is not provided, this may lead to severe accident.
11. Mix design followed in RHD is not appropriate for existing loading condition. Marshall mix design is replaced by superpave to resemble the prevailing road condition and environment factors which is superior to marshall mix design. This method should be introduced in our country.

Recommendation

Since 1955, roads are reconstructed / repaired several times at different location following different methods. At early stage, there was no guideline or specification for road construction to follow. RHD technical specification was published on 2011. Before that “Quality Assurance Plan for Roadwork” manual was introduced on 2006. From then pavement is constructed using that guideline without considering incremental traffic volume. Moreover the construction materials are not always within the RHD specification (as per laboratory test reports of investigation). So, reconstruction of the roads according to present traffic volume and material properties is the best solution to have a sustainable road network. Some specific recommendations are given here.

- 1) Sometimes, construction quality downgrades due to poor workmanship only. Hence, RHD requires forming a pool of qualified contractors. Prequalification of the contractors should also be confirmed to ensure their capacity. Only a capable contractor can add value to quality materials.

- 2) Manpower of RHD is very limited in comparison with its job field. Officer's responsible to execute construction and maintenance works are always overloaded with various administrative works. Moreover due to financial and procedural obligation all construction work of a division/sub-division starts at the same time. It is not always possible for RHD engineers to present and control quality of construction at all construction sites simultaneously. To enhance supervision strength of field divisions, consultants need to be appointed at all field divisions. Consultants will be responsible to executive engineer and will report about construction and material quality.
- 3) Regular updation of specification as well as construction method is also necessary. As traffic volume is increasing rapidly and construction process is updated continuously thorough research is required in this field.

1. Introduction:

Pavement deteriorates with time and fails prematurely due to traffic loading, different climatic conditions and structural inadequacy. Different types of distress may occur in a pavement. In order to give proper treatment to a damaged pavement section, root causes of the distress need to be identified. This study is an attempt to identify causes of failure of 15 (fifteen) important roads of RHD road network at different chainages. Recommendations for remedial measures including rehabilitation/reconstruction of the distressed sections are also covered by this study. This report starts with this introduction followed by the background of this investigation and its purpose and scope.

2. Background:

In the financial year 2016-2017, BRRL appointed 01 (one) Pavement Specialist as a senior consultant for 6 (six) months to carry out a study on “Failure investigation, Data collection, Design correction, Research resource collection etc. under BRRL during the year 2016-2017”. Pavement Specialist is responsible to investigate some specific pavement distress/ problems under supervision of BRRL. BRRL received data from all the road divisions about their failure problem of roads and bridges. Data includes all the details of the particular section. Among these data, Director, BRRL selected some road sections based on their priority and other convenience. Accordingly, Pavement Specialist visited fifteen (15) distressed road section of RHD road network and tried to analyze the failure problems.

3. Purpose and Scope:

The purpose of this investigation was as follows

- 1) To study selective problems and collect data from concerned road divisions about the failure problem of roads.
- 2) Analyzing collected data and finding the cause of the observed inconsistencies in pavement.
- 3) Preparation of notes for concerned road division about corrective measures of the failure.

4. Methodology:

The researcher engaged by BRRL decided to visit the failed sections of concerned divisions with RHD officials. He decided to visually observe failed sections, dig pits, measure different layers of pavement, collect sample of materials from different layers, test the samples collected from field. He also studied the soil report of failed sections submitted by Executive Engineers of concerned divisions.

5. Road Sections under investigation:

Fifteen road sections under six road divisions of RHD were investigated for road failure. From Gopalganj Division the road is Bhanga–Bhatiapara– Mollarhat–Fakirhat–Noapara National Highway, (N 805); From Madaripur Division the roads are Dhaka (Zatrabari)-Mawa-Bhanga-Barisal-Patuakhali Road (Madaripur part) (N8, Length 69Km); Madaripur (Eterpole –Ghosherhat-Dasher-Aguiljhora Road) Z-8603; Madaripur-Kalkini-Bhurghata Road,Z-8604 and Bhanga –Bhatiapara-Mollarhat Road (Bhanga-Muksudpur part). N 805; From Faridpur Division the roads are Bhanga – Faridpur (Goalchamat) Road, N-804; Talma-Nagarkanda Road (Z-8404) and Faridpur Town Bypass Road N-808; From Sariatpur Division the road is Mostofapur-Madaripur-Sariatpur (Monohor Bazar)-Ibrahimpur-Horina-Chandpur(Bhatialpur) R-860 From Natore Division the roads are Kasinathpur-Pabna-Dashuria-Natore-Rajshahi (Natore Part), N6; Bogra (Jahangirabad)-Natore Road (Natore Part) N 502; Hatikamrul-Bonpara Road (Natore part), N507; Naogaon-Atrai-Natore(Natore part), (R548) From Sirajgonj Division the roads are Hatikamrul-Bonpara Road, N507; Khamarkhanda-Belkuchi (Z-5408) Road; From Pabna Division the road is Kasinathpur-Dashuria-Natore-Rajshahi, N6(Pabna part).

6. Investigation and findings:

Detail investigation and findings of above mentioned road sections are given in the following sections.

6.1 Investigation of Road N 804:

Road failure investigation of 15 roads of six divisions of Roads and Highways Department was done during the financial year 2016-2017. Among which N- 804 road was investigated.

6.1.1 Introduction:

The road N-804 starts from N-8 at Bhanga and ends at Faridpur (Goalchamat). The sections investigated are ch. 00+000 to ch. 03+000, ch. 11+000 to ch. 12+500, ch. 16+700 to ch. 16+950, ch. 22+400 to ch. 22+750.

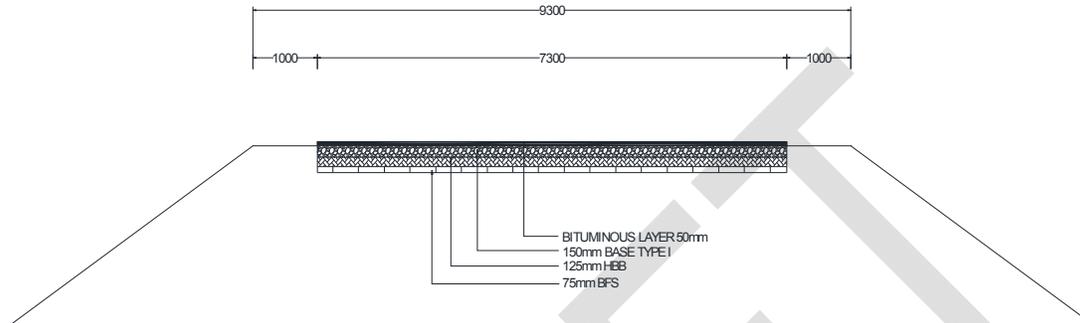


Fig: Road section of N804

6.1.2 Background:

Chief Engineer, RHD vide his memo no: 857 C.E. dated-18-12-2016 sent letter to all Additional Chief Engineers of Field zones to send information about road failure. To his response Additional Chief Engineer of Gopalganj zone has sent road failure information of his zone. Additional Chief Engineer of Gopalganj has explained the sections of failure, type of failure and gave remarks and cross section of road. He explained that pavement undulation, depression and large cracks are found from the year 2008 which are increasing continuously.

He mentioned that in 1955 land was acquired and embankment was constructed, in 1958 HBB was constructed, in 1962 bituminous carpeting with macadam work was done on HBB. Repair and surfacing work was done several times but due to the inferior quality of sub-grade soil the road cannot be maintained in good condition.

6.1.3 Methodology:

After getting written information from field the BRRL consultant team along with RHD officials decided to visit the failed sections of N 804. They decided for visual observation, dig pit in the pavement, measure pavement layer thickness and collect sample for laboratory test.

6.1.4 Investigation procedure:

The BRRL consultant team along with RHD Officials visited the distressed sections of N 804 on 25 April, 2017. They visually observed the failed sections, type of failure, dug pit on the pavement, measured the sections with tape, collected samples for laboratory tests.

6.1.5 Test of samples Collected:

MDD, OMC, CBR, Swelling, Liquid Limit (LL), Plastic Limit (PL) of the collected sub-grade soil was performed in the laboratory. Total six tests were done on sub-grade soil sample. Subsurface soil investigation at the chainage 16+400 and 16+600 was done by consultant firm engaged by Faridpur road division.

Summary of the Test: (Test reports are enclosed in Annexure 1)

| Test Summary | | | |
|---|------------|--------------------------|---|
| Test Parameters | Value | Limits | Remarks |
| MDD, Kg/m ³ | 1780 | | |
| OMC, % | 12.5 | | |
| CBR at % Compaction | 93 | 4.3 | These figures as per Modified Energy. If Standard energy is used, value would less than these figures |
| | 95 | 5.3 | |
| | 98 | 6.50 | |
| Swelling at % Compaction | 93 | 6.50 | % Swelling is higher |
| | 95 | 6.00 | |
| | 98 | 5.50 | |
| Liquid Limit | 35 | ≤50 | Within Limits |
| Plasticity Index(PI) | 20 | ≤15 | Not Within Limits |
| LL & PI tests carried out by the division which are as follows: | | | |
| Test Parameters | Value | Limits | Remarks |
| LL | 46 & 45 | LL=Max 50, PI= Max 15 | At Km 22+942 |
| PI | 17 & 18 | | |
| LL | 46 & 48 | | At Km 23+020 |
| PI | 12 & 25 | | |

The MDD is 1780 kg/m³ and OMC is 12.5% which indicate clayey soil. CBR is 5.37% which is slightly less than our specification. Swelling, Liquid Limit (LL), Plastic Limit (PL) shows that it is clayey soil.

6.1.6 Discussions:

BRRL consultant team along with RHD officials visually found severe cracking at different locations, undulations and depressions at various spots. The test results of sub-grade soil indicate that it is of clayey nature. In the report of sub surface soil investigation at two points it is found that the SPT values up to 19.5 meter are very low which indicates clayey silt. The pavement has no drainage layer. Sub-grade is made of clay soil which is saturated with moisture. Due to the presence of high moisture content, shear failure occurred at sub-grade/embankment under heavy traffic. Due to poor structural capacity, severe cracks (Fatigue) have developed and it will continue until complete failure of the pavement. The existing pavement layer does not have any drainage layer as the sub grade contain high moisture content which causes development of high depression/undulation. Due to the poor structural capacity of the pavement, deflection of the pavement is very high as such any pavements treatment does not become durable. As consequence, pavement requires frequent maintenance.

6.1.7 Conclusion and final remarks:

The sub-grade is made of clay soil which is saturated with moisture. Due to the presence of high moisture content, shear failure occurred at sub-grade/embankment under heavy traffic. Due to poor structural capacity, severe cracks (Fatigue) have developed and it will continue until complete failure of the pavement. The existing pavement layer does not have any drainage layer as the sub grade contain high moisture content which causes development of high depression/undulation. Due to the poor structural capacity of the pavement, deflection of the pavement is very high as such any pavements treatment does not become durable. As consequence, pavement requires frequent maintenance.

6.2 Investigation of road Z-8404:

Road failure investigation of 15 roads under six divisions of Roads and Highways department was done during the financial year 2016-2017. Among which Z-8404 road was investigated.

6.2.1 Introduction:

The road Z-8404 starts at Talma and ends at Nagarkanda. The total length is 12 Km. the section investigated is from ch. 7+200 to ch. 8+800.

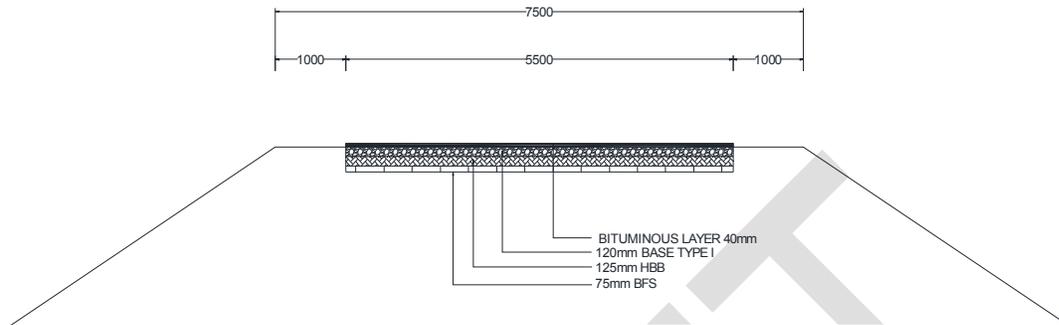


Fig: Road section of Z8404

6.2.2 Background:

Chief Engineer, RHD vide his memo no: 857 C.E. dated-18-12-2016 sent letter to all Additional Chief Engineers of field zones to send information about road failure. To his response Additional Chief Engineer of Gopalganj zone has sent road failure information of his zone. Additional Chief Engineer of Gopalganj has explained that undulation, depression and large cracks are found from the year 2010 which are increasing continuously in the said chainage. In 1962 road was constructed with HBB and Macadam by zilla parisad. In 1982 road was handed over to RHD. Bituminous pavement was done by RHD. Due to the bad sub-grade soil the road condition was poor.

6.2.3 Methodology:

After getting written information from field zone the BRRL consultant team along with RHD Officials decided to visit the failed sections of Z-8404. They decided for visual observation, dig pit in the pavement, measure the failed section and collect sample for laboratory test.

6.2.4 Investigation procedure:

The BRRL consultant team along with RHD officials visited the failed sections of N 507 on 25 April, 2017. They have visually observed the failed sections.

6.2.5 Remedial Measures:

Following remedial measures may be taken.

1. Hard/Soft shoulder is needed with proper side slope for stability and lateral support of the pavement.
2. Severely damaged areas of ch. 7+200 to 8+800 needs full reconstruction from sub-grade according to RHD Design Manual regarding layer thickness and specification.

6.3 Investigation of road N-808:

Road failure investigation of 15 roads under six Divisions of Roads and Highways department was done during the financial year 2016-2017. Among which N-808 road was investigated.

6.3.1 Introduction:

The road Z-8406 starts at Goalchamat and ends at Munshi bazar. Total length is 5 Km. The section investigated is from ch. 0+600 to ch. 0+650, ch. 2+090 to ch. 2+210 and ch. 2+300 to ch. 2+700.

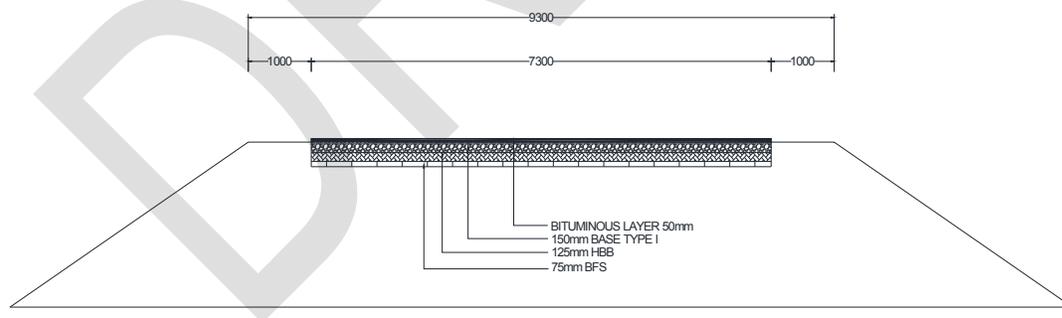


Fig: Road section of Z8404

6.3.2 Background:

Chief Engineer, RHD vide his memo no: 857 C.E. dated-18-12-2016 sent letter to all Additional Chief Engineers of field zones to send information about road failure. To his response Additional Chief Engineer of Gopalganj zone has sent road failure information of his zone. Additional Chief Engineer of Gopalganj has explained the sections of failure, type of failure and gave remarks and cross section of road. He explained that pavement undulation, depression and large cracks are found from the year 2015 which are increasing continuously. He said that in 2011-12 f/y the road was constructed. In 2013 surfacing was done under PMP major. Due to the poor sub-grade soil of the said chainages the sections cannot be maintained in good condition.

6.3.3 Methodology:

After getting written information from field zone the BRRL consultant team along with RHD Officials decided to visit the failure sections of Z 8406. They decided for visual observation, dig pit in the pavement, measure the failed section and collect sample for field test.

6.3.4 Investigation procedure:

BRRL consultant team along with RHD officials visited the failure sections of Z 8406 on 25 April, 2017. They have visually observed the failed sections, type of failure, dug pit on the pavement, measured the failed sections with tape, collected samples for laboratory tests.

6.3.5 Test of materials and subsurface soil:

Sample was collected from base type-1 and sub-base. Gradations of collected samples were done in laboratory. Test summary is given below:

Table 1: Summary of test of road Z 8406 (Test sheets are enclosed in Annexure 3)

| Test Summary (Z 8406) | | | |
|-----------------------|---------------------|---------------|----------------|
| Test Parameters | Value | Limits | Remarks |
| Gradation Base-T1 | Test Sheet enclosed | Out of limits | % finer higher |
| Gradation Sub Base | Test Sheet enclosed | Out of limits | |

sub-surface soil investigation at the chainage 1+700, 1+900, 2+500 and 3+100 was done making bore hole by consultant firm engaged by Faridpur road division.

6.3.6 Discussions:

In the laboratory test result it is found that gradation of base type-1 and sub-base materials are out of limit of RHD specification. In the sub-surface soil investigation of four points it is found that the SPT values of subsurface soil are very low which indicates clayey silt.

6.3.7 Conclusion and final remarks:

The pavement is structural and material (soft soil) failure type. The main causes of failure of the pavement are the presence of subsurface soft soil and construction of road embankment with the same soft soil. Excessive settlement occurred due to heavy traffic and shear failure of the embankment. The pavement is continuously damaging. There is no permanent solution to stop the development of pavement distresses but it requires continuous routine maintenance.

6.4 Investigation of road R-860:

Road failure investigation of 15 roads under six divisions of Roads and Highways department was done during the financial year 2016-2017. Among which R-860 road was investigated.

6.4.1 Introduction:

The road R-860 starts at Mostafapur and ends at Chandpur. Total length is 5k.m. The sections investigated are from ch. 20+860 to 24+600, ch. 26+300 to 42+600 and ch. 53+500 to 56+674.

6.4.2 Background:

Chief Engineer, RHD vide his memo no: 857 C.E. dated-18-12-2016 sent letter to all Additional Chief Engineers of field zones to send information about road failure. To his response Additional Chief Engineer of Gopalganj zone has sent road failure information of his zone. Additional Chief Engineer of Gopalganj has explained the sections of failure, type of failure and gave remarks and cross section of road. He explained that from 2009 alligator crack, rutting, raveling, pavement undulation, depression occurred in the pavement. Afterwards large holes created by damaging the surface and the Sub-base is being damaged which is increasing continuously. The road width was 12 feet. Afterwards it increased to 18 feet and was included in regional highway category. In 2013-2014 f/y DBS wearing course was done under major PMP. Now the road is maintained by minor PMP, routine maintenance, repairing potholes with bats and sand.

6.4.3 Methodology:

After getting written information from field zone the BRRL consultant team along with RHD Officials decided to visit the failure sections of R 860. They decided for visual observation of the site.

6.4.4 Investigation procedure:

BRRL consultant team along with RHD Officials visited the failure sections of R 860 on 26 April, 2017. They have visually observed the failed sections and type of failure.

6.4.5 Findings of the Investigation:

1. This is a regional highway that carries heavy loaded truck from south west region to Chittagong port. This is the shortest road connection from south west region to Chittagong port. Commercially this is a very important road corridor. Though this road is a regional highway but the road was constructed as zilla road pavement standard. Due to the poor structural capacity of the pavement, the pavement is completely damaged under traffic load. Out of 35 km of the road, 30 Km is completely damaged and the road is not structurally capable of carrying present traffic load.
2. During visit we noted more than two heavy vehicles become out of order due to poor condition of the road at different locations.

3. Local people including school going boys/girls and old men are tremendously suffering due of ponding of water, presence of mud, very high depression in numerous isolated locations of the road. The sub grade soil comes up in the surface of the road under traffic load.

6.4.6 Causes of structural defects:

Causes of structural defects on the pavement are as follows. Considering the volume of heavy overloaded trucks, the pavement structure is highly under designed when compare with the RHD Pavement Design Manual (2005).

As per RHD pavement Design manual considering minimum (10m EASL), minimum pavement layer thickness shall be :

- a) 40mm DBS wearing course,
- b) 80mm DBS base course,
- c) 200mm Base Type-1
- d) 250mm Base Type-2
- e) 200mm Sub base
- f) ISG 300 mm .

Different sections of the road as mentioned in above Chainages are structurally failed due to the poor structural capacity of the pavement layers. Following layer thickness was observed in those sections:

- a) DBS : 40mm(carpeting)
- b) Base Type-2 : 150-175mm
- c) Sub Base : 100-125 mm
- d) ISG : 50 – 75 mm

Moreover the road was constructed without following standard construction procedures, without standard specification works, standard test procedures, sub-soil investigation. The pavement is structural, materials and construction failure type.

6.4.7 Remedial measures:

The pavement is structurally failed and the pavement is not capable of carrying the present traffic load. The people are suffering in transportation of goods, materials and men through these roads sections.

The pavement is fully damaged and does not have any capacity to carry present traffic load due to very poor structural capacity. So, this road needs immediate full reconstruction with following standard geometric design, pavement design, method of standard construction procedures, standard test procedure and with sub-soil investigation.

6.5 Investigation of road N-8:

Road failure investigation of 15 roads under six divisions of Roads and Highways department was done during the financial year 2016-2017. Among which N- 8 road was investigated.

6.5.1 Introduction:

The road N-8 starts from N-8 at Dhaka (Zatrabari) and ends at Patuakhali. The sections investigated are ch. 68+000 to ch. 78+148 and ch. 87+990 to ch. 103+130.

6.5.2 Background:

Chief Engineer, RHD vide his memo no: 857 C.E. dated-18-12-2016 sent letter to all Additional Chief Engineers of field zones to send information about road failure. To his response Additional Chief Engineer of Gopalganj zone has sent road failure information of his zone. Additional Chief Engineer of Gopalganj has explained the sections of failure, type of failure and gave remarks and cross section of road. He explained that in 2012-2013 f/y overlay was done under PMP. Now potholes, undulation, depression and longitudinal cracks have occurred in the pavement.

6.5.3 Methodology:

After getting written information from field the BRRL consultant team along with RHD Officials decided to visit the failure sections of N 8. They decided for visual observation, dig pit in the pavement, measure the failed section and collect sample for laboratory test.

6.5.4 Investigation procedure:

BRRL consultant team along with RHD officials visited the failure sections of N 8 on 26 April, 2017. They have visually observed the failed sections, type of failure, dug pit on the pavement, measured the failed sections with tape, and collected samples for laboratory tests.

6.5.5 Test of samples Collected:

ACV, LL, PI and gradation were done of Sub-base and Sub-grade soil, The summary of the test is as below:

Summary of the Test: (Test reports are enclosed in Annexure 1)

| Sl No | Layer type | Parameters | Result | Comments |
|-------|----------------|------------|----------|-------------|
| 1. | Sub Base | ACV | 35.4 | <38 ok |
| 2. | Sub Base | Gradation | Attached | Ok |
| 3. | Sub grade soil | LL | 47.5 | <50 ok |
| 4. | Sub grade soil | PI | 22.4 | > 15 not ok |

6.5.6 Discussions:

In the test it is found that test results of the samples collected are almost within specification of RHD.

6.5.7 Findings of the Investigation in brief as follows:

Main carriageway of the highway pavement comprises of carpeting (170mm), which was constructed in different time Now it became aged bituminous layers, mostly cracked, Macadam(150mm), aggregate disintegrated, little structural capacity of base layer, HBB/Soling (200mm). Recently each side of the carriage widened to 1.0 m and widening portion consists of carpeting (70mm, Sub base (100mm), ISG> 400mm. and ISG layer is not extended up to the embankment slope for drainage of pavement surface water. Widened section is under design, no drainage provision and some distress developed in the widened portion. Out of 47Km, about 25 Km of the road surfaces is highly distressed and remaining 22 KM is repaired recently with DBS (50mm), Base-Type-1 after scarifying of the aged existing carpeting layer. Road

carriage way is 3.66m wide having carpeting 170mm, Macadam=150mm, HBB/Soling=200mm. Each side contains (sample Collected) some layers (B/carpeting 70mm, Sub base 100mm, ISG>400mm and sub grade is consist of soft soil. Embankment height is 3 to 5m, suspecting ingress of rain water through cracks and take away fine particle (ISG) consequences settlement due to soft soil in the sub grade. About 25 Km road is very bad. 22 Km road was repaired recently (After scarifying existing pavement Base Type-1 and DBS was provided) and now it is functioning well. Widened portion of the pavement is very weak in structural composition and materials quality.

6.5.8 Causes of defects

Causes of structural defects on the pavement are as follows:

The structural capacity of the pavement is poor due to inadequate pavement layer thickness, aged action, severe cracks, undulation and depression. Settlement have been developed and it will continue with time due to traffic movement. The existing pavement layer does not have any drainage layer. Pavement is damaged due to serious moisture susceptibility and the sub-grade contain high moisture content which causes development of high depression/ undulation. Due to the presence of high moisture content, shear failure occurred under heavy traffic. Due to the poor structural capacity of the pavement, deflection of the pavement is very high as such any pavements treatment does not become durable. As consequence, pavement requires frequent maintenance. The pavement is structural, material and construction failure type. Severe damaged areas are at ch. 68+000 to 78+148 and ch. 87+990 to 103+430. But scenario of the other areas of the road is same. The structural capacity of the pavement is poor due to the poor thickness of the pavement (compared with the RHD design manual thickness). The existing pavement thickness is inadequate to carry the present traffic load and such the pavement is highly distressed in the form of severe cracking (fatigue), undulation, depression, settlement and potholes. The existing road pavement composition is completely different from that of the widened portion at both sides of existing pavement. At widened part longitudinal cracks have been developed. Existing pavement consists of (Bituminous Carpeting = 200mm (cracked) WBM=150mm, HBB 125mm, Flat soling = 75mm). It was constructed in early 1970. The 200mm surfacing layer (Carpeting) is highly cracked which is called fatigue failure due to

traffic and ageing action. As such frequent development of undulation, cracking, potholes have been occurred under heavy traffic with time.

6.5.9 Remedial measures

As per RHD Pavement Design Guide, the structural capacity of the existing pavement is too poor. Deflection of the existing pavement is very high for which any type of thin overlay will not structurally sustainable. In order to reduce the deflection to a sustainable limits, thick asphalt overlay shall be laid as per:

- (1) Rehabilitation manual MS-17 or
- (2) Reconstruction can be done under periodic maintenance with milling/compacting/shaping the existing pavement surface and adding stone base course 150mm + DBS 120 mm + Wearing course 50mm.

6.6 Investigation of road N-805:

Road failure investigation of 15 roads under six divisions of Roads and Highways department was done during the financial year 2016-2017. Among which N- 805 road was investigated.

6.6.1 Introduction:

The road N-805 starts from Bhanga and ends at Noapara. The sections investigated is ch. 00+000 to ch. 15 + 000.

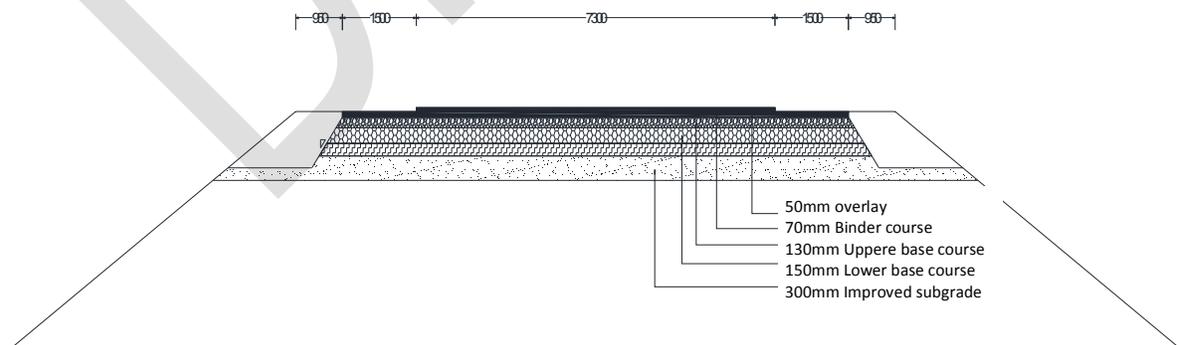


Fig: Road section of N805

6.6.2 Background:

Chief Engineer, RHD vide his memo no: 857 C.E. dated-18-12-2016 sent letter to all Additional Chief Engineers of field zones to send information about road failure. To his response Additional Chief Engineer of Gopalganj zone has sent road failure information of his zone. Additional Chief Engineer of Gopalganj has explained longitudinal cracks occurred in hard shoulder, approaches of culvert and bridges began to settle from 2010. The road was constructed in 2004 and DBST was done in 2013.

