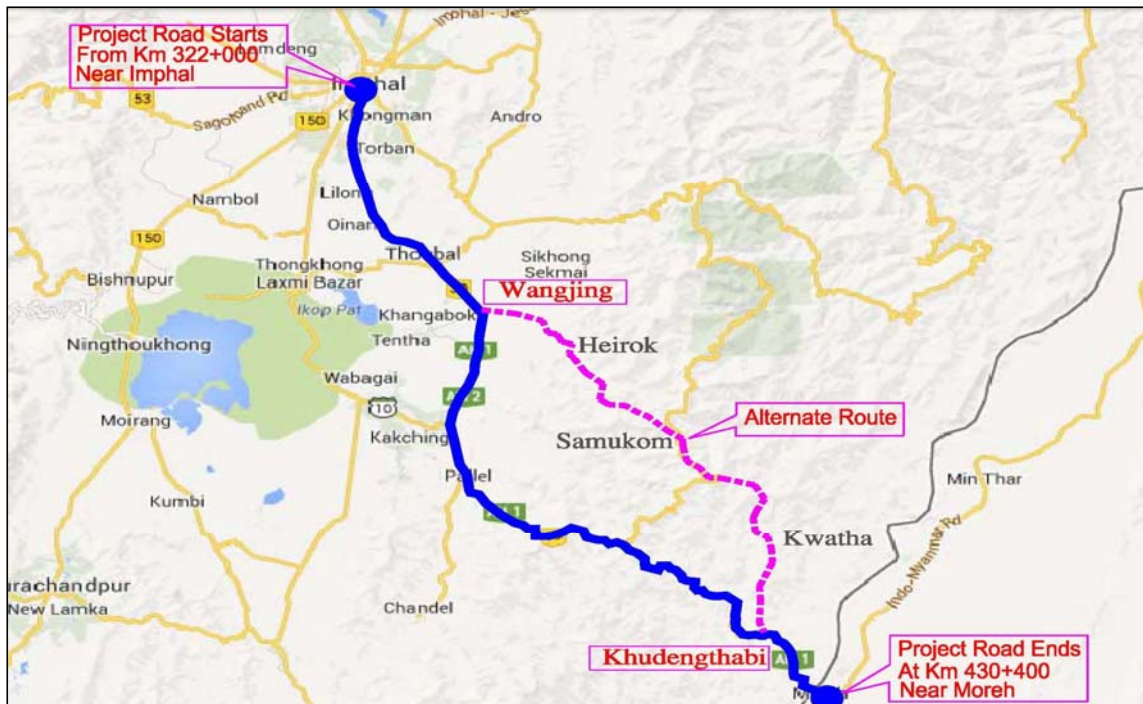


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04.03.14	0	INITIAL SUBMISSION	PNT	SG	SB
DATE	REV. NO.	DESCRIPTION	Designed	Checked	Approved

REVISIONS

FUNDED BY:



ASIAN DEVELOPMENT BANK

IMPLEMENTATION AGENCY:

JOINT PIU OF PWD / MORT&H / MANIPUR

CONCESSIONAIRE:



SHELADIA ASSOCIATES INC., USA

PROJECT:

DETAILED DESIGN FOR INDO MYANMAR ROAD SECTION PROJECT (IMPHAL TO MOREH : AH-01)

JOB No.

TOTAL NO. OF PAGES				TITLE :
	NAME	SIGN	DATE	APPENDIX 3.1 OF VOL II, PART II  GEOTECH REPROT FOR MINOR BRIDGES
DSGN	PNT		04.03.14	
CHKD	SG		04.03.14	
APPD	SB		04.03.14	

DOC. No.	ADB/ AH 01 / GT / MNB / DC / 100 / 02	CODE	REV.
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# GEOTECH REPORT FOR MINOR BRIDGE

AT CH: 334+330



**Geotechnical Investigation Report for determination of allowable bearing pressure for  
MINOR BRIDGE at CH. 334+330 of NH-39 under  
“DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH,  
ADB TA - 8116 IND”**

**ABSTRACT**

**The safe load carrying capacity of the foundation of MINOR BRIDGE at Ch. 334+330 on NH-39 is recommended as follows:**

Location		Bore hole Level (m)	Theoretic al Scour Level (m)	Scour Depth Below Borehole (m)	Pile Cap Top Level (m)	Pile Cap Bottom Level (m)	Pile Tip Level (m)	Length of Pile (m)	Vertical Capacity (t)	Lateral Capacity (t)	Uplift Capacity (T)
335/1A	A1	773.720	767.235	6.485	773.220	771.420	754.220	17.20	300	20	10

## THE STRATA AT GLANCE AND SILT FACTORS

Borehole No.	Type of strata	Depth	Weighted mean dia, $d_m$ (mm)	Silt Factor,
1	2	3	4	5
BH-335/1A	Highly Plastic Clay (CH) mixed with Sand	0.0-18.0m	-	3.47
	Moderately Weathered Rock	18.0-20.0m	-	Non Erodible



**Geotechnical Investigation Report**  
**for determination of allowable bearing pressure for**  
**MINOR BRIDGE at CH. 334+330 on NH-39 under**  
**“Detailed Project for Indo Myanmar Road Section from Imphal to Moreh,**  
**ADB TA - 8116 IND”**

## **1. INTRODUCTION**

Geotechnical investigation was carried out for MINOR BRIDGE at Ch.334+330 on NH-39 under Detailed Project for Indo Myanmar Road Section from Imphal to Moreh, ADB TA - 8116 IND. The Schedule of work and the locations of bore holes were decided by Engineer In-charge of Sheladia Associates, Inc., USA. The locations of boreholes are shown in Key Plan (Fig.B1).

## **2.0 FIELD INVESTIGATION**

### **2.1 Boring**

One bore hole i.e. BH-335/1A was made at the locations decided by Engineer In-charge as shown in Key Plan (Fig.B1). Boring was done by power driven rig as per guidelines of IS: 1892:1979 and IRC-78-2000. Boring was done up to the maximum depth of 20.0m. The soil samples were collected as required for laboratory testing.

### **2.2 Standard Penetration Test (SPT)**

Standard penetration test (SPT) was conducted in the bore hole as per IS 2131-1981. The numbers of blows for first 15 cm penetration is considered as seating drive and are not taken into account. The number of blows required for last 30 cm penetration is taken as SPT number (“N” values). If number of blows for last 30 cm penetration exceeds 100, it is said to be the refusal. SPT were

conducted at regular interval of 1.5m, starting from the depth of 1.5m from the ground surface to the depth of exploration/ refusal. The tests results are shown in Table-B1.1.

### **2.3 Water Table**

The water table was observed at the depth of 1.7m from ground surface, at the time of investigation (i.e. December 2013).

### **3.0 LABORATORY INVESTIGATION**

#### **Soil Samples:**

The following laboratory tests were conducted on the soil samples obtained from test bore holes:

- a) Natural Moisture content
- b) Specific gravity
- c) Liquid & Plastic Limit
- d) Grain size Analysis
- e) Shear strength test
- f) Bulk density (Dry Density)
- g) Free swell test

Test results are shown in borelogs i.e. Table-B1.1.

#### **Laboratory Tests for Rocks:**

Rock samples recovered from various depths of strata are tested for the following properties.

- (1) Water absorption (IS : 13030)
- (2) Specific gravity (IS : 2720 (Part -3))
- (3) Unconfined Compressive strength (IS 9143)
- (4) Point Load Strength Index (IS-8764: 1998)
- (5) Bulk and Dry density (IS 13030: 1991)
- (6) Porosity (IS: 13030: 1991)

#### 4. TYPE OF STRATA

Based on laboratory and field investigation the strata at the site have been described. The bore-log of the strata is presented in Table-B1.1. The strata are as follows:

##### **BH-335/1A**

The upper layer of the strata thickness about 18.0m was found to be Highly Plastic Clay (CH) mixed with Sand. Below this, Moderately Weathered Rock was found up to the depth of exploration i.e. 20.0m. The bore-log is shown in Table-B1.1.

#### 5.0 FOUNDATION ANALYSIS

Pile foundation has been analyzed. The calculation sheets for safe load carrying capacity bearing capacity in vertical and uplift for different borehole locations are attached as Appendix-B1.1. Also the lateral load carrying capacity is given in Appendix-B1.1.1.

#### 6.0 SILT FACTOR

In order to determine maximum score depth the silt factor of the bad material is required to be determine. The silt factor (f) depends upon the average size of bed material and given by Lacey equation as follows:

$$K_{sf} = 1.76 \sqrt{d_m}$$

Where  $d_m$  = the weighted mean diameter in millimeter

Also, in case of soil having  $\phi < 15^\circ$  and  $c$  (cohesion of soil)  $> 0.2 \text{ kg/cm}^2$ , ' $K_{sf}$ ' calculated as follows :

$$K_{sf} = F (1 + \sqrt{c}) \text{ where } c \text{ is in kg/cm}^2$$

where  $F$  = 1.50 for  $\phi > 10^\circ$  and  $< 15^\circ$   
= 1.75 for  $\phi > 5^\circ$  and  $< 10^\circ$   
= 2.00 for  $\phi < 5^\circ$

Borehole No.	Type of strata	Depth	Weighted mean dia, $d_m$ (mm)	Silt Factor,
1	2	3	4	5
BH-335/1A	Highly Plastic Clay (CH) mixed with Sand	0.0-18.0m	-	3.47
	Moderately Weathered Rock	18.0-20.0m	-	Non Erodible

## 7.0 CONCLUSION

1. The strata at the site is described in Section 4.0.
2. The water table was observed at the depth of 1.7m from ground surface, at the time of investigation (i.e. December 2013).
3. Safe load carrying capacity has been recommended as follows:

**The safe load carrying capacity of the foundation of MINOR BRIDGE at Ch. 334+330 on NH-39 is recommended as follows:**

Location		Bore hole Level (m)	Theoretic al Scour Level (m)	Scour Depth Below Borehole (m)	Pile Cap Top Level (m)	Pile Cap Bottom Level (m)	Pile Tip Level (m)	Length of Pile (m)	Vertical Capacity (t)	Lateral Capacity (t)	Uplift Capacity (T)
335/1A	A1	773.720	767.235	6.485	773.220	771.420	754.220	17.20	300	20	10

SCOUR DEPTH CALCULATIONS FOR MAJOR BRIDGE AT CH: 334+330 (Ushoipokpi)

Si.No	Chainage	Proposed Span Arrangement	Location	HFL (m)	Discharge (Cumecs)	Velocity (m/sec)	Design Discharge 1.3xQ (Cumec)	Silt Factor	Eff. Linear Waterway (m)	Discharge per m width (Cumecs/	Mean Scour Depth Dsm(m)	Scour depth below HFL(m)	Borehole Level (m)	Min. Bed Level (m)	Theoretic al Scour level (m)	Seismic case	Actual Scour level (m)	Scour depth below BH (m)
1	334+330	1 x 18	A1	774.720	175	5.56	227.5	2.5	15.6	14.583	5.893	7.485	773.720	-	767.235	767.9839	767.235	6.485
	Ushoipokpi		P	774.720	175	5.56	227.5	2.5	15.6	14.583	5.893	11.787			762.933			

# DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH, ADB TA - 8116 IND

## VERTICAL CAPACITY CALCULATIONS

## APPENDIX-B1.1

Minor Bridge at Ch: 334+330 (Ushoipokpi)

**METHOD II: FOR PILES SOCKETED IN GEO-MATERIAL:**

BH No. 335/1A

**Pile Capacity in compression is determined as below:**

$$Q_u = R_e + R_{sf}$$

$$= C_{ub} \times N_c \times A_b + A_s \times C_{us}$$

where,  $Q_u$  = Ultimate Capacity of PILE socketed in Geo-Material in Newtons

$R_e$  = Ultimate End Bearing Capacity in Newtons

$R_{sf}$  = Ultimate side Socket Shear in Newtons

$C_{ub}$  = Average Shear Strength below base of pile for the depth twice the diameter / least lateral dimension of pile

Shear Strength/Consistency (qc)	Moderately Weak	Weak	Very weak
Approximate N Value	300 to 200	200 to 100	100 to 60
Shear Strength /	3.3 - 1.9	1.9 - 0.7	0.7 - 0.4

### SPT Values along the socket length

Depth	SPT Value
18	19
19	20
20	21
21	22
22	23
23	24
	<b>100</b>

The Average SPT value along the Socket length =

= 100

Average SPT value below base of pile =

= 100

$L_1$  = Length of Scourable soil

= 6.5 m

$L$  = Length of the pile from Cut off level

= 17.2 m

$D$  = Diameter of socket =

= 1200 mm

$L_1$  = Length of over burden soil

= 11.5 m

$L_s$  = Length of Socket =

= 1200 mm

$N_c$  =

= 9

$C_{us}$  = Ultimate Shear Strength along Socket length

= 0.7 N/mm<sup>2</sup>

= but, shall not be more than 3 N/mm<sup>2</sup> for M35 concrete

= 0.7 N/mm<sup>2</sup>

$C_{ub}$  = Average Shear Strength below base of PILE for the depth twice the diameter / least lateral dimension

= 0.7 N/mm<sup>2</sup>

$A_s$  = Pile Surface Area of Socket

= 4523893 Sq.mm.

$A_b$  = Cross Section Area of Base of PILE

= 1130973 Sq.mm.

$R_e$  =  $C_{ub} \times N_c \times A_b$

= 7125.1 KN

$R_{sf}$  =  $A_s \times C_{us}$

= 3166.7 KN

Factor of safety on End Bearing component =

= 3

Factor of safety on Socket Friction Component =

= 6

**Allowable Capacity of PILE in compression =**

= **3430.62 KN**  
**343.1 t**

**The Recommended Vertical Load Carrying Capacity is 300 t**

Ultimate Uplift load carrying capacity is

369.45 Kn

**The Safe Uplift load carrying capacity is**

103.49 Kn

**10.3 Tonnes**

The Recommended Uplift load Carrying Capacity is

**10 Tonnes**

**DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO  
MOREH, ADB TA - 8116 IND**

**APPENDIX-B1.1.1**

**ESTIMATION OF LATERAL LOAD CARRYING CAPACITY OF PILES for A1  
(USHOIPOKPI) MINOR BRIDGE AT CH: 334+330**

Stipulations of IS:2911 (Part I/Sec.2) - 1979 are followed

Diameter of Pile	=	1200 mm
Strength of Pile Concrete	=	35 N/mm <sup>2</sup>
Young's Modulus of Pile Concrete	=	31500 N/mm <sup>2</sup>
	=	31500000 kN/m <sup>2</sup>
Moment of Inertia of Pile Cross Section	=	1.02E+11 mm <sup>4</sup>
	=	0.1018 m <sup>4</sup>
Top Layer of sub-soil strata	=	Clay
Value of Constant, k1	=	5000 kN/m <sup>3</sup>
T	=	5.03 m
Unsupported Length, L <sub>1</sub>	=	4.200 m
L <sub>1</sub> /T	=	0.835
L <sub>r</sub> /T	=	<b>2.08</b>
L <sub>r</sub> (Ref Fig.2, Appendix C of IS 2911 (Part 1/Sec.2) - 1979	=	10.467 m
Cantilever span of pile	=	14.7 m
Lateral Deflection at bottom of pile cap level under unit lateral load	=	0.000082 m
Lateral Deflection at Top of PILE	=	0.0820 mm
Corresponding Deflection at scour level	=	0.0585 mm
Allowable deflection at scour level	=	12 mm
Force that causes 12mm Lateral Deflection at scour level	=	205.052 kN
Thus, Lateral Capacity of INDIVIDUAL PILE	=	205.052 kN

**NOTE: The recommended lateral load carrying capacity is 20 tonnes**



**TABLE-B1.1: RESULT SHEET FOR MINOR BRIDGE AT CH.334+330 ON BH-335/1A**

(W.T. = 1.70M)

**PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH****ADB TA - 8116 IND****Size of Hole : Nx Size****Type of Bit : TC / Diamond****Starting date : 14.12.2013****Completion date : 16.12.2013**

Depth (m)	N - value				IS Classification Soil Descreption	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content,% (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N		Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
1.0	3	4	4	8	<b>HIGHLY PLASTIC CLAY (CH) MIXED WITH SAND</b>	1.60	29.20	13.84	55.36	57.0	27.0	-	2.68	-	-	-	36.6	-
2.0																		
3.0	3	3	4	7														
4.0	2	4	4	8														
5.0																		
6.0	3	4	5	9														
7.0																		
8.0	3	4	6	10														
9.0	4	5	7	12		1.65	26.15	15.88	56.32	60.00	21.0	-	-	-	-	-	43.0	-

\* = Consolidation Test,

c<sub>c</sub> = Compression Index,

DFS = Differential Free Swell,

—v = Water Table,

Sp = Swelling Pressure

**TABLE-B1.1: RESULT SHEET FOR MINOR BRIDGE AT CH.334+330 ON BH-335/1A**

(W.T. = 1.70M)

**PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH****ADB TA - 8116 IND**

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 14.12.2013

Completion date : 16.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Description	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
10.0	5	7	8	15	<b>HIGHLY PLASTIC CLAY (CH) MIXED WITH SAND</b>	2.00	22.95	15.01	60.04	58.5	22.0	-	-	-	-	-	42.4	
11.0																		
12.0	6	7	9	16														
13.0																		
14.0	6	8	10	18														
15.0	7	11	14	25														
16.0																		
17.0	9	14	22	26		1.00	24.30	18.68	56.03	61.7	23.0	-	2.70	-	-	-	46.3	
18.0	32	50/5	-	182														

\* = Consolidation Test,

c<sub>c</sub> = Compression Index,

DFS

= Differential Free Swell,

—v = Water Table,

Sp = Swelling Pressure

**TABLE-B1.1: RESULT SHEET FOR MINOR BRIDGE AT CH.334+330 ON BH-335/1A**

(W.T. = 1.70M)

**PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH**

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 14.12.2013

Completion date : 16.12.2013

Depth (m)	SPT Details				Bore Log	Description of Strata	Core Recovery (%)	RQD (%)	$q_u$ (t/m <sup>2</sup> )	Density (t/m <sup>3</sup> )	Return Water		Remark
	15	30	45	N							Color	Loss (%)	
19.0						<b>MODERATELY WEATHERED ROCK</b>	19	0.0	-	-			
20.0							21	0.0	-	-			
21.0													
22.0													
23.0													
24.0													
25.0													

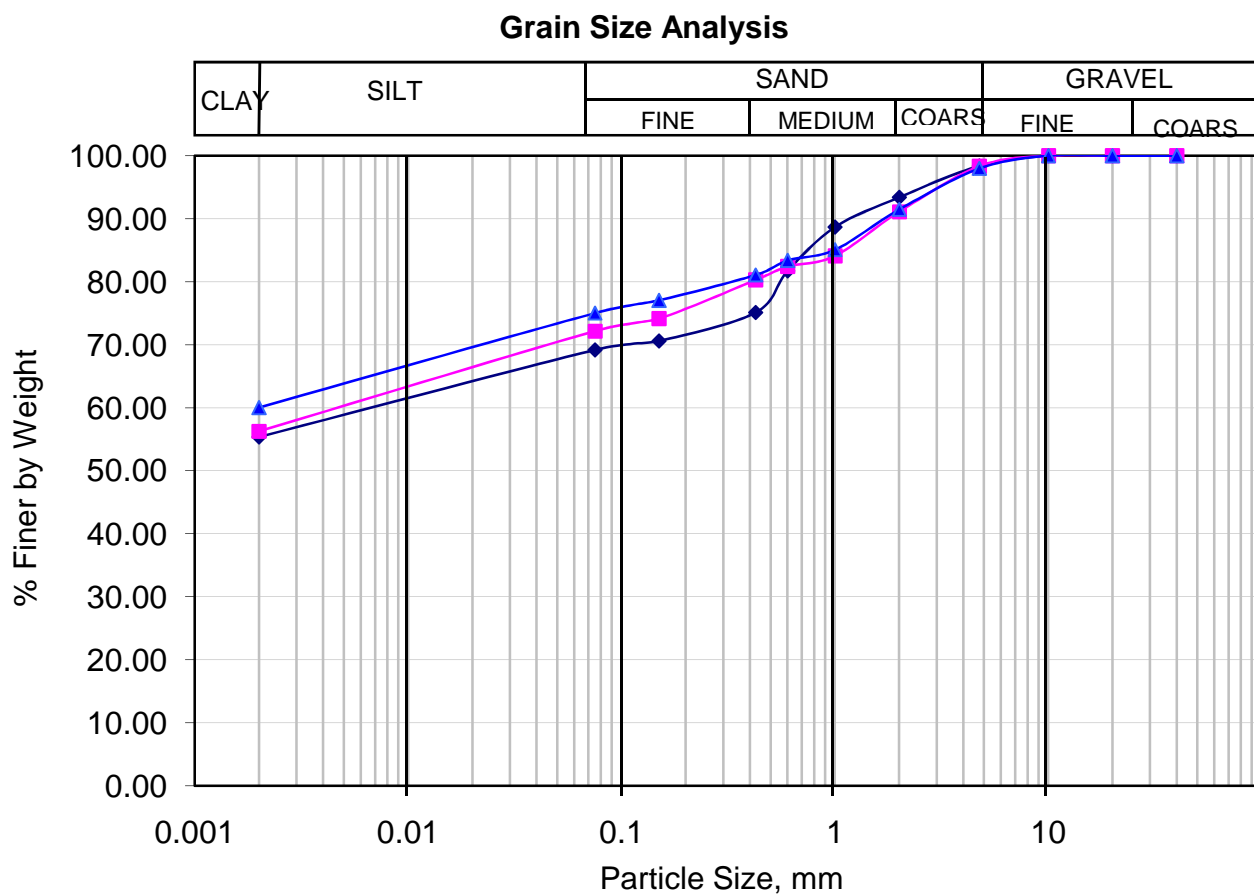
R = Refusal to SPT (N> 50), RQD = Rock Quality Designation,  $q_u$  = Uniaxial Compressive Strength  $\text{—}v$  = Water Table

# PNT DESIGNS PVT. LTD., KOTA

PROJECT - DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH,  
ADB TA - 8116 IND

Determination of Grain Size Analysis Test as per IS:2720-Part 4-1985

MNB AT CH: 334+330 (335/1A)



Symbol	BH No.	Depth,m	Soil description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
—◆—	BH-335/1A	1.50	CH*	1.60	29.20	13.84	55.36
—■—	BH-335/1A	9.00	CH*	1.65	26.15	15.88	56.32
—▲—	BH-335/1A	12.00	CH*	2.00	22.95	15.01	60.04

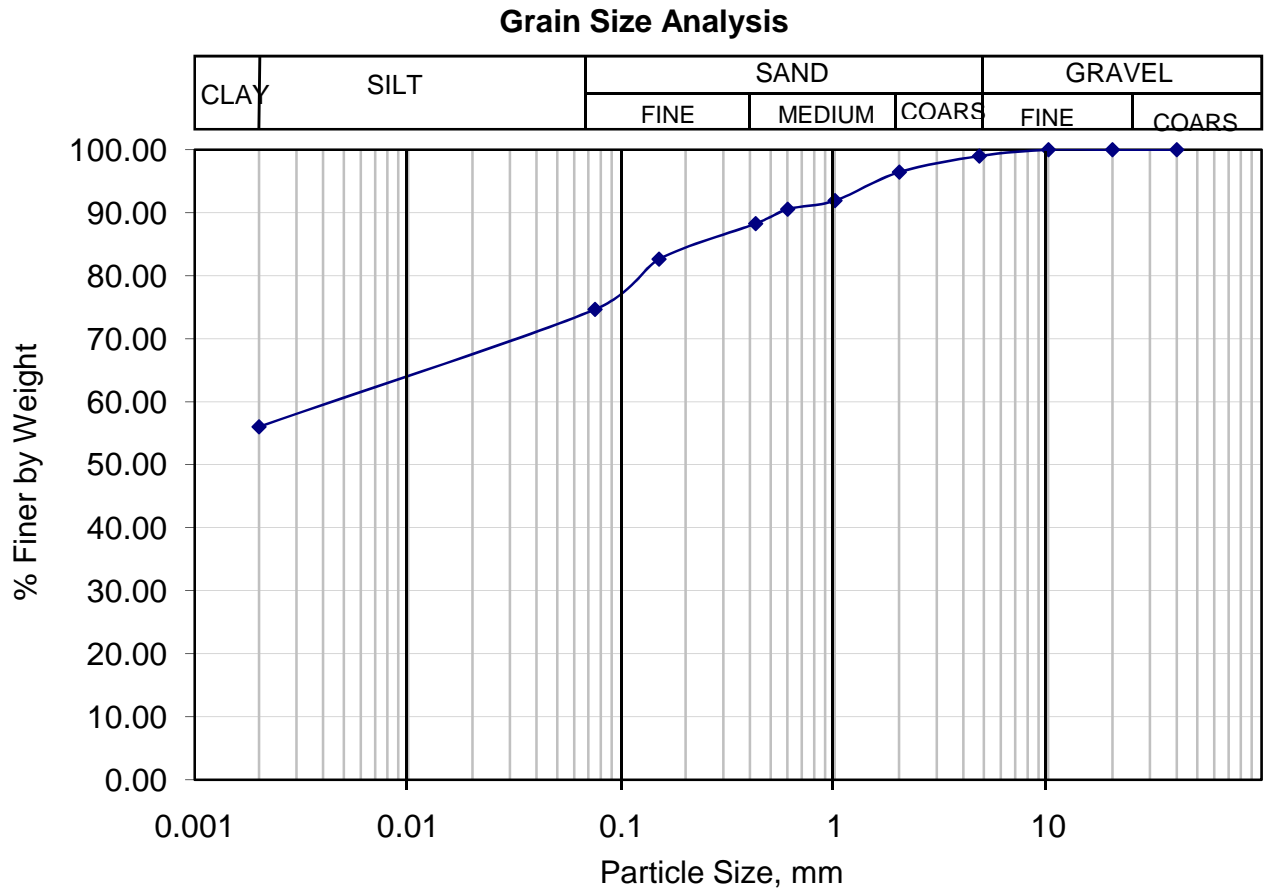
CH\* = HIGHLY PLASTIC CLAY (CH) MIXED WITH SAND

# PNT DESIGNS PVT. LTD., KOTA

PROJECT - DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH,  
ADB TA - 8116 IND