6.6.3 Methodology:

After getting written information from field, BRRL consultant team along with RHD officials decided to visit the failed sections of N 805. They decided for visual observation, dig pit in the pavement, measure pavement layer thickness and collect sample for laboratory test.

6.6.4 Investigation procedure:

The BRRL consultant team along with RHD officials visited the distressed sections of N 805 on 26 April, 2017. They have visually observed the failed sections, type of failure etc.

6.6.5 Findings

Findings of the investigation in brief as follows:

1. Longitudinal Cracks noted in between hard shoulder & Carriageway.
2. Cracks/depression noted at about 20% of the length
3. Embankment height is 3.5 to 4.00m
4. The alignment passes through soft soil & low laying area.
5. About 20 % area of the total length have undulation and depression.

6.6.6 Causes of defects

Bhanga – Bhatiapara – Mollarhat – Fakirhat – Noapara National Highway (N 805) traverse through many soft ground (Sub surface soil) areas in different isolated locations within the highway alignment. At design period of the highway construction the isolated soft ground area were not identified properly and soil stabilization were not done on the soft ground areas. During construction of the highway embankment, part of the embankment slope was construction on the soft ground area. The soft soil moisture contain > 90%. In extreme dry season moisture evaporated causing shrinkage and settle down of the soft ground areas. Settlement depends on depth of

soft ground (2m to 10m). When settlement rate is high, embankment slope constructed on soft ground area settle down causing development of cracking along the hard and soft shoulder along the road.

The highway embankment was constructed on soft surface area in many locations. Due to the presence of soft soil in sub surface, there is a differential settlement between the embankment and the Bridges/culverts approaches.

6.6.7 Remedial measure:

Soft ground areas located along the embankment has to be identified by conducting SPT test along the embankment. After identifying the soft ground area, the soft ground area shall be stabilized by suitable measures like sand piling. Sand piling has to be designed so that entire soft ground area is fully stabilized. In addition to that sand berm (1-2m height) along the embankment slope has to be constructed.

As the depression happened in an isolated way, subsurface stabilization technically is not possible. In this case, depression need to repair time to time until permanent soil stabilization is taken place.

About 20% of the pavement is already cracked which needs immediate structural overlay to avoid further deterioration of the existing pavement. Due to the settlement of sub surface soil, pavement depression has happened which needs repairing with asphalt concrete.

Stone base course 150mm + DBS 120 mm + Wearing course 50mm is suggested.

6.7 Investigation of road Z-8603:

Road failure investigation of 15 roads under six divisions of Roads and Highways department was done during the financial year 2016-2017. Among which **Z-8603** road was investigated.

6.7.1 Introduction:

The road **Z-8603** starts from Eterpole and ends at Agailjhara. The sections investigated is ch. 00+000 to ch. 14+ 000.

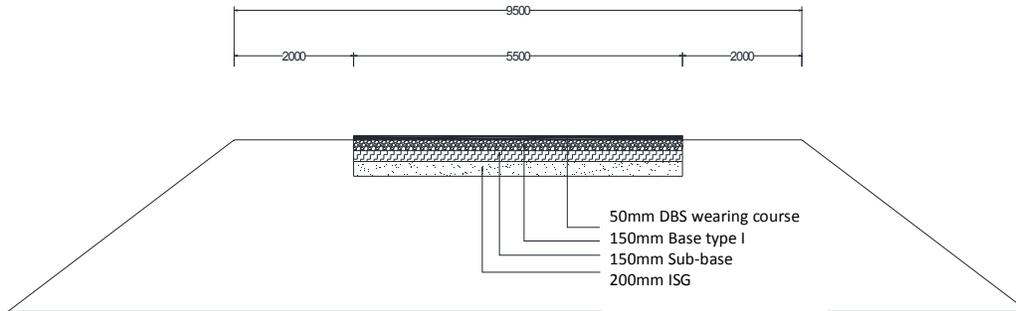


Fig: Road section of Z-8603

6.7.2 Background:

Chief Engineer, RHD vide his memo no: 857 CE dated-18-12-2016 sent letter to all Additional Chief Engineers of field zones to send information about road failure. To his response Additional Chief Engineer of Gopalganj zone has sent road failure information of his zone. Additional Chief Engineer of Gopalganj has explained that carpeting work under ADP from 2010 to 2014 was done. Now potholes and undulation has occurred which are increasing.

6.7.3 Methodology:

After getting written information from field, BRRL consultant team along with RHD officials decided to visit the distressed sections of N 8604. They decided for visual observation, measure the failed section etc.

6.7.4 Investigation procedure:

BRRL consultant team along with RHD officials visited the failed sections of N 8604 on 26 April, 2017. They have visually observed the failed sections, type of failure, took measurement of failed section etc.

6.7.5 Findings

Findings of the investigation in brief as follows:

1. Road condition is very poor under heavy traffic
2. Pothole/Undulation is very frequent
3. At ch. 7+000 (BC=25mm, Sub Base=150mm, ISG >200mm).
4. Very narrow/ No shoulder.
5. Embankment height is 3m or more at both side
6. Steep side slope at both sides.

The pavement is structural, construction and material failure type.

6.7.6 Causes of defects:

As per RHD pavement Design Guide, 2005, when EASL < 3million, the pavement layer thickness shall be following:

BDS wearing 40mm and DBS base 35 mm= 40+35= 75mm.

In granular pavement structure, the surfacing layer has to take substantial tensile stresses induced from traffic load. Again hand mix carpeting on the pavement cannot take tensile stress induced from the traffic causing development of surface crack. During raining season crack propagate more due to infiltration of water. Due to the increase of continuous traffic load, this 50mm DBS wearing course is not sustainable.

6.7.7 Remedial measures:

The deflection survey shall be done to find the structural capacity of the existing pavement. Based on the survey, the structural capacity of the existing pavement has to be improved by providing required thickness of Base Course type-1 and DBS/wearing course to carry the present and future traffic.

So, Shoulder reinstatement and excessive road deflection areas need immediate rehabilitation following RHD Design Manual.

6.8 Investigation of road Z-8604:

Road failure investigation of 15 roads under six divisions of Roads and Highways department was done during the financial year 2016-2017. Among which Z-8604 road was investigated.

6.8.1 Introduction:

The road Z-8604 starts from Madaripur and ends at Bhurghata. The section investigated is ch. 00+000 to ch. 18+570.

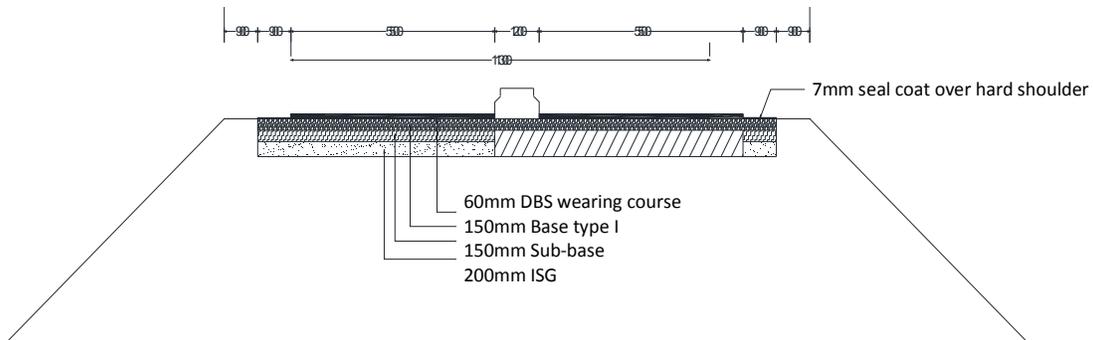


Fig: Road section of Z-8604

6.8.2 Background:

Chief Engineer, RHD vide his memo no: 857 C.E. dated-18-12-2016 sent letter to all Additional Chief Engineers of Field zones to send information about road failure. To his response Additional Chief Engineer of Gopalganj zone has sent road failure information of his zone. Additional Chief Engineer of Gopalganj has explained that carpeting work under ADP was done from 2010 to 2015. Now potholes and undulation has occurred which are increasing.

6.8.3 Methodology:

After getting written information from field, BRRL consultant team along with RHD officials decided to visit the distressed sections of Z-8604. They decided for visual observation, measure the failed section etc.

6.8.4 Investigation procedure:

The BRRL consultant team along with RHD officials visited the failed sections of N 8604 on 26 April, 2017. They have visually observed the failed sections, type of failure, took measurement of failed section etc.

6.8.5 Findings:

Findings of the investigation in brief as follows:

1. At Ch 18+000 (BC=25mm, Base-1=150mm, Sub Base=150mm, ISG > 300mm)
2. Road top width at ch. 0+000 to 6+000=5.5m, at ch. 6+000 to 12+700= 3.7m, at ch. 12+700 to 18+000=5.5m
3. 25 mm BC (0+000 to 15+000) and 40mm DBS (15+000 to 18+000) was measure.
4. Very narrow/ no shoulder at the pavement edge.

5. Embankment height 3m or more at both sides.
6. Step side slope at both side and no lateral support for the pavement.
7. Undulation/settlement/damage is developing continuously due to poor structural capacity of the pavement under present traffic load.

6.8.6 Causes of structural defects:

Causes of structural defects on the pavement are as follows:

As per RHD pavement Design Guide (2005), surfacing layer when EASL < 3million, the pavement layer thickness shall be

BC wearing 40mm and DBS base 35 mm, in total 75mm.

In granular pavement structure, the surfacing layer has to take substantial tensile stresses induced from traffic load. Again hand mix carpeting on the pavement cannot take tensile stress induced from the traffic causing development of surface crack. During raining season crack propagate more due to infiltration of water. Due to the increase of continuous traffic load, this 60mm carpeting (as per the letter) layer is not sustainable.

6.8.7 Remedial measures:

The deflection survey shall be done to find structural capacity of the existing pavement by deflection survey.

Based on the survey, asphalt layer overlay shall be provided as per RHD Road Design guidelines/MS-17 to improve the structural and functional capacity of the road.

6.9 Investigation of road N-805:

Road failure investigation of 15 roads under six divisions of Roads and Highways department was done during the financial year 2016-2017. Among which N-805 road was investigated.

6.9.1 Introduction:

The road N-805 starts at Bhanga and ends at Mollarhat. Total length is 111k.m. The sections investigated are ch 24+000 to ch 27+000, ch.30+000 to ch. 35+000, ch. 37+000 to ch. 37+500, ch.38+000 to ch.40+000, ch.49+000 to ch.51+000, ch.63+000 to ch. 64+000.

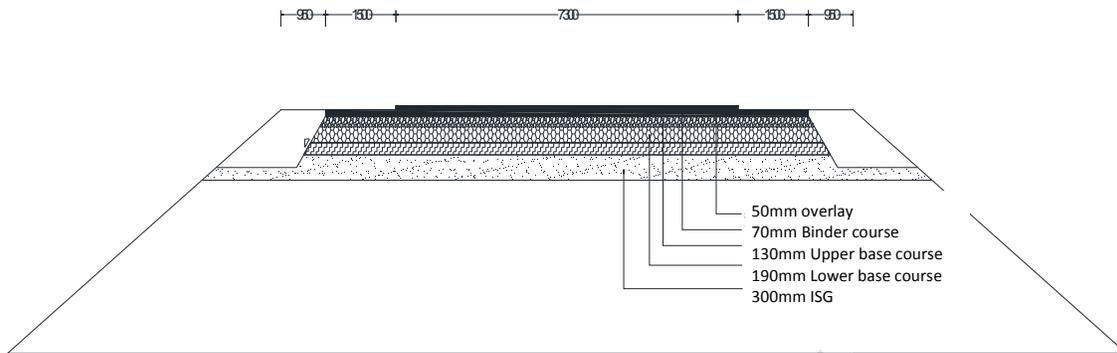


Fig: Road section of N-805

6.9.2 Background:

Chief Engineer, RHD vide his memo no: 857 C.E. dated-18-12-2016 sent letter to all Additional Chief Engineers of field zones to send information about road failure. To his response Additional Chief Engineer of Gopalganj zone has sent road failure information of his zone. Additional Chief Engineer of Gopalganj has explained the sections of failure, type of failure and gave remarks and cross section of road. He explained that longitudinal cracks developed in hard shoulder from 2010. Pavement surface began to settle in different places. pavement undulation, depression and large cracks are found from the year 2008 which are increasing continuously. The road was constructed in 2004 and DBST was done in 2013.

6.9.3 Methodology:

After getting written information from field zone, BRRL consultant team along with RHD officials decided to visit the failed sections of N 805 . They decided for visual observation, measure the failed section.

6.9.4 Investigation procedure:

The BRRL consultant team along with RHD officials visited the distressed sections of N 507 on 25 April, 2017. They have visually observed the failed sections, type of failure, measured the failed sections with tape.

6.9.5 Test of subsurface soil:

Subsurface soil investigation at the chainage 21+360, 33+150 and 39+780 was done by consultant firm engaged by Gopalganj road division

6.9.6 Discussions:

BRRL consultant team along with RHD officials visually found longitudinal cracks in between hard shoulder & carriageway in few isolated locations. Cracks/depressions has been developed in different isolated locations of chainage 20+00 to 55+00Km, The road alignment passes through soft ground sections & low laying area. In the sub surface soil investigation of three points it has found that the top layer comprises of gray silt with fine sand with low SPT value which indicates medium type soil. Bhanga – Bhatiapara – Mollarhat – Fakirhat – Noapara National Highway (N 805) traversed through many soft ground (Sub surface soil) areas in numerous isolated locations within the highway alignment, During the design/ construction period of the highway the soft ground sections (pocket area) were not identified properly and soil stabilization were not done of those numerous isolated locations of soft ground areas. During construction of the highway embankment, part of the embankment slope was construction on the soft ground area (isolated area). Moisture content of soft soil is normally higher. In extreme dry season moisture content of soft soil is evaporated causing shrinkage and settlement of the soft ground areas. Settlement depends on the depth of soft ground and depth of soft soil varies from 2m to 10m. When the settlement rate is high, the embankment slope constructed on soft ground area settled downward causing development of depression, cracking along the hard and soft shoulder. The highway passes through low laying area and sub surface soil beneath the embankment is soft soil and as such the rate of pavement distress is comparatively high. The department should periodically conduct road condition and deflection survey to assess the structural capacity of the pavement and undertake corrective measures to maintain functional and structural capacity of the highway sections.

6.9.7 Conclusion and final remarks:

The soft ground area located along the embankment slope has to be identified by conducting SPT test. After identifying the soft ground area, the soft ground area shall be stabilized by suitable measures like sand piling. Sand piling has to be designed so that entire soft ground area along the slope is fully stabilized. In addition to that sand berm (1-2m height) along the embankment slope can be constructed. Lateral displacement will not happen if the adjacent soft ground area is stabilized.

As the depressions, undulations and cracks appeared in the pavement surface, the pavement surface shall be provided with structural overlay with asphalt concrete. The thickness of asphalt overlay will be based on deflection survey for rehabilitation design. If the pavement cracks is not sealed with overlay in time, moisture will enter the pavements by means of infiltration from the surface. Moisture can occupy pavement in the form of liquid water or moisture vapor above the capillary fringe.

Damage due to moisture in pavements usually initiates at or near the bottom of the asphalt bound layers or at interface between the layers. Advanced moisture damage in asphalt pavements can lead to rutting, shoving, corrugation, fatigue cracking, raveling and flushing and pot holes.

About 20-30 %of the pavement surface is already cracked which needs immediate structural overlay to avoid further deterioration of the existing pavement. Due to the settlement of sub surface soil, pavement depression has happened which needs repairing with asphalt concrete.

6.10 Investigation of road N-507:

Road failure investigation of 15 roads under six divisions of Roads and Highways department was done during the financial year 2016-2017. Among which N- 507 road was investigated.

6.10.1 Introduction:

The road N-507 starts at Hatikamrul and ends at Bonpara. Total length is 51k.m. The section investigated is from ch. 16+000 to ch 25+000.

6.10.2 Background:

Chief Engineer, RHD vide his memo no: 857 C.E. dated-18-12-2016 sent letter to all Additional Chief Engineers of field zones to send information about road failure. To his response Additional Chief Engineer of Gopalganj zone has sent road failure information of his zone. Additional Chief Engineer of Gopalganj has explained the sections of failure, type of failure and gave remarks and cross section of road. He explained that pavement undulation, depression and large cracks are found from the year 2008 which are increasing continuously.

He said that in 1955 land was acquired and embankment was constructed, in 1958 HBB was constructed, in 1962 bituminous carpeting with macadam work was done on HBB repair and surfacing work was done several times but due to the inferior quality of subgrade soil the road cannot be maintained in good condition.

6.10.3 Methodology:

After getting written information from field zone, BRRL consultant team along with RHD officials decided to visit the distressed sections of N 507. They decided for visual observation, dig pit in the pavement, measure the failed section and collect sample for field test.

6.10.4 Investigation procedure:

BRRL consultant team along with RHD officials visited the failed sections of N 507 on 25 April, 2017. They have visually observed the failed sections, type of failure, dug pit on the pavement, measured the pavement layer thickness with tape, collected samples for laboratory tests.

6.10.5 Test of samples Collected:

Summary of tests are as follows:

| Sl No | Layer Type | Parameters | Result | Comments | | |
|---|------------------------------|--|----------------|-----------------------------|--------------------------|----|
| 1. | Bituminous W/C 40-50 | Gradation | Enclosed | Out of limits | Not OK | |
| | | Fracture faces | 78% | ≥ 90 % | Not Ok | |
| | | % Bitumen | 5 | | Limit not known | |
| 2. | If DBS (60-70) Base Course | Gradation | Enclosed | Out of limits | Not OK | |
| | | Gradation (Consultant) | Enclosed | | | |
| | | Fracture faces | 73 | ≥ 90 % | Not Ok | |
| | | % Bitumen | 2.6 | | Limit not known | |
| | If DBS (40-60) Base/W Course | % Bitumen(Consultant) | 6.72 | | | |
| | | Gradation | Enclosed | Out of limits | Not OK | |
| | | Gradation (Consultant) | Enclosed | | | |
| | | Fracture faces | 73 | ≥ 90 % | Not Ok | |
| 3. | If Base Type-1 (A) | % Bitumen | 2.6 | 2.6 | Limit not known | |
| | | % Bitumen(Consultant) | 7.53 | | | |
| | | Gradation | Enclosed | Max ^m finer side | Within limits | |
| | | Gradation (Consultant) | Enclosed | Max ^m finer side | Within limits | |
| | | Fracture faces | 77 | > 75 % | OK | |
| | | Fracture faces(Consultant) | 75.4 | > 75 % | OK | |
| | If Base Type-1 (B) | LAA | 31 | ≤ 35% | OK | |
| | | LAA (Consultant) | 31.8 | ≤ 35% | OK | |
| | 4. | Base & Sub Base Mixture | Gradation | Enclosed | ok but are on finer side | Ok |
| | | | Fracture faces | | > 75 % | |
| 5. | If Sub base (A) | Gradation | Enclosed | Finer side | Ok | |
| | | Gradation (Consultant) | Enclosed | | OK | |
| | | Fracture faces | 77 | >50 % | OK | |
| | | Fracture faces (Consultant) | 75 | >50 % | OK | |
| | If Sub Base (B) | Gradation | Enclosed | OK other than 20mm sieve | Not Ok | |
| | | Fracture faces | 77 | > 50 % | OK | |
| 6. | ISG | ISG materials are mixture of coarse and fine sand/soil. We have done the gradation of this materials passing through 5.00mm sieve which do not comply with any zone of RHD specification, This may due to intrusion of soil slurry coming from bottom sub soil layers. | | | | |
| 7. | Embankment soil | LL(Consultant) | 41 | ≤50 | Comply | |
| | | PI(Consultant) | 18 | ≤15 | | |
| “(Consultant)” for materials collected by the consultant and others are sent by the division and tested by the Consultant | | | | | | |

Gradation, fracture faces, bitumen content of bituminous wearing course, DBS base course, base type-1, sub-base, and sub-grade, LA test of base type-1, liquid limit (LL), plastic limit (PL), plasticity index of embankment soil were performed in the laboratory. Total of thirty two tests were done in the laboratory.

6.10.6 Discussions:

BRRL consultant team along with RHD officials visually found severe damage in the form of settlement at different locations. Gradation of bituminous wearing course, DBS base course is not within the limit of RHD specification. Gradation of base type-1 and sub-base is within RHD specification but are of finer side. In case of bituminous wearing course & DBS base course, percentage of fracture faces is less than required specification. In case of base type-1 and sub-base, percentage of fracture face is within limit.

The gradation of ISG materials does not comply with the RHD specification as there might be intrusion of soil in the ISG materials. The liquid limit (LL), plastic limit (PL), and plasticity index (PI) are within the limit.

The pavement at different locations from ch. 16+000 to 25+000 has been damaged in the form of settlement of the pavement due to presence of soft soil in the sub-surface and delimitation of wearing course from the dense bituminous base course. The existing base course is structurally very poor as the base layer was not properly constructed. The weak base layer is one of the weaknesses of the pavement structure. The pavement distress happened due to many reasons as mentioned below.

The road embankment has been constructed on soft sub surface soil. When the pavement is constructed on soft soil area without any stabilization of the soft ground, the pavement constructed on the embankment is settled due to shear failure of the embankment and asphalt layer is damaged prematurely.

Construction of the granular base course is not structurally sound due to poor workmanship and poor materials in the mix.

The wearing course in different location from ch. 19+000 to 25+000 has been damaged or the delaminating of wearing course has been happened. This distress of the pavement is due to the poor construction of the wearing course as the mix design of the asphalt wearing course contains high percentage of fine materials.

If the mixes have stiffening effect mixtures become more sensitive to rutting. More over when the asphalt mix contain high percentage of fine dust it become moisture sensitive and the layer become weak due to the presence of water. Due to the water sensitivity the upper layer is damaged prematurely. The delimitation of the pavement layer happened when the tack coat is weak compare to the tensile stress due to heavy traffic load. Tack coat bonding is failed to sustain high imposed tensile stress of the wearing course and the layer is separated from DBS base course.

At around 350mm depth ch. (16+950) a thin oily black layer noted which not bituminous layer is. Upon smelling, it gave a different feeling than bitumen. This layer is still in raw stage, volatile material slowly moving upward from this oily layer which may be one of the causes of failures. At this depth material noted very loose while digging hole. Until the black oily layers are removed no repair work will sustain. So, full reconstruction up to sub base is the best option.

6.10.7 Conclusion and final remarks:

The pavement distress was started since after construction of the highway. The pavement distresses were repaired in many times but the repairing is not becoming durable due defective construction of the original pavement. It will be better to reconstruct 1km of pavement as per RHD specification and monitoring the performance of the pavement for few years. If the performance of the reconstructed pavement is found good then the remaining pavement may be taken up for reconstruction. The existing pavement is required proper routine and periodic maintenance to keep the road at reasonable good condition for smooth plying of present highway traffic.

6.11 Investigation of Kasinathpur - Pabna - Dashuria – Natore -Rajshahi (Natore part), N-6:

Road failure investigation of 15 roads under six divisions of Roads and Highways department was done during the financial year 2016-2017. Among which N- 6 (Natore part) was investigated.

6.11.1 Introduction:

The road N-6 starts at Kasinathpur and ends at Baliadighi Border. Total length is 232km. The section investigated is ch 84+780 (Bonpara Intersection).

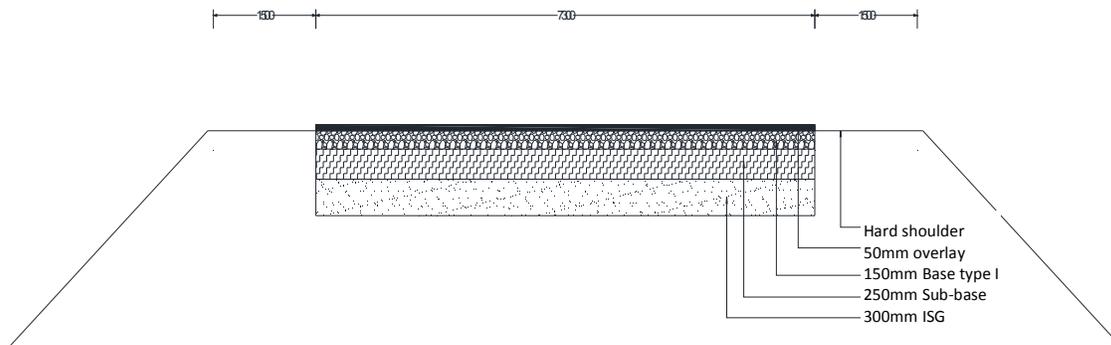


Fig: Road section of N-6

6.11.2 Background:

Chief Engineer, RHD vide his memo no: 857 C.E. dated-18-12-2016 sent letter to all Additional Chief Engineers of field zones to send information about road failure. To his response, executive engineer of Natore road division has sent road failure information of his division. Executive engineer of Natore road division has explained the sections of failure, type of failure and gave remarks and cross section of road. He explained that pavement has deteriorated at ch 84+780 (Bonpara Intersection) of Kasinathpur-Pabna-Dashuria-Natore-Rajshahi (Natore part), N-6.

He explained that construction of rigid pavement or reconstruction is needed at the distressed section.

6.11.3 Methodology:

After getting written information from field zone BRRL consultant team along with RHD officials decided to visit the failure sections of N 805. They decided for visual observation, measure the failed section.

6.11.4 Investigation procedure:

BRRL consultant team along with RHD officials visited the failure sections of N 507 on 5 May, 2017. They have visually observed the failed sections, type of failure, measured the failed sections with tape.

6.11.5 Findings:

Findings of the investigation as follows:

1. Heaving of asphalt material towards outer edge of the lane.
2. Water logging noted.
3. Asphalt bleeding noted.
4. Water logging at the outer edge of super elevation.
5. Proper drainage problem.
6. Loaded vehicle passing with high speed.

6.11.6 Causes of structural defects:

Causes of structural defects on the pavement are as follows:

1. Bitumen bleeding.
2. Frequent acceleration/retardation of vehicles. Shovel and potholes are increasing continuously with time
3. Lower Super elevation, water ponding etc.

6.11.7 Remedial measures:

The pavement surface at the intersection is prone to bleeding.

Bleeding in this layer has to be removed and replaced with new asphalt layer. At super elevation area, outer edge of the pavement hard shoulder is constructed at lower level and water is ponded at the outer edge of main carriageway. The outer edge of super elevation needs to be raised by laying asphalt layer to avoid water ponding.

6.12 Investigation of Kasinathpur-Pabna-Dashuria-Natore-Rajshahi (Natore part), N-6:

Road failure investigation of 15 roads under six divisions of Roads and Highways department was done during the financial year 2016-2017. Among which N- 6 (Natore part) was investigated.

6.12.1 Introduction:

The road N-6 starts at Kasinathpur and ends at Baliadighi border. Total length is 232km. The section investigated is ch. 100+350 (Horispur by pass Intersection)

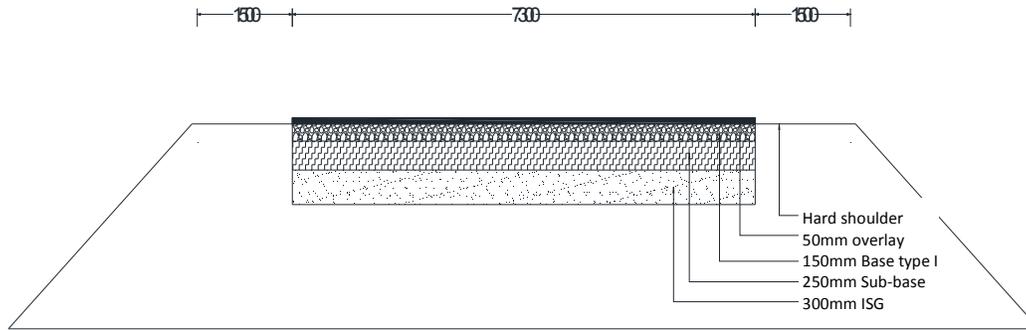


Fig: Road section of N-6

6.12.2 Background:

Chief Engineer, RHD vide his memo no: 857 C.E. dated-18-12-2016 sent letter to all Additional Chief Engineers of field zones to send information about road failure. To his response executive engineer of Natore road division has sent road failure information of his division. Executive Engineer of Natore road division has explained the sections of failure, type of failure and gave remarks and cross section of road. He explained that pavement has deteriorated at ch 100+350 (Horispur by pass Intersection) of Kasinathpur-Pabna-Dashuria-Natore-Rajshahi (Natore part), N-6. He explained that construction of rigid pavement or reconstruction is needed at the distressed section.

6.12.3 Methodology:

After getting written information from field zone, BRRL consultant team along with RHD officials decided to visit the failure sections of N 805. They decided for visual observation, measure the failed section.

6.12.4 Investigation procedure:

BRRL consultant team along with RHD officials visited the failure sections of N 507 on 25 April, 2017. They have visually observed the failed sections, type of failure, measured the failed sections with tape.

6.12.5 Findings:

Findings of the investigation as follows:

1. Water dropping from fish carrying area and causing damages
2. Road level is lower than neighboring area consequences water logging
3. Scarifying and adding of Base-1 + DBS-WC/Base course.

6.12.6 Causes of structural defects:

Causes of structural defects on the pavement are as follows:

1. Water is dropping constantly from fish carrying trucks and pavement surface is wetted all the time. The stripping in the pavement surface is happened in the presence of water and causing damages.
2. Road level is lower than neighboring area consequences water logging. The presence of water in the pavement reduces the pavement structural capacity. Moreover water initiates the disintegration of pavement structure and pavement is damaged.

6.12.7 Remedial measures:

Scarifying/Shaping/compacting the surface with repairing the potholes accordingly, then addition of Base type-I and DBS Wearing course will provide greater advantage.

6.13 Investigation of Kasinathpur-Pabna-Dashuria-Natore-Rajshahi (Natore part), N-6:

Road failure investigation of 15 roads under six divisions of Roads and Highways department was done during the financial year 2016-2017. Among which N- 6 (Natore part) was investigated.

6.13.1 Introduction:

The road N-6 starts at Kasinathpur and ends at Baliadighi Border. Total length is 232k.m. The section investigated is ch 105+000 (Tabaria rail gate).

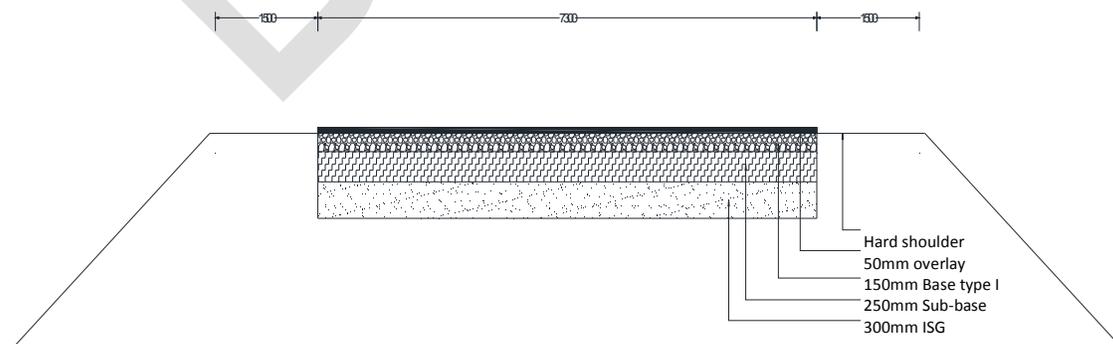


Fig: Road section of N-6

6.13.2 Background:

Chief Engineer, RHD vide his memo no: 857 C.E. dated-18-12-2016 sent letter to all Additional Chief Engineers of field zones to send information about road failure. To his response executive engineer of Natore road division has sent road failure information of his division. Executive engineer of Natore road division has explained the sections of failure, type of failure and gave remarks and cross section of road. He explained that pavement has deteriorated at ch. 105+000 (Tabaria rail gate) of Kasinathpur-Pabna-Dashuria-Natore-Rajshahi (Natore part), N-6. He explained that construction of rigid pavement or reconstruction is needed at the distressed section.

6.13.3 Methodology:

After getting written information from field zone, BRRL consultant team along with RHD officials decided to visit the failure sections of N 805. They decided for visual observation, measure pavement layer thickness.

6.13.4 Investigation procedure:

BRRL consultant team along with RHD officials visited the distressed sections of N 507 on 25 April, 2017. They have visually observed the failed sections, type of failure, measured the failed sections with tape.

6.13.5 Findings:

Findings of the investigation as follows:

1. Water is dropping from fish carrying area and causing damages (Damage due to water presence at the surface).
2. Road level is lower than neighboring area consequences water logging
3. 200m rigid pavement is required at both side of rail gate.

6.13.6 Remedial measures:

The Damaged pavement section other than from Belghoria round about to Tabaria Rail gate needs scarifying/shaping/compacting existing surface and adding additional layers of crushed stone Base type-1 + 70mm DBS base + 50mm WC/ are the best solution.

6.14 Investigation of Kasinathpur-Pabna-Dashuria-Natore-Rajshahi (Natore part), N-6:

Road failure investigation of 15 roads under six divisions of Roads and Highways department was done during the financial year 2016-2017. Among which N-6 (Natore part) was investigated.

6.14.1 Introduction:

The road N-6 starts at Kasinathpur and ends at Baliadighi Border. Total length is 232 km. The section investigated is ch. 106+150 (Belghoria bypass)

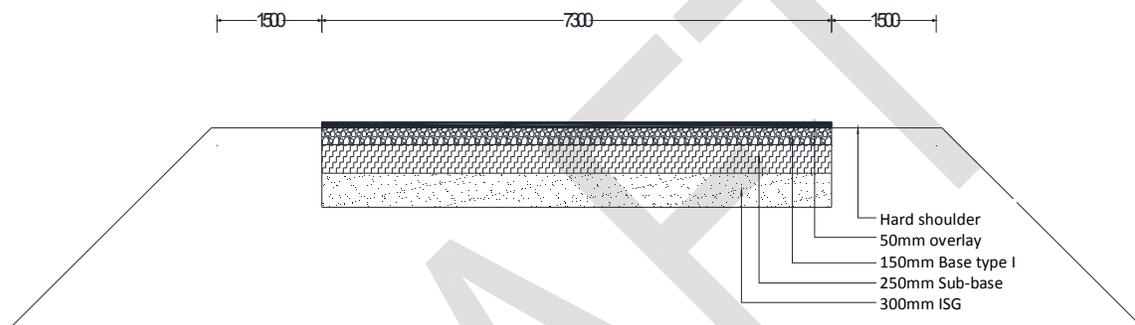


Fig: Road section of N-6

6.14.2 Background:

Chief Engineer, RHD vide his memo no: 857 C.E. dated-18-12-2016 sent letter to all Additional Chief Engineers of field zones to send information about road failure. To his response executive engineer of Natore road division has sent road failure information of his division. Executive engineer of Natore road division has explained the sections of failure, type of failure and gave remarks and cross section of road. He explained that pavement has deteriorated at ch. 106+150 (Belghoria bypass) of Kasinathpur-Pabna-Dashuria-Natore-Rajshahi (Natore part), N-6. He explained that construction of rigid pavement or reconstruction is needed at the distressed section.

6.14.3 Methodology:

After getting written information from field zone, BRRL consultant team along with RHD officials decided to visit the failure sections of N 805. They decided for visual observation, measure the failed section.

6.14.4 Investigation procedure:

The BRRL consultant team along with RHD officials visited the failure sections of N 507 on 25 April, 2017. They have visually observed the failed sections, type of failure, measured pavement layer thickness with tape.

6.14.5 Findings:

Findings of the investigation as follows:

1. Water is dropping from fish carrying area and causing damages.
2. Road level is lower than neighboring area consequences of water logging
3. Pavement surface is in distressed condition in the form of cracking, undulation, stripping, raveling etc. Photos are taken at different places.

6.14.6 Causes of structural defects:

Causes of structural defects on the pavement are as follows:

1. Water dropping from fish carrying area and causing damages.
2. Road level is lower than neighboring area consequences of water logging.
3. Heavy loaded vehicle passing.
4. Pavement surface is in distress condition in the form of cracking, undulation, stripping, raveling etc.

6.14.7 Remedial measures:

Remedial measures as follows:

1. Scarifying, shaping, compaction of the surface in addition of Base-1 + DBS/ Wearing are the best option.
2. Construction of proper drainage on both side to avoid water logging.

6.15 Bogra (Jahangirabad) –Natore road (Natore part) N 502 :

Road failure investigation of 15 roads under six divisions of Roads and Highways department was done during the financial year 2016-2017. Among which N- 502 (Natore part) was investigated.

6.15.1 Introduction:

The road N-502 starts at Jahangirabad and ends at Natore. Total length is 63km. The section investigated is ch. 47+250 to ch. 44+500 and ch. 35+150 to ch. 39+600.

6.15.2 Background:

Chief Engineer, RHD vide his memo no: 857 C.E. dated-18-12-2016 sent letter to all Additional Chief Engineers of field zones to send information about road failure. To his response executive engineer of Natore road division has sent road failure information of his division. Executive engineer of Natore road division has explained the sections of failure, type of failure and gave remarks and cross section of road. He explained that pavement of the side chainages have settled. The road sections need to be reconstructed. As the road passes through Chalanbil different sections of the road gets settled down.

6.15.3 Methodology:

After getting written information from field zone the BRRL consultant team along with RHD officials decided to visit the failure sections of N 502. They decided for visual observation, measure the failed section, collect sample from failed section.

6.15.4 Investigation procedure:

The BRRL consultant team along with RHD officials visited the failure sections of N 502 on 5 May, 2017. They have visually observed the failed sections, type of failure, measured the failed sections with tape and collected sample.

6.15.5 Test summary:

Test summary are given below

| Sl. No | Parameters | Result | Comments | |
|--------|----------------|----------|----------|--------|
| 1. | ACV | 19 | ≤ 38% | Ok |
| 2. | LL | 37 | ≤ 50% | Ok |
| 3. | PI | 17 | ≥ 15% | Not ok |
| 4. | Base Gradation | Attached | | Not oK |
| 5. | Sub Base | Attached | | OK |

6.15.6 Discussions:

ACV of base, LL & PL of sub-grade, gradation of sub-base and base were done in the laboratory. Total of five (5) tests were done in the laboratory. In the test result it is found that the value of ACV of base, LL, PL of sub-grade are within the limit but gradation of sub-base and base are beyond limit.

6.15.7 Findings:

Findings of the Investigation as follows:

1. The pavement on Bogra-Natore road was constructed on soft ground sub surface soil without stabilization of sub-surface soft soil.
2. The embankment of the road was also constructed with soft soil.
3. The pavement constructed on road embankment which was constructed on soft ground was unsuitable for embankment construction in nature and as such the pavement are damaged constantly.
4. Settlement noted : ch. 47+250 to 44+500, ch. 35+150 to 39+600.
5. Embankment height is more than 5m, width 5.5m.
6. Pavement settlement occurring continuously with time under traffic (especially at LHS towards Bogra)
7. Needs repairing continuously by adding Base-Type-1 and DBS-WC.

6.15.8 Causes of structural defects:

Causes of structural defects on the pavement are as follows:

1. The road alignment is traversed through marshy/swampy land where subsurface soil is soft in nature.
2. At Bogra-Natore road (Natore part) road embankment was constructed with soft soil without stabilization of sub surface soil.
3. Technically Highway shall not be constructed on soft ground area without proper stabilization of soft surface soil and embankment should not be constructed with soft soil.
4. Pavements constructed in soft ground area without stabilization are prematurely cracked, damaged in the form of undulation, depression and settlement. Pavement settlement is considered as pavement failure. The embankment soft soil and soft subsurface soil is moved under traffic and pavement is cracked and settled. Shear failure and displacement of pavement is common in nature. Potholes are formed when pavement starts cracking with traffic.

6.15.9 Remedial measures:

Bogra-Natore road (Natore part) was constructed with soft ground soil and the road embankment was constructed on soft sub surface soil. Technically Highway shall not be constructed on soft ground area without proper stabilization of soft sub surface soil and embankment materials should not constructed with soft soil.

The structural capacity of the embankment is too poor and the bearing capacity of the sub-surface soil is also too poor. The sub-surface soil and the embankment soil cannot carry the traffic load coming from the pavement structure. As the embankment and the sub-surface soil cannot carry the imposed load and as such the pavement structure is constantly settled, cracked, depression, undulation and pavement is damaged.

There are no technical remedial measures to stop the settlement of the pavement until the highway is reconstructed and rebuild with stabilization of the sub surface soil and construction of the embankment with improved soil for highway embankment.

The reconstruction of highway is not possible at the present stage, so the damaged pavement in isolated locations have to be repaired regularly when necessary. Suitable pavement treatment option at selected sections should be adopted

6.16 Investigation of Hatikamrul-Bonpara road N-507 (Natore part):

Road failure investigation of 15 roads under six divisions of Roads and Highways department was done during the financial year 2016-2017. Among which N- 507 (Natore part) was investigated.

6.16.1 Introduction:

The road N-507 starts at Hatikamrul and ends at Bonpara. Total length is 23 km. The section investigated is ch. 27+000.

6.16.2 Background:

Chief Engineer, RHD vide his memo no: 857 C.E. dated-18-12-2016 sent letter to all Additional Chief Engineers of field zones to send information about road failure. To his response executive engineer of Natore road division has sent road failure information of his division. Executive engineer of Natore road division has explained the sections of failure, type of failure and gave remarks and cross section of road. He explained that both sides of the toll plaza at 27th km. have got distressed. He said

that on both sides of the toll plaza about 200 m rcc pavement is required to be constructed on lane 1,2,3,4. Previously 84 m rcc pavement was constructed on lane 1 and 2.

6.16.3 Methodology:

After getting written information from field zone, BRRL consultant team along with RHD officials decided to visit the failure sections of N 805. They decided for visual observation, measure the failed section.

6.16.4 Investigation procedure:

The BRRL consultant team along with RHD officials visited the distressed sections of N 507 on 5 May, 2017. They have visually observed the failed sections, type of failure, measured the failed sections with tape.

6.16.5 Findings:

Findings of the investigation as follows:

1. Pavement is damaged due to the frequent breaking of the vehicle at toll plaza for toll payment.
2. Breaking stresses causing frequent damage of the pavement.
3. Water is dropping from fish carrying vehicles which frequently stop at toll plaza and damage the road by making potholes. Water infiltration into the pavement causes damage of the pavement.
4. Rigid pavement constructed in many areas is functioning well.
5. Construction of 100m length rigid pavement on both sides of the toll plaza is a good solution.
6. Photos are taken from different location.

6.16.6 Causes of structural defects:

Causes of structural defects on the pavement are as follows:

1. Water is dropping from the fish carrying vehicle. Water in the pavement surface accelerates stripping of pavement and damage pavement. Water infiltrate into the pavement layer and structural capacity is reduced and pavement is damaged.
2. Acceleration and retardation of heavy vehicles at this location is very common. These actions induced the formation of upheaval and depression of pavement surface and damaged pavement structure.

6.16.7 Remedial measures:

Construction of rigid pavement at both side of the toll plazas will be a best option.

6.17 Investigation of : Naogaon Atrai – Natore R548 (Natore part) :

Road failure investigation of 15 roads under six divisions of Roads and Highways department was done during the financial year 2016-2017. Among which R548 was investigated.

6.17.1 Introduction:

The road R548 starts at Naogaon and ends at Natore. Total length is 53km. The section investigated is ch. 35+600 (Naldanga Bazar Upazilla)

6.17.2 Background:

Chief Engineer, RHD vide his memo no: 857 C.E. dated-18-12-2016 sent letter to all Additional Chief Engineers of field zones to send information about road failure. To his response executive engineer of Natore road division has sent road failure information of his division. Executive engineer of Natore road division has explained the sections of failure, type of failure and gave remarks and cross section of road. He explained that the Naldanga bazar upazilla point gets submerged under water. Rcc pavement or reconstruction is needed at the portion of the road.

6.17.3 Methodology:

After getting written information from field zone, BRRL consultant team along with RHD officials decided to visit the distressed sections of N 805. They decided for visual observation, measure pavement layer thickness.

6.17.4 Investigation procedure:

BRRL consultant team along with RHD officials visited the failure sections of R 548 on 5 May, 2017. They have visually observed the failed sections, type of failure, measured the failed sections with tape.

6.17.5 Findings:

Findings of the Investigation as follows:

1. Damage of pavement due to stagnant water for long period on pavement surface.
2. Narrow Road, both side of the road level is higher than the pavement carriageway.
3. During rainy season, water from the outer area passes through the road.
4. Road surface damages frequently by traffic and water logging.

5. Road width is 5.5m

6. This area around 150m needs rigid pavement and both side surface drain.

6.17.6 Causes of structural defects:

Causes of structural defects on the pavement are as follows:

1. The road level is lower than the neighboring public structure/ buildings GL. As a result the pavement acts as water passing channel during rainy season.
2. No surface drainage facilities.

6.17.7 Remedial measures:

The pavement of the said location is damaged due to drainage problem. So, construction of surface drains at both side of the road and construction of rigid pavement (200m) at the damage section is technically the best option.

6.18 Investigation of road N-6 (Pabna part):

Road failure investigation of 15 roads under six divisions of Roads and Highways Department was done during the financial year 2016-2017. Among which N- 6 (Pabna part) road was investigated.

6.18.1 Introduction:

The road N-6 (Pabna part) starts at Kashinathpur and ends at Baliadighi border. Total length is 232 km. The section investigated is ch. 62+000.

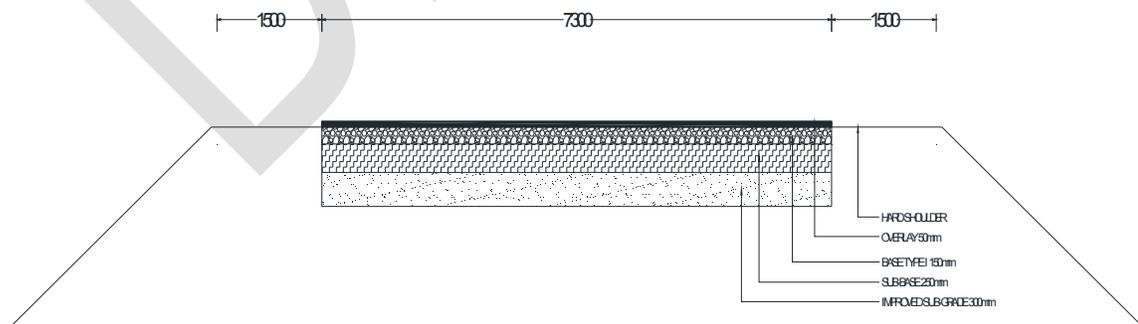


Fig: Road section of N-6

6.18.2 Background:

Chief Engineer, RHD vide his memo no: 857 C.E. dated-18-12-2016 sent letter to all Additional Chief Engineers of field zones to send information about road failure. To his response executive engineer of Pabna road division vide his memo no-187 date-25/01/2017 informed that road failure occurred at 62th km. of Kasinathpur-Pabna-Dashuria-Natore-Rajshahi (Pabna Part), the road section is damaging from the construction period of the road. Soil test was done where SPT value of soil below sub-grade was found very low. Due to severe damage road section is maintained by brick flat soling.

6.18.3 Methodology:

After getting written information from field zone, BRRL consultant team along with RHD officials decided to visit the distressed sections of N6 (Pabna part). They decided for visual observation, dig pit in the pavement, measure the failed section and collect sample for field test.

6.18.4 Investigation procedure:

BRRL consultant team along with RHD officials visited the distressed sections of N6 on 4 may, 2017. They have visually observed the failed sections, type of failure, dug pit on the pavement, measured the failed sections with tape, collected samples for laboratory tests.

| Sl. No | Layer Type | Parameters | Result | Comments | |
|--------|-------------------------------------|---------------------------|----------|-----------------------------------|----------|
| 1. | Base Type-1- B (Brick aggregate) | Gradation (Consultant) | Enclosed | Not Ok as Base course material | |
| | | | Enclosed | Not ok as sub base material | |
| | | ACV | 30 | ≤30(Base), ≤38 Sub Base | Critical |

6.18.5 Test of samples Collected:

Gradation of base type-1, sub-base, aggregate crushing values (ACV) of sub-base were performed in the laboratory. Total of three tests were done in the laboratory.

Summary of the tests are as follows

6.18.6 Discussions:

BRRL consultant team along with RHD officials visually found that heavy traffic passes over the section, during rainy season this area is submerged under water and act as water passing channel. Top 50mm B/C (80% damaged) is damaged at around 1200m sections. In laboratory test, it is found that the gradation of base type-1 and sub-base materials do not comply with the RHD Specification rather it is in the coarser side. The ACV of Sub-base materials is within the limit. From the soil report submitted by Pabna road division it is found that SPT value of soil below sub-grade is very low which indicates clayey soil.

6.18.7 Remedial measures:

Following remedial measures can be taken.

1. Strengthening of soil below sub-grade,
2. Rising of the existing highway embankment above flood level,
3. Construction of rcc drain for drainage of rain water/flood water,
4. Reconstruction of the road following RHD road design manual.

7. Conclusion and final remarks:

Since 1955, the road was reconstructed/ repaired several times at different location with different specification/method, without considering incremental traffic volume and without maintaining RHD design manuals guidelines. Moreover the construction materials properties did not always meet RHD specifications (as per laboratory test result). The structural capacity of the existing pavement is extremely poor with the present traffic load.

So, reconstruction of the road according to present traffic volume and material properties is the only solutions to have a sustainable road.

Annexure 1: Laboratory test report and photos of Road N 804

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD

Paikpara, Mirpur, Dhaka, Bangladesh

| Test Summary (Annex-#1 (N 804)) | | | |
|---------------------------------|-------|--------|--|
| Test Parameters | Value | Limits | Remarks |
| MDD, Kg/m ³ | 1780 | | |
| OMC, % | 12.5 | | |
| CBR at % Compaction | 93 | 4.3 | These figures as per Modified Energy. If Standard energy is used, value would less than thes figures |
| | 95 | 5.3 | |
| | 98 | 6.50 | |
| Swelling at % Compaction | 93 | 6.50 | % Swelling is higher |
| | 95 | 6.00 | |
| | 98 | 5.50 | |
| Liquid Limit | 35 | ≤50 | Within Limits |
| Plasticity Index(PI) | 20 | ≤25 | |

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD

Paikpara, Mirpur, Dhaka, Bangladesh

Maximum Dry Density and Optimum Moisture Content (Data and Report Sheet)

AASHTO T99 /T180; STP4.4

| | | | |
|------------------------|---|-------------------|----------|
| Memo No | | Date | |
| Client | | | |
| Project / Work | | | |
| Location | Bhanga – Faridpur (Goalchamat) Road, N 804 (12Km From Faridpur) | | |
| Date of receive at lab | | Date of test | 4-May-17 |
| Sample Description | | Quantity Supplied | |
| Name of Agency | RHD | | |

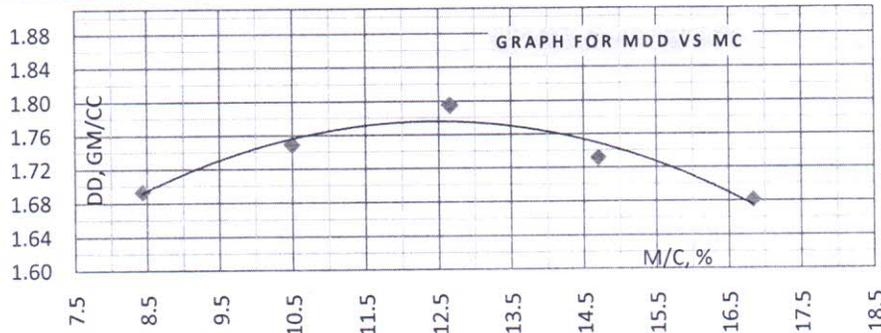
Laboratory Work

Compaction

| Description | Notation | Determination No/Mould # | | | | | Remarks |
|-------------------------------|----------------------|--------------------------|-------|-------|-------|-------|------------------------|
| | | 1/#1 | 2/#1 | 3/#1 | 4/#1 | 5/#1 | |
| Mass of Sample, gm | W | 3000 | 3000 | 3000 | 3000 | 3000 | Modified Compaction |
| Water added, % | m2 | 8 | 10 | 12 | 14 | 16 | |
| Water added, gm | $(m2-m1)/(100+m1)*W$ | 240.0 | 300.0 | 360.0 | 420.0 | 480.0 | |
| Mass of Mould +wet | a | 3710 | 3800 | 3885 | 3851 | 3830 | |
| Mass of Mould, gm | b | 1980 | 1980 | 1980 | 1980 | 1980 | |
| Mass of wet Sample, gm | c = a-b | 1730 | 1820 | 1905 | 1871 | 1850 | |
| Bulk density(wet), gm/cc | $d = c/v_m$ | 1.836 | 1.932 | 2.022 | 1.986 | 1.964 | |
| Dry density, gm/cc | $d*100/(100+m)$ | 1.693 | 1.748 | 1.795 | 1.732 | 1.681 | |
| Vol ^m of Mould, cc | v_m | 942.1 | 942.1 | 942.1 | 942.1 | 942.1 | |

Moisture Content determination

| Description | Notation | 201 | 212 | 107 | 17 | A/8 | Initial M/C, m1 | |
|--------------------------------|-------------------|-------|--------|--------|--------|--------|-----------------|------|
| Mass of soil + container, gm | a1 | 119.9 | 131.31 | 150.71 | 143.99 | 145.25 | | |
| Mass of dry soil+container, gm | a2 | 113.8 | 123.3 | 138.83 | 129.47 | 130.40 | | |
| Mass of container, gm | b1 | 41.66 | 46.46 | 44.98 | 30.70 | 42.21 | | |
| Mass of water, gm | $c1 = a1 - a2$ | 6.090 | 8.060 | 11.880 | 14.520 | 14.850 | | |
| Mass of dry soil, gm | $d1 = a2 - b1$ | 72.14 | 76.79 | 93.85 | 98.77 | 88.19 | | |
| Moisture Content, gm | $m = (c1/d1)*100$ | 8.44 | 10.50 | 12.66 | 14.70 | 16.84 | | 0.00 |



| | | |
|------------------------|-------|----|
| OMC, % | 12.5 | |
| MDD, gm/cc | 1.780 | |
| MDD, Kg/m ³ | 1780 | |
| Mould Dia= | 101.7 | mm |
| Mould Ht= | 116 | mm |
| Mould Vol= | 942.1 | cc |

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Road Research Laboratory, Mirpur, Dhaka

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD

Paikpara, Mirpur, Dhaka, Bangladesh

| California Bearing Ratio Test (AASHTO T193) | | | | | | | |
|---|---|-------------------|------------------|-------------------------------------|-------------------------|----------|---------|
| Memo No | | Date | | | | | |
| Client | | | | | | | |
| Project / Work | Failure investigation on Faridpur | | | | | | |
| Location | Bhanga – Faridpur (Goalchamat) Road, N 804 (12Km From Faridpur) | | | | | | |
| Date of receive at lab | | Date of test | 7-11/5/2017 | | | | |
| Sample Description | | Quantity Supplied | | | | | |
| Name of Agency | RHD | | | | | | |
| Compaction | | | | | CBR:1/4 | | |
| Compaction Date | 18-05-2017 | | Penetration Date | 5/0/2017 | | | |
| CBR Densities and Moisture. | | | | | | | |
| TEST No.(mould no) | #03 | #13 | #5 | Compaction Criteria | Type | Laye No. | Blow No |
| Number of Blows | Heavy/62 | Medium/30 | Light/16 | | Heavy | 5 | 62 |
| Wt of Mould +Sample (gm), W1 | 9190 | 8957 | 8776 | | Medium | 5 | 30 |
| Wt of Mould (gm), W2 | 4590 | 4616 | 4730 | | | | |
| Wt of sample (gm), W = W1-W2 | 4600 | 4341 | 4046 | | Light | 5 | 10 |
| Volume of mould, cc | 2305.4 | 2305.4 | 2305.4 | | | | |
| Wet density (gm/cc), Y_{wet} | 1.995 | 1.883 | 1.755 | | | | |
| Moisture Container No | 121 | 107 | 17 | MDD, Kg/m ³ | | | 1780 |
| Wt of wet soil + cont.(g) | 107.1 | 124.8 | 131.73 | | | | |
| Wt of dry soil + cont. (g) | 100.3 | 115.9 | 120.65 | OMC, % | | | 12.50 |
| Wt of container | 46.48 | 45.02 | 33.03 | Initial M/C %, m₁ | Sample+Can, gm | | 240.0 |
| Wt of water (g) | 6.8 | 9.0 | 11.1 | | Dry Sample+Can, gm | | 231 |
| Wt of dry soil (g) | 53.8 | 70.8 | 87.6 | | Can wt, gm | | 87.0 |
| Moisture Content (%) | 12.70 | 12.66 | 12.65 | | m ₁ , %, M/C | | 6.25 |
| AV. Moisture content(%), m | 12.7 | | | Total sample Wt(gm), W | | 15000.0 | |
| Dry Density, Kg/m ³ , $Y_d = 100/(100+m) \cdot YW$ | 1770.89 | 1671.18 | 1557.61 | OMC, m ₂ | | | 12.50 |
| % Compaction | 99 | 94 | 88 | Water added, gm | | 882.4 | |