Determination of Grain Size Analysis Test as per IS:2720-Part 4-1985

MNB AT CH: 334+330 (335/1A)



Symbol	BH No.	Depth,m	Soil description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
—◆—	BH-335/1A	16.50	CH*	1.00	24.30	18.68	56.03

CH\* = HIGHLY PLASTIC CLAY (CH) MIXED WITH SAND

SILT FACTOR CALCULATION BASED ON COHESION OF SOIL  
MNB AT CH.334+330

Location : BH-335/1A

Depth : 0.0-18.0m

In order to determine maximum score depth the silt factor of the bad material is required to be determined. The silt factor ( $K_{sf}$ ) depends upon the average size of bed material and given by Lacey equation as follows:

$$K_{sf} = 1.76 \sqrt{d_m} \quad \dots\dots 1$$

Where  $d_m$  = the weighted mean diameter in millimeter

Also, in case of soil having  $\phi < 15^\circ$  and  $c$  (cohesion of soil)  $> 0.2 \text{ kg/cm}^2$ , ' $K_{sf}$ ' calculated as follows :

$$K_{sf} = F (1 + \sqrt{c}) \text{ where } c \text{ is in } \text{kg/cm}^2 \quad \dots\dots 2$$

where  $F = 1.50$  for  $\phi > 10^\circ$  and  $< 15^\circ$

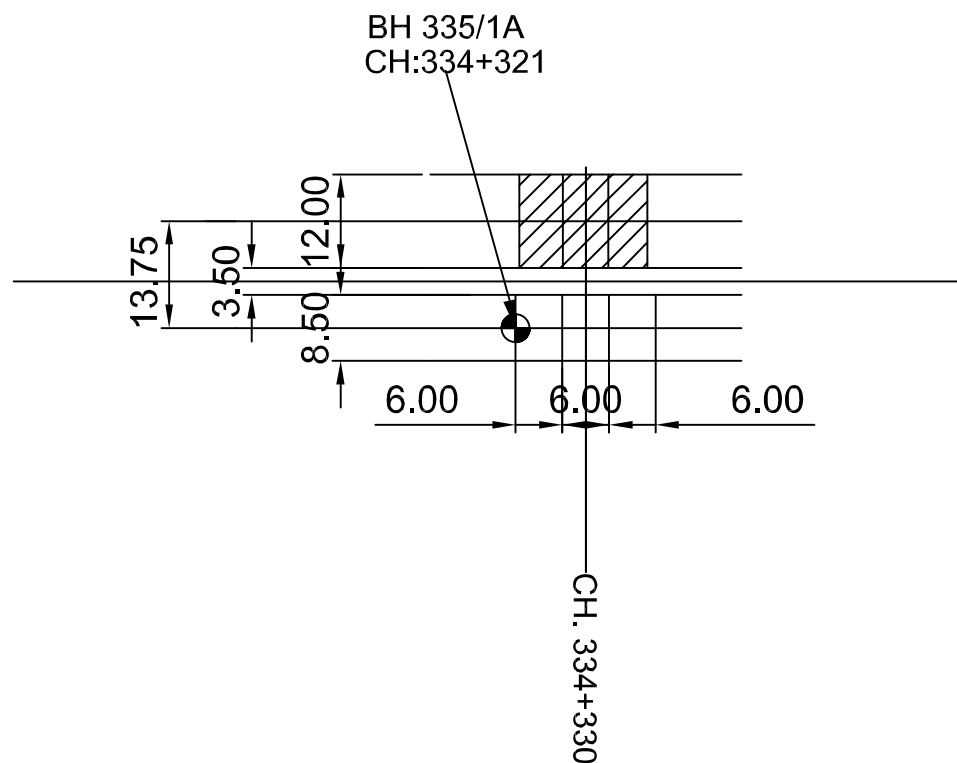
$= 1.75$  for  $\phi > 5^\circ$  and  $< 10^\circ$

$= 2.00$  for  $\phi < 5^\circ$

The strata at this location found to be Highly Plastic Clay (CH). The silt factor has been calculated on the basis of undrained cohesion ( $c$ ) of the soil using equation (2) above. The undrained cohesion has been obtained from SPT data recorded at the site. The calculation of silt factor is as follows :

Design SPT-value of the Strata (Refusal, $N > 100$ )	:	9	= (8+7+8+9+10+12)/6
(below the Founding level)	:		
Cohesion, $C_u = 6 \text{ N (kPa)}$	:	54	
Angle of shearing resistance (restricted) $\phi$	:	0	
Cohesion, $C_u \text{ (kg/cm}^2\text{)}$	:	0.54	
The silt factor shall be as follows :	:	$K_{sf} = F (1 + \sqrt{c})$	
Where :	:	2	
	:	$2 * (1 + \sqrt{0.54})$	
	:	<b>3.47</b>	

## BOREHOLE LOCATION PLAN FOR MINOR BRIDGE AT CH: 334+330 (Ushoipokpi)



Existing Span Arrangements  
(5.6 + 5.9+5.6)

Proposed Span Arrangements  
(3 x 6.0)

(The borehole locations are given for  
Existing chainage)

### LEGEND:



Borehole Location



Existing Bridge

### PROJECT

DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION  
FROM IMPHAL TO MOREH, ADB TA - 8116 IND

Design Consultant :

**SHELADIA ASSOCIATES INC., USA**



Amsrl Shamlra, Flat No: 206 & 207,  
S D Road, Old Lancer Lanes,  
Secunderabad-500003, AP.





## GEOTECH REPORT FOR MINOR BRIDGE

AT CH: 336+100



**Geotechnical Investigation Report for determination of allowable  
bearing pressure for MINOR BRIDGE at  
CH. 336+100 of NH-39 under  
“DETAILED PROJECT FOR INDO MYANMAR ROAD  
SECTION FROM IMPHAL TO MOREH, ADB TA - 8116 IND”**

**ABSTRACT**

The safe load carrying capacity of the foundation of MAJOR BRIDGE at Ch. 336+100 on NH-39 is recommended as follows:

<b>Location of Borehole</b>	<b>Existing Ground Level</b>	<b>Founding Level</b>	<b>Depth of Foundation Df (m)</b>	<b>Net Allowable Bearing Capacity (t/m<sup>2</sup>)</b>	<b>Type of foundation</b>
<b>337/1A</b>	<b>773.480</b>	<b>765.000</b>	<b>8.48</b>	<b>40.0</b>	<b>Open</b>
<b>337/1B</b>	<b>770.480</b>	<b>764.480</b>	<b>6.00</b>	<b>50.0</b>	<b>Open</b>

## THE STRATA AT GLANCE AND SILT FACTORS

Borehole No.	Type of strata	Depth	Weighted mean dia, $d_m$ (mm)	Silt Factor,
1	2	3	4	5
BH-337/1A	Filled-up Material	0.0-6.25m	-	-
	Clayey Sand (SC) mixed with Gravels	6.25-12.0m	1.80-1.91	2.36-2.43
	Moderately Weathered Rock	12.0-15.5m	-	Non Erodible
BH-337/1B	Medium Plastic Clay (Cl) mixed with Sand	0.0-3.0m	-	4.30
	Clayey Sand (SC) mixed with Gravels	3.0-4.5m	1.52	2.17
	Moderately Weathered Rock	4.50-6.50m	-	Non Erodible

**Geotechnical Investigation Report**  
**for determination of allowable bearing pressure for**  
**MINOR BRIDGE at CH. 336+100 on NH-39 under**  
**“Detailed Project for Indo Myanmar Road Section from Imphal to Moreh,**  
**ADB TA - 8116 IND”**

## **1. INTRODUCTION**

Geotechnical investigation was carried out for MINOR BRIDGE at Ch.336+100 on NH-39 under Detailed Project for Indo Myanmar Road Section from Imphal to Moreh, ADB TA - 8116 IND. The Schedule of work and the locations of bore holes were decided by Engineer In-charge of Sheladia Associates, Inc., USA. The locations of boreholes are shown in Key Plan (Fig.B2).

## **2.0 FIELD INVESTIGATION**

### **2.1 Boring**

Two bore hole i.e. BH-337/1A & BH-337/1B was made at the locations decided by Engineer In-charge as shown in Key Plan (Fig.B2). Boring was done by power driven rig as per guidelines of IS: 1892:1979 and IRC-78-2000. Boring was done up to the maximum depth of 15.5m. The soil samples were collected as required for laboratory testing.

### **2.2 Standard Penetration Test (SPT)**

Standard penetration test (SPT) was conducted in the bore hole as per IS 2131-1981. The numbers of blows for first 15 cm penetration is considered as seating drive and are not taken into account. The number of blows required for last 30 cm penetration is taken as SPT number (“N” values). If number of blows for last 30 cm penetration exceeds 100, it is said to be the refusal. SPT were conducted at regular interval of 1.5m, starting from the depth of 1.5m from the

ground surface to the depth of exploration/ refusal. The tests results are shown in Table-B2.1 to B2.2.

### **2.3 Water Table**

The water table was observed at the depth of 1.9-5.0m from ground surface, at the time of investigation (i.e. December 2013).

### **3.0 LABORATORY INVESTIGATION**

#### **Soil Samples:**

The following laboratory tests were conducted on the soil samples obtained from test bore holes:

- a) Natural Moisture content
- b) Specific gravity
- c) Liquid & Plastic Limit
- d) Grain size Analysis
- e) Shear strength test
- f) Bulk density (Dry Density)
- g) Free swell test

Test results are shown in borelogs i.e. Table-B2.1 to B2.2.

### **4. TYPE OF STRATA**

Based on laboratory and field investigation the strata at the site have been described. The bore-log of the strata is presented in Table-B2.1 to B2.2. The strata are as follows:

#### **BH-337/1A**

The upper layer of the strata thickness about 6.25m was found to be Filled-up Material. Below this, Clayey Sand (SC) mixed with Gravels was found up to the depth of 12.0m. Beyond this, Moderately Weathered Rock was found up to the depth of exploration i.e. 15.5m. The bore-log is shown in Table-B2.1.

## **BH-337/1B**

The upper layer of the strata thickness about 3.0m was found to be Medium Plastic Clay (CI) mixed with Sand. Below this, Clayey Sand (SC) mixed with Gravels was found up to the depth of 4.5m. Beyond this, Moderately Weathered Rock was found up to the depth of exploration i.e. 6.5m. The bore-log is shown in Table-B2.2.

## **5.0 FOUNDATION ANALYSIS**

Open foundation has been analyzed based on results of SPT. The calculation sheets for allowable bearing capacity at borehole locations BH-337/1A & BH-337/1B are attached as Appendix-B2.1 & Appendix-B2.2 respectively.

## **6.0 SILT FACTOR**

In order to determine maximum score depth the silt factor of the bad material is required to be determine. The silt factor (f) depends upon the average size of bed material and given by Lacey equation as follows:

$$K_{sf} = 1.76 \sqrt{d_m}$$

Where  $d_m$  = the weighted mean diameter in millimeter

Also, in case of soil having  $\phi < 15^\circ$  and  $c$  (cohesion of soil)  $> 0.2 \text{ kg/cm}^2$ , ' $K_{sf}$ ' calculated as follows :

$$K_{sf} = F (1 + \sqrt{c}) \text{ where } c \text{ is in kg/cm}^2$$

where  $F$

- $= 1.50$  for  $\phi > 10^\circ$  and  $< 15^\circ$
- $= 1.75$  for  $\phi > 5^\circ$  and  $< 10^\circ$
- $= 2.00$  for  $\phi < 5^\circ$

<b>Borehole No.</b>	<b>Type of strata</b>	<b>Depth</b>	<b>Weighted mean dia, <math>d_m</math> (mm)</b>	<b>Silt Factor,</b>
<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
BH-337/1A	Filled-up Material	0.0-6.25m	-	-
	Clayey Sand (SC) mixed with Gravels	6.25-12.0m	1.80-1.91	2.36-2.43
	Moderately Weathered Rock	12.0-15.5m	-	Non Erodible
BH-337/1B	Medium Plastic Clay (CI) mixed with Sand	0.0-3.0m	-	4.30
	Clayey Sand (SC) mixed with Gravels	3.0-4.5m	1.52	2.17
	Moderately Weathered Rock	4.50-6.50m	-	Non Erodible

## 7.0 CONCLUSION

1. The strata at the site is described in Section 4.0.
2. The water table was observed at the depth of 1.9-5.0m from ground surface, at the time of investigation (i.e. December 2013).
3. Safe load carrying capacity has been recommended as follows:

<b>Location of Borehole</b>	<b>Existing Ground Level</b>	<b>Founding Level</b>	<b>Depth of Foundation Df (m)</b>	<b>Net Allowable Bearing Capacity (t/m<sup>2</sup>)</b>	<b>Type of foundation</b>
<b>337/1A</b>	<b>773.480</b>	<b>765.000</b>	<b>8.48</b>	<b>40.0</b>	<b>Open</b>
<b>337/1B</b>	<b>770.480</b>	<b>764.480</b>	<b>6.00</b>	<b>50.0</b>	<b>Open</b>



SCOUR DEPTH CALCULATIONS FOR MINOR BRIDGE AT CH: 336+100 (Waithou)

Si.No	Chainage	Proposed Span Arrangement	Location	HFL (m)	Discharge (Cumecs)	Velocity (m/sec)	Design Discharge 1.3xQ (Cumec)	Silt Factor	Eff. Linear Waterway (m)	Discharge per m width (Cumecs/	Mean Scour Depth Dsm(m)	Scour depth below HFL(m)	Borehole Level (m)	Min. Bed Level (m)	Theoretic al Scour level (m)	Restricted Scour Level (m)	Actual Scour level (m)	Scour depth below BH (m)
2	336+100	2 X 20.0	A1	774.480	408	3.56	530.4	2.5	36.4	14.571	5.890	7.480	773.480	-	767.000		767.000	6.480
	(Waithou)		P	774.480	408	3.56	530.4	2.5	36.4	14.571	5.890	11.780	770.480	-	762.700	765.980	765.980	4.500

**DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH, ADB TA - 8116 IND**  
**APPENDIX-B2.1**

**Minor Bridge**

**DETERMINATION OF BEARING CAPACITY OF SHALLOW FOUNDATIONS**  
**COMPUTATION OF BEARING CAPACITY AS PER IS:6403**

**CH: 336+100**

**Location : BH-337/1A**

**1.1 Foundation Details**

Type of Foundation System	: Open Foundation
<b>Depth of filled-up soil, m</b>	: 6.25
Depth of Foundation below existing ground level in (m)	: 14.73
<b>Depth of Foundation below natural ground surface</b>	: 8.48
width of foundation in (m)	: 6.0
Length of foundation in (m)	: 8.0

**1.2 Soil Parameters:**

Bearing capacity has been calculated on the basis of average SPT value for the depth of 1.5 times width of foundation, below the base of foundation. The refusal to SPT has been considered when  $N > 100$ . The angle of shearing resistance of soil ( $\phi$ ) has been obtained for average value of SPT so obtained, using Fig. No.1 of IS:6403-1981.

Design SPT-value of the Bearing Strata (Refusal, $N > 100$ )	: 100
(below the Founding level)	:
Cohesion, $C_u = 6N$ (kpa)	: 0
Angle of shearing resistance (restricted) $\phi$	: 34
Cohesion, $C_u$ ( $t/m^2$ )	: 0
Bulk density of the strata ( $t/m^3$ )	: 2
Submerged density of the strata ( $t/m^3$ )	: 1.000
$N_\phi = \tan^2 (45 + \phi/2)$	: 3.537

**1.3 Design Parameters:**

<b>Bearing Capacity Factors:</b>	<b>Shape Factors</b>	<b>Depth Factors</b>	<b>Inclination Factors</b>	<b>W.C Factor</b>
$N_c = 42.924$	$S_c = 1.2$	$D_c = 1.5$	$i_c = 1.0$	$i_w = 0.5$
$N_q = 30.32$	$S_q = 1.2$	$D_q = 1.3$	$i_q = N/A$	
$N_\gamma = 42.904$	$S_\gamma = 0.7$	$D_\gamma = 1.3$	$i_\gamma = 1$	

**Net Ultimate Bearing Capacity:**

$$Q_u = (C_u * N_c * D_c * i_c * S_c) + (\gamma * d * (N_q - 1) * S_q * d_q * i_q) + (0.5 * B / 2 * \gamma * N_\gamma * S_\gamma * d_\gamma * i_\gamma)$$

$$= 475.98$$

Factor of Safety = 2.5

Net Safe Bearing Cap. = 190.39  $t/m^2$

**Settlement Criterial**

The settlement has been obtained from IS:8009 part-I. For  $N = > 100$ ,  $W' = 0.5$  and pressure of 10  $t/m^2$ , the settlement has been obtained as 9mm. Settlement obtained from lower most curve corresponding to  $N = 60$  from Fig.9 of IS:8009- (Part-I) 1976.

$$\text{Settlement} = 9 \text{ mm}$$

Therefore, safe bearing pressure for permissible settlement of 50mm shall be  $(10/9 \times 50)$   
55.56  $t/m^2$

after applying rigidity factor 0.8, the SBC shall be 69.444  $t/m^2$

$$L/B = 1.33 \quad D/\sqrt{LB} = 1.224$$

Depth factor as per Fig: 12 of IS 8009 Part -I = 0.94

after applying depth factor 0.94, the SBC shall be = 73.877  $t/m^2$

**The Recommended Net allowable Bearing pressure = 40.0  $t/m^2$**

**DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH, ADB TA - 8116 IND**  
**APPENDIX-B2.2**

**MINOR BRIDGE**

**DETERMINATION OF BEARING CAPACITY OF SHALLOW FOUNDATIONS**  
**COMPUTATION OF BEARING CAPACITY AS PER IS:6403**

**CH: 336+100**

**Location : BH-337/1B**

**1.1 Foundation Details**

Type of Foundation System	: Open Foundation
<b>Depth of filled-up soil, m</b>	: 0
Depth of Foundation below existing ground level in (m)	: 6
<b>Depth of Foundation below natural ground surface</b>	: 6
width of foundation in (m)	: 6.0
Length of foundation in (m)	: 8.0

**1.2 Soil Parameters:**

Bearing capacity has been calculated on the basis of average SPT value for the depth of 1.5 times width of foundation, below the base of foundation. The refusal to SPT has been considered when  $N > 100$ . The angle of shearing resistance of soil ( $\phi$ ) has been obtained for average value of SPT so obtained, using Fig. No.1 of IS:6403-1981.

Design SPT-value of the Bearing Strata (Refusal, $N > 100$ )	: 100
(below the Founding level)	:
Cohesion, $C_u = 6N$ (kpa)	: 0
Angle of shearing resistance (restricted) $\phi$	: 34
Cohesion, $C_u$ ( $t/m^2$ )	: 0
Bulk density of the strata ( $t/m^3$ )	: 2
Submerged density of the strata ( $t/m^3$ )	: 1.000
$N_\phi = \tan^2 (45 + \phi/2)$	: 3.537

**1.3 Design Parameters:**

Bearing Capacity Factors:	Shape Factors	Depth Factors	Inclination Factors	W.C Factor
$N_c = 42.924$	$S_c = 1.2$	$D_c = 1.4$	$i_c = 1.0$	$i_w = 0.5$
$N_q = 30.32$	$S_q = 1.2$	$D_q = 1.2$	$i_q = N/A$	
$N_\gamma = 42.904$	$S_\gamma = 0.7$	$D_\gamma = 1.2$	$i_\gamma = 1$	

**Net Ultimate Bearing Capacity:**

$$Q_u = (C_u * N_c * D_c * i_c * S_c) + (\gamma * d * (N_q - 1) * S_q * d_q * i_q) + (0.5 * B / 2 * \gamma * N_\gamma * S_\gamma * d_\gamma * i_\gamma)$$

$$= 347.40$$

Factor of Safety = 2.5

Net Safe Bearing Cap. = 138.96  $t/m^2$

**Settlement Criterial**

The settlement has been obtained from IS:8009 part-I. For  $N = > 100$ ,  $W' = 0.5$  and pressure of 10  $t/m^2$ , the settlement has been obtained as 9mm. Settlement obtained from lower most curve corresponding to  $N = 60$  from Fig.9 of IS:8009- (Part-I) 1976.

$$\text{Settlement} = 9 \text{ mm}$$

Therefore, safe bearing pressure for permissible settlement of 50mm shall be  $(10/9 \times 50)$   
55.56  $t/m^2$

after applying rigidity factor 0.8, the SBC shall be 69.444  $t/m^2$

$$L/B = 1.33 \quad D/\sqrt{LB} = 0.866$$

Depth factor as per Fig: 12 of IS 8009 Part -I = 0.94

after applying depth factor 0.94, the SBC shall be = 73.877  $t/m^2$

**The Recommended Net allowable Bearing pressure = 50.0  $t/m^2$**

**TABLE-B2.1: RESULT SHEET FOR MINOR BRIDGE AT CH.336+100 ON BH-337/1A**

(W.T. = 5.0M)

**PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH****ADB TA - 8116 IND****Size of Hole : Nx Size****Type of Bit : TC / Diamond****Starting date : 10.12.2013****Completion date : 13.12.2013**

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Descreption	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
1.0	3.	4	5	7	<b>FILLED-UP MATERIAL</b>													
2.0																		
3.0	5	6	12	18														
4.0	8	9	14	23														
6.0	9	14	20	34	<b>CLAYEY SAND (SC) MIXED WITH GRAVELS</b>													
7.0																		
8.0	5	4	9	13		13.88	47.66	7.69	30.77	38.7	18.0	-	2.71	-	-	-	20.0	-
9.0	6	6	9	15														

\* = Consolidation Test,

c<sub>c</sub> = Compression Index,

DFS

= Differential Free Swell,

—v = Water Table,

Sp = Swelling Pressure

**TABLE-B2.1: RESULT SHEET FOR MINOR BRIDGE AT CH.336+100 ON BH-337/1A**

(W.T. = 5.0M)

**PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH**

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 10.12.2013

Completion date : 13.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Description	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
10.0	13	18	20	38	<b>CLAYEY SAND (SC) MIXED WITH GRAVELS</b>													
11.0						16.60	46.40	8.14	28.86	36.0	18.0	-	-	-	-	-	28.5	
12.0	50/4	-	-	375														
13.0																		
14.0																		
15.0																		
16.0																		
17.0																		
18.0																		

\* = Consolidation Test, c<sub>c</sub> = Compression Index, DFS = Differential Free Swell, —v = Water Table, Sp = Swelling Pressure

**TABLE-B2.1: RESULT SHEET FOR MINOR BRIDGE AT CH.336+100 ON BH-337/1A**

(W.T. = 5.0M)

**PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH**

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 10.12.2013

Completion date : 13.12.2013

Depth (m)	SPT Details				Bore Log	Description of Strata	Core Recovery (%)	RQD (%)	$q_u$ (t/m <sup>2</sup> )	Density (t/m <sup>3</sup> )	Return Water		Remark
	15	30	45	N							Color	Loss (%)	
13.0						MODERATELY WEATHERED ROCK	12	0	-	-	Blueish	100	
14.0							20	10	2151	2.50	Blueish	100	
15.0							57	14	-	-	Blueish	100	
16.0													
17.0													
18.0													
19.0													

R = Refusal to SPT (N> 50), RQD = Rock Quality Designation,  $q_u$  = Uniaxial Compressive Strength  $\gamma$  = Water Table

**TABLE-B2.2: RESULT SHEET FOR MINOR BRIDGE AT CH.336+100 ON BH-337/1B**

(W.T. = 1.90M)

**PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH****ADB TA - 8116 IND****Size of Hole : Nx Size****Type of Bit : TC / Diamond****Starting date : 14.12.2013****Completion date : 14.12.2013**

Depth (m)	N - value				IS Classification Soil Descreption	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content,% (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N		Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				C t/m <sup>2</sup>	ø deg.		
1.0	4	9	13	22	<b>MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND</b>	7.35	26.23	13.29	53.14	48.6	23.0	-	2.69	-	-	-	30.0	-
2.0																		
3.0	8	11	16	27	<b>CLAYEY SAND (SC) MIXED WITH GRAVELS</b>	14.16	43.96	9.21	32.67	39.0	18.5	-	-	-	-	-	24.0	-
4.0																		
5.0	50/9			168														
6.0																		
7.0																		
8.0																		
9.0																		

\* = Consolidation Test, c<sub>c</sub> = Compression Index, DFS = Differential Free Swell, —v = Water Table, Sp = Swelling Pressure

**TABLE-B2.2: RESULT SHEET FOR MINOR BRIDGE AT CH.336+100 ON BH-337/1B**

(W.T. = 1.90M)

**PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH**

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 14.12.2013

Completion date : 14.12.2013

Depth (m)	SPT Details				Bore Log	Description of Strata	Core Recovery (%)	RQD (%)	$q_u$ (t/m <sup>2</sup> )	Density (t/m <sup>3</sup> )	Return Water		Remark
	15	30	45	N							Color	Loss (%)	
5.0						<b>MODERATELY WEATHERED ROCK</b>	40	10	-	-			
6.0							46	15	1852	2.45			
7.0													
8.0													
9.0													
10.0													
11.0													

R = Refusal to SPT (N> 50), RQD = Rock Quality Designation,  $q_u$  = Uniaxial Compressive Strength  $\gamma$  = Water Table