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|--|
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| Road Research Laboratory, Mirpur, Dhaka |

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD

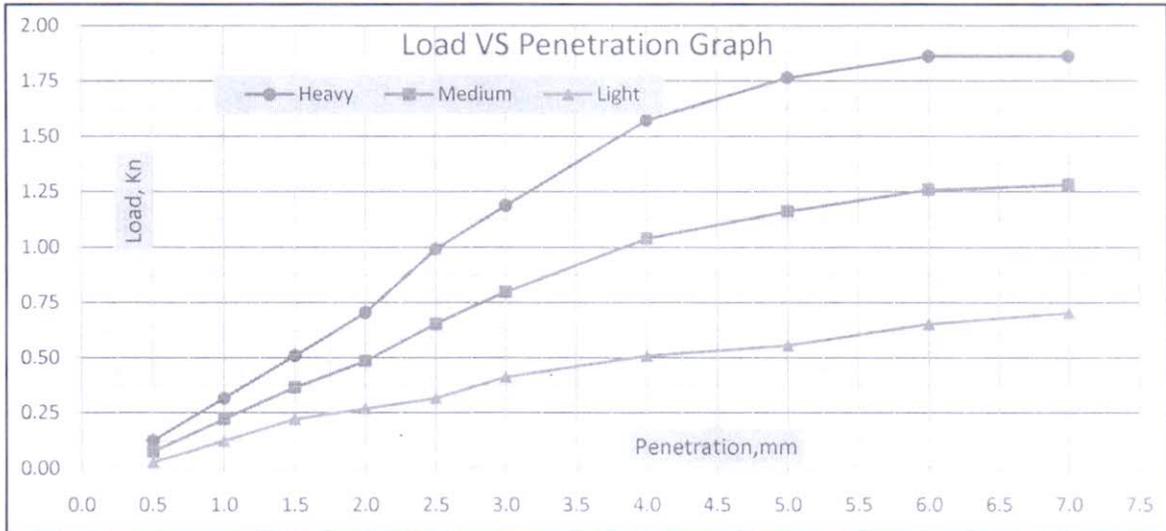
Paikpara, Mirpur, Dhaka, Bangladesh

| California Bearing Ratio Test (AASHTO T193) | | | |
|--|---|-------------------|-------------|
| Memo No | | Date | |
| Client | | | |
| Project / Work | | | |
| Location | Bhanga – Faridpur (Goalchamat) Road, N 804 (12Km From Faridpur) | | |
| Date of receive at lab | | Date of test | 7-11/5/2017 |
| Sample Description | | Quantity Supplied | |
| Name of Agency | | | |

CBR Calculation

CBR:3/3

| | | | |
|-----------------|------------|------------------|--|
| Compaction Date | 18-05-2017 | Penetration Date | |
|-----------------|------------|------------------|--|



| Penetration, mm | Heavy | | | | Load, Medium | | | | Load, Light | | | |
|---------------------|-------------------------|-----|----------------------|-----|------------------|-----|----------|-----|-------------|-----|------|-----|
| | Load | CBR | Load | CBR | Load | CBR | Load | CBR | Load | CBR | Load | CBR |
| 2.540 | 1.000 | 7.5 | 0.62 | 4.6 | 0.31 | 2.3 | | | | | | |
| 5.080 | 1.750 | 8.8 | 1.12 | 5.6 | 0.56 | 2.8 | | | | | | |
| Note: (AASHTO T193) | Standard penetration at | | Standard Stress, Kpa | | Plunger Area, m2 | | Load, KN | | | | | |
| | 2.54 mm | | 6900 | | 0.001935 | | 13.352 | | | | | |
| | 5.08 mm | | 10300 | | 0.001935 | | 19.931 | | | | | |

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Bangladesh Road Research Laboratory, RHD

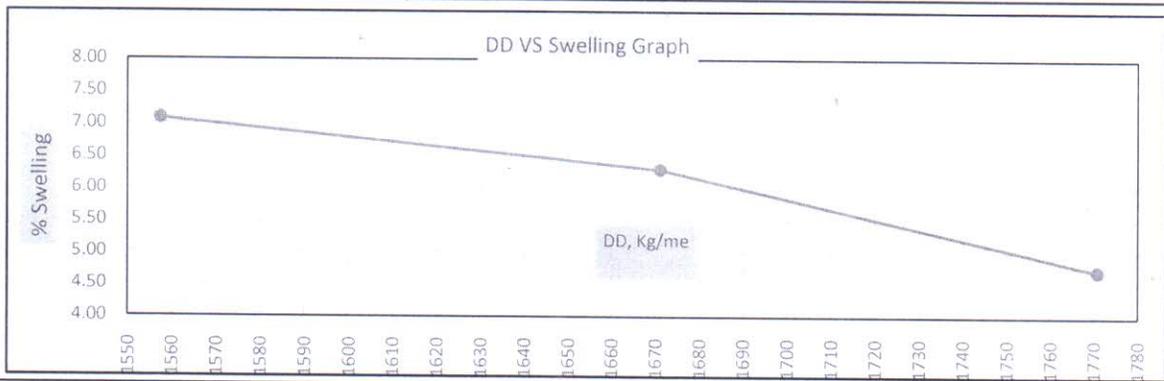
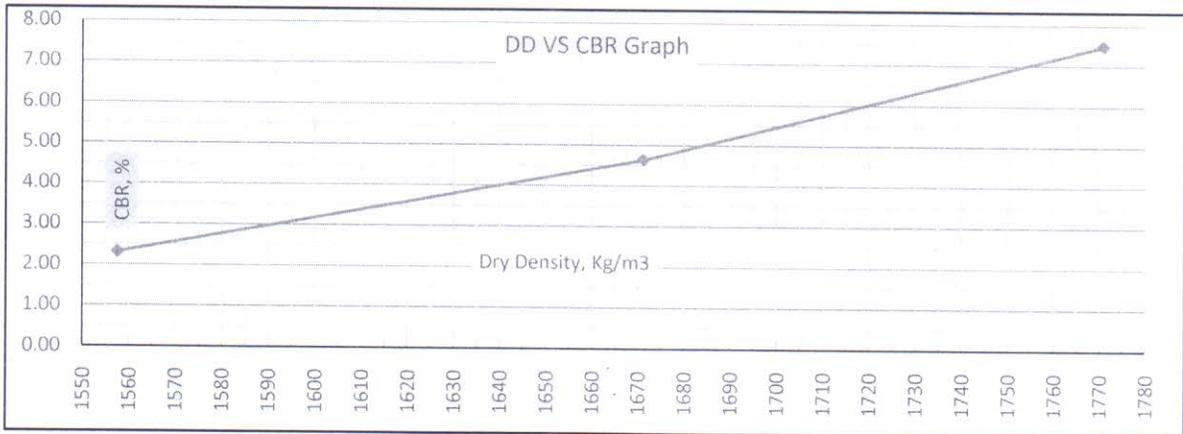
Paikpara, Mirpur, Dhaka, Bangladesh

| California Bearing Ratio Test (AASHTO T193) | | | |
|--|---|-------------------|-------------|
| Memo No | | Date | |
| Client | | | |
| Project / Work | | | |
| Location | Bhanga - Faridpur (Goalchamat) Road, N 804 (12Km From Faridpur) | | |
| Date of receive at lab | | Date of test | 7-11/5/2017 |
| Sample Description | | Quantity Supplied | |
| Name of Agency | | | |

CBR Calculation

CBR:2/4

| Compaction Date | | 18-05-2017 | | Penetration Date | | 5/0/2017 | | | |
|-------------------------------------|---------------|------------|---------|-------------------------|-------|---------------|-----------------------|-----|----------------|
| Dry Density (kg/m ³) | % com'tion | CBR | Sw'ling | Proctor Information | | % Com'tion | DD, Kg/m ³ | CBR | Swelling, % |
| 1771 | 99.5 | 7.49 | 4.72 | OMC (%) | 12.50 | 93 | 1655 | 4.3 | 6.5 |
| 1671 | 93.9 | 4.64 | 6.30 | MDD(kg/m ³) | 1780 | 95 | 1691 | 5.3 | 6.0 |
| 1558 | 87.5 | 2.32 | 7.09 | | | 98 | 1744 | 6.5 | 5.5 |



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(RHD)

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Road Research Laboratory, Mirpur, Dhaka

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD

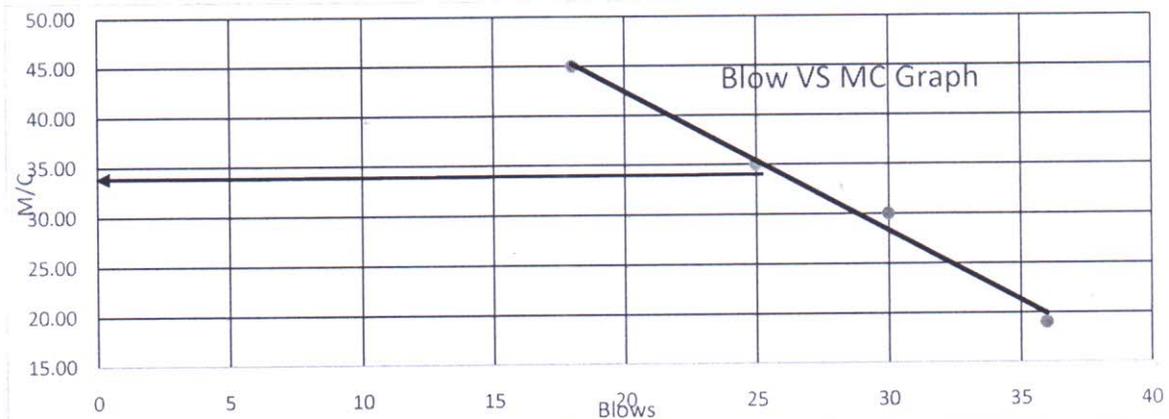
Paikpara, Mirpur, Dhaka, Bangladesh

| Atterberg Limits (Casagrande method) (Data and Report Sheet) | | | |
|--|---|-------------------|----------|
| AASHTO T89 (LL) & T90 (PL) | | | |
| Memo No | | Date | |
| Client | | | |
| Project / Work | | | |
| Location | Bhanga – Faridpur (Goalchamat) Road, N 804 (12Km From Faridpur) | | |
| Date of receive at lab | | Date of test | 4-May-17 |
| Sample Description | | Quantity Supplied | |
| Name of Agency | RHD | | |

Laboratory Work

| Atterberg Limits | | PL(A2) | | LL(A2) | | | |
|-------------------------------|-------------|--------|-------|-------------|-------|-------|-------|
| Can # | | 50 | 17 | 5 | 56 | 35 | 58 |
| Blow No | | | | 36 | 30 | 25 | 18 |
| Wt. of container, gm | a | 1.70 | 1.66 | 1.69 | 1.67 | 1.68 | 1.71 |
| Wt. of container+wet soil, gm | b | 6.33 | 8.70 | 13.59 | 21.17 | 20.98 | 24.76 |
| Wt. of container+dry soil, gm | c | 5.74 | 7.80 | 11.69 | 16.67 | 15.98 | 17.61 |
| Wt. of moisture, gm | d=b-c | 0.59 | 0.90 | 1.90 | 4.50 | 5.00 | 7.15 |
| Wt. of dry soil, gm | e=c-a | 4.04 | 6.14 | 10.00 | 15.00 | 14.30 | 15.90 |
| m/c, % | m = d/e*100 | 14.60 | 14.66 | 19.0 | 30.0 | 35.0 | 45.0 |
| Average, M/C | | 15 | | | | | |
| Nos of taps | | | | LL @25 blow | | | |
| PL | | PL= | 15 | LL= | 35.00 | PI= | 20 |

ISG material " NP)



Tested By

Remarks

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(RHD)

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(RHD)

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(RHD)

Material Testing & Maintenance Division
Road Research Laboratory, Mirpur, Dhaka

Photos of damaged pavement surface

1. This point is 12Km from Faripur (12' central), B.carpeting=75mm to 150mm, Macadam=100mm, HBB+Soling =200mm on Soil



2. Longitudinal cracks, crack along the road and crack between carriage and extension part



3. Heavy traffic passing (Bakhunda), Severe depression, at ch 23+00 (300m damaged surface)



4. Basargari Area (Severe Damage, Depression) and Embankment height around 6m



5. At ch 11+800 (Basargari), DBS(WC)>50mm, Base Type-1=200mm



6. Basargari area was repaired recently



Annexure 2: Laboratory test report and photos of Road Z 8404

BORE HOLE LOG



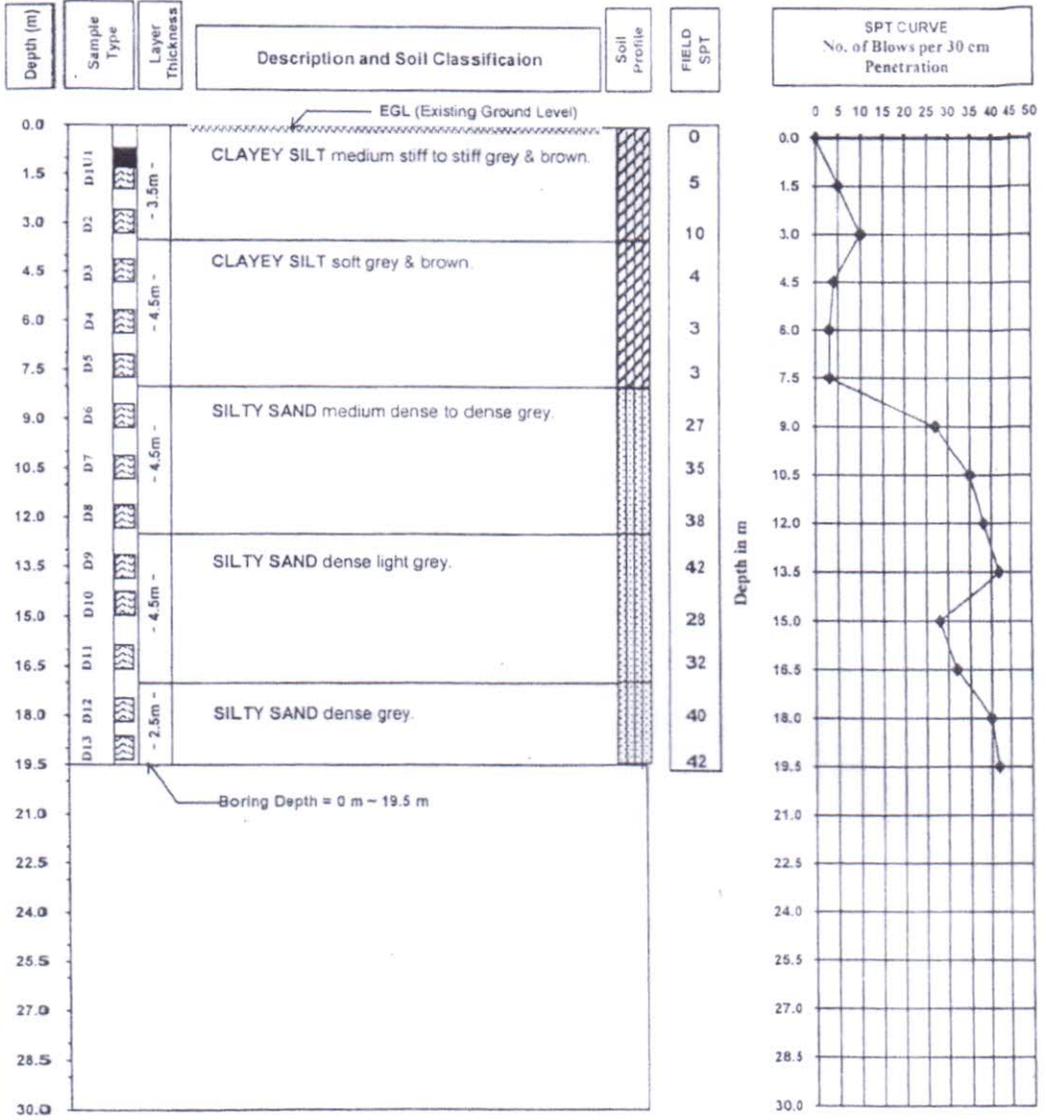
CLIENT : R. H. D. , Faridpur
 PROJECT : Bhanga-Faridpur National Highway Road (Z-8404)
 LOCATION : Talma Nagarkanda Road, Faridpur.

ch. 8+332

BORE HOLE # 01

Start Date : 13.04.17 R. L. : (-) 0.00 m From Road Level
 Finish Date : 13.04.17 W. L. : (-) 1.50 m From EGL.

Drilling Method: Wash Boring Method
 Executed by:



- Disturbed Sample (D)
- CLAY
- SAND
- SILTY CLAY
- SILTY SAND
- Undisturbed Sample (U)
- SILT
- RUBBISH
- CLAYEY SILT

FIGURE 02

প্রতিস্বাক্ষরিত

Signature

মোঃ মাসুদুর রহমান
 পরিচিতি নং: ৩০০২২২
 উপসহকারী প্রকৌশলী (সি.এস.), সড়ক
 সড়ক বিভাগ, ফরিদপুর।

প্রতিস্বাক্ষরিত

Signature

(মোহাম্মদ জাহাঙ্গীর আলম)
 পরিচিতি নং: ৬০১৯২৯
 নির্মাতা প্রকৌশলী, সড়ক
 সড়ক বিভাগ, ফরিদপুর।

BORE HOLE LOG

EES

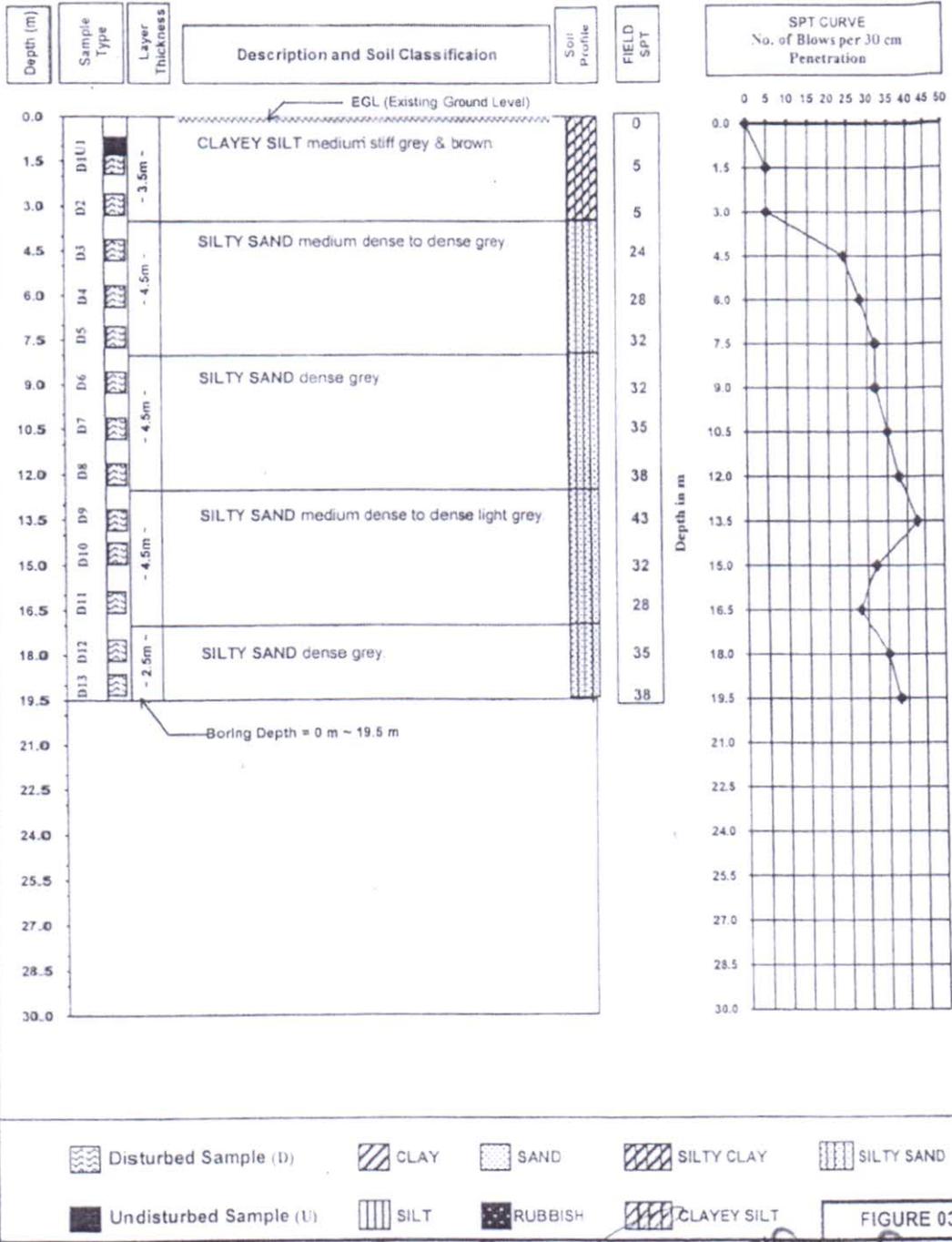
CLIENT : R. H. D. , Faridpur
 PROJECT : Bhanga-Faridpur National Highway Road (Z-8404)
 LOCATION : Talma Nagarkanda Road, Faridpur.

EL. 5+662

BORE HOLE # 02

Start Date : 13.04.17 R. L. : (-) 0.00 m From Road Level
 Finish Date : 13.04.17 W. L. : (-) 1.50 m From EGL.

Drilling Method: Wash Boring Method
 Executed by:



- Disturbed Sample (D)
- CLAY
- SAND
- SILTY CLAY
- SILTY SAND
- Undisturbed Sample (U)
- SILT
- RUBBISH
- CLAYEY SILT

প্রতিস্বাক্ষরিত

30/04/17

মোঃ মাসুদুল রহমান
 পরিচালক (সি.এস.)
 জাতীয় সড়ক কর্তৃক পরিচালিত
 সড়ক ও জনস্বাস্থ্য বিভাগ, ঢাকা

প্রতিস্বাক্ষরিত

(মোহাম্মদ জাহাঙ্গীর আলম)
 পরিচালক (সি.এস.)
 জাতীয় সড়ক কর্তৃক পরিচালিত
 সড়ক ও জনস্বাস্থ্য বিভাগ, ঢাকা

Particle Size Analysis Report

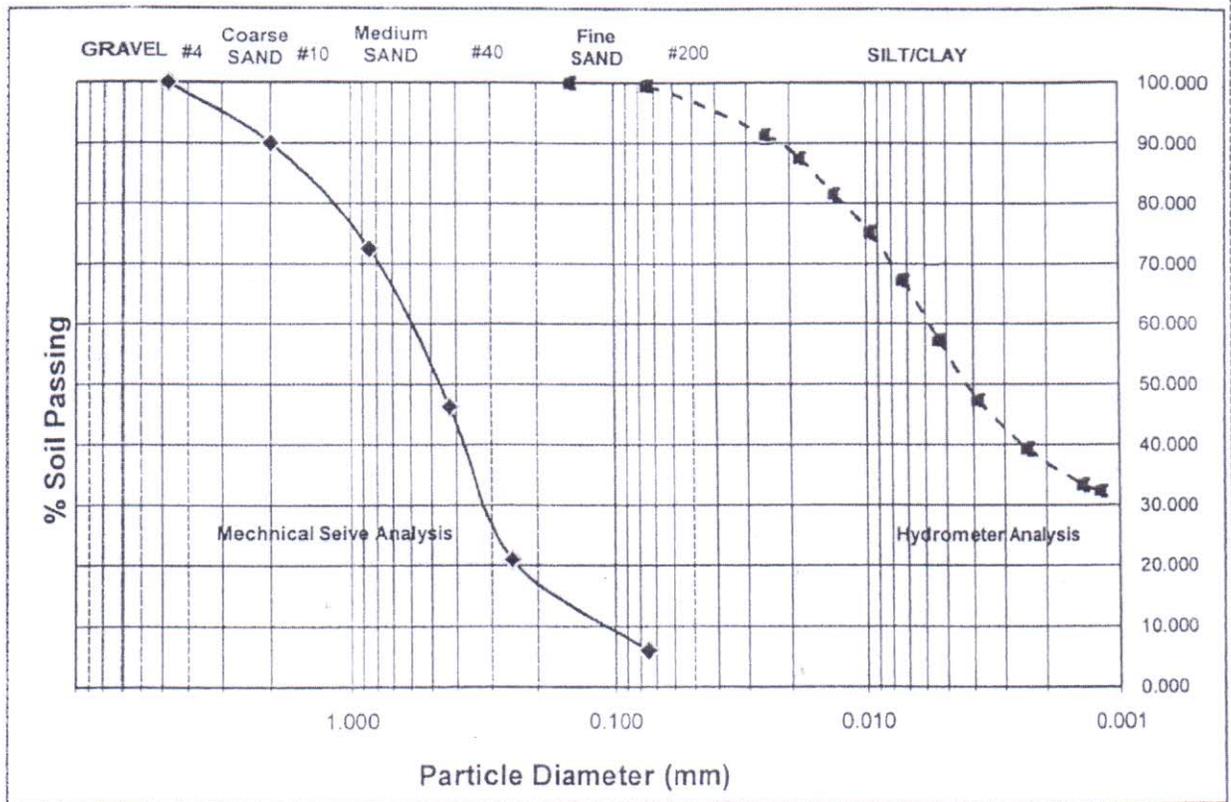
As Per ASTM D422-63 (2007)

EES

Client : R. H. D. , Faridpur
 Project Name: Bhanga-Faridpur National Highway Road (Z-8404)
 Location : Talma Nagarkanda Road, Faridpur.
 Boring No : BH-02 Ch. 9+662 Tested By : Engr. Sohel Test Number : 2
 Sample Depth: (-) 3.00 m (-) 15.00 m Checked By : Engr. Samir Date : _____

USCS Soil Classification: SW - Well Graded Sand

Weight of Container : 400.0 gm Weight of Container & Soil : 762.0 gm
 Weight of Dry Sample : 362.0 gm Specific Gravity of Soil : 2.65



Grain Size Distribution Curve Results:

| | | | | | |
|------------|------|-------------------|-------|------------------|-------|
| % Gravel : | 0.0 | D ₁₀ : | 0.122 | C _u : | 5.305 |
| % Sand : | 94.0 | D ₃₀ : | 0.313 | C _c : | 1.235 |
| % Fines : | 6.0 | D ₆₀ : | 0.648 | | |

Atterberg Limit Results :

| | | | | | |
|------|----|------|----|------|----|
| LL : | 45 | PL : | 19 | PI : | 26 |
|------|----|------|----|------|----|

প্রতিশ্রুত

প্রতিশ্রুত

30/05/17

মোঃ মাসুদুল রহমান
 পরিচিতি নং- ৩০০২২২
 উপ-নির্বাহী প্রকৌশলী (সি.এস.), সওজ
 সড়ক ও জন-সেবা-২, ফরিদপুর।

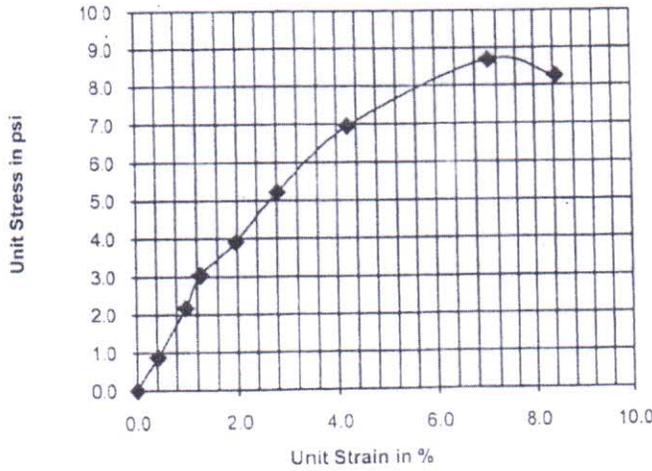
(মোহাম্মদ জাহাঙ্গীর আলম)
 পরিচিতি নং- ৬০১৯২৯
 নির্বাহী প্রকৌশলী, সওজ
 সড়ক বিভাগ, ফরিদপুর।

CLIENT: R. H. D., Faridpur
 PROJECT: Bhangra-Faridpur National Highway Road (Z-8404)
 LOCATION: Taima Nagarkanda Road, Faridpur.



UNCONFINED COMPRESSION TEST

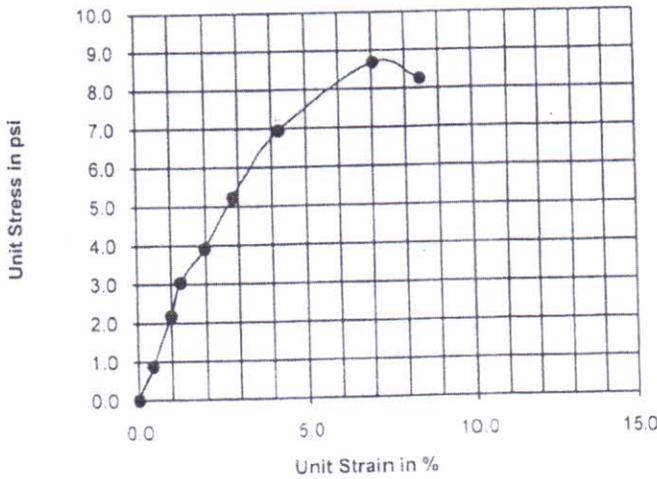
ch. 8+992



| | |
|---------------------------|---------------|
| Bore Hole Location | BH - 1 |
| Sample ID | UD-1 |
| Depth (m) | 0.90-1.35 |

Unconfined Compressive Strength, $q_u = 8.69$ psi
 $c = q_u/2 = 4.35$ psi
 Strain at Max Stress, $\epsilon = 7.042\%$
 Soil Unit weight, $\gamma_{sat} = 118.0$ pcf
 Dry Unit weight, $\gamma_{dry} = 92.3$ pcf
 Moisture Content, $w = 27.8\%$

ch. 9+662



| | |
|---------------------------|---------------|
| Bore Hole Location | BH - 2 |
| Sample ID | UD-1 |
| Depth (m) | 0.90-1.35 |

Unconfined Compressive Strength, $q_u = 8.69$ psi
 $c = q_u/2 = 4.35$ psi
 Strain at Max Stress, $\epsilon = 7.042\%$
 Soil Unit weight, $\gamma_{sat} = 118.0$ pcf
 Dry Unit weight, $\gamma_{dry} = 91.0$ pcf
 Moisture Content, $w = 29.7\%$

Job Done: Engr. Samir K. Sutradhar
 B.Sc. in Civil Engg. (BUET)
 Mob: 01683586089

Fig: 6

প্রতিস্বাক্ষরিত

১০/৩০/১৭

মোঃ মাসুদুর রহমান
 পরিচিতি নং- ৩০০২২২
 উপ-বিভাগীয় প্রকৌশলী (সি.এস.), সড়ক
 সড়ক বিভাগ, ফরিদপুর।

প্রতিস্বাক্ষরিত

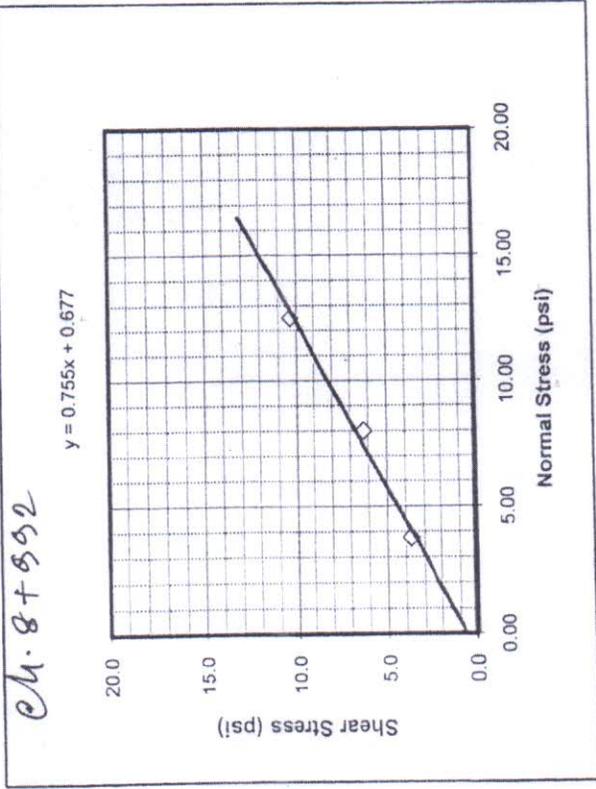
(মোঃমুহম্মদ জাহাঙ্গীর আলম)
 পরিচিতি নং- ৬০১৯২৯
 নির্বাহী প্রকৌশলী, সড়ক
 সড়ক বিভাগ, ফরিদপুর।

CLIENT : R. H. D. , Faridpur
 PROJECT : Bhanga-Faridpur National Highway Road (Z-8404)
 LOCATION : Talma Nagarkanda Road, Faridpur.

Direct Shear Test

BORE HOLE : BH-01 DEPTH 12.0 m

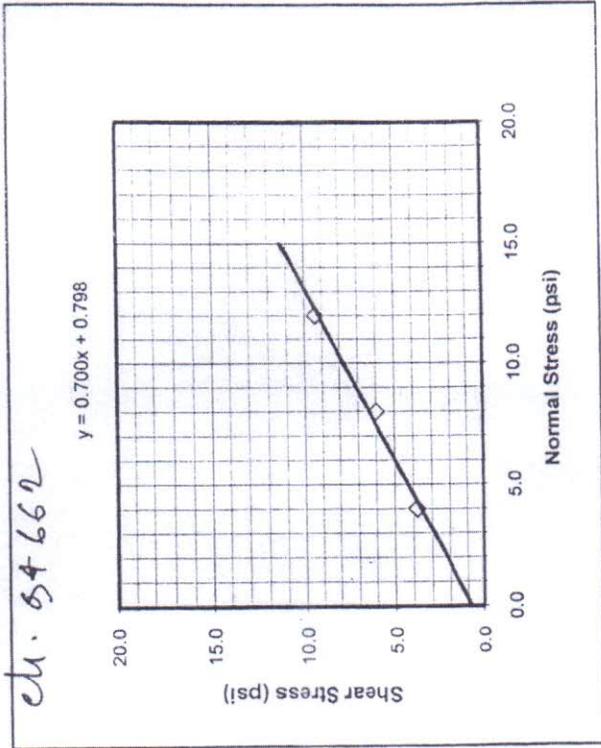
BORE HOLE : BH-02 DEPTH 15.0 m



| | |
|------------------|------|
| Shearing Angle | 37° |
| Cohesion c (psi) | 0.68 |

Job Done: Engr. Samir K. Sutradhar
 B.Sc. in Civil Engg. (BUET)

প্রতিস্বাক্ষরিত
 ১০/১০/১৭
 ১০১৪ মাসপুর গ্রহমান
 পরিচিতি নং- ১০০২২২
 উপ-বিভাগীয় প্রকৌশলী (সি.এম.), সড়ক
 সড়ক উপ-বিভাগ, ২, তরলপুর।



| | |
|------------------|------|
| Shearing Angle | 35° |
| Cohesion c (psi) | 0.80 |

EVIDENT ENGINEERING SOLUTION

Figure : 07 মোহাম্মদ জাহাঙ্গীর আলম
 পরিচিতি নং- ৩০১৯২৯
 নির্বাহী প্রকৌশলী, সড়ক
 সড়ক বিভাগ, ফারিদপুর।

প্রতিস্বাক্ষরিত
 ১০/১০/১৭

Photos of damaged pavement surface

1. Road central area settled by $>150\text{mm}$ (Sosa area, CH-7+200)



2. High embankment ($>6\text{m}$) at both side of Sosa area
Water ingresses through central settlement area accelerating damages
Heavy loaded vehicle passing this area.



Annexure 3: Laboratory test report and photos of Road Z 8406

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD

Paikpara, Mirpur, Dhaka, Bangladesh

| Test Summary (Z 8406) | | | |
|-----------------------|---------------------|---------------|----------------|
| Test Parameters | Value | Limits | Remarks |
| Gradation Base-T1 | Test Sheet enclosed | Out of limits | % finer higher |
| Gradation Sub Base | Test Sheet enclosed | Out of limits | |

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD

Paikpara, Mirpur, Dhaka, Bangladesh

| Base Gradation, Type-A, (Data and Report Sheet) | | | | | | | | | |
|--|-----------------|-------------------|-----------------------|-----------|--------------|-------------------|----------|--|--|
| Memo No | | | | | | Date | | | |
| Client | | | | | | | | | |
| Project / Work | | | Faridpur Bypass | | | | | | |
| Location | | | 1+900 (LHS) | | | | | | |
| Date of receive at lab | | | 25-Apr-17 | | Date of test | | 3-May-17 | | |
| Sample Description | | | Base-1, Gradation | | | Quantity Supplied | | | |
| Name of Agency | | | RHD | | | | | | |
| Laboratory Work | | | | | Test Code | | STP 7.2 | | |
| Dry mass of material, gm | | | 6945 | | | | | | |
| | Material wt, gm | Cumulative wt, gm | Cumulative % retained | % Passing | Sp. L.LM | Sp. ULM | | Remarks | |
| 50.00 | 0 | 0 | 0 | 100.0 | 100 | 100 | | Gradation out of limits (Sand & Shingles mixture). | |
| 38.00 | 0 | 0 | 0 | 100.0 | 90 | 100 | | | |
| 20.00 | 1055 | 1055 | 15.191 | 84.8 | 50 | 85 | | | |
| 10.00 | 2222 | 3277 | 47.185 | 52.8 | 30 | 65 | | | |
| 5.00 | 228 | 3505 | 50.468 | 49.5 | 25 | 50 | | | |
| 2.40 | 312 | 3817 | 54.96 | 45.0 | 15 | 38 | | | |
| 0.60 | 284 | 4101 | 59.05 | 41.0 | 8 | 22 | | | |
| 0.30 | 218 | 4319 | 62.189 | 37.8 | 6 | 16 | | | |
| 0.08 | 1854 | 6173 | 88.884 | 11.1 | 2 | 8 | | | |
| Pan | 772 | | | | | | | | |

Base Gradation-A

Tested By

Remarks

ARO

AE

SDE

EE

(RHD)

(RHD)

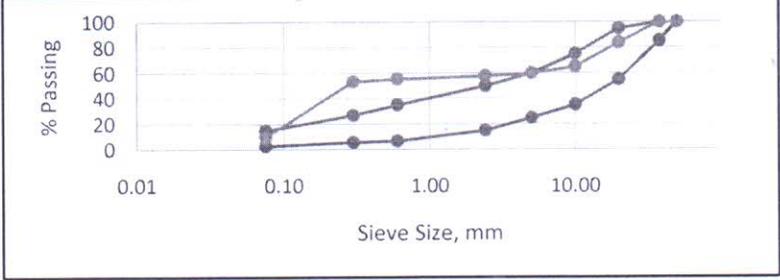
(RHD)

(RHD)

| |
|--|
| Material Testing & Maintenance Division |
| Road Research Laboratory, Mirpur, Dhaka |

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD
Paikpara, Mirpur, Dhaka, Bangladesh

| Sub-Base Gradation, Type-A, (Data and Report Sheet) | | | | | | | | | |
|--|-----------------|-------------------|-----------------------|-----------|----------------------|---------|-------|----------|------------|
| Memo No | | | | | Date | | | | |
| Client | | | | | | | | | |
| Project / Work | | | | | Faridpur Bypass | | | | |
| Location | | | | | 1+900 (LHS) | | | | |
| Date of receive at lab | | | 25-Apr-17 | | Date of test | | | 3-May-17 | |
| Sample Description | | | Sub base, Gradation | | Quantity Supplied | | | | |
| Name of Agency | | | | | RHD | | | | |
| Laboratory Work | | | | | Test Code | | 7.2 | | |
| Dry mass of material, gm | | | 1610 | | | | | | |
| | Material wt, gm | Cumulative wt, gm | Cumulative % retained | % Passing | Sp. LLM | Sp. ULM | JMLLM | JMUL | Remarks |
| 50.00 | 0 | 0 | 0 | 100.0 | 100 | 100 | | | Brick Agg. |
| 38.00 | 0 | 0 | 0 | 100.0 | 85 | 100 | | | |
| 20.00 | 265 | 265 | 16.46 | 83.5 | 55 | 95 | | | |
| 10.00 | 300 | 565 | 35.093 | 64.9 | 35 | 75 | | | |
| 5.00 | 78 | 643 | 39.938 | 60.1 | 25 | 60 | | | |
| 2.40 | 40 | 683 | 42.422 | 57.6 | 15 | 50 | | | |
| 0.60 | 36 | 719 | 44.658 | 55.3 | 7 | 35 | | | |
| 0.30 | 30 | 749 | 46.522 | 53.5 | 6 | 27 | | | |
| 0.08 | 705 | 1454 | 90.311 | 9.7 | 3 | 15 | | | |
| Pan | 156 | | | | | | | | |
|  | | | | | Sub-Base Gradation-A | | | | |

Tested By

Remarks

| | | | |
|--|-------|-------|-------|
| ARO | AE | SDE | EE |
| (RHD) | (RHD) | (RHD) | (RHD) |
| Material Testing & Maintenance Division | | | |
| Road Research Laboratory, Mirpur, Dhaka | | | |

Photos of damaged pavement surface

1. Shoulder area sliding



2. Heavy loaded truck passing



3. Depression area: At chainage 1+900, depression on side by $> 150\text{mm}$



4. Settlement area and Longitudinal crack area



5. Asphalt core sampling.



6. Core thickness is >120mm



Annexure 4: Photos of Road R 860

Photos of damaged pavement surface

1. Damaged pavement



2. Damaged pavement



3. Damaged pavement



Annexure 5: Laboratory test report and photos of Road N 8

5

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Bangladesh Road Research Laboratory, RHD

Paikpara, Mirpur, Dhaka, Bangladesh

Test Summary, N 8

| SI No | Layer Type | Parameters | Result | Comments |
|-------|----------------|------------|----------|------------|
| 1. | Sub Base | ACV | 35.4 | <38 OK |
| 2. | Sub grade soil | LL | 47.5 | < 50 , Ok |
| | | PI | 22.4 | >15 Not OK |
| 3. | Sub Base | Gradation | Attached | OK |

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Bangladesh Road Research Laboratory, RHD

Paikpara, Mirpur, Dhaka, Bangladesh

| Aggregate Crushing and 10% Fines Value (Data and Report Sheet) | | | | | | |
|---|---------------------------------------|--------------------|-----------|--------------------------------|---------|--------------|
| Memo No | | | Date | | | |
| Client | | | | | | |
| Project / Work | | | | | | |
| Location | 3+000(From here to Takerhat 3Km), N8 | | | | | |
| Date of receive at lab | 27-Apr-17 | Date of test | 2-May-17 | | | |
| Sample Description | Sub base Material | Quantity Supplied | 8Kg | | | |
| Name of Agency | RHD | | | | | |
| Laboratory Work | | | Test Code | BS 812: Part 110: 1990, STP7.7 | | |
| Description | Unit | Notation / Formula | Load -1 | Load -2 | Load -3 | Load - 4 |
| Applied Force | KN | | | | | 400 |
| Mass of Original test specimen(Dry) | g | M_1 | | | | 1604 |
| Mass of Material passing 2.36mm sieve | g | M_2 | | | | 568 |
| Mass of Material retained on 2.36mm sieve | g | M_3 | | | | 1036 |
| Mass passing and retained on 2.36mm sieve | g | $M_2 + M_3$ | | | | 1604 |
| % Fines | % | $(M_2/M_1)*100$ | | | | 35.4 |
| ACV(400KN) | % | | 35.4 | | | ACV < 38% OK |

Note: Fraction tested 14mm to 10mm, Separating sieve 2.36mm

Tested By

Counter Signed by

Md. Nazimuddin
Assistant Research Officer

Jannat-E-Neehar
Assistant Engineer

Md. Tanveer Hussein
Sub Divisional Engineer

Mohammad Bulbul Hossain
Executive Engineer

(RHD)

(RHD)

(RHD)

(RHD)

| |
|--|
| Material Testing & Maintenance Division Road Research Laboratory, Mirpur, Dhaka |
|--|

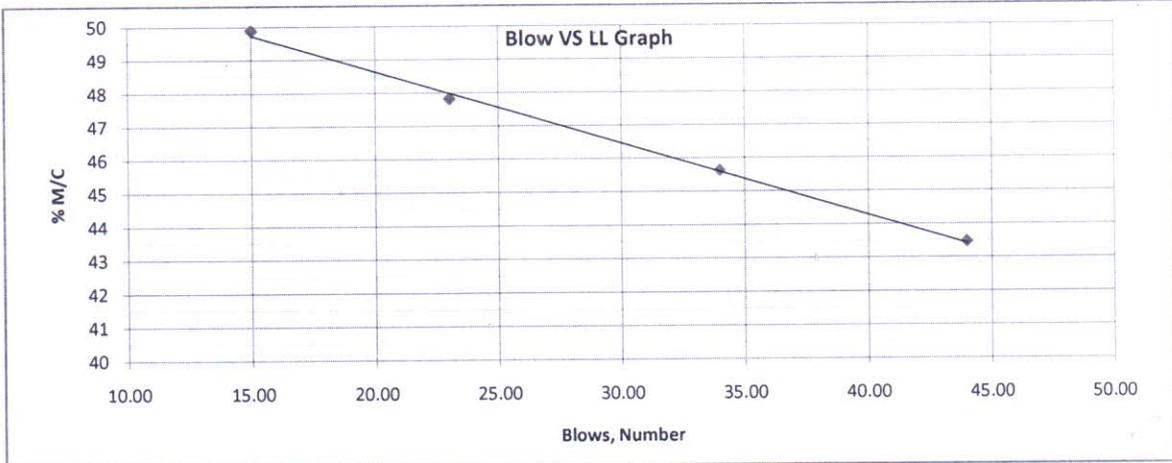
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Bangladesh Road Research Laboratory, RHD

Paikpara, Mirpur, Dhaka, Bangladesh

| Atterberg Limits (Casagrande method) (Data and Report Sheet) | | | |
|---|----------------------------|-------------------|----------|
| AASHTO T89 (LL) & T90 (PL) | | | |
| Memo No | | Date | |
| Client | | | |
| Project / Work | | | |
| Location | 3+000 (Sub grade Soil), N8 | | |
| Date of receive at lab | 27-Apr-17 | Date of test | 7-May-17 |
| Sample Description | Atterberg Limit | Quantity Supplied | 2Kg |
| Name of Agency | RHD | | |

| Laboratory Work | | | | | | | |
|---|-------------|------------|-------------|------------|-------------|------------|-------------|
| Atterberg Limits | | PL(A2) | | LL(A2) | | | |
| Can # | | 56 | 35 | 49 | 5 | 76 | 2 |
| Wt. of container, gm | a | 1.65 | 1.68 | 1.68 | 1.67 | 1.70 | 1.67 |
| Wt. of container+wet soil, gm | b | 5.35 | 5.09 | 14.52 | 15.81 | 17.87 | 19.40 |
| Wt. of container+dry soil, gm | c | 4.67 | 4.35 | 10.63 | 11.38 | 12.64 | 13.50 |
| Wt. of moisture, gm | d=b-c | 0.68 | 0.74 | 3.89 | 4.43 | 5.23 | 5.90 |
| Wt. of dry soil, gm | e=c-a | 3.02 | 2.67 | 8.95 | 9.71 | 10.94 | 11.83 |
| m/c, % | m = d/e*100 | 22.52 | 27.72 | 43 | 46 | 48 | 50 |
| PL, Average, M/C | | 25.12 | | | | | |
| Nos of taps | | | | 44 | 34 | 23 | 15 |
| Note: M/C at 25 blows is the Liquid Limit, PI=LL-PL | | PL= | 25.1 | LL= | 47.5 | PI= | 22.4 |



Tested By

Remarks

ARO
(RHD)

AE
(RHD)

SDE
(RHD)

EE
(RHD)

| |
|--|
| Material Testing & Maintenance Division |
| Road Research Laboratory, Mirpur, Dhaka |

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Bangladesh Road Research Laboratory, RHD
Paikpara, Mirpur, Dhaka, Bangladesh

| Sub-Base Gradation, Type-A, (Data and Report Sheet) | | | | | | | | | | |
|--|---------------------|----------------------|-------------------------------|-----------|----------------------|---------|---------|-------------------|-------------------------|----------|
| Memo No | | | | | Date | | | | | |
| Client | | | | | | | | | | |
| Project / Work | | | | | | | | | | |
| Location | | | | | 3+000(LHS), N8 | | | | | |
| Date of receive at lab | | | | | 27-Apr-17 | | | Date of test | | 2-May-17 |
| Sample Description | | | | | Sub base Gradation-A | | | Quantity Supplied | | 8Kg |
| Name of Agency | | | | | RHD | | | | | |
| Laboratory Work | | | | | Test Code | | STP 7.2 | | | |
| Dry mass of material, gm | | | 3880 | | | | | | | |
| | Material wt , gm | Cumulative wt, gm | Cumulative e % retained | % Passing | Sp. L.LM | Sp. ULM | JMLLM | JMUL | Remarks | |
| 50.00 | 0 | 0 | 0 | 100.0 | 100 | 100 | | | 3rd Class Brick Agg. | |
| 38.00 | 438 | 438 | 11.289 | 88.7 | 85 | 100 | | | | |
| 20.00 | 356 | 794 | 20.464 | 79.5 | 55 | 95 | | | | |
| 10.00 | 908 | 1702 | 43.866 | 56.1 | 35 | 75 | | | | |
| 5.00 | 485 | 2187 | 56.366 | 43.6 | 25 | 60 | | | | |
| 2.40 | 376 | 2563 | 66.057 | 33.9 | 15 | 50 | | | | |
| 0.60 | 404 | 2967 | 76.469 | 23.5 | 7 | 35 | | | | |
| 0.30 | 108 | 3075 | 79.253 | 20.7 | 6 | 27 | | | | |
| 0.08 | 517 | 3592 | 92.577 | 7.4 | 3 | 15 | | | | |
| Pan | | | | | | | | | | |

Sub-Base Gradation-A

Sub-Base Gradation-A

Tested By
Remarks

ARO
(RHD)

AE
(RHD)

SDE
(RHD)

EE
(RHD)

Material Testing & Maintenance Division
Road Research Laboratory, Mirpur, Dhaka

Photos of damaged pavement surface

1. At Taker hat (LHS), B/Carpeting=70mm, Sub base=100mm, ISG>400mm



2. At Taker hat (LHS), Bituminous Carpeting = 30-40 mm, Sub Base=120mm, ISG =200mm and more



Photos of damaged pavement surface

1. One side is settled by 75mm (5Km away from Bhanga)



2. Structure approach settlement/damage



3. Settlement at culvert approach



Annexure 7: Photos of Road Z 8603

Photos of damaged pavement surface

1. Depression of the road at some places are 200mm or more.



Annexure 8: Photos of Road Z 8604

Photos of damaged pavement surface

1. 18Km away from Bhurghata



Annexure 9: Photos of Road N 805

(ch. 24+000 to ch. 64+000)

Photos of damaged pavement surface

1. Crack/depression/damages at ch 20+00 to ch 55+00Km



2. Longitudinal crack/carrigeway depression



3. Shoulder settlement ranging 50mm to 75mm



4. Settlement/Crack



5. At ch 20+00 to ch 55+00 scenario is more or less same



**Annexure 10: Laboratory test report and photos of Road N 507
(Sirajganj part)**

Contents

1. Observation and comment
2. Summary of test reports
3. Asphalt wc Gradation 40- 50 mm
4. Asphalt Base Gradation 60-75, 40-60 m
5. Gradation Base-1
6. Gradation Base – 1 & Sub Base mixture
7. Gradation Sub Base
8. Gradation ISG 2.8, 1.5 – 2.8
9. Gradation ISG. 1-1.5, 0.8-1.0
10. LAA (Base Type – 1)
11. Photo of the material during test

SUMMARY OF THE INVESTIGATION (Material Tests)

Hatikamrul-Bonpara(Sirajgonj Part): N 507

| SI No | Layer Type | Parameters | Result | Comments | |
|---|---------------------------------|--|----------|-----------------------------|-----------------|
| 1. | Bituminous W/C 40-50 | Gradation | Enclosed | Out of limits | Not OK |
| | | Fracture faces | 78% | < 90 % | Not Ok |
| | | % Bitumen | 5 | | Limit not known |
| 2. | If DBS (60-70) Base Course | Gradation | Enclosed | Out of limits | Not OK |
| | | Gradation (Consultant) | Enclosed | | |
| | | Fracture faces | 73 | < 90 % | Not Ok |
| | | % Bitumen | 2.6 | | Limit not known |
| | If DBS (40-60) Base/W Course | % Bitumen(Consultant) | 6.72 | | |
| | | Gradation | Enclosed | Out of limits | Not OK |
| | | Gradation (Consultant) | Enclosed | | |
| | | Fracture faces | 73 | < 90 % | Not Ok |
| 3. | If Base Type-1 (A) | % Bitumen | 2.6 | 2.6 | Limit not known |
| | | % Bitumen(Consultant) | 7.53 | | |
| | | Gradation | Enclosed | Max ^m finer side | Within limits |
| | | Gradation (Consultant) | Enclosed | Max ^m finer side | Within limits |
| | If Base Type-1 (B) | Fracture faces | 77 | > 75 % | OK |
| | | Fracture faces(Consultant) | 75.4 | > 75 % | OK |
| | | LAA | 31 | ≤ 35% | OK |
| | | LAA (Consultant) | 31.8 | ≤ 35% | OK |
| 4. | Base & Sub Base Mixture | Gradation | Enclosed | ok but are on finer side | Ok |
| | | Fracture faces | | > 75 % | |
| | | | | | |
| 5. | If Sub base (A) | Gradation | Enclosed | Finer side | Ok |
| | | Gradation (Consultant) | Enclosed | | OK |
| | | Fracture faces | 77 | >50 % | OK |
| | | Fracture faces(Consultant) | 75 | >50 % | OK |
| | If Sub Base (B) | Gradation | Enclosed | OK other than 20mm sieve | Not Ok |
| | | Fracture faces | 77 | > 50 % | OK |
| 6. | ISG | ISG materials are mixture of coarse and fine sand/soil. We have done the gradation of this materials passing through 5.00mm sieve which do not comply with any zone of RHD specification may due to intrusion of soil slurry coming from bottom sub soil layers. | | | |
| 7. | Embankment soil | LL(Consultant) | 41 | ≤50 | Comply |
| | | PI(Consultant) | 18 | ≤25 | |
| “(Consultant)” for materials collected by the consultant and others are sent by the division and tested by the Consultant | | | | | |