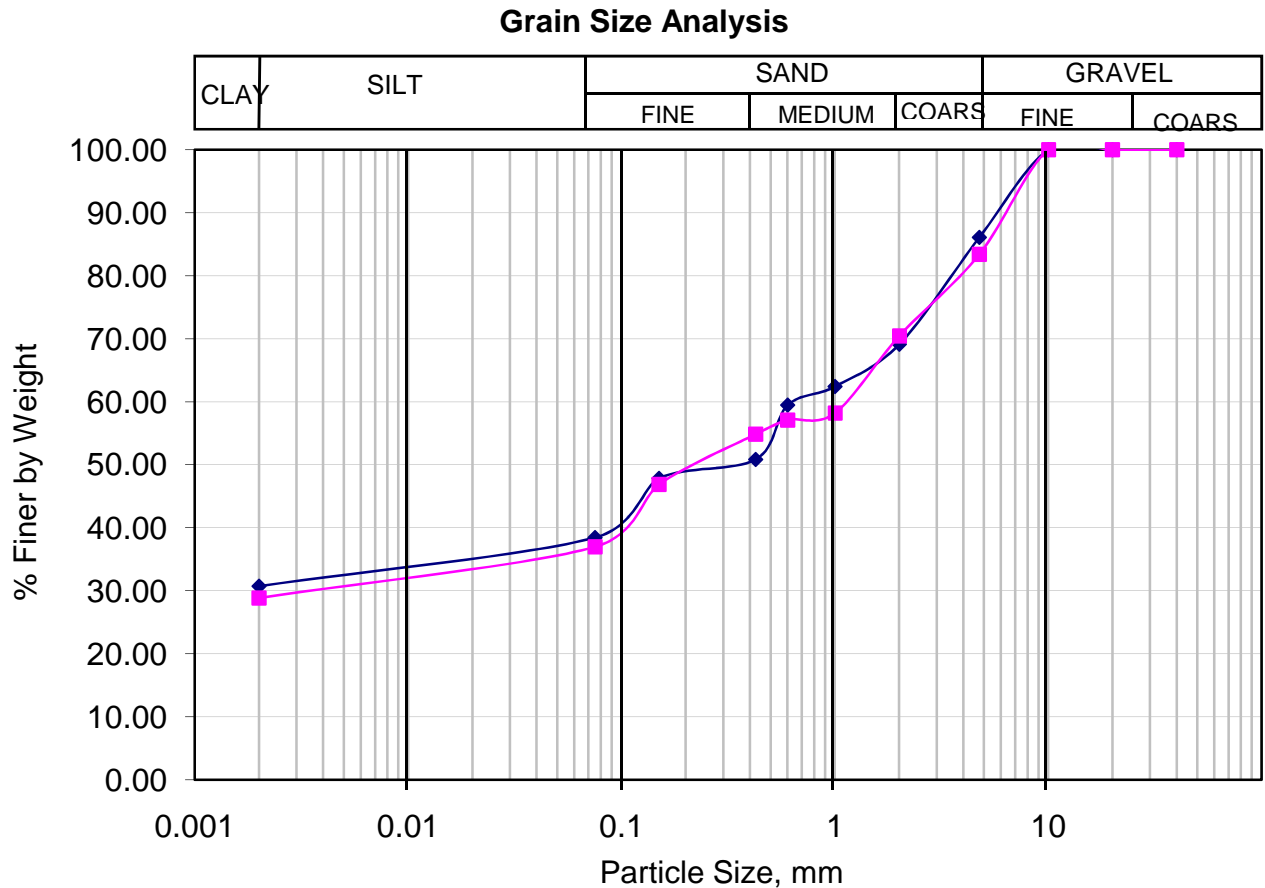


# PNT DESIGNS PVT. LTD., KOTA

PROJECT - DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH,  
ADB TA - 8116 IND

Determination of Grain Size Analysis Test as per IS:2720-Part 4-1985

MNB AT CH: 336+100 (337/1A)



Symbol	BH No.	Depth,m	Soil description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
	BH-337/1A	7.50	SC*	13.88	47.66	7.69	30.77
	BH-337/1A	12.00	SC*	16.60	46.40	8.14	28.86

**SC\* = CLAYEY SAND (SC) MIXED WITH GRAVELS**

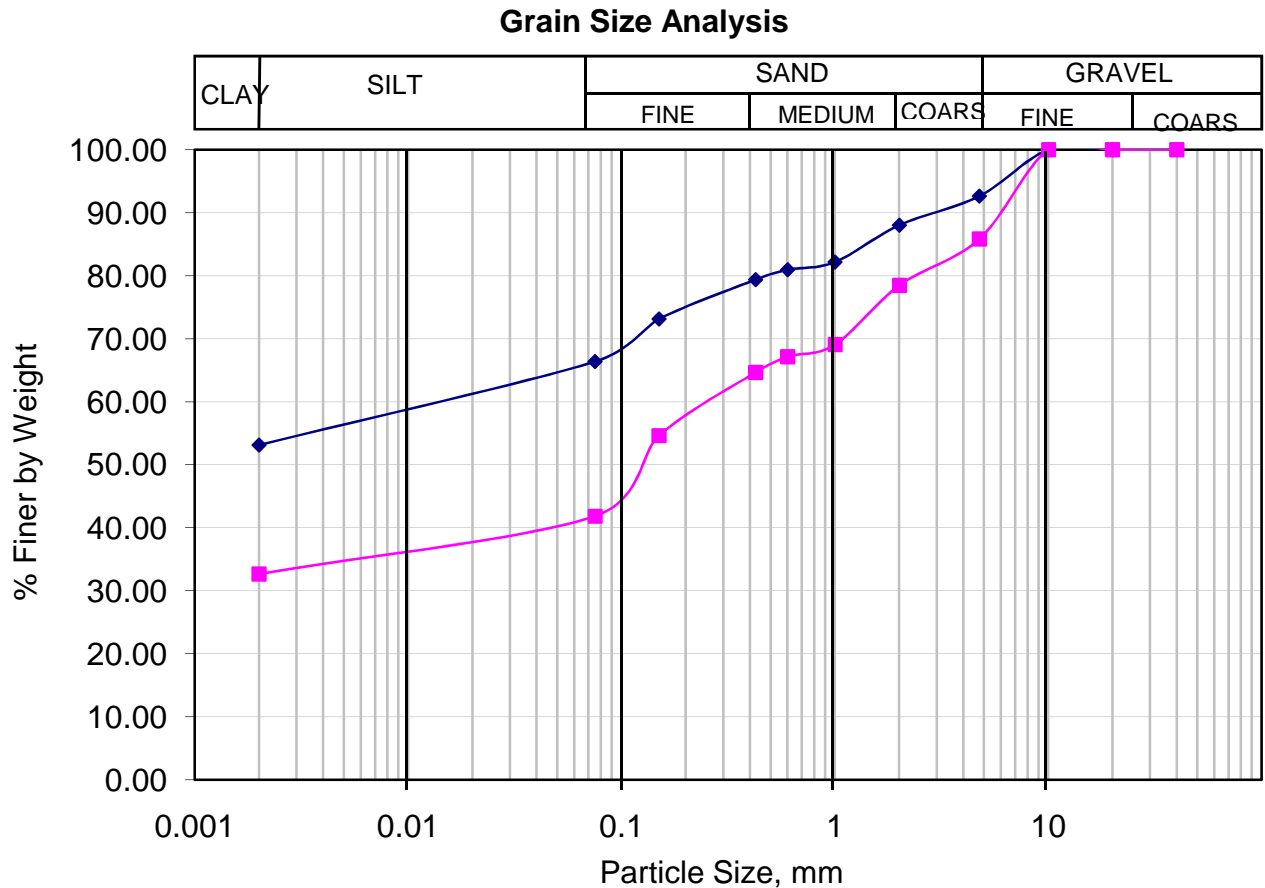
Depth = 7.50      Weighted Mean Dia,  $d_m$  = 1.80 mm,  $f = 2.36$   
 Depth = 12.00      Weighted Mean Dia,  $d_m$  = 1.91 mm,  $f = 2.43$

# PNT DESIGNS PVT. LTD., KOTA

PROJECT - DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH,  
ADB TA - 8116 IND

Determination of Grain Size Analysis Test as per IS:2720-Part 4-1985

MNB AT CH: 336+100 (337/1B)



Symbol	BH No.	Depth,m	Soil description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
	BH-337/1B	1.50	CI*	7.35	26.23	13.29	53.14
	BH-337/1B	4.50	SC*	14.16	43.96	9.21	32.67

CI\* = MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND

SC\* = CLAYEY SAND (SC) MIXED WITH GRAVELS

Depth = 4.50 Weighted Mean Dia,  $d_m$  = 1.52 mm,  $f = 2.17$

SILT FACTOR CALCULATION BASED ON COHESION OF SOIL  
MNB AT CH.336+100

Location : BH-337/1B

Depth : 0.00m-3.0m

In order to determine maximum score depth the silt factor of the bad material is required to be determined. The silt factor ( $K_{sf}$ ) depends upon the average size of bed material and given by Lacey equation as follows:

$$K_{sf} = 1.76 \sqrt{d_m} \quad \dots\dots 1$$

Where  $d_m$  = the weighted mean diameter in millimeter

Also, in case of soil having  $\phi < 15^\circ$  and  $c$  (cohesion of soil)  $> 0.2 \text{ kg/cm}^2$ , ' $K_{sf}$ ' calculated as follows :

$$K_{sf} = F (1 + \sqrt{c}) \text{ where } c \text{ is in } \text{kg/cm}^2 \quad \dots\dots 2$$

where  $F = 1.50$  for  $\phi > 10^\circ$  and  $< 15^\circ$

$= 1.75$  for  $\phi > 5^\circ$  and  $< 10^\circ$

$= 2.00$  for  $\phi < 5^\circ$

The strata at this location found to be Medium Plastic Clay (CI). The silt factor has been calculated on the basis of undrained cohesion ( $c$ ) of the soil using equation (2) above. The undrained cohesion has been obtained from SPT data recorded at the site. The calculation of silt factor is as follows :

Design SPT-value of the Strata (Refusal, $N > 100$ )		: 22
(below the Founding level)		:
Cohesion, $C_u = 6 \text{ N (kPa)}$		: 132
Angle of shearing resistance (restricted)	$\phi$	: 0
Cohesion, $C_u \text{ (kg/cm}^2\text{)}$		: 1.32
The silt factor shall be as follows :		: $K_{sf} = F (1 + \sqrt{c})$
Where :	$F$	: 2
	$K_{sf} =$	: $2 * (1 + \sqrt{1.32})$
		: <b>4.30</b>

**SILT FACTOR CALCULATIONS**  
**MNB AT CH: 336+100 (337/1A)**

Total Weight of Dry Soil Taken =  
 Depth =

500  
7.5

Sieve Size in mm	Average Size (mm)	Weight Retained in g	% Weight Retained	Cumulative % Retained	% Finer (N)	Weighted % weight retained
1	2	3	4	5	6	7 = (2X3)
80		0	0.00	0.00	100.00	0.000
40		0	0.00	0.00	100.00	0.000
20	30	0	0.00	0.00	100.00	0.000
10	15	0	0.00	0.00	100.00	0.000
4.75	7.375	69.4	13.88	13.88	86.12	102.365
2	3.375	84.9	16.98	30.86	69.14	57.308
1	1.5	33.5	6.70	37.56	62.44	10.050
0.6	0.8	14.8	2.96	40.52	59.48	2.368
0.425	0.5125	43.1	8.62	49.14	50.86	4.418
0.15	0.2875	15	3.00	52.14	47.86	0.863
0.075	0.1125	47	9.40	61.54	38.46	1.058
PAN	0.0375	192.3	38.46	100.00	0.00	1.442
		Sum =	100.00			179.871

200  
12

Sieve Size in mm	Average Size (mm)	Weight Retained in g	% Weight Retained	Cumulative % Retained	% Finer (N)	Weighted % weight retained
1	2	3	4	5	6	7 = (2X3)
		0	0.00	0.00	100.00	0.000
40		0	0.00	0.00	100.00	0.000
20	30	0	0.00	0.00	100.00	0.000
10	15	0	0.00	0.00	100.00	0.000
4.75	7.375	33.2	16.60	16.60	83.40	122.425
2	3.375	25.9	12.95	29.55	70.45	43.706
1	1.5	24.5	12.25	41.80	58.20	18.375
0.6	0.8	2.2	1.10	42.90	57.10	0.880
0.425	0.5125	4.5	2.25	45.15	54.85	1.153
0.15	0.2875	15.9	7.95	53.10	46.90	2.286
0.075	0.1125	19.8	9.90	63.00	37.00	1.114
PAN	0.0375	74	37.00	100.00	0.00	1.388
		Sum =	100.00			191.326

Sum of Weighted % Weight retained on each seive  
 Mean Dia meter, dm = -----  
 Cumulative % retained

$$\begin{aligned} dm &= 179.8705 / 100 &= & 1.80 \\ \text{Silt Factor, } f &= 1.76 \text{ Sqrt (dm)} &= & 2.36 \end{aligned}$$

$$\begin{aligned} dm &= 191.32625 / 100 &= & 1.91 \\ \text{Silt Factor, } f &= 1.76 \text{ Sqrt (dm)} &= & 2.43 \end{aligned}$$

# **SILT FACTOR CALCULATIONS**

**MNB AT CH: 336+100 (337/1B)**

Total Weight of Dry Soil Taken = 250

Depth = 4.5

Sieve Size in mm	Average Size (mm)	Weight Retained in g	% Weight Retained	Cumulative % Retained	% Finer (N)	Weighted % weight retained
1	2	3	4	5	6	7 = (2X3)
		0	0.00	0.00	100.00	0.000
40		0	0.00	0.00	100.00	0.000
20	30	0	0.00	0.00	100.00	0.000
10	15	0	0.00	0.00	100.00	0.000
4.75	7.375	35.4	14.16	14.16	85.84	104.430
2	3.375	18.4	7.36	21.52	78.48	24.840
1	1.5	23.5	9.40	30.92	69.08	14.100
0.6	0.8	4.8	1.92	32.84	67.16	1.536
0.425	0.5125	6.2	2.48	35.32	64.68	1.271
0.15	0.2875	25	10.00	45.32	54.68	2.875
0.075	0.1125	32	12.80	58.12	41.88	1.440
PAN	0.0375	104.7	41.88	100.00	0.00	1.571
		Sum =	100.00			152.063

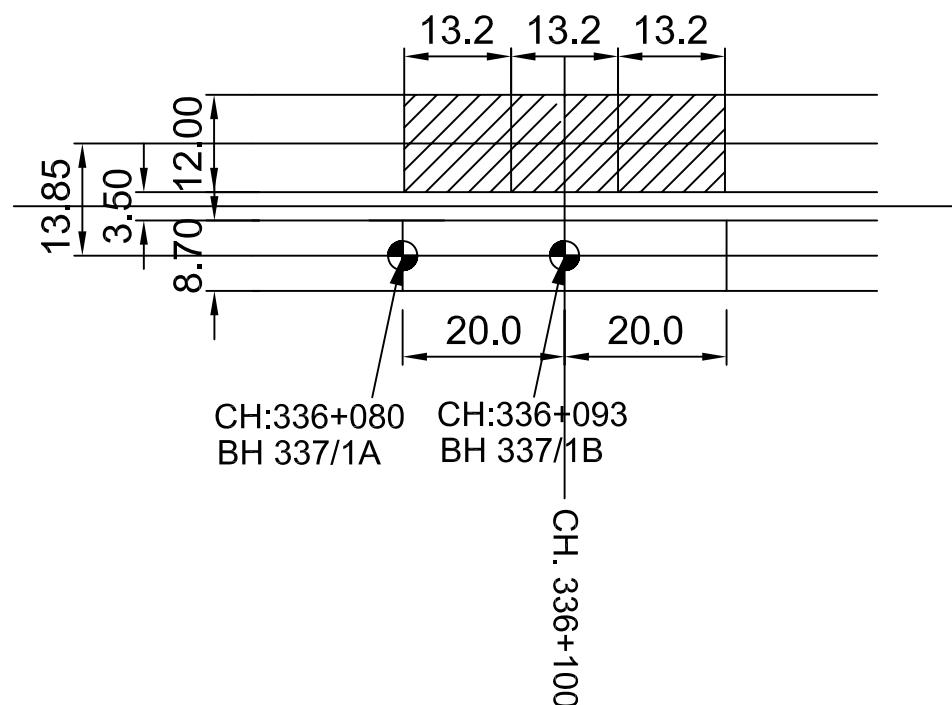
$$dm = 152.0625 / 100 = 1.52$$

$$\text{Silt Factor, } f = 1.76 \text{ Sqrt } (dm) = 2.17$$

← IMPHAL

MOREH →

## BOREHOLE LOCATION PLAN FOR MINOR BRIDGE AT CH: 336+100 (Waithou)



Existing Span Arrangements  
(3x 13.2)

Proposed Span Arrangements  
(2 x 20.0)

(The borehole locations are given for  
Existing chainage)

### LEGEND:



Borehole Location



Existing Bridge

### PROJECT

DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION  
FROM IMPHAL TO MOREH, ADB TA - 8116 IND

Design Consultant :

**SHELADIA ASSOCIATES INC., USA**



Amsri Shamira, Flat No: 206 & 207,  
S D Road, Old Lancer Lanes,  
Secunderabad - 500 003, AP.

## GEOTECH REPORT FOR MINOR BRIDGE

AT CH: 344+150





**Geotechnical Investigation Report for determination of allowable bearing pressure for MINOR  
BRIDGE at CH. 344+150 of NH-39 under  
“DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH,  
ADB TA - 8116 IND”**

**ABSTRACT**

The safe load carrying capacity of the foundation of MAJOR BRIDGE at Ch. 344+150 on NH-39 is recommended as follows:

Location		OGL (m)	Theoretical Scour Level (m)	Scour Depth Below Borehole (m)	Pile Cap Top Level (m)	Pile Cap Bottom Level (m)	Pile Tip Level (m)	Length of Pile (m)	Vertical Capacity (t)	Lateral Capacity (t)	Uplift Capacity (T)
345/1A	A1	772.990	-	3.0	772.490	770.690	738.690	32.0	230	20	95
345/1B	P1	772.990	-	3.0	772.490	770.690	738.690	32.0	230	20	95

## THE STRATA AT GLANCE AND SILT FACTORS

Borehole No.	Type of strata	Depth	Weighted mean dia, $d_m$ (mm)	Silt Factor,
1	2	3	4	5
BH-345/1A	Filled-up Material	0.0-1.5m	-	-
	Medium Plastic Clay (CI) mixed with Sand	1.5-33.0m	-	3.28
BH-345/1B	Clayey Sand (SC) mixed with Gravels	0.0-1.5m	1.62	2.24
	Medium Plastic Clay (CI) mixed with Sand	1.5-30.0m	-	3.31

**Geotechnical Investigation Report**  
**for determination of allowable bearing pressure for**  
**MINOR BRIDGE at CH. 344+150 on NH-39 under**  
**“Detailed Project for Indo Myanmar Road Section from Imphal to Moreh,**  
**ADB TA - 8116 IND”**

## **1. INTRODUCTION**

Geotechnical investigation was carried out for MINOR BRIDGE at Ch.344+150 on NH-39 under Detailed Project for Indo Myanmar Road Section from Imphal to Moreh, ADB TA - 8116 IND. The Schedule of work and the locations of bore holes were decided by Engineer In-charge of Sheladia Associates, Inc., USA. The locations of boreholes are shown in Key Plan (Fig.B3).

## **2.0 FIELD INVESTIGATION**

### **2.1 Boring**

Two bore hole i.e. BH-345/1A & BH-345/1B was made at the locations decided by Engineer In-charge as shown in Key Plan (Fig.B3). Boring was done by power driven rig as per guidelines of IS: 1892:1979 and IRC-78-2000. Boring was done up to the maximum depth of 33.0m. The soil samples were collected as required for laboratory testing.

### **2.2 Standard Penetration Test (SPT)**

Standard penetration test (SPT) was conducted in the bore hole as per IS 2131-1981. The numbers of blows for first 15 cm penetration is considered as seating drive and are not taken into account. The number of blows required for last 30 cm penetration is taken as SPT number (“N” values). If number of blows for last 30 cm penetration exceeds 100, it is said to be the refusal. SPT were conducted at regular interval of 1.5m, starting from the depth of 1.5m from the

ground surface to the depth of exploration/ refusal. The tests results are shown in Table-B3.1 to B3.2.

### **2.3 Water Table**

The water table was observed at the depth of 1.0-1.4m from ground surface, at the time of investigation (i.e. Nov-Dec 2013).

## **3.0 LABORATORY INVESTIGATION**

### **Soil Samples:**

The following laboratory tests were conducted on the soil samples obtained from test bore holes:

- a) Natural Moisture content
- b) Specific gravity
- c) Liquid & Plastic Limit
- d) Grain size Analysis
- e) Shear strength test
- f) Bulk density (Dry Density)
- g) Free swell test

Test results are shown in borelogs i.e. Table-B3.1 to B3.2.

## **4. TYPE OF STRATA**

Based on laboratory and field investigation the strata at the site have been described. The bore-log of the strata is presented in Table-B3.1 to B3.2. The strata are as follows:

### **BH-345/1A**

The upper layer of the strata thickness about 1.5m was found to be Filled-up Material. Below this, Medium Plastic Clay (CI) mixed with Sand was found up to the depth of exploration i.e. 33.0m. The bore-log is shown in Table-B3.1.

## **BH-345/1B**

The upper layer of the strata thickness about 1.5m was found to be Clayey Sand (SC) mixed with Gravels. Below this, Medium Plastic Clay (CI) mixed with Sand was found up to the depth of exploration i.e. 30.0m. The bore-log is shown in Table-B3.2.

### **5.0 FOUNDATION ANALYSIS**

Pile foundation has been analyzed. The calculation sheets for safe load carrying capacity bearing capacity in vertical and uplift for different borehole locations are attached as Appendix-B3.1 to Appendix-B3.2. Also the lateral load carrying capacity is given in Appendix-B3.1.1 to Appendix-B3.2.1.

### **6.0 SILT FACTOR**

In order to determine maximum score depth the silt factor of the bad material is required to be determine. The silt factor (f) depends upon the average size of bed material and given by Lacey equation as follows:

$$K_{sf} = 1.76 \sqrt{d_m}$$

Where  $d_m$  = the weighted mean diameter in millimeter

Also, in case of soil having  $\phi < 15^\circ$  and  $c$  (cohesion of soil)  $> 0.2 \text{ kg/cm}^2$ , ' $K_{sf}$ ' calculated as follows :

$$K_{sf} = F (1 + \sqrt{c}) \text{ where } c \text{ is in kg/cm}^2$$

where  $F$  = 1.50 for  $\phi > 10^\circ$  and  $< 15^\circ$   
= 1.75 for  $\phi > 5^\circ$  and  $< 10^\circ$   
= 2.00 for  $\phi < 5^\circ$

Borehole No.	Type of strata	Depth	Weighted mean dia, $d_m$ (mm)	Silt Factor,
1	2	3	4	5
BH-345/1A	Filled-up Material	0.0-1.5m	-	-
	Medium Plastic Clay (CI) mixed with Sand	1.5-33.0m	-	3.28
BH-345/1B	Clayey Sand (SC) mixed with Gravels	0.0-1.5m	1.62	2.24
	Medium Plastic Clay (CI) mixed with Sand	1.5-30.0m	-	3.31

## 7.0 CONCLUSION

1. The strata at the site is described in Section 4.0.
2. The water table was observed at the depth of 1.0-1.4m from ground surface, at the time of investigation (i.e. Nov-Dec 2013).
3. Safe load carrying capacity has been recommended as follows:

Location		OGL (m)	Theoretical Scour Level (m)	Scour Depth Below Borehole (m)	Pile Cap Top Level (m)	Pile Cap Bottom Level (m)	Pile Tip Level (m)	Length of Pile (m)	Vertical Capacity (t)	Lateral Capacity (t)	Uplift Capacity (T)
345/1A	A1	772.990	-	3.0	772.490	770.690	738.690	32.0	230	20	95
345/1B	P1	772.990	-	3.0	772.490	770.690	738.690	32.0	230	20	95

SCOUR DEPTH CALCULATIONS FOR MINOR BRIDGE AT CH: 344+150 (Arong)

Si.No	Chainage	Proposed Span Arrangement	Location	HFL (m)	Discharge (Cumecs)	Velocity (m/sec)	Design Discharge 1.3xQ (Cumec)	Silt Factor	Eff. Linear Waterway (m)	Discharge per m width (Cumecs/	Mean Scour Depth Dsm(m)	Scour depth below HFL(m)	Borehole Level (m)	Min. Bed Level (m)	Theoretic al Scour level (m)	Restricted Scour Level (m)	Actual Scour level (m)	Scour depth below BH (m)
3	344+150	1 x 33	A1	Irrigation Canal		-	-	-	94.2	-	-	-	772.990	-	-	-	769.990	3.000
	(Arong)																	



DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH, ADB TA - 8116 IND

APPENDIX-B3.1

Pile Capacity Calculations (IS:2911/Part-1/Sec-2)-1979

Bored Cast in Situ Piles

Structure: Minor Bridge ( Arong )

Chainage: 344+150

Location: 345/1A

Calculation of Skin friction Resistance

(Existing)

Item	Layer -I	Layer -II	Layer -III	Layer -IV	Layer -V	Layer -VI	Layer -VII
Type of strata	Clay	Clay	Clay	Clay	Clay	Clay	Clay
Diameter of Pile (D)	1.2 m	1.2 m	1.2 m	1.2 m	1.2 m	1.2 m	1.2 m
Length of Pile (L)	32.0 m	32 m	32 m	32 m	32 m	32 m	32 m
Bulk density of the strata ( $\gamma$ )							
Submerged Unit Weight ( $\gamma'$ ) (Minimum)		10	10	10	10	10	10
Undrained shear strength ( $C_u$ )	0 kn/m2	30 kn/m2	90 kn/m2	100 kn/m2	138 kn/m2	230 kn/m2	250 kn/m2
Angle of internal friction of soil ( $\phi$ )	0	0	0	0	0	0	0
Thickness of soil layer (h)	3 m	4.5 m	4.5 m	4.0 m	8.0 m	6.0 m	4.5 m
Effective over burden pressure over the top of strata	0 kn/m2	0 kn/m2	45 kn/m2	90 kn/m2	130 kn/m2	210 kn/m2	270 kn/m2
Effective over burden pressure over the bottom of strata	0	45	90	130	210	270	315
Adhesion ( $\alpha$ )	-	0.3	0.3	0.3	0.3	0.3	0.3
K= Coefficient of earth pressure in loose to medium sands = 1 - 3		1	1	1	1	1	1
Effective over burden pressure $P_d$ =		22.5	67.5	110	170	240	292.5
Angle of wall friction $\delta=\phi$		0	0	0	0	0	0
(It is equal to angle of internal friction)							
$A_s = 3.142 \cdot D \cdot h$		16.9668	16.9668	15.0816	30.1632	22.62	16.97
<b>(for Granular soils) <math>K \times P_d \times \tan \delta \times A_s =</math></b>		0 Kn	0 Kn	0 Kn	0.00 Kn	0 Kn	0 Kn
<b>(for Cohesive soils) <math>\alpha C_u A_s = \alpha \cdot C_u \cdot 3.142 \cdot D \cdot h</math></b>	No skin resistance is considered for this layer	152.7012 Kn	458.1036 Kn	452.45 Kn	1248.756 Kn	1560.95 Kn	1273 Kn

Skin friction resistance due to cohesive soil layers

$$\sum (\alpha C_u A_s) = 5145.46 \text{ kN}$$

Skin friction resistance due to granular soil layers

$$\sum (K \times P_d \times \tan \delta \times A_s) = 0 \text{ kN}$$

Negtaive skin friction

$$= 257.273 \text{ kN}$$

**Total Skin friction resistance of the pile,  $q_s$**

$$R_f = \sum (\alpha C_u A_s + K \times P_d \times \tan \delta \times A_s) = 4888.19$$

**Calculation of End bearing resistance**

Type of bearing strata	Clay
C/S area of Pile	1.131 sqm
Length of Pile (L)	32 m
SPT value (N)	
Angle of internal friction of soil ( $\phi$ )	$\phi$ 0
Bearing capacity factor	$N_c$ 9
	$N_q$ 17
	$N_\gamma$ 0
Effective over burden pressure	$P_d$ 0 Kn/m2
<b>Total End bearing resistance of the pile (<math>Q_p</math>)</b>	$Q_p = A_p \cdot (1/2 \cdot D \cdot \gamma' \cdot N_r + P_d \cdot N_q) + (A_p \cdot N_c \cdot C_p) = 1017.876 \text{ kN}$
Ultimate load carrying capacity	$Q_u = Q_s + Q_p = 5906.07$
Safe load carrying capacity	$Q_{safe} = 2362.4271 \text{ kN}$
<b>The Safe load carrying capacity of pile=</b>	<b>236 t</b>

**The Recommended vertical load carrying capacity is 230t**

Ultimate Uplift load carrying capacity is 3421.73 Kn

**The Safe Uplift load carrying capacity is**

95.8469 Tonnes

**The Recommended Uplift load carrying capacity is 95.00 Tonnes**

DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH, ADB TA - 8116 IND

APPENDIX-B3.2

Pile Capacity Calculations (IS:2911/Part-1/Sec-2)-1979

Bored Cast in Situ Piles

Structure: Minor Bridge ( Arong )

Chainage: 344+150

Location: 345/1B

Calculation of Skin friction Resistance

(Existing)

Item	Layer -I	Layer -II	Layer -III	Layer -IV	Layer -V	Layer -VI	Layer -VII
Type of strata	Clay	Clay	Clay	Clay	Clay	Clay	Clay
Diameter of Pile (D)	1.2 m	1.2 m	1.2 m	1.2 m	1.2 m	1.2 m	1.2 m
Length of Pile (L)	32.0 m	32 m	32 m	32 m	32 m	32 m	32 m
Bulk density of the strata ( $\gamma$ )							
Submerged Unit Weight ( $\gamma'$ ) (Minimum)		10	10	10	10	10	10
Undrained shear strength ( $C_u$ )	0 kn/m2	30 kn/m2	90 kn/m2	100 kn/m2	138 kn/m2	230 kn/m2	250 kn/m2
Angle of internal friction of soil ( $\phi$ )	0	0	0	0	0	0	0
Thickness of soil layer (h)	3 m	4.5 m	4.5 m	4.0 m	8.0 m	6.0 m	4.5 m
Effective over burden pressure over the top of strata	0 kn/m2	0 kn/m2	45 kn/m2	90 kn/m2	130 kn/m2	210 kn/m2	270 kn/m2
Effective over burden pressure over the bottom of strata	0	45	90	130	210	270	315
Adhesion ( $\alpha$ )	-	0.3	0.3	0.3	0.3	0.3	0.3
K= Coefficient of earth pressure in loose to medium sands = 1 - 3		1	1	1	1	1	1
Effective over burden pressure $P_d$ =		22.5	67.5	110	170	240	292.5
Angle of wall friction $\delta=\phi$		0	0	0	0	0	0
(It is equal to angle of internal friction)							
$A_s = 3.142 \cdot D \cdot h$		16.9668	16.9668	15.0816	30.1632	22.62	16.97
<b>(for Granular soils) <math>K \times P_d \times \tan \delta \times A_s =</math></b>		0 Kn	0 Kn	0 Kn	0.00 Kn	0 Kn	0 Kn
<b>(for Cohesive soils) <math>\alpha C_u A_s = \alpha \cdot C_u \cdot 3.142 \cdot D \cdot h</math></b>	No skin resistance is considered for this layer	152.7012 Kn	458.1036 Kn	452.45 Kn	1248.756 Kn	1560.95 Kn	1273 Kn

Skin friction resistance due to cohesive soil layers

$$\sum (\alpha C_u A_s) = 5145.46 \text{ kN}$$

Skin friction resistance due to granular soil layers

$$\sum (K \times P_d \times \tan \delta \times A_s) = 0 \text{ kN}$$

Negtaive skin friction

$$= 257.273 \text{ kN}$$

**Total Skin friction resistance of the pile,  $q_s$**

$$R_f = \sum (\alpha C_u A_s + K \times P_d \times \tan \delta \times A_s) = 4888.19$$

**Calculation of End bearing resistance**

Type of bearing strata	Clay
C/S area of Pile	1.131 sqm
Length of Pile (L)	32 m
SPT value (N)	
Angle of internal friction of soil ( $\phi$ )	$\phi$ 0
Bearing capacity factor	$N_c$ 9
	$N_q$ 17
	$N_\gamma$ 0
Effective over burden pressure	$P_d$ 0 Kn/m2
<b>Total End bearing resistance of the pile (<math>Q_p</math>)</b>	$Q_p = A_p \cdot (1/2 \cdot D \cdot \gamma \cdot N_r + P_d \cdot N_q) + (A_p \cdot N_c \cdot C_p) = 1017.876 \text{ kN}$
Ultimate load carrying capacity	$Q_u = Q_s + Q_p = 5906.07$
Safe load carrying capacity	$Q_{safe} = 2362.4271 \text{ kN}$
<b>The Safe load carrying capacity of pile=</b>	<b>236 t</b>

**The Recommended vertical load carrying capacity is 230t**

Ultimate Uplift load carrying capacity is 3421.73 Kn

The Safe Uplift load carrying capacity is 958.469 Kn

95.8469 Tonnes

The Recommended Uplift load carrying capacity is 95.00 Tonnes

**DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO  
MOREH, ADB TA - 8116 IND**

**APPENDIX-B3.1.1**

**ESTIMATION OF LATERAL LOAD CARRYING CAPACITY OF PILES for 1A  
(ARONG) MINOR BRIDGE AT CH: 344+150**

Stipulations of IS:2911 (Part I/Sec.2) - 1979 are followed

Diameter of Pile	=	1200 mm
Strength of Pile Concrete	=	35 N/mm <sup>2</sup>
Young's Modulus of Pile Concrete	=	31500 N/mm <sup>2</sup>
	=	31500000 kN/m <sup>2</sup>
Moment of Inertia of Pile Cross Section	=	1.02E+11 mm <sup>4</sup>
	=	0.1018 m <sup>4</sup>
Top Layer of sub-soil strata	=	Clay
Value of Constant, k1	=	2333 kN/m <sup>3</sup>
T	=	6.09 m
Unsupported Length, L <sub>1</sub>	=	0.000 m
L <sub>1</sub> /T	=	0.000
L <sub>1</sub> /T	=	<b>2.15</b>
L <sub>1</sub> (Ref Fig.2, Appendix C of IS 2911 (Part 1/Sec.2) - 1979	=	13.090 m
Cantilever span of pile	=	13.1 m
Lateral Deflection at bottom of pile cap level under unit lateral load	=	0.000058 m
Lateral Deflection at Top of PILE	=	0.0583 mm
Corresponding Deflection at scour level	=	0.0583 mm
Allowable deflection at scour level	=	12 mm
Force that causes 12mm Lateral Deflection at scour level	=	205.841 kN
Thus, Lateral Capacity of INDIVIDUAL PILE	=	205.841 kN

**NOTE: The recommended lateral load carrying capacity is 20 tonnes**

**DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO  
MOREH, ADB TA - 8116 IND**

**APPENDIX-B3.1.2**

**ESTIMATION OF LATERAL LOAD CARRYING CAPACITY OF PILES for 1B  
(ARONG) MINOR BRIDGE AT CH: 344+150**

Stipulations of IS:2911 (Part I/Sec.2) - 1979 are followed

Diameter of Pile	=	1200 mm
Strength of Pile Concrete	=	35 N/mm <sup>2</sup>
Young's Modulus of Pile Concrete	=	31500 N/mm <sup>2</sup>
	=	31500000 kN/m <sup>2</sup>
Moment of Inertia of Pile Cross Section	=	1.02E+11 mm <sup>4</sup>
	=	0.1018 m <sup>4</sup>
Top Layer of sub-soil strata	=	Clay
Value of Constant, k1	=	2333 kN/m <sup>3</sup>
T	=	6.09 m
Unsupported Length, L <sub>1</sub>	=	0.000 m
L <sub>1</sub> /T	=	0.000
L <sub>1</sub> /T	=	<b>2.15</b>
L <sub>f</sub> (Ref Fig.2, Appendix C of IS 2911 (Part 1/Sec.2) - 1979	=	13.090 m
Cantilever span of pile	=	13.1 m
Lateral Deflection at bottom of pile cap level under unit lateral load	=	0.000058 m
Lateral Deflection at Top of PILE	=	0.0583 mm
Corresponding Deflection at scour level	=	0.0583 mm
Allowable deflection at scour level	=	12 mm
Force that causes 12mm Lateral Deflection at scour level	=	205.841 kN
Thus, Lateral Capacity of INDIVIDUAL PILE	=	205.841 kN

**NOTE: The recommended lateral load carrying capacity is 20 tonnes**

**TABLE-B3.1: RESULT SHEET FOR MINOR BRIDGE AT CH.344+150 ON BH-345/1A**

(W.T. = 1.40M)

**PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH**

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 30.11.2013

Completion date : 05.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Description	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
1.0	2	2	3	5	<b>FILLED-UP MATERIAL</b>													
2.0					<b>MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND</b>													
3.0	2	3	3	6		0.55	29.53	13.99	55.94	48.9	21.0	-	2.68	-	-	-	27.0	-
4.0																		
5.0	1	2	3	5														
6.0	3	3	4	7														
7.0					<b>MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND</b>													
8.0	2	3	4	7														
9.0	2	4	7	11		3.33	24.83	15.80	56.03	41.00	19.5	-	2.67	-	-	-	24.2	-

\* = Consolidation Test,

c<sub>c</sub> = Compression Index,

DFS = Differential Free Swell,

—v = Water Table,

Sp = Swelling Pressure

**TABLE-B3.1: RESULT SHEET FOR MINOR BRIDGE AT CH.344+150 ON BH-345/1A**

(W.T. = 1.40M)

**PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH**

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 30.11.2013

Completion date : 05.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Description	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
10.0	3	4	8	12	<b>MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND</b>	1.78	27.50	14.14	56.58	49.0	22.3	-	2.68	-	-	-	25.8	
11.0																		
12.0	4	5	8	13														
13.0	4	6	9	15														
14.0																		
15.0	3	7	9	16														
16.0																		
17.0	4	6	11	17														
18.0	4	7	12	19		3.33	26.23	14.09	56.35	45.6	20.0	-	-	-	-	-	21.6	

\* = Consolidation Test,

c<sub>c</sub> = Compression Index,

DFS = Differential Free Swell,

—v = Water Table,

Sp = Swelling Pressure

**TABLE-B3.1: RESULT SHEET FOR MINOR BRIDGE AT CH.344+150 ON BH-345/1A**

(W.T. = 1.40M)

**PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH**

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 30.11.2013

Completion date : 05.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Description	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
19.0	5	8	14	22	<b>MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND</b>	3.51	30.89	14.43	51.17	43.4	20.4	-	2.70	-	-	-	22.5	
20.0																		
21.0	6	9	15	24														
22.0	7	10	17	27														
23.0																		
24.0	6	12	21	33														
25.0																		
26.0	9	14	22	36														
27.0	8	16	24	40														

\* = Consolidation Test,

c<sub>c</sub> = Compression Index,

DFS

= Differential Free Swell,

—v = Water Table,

Sp = Swelling Pressure

**TABLE-B3.1: RESULT SHEET FOR MINOR BRIDGE AT CH.344+150 ON BH-345/1A**

(W.T. = 1.40M)

**PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH**

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 30.11.2013

Completion date : 05.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content,% (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Descreption	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
28.0	9	18	27	45	MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND	4.13	25.13	14.15	56.60	45.3	20.0	-	-	-	-	-	21.8	
29.0																		
30.0	11	24	30	54														
31.0	14	26	31	57														
32.0						2.17	27.17	14.13	56.53	48.9	21.2	-	2.73	-	-	-	29.5	
33.0	16	28	34	62														
34.0																		
36.0																		
37.0																		

\* = Consolidation Test, c<sub>c</sub> = Compression Index, DFS = Differential Free Swell, —v = Water Table, Sp = Swelling Pressure



**TABLE-B3.2: RESULT SHEET FOR MINOR BRIDGE AT CH.344+150 ON BH-345/1B**

(W.T. = 1.00M)

**PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH**

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 06.12.2013

Completion date : 08.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N		Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
1.0	2	2	3	5	CLAYEY SAND (SC) MIXED WITH GRAVELS	14.68	55.93	5.88	23.52	34.0	17.0	-	-	-	-	-	17.7	-
2.0	3	3	4	7	MEDIUM PLASTIC CLAY (C) MIXED WITH SAND	0.60	30.52	15.15	53.73	43.0	22.9	-	2.69	-	-	-	28.80	-
3.0	2	3	3	6														
4.0	2	3	5	8														
5.0	3	4	6	10														
6.0	3	5	7	12														

\* = Consolidation Test,

c<sub>c</sub> = Compression Index,

DFS = Differential Free Swell,

—v = Water Table,

Sp = Swelling Pressure

**TABLE-B3.2: RESULT SHEET FOR MINOR BRIDGE AT CH.344+150 ON BH-345/1B**

(W.T. = 1.00M)

**PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH**

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 06.12.2013

Completion date : 08.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Description	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
10.0	4	6	8	14	<b>MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND</b>	1.10	24.80	14.82	59.28	47.6	20.5	-	2.71	-	-	-	30.9	
11.0																		
12.0	3	7	9	16														
13.0	4	6	11	17														
14.0																		
15.0	4	8	10	18														
16.0																		
17.0	5	9	12	21														
18.0	6	10	13	23		0.20	31.06	13.75	54.99	44.5	20.0	-	-	-	-	-	21.7	

\* = Consolidation Test,

c<sub>c</sub> = Compression Index,

DFS = Differential Free Swell,

—v = Water Table,

Sp = Swelling Pressure

**TABLE-B3.2: RESULT SHEET FOR MINOR BRIDGE AT CH.344+150 ON BH-345/1B**

(W.T. = 1.00M)

**PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH**

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 06.12.2013

Completion date : 08.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Description	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
19.0	5	10	15	25	<b>MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND</b>	1.33	27.50	15.66	55.51	42.0	22.0	-	2.68	-	-	-	26.0	
20.0																		
21.0	9	12	18	30														
22.0	10	14	21	35														
23.0																		
24.0	12	15	30	45														
25.0																		
26.0	11	17	31	48														
27.0	13	19	30	49														

\* = Consolidation Test,

c<sub>c</sub> = Compression Index,

DFS

= Differential Free Swell,

—v = Water Table,

Sp = Swelling Pressure

**TABLE-B3.2: RESULT SHEET FOR MINOR BRIDGE AT CH.344+150 ON BH-345/1B**

(W.T. = 1.00M)

**PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH**

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 06.12.2013

Completion date : 08.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Description	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
28.0	14	22	32	54	<b>MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND</b>	2.67	29.27	13.61	54.45	38.8	19.6	-	-	-	-	-	25.0	
29.0																		
30.0	16	26	33	59														
31.0																		
32.0																		
33.0																		
34.0																		
36.0																		
37.0																		

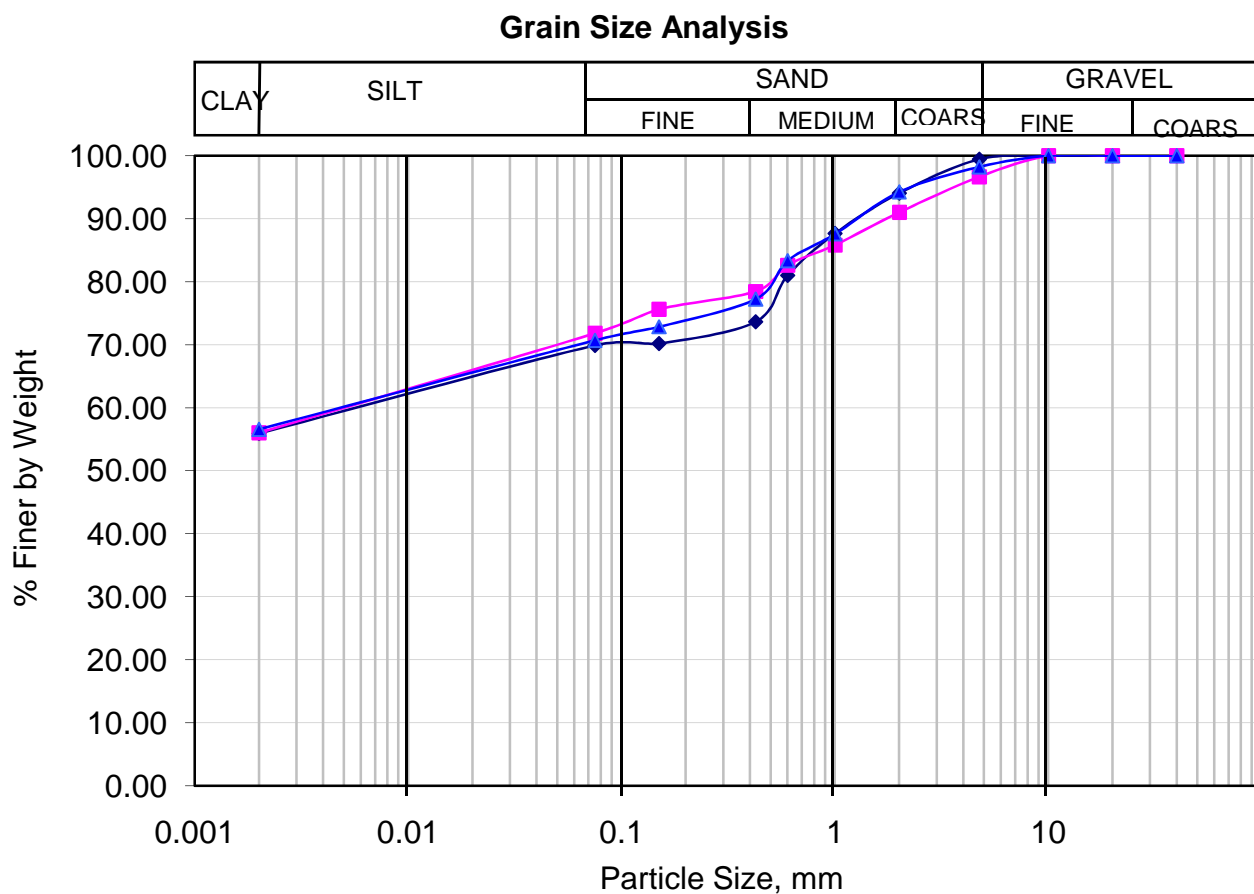
\* = Consolidation Test, c<sub>c</sub> = Compression Index, DFS = Differential Free Swell, —v = Water Table, Sp = Swelling Pressure

# PNT DESIGNS PVT. LTD., KOTA

PROJECT - DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH,  
ADB TA - 8116 IND

Determination of Grain Size Analysis Test as per IS:2720-Part 4-1985

MNB AT CH: 344+150 (345/1A)



Symbol	BH No.	Depth,m	Soil description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
	BH-345/1A	3.00	CI*	0.55	29.53	13.99	55.94
	BH-345/1A	9.00	CI*	3.33	24.83	15.80	56.03
	BH-345/1A	12.00	CI*	1.78	27.50	14.14	56.58

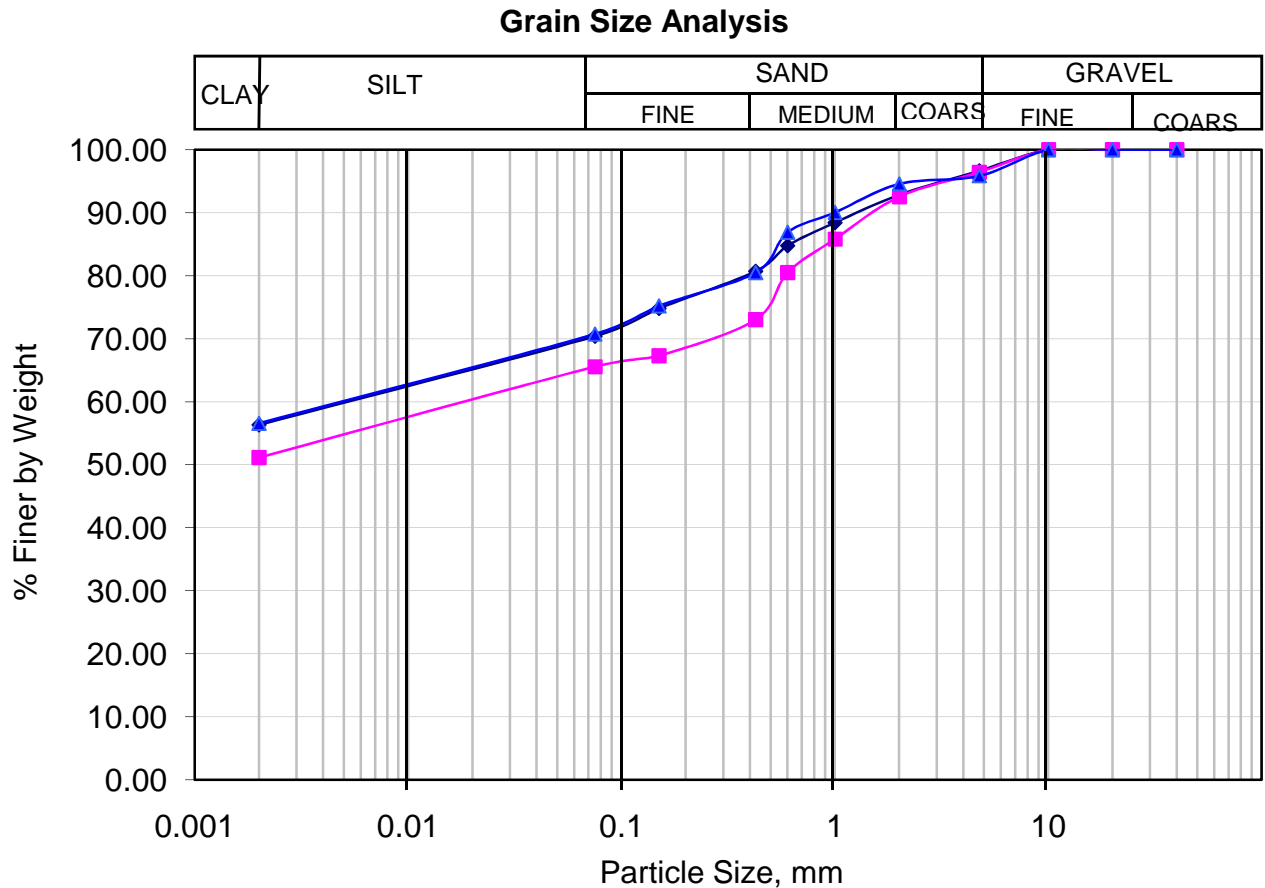
CI\* = MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND

# PNT DESIGNS PVT. LTD., KOTA

PROJECT - DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH,  
ADB TA - 8116 IND

Determination of Grain Size Analysis Test as per IS:2720-Part 4-1985

MNB AT CH: 344+150 (345/1A)



Symbol	BH No.	Depth,m	Soil description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
—◆—	BH-345/1A	18.00	CI*	3.33	26.23	14.09	56.35
—■—	BH-345/1A	21.00	CI*	3.51	30.89	14.43	51.17
—▲—	BH-345/1A	28.50	CI*	4.13	25.13	14.15	56.60

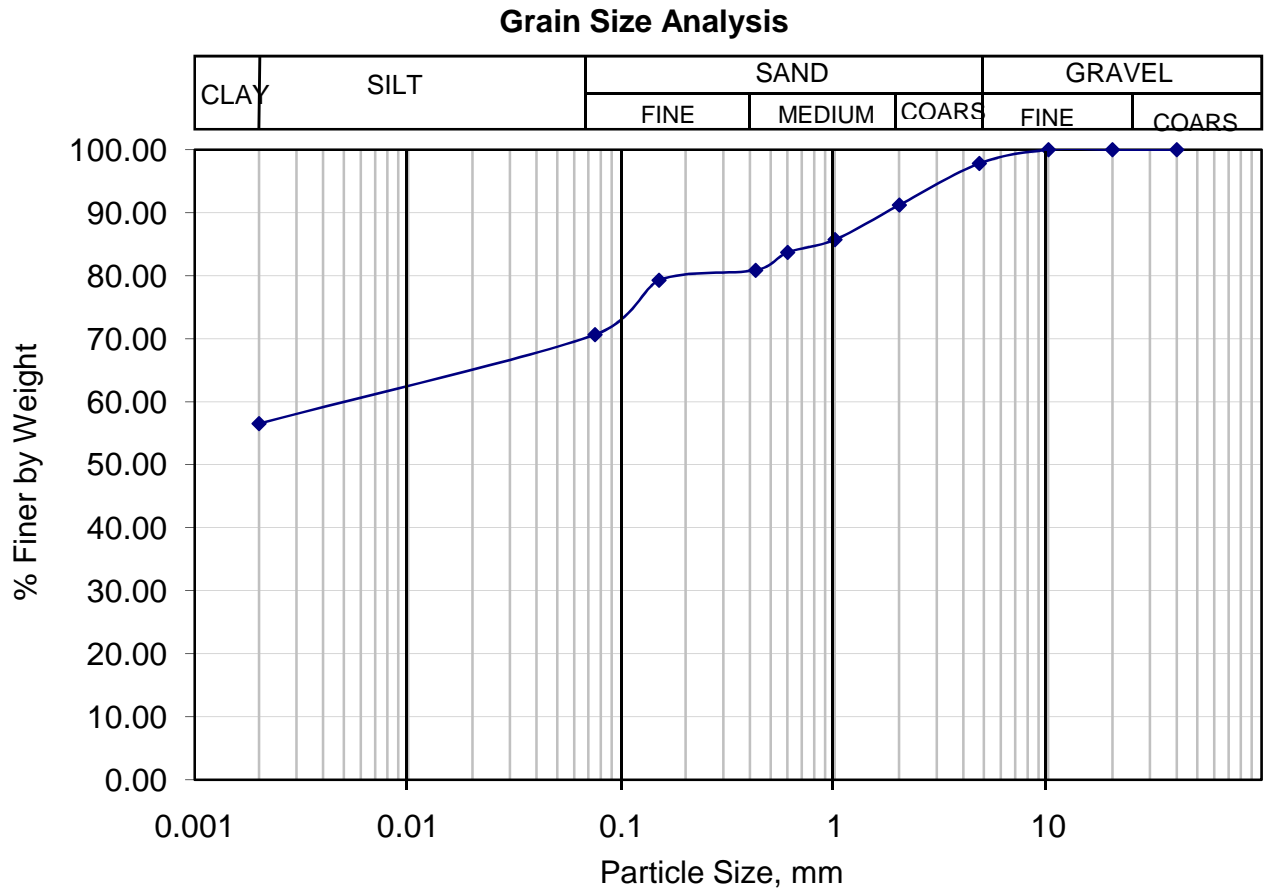
CI\* = MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND