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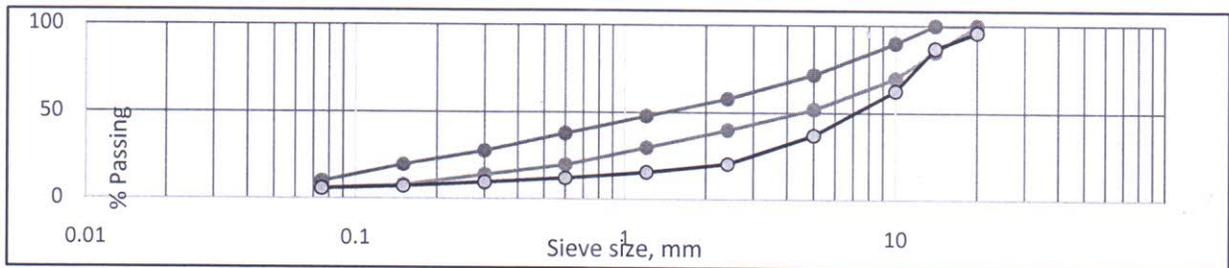
Bangladesh Road Research Laboratory, RHD

Paikpara, Mirpur, Dhaka, Bangladesh

Gradation Dense Bituminous Surfacing Agg (Wearing Course, 40-50mm thickness (Data and Report Sheet))

| | | | |
|------------------------|--|-------------------|-----------|
| Memo No | Ref.: R514/G-283/G-108/ 855(5) | Date | 2-Apr-17 |
| Client | Additional Chief Engineer, RHD, Rajshahi | | |
| Project / Work | PMP by DBS-Wearing Course 16+000 to 25+000(H-B-R), 0+000 to 8+200 K-Belkuchi(Z-5408)Road under Road Division . Sirajgoni (2015-2016). Technical help related | | |
| Location | 17+600 (N507) | | |
| Date of receive at lab | 10-Apr-17 | Date of test | 12-Apr-17 |
| Sample Description | DBS W/C-40-50mm | Quantity Supplied | 6 Kg |
| Name of Agency | RHD Rajshahi Zone, Rajshahi | | |

| Laboratory Work | | | | Test Code | | | |
|--------------------------|------------------|-------------------|---|-----------|-------|---------|--------------------------------|
| Dry mass of material, gm | | 500 | For 40-50 mm thickness DBS, Plant Method | | | | |
| Sieve Size mm | Material wt , gm | Cumulative wt, gm | Cumulative % retained | % Passing | S.LLM | S. ULIM | Remarks |
| 20 | 20 | 20 | 4 | 96 | 100 | 100 | Gradation out of limits |
| 14 | 45 | 65 | 13 | 87 | 85 | 100 | |
| 10 | 120.5 | 185.5 | 37 | 63 | 70 | 90 | |
| 5 | 128 | 313.5 | 63 | 37 | 52 | 72 | |
| 2.40 | 83 | 396.5 | 79 | 21 | 40 | 58 | |
| 1.20 | 25 | 421.5 | 84 | 16 | 30 | 48 | |
| 0.60 | 17 | 438.5 | 88 | 12 | 20 | 38 | |
| 0.30 | 13 | 451.5 | 90 | 10 | 14 | 28 | |
| 0.15 | 11.5 | 463 | 93 | 7 | 8 | 20 | |
| 0.075 | 8 | 471 | 94 | 6 | 6 | 10 | |
| Pan | | | | | | | |



| | | | | | | |
|--------------------|------------------------|---------|--------------------------------|--------------------------------|------------|------------|
| Fracture faces, % | Shingle (unbroken), gm | | 42.000 | Shingle (unbroken), % | | 22.3 |
| | Broken faces , gm | | 146.700 | Broken faces, % | | 78 |
| | Total, gm | | 188.700 | Not ok as less than 90% | | |
| Bitumen Extraction | Total sample, gm | 500.000 | Sample wt after extraction, gm | 476.0 | % Bitumen, | 5.0 |

Tested By

Remarks:

Assistant Research Officer

(RHD)

Assistant Engineer

(RHD)

Sub Divisional Engineer

(RHD)

Executive Engineer

(RHD)

Material Testing & Maintenance Division
Road Research Laboratory, Mirpur, Dhaka

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD

Paikpara, Mirpur, Dhaka, Bangladesh

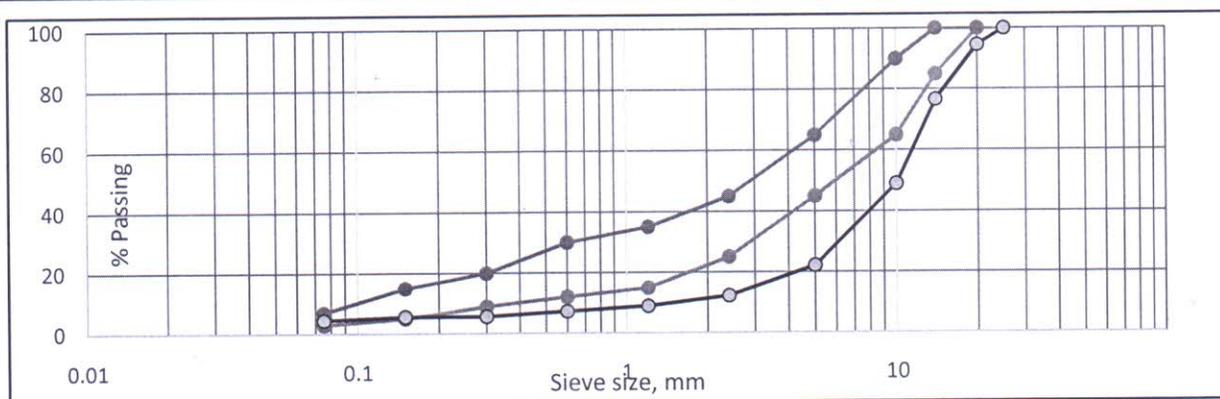
| DBS 60-70mm (Base), (Data and Report Sheet) | | | | | | | | |
|--|--|--------------------|---|-----------------------------------|------------|--------------------|--------------------------------|--|
| Memo No | Ref.: R514/G-283/G-108/ 855(5) | | | Date | 2-Apr-17 | | | |
| Client | Additional Chief Engineer, RHD, Rajshahi | | | | | | | |
| Project / Work | PMP by DBS-Wearing Course 16+000 to 25+000(H-B-R), 0+000 to 8+200 K-Belkuchi(Z-5408)Road under Road Division , Siraigoni (2015-2016). Technical help related | | | | | | | |
| Location | 17+600 (N507) | | | | | | | |
| Date of receive at lab | 10-Apr-17 | Date of test | 12-Apr-17 | | | | | |
| Sample Description | DBS-60-70mm | Quantity Supplied | 10 Kg | | | | | |
| Name of Agency | RHD Rajshahi Zone, Rajshahi | | | | | | | |
| Laboratory Work | | | | Test Code | | | | |
| Dry mass of material, gm | 500 | | For 60-70 mm thickness DBS, Plant Method | | | | | |
| Sieve Size mm | Material wt , gm | Cumulative wt, gm | Cumulative % retained | % Passing | S.LLM | S. ULIM | Remarks | |
| 25 | 0 | 0 | 0 | 100.0 | 100 | 100 | Gradation out of limits | |
| 20 | 26.5 | 26.5 | 5 | 94.7 | 90 | 100 | | |
| 10 | 228.5 | 255 | 51 | 49.0 | 55 | 82 | | |
| 5 | 134.0 | 389 | 78 | 22.2 | 35 | 57 | | |
| 2.4 | 50.0 | 439 | 88 | 12.2 | 20 | 40 | | |
| 1.2 | 16.0 | 455 | 91 | 9.0 | 15 | 33 | | |
| 0.6 | 8.5 | 463.5 | 93 | 7.3 | 10 | 26 | | |
| 0.3 | 8.0 | 471.5 | 94 | 5.7 | 6 | 20 | | |
| 0.15 | 0.7 | 472.2 | 94 | 5.6 | 5 | 13 | | |
| 0.075 | 5 | 477.2 | 95 | 4.6 | 3 | 7 | | |
| Pan | 22.8 | | | | | | | |
| | | | | | | | | |
| Remarks | Shingle (unbroken), gm | | 46.700 | Shingle (unbroken), % | | 26.5 | | |
| | Broken faces , gm | | 129.400 | Broken faces, % | | 73 | | |
| | Total, gm | | 176.100 | Not ok as as less than 90% | | | | |
| Bitumen Extraction | Total sample, gm | 500.000 | Sample wt after extraction, gm | 487.0 | % Bitumen, | 2.67 | | |
| Tested By | | | | | | | | |
| Remarks | | | | | | | | |
| Assistant Research Officer | | Assistant Engineer | | Sub Divisional Engineer | | Executive Engineer | | |
| (RHD) | | (RHD) | | (RHD) | | (RHD) | | |
| Material Testing & Maintenance Division | | | | | | | | |
| Road Research Laboratory, Mirpur, Dhaka | | | | | | | | |

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Paikpara, Mirpur, Dhaka, Bangladesh

| | | | |
|--|--|-------------------|-----------|
| DBS 40-60mm (B & W/C), (Data and Report Sheet) | | | |
| Memo No | Ref.: R514/G-283/G-108/ 855(5) | Date | 2-Apr-17 |
| Client | Additional Chief Engineer, RHD, Rajshahi | | |
| Project / Work | PMP by DBS-Wearing Course 16+000 to 25+000(H-B-R), 0+000 to 8+200 K-Belkuchi(Z-5408)Road under Road Division , Siraijoni (2015-2016), Technical help related | | |
| Location | 17+600 (N507) | | |
| Date of receive at lab | 10-Apr-17 | Date of test | 12-Apr-17 |
| Sample Description | DBS-40-60mm | Quantity Supplied | 10 Kg |
| Name of Agency | RHD Rajshahi Zone, Rajshahi | | |

| Laboratory Work | | | | Test Code | | | |
|--------------------------|------------------|-------------------|-----------------------|---|-------|---------|--------------------------------|
| Dry mass of material, gm | | 500 | | For 40-60 mm thickness DBS, Plant Method | | | |
| Sieve Size mm | Material wt , gm | Cumulative wt, gm | Cumulative % retained | % Passing | S.LLM | S. ULIM | Remarks |
| 25 | 0.0 | 0 | 0 | 100.0 | 100 | 100 | Gradation out of limits |
| 20 | 26.5 | 26.5 | 5 | 94.7 | 100 | 100 | |
| 14 | 90.0 | 116.5 | 23 | 76.7 | 85 | 100 | |
| 10 | 138.5 | 255 | 51 | 49.0 | 65 | 90 | |
| 5 | 134.0 | 389 | 78 | 22.2 | 45 | 65 | |
| 2.4 | 50.0 | 439 | 88 | 12.2 | 25 | 45 | |
| 1.2 | 16.0 | 455 | 91 | 9.0 | 15 | 35 | |
| 0.6 | 8.5 | 463.5 | 93 | 7.3 | 12 | 30 | |
| 0.3 | 8.0 | 471.5 | 94 | 5.7 | 9 | 20 | |
| 0.15 | 0.7 | 472.2 | 94 | 5.6 | 5 | 15 | |
| 0.075 | 5.0 | 477.2 | 95 | 4.6 | 3 | 7 | |
| Pan | 22.8 | | | | | | |



| | | | | | | |
|--------------------|------------------------|---------|--------------------------------|-------|------------|-------------|
| Remarks | Shingle (unbroken), gm | 46.700 | Shingle (unbroken), % | 26.5 | | |
| | Broken faces, gm | 129.400 | Broken faces, % | 73.5 | | |
| | Total, gm | 176.100 | Not ok as less than 90% | | | |
| Bitumen Extraction | Total sample, gm | 500.000 | Sample wt after extraction, gm | 487.0 | % Bitumen, | 2.67 |

Tested By

Remarks

Assistant Research Officer

(RHD)

Assistant Engineer

(RHD)

Sub Divisional Engineer

(RHD)

Executive Engineer

(RHD)

Material Testing & Maintenance Division
Road Research Laboratory, Mirpur, Dhaka

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD
Paikpara, Mirpur, Dhaka, Bangladesh

| Base Gradation, Type-1(A), (Data and Report Sheet) | | | | | | | |
|---|------------------------|--|-------------------------|-------------------|---------------------------|-----------|-----------------------------|
| Memo No | | Ref.: R514/G-283/G-108/ 855(5) | | | Date | | 2-Apr-17 |
| Client | | Additional Chief Engineer, RHD, Rajshahi | | | | | |
| Project / Work | | PMP by DBS-Wearing Course 16+000 to 25+000(H-B-R), 0+000 to 8+200 K-Belkuchi(Z-5408)Road under Road Division , Sirajgonj (2015-2016), Technical help related | | | | | |
| Location | | 17+600 (N507) | | | | | |
| Date of receive at lab | | 10-Apr-17 | | Date of test | | 12-Apr-17 | |
| Sample Description | | Base Type-1(A Gradaing) | | Quantity Supplied | | 10 Kg | |
| Name of Agency | | RHD Rajshahi Zone, Rajshahi | | | | | |
| Laboratory Work | | | | Test Code | | STP 7.2 | |
| Dry mass of material, gm | | 5884 | | | | | |
| | Material wt, gm | Cumulative wt, gm | Cumulative e % retained | % Passing | Sp. L.LM | Sp. ULM | Remarks |
| 50.0 | 0 | 0 | 0 | 100.0 | 100 | 100 | Max ^m finer side |
| 38.0 | 0 | 0 | 0 | 100.0 | 90 | 100 | |
| 20.0 | 678 | 678 | 11.5 | 88.5 | 50 | 85 | |
| 10.0 | 1448 | 2126 | 36.1 | 63.9 | 30 | 65 | |
| 5.0 | 1152 | 3278 | 55.7 | 44.3 | 25 | 50 | |
| 2.40 | 690 | 3968 | 67.4 | 32.6 | 15 | 38 | |
| 0.60 | 764 | 4732 | 80.4 | 19.6 | 8 | 22 | |
| 0.30 | 251 | 4983 | 84.7 | 15.3 | 6 | 16 | |
| 0.075 | 539 | 5522 | 93.8 | 6.2 | 2 | 8 | |
| Pan | 362 | | | | | | |
| | | | | | | | Remarks |
| | | | | | | | |
| Remarks | Shingle (unbroken), gm | | 435.500 | | Shingle (unbroken), % | | 23.2 |
| | Broken faces, gm | | 1443.300 | | Broken faces, % | | 76.8 |
| | Total, gm | | 1878.800 | | OK as >than 75% | | |

Tested By

Remarks

Assistant Research Officer

(RHD)

Assistant Engineer

(RHD)

Sub Divisional Engineer

(RHD)

Executive Engineer

(RHD)

Material Testing & Maintenance Division

Road Research Laboratory, Mirpur, Dhaka

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD
Paikpara, Mirpur, Dhaka, Bangladesh

| Base Gradation, Type-1(B), (Data and Report Sheet) | | | | | | | |
|---|------------------------|--|-----------------------|-------------------|---------------------------|-----------|------------------------|
| Memo No | | Ref.: R514/G-283/G-108/ 855(5) | | | Date | | 2-Apr-17 |
| Client | | Additional Chief Engineer, RHD, Rajshahi | | | | | |
| Project / Work | | PMP by DBS-Wearing Course 16+000 to 25+000(H-B-R), 0+000 to 8+200 K-Belkuchi(Z-5408)Road under Road Division , Sirajgonj (2015-2016), Technical help related | | | | | |
| Location | | 17+600 (N507) | | | | | |
| Date of receive at lab | | 10-Apr-17 | | Date of test | | 12-Apr-17 | |
| Sample Description | | Base Type-1(B Gradaing) | | Quantity Supplied | | 10 Kg | |
| Name of Agency | | RHD Rajshahi Zone, Rajshahi | | | | | |
| Laboratory Work | | | | Test Code | | STP 7.2 | |
| Dry mass of material, gm | | 5884 | | | | | |
| | Material wt, gm | Cumulative wt, gm | Cumulative % retained | % Passing | Sp. L.LM | Sp. ULM | Remarks |
| 50.0 | 0 | 0 | 0 | 100.0 | 100 | 100 | Out ou limits(Coarser) |
| 38.0 | 0 | 0 | 0 | 100.0 | 100 | 100 | |
| 20.0 | 678 | 678 | 11.5 | 88.5 | 100 | 100 | |
| 10.0 | 1448 | 2126 | 36.1 | 63.9 | 80 | 100 | |
| 5.0 | 1152 | 3278 | 55.7 | 44.3 | 50 | 80 | |
| 2.40 | 690 | 3968 | 67.4 | 32.6 | 35 | 65 | |
| 0.60 | 764 | 4732 | 80.4 | 19.6 | 15 | 40 | |
| 0.30 | 251 | 4983 | 84.7 | 15.3 | 10 | 30 | |
| 0.075 | 539 | 5522 | 93.8 | 6.2 | 5 | 10 | |
| Pan | 362 | | | | | | |
| | | | | | | | Remarks |
| | | | | | | | |
| Remarks | Shingle (unbroken), gm | | 435.500 | | Shingle (unbroken), % | | 23.2 |
| | Broken faces , gm | | 1443.300 | | Broken faces, % | | 77 |
| | Total, gm | | 1878.800 | | OK as >than 75% | | |

Tested By

Remarks

Assistant Research Officer

(RHD)

Assistant Engineer

(RHD)

Sub Divisional Engineer

(RHD)

Executive Engineer

(RHD)

Material Testing & Maintenance Division
Road Research Laboratory, Mirpur, Dhaka

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD

Paikpara, Mirpur, Dhaka, Bangladesh

| Sub Base Gradation, Type-B (Data and Report Sheet) | | | | | | | |
|---|------------------------|--|-----------------------|-------------------|----------------------------|-----------|--------------------------|
| Memo No | | Ref.: R514/G-283/G-108/ 855(5) | | | Date | | 2-Apr-17 |
| Client | | Additional Chief Engineer, RHD, Rajshahi | | | | | |
| Project / Work | | PMP by DBS-Wearing Course 16+000 to 25+000(H-B-R), 0+000 to 8+200 K-Belkuchi(Z-5408)Road under Road Division , Sirajgonj (2015-2016), Technical help related | | | | | |
| Location | | 17+600 (N507) | | | | | |
| Date of receive at lab | | 10-Apr-17 | | Date of test | | 12-Apr-17 | |
| Sample Description | | Sub Base-B | | Quantity Supplied | | 8.052 Kg | |
| Name of Agency | | RHD Rajshahi Zone, Rajshahi | | | | | |
| Laboratory Work | | | | Test Code | | STP 7.2 | |
| Dry mass of material, gm | | 8052 | | | | | |
| | Material wt, gm | Cumulative wt, gm | Cumulative % retained | % Passing | Sp. L.LM | Sp. ULM | Remarks |
| 50.0 | 0 | 0 | 0 | 100.0 | 100 | 100 | OK other than 20mm sieve |
| 38.0 | 0 | 0 | 0 | 100.0 | 100 | 100 | |
| 20.0 | 1032 | 1032 | 12.8 | 87.2 | 100 | 100 | |
| 10.0 | 1682 | 2714 | 33.7 | 66.3 | 70 | 100 | |
| 5.0 | 1172 | 3886 | 48.3 | 51.7 | 45 | 85 | |
| 2.40 | 924 | 4810 | 59.7 | 40.3 | 30 | 70 | |
| 0.60 | 1058 | 5868 | 72.9 | 27.1 | 10 | 45 | |
| 0.30 | 275 | 6143 | 76.3 | 23.7 | 7 | 30 | |
| 0.075 | 942 | 7085 | 88.0 | 12.0 | 4 | 20 | |
| Pan | 967 | | | | | | |
| | | | | | | | Remarks |
| | | | | | | | |
| Remarks | Shingle (unbroken), gm | | 308.000 | | Shingle (unbroken), % | | 23.2 |
| | Broken faces , gm | | 1019.000 | | Broken faces, % | | 77 |
| | Total, gm | | 1327.000 | | OK as > than 50% | | |

Tested By

Remarks

Assistant Research Officer
(RHD)

Assistant Engineer
(RHD)

Sub Divisional Engineer
(RHD)

Executive Engineer
(RHD)

Material Testing & Maintenance Division
Road Research Laboratory, Mirpur, Dhaka

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD

Paikpara, Mirpur, Dhaka, Bangladesh

| Sub Base Gradation, Type-A, (Data and Report Sheet) | | | | | | | | |
|--|------------------------|--|--------------------------|-------------------|----------------------------|-----------|--------------------------|--|
| Memo No | | Ref.: R514/G-283/G-108/ 855(5) | | | Date | | 2-Apr-17 | |
| Client | | Additional Chief Engineer, RHD, Rajshahi | | | | | | |
| Project / Work | | PMP by DBS-Wearing Course 16+000 to 25+000(H-B-R), 0+000 to 8+200 K-Belkuchi(Z-5408)Road under Road Division , Sirajgonj (2015-2016), Technical help related | | | | | | |
| Location | | 17+600 (N507) | | | | | | |
| Date of receive at lab | | 10-Apr-17 | | Date of test | | 12-Apr-17 | | |
| Sample Description | | Sub Base-A | | Quantity Supplied | | 8.052 Kg | | |
| Name of Agency | | RHD Rajshahi Zone, Rajshahi | | | | | | |
| Laboratory Work | | | | Test Code | | STP 7.2 | | |
| Dry mass of material, gm | | 8052 | | | | | | |
| | Material wt , gm | Cumulative wt, gm | Cumulative % retained | % Passing | Sp. L.LM | Sp. ULM | Remarks | |
| | 50.0 | 0 | 0 | 100.0 | 100 | 100 | ok but are on finer side | |
| | 38.0 | 0 | 0 | 100.0 | 85 | 100 | | |
| | 20.0 | 1032 | 1032 | 12.8 | 55 | 95 | | |
| | 10.0 | 1682 | 2714 | 33.7 | 35 | 75 | | |
| | 5.0 | 1172 | 3886 | 48.3 | 25 | 60 | | |
| | 2.40 | 924 | 4810 | 59.7 | 15 | 50 | | |
| | 0.60 | 1058 | 5868 | 72.9 | 7 | 35 | | |
| | 0.30 | 275 | 6143 | 76.3 | 6 | 27 | | |
| | 0.075 | 942 | 7085 | 88.0 | 3 | 15 | | |
| | Pan | 967 | | | | | | |
| | | | | | | | Remarks | |
| | | | | | | | Remarks | |
| Remarks | Shingle (unbroken), gm | | 308.000 | | Shingle (unbroken), % | | 23.2 | |
| | Broken faces , gm | | 1019.000 | | Broken faces, % | | 77 | |
| | Total, gm | | 1327.000 | | OK as > than 50% | | | |

Remarks

Assistant Research Officer

(RHD)

Assistant Engineer

(RHD)

Sub Divisional Engineer

(RHD)

Executive Engineer

(RHD)

| |
|--|
| Material Testing & Maintenance Division |
| Road Research Laboratory, Mirpur, Dhaka |

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD

Paikpara, Mirpur, Dhaka, Bangladesh

| Base Gradation, Type-1 & Sub Base Mixture, (Data and Report Sheet) | | | | | | | |
|---|--|-------------------|-------------------------|-----------|----------|---------|---|
| Memo No | Ref.: R514/G-283/G-108/ 855(5) | | | Date | 2-Apr-17 | | |
| Client | Additional Chief Engineer, RHD, Rajshahi | | | | | | |
| Project / Work | PMP by DBS-Wearing Course 16+000 to 25+000(H-B-R), 0+000 to 8+200 K-Belkuchi(Z-5408)Road under Road Division , Sirajgonj (2015-2016), Technical help related | | | | | | |
| Location | Ch: 17+600 (N507) | | | | | | |
| Date of receive at lab | 10-Apr-17 | | Date of test | 12-Apr-17 | | | |
| Sample Description | Base Type-1 & Sub Base Mixture (Base Type-1, A gradation) | | Quantity Supplied | 10 Kg | | | |
| Name of Agency | RHD Rajshahi Zone, Rajshahi | | | | | | |
| Laboratory Work | | | Test Code | STP 7.2 | | | |
| Dry mass of material, gm | 10000 | | | | | | |
| | Material wt, gm | Cumulative wt, gm | Cumulative e % retained | % Passing | Sp. L.LM | Sp. ULM | Remarks |
| 50.0 | 0 | 0 | 0 | 100.0 | 100 | 100 | |
| 38.0 | 0 | 0 | 0 | 100.0 | 90 | 100 | |
| 20.0 | 1375 | 1375 | 13.8 | 86.3 | 50 | 85 | % passing higher than limit |
| 10.0 | 3148 | 4523 | 45.2 | 54.8 | 30 | 65 | Close to finer side |
| 5.0 | 1705 | 6228 | 62.3 | 37.7 | 25 | 50 | |
| 2.40 | 824 | 7052 | 70.5 | 29.5 | 15 | 38 | |
| 0.60 | 940 | 7992 | 79.9 | 20.1 | 8 | 22 | Close to finer side |
| 0.30 | 524 | 8516 | 85.2 | 14.8 | 6 | 16 | Close to finer side |
| 0.075 | 1117 | 9633 | 96.3 | 3.7 | 2 | 8 | |
| Pan | 367 | | | | | | |
| | | | | | | | Remarks |
| | | | | | | | Gradation limits as per Base-1(A Gradation) |

Tested By

Remarks

Assistant Research Officer

(RHD)

Assistant Engineer

(RHD)

Sub Divisional Engineer

(RHD)

Executive Engineer

(RHD)

Material Testing & Maintenance Division
Road Research Laboratory, Mirpur, Dhaka

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD

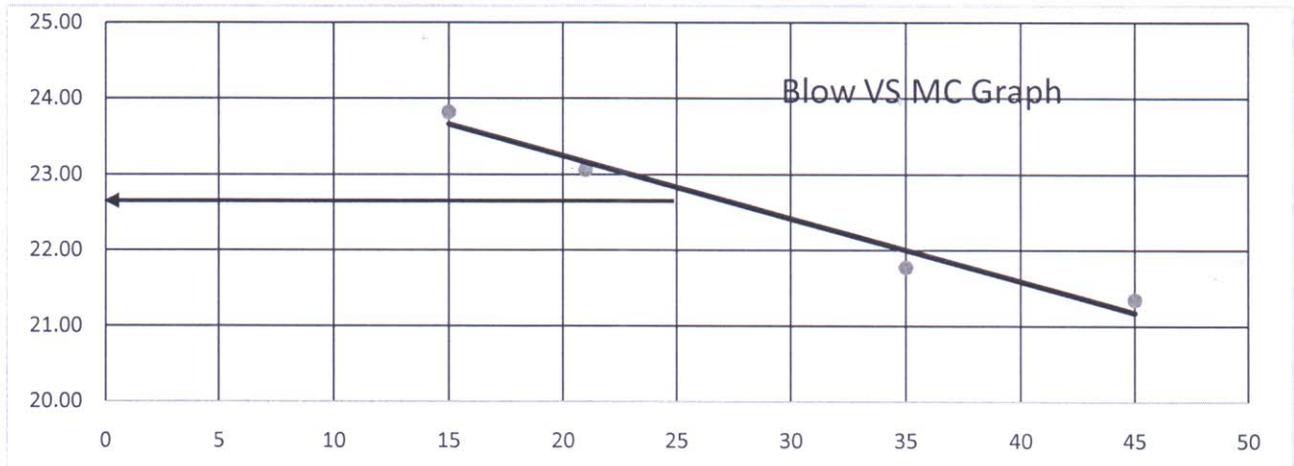
Paikpara. Mirpur, Dhaka, Bangladesh

| Atterberg Limits (Casagrande method) (Data and Report Sheet) | | | |
|---|--|-------------------|-----------|
| AASHTO T89 (LL) & T90 (PL) | | | |
| Memo No | Ref.: R514/G-283/G-108/ 855(5) | Date | 2-Apr-17 |
| Client | Additional Chief Engineer, RHD, Rajshahi | | |
| Project / Work | PMP by DBS-Wearing Course 16+000 to 25+000(H-B-R), 0+000 to 8+200 K-Belkuchi(Z-5408)Road under Road Division , Sirajgonj (2015-2016), Technical help related | | |
| Location | 17+600 (N507) | | |
| Date of receive at lab | 10-Apr-17 | Date of test | 16-Apr-17 |
| Sample Description | ISG | Quantity Supplied | |
| Name of Agency | RHD Rajshahi Zone, Rajshahi | | |