# PNT DESIGNS PVT. LTD., KOTA

PROJECT - DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH,  
ADB TA - 8116 IND

Determination of Grain Size Analysis Test as per IS:2720-Part 4-1985

MNB AT CH: 344+150 (345/1A)



Symbol	BH No.	Depth,m	Soil description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
—◆—	BH-345/1A	33.00	CI*	2.17	27.17	14.13	56.53

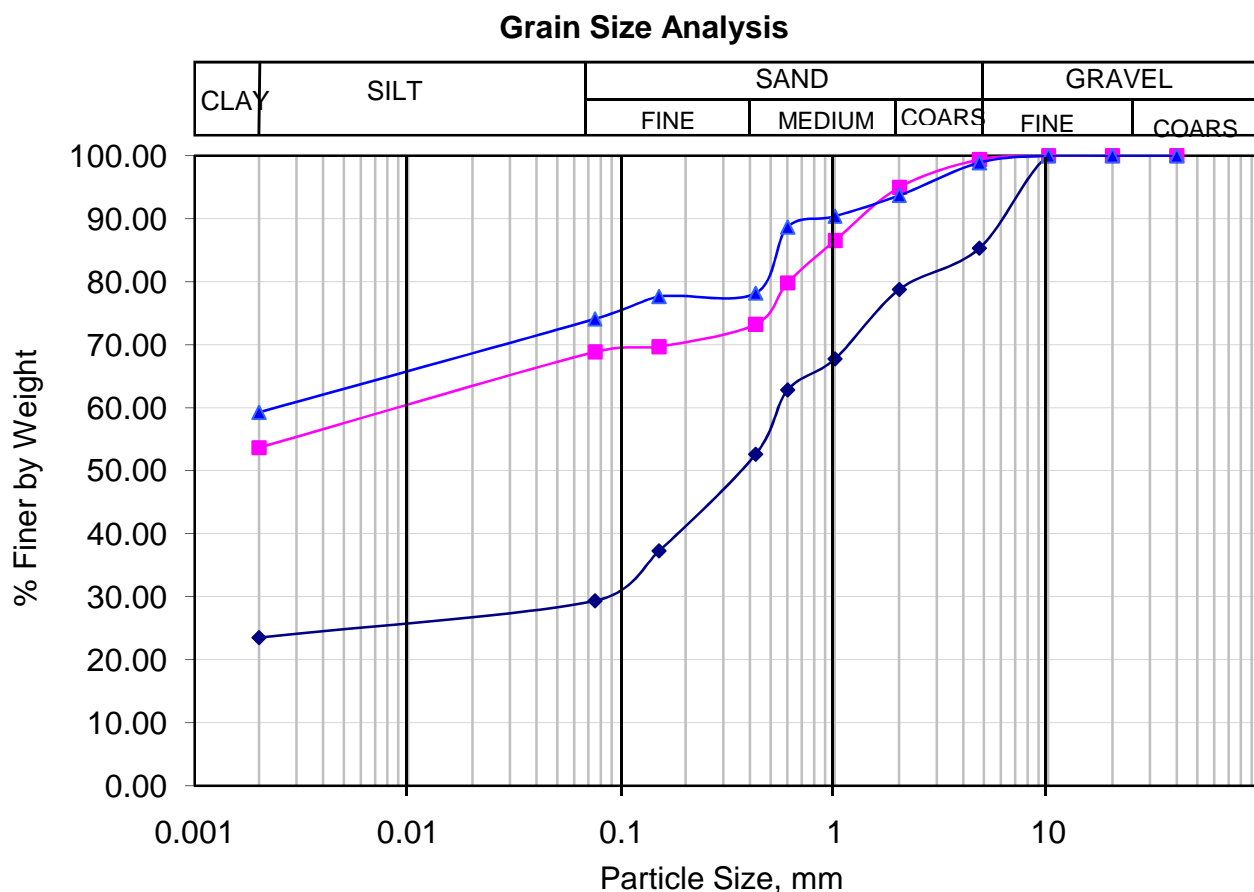
CI\* = MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND

# PNT DESIGNS PVT. LTD., KOTA

PROJECT - DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH,  
ADB TA - 8116 IND

Determination of Grain Size Analysis Test as per IS:2720-Part 4-1985

MNB AT CH: 344+150 (345/1B)



Symbol	BH No.	Depth,m	Soil description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
◆	BH-345/1B	1.00	SC*	14.68	55.93	5.88	23.52
■	BH-345/1B	6.00	CI*	0.60	30.52	15.15	53.73
▲	BH-345/1B	10.50	CI*	1.10	24.80	14.82	59.28

SC\* = CLAYEY SAND (SC) MIXED WITH GRAVELS

CI\* = MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND

Depth = 1.00 Weighted Mean Dia,  $d_m$  = 1.62 mm,  $f = 2.24$

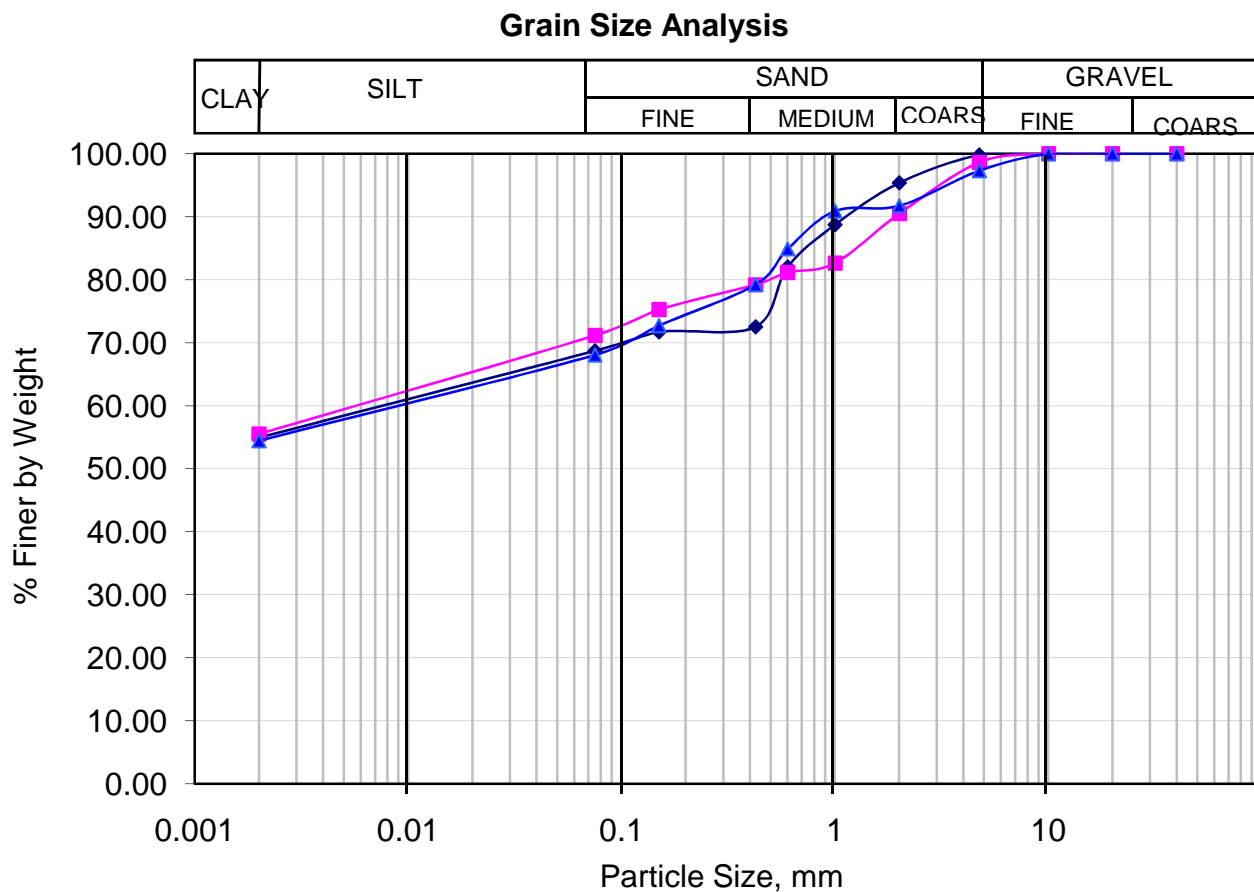


# PNT DESIGNS PVT. LTD., KOTA

PROJECT - DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH,  
ADB TA - 8116 IND

Determination of Grain Size Analysis Test as per IS:2720-Part 4-1985

MNB AT CH: 344+150 (345/1B)



Symbol	BH No.	Depth,m	Soil description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
—◆—	BH-345/1B	18.00	CI*	0.20	31.06	13.75	54.99
—■—	BH-345/1B	21.00	CI*	1.33	27.50	15.66	55.51
—▲—	BH-345/1B	28.50	CI*	2.67	29.27	13.61	54.45

CI\* = MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND

### SILT FACTOR CALCULATIONS

**MNB AT CH: 344+150 (345/1B)**

Total Weight of Dry Soil Taken =

400

Depth =

1

Sieve Size in mm	Average Size (mm)	Weight Retained in g	% Weight Retained	Cumulative % Retained	% Finer (N)	Weighted % weight retained
1	2	3	4	5	6	7 = (2X3)
80		0	0.00	0.00	100.00	0.000
40		0	0.00	0.00	100.00	0.000
20	30	0	0.00	0.00	100.00	0.000
10	15	0	0.00	0.00	100.00	0.000
4.75	7.375	58.7	14.68	<b>14.68</b>	<b>85.33</b>	108.228
2	3.375	26.2	6.55	21.23	78.78	22.106
1	1.5	44	11.00	32.23	67.78	16.500
0.6	0.8	19.8	4.95	37.18	62.83	3.960
0.425	0.5125	40.7	10.18	47.35	52.65	5.215
0.15	0.2875	61.5	15.38	62.73	37.28	4.420
0.075	0.1125	31.5	7.88	70.60	29.40	0.886
PAN	0.0375	117.6	29.40	100.00	0.00	1.103
		Sum =	100.00			162.418

Sum of Weighted % Weight retained on each seive

Mean Dia meter, dm = -----

Cummulative % retained

$$\begin{aligned} dm &= 162.4178125 / 100 &= & 1.62 \\ \text{Silt Factor, } f &= 1.76 \text{ Sqrt (dm)} &= & 2.24 \end{aligned}$$

DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH, ADB TA - 8116 IND

SILT FACTOR CALCULATION BASED ON COHESION OF SOIL  
MNB AT CH.344+150

Location : BH-345/1A

Depth : 1.50-33.0m

In order to determine maximum score depth the silt factor of the bad material is required to be determined. The silt factor ( $K_{sf}$ ) depends upon the average size of bed material and given by Lacey equation as follows:

$$K_{sf} = 1.76 \sqrt{d_m} \quad \dots\dots 1$$

Where  $d_m$  = the weighted mean diameter in millimeter

Also, in case of soil having  $\phi < 15^\circ$  and  $c$  (cohesion of soil)  $> 0.2 \text{ kg/cm}^2$ , ' $K_{sf}$ ' calculated as follows :

$$K_{sf} = F (1 + \sqrt{c}) \text{ where } c \text{ is in } \text{kg/cm}^2 \quad \dots\dots 2$$

where  $F = 1.50$  for  $\phi > 10^\circ$  and  $< 15^\circ$

$= 1.75$  for  $\phi > 5^\circ$  and  $< 10^\circ$

$= 2.00$  for  $\phi < 5^\circ$

The strata at this location found to be Medium Plastic Clay (CI). The silt factor has been calculated on the basis of undrained cohesion ( $c$ ) of the soil using equation (2) above. The undrained cohesion has been obtained from SPT data recorded at the site. The calculation of silt factor is as follows :

Design SPT-value of the Strata (Refusal, $N > 100$ )	:	6.83	= (5+6+5+7+7+11)/6
(below the Founding level)	:		
Cohesion, $C_u = 6 \text{ N (kPa)}$	:	41	
Angle of shearing resistance (restricted) $\phi$	:	0	
Cohesion, $C_u \text{ (kg/cm}^2\text{)}$	:	0.41	
The silt factor shall be as follows :	:	$K_{sf} = F (1 + \sqrt{c})$	
Where :	F	: 2	
	$K_{sf} =$	: $2 * (1 + \sqrt{0.41})$	
		: <b>3.28</b>	

DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH, ADB TA - 8116 IND

SILT FACTOR CALCULATION BASED ON COHESION OF SOIL  
MNB AT CH.344+150

Location : BH-345/1B

Depth : 1.50-30.0m

In order to determine maximum score depth the silt factor of the bad material is required to be determined. The silt factor ( $K_{sf}$ ) depends upon the average size of bed material and given by Lacey equation as follows:

$$K_{sf} = 1.76 \sqrt{d_m} \quad \dots\dots 1$$

Where  $d_m$  = the weighted mean diameter in millimeter

Also, in case of soil having  $\phi < 15^\circ$  and  $c$  (cohesion of soil)  $> 0.2 \text{ kg/cm}^2$ , ' $K_{sf}$ ' calculated as follows :

$$K_{sf} = F (1 + \sqrt{c}) \text{ where } c \text{ is in } \text{kg/cm}^2 \quad \dots\dots 2$$

where  $F = 1.50$  for  $\phi > 10^\circ$  and  $< 15^\circ$

$= 1.75$  for  $\phi > 5^\circ$  and  $< 10^\circ$

$= 2.00$  for  $\phi < 5^\circ$

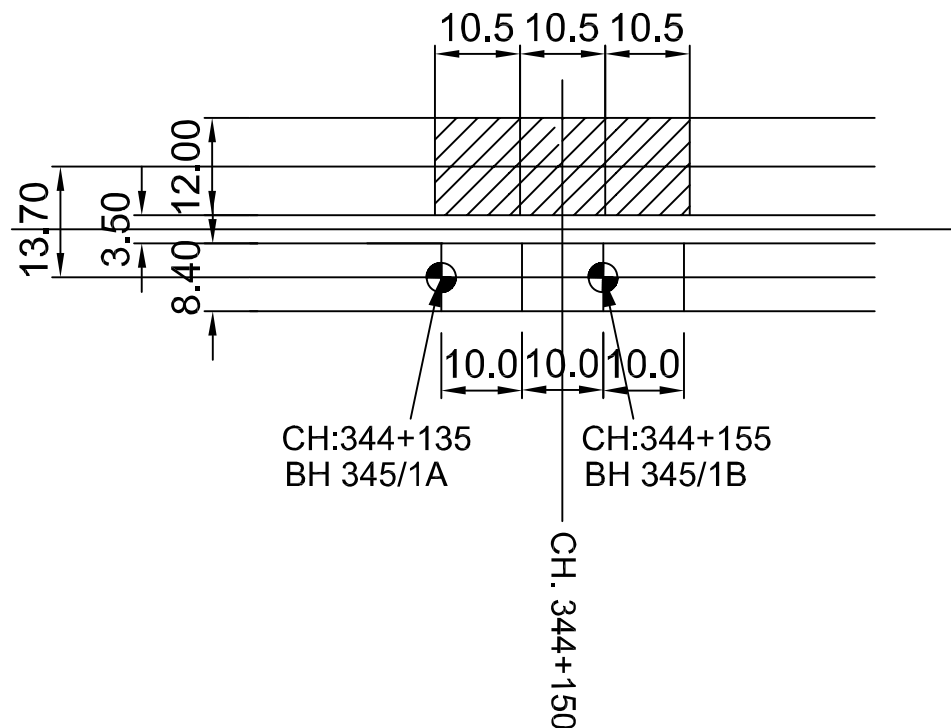
The strata at this location found to be Medium Plastic Clay (CI). The silt factor has been calculated on the basis of undrained cohesion ( $c$ ) of the soil using equation (2) above. The undrained cohesion has been obtained from SPT data recorded at the site. The calculation of silt factor is as follows :

Design SPT-value of the Strata (Refusal, $N > 100$ )	:	7.2	= (5+7+6+8+10)/5
(below the Founding level)	:		
Cohesion, $C_u = 6 \text{ N (kPa)}$	:	43.2	
Angle of shearing resistance (restricted) $\phi$	:	0	
Cohesion, $C_u (\text{kg/cm}^2)$	:	0.432	
The silt factor shall be as follows :	:	$K_{sf} = F (1 + \sqrt{c})$	
Where :	:	2	
	:	$K_{sf} =$	$2 * (1 + \sqrt{0.432})$
	:		3.31

← IMPHAL

MOREH →

## BOREHOLE LOCATION PLAN FOR MINOR BRIDGE AT CH: 344+150 (Arong)



Existing Span Arrangements  
(3x 10.5)

Proposed Span Arrangements  
(3 x 10.0)

(The borehole locations are given for  
Existing chainage)

### LEGEND:



Borehole Location



Existing Bridge

### PROJECT

DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION  
FROM IMPHAL TO MOREH, ADB TA - 8116 IND

Design Consultant :

**SHELADIA ASSOCIATES INC., USA**



Amsrl Shamra, Flat No: 206 & 207,  
S D Road, Old Lancer Lanes,  
Secunderabad - 500 003, AP.



## GEOTECH REPORT FOR MINOR BRIDGE

AT CH: 347+600





**Geotechnical Investigation Report for determination of allowable  
bearing pressure for MINOR BRIDGE at CH. 347+600 of NH-39  
under  
“DETAILED PROJECT FOR INDO MYANMAR ROAD  
SECTION FROM IMPHAL TO MOREH, ADB TA - 8116 IND”**

**ABSTRACT**

The safe load carrying capacity of the foundation of MINOR BRIDGE at Ch. 347+600 on NH-39 is recommended as follows:

<b>Location of Borehole</b>	<b>Existing Ground Level</b>	<b>Founding Level</b>	<b>Depth of Foundation Df (m)</b>	<b>Net Allowable Bearing Capacity (t/m<sup>2</sup>)</b>	<b>Type of foundation</b>
<b>348/1A</b>	<b>773.315</b>	<b>766.815</b>	<b>6.50</b>	<b>28.0</b>	<b>Open</b>

Note: The depth of 1.5m soil below the founding level shall be replaced with a good granular material and proper compaction

## THE STRATA AT GLANCE AND SILT FACTORS

Borehole No.	Type of strata	Depth	Weighted mean dia, $d_m$ (mm)	Silt Factor,
1	2	3	4	5
BH-348/1A	Filled-up Material	0.0-1.50m	-	-
	Medium Plastic Clay (CI) mixed with Sand	1.50-12.0m	-	3.44
	Clayey Sand (SC) mixed with Gravels	12.0-25.5m	1.43-2.17	2.11-2.59

**Geotechnical Investigation Report**  
**for determination of allowable bearing pressure for**  
**MINOR BRIDGE at CH. 347+600 on NH-39 under**  
**“Detailed Project for Indo Myanmar Road Section from Imphal to Moreh,**  
**ADB TA - 8116 IND”**

## **1. INTRODUCTION**

Geotechnical investigation was carried out for MINOR BRIDGE at Ch.347+600 on NH-39 under Detailed Project for Indo Myanmar Road Section from Imphal to Moreh, ADB TA - 8116 IND. The Schedule of work and the locations of bore holes were decided by Engineer In-charge of Sheladia Associates, Inc., USA. The locations of boreholes are shown in Key Plan (Fig.B4).

## **2.0 FIELD INVESTIGATION**

### **2.1 Boring**

One bore hole i.e. BH-348/1A was made at the locations decided by Engineer In-charge as shown in Key Plan (Fig.B4). Boring was done by power driven rig as per guidelines of IS: 1892:1979 and IRC-78-2000. Boring was done up to the maximum depth of 25.5m. The soil samples were collected as required for laboratory testing.

### **2.2 Standard Penetration Test (SPT)**

Standard penetration test (SPT) was conducted in the bore hole as per IS 2131-1981. The numbers of blows for first 15 cm penetration is considered as seating drive and are not taken into account. The number of blows required for last 30 cm penetration is taken as SPT number (“N” values). If number of blows for last 30 cm penetration exceeds 100, it is said to be the refusal. SPT were conducted at regular interval of 1.5m, starting from the depth of 1.5m from the

ground surface to the depth of exploration/ refusal. The tests results are shown in Table-B4.1.

### **2.3 Water Table**

The water table was observed at the depth of 1.4m from ground surface, at the time of investigation (i.e. December 2013).

### **3.0 LABORATORY INVESTIGATION**

#### **Soil Samples:**

The following laboratory tests were conducted on the soil samples obtained from test bore holes:

- a) Natural Moisture content
- b) Specific gravity
- c) Liquid & Plastic Limit
- d) Grain size Analysis
- e) Shear strength test
- f) Bulk density (Dry Density)
- g) Free swell test

Test results are shown in borelogs i.e. Table-B4.1.

### **4. TYPE OF STRATA**

Based on laboratory and field investigation the strata at the site have been described. The bore-log of the strata is presented in Table-B4.1. The strata are as follows:

#### **BH-348/1A**

The upper layer of the strata thickness about 1.5m was found to be Filled-up Material. Below this, Medium Plastic Clay (CI) mixed with Sand was found up to the depth of 12.0m. Beyond this, Clayey Sand (SC) mixed with Gravels was found up to the depth of exploration i.e. 25.5m. The bore-log is shown in Table-B4.1.

## 5.0 FOUNDATION ANALYSIS

Open foundation has been analyzed based on results of SPT. The calculation sheets for allowable bearing capacity at borehole locations 348/1A is attached as Appendix-B4.1.

## 6.0 SILT FACTOR

In order to determine maximum score depth the silt factor of the bad material is required to be determine. The silt factor (f) depends upon the average size of bed material and given by Lacey equation as follows:

$$K_{sf} = 1.76 \sqrt{d_m}$$

Where  $d_m$  = the weighted mean diameter in millimeter

Also, in case of soil having  $\phi < 15^\circ$  and  $c$  (cohesion of soil)  $> 0.2 \text{ kg/cm}^2$ , ' $K_{sf}$ ' calculated as follows :

$$K_{sf} = F (1 + \sqrt{c}) \text{ where } c \text{ is in kg/cm}^2$$

where  $F$  = 1.50 for  $\phi > 10^\circ$  and  $< 15^\circ$   
= 1.75 for  $\phi > 5^\circ$  and  $< 10^\circ$   
= 2.00 for  $\phi < 5^\circ$

Borehole No.	Type of strata	Depth	Weighted mean dia, $d_m$ (mm)	Silt Factor,
1	2	3	4	5
BH-348/1A	Filled-up Material	0.0-1.50m	-	-
	Medium Plastic Clay (Cl) mixed with Sand	1.50-12.0m	-	3.44
	Clayey Sand (SC) mixed with Gravels	12.0-25.5m	1.43-2.17	2.11-2.59

## **7.0 CONCLUSION**

1. The strata at the site is described in Section 4.0.
2. The water table was observed at the depth of 1.4m from ground surface, at the time of investigation (i.e. December 2013).
3. Safe load carrying capacity has been recommended as follows:

<b>Location of Borehole</b>	<b>Existing Ground Level</b>	<b>Founding Level</b>	<b>Depth of Foundation Df (m)</b>	<b>Net Allowable Bearing Capacity (t/m<sup>2</sup>)</b>	<b>Type of foundation</b>
<b>348/1A</b>	<b>773.315</b>	<b>766.815</b>	<b>6.50</b>	<b>28.0</b>	<b>Open</b>

Note: The depth of 1.5m soil below the founding level shall be replaced with a good granular material and proper compaction

SCOUR DEPTH CALCULATIONS FOR MINOR BRIDGE AT CH: 347+600 (Khabakong)

Si.No	Chainage	Proposed Span Arrangement	Location	HFL (m)	Discharge (Cumecs)	Velocity (m/sec)	Design Discharge 1.3xQ (Cumec)	Silt Factor	Eff. Linear Waterway (m)	Discharge per m width (Cumecs/	Mean Scour Depth Dsm(m)	Scour depth below HFL(m)	Borehole Level (m)	Min. Bed Level (m)	Theoretic al Scour level (m)	Restricted Scour Level (m)	Actual Scour level (m)	Scour depth below BH (m)
4	347+600	2 X 7.0	A1	Irrigation Canal		-	-	2.0	11	-	-	-	773.315	771.815	-	-	771.515	1.8
	(Khabakong)		P		-	-	-	2.0	11	-	-	-	771.815	771.815	-	-	771.515	0.3

**MINOR BRIDGE**  
**DETERMINATION OF BEARING CAPACITY OF SHALLOW FOUNDATIONS** **CH: 347+600**

**COMPUTATION OF BEARING CAPACITY AS PER IS:6403**

**Location : BH-348/1A**

**1.1 Foundation Details**

Type of Foundation System : Open Foundation  
**Thickness of filled-up soil, m** : 1.5  
 Depth of Foundation below existing ground level in (m) : 8  
**Depth of Foundation below natural ground surface** : 6.5  
**Note: 1.5m Soil layer below founding level be replace by well compacted granular soil.**  
 width of foundation in (m) : 6.0  
 Length of foundation in (m) : 8.0

**1.2 Soil Parameters:**

Bearing capacity has been calculated on the basis of average SPT value for the depth of 1.5 times width of foundation, below the base of foundation. The refusal to SPT has been considered when  $N > 100$ . The strata at the site was found to be hard clay. The unconfined compressive strength  $q_u$  is given as  $q_u = kN$  (kPa) where,  $k = 12$  (refer text book of J.E. Bowles 2012 page-165). Therefore,  $C_u = q_u/2 = (12/2) \times N$  (kPa).

Design SPT-value of the Bearing Strata (Refusal, $N > 100$ )	: 21.17	= (13+15+16+21+23+39)/6
(below the Founding level)	:	
Cohesion, $C_u = 6N$ (kPa)	: 127	
Average Shear Strength below base of foundation	:	
Angle of shearing resistance (restricted) $\phi$	: 0	
Unconfined comp. strength $q_u = 12 N$ (kPa)	: 254	
Cohesion, $C_u$ (t/m <sup>2</sup> )	: 12.7	
Bulk density of the strata (t/m <sup>3</sup> )	:	
Submerged density of the strata (t/m <sup>3</sup> )	: 1.000	
$N_{\phi} = \tan^2 (45 + \phi/2)$	: 1.000	

**1.3 Design Parameters:**

Bearing Capacity Factors:	Shape Factors	Depth Factors	Inclination Factors
$N_c = 5.14$	$S_c = 1.1$	$D_c = 1.2$	$i_c = 1.0$
$N_q = 1$	$S_q = 1.1$	$D_q = 1.0$	$i_q = N/A$
$N_{\gamma} = 0$	$S_{\gamma} = 0.8$	$D_{\gamma} = 1.0$	$i_{\gamma} = N/A$

**Net Ultimate Bearing Capacity:**

$$Q_u = (C_u \cdot N_c \cdot D_c \cdot i_c) + (\gamma \cdot d \cdot (N_q - 1) \cdot S_q \cdot d_q \cdot i_q) + (0.5 \cdot B/2 \cdot \gamma \cdot N_{\gamma} \cdot S_{\gamma} \cdot d_{\gamma} \cdot i_{\gamma})$$

$$= 87.36$$

Factor of Safety = 2.5

Net Safe Bearing Cap. = 34.95 t/m<sup>2</sup>

**Settlement Criterial**

The settlement has been obtained from IS:8009 part-I. The immediate settlement is given as follows (Sec.9.2.3.2 of IS:8009).

$$S_i = pB (1 - m^2) \times I/E = 50 \text{ mm (permissible settlement)}$$

$$m = 0.5 \text{ for clays, } I = 0.95, B = 6m$$

$$E = (200 \text{ to } 500) \times C_u \text{ (t/m}^2\text{)} \text{ (J.E. Bowel, 2012 Pg. 127), taking minimum value of E i.e. } 200 \times C_u \text{ (t/m}^2\text{)}$$

$$E = 2540 \text{ (t/m}^2\text{)}$$

Therefore, safe bearing pressure for permissible settlement of 50mm shall be

$$(0.05 \times E) / (0.95 \times B \times (1 - 0.5^2)) \text{ t/m}^2 = 29.7076 \text{ t/m}^2$$

**The Recommended Net allowable Bearing pressure = 28.0 t/m<sup>2</sup>**

**Note: 1.5m Soil layer below founding level be replace by well compacted granular soil.**



**TABLE-B4.1:** RESULT SHEET FOR MINOR BRIDGE AT CH.347+600 ON BH-348/1A

(W.T. = 1.40M)

**PROJECT :** DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 01.12.2013

Completion date : 04.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Description	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
1.0	7	9	10	19	<b>FILLED-UP MATERIAL</b>													
2.0					<b>MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND</b>													
3.0	2	3	3	6		3.30	32.70	12.85	51.20	41.0	22.3	-	2.70	-	-	-	30.4	-
4.0	2	3	4	7														
5.0																		
6.0	3	3	5	8														
7.0																		
8.0	3	4	5	9														
9.0	4	5	8	13		1.28	33.34	14.38	51.00	48.5	23.0	-	-	-	-	-	35.0	-

\* = Consolidation Test, c<sub>c</sub> = Compression Index, DFS = Differential Free Swell, —v = Water Table, Sp = Swelling Pressure

**TABLE-B4.1: RESULT SHEET FOR MINOR BRIDGE AT CH.347+600 ON BH-348/1A**

(W.T. = 1.40M)

**PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH****ADB TA - 8116 IND**

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 01.12.2013

Completion date : 04.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m³)	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Descreption	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m²	ø deg.		
10.0	5	6	9	15	MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND	13.75	49.93	7.27	29.06	34.5	19.0	-	2.68	-	-	-	25.0	
11.0																		
12.0	4	6	10	16	CLAYEY SAND (SC) MIXED WITH GRAVELS													
13.0																		
14.0	5	9	12	21														
15.0	6	10	13	23														
16.0																		
17.0	7	11	28	39														
18.0	8	12	31	43														

\* = Consolidation Test,

c<sub>c</sub> = Compression Index,

DFS

= Differential Free Swell,

—v = Water Table,

Sp = Swelling Pressure

**TABLE-B4.1: RESULT SHEET FOR MINOR BRIDGE AT CH.347+600 ON BH-348/1A**

(W.T. = 1.40M)

**PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH****ADB TA - 8116 IND**

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 01.12.2013

Completion date : 04.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Description	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
19.0	9	15	29	44	<b>CLAYEY SAND (SC) MIXED WITH GRAVELS</b>	11.88	53.50	6.93	27.70	36.3	20.0	-	-	-	-	-	19.0	
20.0																		
21.0	12	19	24	43														
22.0																		
23.0	11	21	27	48														
24.0	12	23	30	53		16.05	51.48	7.14	25.33	36.2	19.7	-	2.71	-	-	-	23.8	
25.0																		
26.0	11	24	32	56														
27.0																		

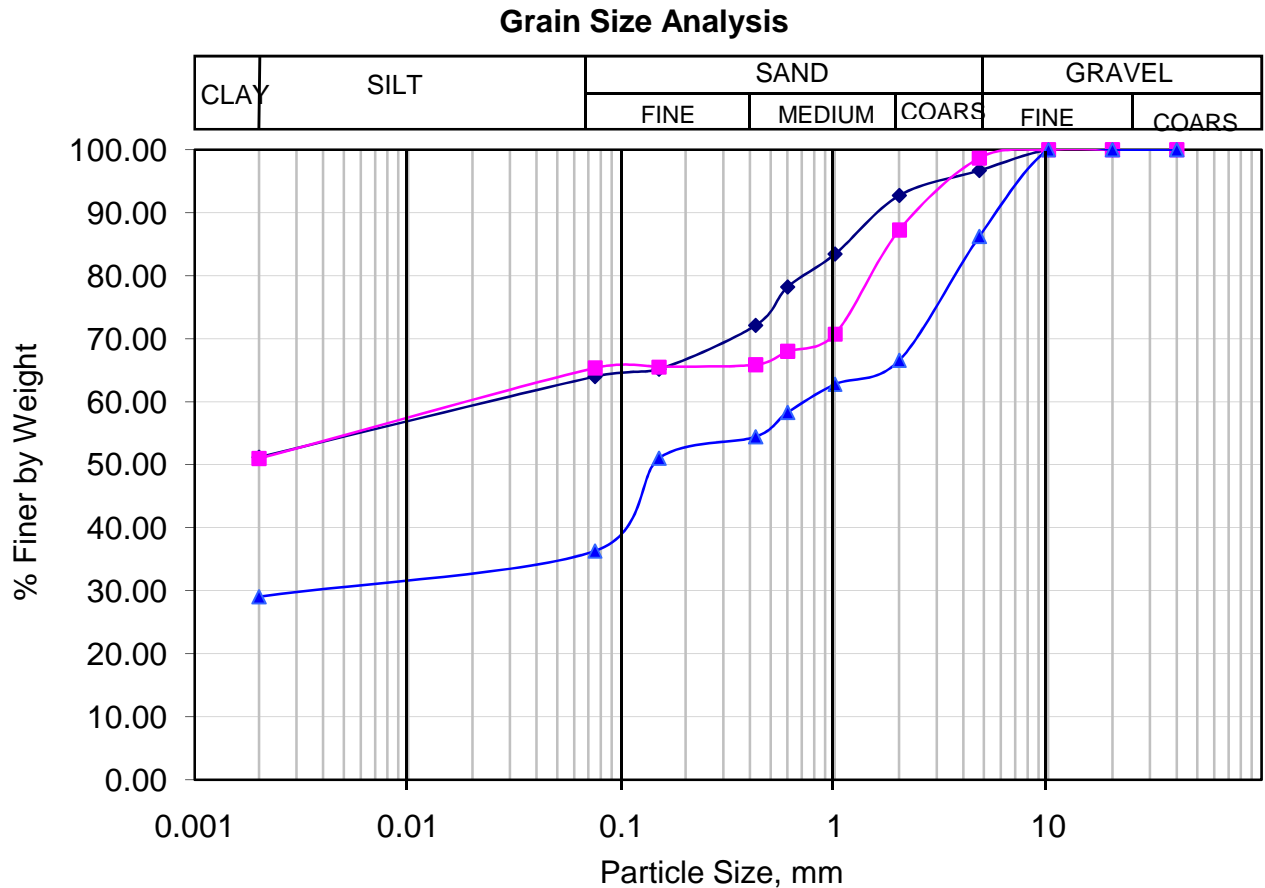
\* = Consolidation Test, c<sub>c</sub> = Compression Index, DFS = Differential Free Swell, W = Water Table, Sp = Swelling Pressure

# PNT DESIGNS PVT. LTD., KOTA

PROJECT - DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH,  
ADB TA - 8116 IND

Determination of Grain Size Analysis Test as per IS:2720-Part 4-1985

MNB AT CH: 347+600 (348/1A)



Symbol	BH No.	Depth,m	Soil description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
◆	BH-348/1A	3.00	CI*	3.30	32.70	12.80	51.20
■	BH-348/1A	9.00	CI*	1.28	33.34	14.38	51.00
▲	BH-348/1A	13.50	SC*	13.75	49.93	7.27	29.06

CI\* = MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND

SC\* = CLAYEY SAND (SC) MIXED WITH GRAVELS

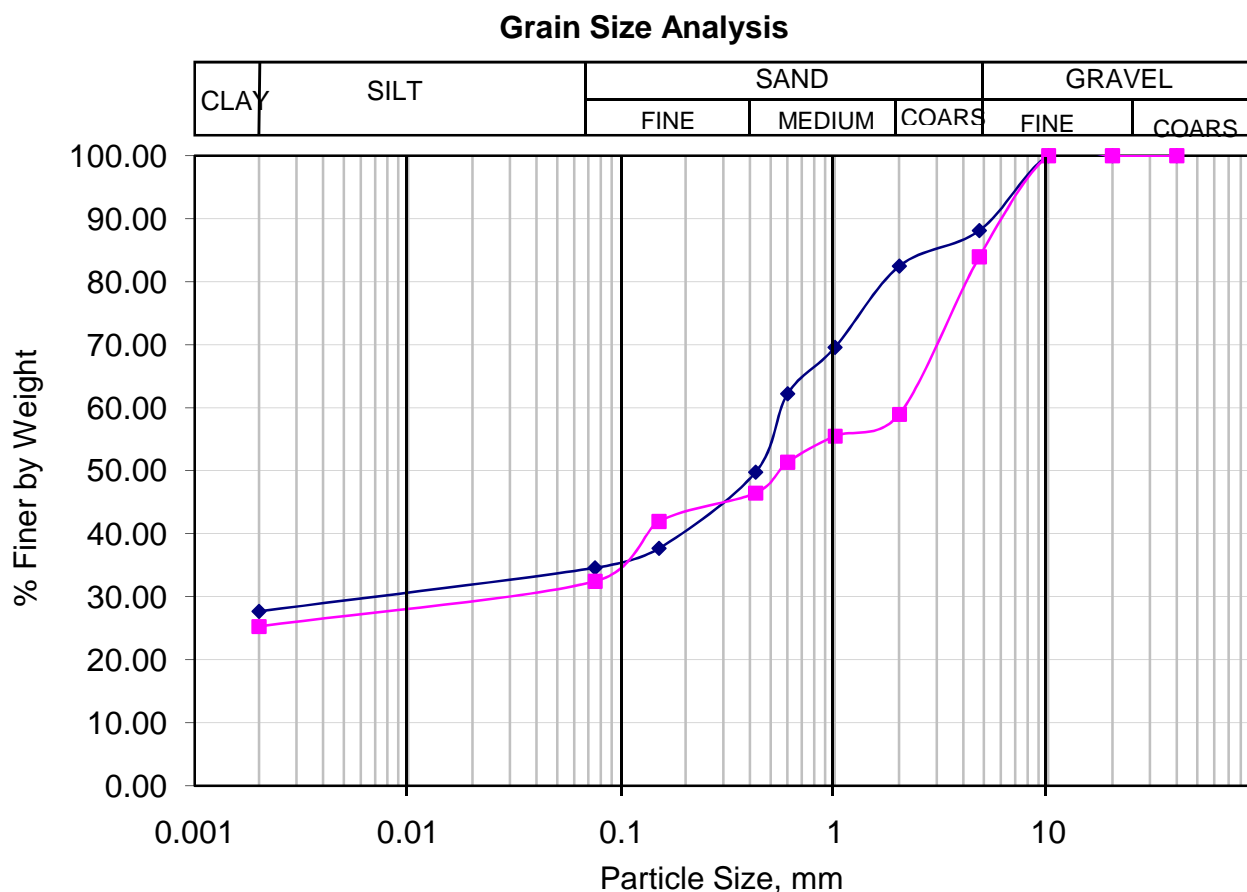
Depth = 13.50 Weighted Mean Dia,  $d_m$  = 1.83 mm,  $f = 2.38$

# PNT DESIGNS PVT. LTD., KOTA

PROJECT - DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH,  
ADB TA - 8116 IND

Determination of Grain Size Analysis Test as per IS:2720-Part 4-1985

MNB AT CH: 347+600 (348/1A)



Symbol	BH No.	Depth,m	Soil description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
	BH-348/1A	19.50	SC*	11.88	53.50	6.93	27.70
	BH-348/1A	24.00	SC*	16.05	51.48	7.14	25.33

SC\* = CLAYEY SAND (SC) MIXED WITH GRAVELS

Depth =	19.50	Weighted Mean Dia, $d_m$	=	1.43	mm,	$f = 2.11$
Depth =	24.00	Weighted Mean Dia, $d_m$	=	2.17	mm,	$f = 2.59$

DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH, ADB TA - 8116 IND

SILT FACTOR CALCULATION BASED ON COHESION OF SOIL  
MNB AT CH.347+600

Location : BH-348/1A

Depth : 1.50m-12.0m

In order to determine maximum score depth the silt factor of the bad material is required to be determined. The silt factor ( $K_{sf}$ ) depends upon the average size of bed material and given by Lacey equation as follows:

$$K_{sf} = 1.76 \sqrt{d_m} \quad \dots\dots 1$$

Where  $d_m$  = the weighted mean diameter in millimeter

Also, in case of soil having  $\phi < 15^\circ$  and  $c$  (cohesion of soil)  $> 0.2 \text{ kg/cm}^2$ , ' $K_{sf}$ ' calculated as follows :

$$K_{sf} = F (1 + \sqrt{c}) \text{ where } c \text{ is in } \text{kg/cm}^2 \quad \dots\dots 2$$

where  $F = 1.50$  for  $\phi > 10^\circ$  and  $< 15^\circ$

$= 1.75$  for  $\phi > 5^\circ$  and  $< 10^\circ$

$= 2.00$  for  $\phi < 5^\circ$

The strata at this location found to be Medium Plastic Clay (CI). The silt factor has been calculated on the basis of undrained cohesion ( $c$ ) of the soil using equation (2) above. The undrained cohesion has been obtained from SPT data recorded at the site. The calculation of silt factor is as follows :

Design SPT-value of the Strata (Refusal, $N > 100$ )	:	8.6	= (6+7+8+9+13)/5
(below the Founding level)	:		
Cohesion, $C_u = 6 \text{ N (kPa)}$	:	51.6	
Angle of shearing resistance (restricted) $\phi$	:	0	
Cohesion, $C_u (\text{kg/cm}^2)$	:	0.516	
The silt factor shall be as follows :	:	$K_{sf} = F (1 + \sqrt{c})$	
Where :	F	: 2	
	$K_{sf} =$	: $2 * (1 + \sqrt{0.516})$	
		: <b>3.44</b>	

## SILT FACTOR CALCULATIONS

**MNB AT CH: 347+600 (348/1A)**

Total Weight of Dry Soil Taken = 400

Depth = 13.5

Sieve Size in mm	Average Size (mm)	Weight Retained in g	% Weight Retained	Cumulative % Retained	% Finer (N)	Weighted % weight retained
1	2	3	4	5	6	7 = (2X3)
		0	0.00	0.00	100.00	0.000
40		0	0.00	0.00	100.00	0.000
20	30	0	0.00	0.00	100.00	0.000
10	15	0	0.00	0.00	100.00	0.000
4.75	7.375	55	13.75	13.75	86.25	101.406
2	3.375	78.6	19.65	33.40	66.60	66.319
1	1.5	15.2	3.80	37.20	62.80	5.700
0.6	0.8	18	4.50	41.70	58.30	3.600
0.425	0.5125	15.4	3.85	45.55	54.45	1.973
0.15	0.2875	13.6	3.40	48.95	51.05	0.978
0.075	0.1125	58.9	14.73	63.68	36.33	1.657
PAN	0.0375	145.3	36.33	100.00	0.00	1.362
		Sum =	100.00			182.994

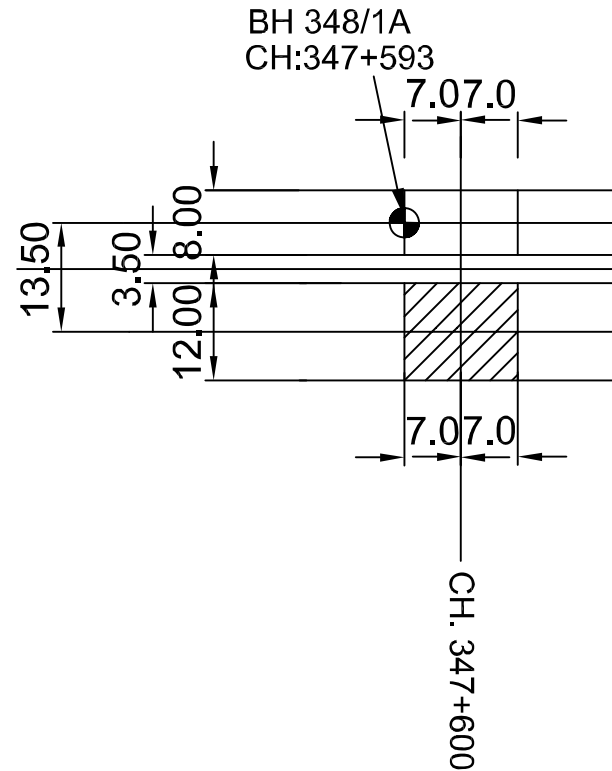
$$dm = 182.994375 / 100 = 1.83$$

$$\text{Silt Factor, } f = 1.76 \sqrt{dm} = 2.38$$





## BOREHOLE LOCATION PLAN FOR MINOR BRIDGE AT CH: 347+600 (Khabakong)



Proposed Span Arrangements  
(2 x 7.0)

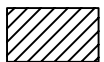
Existing Span Arrangements  
(2 x 7.0)

(The borehole locations are given for  
Existing chainage)

### LEGEND:



Borehole Location



Existing Bridge

### PROJECT

DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION  
FROM IMPHAL TO MOREH, ADB TA - 8116 IND

Design Consultant :

**SHELADIA ASSOCIATES INC., USA**



Amsrl Shamra, Flat No: 206 & 207,  
S D Road, Old Lancer Lanes,  
Secunderabad - 500 003, AP.



## GEOTECH REPORT FOR MINOR BRIDGE

AT CH: 348+150



**Geotechnical Investigation Report for determination of allowable  
bearing pressure for MINOR BRIDGE at CH. 348+150 of NH-39  
under  
“DETAILED PROJECT FOR INDO MYANMAR ROAD  
SECTION FROM IMPHAL TO MOREH, ADB TA - 8116 IND”**

**ABSTRACT**

The safe load carrying capacity of the foundation of MINOR BRIDGE at Ch. 348+150 ( Wangjing) on NH-39 is recommended as follows:

<b>Location of Borehole</b>	<b>Existing Ground Level</b>	<b>Founding Level</b>	<b>Depth of Foundation Df (m)</b>	<b>Net Allowable Bearing Capacity (t/m<sup>2</sup>)</b>	<b>Type of foundation</b>
<b>349/1A</b>	<b>774.000</b>	<b>767.000</b>	<b>7.00</b>	<b>30.00</b>	<b>Open</b>

## THE STRATA AT GLANCE AND SILT FACTORS

Borehole No.	Type of strata	Depth	Weighted mean dia, $d_m$ (mm)	Silt Factor,
1	2	3	4	5
BH-349/1A	Filled-up Material	0.0-2.70m	-	-
	Medium Plastic Clay (Cl) mixed with Sand	2.7-15.0m	-	3.77
	Highly Plastic Clay (CH) mixed with Sand	15.0-24.0m	-	>3.77

**Geotechnical Investigation Report**  
**for determination of allowable bearing pressure for**  
**MINOR BRIDGE at CH. 348+150 on NH-39 under**  
**“Detailed Project for Indo Myanmar Road Section from Imphal to Moreh,**  
**ADB TA - 8116 IND”**

## **1. INTRODUCTION**

Geotechnical investigation was carried out for MINOR BRIDGE at Ch.348+150 on NH-39 under Detailed Project for Indo Myanmar Road Section from Imphal to Moreh, ADB TA - 8116 IND. The Schedule of work and the locations of bore holes were decided by Engineer In-charge of Sheladia Associates, Inc., USA. The locations of boreholes are shown in Key Plan (Fig.B5).

## **2.0 FIELD INVESTIGATION**

### **2.1 Boring**

One bore hole i.e. BH-349/1A was made at the locations decided by Engineer In-charge as shown in Key Plan (Fig.B5). Boring was done by power driven rig as per guidelines of IS: 1892:1979 and IRC-78-2000. Boring was done up to the maximum depth of 24.0m. The soil samples were collected as required for laboratory testing.

### **2.2 Standard Penetration Test (SPT)**

Standard penetration test (SPT) was conducted in the bore hole as per IS 2131-1981. The numbers of blows for first 15 cm penetration is considered as seating drive and are not taken into account. The number of blows required for last 30 cm penetration is taken as SPT number (“N” values). If number of blows for last 30 cm penetration exceeds 100, it is said to be the refusal. SPT were conducted at regular interval of 1.5m, starting from the depth of 1.5m from the

ground surface to the depth of exploration/ refusal. The tests results are shown in Table-B5.1.

### **2.3 Water Table**

The water table was observed at the depth of 1.8m from ground surface, at the time of investigation (i.e. December 2013).

### **3.0 LABORATORY INVESTIGATION**

#### **Soil Samples:**

The following laboratory tests were conducted on the soil samples obtained from test bore holes:

- a) Natural Moisture content
- b) Specific gravity
- c) Liquid & Plastic Limit
- d) Grain size Analysis
- e) Shear strength test
- f) Bulk density (Dry Density)
- g) Free swell test

Test results are shown in borelogs i.e. Table-B5.1.

### **4. TYPE OF STRATA**

Based on laboratory and field investigation the strata at the site have been described. The bore-log of the strata is presented in Table-B5.1. The strata are as follows:

#### **BH-349/1A**

The upper layer of the strata thickness about 2.7m was found to be Filled-up Material. Below this, Medium Plastic Clay (CI) mixed with Sand was found up to the depth of 15.0m. Beyond this, Highly Plastic Clay (CH) mixed with Sand was found up to the depth of exploration i.e. 24.0m. The bore-log is shown in Table-B5.1.



## 5.0 FOUNDATION ANALYSIS

Open foundation has been analyzed based on results of SPT. The calculation sheets for allowable bearing capacity at borehole locations 349/1A is attached as Appendix-B5.1.