Laboratory Work

| Atterberg Limits | | PL(A2) | | LL(A2) | | | |
|-------------------------------|-------------|------------|-------------|-------------|--------------|------------|------------|
| Can # | | 50 | 17 | 5 | 56 | 35 | 58 |
| Blow No | | | | 45 | 35 | 21 | 15 |
| Wt. of container, gm | a | 1.70 | 1.66 | 1.69 | 1.67 | 1.68 | 1.71 |
| Wt. of container+wet soil, gm | b | 6.33 | 7.56 | 11.24 | 13.58 | 14.86 | 12.99 |
| Wt. of container+dry soil, gm | c | 5.51 | 6.58 | 9.56 | 11.45 | 12.39 | 10.82 |
| Wt. of moisture, gm | d=b-c | 0.82 | 0.98 | 1.68 | 2.13 | 2.47 | 2.17 |
| Wt. of dry soil, gm | e=c-a | 3.81 | 4.92 | 7.87 | 9.78 | 10.71 | 9.11 |
| m/c, % | m = d/e*100 | 21.52 | 19.92 | 21.35 | 21.78 | 23.06 | 23.82 |
| Average, M/C | | 20.72 | | | | | |
| Nos of taps | | | | LL @25 blow | | | |
| PL | | PL= | 20.7 | LL= | 22.75 | PI= | 2.0 |

ISG material " NP)



Tested By

Remarks

Assistant Research Officer

(RHD)

Assistant Engineer

(RHD)

Sub Divisional Engineer

(RHD)

Executive Engineer

(RHD)

Material Testing & Maintenance Division
Road Research Laboratory, Mirpur, Dhaka

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD

Paikpara. Mirpur, Dhaka, Bangladesh

| Los Angeles Abrasion for Coarse Aggregate (Data and Report Sheet) | | | | | | | | | |
|--|--|---|----------------|-------------------|----------------------|--------------------------|---|--|--|
| Memo No | | Ref.: R514/G-283/G-108/ 855(5) | | | Date | 2-Apr-17 | | | |
| Client | | Additional Chief Engineer, RHD, Rajshahi | | | | | | | |
| Project / Work | | PMP by DBS-Wearing Course 16+000 to 25+000(H-B-R), 0+000 to 8+200 K-Belkuchi(Z-5408)Road under Road Division, Sirajgoni (2015-2016). Technical help related | | | | | | | |
| Location | | 17+600 (N507) | | | | | | | |
| Date of receive at lab | | 10-Apr-17 | | Date of test | | 16-Apr-17 | | | |
| Sample Description | | LAA (Base Material) | | Quantity Supplied | | 6 Kg | | | |
| Name of Agency | | RHD Rajshahi Zone, Rajshahi | | | | | | | |
| Laboratory Work | | | | Test Code | T96, C 131, STP | | | | |
| Sieve Size | | Mass of indicated Sizes, (g) | | | | Remarks | | | |
| | | Grading | | | | | | | |
| Passing,mm | Retained on | A (Sph/res12) | B (Sph/res11) | C(Sph/res8) | D (Sph/res6) | Seperating Sieve: 1.70mm | | | |
| 37.50 | 25.00 | 1250±25 | | | | | | | |
| 25.00 | 19.00 | 1250±25 | | | | | | | |
| 19.00 | 12.50 | 1250±10 | 2500±10 | | | | | | |
| 12.50 | 9.50 | 1250±10 | 2500±10 | | | | | | |
| 9.50 | 6.30 | | | 2500±10 | | | | | |
| 6.30 | 4.75 | | | 2500±10 | | | | | |
| 4.75 | 2.36 | | | | 5000±10 | | | | |
| Total | | 5000±10 | 5000±10 | 5000±10 | 5000±10 | | | | |
| Sample reference | | | | | | | | | |
| | | Grading used | | A | B | C | D | | |
| Mass | Wt Of sample before Test, m ₁ (g) | Passing Sieve | Retained Sieve | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | 2500 | | | |
| | | | | | | 2500 | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | Total | | | 5000 | | | | |
| | | Retained on Sieve Size 1.70 mm, m ₂ (g) | | | 3434 | | | | |
| | | Passing Sieve Size 1.70 mm, (m ₁ – m ₂) (g) | | | 1566 | | | | |
| | | LAA Value, 100*(m ₁ – m ₂)/m ₁ , (%) | | | 31 | | | | |

Tested By:

Remarks

Assistant Research Officer

(RHD)

Assistant Engineer

(RHD)

Sub Divisional Engineer

(RHD)

Executive Engineer

(RHD)

Material Testing & Maintenance Division

Road Research Laboratory, Mirpur, Dhaka

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD

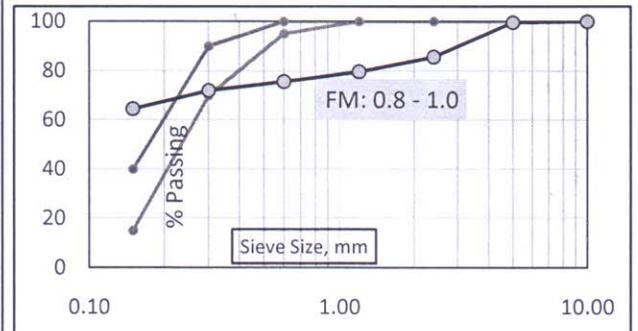
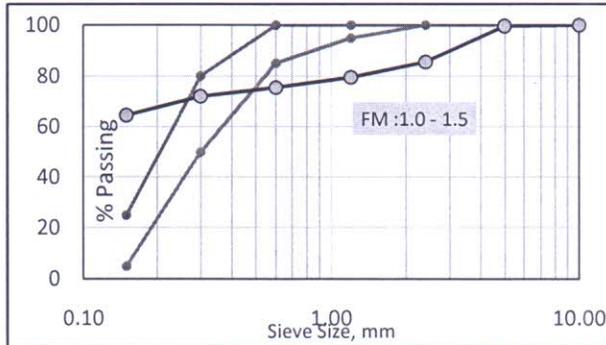
Paikpara, Mirpur, Dhaka, Bangladesh

ISG Gradation: FM 1.0 - 1.5; 0.8- 1.0, (Data and Report Sheet)

| | | | |
|------------------------|--|-------------------|-----------|
| Memo No | Ref.: R514/G-283/G-108/ 855(5) | Date | 2-Apr-17 |
| Client | Additional Chief Engineer, RHD, Rajshahi | | |
| Project / Work | PMP by DBS-Wearing Course 16+000 to 25+000(H-B-R), 0+000 to 8+200 K-Belkuchi(Z-5408)Road under Road Division , Sirajgonj (2015-2016), Technical help related | | |
| Location | 17 +600(N507) | | |
| Date of receive at lab | 10-Apr-17 | Date of test | 12-Apr-17 |
| Sample Description | ISG | Quantity Supplied | 2.5Kg |
| Name of Agency | RHD Rajshahi Zone, Rajshahi | | |

| | |
|--------------------------|-----------|
| Laboratory Work | Test Code |
| | STP-7.2 |
| Dry mass of material, gm | 500 |

| Sieve size(mm) | Material wt, gm | Cumulative wt, gm | Cumulative % retained | % Passing | Sp. L.L.M | Sp. U.L.M | Sp. L.L.M | Sp. U.L.M | Remarks |
|----------------|-----------------|-------------------|-----------------------|-----------|---------------|-----------|---------------|-----------|--|
| | | | | | FM: 1.0 - 1.5 | | FM: 0.8 - 1.0 | | |
| 10.00 | 0 | 0 | 0 | 100.0 | 100 | 100 | 100 | 100 | Gradation was done with material passing 5mm sieve |
| 5.00 | 2 | 2 | 0.4 | 99.6 | 100 | 100 | 100 | 100 | |
| 2.40 | 70 | 72 | 14.4 | 85.6 | 100 | 100 | 100 | 100 | |
| 1.20 | 30 | 102 | 20.4 | 79.6 | 95 | 100 | 100 | 100 | |
| 0.60 | 20 | 122 | 24.4 | 75.6 | 85 | 100 | 95 | 100 | |
| 0.30 | 18 | 140 | 28 | 72.0 | 50 | 80 | 70 | 90 | |
| 0.150 | 37.5 | 177.5 | 35.5 | 64.5 | 5 | 25 | 15 | 40 | |
| Pan | | | | | | | | | |



Tested By

Remarks: Gradation was done with material passing 5.00mm sieve

Assistant Research Officer

Assistant Engineer

Sub Divisional Engineer

Executive Engineer

(RHD)

(RHD)

(RHD)

(RHD)

Material Testing & Maintenance Division
Road Research Laboratory, Mirpur, Dhaka

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD
Paikpara, Mirpur, Dhaka, Bangladesh

| ISG Gradation: FM >2.8 ; 1.5 - 2.8, (Data and Report Sheet) | | | | | | | | | |
|---|-----------------|--|-------------------------|-----------|-------------------|---------|--------------|---------|--|
| Memo No | | Ref.: R514/G-283/G-108/ 855(5) | | | Date | | 2-Apr-17 | | |
| Client | | Additional Chief Engineer, RHD, Rajshahi | | | | | | | |
| Project / Work | | PMP by DBS-Wearing Course 16+000 to 25+000(H-B-R), 0+000 to 8+200 K-Belkuchi(Z-5408)Road under Road Division , Sirajgonj (2015-2016), Technical help related | | | | | | | |
| Location | | 17+600 (N507) | | | | | | | |
| Date of receive at lab | | 10-Apr-17 | | | Date of test | | 12-Apr-17 | | |
| Sample Description | | ISG | | | Quantity Supplied | | 2.5 Kg | | |
| Name of Agency | | RHD Rajshahi Zone, Rajshahi | | | | | | | |
| Laboratory Work | | | | | Test Code | | | | |
| Dry mass of material, gm | | 500 | | | | | | | |
| Sieve size(mm) | Material wt, gm | Cumulative wt, gm | Cumulative e % retained | % Passing | Sp. L.LM | Sp. ULM | Sp. L.LM | Sp. ULM | Remarks |
| | | | | | FM > 2.8 | | FM 1.5 - 2.8 | | |
| 10.00 | 0 | 0 | 0.0 | 100 | 100 | 100 | 100 | 100 | Gradation was done with material passing 5mm sieve |
| 5.00 | 2 | 2 | 0.4 | 100 | 90 | 95 | 95 | 100 | |
| 2.40 | 70 | 72 | 14.4 | 86 | 70 | 90 | 90 | 100 | |
| 1.20 | 30 | 102 | 20.4 | 80 | 45 | 70 | 70 | 95 | |
| 0.600 | 20 | 122 | 24.4 | 76 | 25 | 45 | 40 | 80 | |
| 0.300 | 18 | 140 | 28.0 | 72 | 10 | 20 | 10 | 50 | |
| 0.150 | 37.5 | 177.5 | 35.5 | 65 | 0 | 2 | 0 | 20 | |
| 0.075 | 68 | 245.5 | 49.1 | 51 | | | | | |
| Pan | 254.5 | | | | | | | | |

Tested By

Remarks: Gradation was done with material passing on 5mm sieve

Assistant Research Officer

(RHD)

Assistant Engineer

(RHD)

Sub Divisional Engineer

(RHD)

Executive Engineer

(RHD)

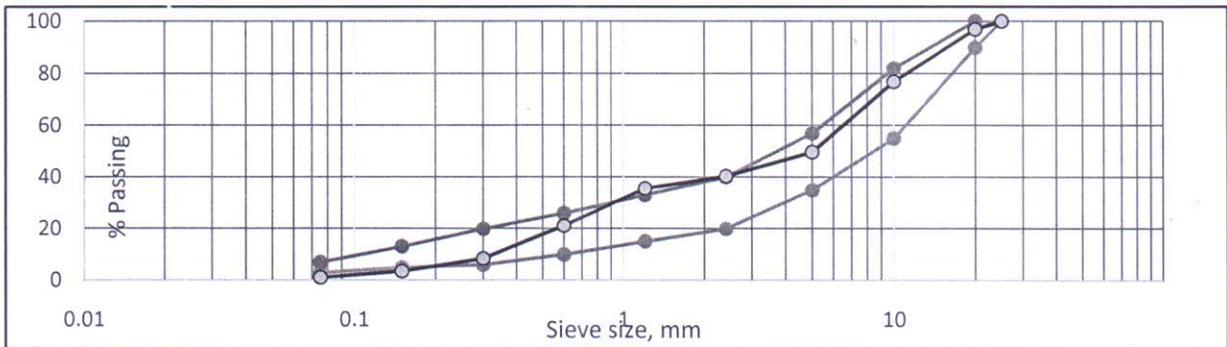
Material Testing & Maintenance Division
Road Research Laboratory, Mirpur, Dhaka

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD
Paikpara, Mirpur, Dhaka, Bangladesh

| | | | |
|--|-------------------------------|-------------------|-----------|
| DBS 60-70mm (Base), (Data and Report Sheet) | | | |
| Memo No | | Date | |
| Client | | | |
| Project / Work | Hatikamrul-Bonpara Road, N507 | | |
| Location | Km16+950 | | |
| Date of receive at lab | 7-May-17 | Date of test | 28-May-17 |
| Sample Description | DBS-60-70mm | Quantity Supplied | 15 Kg |
| Name of Agency | | | |

| Laboratory Work | | | | Test Code | | | |
|--------------------------|-----------------|-------------------|-----------------------|---|-------|---------|---------|
| Dry mass of material, gm | | 468.5 | | For 60-70 mm thickness DBS, Plant Method | | | |
| Sieve Size mm | Material wt, gm | Cumulative wt, gm | Cumulative % retained | % Passing | S.LLM | S. ULIM | Remarks |
| 25 | 0 | 0 | 0 | 100.0 | 100 | 100 | |
| 20 | 14 | 14 | 3 | 97.0 | 90 | 100 | |
| 10 | 94 | 108 | 23 | 76.9 | 55 | 82 | |
| 5 | 127.5 | 235.5 | 50 | 49.7 | 35 | 57 | |
| 2.4 | 44.0 | 279.5 | 60 | 40.3 | 20 | 40 | |
| 1.2 | 22.5 | 302 | 64 | 35.5 | 15 | 33 | |
| 0.6 | 67.0 | 369 | 79 | 21.2 | 10 | 26 | |
| 0.3 | 59.5 | 428.5 | 91 | 8.5 | 6 | 20 | |
| 0.15 | 23.0 | 451.5 | 96 | 3.6 | 5 | 13 | |
| 0.075 | 12 | 463.5 | 99 | 1.1 | 3 | 7 | |
| Pan | | | | | | | |



| | | | | | | |
|--------------------|------------------|---------|--------------------------------|-------|------------|-------------|
| Bitumen Extraction | Total sample, gm | 500.000 | Sample wt after extraction, gm | 468.5 | % Bitumen, | 6.72 |
|--------------------|------------------|---------|--------------------------------|-------|------------|-------------|

Tested By

Remarks

Assistant Research Officer

Assistant Engineer

Sub Divisional Engineer

Executive Engineer

(RHD)

(RHD)

(RHD)

(RHD)

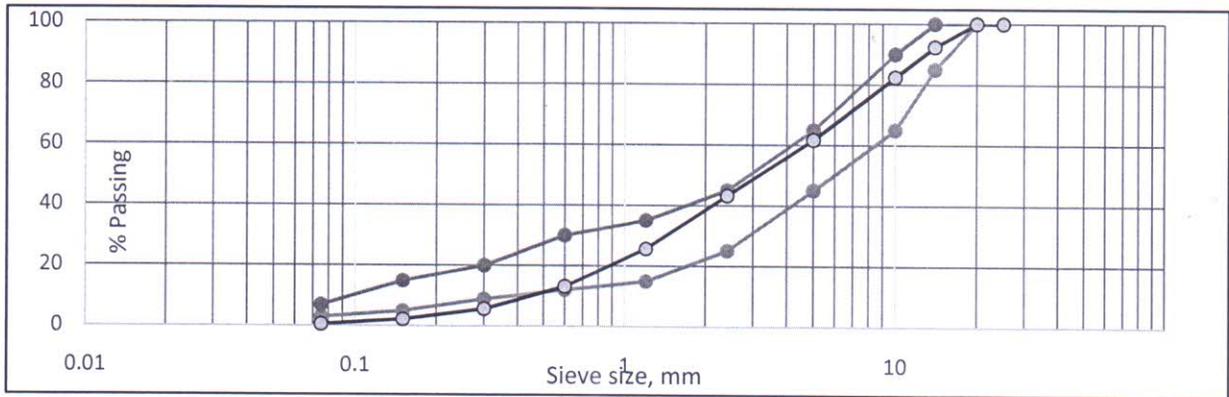
Material Testing & Maintenance Division
Road Research Laboratory, Mirpur, Dhaka

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD

Paikpara, Mirpur, Dhaka, Bangladesh

| DBS 40-60mm (B& W/C), (Data and Report Sheet) | | | | | | | |
|---|-----------------|-------------------|-------------------------------|---|-------|-----------|---------|
| Memo No | | | Date | | | | |
| Client | | | | | | | |
| Project / Work | | | Hatikamrul-Bonpara Road, N507 | | | | |
| Location | | | Km16+950 | | | | |
| Date of receive at lab | | 7-May-17 | | Date of test | | 28-May-17 | |
| Sample Description | | DBS-40-60mm | | Quantity Supplied | | 15 Kg | |
| Name of Agency | | | | | | | |
| Laboratory Work | | | | Test Code | | | |
| Dry mass of material, gm | | 465.00 | | For 40-60 mm thickness DBS, Plant Method | | | |
| Sieve Size mm | Material wt, gm | Cumulative wt, gm | Cumulative % retained | % Passing | S.LLM | S. ULIM | Remarks |
| 25 | 0.0 | 0 | 0 | 100.0 | 100 | 100 | |
| 20 | 0.0 | 0 | 0 | 100.0 | 100 | 100 | |
| 14 | 35.0 | 35 | 8 | 92.5 | 85 | 100 | |
| 10 | 46.5 | 81.5 | 18 | 82.5 | 65 | 90 | |
| 5 | 96.5 | 178 | 38 | 61.7 | 45 | 65 | |
| 2.4 | 86.0 | 264 | 57 | 43.2 | 25 | 45 | |
| 1.2 | 81.5 | 345.5 | 74 | 25.7 | 15 | 35 | |
| 0.6 | 58.5 | 404 | 87 | 13.1 | 12 | 30 | |
| 0.3 | 34.5 | 438.5 | 94 | 5.7 | 9 | 20 | |
| 0.15 | 16.0 | 454.5 | 98 | 2.3 | 5 | 15 | |
| 0.075 | 8.0 | 462.5 | 99 | 0.5 | 3 | 7 | |
| Pan | 2.5 | | | | | | |



| | | | | | | |
|--------------------|------------------|---------|--------------------------------|-------|------------|-------------|
| Bitumen Extraction | Total sample, gm | 500.000 | Sample wt after extraction, gm | 465.0 | % Bitumen, | 7.53 |
|--------------------|------------------|---------|--------------------------------|-------|------------|-------------|

Tested By

Assistant Research Officer

(RHD)

Assistant Engineer

(RHD)

Sub Divisional Engineer

(RHD)

Executive Engineer

(RHD)

| |
|--|
| Material Testing & Maintenance Division |
| Road Research Laboratory, Mirpur, Dhaka |

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD
Paikpara, Mirpur, Dhaka, Bangladesh

| Base Gradation, Type-1(A), (Data and Report Sheet) | | | | | | | |
|---|------------------------|-----------------------------|-------------------------|-------------------|---------------------------|-----------|-----------------------------|
| Memo No | | | | | | | |
| Client | | | | | | | |
| Project / Work | | | | | | | |
| Location | | B-H Road 16+950 (N507) | | | | | |
| Date of receive at lab | | 7-May-17 | | Date of test | | 16-May-17 | |
| Sample Description | | Base Type-1(A Gradaing) | | Quantity Supplied | | 10 Kg | |
| Name of Agency | | RHD Rajshahi Zone, Rajshahi | | | | | |
| Laboratory Work | | | | Test Code | | STP 7.2 | |
| Dry mass of material, gm | | 9000 | | | | | |
| | Material wt, gm | Cumulative wt, gm | Cumulative e % retained | % Passing | Sp. L.LM | Sp. ULM | Remarks |
| 50.0 | 0 | 0 | 0 | 100.0 | 100 | 100 | Max ^m finer side |
| 38.0 | 0 | 0 | 0 | 100.0 | 90 | 100 | |
| 20.0 | 1040 | 1040 | 11.6 | 88.4 | 50 | 85 | |
| 10.0 | 2215 | 3255 | 36.2 | 63.8 | 30 | 65 | |
| 5.0 | 1762 | 5017 | 55.7 | 44.3 | 25 | 50 | |
| 2.40 | 1056 | 6073 | 67.5 | 32.5 | 15 | 38 | |
| 0.60 | 1170 | 7243 | 80.5 | 19.5 | 8 | 22 | |
| 0.30 | 395 | 7638 | 84.9 | 15.1 | 6 | 16 | |
| 0.075 | 852 | 8490 | 94.3 | 5.7 | 2 | 8 | |
| Pan | 510 | | | | | | |
| | | | | | | | Remarks |
| | | | | | | | |
| Remarks | Shingle (unbroken), gm | | 495.000 | | Shingle (unbroken), % | | 24.6 |
| | Broken faces, gm | | 1520.000 | | Broken faces, % | | 75.4 |
| | Total, gm | | 2015.000 | | OK as >than 75% | | |

Tested By

Remarks

Assistant Research Officer

(RHD)

Assistant Engineer

(RHD)

Sub Divisional Engineer

(RHD)

Executive Engineer

(RHD)

| |
|--|
| Material Testing & Maintenance Division |
| Road Research Laboratory, Mirpur, Dhaka |

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD

Paikpara, Mirpur, Dhaka, Bangladesh

| Sub Base Gradation, Type-A, (Data and Report Sheet) | | | | | | | |
|--|------------------------|-------------------|-----------------------|-----------|----------------------------|-----------|------------------------------|
| Memo No | | | | | | Date | |
| Client | | | | | | | |
| Project / Work | | | B-H Road (N507) | | | | |
| Location | | | 16+950 (N507) | | | | |
| Date of receive at lab | | | 7-May-17 | | Date of test | | 16-May-17 |
| Sample Description | | | Sub Base-A | | Quantity | | 15Kg |
| Name of Agency | | | | | | | |
| Laboratory Work | | | | | Test Code | STP 7.2 | |
| Dry mass of material, gm | | | 12669 | | | | |
| | Material wt, gm | Cumulative wt, gm | Cumulative % retained | % Passing | Sp. L.L.M | Sp. U.L.M | Remarks |
| 50.0 | 0 | 0 | 0 | 100.0 | 100 | 100 | ok |
| 38.0 | 0 | 0 | 0 | 100.0 | 85 | 100 | |
| 20.0 | 1748 | 1748 | 13.8 | 86.2 | 55 | 95 | |
| 10.0 | 3982 | 5730 | 45.2 | 54.8 | 35 | 75 | |
| 5.0 | 1534 | 7264 | 57.3 | 42.7 | 25 | 60 | |
| 2.40 | 1005 | 8269 | 65.3 | 34.7 | 15 | 50 | |
| 0.60 | 1112 | 9381 | 74.0 | 26.0 | 7 | 35 | |
| 0.30 | 500 | 9881 | 78.0 | 22.0 | 6 | 27 | |
| 0.075 | 1812 | 11693 | 92.3 | 7.7 | 3 | 15 | |
| Pan | 976 | | | | | | |
| | | | | | | | Remarks |
| | | | | | | | Sampled/tested by Consultant |
| | | | | | | | |
| Remarks | Shingle (unbroken), gm | | 378.000 | | Shingle (unbroken), % | | 25.4 |
| | Broken faces, gm | | 1110.000 | | Broken faces, % | | 75 |
| | Total, gm | | 1488.000 | | OK as > than 50% | | |

Remarks

ARO

AE

SDE

EE

(RHD)

(RHD)

(RHD)

(RHD)

| |
|--|
| Material Testing & Maintenance Division |
| Road Research Laboratory, Mirpur, Dhaka |

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD

Paikpara. Mirpur, Dhaka, Bangladesh

| Los Angeles Abrasion for Coarse Aggregate (Data and Report Sheet) | | | | | | | |
|--|--|------------------------------|----------------|-------------------|--------------|--------------------------|---|
| Memo No | | | | | | | |
| Client | | | | | | | |
| Project / Work | | | | | | | |
| Location | | B-H Road: 16+950 (N507) | | | | | |
| Date of receive at lab | | 7-May-17 | | Date of test | | 16-May-17 | |
| Sample Description | | LAA (Base Material) | | Quantity Supplied | | 6 Kg | |
| Name of Agency | | RHD Rajshahi Zone, Rajshahi | | | | | |
| Laboratory Work | | | | Test Code | | T96, C 131, STP | |
| Sieve Size | | Mass of indicated Sizes, (g) | | | | Remarks | |
| | | Grading | | | | | |
| Passing,mm | Retained on | A (Sph'res12) | B (Sph'res11) | C(Sph'res8) | D (Sph'res6) | Seperating Sieve: 1.70mm | |
| 37.50 | 25.00 | 1250±25 | | | | | |
| 25.00 | 19.00 | 1250±25 | | | | | |
| 19.00 | 12.50 | 1250±10 | 2500±10 | | | | |
| 12.50 | 9.50 | 1250±10 | 2500±10 | | | | |
| 9.50 | 6.30 | | | 2500±10 | | | |
| 6.30 | 4.75 | | | 2500±10 | | | |
| 4.75 | 2.36 | | | | 5000±10 | | |
| Total | | 5000±10 | 5000±10 | 5000±10 | 5000±10 | | |
| Sample reference | | | | | | | |
| | | Grading used | | A | B | C | D |
| Mass | Wt Of sample before Test, m ₁ (g) | Passing Sieve | Retained Sieve | | | | |
| | | 37.50 | 25.00 | | | | |
| | | 25.00 | 19.00 | | | | |
| | | 19.00 | 12.50 | | 2500 | | |
| | | 12.50 | 9.50 | | 2500 | | |
| | | 9.50 | 6.30 | | | | |
| | | 6.30 | 4.75 | | | | |
| | | 4.75 | 2.36 | | | | |
| | | Total | | | 5000 | | |
| Retained on Sieve Size 1.70 mm, m ₂ (g) | | | | | 3410 | | |
| Passing Sieve Size 1.70 mm, (m ₁ - m ₂) (g) | | | | | 1590 | | |
| LAA Value, 100*(m ₁ - m ₂)/m ₁ , (%) | | | | | 31.8 | | |

Tested By:

Remarks

Assistant Research Officer

Assistant Engineer

Sub Divisional Engineer

Executive Engineer

(RHD)

(RHD)

(RHD)

(RHD)

Material Testing & Maintenance Division

Road Research Laboratory, Mirpur, Dhaka

Government of the People's Republic of Bangladesh

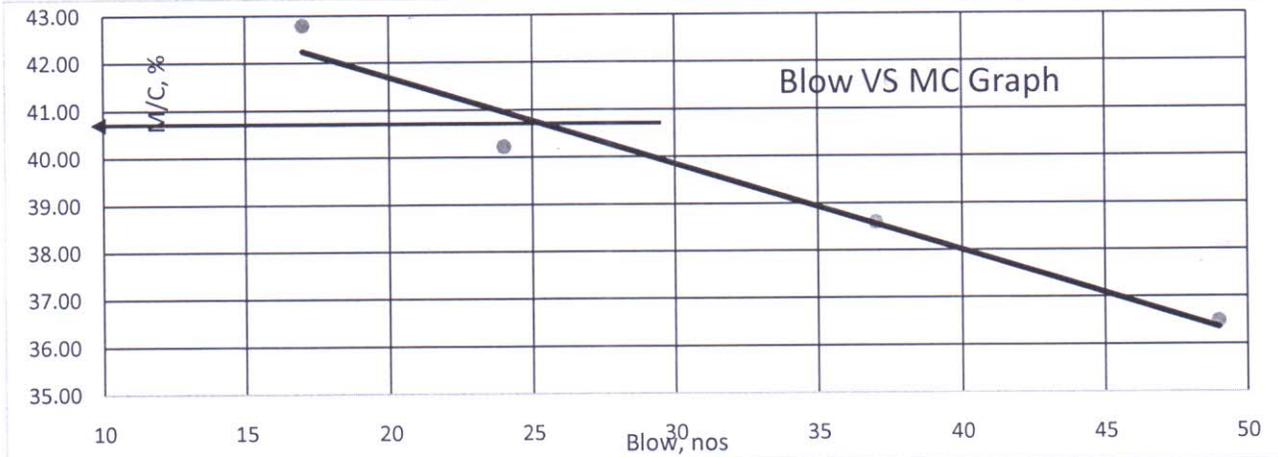
Bangladesh Road Research Laboratory, RHD