## 6.0 SILT FACTOR

In order to determine maximum score depth the silt factor of the bad material is required to be determine. The silt factor (f) depends upon the average size of bed material and given by Lacey equation as follows:

$$K_{sf} = 1.76 \sqrt{d_m}$$

Where  $d_m$  = the weighted mean diameter in millimeter

Also, in case of soil having  $\phi < 15^\circ$  and  $c$  (cohesion of soil)  $> 0.2 \text{ kg/cm}^2$ , ' $K_{sf}$ ' calculated as follows :

$$K_{sf} = F (1 + \sqrt{c}) \text{ where } c \text{ is in kg/cm}^2$$

where  $F$  = 1.50 for  $\phi > 10^\circ$  and  $< 15^\circ$   
= 1.75 for  $\phi > 5^\circ$  and  $< 10^\circ$   
= 2.00 for  $\phi < 5^\circ$

Borehole No.	Type of strata	Depth	Weighted mean dia, $d_m$ (mm)	Silt Factor,
1	2	3	4	5
BH-349/1A	Filled-up Material	0.0-2.70m	-	-
	Medium Plastic Clay (CI) mixed with Sand	2.7-15.0m	-	3.77
	Highly Plastic Clay (CH) mixed with Sand	15.0-24.0m	-	>3.77

## **7.0 CONCLUSION**

1. The strata at the site is described in Section 4.0.
2. The water table was observed at the depth of 1.8m from ground surface, at the time of investigation (i.e. December 2013).
3. Safe load carrying capacity has been recommended as follows:

<b>Location of Borehole</b>	<b>Existing Ground Level</b>	<b>Founding Level</b>	<b>Depth of Foundation Df (m)</b>	<b>Net Allowable Bearing Capacity (t/m<sup>2</sup>)</b>	<b>Type of foundation</b>
<b>349/1A</b>	<b>774.000</b>	<b>767.000</b>	<b>7.00</b>	<b>30.00</b>	<b>Open</b>

SCOUR DEPTH CALCULATIONS FOR MINOR BRIDGE AT CH: 348+150 (Wangjing)

Si.No	Chainage	Proposed Span Arrangement	Location	HFL (m)	Discharge (Cumecs)	Velocity (m/sec)	Design Discharge 1.3xQ (Cumec)	Silt Factor	Eff. Linear Waterway (m)	Discharge per m width (Cumecs/	Mean Scour Depth Dsm(m)	Scour depth below HFL(m)	Borehole Level (m)	Min. Bed Level (m)	Theoretic al Scour level (m)	Restricted Scour Level (m)	Actual Scour level (m)	Scour depth below BH (m)
5	348+150	8.8+8.0+8.8	A1	775.750	204	3.47	265.2	3.0	22	12.055	4.885	6.203	774.000	772.000	769.547	770.167	769.547	4.453
	(Wangjing)		P	775.750	204	3.47	265.2	3.0	22	12.055	4.885	9.769	772.000	772.000	765.981	766.958	765.981	6.019

**MINOR BRIDGE**  
**DETERMINATION OF BEARING CAPACITY OF SHALLOW FOUNDATIONS** **CH: 348+150**

**COMPUTATION OF BEARING CAPACITY AS PER IS:6403**

**Location : BH-349/1A**

**1.1 Foundation Details**

Type of Foundation System	: Open Foundation
Thickness of filled-up soil, m	: 2.7
Depth of Foundation below existing ground level in (m)	: 9.7
Depth of Foundation below natural ground surface	: 7

width of foundation in (m)	: 6.0
Length of foundation in (m)	: 8.0

**1.2 Soil Parameters:**

Bearing capacity has been calculated on the basis of average SPT value for the depth of 1.5 times width of foundation, below the base of foundation. The refusal to SPT has been considered when  $N > 100$ . The strata at the site was found to be hard clay. The unconfined compressive strength  $q_u$  is given as  $q_u = kN$  (kPa) where,  $k = 12$  (refer text book of J.E. Bowels 2012 page-165). Therefore,  $C_u = q_u/2 = (12/2) \times N$  (kPa).

Design SPT-value of the Bearing Strata (Refusal, $N > 100$ )	: 21.43	= $(15+17+19+21+24+26+28)/7$
(below the Founding level)	:	
Cohesion, $C_u = 6N$ (kPa)	: 128.5714	
Average Shear Strength below base of foundation	:	
Angle of shearing resistance (restricted) $\phi$	: 0	
Unconfined comp. strength $q_u = 12 N$ (kPa)	: 257.1429	
Cohesion, $C_u$ (t/m <sup>2</sup> )	: 12.85714	
Bulk density of the strata (t/m <sup>3</sup> )	:	
Submerged density of the strata (t/m <sup>3</sup> )	: 1.000	
$N_{\phi} = \tan^2 (45 + \phi/2)$	: 1.000	

**1.3 Design Parameters:**

Bearing Capacity Factors:	Shape Factors	Depth Factors	Inclination Factors
$N_c = 5.14$	$S_c = 1.1$	$D_c = 1.2$	$i_c = 1.0$
$N_q = 1$	$S_q = 1.1$	$D_q = 1.0$	$i_q = N/A$
$N_{\gamma} = 0$	$S_{\gamma} = 0.8$	$D_{\gamma} = 1.0$	$i_{\gamma} = N/A$

**Net Ultimate Bearing Capacity:**

$$Q_u = (C_u \cdot N_c \cdot D_c \cdot i_c) + (\gamma \cdot d \cdot (N_q - 1) \cdot S_q \cdot d_q \cdot i_q) + (0.5 \cdot B/2 \cdot \gamma \cdot N_{\gamma} \cdot S_{\gamma} \cdot d_{\gamma} \cdot i_{\gamma})$$

$$= 89.66$$

Factor of Safety = 2.5

Net Safe Bearing Cap. = 35.86 t/m<sup>2</sup>

**Settlement Criterial**

The settlement has been obtained from IS:8009 part-I. Since the strata is found to be hard clay, the long term consolidation settlement is unlikely to occur. The immediate settlement is given as follows (Sec.9.2.3.2 of IS:8009).

$$S_i = pB (1 - m^2) \times I/E = 50 \text{ mm (permissible settlement)}$$

$m = 0.5$  for clays,  $I = 0.95$ ,  $B = 6\text{m}$

$$E = (200 \text{ to } 500) \times C_u \text{ (t/m}^2\text{)} \text{ (J.E. Bowel, 2012 Pg. 127), taking minimum value of E i.e. } 200 \times C_u \text{ (t/m}^2\text{)}$$

$$E = 2571.4 \text{ (t/m}^2\text{)}$$

Therefore, safe bearing pressure for permissible settlement of 50mm shall be

$$(0.05 \times E) / (0.95 \times B \times (1 - 0.5^2)) \text{ t/m}^2$$

$$= 30.07519 \text{ t/m}^2$$

**The Recommended Net allowable Bearing pressure = 30.0 t/m<sup>2</sup>**

**TABLE-B5.1:** RESULT SHEET FOR MINOR BRIDGE AT CH.348+150 ON BH-349/1A

(W.T. = 1.80M)

**PROJECT :** DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 15.12.2013

Completion date : 16.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Description	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
1.0	4	8	15	23	<b>FILLED-UP MATERIAL</b>	4.34	32.70	12.59	50.37	35.0	18.0	-	2.71	-	-	-	22.0	-
2.0																		
2.7					<b>MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND</b>	4.34	32.70	12.59	50.37	35.0	18.0	-	2.71	-	-	-	22.0	-
3.0	5	6	7	13														
4.0																		
5.0	4	5	6	11														
6.0	4	6	7	13														
7.0																		
8.0	5	7	8	15														
9.0	6	8	9	17		5.95	25.75	15.03	53.27	38.30	19.8	-	-	-	-	-	24.0	-

\* = Consolidation Test, c<sub>c</sub> = Compression Index, DFS = Differential Free Swell, —v = Water Table, Sp = Swelling Pressure

**TABLE-B5.1:** RESULT SHEET FOR MINOR BRIDGE AT CH.348+150 ON BH-349/1A

(W.T. = 1.80M)

**PROJECT :** DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 15.12.2013

Completion date : 16.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Description	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
10.0	6	9	10	19	MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND	3.10	27.78	13.83	55.30	37.1	18.4	-	2.68	-	-	-	29.0	
11.0																		
12.0	5	10	11	21														
13.0	5	12	12	24	HIGHLY PLASTIC CLAY (CH) MIXED WITH SAND	2.20	29.44	13.67	54.69	58.5	23.0	-	2.72	-	-	-	35.0	
14.0																		
15.0	6	12	14	26														
16.0	7	13	25	28														
17.0																		
18.0	7	14	15	29														

\* = Consolidation Test,

c<sub>c</sub> = Compression Index,

DFS

= Differential Free Swell,

—v =

Water Table,

Sp = Swelling Pressure

**TABLE-B5.1: RESULT SHEET FOR MINOR BRIDGE AT CH.348+150 ON BH-349/1A**

(W.T. = 1.80M)

**PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH**

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 15.12.2013

Completion date : 16.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Description	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
19.0	6	14	17	31	<b>HIGHLY PLASTIC CLAY (CH) MIXED WITH SAND</b>													
20.0																		
21.0	7	15	18	33														
22.0	8	16	20	36		1.70	30.38	14.94	52.98	65.2	26.0	-	-	-	-	-	46.4	
23.0																		
24.0	8	17	24	41														
25.0																		
26.0																		
27.0																		

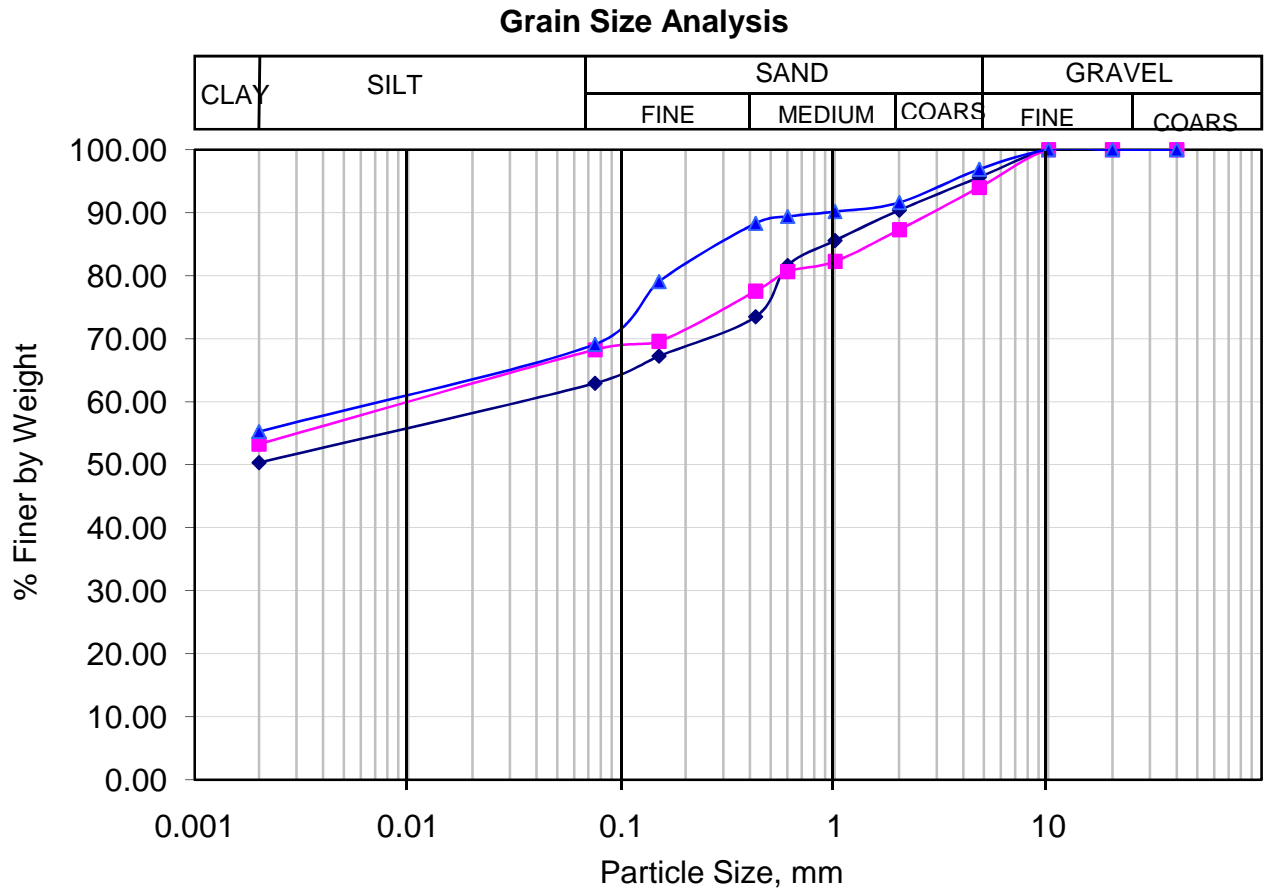
\* = Consolidation Test, c<sub>c</sub> = Compression Index, DFS = Differential Free Swell, —v = Water Table, Sp = Swelling Pressure

# PNT DESIGNS PVT. LTD., KOTA

PROJECT - DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH,  
ADB TA - 8116 IND

Determination of Grain Size Analysis Test as per IS:2720-Part 4-1985

MNB AT CH: 348+150 (349/1A)



Symbol	BH No.	Depth,m	Soil description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
◆	BH-349/1A	3.00	CI*	4.34	32.70	12.59	50.37
■	BH-349/1A	9.00	CI*	5.95	25.75	15.03	53.27
▲	BH-349/1A	12.00	CI*	3.10	27.78	13.83	55.30

CI\* = MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND

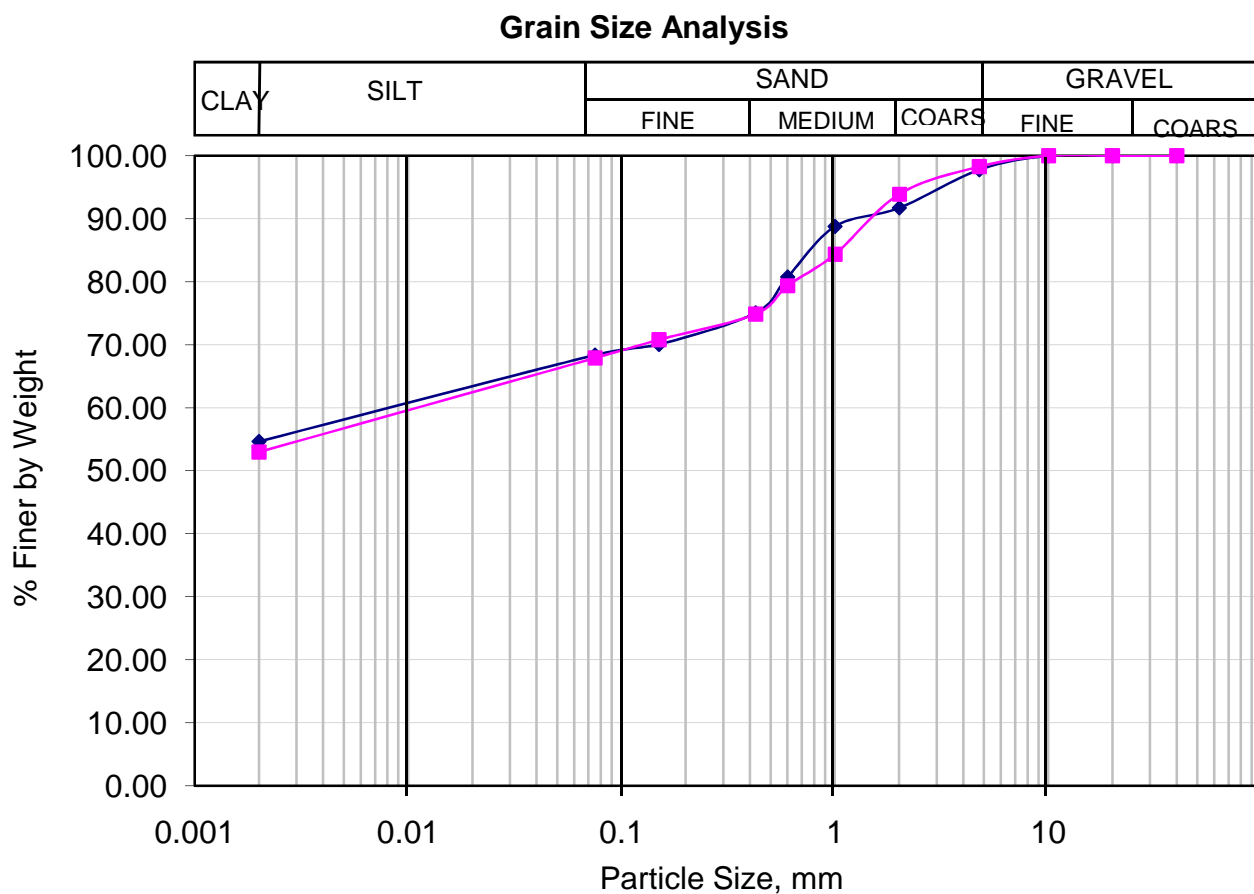


# PNT DESIGNS PVT. LTD., KOTA

PROJECT - DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH,  
ADB TA - 8116 IND

Determination of Grain Size Analysis Test as per IS:2720-Part 4-1985

MNB AT CH: 348+150 (349/1A)



Symbol	BH No.	Depth,m	Soil description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
	BH-349/1A	16.50	CH*	2.20	29.44	13.67	54.69
	BH-349/1A	22.50	CH*	1.70	30.38	14.94	52.98

CH\* = HIGHLY PLASTIC CLAY (CH) MIXED WITH SAND

SILT FACTOR CALCULATION BASED ON COHESION OF SOIL  
MNB AT CH.348+150

Location : BH-349/1A

Depth : 2.70-15.0m

In order to determine maximum score depth the silt factor of the bad material is required to be determined. The silt factor ( $K_{sf}$ ) depends upon the average size of bed material and given by Lacey equation as follows:

$$K_{sf} = 1.76 \sqrt{d_m} \quad \dots\dots 1$$

Where  $d_m$  = the weighted mean diameter in millimeter

Also, in case of soil having  $\phi < 15^\circ$  and  $c$  (cohesion of soil)  $> 0.2 \text{ kg/cm}^2$ , ' $K_{sf}$ ' calculated as follows :

$$K_{sf} = F (1 + \sqrt{c}) \text{ where } c \text{ is in } \text{kg/cm}^2 \quad \dots\dots 2$$

where  $F = 1.50$  for  $\phi > 10^\circ$  and  $< 15^\circ$

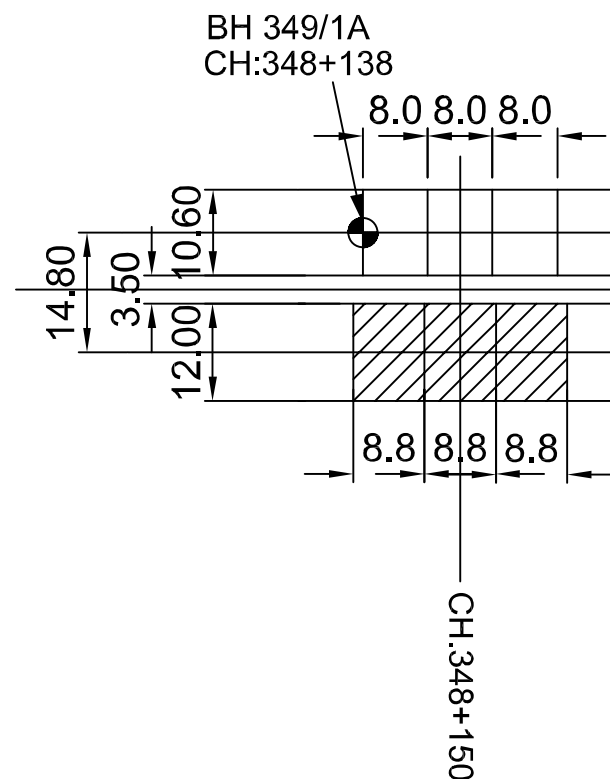
$= 1.75$  for  $\phi > 5^\circ$  and  $< 10^\circ$

$= 2.00$  for  $\phi < 5^\circ$

The strata at this location found to be Medium Plastic Clay (CI). The silt factor has been calculated on the basis of undrained cohesion ( $c$ ) of the soil using equation (2) above. The undrained cohesion has been obtained from SPT data recorded at the site. The calculation of silt factor is as follows :

Design SPT-value of the Strata (Refusal, $N > 100$ )	:	13	= (13+11+13+15)/4
(below the Founding level)	:		
Cohesion, $C_u = 6 \text{ N (kPa)}$	:	78	
Angle of shearing resistance (restricted) $\phi$	:	0	
Cohesion, $C_u (\text{kg/cm}^2)$	:	0.78	
The silt factor shall be as follows :	:	$K_{sf} = F (1 + \sqrt{c})$	
Where :	:	2	
	:	$K_{sf} = 2 * (1 + \sqrt{0.78})$	
	:	3.77	

# BOREHOLE LOCATION PLAN FOR MINOR BRIDGE AT CH: 348+150 (Wangjing)



Proposed Span Arrangements  
(3 x 8.0)

Existing Span Arrangements  
(3 x 8.8)

(The borehole locations are given for  
Existing chainage)

## LEGEND:

## PROJECT

Design Consultant :



Borehole Location



Existing Bridge

DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION  
FROM IMPHAL TO MOREH, ADB TA - 8116 IND



SHELADIA ASSOCIATES INC., USA

Amsrl Shamra, Flat No: 206 & 207,  
S D Road, Old Lancer Lanes,  
Secunderabad-500003, AP.



## GEOTECH REPORT FOR MINOR BRIDGE

AT CH: 349+900



**Geotechnical Investigation Report for determination of allowable  
bearing pressure for MINOR BRIDGE at CH. 349+900 of NH-39  
under  
“DETAILED PROJECT FOR INDO MYANMAR ROAD  
SECTION FROM IMPHAL TO MOREH, ADB TA - 8116 IND”**

**ABSTRACT**

The safe load carrying capacity of the foundation of MINOR BRIDGE (Unikhong) at Ch. 349+900 on NH-39 is recommended as follows:

<b>Location of Borehole</b>	<b>Existing Ground Level</b>	<b>Founding Level</b>	<b>Depth of Foundation Df (m)</b>	<b>Net Allowable Bearing Capacity (t/m<sup>2</sup>)</b>	<b>Type of foundation</b>
<b>350/1A</b>	<b>770.275</b>	<b>768.425</b>	<b>1.85m</b>	<b>10.0</b>	<b>Raft</b>

Note: The depth of 3.0m soil below the founding level shall be replaced with a good granular material and proper compaction

## THE STRATA AT GLANCE AND SILT FACTORS

Borehole No.	Type of strata	Depth	Weighted mean dia, $d_m$ (mm)	Silt Factor,
1	2	3	4	5
BH-350/1A	Medium Plastic Clay (Cl) mixed with Sand	0.0-25.5m	-	3.41



**Geotechnical Investigation Report**  
**for determination of allowable bearing pressure for**  
**MINOR BRIDGE at CH. 349+900 on NH-39 under**  
**“Detailed Project for Indo Myanmar Road Section from Imphal to Moreh,**  
**ADB TA - 8116 IND”**

## **1. INTRODUCTION**

Geotechnical investigation was carried out for MINOR BRIDGE at Ch.349+900 on NH-39 under Detailed Project for Indo Myanmar Road Section from Imphal to Moreh, ADB TA - 8116 IND. The Schedule of work and the locations of bore holes were decided by Engineer In-charge of Sheladia Associates, Inc., USA. The locations of boreholes are shown in Key Plan (Fig.B6).

## **2.0 FIELD INVESTIGATION**

### **2.1 Boring**

One bore hole i.e. BH-350/1A was made at the locations decided by Engineer In-charge as shown in Key Plan (Fig.B6). Boring was done by power driven rig as per guidelines of IS: 1892:1979 and IRC-78-2000. Boring was done up to the maximum depth of 25.5m. The soil samples were collected as required for laboratory testing.

### **2.2 Standard Penetration Test (SPT)**

Standard penetration test (SPT) was conducted in the bore hole as per IS 2131-1981. The numbers of blows for first 15 cm penetration is considered as seating drive and are not taken into account. The number of blows required for last 30 cm penetration is taken as SPT number (“N” values). If number of blows for last 30 cm penetration exceeds 100, it is said to be the refusal. SPT were conducted at regular interval of 1.5m, starting from the depth of 1.5m from the

ground surface to the depth of exploration/ refusal. The tests results are shown in Table-B6.1.

### **2.3 Water Table**

The water table was observed at the depth of 1.3m from ground surface, at the time of investigation (i.e. December 2013).

### **3.0 LABORATORY INVESTIGATION**

#### **Soil Samples:**

The following laboratory tests were conducted on the soil samples obtained from test bore holes:

- a) Natural Moisture content
- b) Specific gravity
- c) Liquid & Plastic Limit
- d) Grain size Analysis
- e) Shear strength test
- f) Bulk density (Dry Density)
- g) Free swell test

Test results are shown in borelogs i.e. Table-B6.1.

### **4. TYPE OF STRATA**

Based on laboratory and field investigation the strata at the site have been described. The bore-log of the strata is presented in Table-B6.1. The strata are as follows:

#### **BH-350/1A**

The strata mainly consist of Medium Plastic Clay (CI) mixed with Sand up to the depth of exploration i.e. 25.5m. The bore-log is shown in Table-B6.1.

## 5.0 FOUNDATION ANALYSIS

Open foundation has been analyzed based on results of SPT. The calculation sheets for allowable bearing capacity at borehole locations 350/1A is attached as Appendix-B6.1.

## 6.0 SILT FACTOR

In order to determine maximum score depth the silt factor of the bad material is required to be determine. The silt factor (f) depends upon the average size of bed material and given by Lacey equation as follows:

$$K_{sf} = 1.76 \sqrt{d_m}$$

Where  $d_m$  = the weighted mean diameter in millimeter

Also, in case of soil having  $\phi < 15^\circ$  and  $c$  (cohesion of soil)  $> 0.2 \text{ kg/cm}^2$ , ' $K_{sf}$ ' calculated as follows :

$$K_{sf} = F (1 + \sqrt{c}) \text{ where } c \text{ is in kg/cm}^2$$

where  $F$  = 1.50 for  $\phi > 10^\circ$  and  $< 15^\circ$   
= 1.75 for  $\phi > 5^\circ$  and  $< 10^\circ$   
= 2.00 for  $\phi < 5^\circ$

Borehole No.	Type of strata	Depth	Weighted mean dia, $d_m$ (mm)	Silt Factor,
1	2	3	4	5
BH-350/1A	Medium Plastic Clay (Cl) mixed with Sand	0.0-25.5m	-	3.41

## 7.0 CONCLUSION

1. The strata at the site is described in Section 4.0.
2. The water table was observed at the depth of 1.3m from ground surface, at the time of investigation (i.e. December 2013).