Paikpara, Mirpur, Dhaka, Bangladesh

| Atterberg Limits (Casagrande method) (Data and Report Sheet) | | | |
|---|--|-------------------|-----------|
| AASHTO T89 (LL) & T90 (PL) | | | |
| Memo No | | | |
| Client | | | |
| Project / Work | | | |
| Location | B-H Road 16+950, Nearby embankment soil (N507) | | |
| Date of receive at lab | 7-May-17 | Date of test | 17-May-17 |
| Sample Description | Embankment Soil | Quantity Supplied | |
| Name of Agency | | | |

Laboratory Work

| Atterberg Limits | | PL(A2) | | LL(A2) | | | |
|-------------------------------|-------------|------------|-----------|-------------|-------------|------------|-------------|
| Can # | | 2 | 24 | 34 | 49 | 76 | 79 |
| Blow No | | | | 49 | 37 | 24 | 17 |
| Wt. of container, gm | a | 1.70 | 1.69 | 1.69 | 1.70 | 1.72 | 1.68 |
| Wt. of container+wet soil, gm | b | 4.96 | 4.98 | 12.35 | 14.95 | 15.63 | 16.06 |
| Wt. of container+dry soil, gm | c | 4.36 | 4.37 | 9.50 | 11.26 | 11.64 | 11.75 |
| Wt. of moisture, gm | d=b-c | 0.60 | 0.61 | 2.85 | 3.69 | 3.99 | 4.31 |
| Wt. of dry soil, gm | e=c-a | 2.66 | 2.68 | 7.81 | 9.56 | 9.92 | 10.07 |
| m/c, % | m = d/e*100 | 22.56 | 22.76 | 36.49 | 38.60 | 40.22 | 42.80 |
| Average, M/C | | 23 | | | | | |
| Nos of taps | | | | LL @25 blow | | | |
| PL | | PL= | 23 | LL= | 40.9 | PI= | 18.2 |



Tested By

Remarks

ARO

(RHD)

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(RHD)

SDE

(RHD)

EE

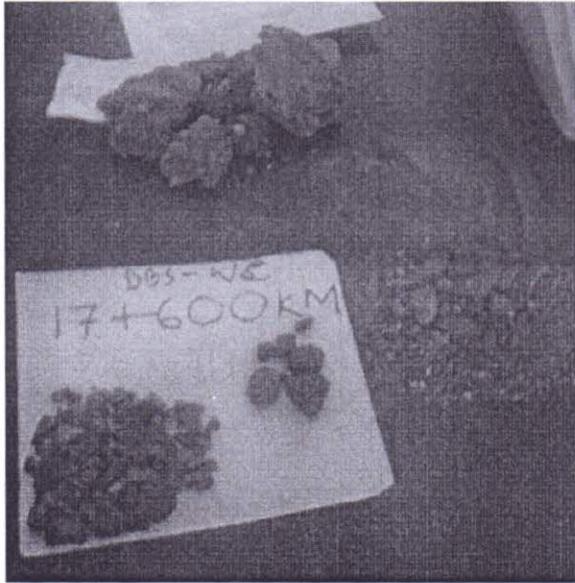
(RHD)

Material Testing & Maintenance Division

Road Research Laboratory, Mirpur, Dhaka

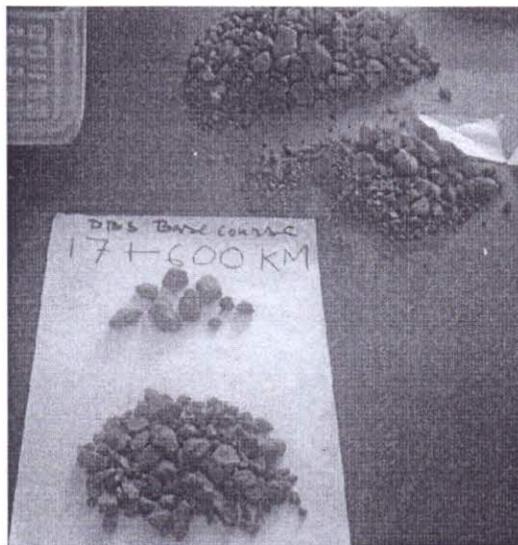
PHOTO OF MATERIALS

Photo 1(DBS-WC, retained on 5.00mm sieve)



Materials are of broken shingles (River born)

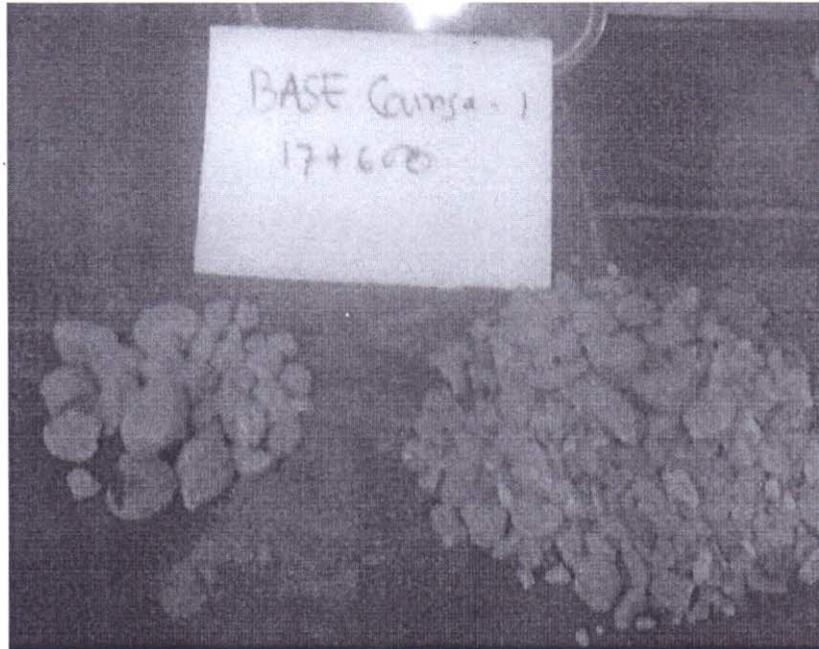
Photo 2(DBS base, retained on 5mm sieve)



Materials are of broken shingles (River born)

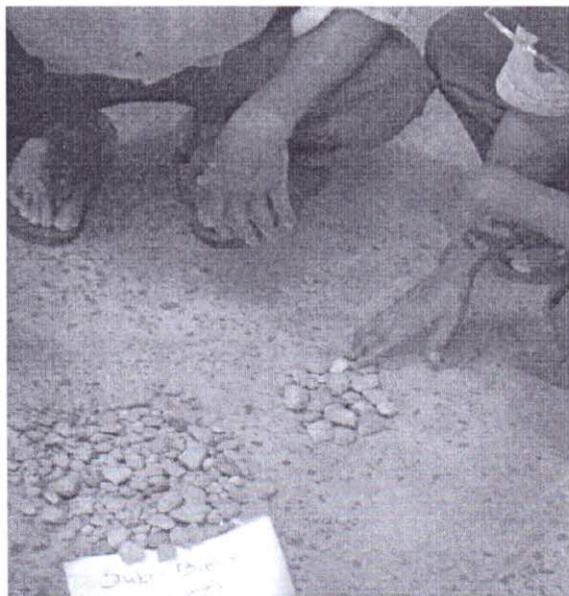
PHOTO OF MATERIALS

Photo 3(Base course Type-1, Retained on 5mm sieve)



Materials are of broken shingles (River born)

Photo 4(Sub Base, retained on 5mm sieve)



Materials are of broken shingles (River born)

Photos of damaged pavement surface

1. Damaged Pavement



2. At around ch 16+950 (No bond between DBS WC and DBS Base)



3. Damaged Pavement



4. At around ch 16+950 (Bond failure)



5. At around ch 23+500 (Settlement >100mm)



6. Marsh area



Annexure 11: Photos of Road N 6 (Bonpara intersection)

Photos of damaged pavement surface

1. Heaving of asphalt material



2. Potholes



3. Water logging



4. Bleeding



Annexure 12: Photos of Road N 6 (Horishpur bypass intersection)

Photos of damaged pavement surface

1. Damaged pavement



2. Damaged pavement



Annexure 13: Photos of Road N 6 (Tabaria rail gate)

Photos of damaged pavement surface

1. Damaged Pavement



Annexure 14: Photos of Road N 6 (Belghoria bypass)

Photos of damaged pavement surface

1. Damaged Pavement



2. Sampling



3. Damaged Pavement



4. DBS=50mm on Sub base =700mm



1. Heavy loaded truck passing



Annexure 15: Laboratory test report and photos of Road N 502

Summary of tests

| Sl No | Parameters | Result | Comments |
|-------|----------------|----------|----------|
| 1. | ACV | 19 | ≤ 38% |
| 2. | LL | 37 | ≤ 50% |
| 3. | PI | 17 | ≤ 25% |
| 4. | Base Gradation | Attached | Not OK |
| 5. | Sub Base | Attached | OK |

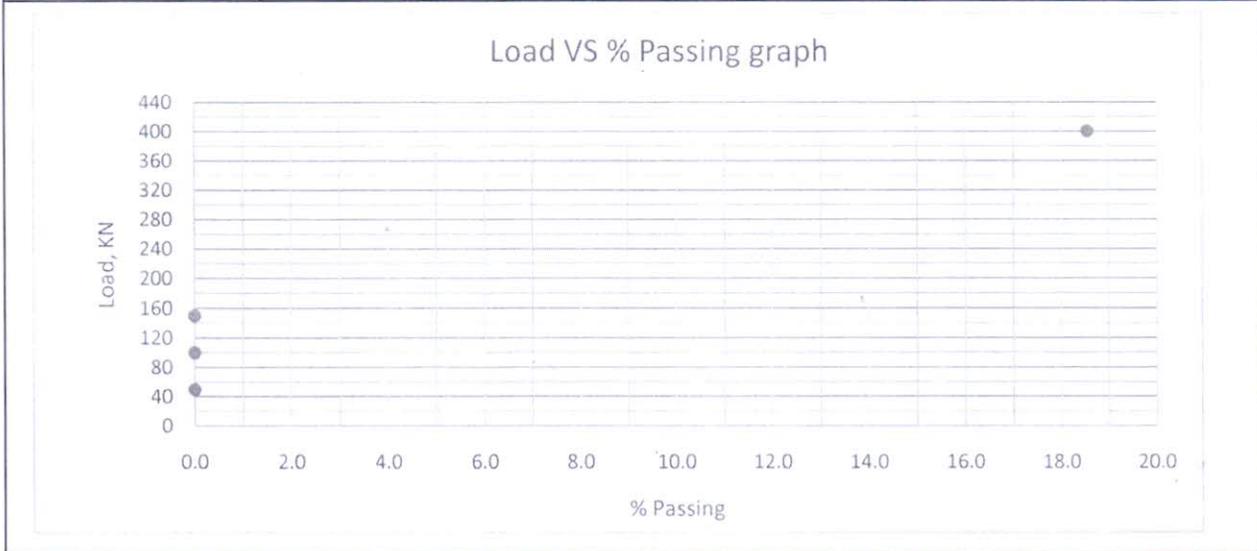
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Bangladesh Road Research Laboratory, RHD

Paikpara, Mirpur, Dhaka, Bangladesh

| Aggregate Crushing and 10% Fines Value (Data and Report Sheet) | | | |
|---|---|-------------------|-----------|
| Memo No | | | |
| Client | | | |
| Project / Work | | | |
| Location | Bogra -Natore, N502 MK post (Nowabgonj-123) | | |
| Date of receive at lab | 8-May-17 | Date of test | 17-May-17 |
| Sample Description | ACV | Quantity Supplied | |
| Name of Agency | | | |

| Laboratory Work | | | Test Code | BS 812: Part 110: 1990, STP7.7 | | | |
|---|------|--------------------|-----------|--------------------------------|---------|-----------|--|
| Description | Unit | Notation / Formula | Load -1 | Load -2 | Load -3 | Load - 4 | |
| Applied Force | KN | | 50 | 100 | 150 | | |
| Mass of Original test specimen(Dry) | g | M_1 | | | | 2416 | |
| Mass of Material passing 2.36mm sieve | g | M_2 | | | | 448 | |
| Mass of Material retained on 2.36mm sieve | g | M_3 | | | | 1968 | |
| Mass passing and retained on 2.36mm sieve | g | $M_2 + M_3$ | | | | 2416 | |
| % Fines | % | $(M_2/M_1)*100$ | | | | 19 | |
| ACV(400KN) | % | | 19 | | | < 38 , Ok | |
| 10% fines | KN | | | | | | |



Note: Fraction tested 14mm to 10mm, Separating sieve 2.36mm

ARO

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(RHD)

(RHD)

(RHD)

(RHD)

| |
|---|
| Material Testing & Maintenance Division |
| Road Research Laboratory, Mirpur, Dhaka |

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Paikpara, Mirpur, Dhaka, Bangladesh

| Base Gradation, Type-B, (Data and Report Sheet) | | | | | | | |
|--|-----------------|---|------------|-------------------|---------|-----------|--------------------------|
| Memo No | | | | | | | |
| Client | | | | | | | |
| Project / Work | | | | | | | |
| Location | | Bogra -Natore, N502 MK post (Nowabgonj-123) | | | | | |
| Date of receive at lab | | 8-May-17 | | Date of test | | 17-May-17 | |
| Sample Description | | Agg. Base | | Quantity Supplied | | | |
| Name of Agency | | | | | | | |
| Laboratory Work | | | | Test Code | | STP 7.2 | |
| Dry mass of material, gm | | 7000 | | | | | |
| | Material wt, gm | Cumulative wt, gm | % Retained | % Passing | Sp. LLM | Sp. ULM | Remarks |
| 50.0 | 0 | 0 | 0 | 100.0 | 100 | 100 | Not ok as Base gradation |
| 38.0 | 264 | 264 | 3.77 | 96.2 | 100 | 100 | |
| 20.0 | 1257 | 1521 | 21.73 | 78.3 | 100 | 100 | |
| 10.0 | 2122 | 3643 | 52.04 | 48.0 | 80 | 100 | |
| 5.0 | 982 | 4625 | 66.07 | 33.9 | 50 | 80 | |
| 2.40 | 508 | 5133 | 73.33 | 26.7 | 35 | 65 | |
| 0.60 | 602 | 5735 | 81.93 | 18.1 | 15 | 40 | |
| 0.30 | 422 | 6157 | 87.96 | 12.0 | 10 | 30 | |
| 0.075 | 821 | 6978 | 99.69 | 0.3 | 5 | 10 | |
| Pan | 22 | | | | | | |
| | | | | | | | Remarks |
| | | | | | | | Stone Agg |
| Remarks | | | | | | | |

Tested By

Remarks

Assistant Research Officer

(RHD)

Assistant Engineer

(RHD)

Sub Divisional Engineer

(RHD)

Executive Engineer

(RHD)

| |
|--|
| Material Testing & Maintenance Division |
| Road Research Laboratory, Mirpur, Dhaka |

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD
Paikpara, Mirpur, Dhaka, Bangladesh

| Sub Base Gradation-A, (Data and Report Sheet) | | | | | | | |
|--|---------------------|---|------------------------------|-------------------|---------|-----------|--------------------------------|
| Memo No | | | | | | | |
| Client | | | | | | | |
| Project / Work | | | | | | | |
| Location | | Bogra -Natore, N502 MK post (Nowabgonj-123) | | | | | |
| Date of receive at lab | | 8-May-17 | | Date of test | | 17-May-17 | |
| Sample Description | | Sub Base/ Macadam | | Quantity Supplied | | | |
| Name of Agency | | RHD Rajshahi Zone, Rajshahi | | | | | |
| Laboratory Work | | | | Test Code | | STP 7.2 | |
| Dry mass of material, gm | | 5400 | | | | | |
| | Material wt , gm | Cumulativ e wt, gm | Cumulativ e % retained | % Passing | Sp. LLM | Sp. ULM | Remarks |
| 50.0 | 0 | 0 | 0 | 100.0 | 100 | 100 | Complies as Sub base gradation |
| 38.0 | 0 | 0 | 0 | 100.0 | 85 | 100 | |
| 20.0 | 604 | 604 | 11.2 | 88.8 | 55 | 95 | |
| 10.0 | 988 | 1592 | 29.5 | 70.5 | 35 | 75 | |
| 5.0 | 1000 | 2592 | 48.0 | 52.0 | 25 | 60 | |
| 2.40 | 606 | 3198 | 59.2 | 40.8 | 15 | 50 | |
| 0.60 | 756 | 3954 | 73.2 | 26.8 | 7 | 35 | |
| 0.30 | 315 | 4269 | 79.1 | 20.9 | 6 | 27 | |
| 0.075 | 910 | 5179 | 95.9 | 4.1 | 3 | 15 | |
| Pan | 221 | | | | | | |
| | | | | | | | Remarks |
| | | | | | | | Brick agg |
| Remarks | | | | | | | |

Tested By

Remarks

Assistant Research Officer

(RHD)

Assistant Engineer

(RHD)

Sub Divisional Engineer

(RHD)

Executive Engineer

(RHD)

| |
|--|
| Material Testing & Maintenance Division |
| Road Research Laboratory, Mirpur, Dhaka |

Photos of damaged pavement surface

1. At chainage 38+000 , Settlement by 150mm



2. Crack on surface



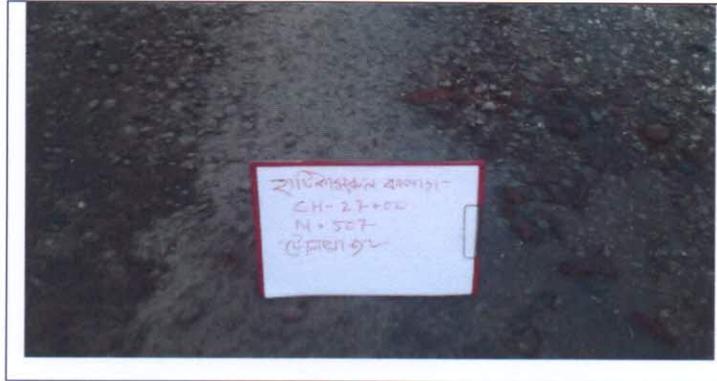
3. BC=50mm, Base-1=150mm, Macadam=275mm, Subgrade=Soil



Annexure 16: Photos of Road N 507 (Natore part)

Photos of damaged pavement surface

1. Hatikamrul-Bonpara Road at toll plaza



2. Damaged area and partially rigid pavement



3. Water dripping from fish carrying vehicle



Annexure 17: Photos of Road R 548

Photos of damaged pavement surface

1. Low lying road



2. Narrow road



Annexure 18: Laboratory test report and photos of Road N 6

SUMMARY OF THE INVESTIGATION (Material Tests)

Kashinathpur-Dashuria-Natore-Rajshahi (Pabna Part), Dashuria More: Km 62+000, N6

| Sl No | Layer Type | Parameters | Result | Comments | |
|-------|-------------------------------------|---------------------------|----------|--------------------------------|------------------|
| 1. | Base Type-1- B (Brick aggregate) | Gradation (Consultant) | Enclosed | Not Ok as Base course layer | Out of limits |
| | | | Enclosed | Not ok as sub base material | |
| | | ACV | 30 | ≤30(Base), ≤38 Sub Base | Critical |

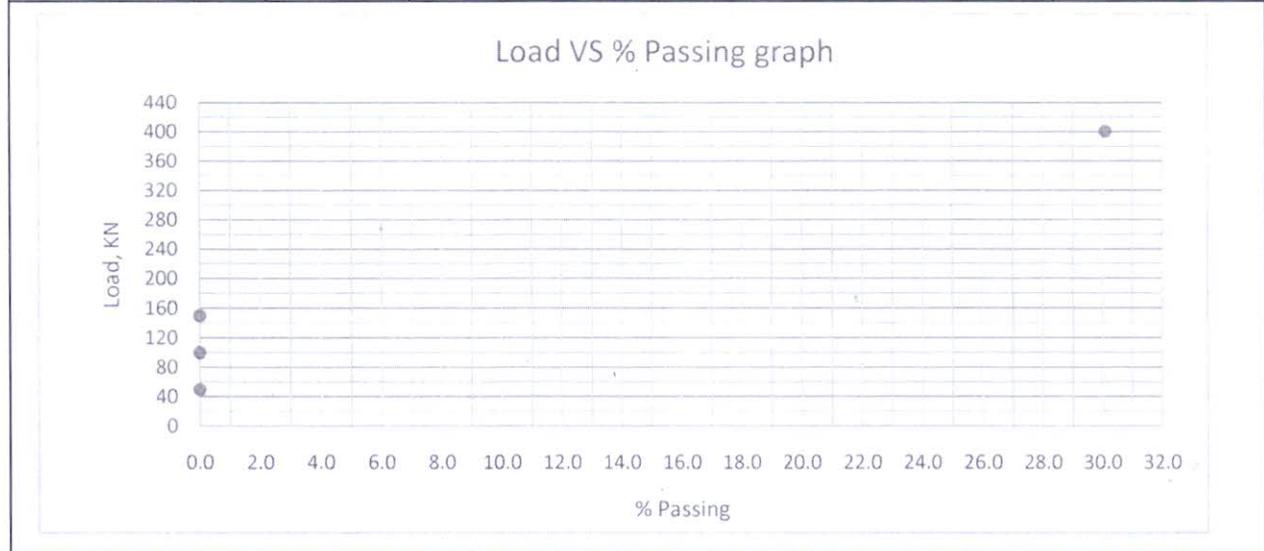
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Bangladesh Road Research Laboratory, RHD

Paikpara, Mirpur, Dhaka, Bangladesh

| Aggregate Crushing and 10% Fines Value (Data and Report Sheet) | | | |
|---|--|-------------------|-----------|
| Memo No | | Date | |
| Client | | | |
| Project / Work | | | |
| Location | K'pur-Dashuria-Natore- Rajshahi (Pabna Part), Dashuria More: Km 62+000 | | |
| Date of receive at lab | 8-May-17 | Date of test | 17-May-17 |
| Sample Description | Brick agg (Sub/Base) | Quantity Supplied | 8Kg |
| Name of Agency | 0 | | |

| Laboratory Work | | | Test Code | BS 812: Part 110: 1990, STP7.7 | | | |
|---|------|--------------------|-----------|--------------------------------|----------|-----------|--|
| Description | Unit | Notation / Formula | Load - 1 | Load - 2 | Load - 3 | Load - 4 | |
| Applied Force | KN | | 50 | 100 | 150 | | |
| Mass of Original test specimen(Dry) | g | M_1 | | | | 2007 | |
| Mass of Material passing 2.36mm sieve | g | M_2 | | | | 604 | |
| Mass of Material retained on 2.36mm sieve | g | M_3 | | | | 1403 | |
| Mass passing and retained on 2.36mm sieve | g | $M_2 + M_3$ | | | | 2007 | |
| % Fines | % | $(M_2/M_1)*100$ | | | | 30 | |
| ACV(400KN) | % | | 30 | | | < 38 , Ok | |
| 10% fines | KN | | | | | | |



Note: Fraction tested 14mm to 10mm, Separating sieve 2.36mm

ARO

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SDE

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(RHD)

(RHD)

(RHD)

(RHD)

Material Testing & Maintenance Division
Road Research Laboratory, Mirpur, Dhaka

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD
Paikpara, Mirpur, Dhaka, Bangladesh

| Base Gradation, Type-B, (Data and Report Sheet) | | | | | | | |
|---|-----------------|-------------------|-------------------------|-----------|-----------|-----------|--------------------------|
| Memo No | | | Date | | | | |
| Client | | | | | | | |
| Project / Work | | | | | | | |
| Location: K'pur-Dashuria-Natore- Rajshahi (Pabna Part), Dashuria Round about: Km 62+000 | | | | | | | |
| Date of receive at lab: 8-May-17 | | | Date of test: 17-May-17 | | | | |
| Sample Description: Base Type-1(A Gradaing) | | | Quantity Supplied: 8 Kg | | | | |
| Name of Agency: RHD Rajshahi Zone, Rajshahi | | | | | | | |
| Laboratory Work | | | | | Test Code | STP 7.2 | |
| Dry mass of material, gm: 4270 | | | | | | | |
| | Material wt, gm | Cumulative wt, gm | 4270 | % Passing | Sp. L.L.M | Sp. U.L.M | Remarks |
| 50.0 | 0 | 0 | 0 | 100.0 | 100 | 100 | Not ok as Base gradation |
| 38.0 | 138 | 138 | 3.23 | 96.8 | 100 | 100 | |
| 20.0 | 482 | 620 | 14.52 | 85.5 | 100 | 100 | |
| 10.0 | 800 | 1420 | 33.26 | 66.7 | 80 | 100 | |
| 5.0 | 4.91 | 1424.9 | 33.37 | 66.6 | 50 | 80 | |
| 2.40 | 358 | 1782.9 | 41.75 | 58.2 | 35 | 65 | |
| 0.60 | 500 | 2282.9 | 53.46 | 46.5 | 15 | 40 | |
| 0.30 | 202 | 2484.9 | 58.19 | 41.8 | 10 | 30 | |
| 0.075 | 952 | 3436.9 | 80.49 | 19.5 | 5 | 10 | |
| Pan | 833.09 | | | | | | |
| | | | | | | | Remarks |
| | | | | | | | Brick Aggregate |
| Remarks | | | | | | | |

Tested By

Remarks

Assistant Research Officer

(RHD)

Assistant Engineer

(RHD)

Sub Divisional Engineer

(RHD)

Executive Engineer

(RHD)

Material Testing & Maintenance Division
Road Research Laboratory, Mirpur, Dhaka

Government of the People's Republic of Bangladesh

Bangladesh Road Research Laboratory, RHD
Paikpara, Mirpur, Dhaka, Bangladesh

| Sub Base Gradation-A, (Data and Report Sheet) | | | | | | | | | | |
|--|---------------------|--|------------------------------|-------------------|-----------|-----------|------------------------------|--|--|--|
| Memo No | | | | | Date | | | | | |
| Client | | | | | | | | | | |
| Project / Work | | | | | | | | | | |
| Location | | K'pur-Dashuria-Natore- Rajshahi (Pabna Part), Dashuria More: Km 62+000 | | | | | | | | |
| Date of receive at lab | | 8-May-17 | | Date of test | | 17-May-17 | | | | |
| Sample Description | | Sub Base-A | | Quantity Supplied | | 8 Kg | | | | |
| Name of Agency | | RHD Rajshahi Zone, Rajshahi | | | | | | | | |
| Laboratory Work | | | | Test Code | | STP 7.2 | | | | |
| Dry mass of material, gm | | 4270 | | | | | | | | |
| | Material wt , gm | Cumulativ e wt, gm | Cumulativ e % retained | % Passing | Sp. L.L.M | Sp. U.L.M | Remarks | | | |
| 50.0 | 0 | 0.0 | 0 | 100.0 | 100 | 100 | Not OK as Sub base gradation | | | |
| 38.0 | 138 | 138.0 | 3.23 | 96.8 | 85 | 100 | | | | |
| 20.0 | 482 | 620.0 | 14.52 | 85.5 | 55 | 95 | | | | |
| 10.0 | 800 | 1420.0 | 33.26 | 66.7 | 35 | 75 | | | | |
| 5.0 | 4.91 | 1424.9 | 33.37 | 66.6 | 25 | 60 | | | | |
| 2.40 | 358 | 1782.9 | 41.75 | 58.2 | 15 | 50 | | | | |
| 0.60 | 500 | 2282.9 | 53.46 | 46.5 | 7 | 35 | | | | |
| 0.30 | 202 | 2484.9 | 58.19 | 41.8 | 6 | 27 | | | | |
| 0.075 | 952 | 3436.9 | 80.49 | 19.5 | 3 | 15 | | | | |
| Pan | 833.1 | | | | | | | | | |
| | | | | | | | Remarks | | | |
| | | | | | | | | | | |
| Remarks | | | | | | | | | | |

Tested By

Remarks

Assistant Research Officer

(RHD)

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Photos of damaged pavement surface

1. Damaged Pavement at ch 62+000



2. Damage repaired by HBB



3. Damaged Pavement