3. Safe load carrying capacity has been recommended as follows:

<b>Location of Borehole</b>	<b>Existing Ground Level</b>	<b>Founding Level</b>	<b>Depth of Foundation Df (m)</b>	<b>Net Allowable Bearing Capacity (t/m<sup>2</sup>)</b>	<b>Type of foundation</b>
<b>350/1A</b>	<b>770.275</b>	<b>768.425</b>	<b>1.85m</b>	<b>10.0</b>	<b>Raft</b>

Note: The depth of 3.0m soil below the founding level shall be replaced with a good granular material and proper compaction

SCOUR DEPTH CALCULATIONS FOR MINOR BRIDGE AT CH: 349+900 (Unikhong)

Si.No	Chainage	Proposed Span Arrangement	Location	HFL (m)	Discharge (Cumecs)	Velocity (m/sec)	Design Discharge 1.3xQ (Cumec)	Silt Factor	Eff. Linear Waterway (m)	Discharge per m width (Cumecs/	Mean Scour Depth Dsm(m)	Scour depth below HFL(m)	Borehole Level (m)	Min. Bed Level (m)	Theoretic al Scour level (m)	Restricted Scour Level (m)	Actual Scour level (m)	Scour depth below BH (m)
6	349+900	2 X 5.8	A1	Irrigation Canal	-	-	-	-	-	-	-	-	770.275	769.275	-	-	-	-

**MINOR BRIDGE**  
**DETERMINATION OF BEARING CAPACITY OF SHALLOW FOUNDATIONS** **CH: 349+900**

**COMPUTATION OF BEARING CAPACITY AS PER IS:6403**

Location : **BH-350/1A**

**1.1 Foundation Details**

Type of Foundation System : Box  
**Thickness of filled-up soil, m** : 0  
 Depth of Foundation below existing ground level in (m) : 0.5  
**Depth of Foundation below natural ground surface** : 0.5  
**Note: 3.0m Soil layer below founding level be replace by well compacted granular soil.**  
 width of foundation in (m) : 6.0

**1.2 Soil Parameters:**

Bearing capacity has been calculated on the basis of average SPT value for the depth of 1.5 times width of foundation, below the base of foundation. The refusal to SPT has been considered when  $N > 100$ . The strata at the site was found to be hard clay. The unconfined compressive strength  $q_u$  is given as  $q_u = kN$  (kPa) where,  $k = 12$  (refer text book of J.E. Bowels 2012 page-165). Therefore,  $C_u = q_u/2 = (12/2) \times N$  (kPa).

Design SPT-value of the Bearing Strata (Refusal,  $N > 100$ ) : 10.2 =  $(6+9+10+12+14)/5$   
 (below the Founding level) :  
 Cohesion,  $C_u = 6N$  (kPa) : 61.2  
 Average Shear Strength below base of foundation :  
 Angle of shearing resistance (restricted)  $\phi$  : 0  
 Unconfined comp. strength  $q_u = 12 N$  (kPa) : 122.4  
 Cohesion,  $C_u$  (t/m<sup>2</sup>) : 6.12  
 Bulk density of the strata (t/m<sup>3</sup>) :  
 Submerged density of the strata (t/m<sup>3</sup>) : 1.000  
 $N_\phi = \tan^2 (45 + \phi/2)$  : 1.000

**1.3 Design Parameters:**

Bearing Capacity Factors:	Shape Factors	Depth Factors	Inclination Factors
$N_c = 5.14$	$S_c = 1.1$	$D_c = 1.0$	$i_c = 1.0$
$N_q = 1$	$S_q = 1.1$	$D_q = 1.0$	$i_q = N/A$
$N_\gamma = 0$	$S_\gamma = 0.8$	$D_\gamma = 1.0$	$i_\gamma = N/A$

**Net Ultimate Bearing Capacity:**

$$Q_u = (C_u \cdot N_c \cdot D_c \cdot i_c) + (\gamma \cdot d \cdot (N_q - 1) \cdot S_q \cdot d_q \cdot i_q) + (0.5 \cdot B \cdot \gamma \cdot N_\gamma \cdot S_\gamma \cdot d_\gamma \cdot i_\gamma)$$

$$= 35.18$$

Factor of Safety = 2.5

Net Safe Bearing Cap. = 14.07 t/m<sup>2</sup>

**Settlement Criterial**

The settlement has been obtained from IS:8009 part-I. Since the strata is found to be hard clay, the long term consolidation settlement is unlikely to occure. The immediate settlement is given as follows (Sec.9.2.3.2 of IS:8009).

$$S_i = pB (1 - m^2) \times I/E = 50 \text{ mm (permissible settelement)}$$

$$m = 0.5 \text{ for clays, } I = 0.95, B = 6m$$

$$E = (200 \text{ to } 500) \times C_u \text{ (t/m}^2\text{)} \text{ (J.E. Bowel, 2012 Pg. 127), taking minimum value of E i.e. } 200 \times C_u \text{ (t/m}^2\text{)}$$

$$E = 122.4 \text{ (t/m}^2\text{)}$$

Therefore, safe bearing pressure for permissible settlement of 50mm shall be

$$(0.05 \times E) / (0.95 \times B \times (1 - 0.5^2)) \text{ t/m}^2$$

$$= 14.31579 \text{ t/m}^2$$

**The Recommended Net allowable Bearing pressure = 10.0 t/m<sup>2</sup>**

**Note: 3.0m Soil layer below founding level be replace by well compacted granular soil.**

**TABLE-B6.1:** RESULT SHEET FOR MINOR BRIDGE AT CH.349+900 ON BH-350/1A

(W.T. = 1.30M)

**PROJECT :** DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 03.12.2013

Completion date : 04.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Descreption	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
1.0	2	3	3	6	<b>MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND</b>	2.80	29.42	13.56	54.22	40.9	23.9	-	2.68	-	-	-	21.7	-
2.0																		
3.0	2	3	4	7														
4.0																		
5.0	3	3	3	6														
6.0	3	4	5	9														
7.0					<b>MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND</b>	1.66	22.54	16.68	59.12	44.60	22.8	-	-	-	-	-	24.2	-
8.0	2	4	6	10														
9.0	3	5	7	12														

\* = Consolidation Test, c<sub>c</sub> = Compression Index, DFS = Differential Free Swell, —v = Water Table, Sp = Swelling Pressure

**TABLE-B6.1:** RESULT SHEET FOR MINOR BRIDGE AT CH.349+900 ON BH-350/1A

(W.T. = 1.30M)

**PROJECT :** DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 03.12.2013

Completion date : 04.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Description	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
10.0	4	6	8	14	<b>MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND</b>	0.75	29.33	13.99	55.94	40.2	21.50	-	2.71	-	-	-	28.0	
11.0																		
12.0	5	7	9	16														
13.0	6	8	10	18														
14.0																		
15.0	6	7	11	18														
16.0																		
17.0	6	9	12	21														
18.0	6	10	13	23		0.20	30.42	13.88	55.50	41.5	22.4	-	-	-	-	-	26.3	

\* = Consolidation Test,

c<sub>c</sub> = Compression Index,

DFS = Differential Free Swell,

—v = Water Table,

Sp = Swelling Pressure



**TABLE-B6.1:** RESULT SHEET FOR MINOR BRIDGE AT CH.349+900 ON BH-350/1A

(W.T. = 1.30M)

**PROJECT :** DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 03.12.2013

Completion date : 04.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Description	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
19.0	7	11	14	25	<b>MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND</b>													
20.0																		
21.0	8	12	16	28														
22.0																		
23.0	9	14	20	34		2.50	24.28	16.11	57.11	45.0	23.40	-	2.71	-	-	-	30.0	
24.0	10	15	21	36														
25.0																		
26.0	13	18	23	41														
27.0																		

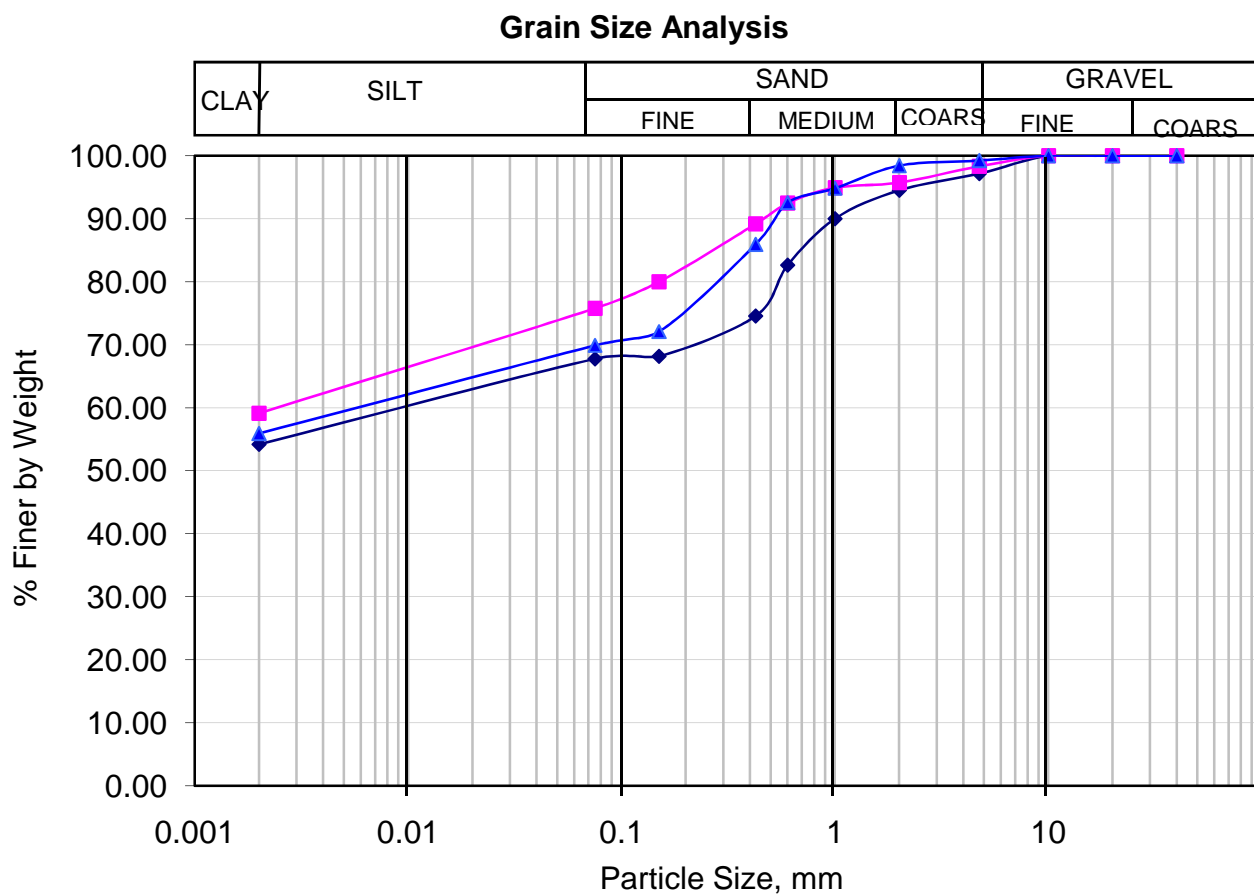
\* = Consolidation Test, c<sub>c</sub> = Compression Index, DFS = Differential Free Swell, —v = Water Table, Sp = Swelling Pressure

# PNT DESIGNS PVT. LTD., KOTA

PROJECT - DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH,  
ADB TA - 8116 IND

Determination of Grain Size Analysis Test as per IS:2720-Part 4-1985

MNB AT CH: 349+900 (350/1A)



Symbol	BH No.	Depth,m	Soil description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
◆	BH-350/1A	1.50	CI*	2.80	29.42	13.56	54.22
■	BH-350/1A	9.00	CI*	1.66	22.54	16.68	59.12
▲	BH-350/1A	12.00	CI*	0.75	29.33	13.99	55.94

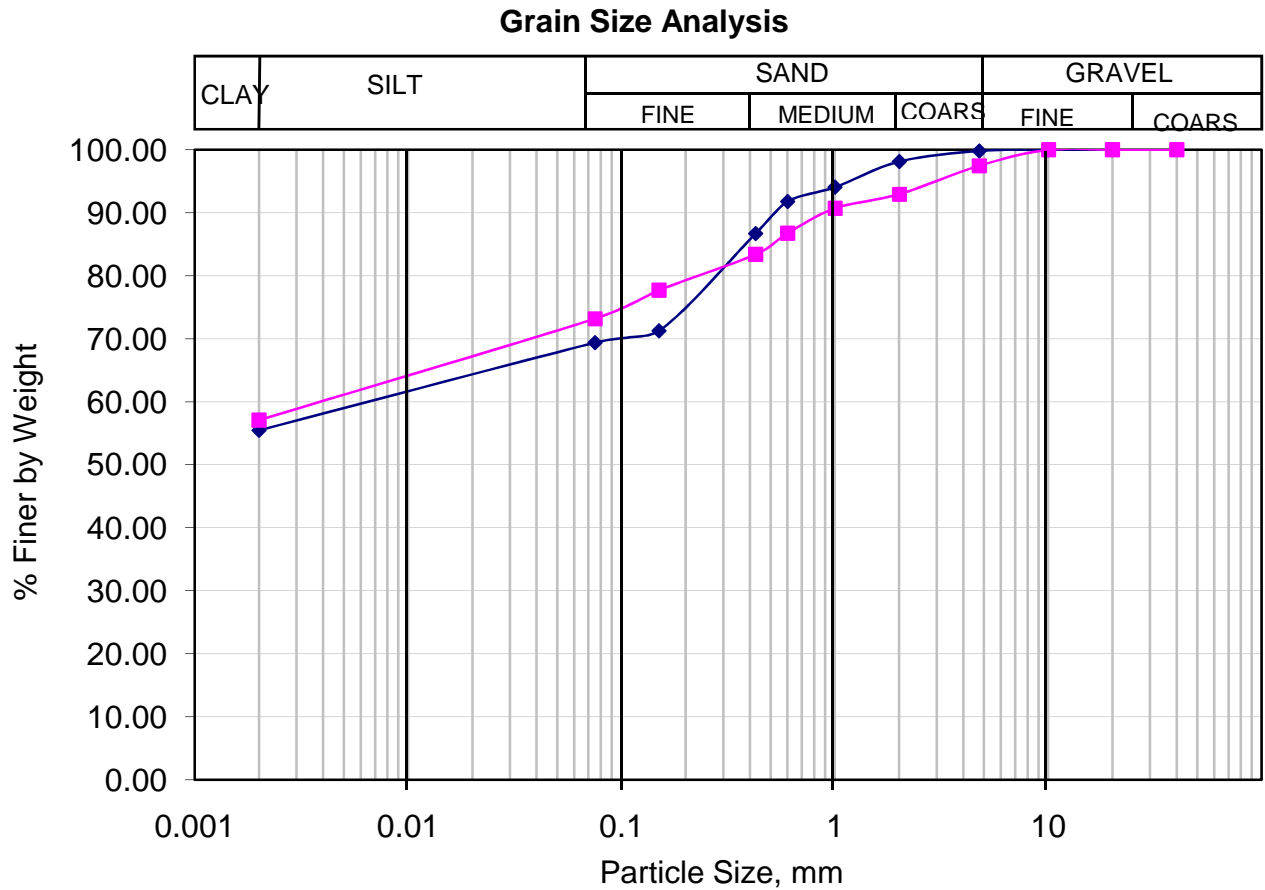
CI\* = MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND

# PNT DESIGNS PVT. LTD., KOTA

PROJECT - DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH,  
ADB TA - 8116 IND

Determination of Grain Size Analysis Test as per IS:2720-Part 4-1985

MNB AT CH: 349+900 (350/1A)



Symbol	BH No.	Depth,m	Soil description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
	BH-350/1A	18.00	CI*	0.20	30.42	13.88	55.50
	BH-350/1A	22.50	CI*	2.50	24.28	16.11	57.11

CI\* = MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND

DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH, ADB TA - 8116 IND

SILT FACTOR CALCULATION BASED ON COHESION OF SOIL  
MNB AT CH.349+900

Location : BH-350/1A

Depth : 0.0-25.50m

In order to determine maximum score depth the silt factor of the bad material is required to be determined. The silt factor ( $K_{sf}$ ) depends upon the average size of bed material and given by Lacey equation as follows:

$$K_{sf} = 1.76 \sqrt{d_m} \quad \dots\dots 1$$

Where  $d_m$  = the weighted mean diameter in millimeter

Also, in case of soil having  $\phi < 15^\circ$  and  $c$  (cohesion of soil)  $> 0.2 \text{ kg/cm}^2$ , ' $K_{sf}$ ' calculated as follows :

$$K_{sf} = F (1 + \sqrt{c}) \text{ where } c \text{ is in } \text{kg/cm}^2 \quad \dots\dots 2$$

where  $F = 1.50$  for  $\phi > 10^\circ$  and  $< 15^\circ$

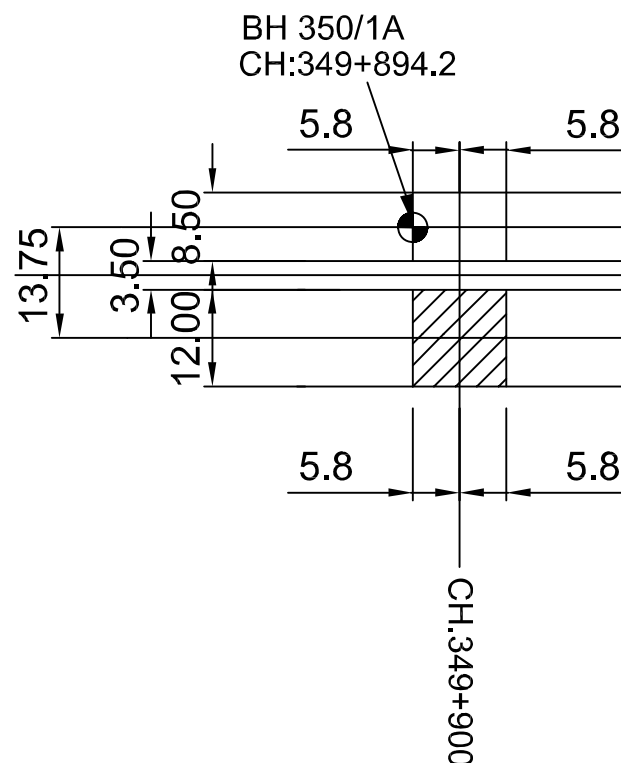
$= 1.75$  for  $\phi > 5^\circ$  and  $< 10^\circ$

$= 2.00$  for  $\phi < 5^\circ$

The strata at this location found to be Medium Plastic Clay (CI). The silt factor has been calculated on the basis of undrained cohesion ( $c$ ) of the soil using equation (2) above. The undrained cohesion has been obtained from SPT data recorded at the site. The calculation of silt factor is as follows :

Design SPT-value of the Strata (Refusal, $N > 100$ )	:	8.33	= (6+7+6+9+10+12)/6
(below the Founding level)	:		
Cohesion, $C_u = 6 \text{ N (kPa)}$	:	50	
Angle of shearing resistance (restricted) $\phi$	:	0	
Cohesion, $C_u \text{ (kg/cm}^2\text{)}$	:	0.5	
The silt factor shall be as follows :	:	$K_{sf} = F (1 + \sqrt{c})$	
Where :	F	: 2	
	$K_{sf} =$	: $2 * (1 + \sqrt{0.5})$	
		: <b>3.41</b>	

## BOREHOLE LOCATION PLAN FOR MINOR BRIDGE AT CH: 349+900 (Unikhong)



Proposed Span Arrangements  
(2 x 5.8)

Existing Span Arrangements  
(2 x 5.8)

(The borehole locations are given for  
Existing chainage)

### LEGEND:

### PROJECT

Design Consultant :



Borehole Location



Existing Bridge

DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION  
FROM IMPHAL TO MOREH, ADB TA - 8116 IND



SHELADIA ASSOCIATES INC., USA

Amsrl Shamra, Flat No: 206 & 207,  
S D Road, Old Lancer Lanes,  
Secunderabad-500003, AP.



## GEOTECH REPORT FOR MINOR BRIDGE

AT CH: 352+800





**Geotechnical Investigation Report for determination of allowable  
bearing pressure for MINOR BRIDGE at CH. 352+800 of NH-39  
under  
“DETAILED PROJECT FOR INDO MYANMAR ROAD  
SECTION FROM IMPHAL TO MOREH, ADB TA - 8116 IND”**

**ABSTRACT**

The safe load carrying capacity of the foundation of MINOR BRIDGE (Khongjom) at Ch. 352+800 on NH-39 is recommended as follows:

<b>Location of Borehole</b>	<b>Existing Ground Level</b>	<b>Founding Level</b>	<b>Depth of Foundation Df (m)</b>	<b>Net Allowable Bearing Capacity (t/m<sup>2</sup>)</b>	<b>Type of foundation</b>
<b>353/1A</b>	<b>773.596</b>	<b>771.946</b>	<b>1.65</b>	<b>10.0</b>	<b>Raft</b>

Note: The depth of 3.0m soil below the founding level shall be replaced with a good granular material and proper compaction

## THE STRATA AT GLANCE AND SILT FACTORS

Borehole No.	Type of strata	Depth	Weighted mean dia, $d_m$ (mm)	Silt Factor,
1	2	3	4	5
BH-353/1A	Clayey Sand (SC) mixed with Gravels	0.0-1.8m	1.67	2.28
	Medium Plastic Clay (CI) mixed with Sand	1.8-18.0m	-	3.49
	Highly Plastic Clay (CH) mixed with Sand	18.0-24.0m	-	>3.49

**Geotechnical Investigation Report**  
**for determination of allowable bearing pressure for**  
**MINOR BRIDGE at CH. 352+800 on NH-39 under**  
**“Detailed Project for Indo Myanmar Road Section from Imphal to Moreh,**  
**ADB TA - 8116 IND”**

## **1. INTRODUCTION**

Geotechnical investigation was carried out for MINOR BRIDGE at Ch.352+800 on NH-39 under Detailed Project for Indo Myanmar Road Section from Imphal to Moreh, ADB TA - 8116 IND. The Schedule of work and the locations of bore holes were decided by Engineer In-charge of Sheladia Associates, Inc., USA. The locations of boreholes are shown in Key Plan (Fig.B7).

## **2.0 FIELD INVESTIGATION**

### **2.1 Boring**

One bore hole i.e. BH-353/1A was made at the locations decided by Engineer In-charge as shown in Key Plan (Fig.B7). Boring was done by power driven rig as per guidelines of IS: 1892:1979 and IRC-78-2000. Boring was done up to the maximum depth of 24.0m. The soil samples were collected as required for laboratory testing.

### **2.2 Standard Penetration Test (SPT)**

Standard penetration test (SPT) was conducted in the bore hole as per IS 2131-1981. The numbers of blows for first 15 cm penetration is considered as seating drive and are not taken into account. The number of blows required for last 30 cm penetration is taken as SPT number (“N” values). If number of blows for last 30 cm penetration exceeds 100, it is said to be the refusal. SPT were conducted at regular interval of 1.5m, starting from the depth of 1.5m from the

ground surface to the depth of exploration/ refusal. The tests results are shown in Table-B7.1.

### **2.3 Water Table**

The water table was observed at the depth of 2.0m from ground surface, at the time of investigation (i.e. December 2013).

### **3.0 LABORATORY INVESTIGATION**

#### **Soil Samples:**

The following laboratory tests were conducted on the soil samples obtained from test bore holes:

- a) Natural Moisture content
- b) Specific gravity
- c) Liquid & Plastic Limit
- d) Grain size Analysis
- e) Shear strength test
- f) Bulk density (Dry Density)
- g) Free swell test

Test results are shown in borelogs i.e. Table-B7.1.

### **4. TYPE OF STRATA**

Based on laboratory and field investigation the strata at the site have been described. The bore-log of the strata is presented in Table-B7.1. The strata are as follows:

#### **BH-353/1A**

The upper layer of the strata thickness about 1.8m was found to be Clayey Sand (SC) mixed with Gravels. Below this, Medium Plastic Clay (CI) mixed with Sand was found up to the depth of 18.0m. Beyond this, Highly Plastic Clay (CH) mixed with Sand was found up to the depth of exploration i.e. 24.0m. The bore-log is shown in Table-B7.1.

## 5.0 FOUNDATION ANALYSIS

Open foundation has been analyzed based on results of SPT. The calculation sheets for allowable bearing capacity at borehole locations 353/1A is attached as Appendix-B7.1.

## 6.0 SILT FACTOR

In order to determine maximum score depth the silt factor of the bad material is required to be determine. The silt factor (f) depends upon the average size of bed material and given by Lacey equation as follows:

$$K_{sf} = 1.76 \sqrt{d_m}$$

Where  $d_m$  = the weighted mean diameter in millimeter

Also, in case of soil having  $\phi < 15^\circ$  and  $c$  (cohesion of soil)  $> 0.2 \text{ kg/cm}^2$ , ' $K_{sf}$ ' calculated as follows :

$$K_{sf} = F (1 + \sqrt{c}) \text{ where } c \text{ is in kg/cm}^2$$

where  $F$  = 1.50 for  $\phi > 10^\circ$  and  $< 15^\circ$   
= 1.75 for  $\phi > 5^\circ$  and  $< 10^\circ$   
= 2.00 for  $\phi < 5^\circ$

Borehole No.	Type of strata	Depth	Weighted mean dia, $d_m$ (mm)	Silt Factor,
1	2	3	4	5
BH-353/1A	Clayey Sand (SC) mixed with Gravels	0.0-1.8m	1.67	2.28
	Medium Plastic Clay (CI) mixed with Sand	1.8-18.0m	-	3.49
	Highly Plastic Clay (CH) mixed with Sand	18.0-24.0m	-	>3.49

## **7.0 CONCLUSION**

1. The strata at the site is described in Section 4.0.
2. The water table was observed at the depth of 1.8m from ground surface, at the time of investigation (i.e. December 2013).
3. Safe load carrying capacity has been recommended as follows:

<b>Location of Borehole</b>	<b>Existing Ground Level</b>	<b>Founding Level</b>	<b>Depth of Foundation Df (m)</b>	<b>Net Allowable Bearing Capacity (t/m<sup>2</sup>)</b>	<b>Type of foundation</b>
<b>353/1A</b>	<b>773.596</b>	<b>771.946</b>	<b>1.65</b>	<b>10.0</b>	<b>Raft</b>

Note: The depth of 3.0m soil below the founding level shall be replaced with a good granular material and proper compaction

SCOUR DEPTH CALCULATIONS FOR MINOR BRIDGE AT CH: 352+800 (Khongjom)

Si.No	Chainage	Proposed Span Arrangement	Location	HFL (m)	Discharge (Cumecs)	Velocity (m/sec)	Design Discharge 1.3xQ (Cumec)	Silt Factor	Eff. Linear Waterway (m)	Discharge per m width (Cumecs/	Mean Scour Depth Dsm(m)	Scour depth below HFL(m)	Borehole Level (m)	Min. Bed Level (m)	Theoretic al Scour level (m)	Seismic Scour Level (m)	Actual Scour level (m)	Scour depth below BH (m)
7	352+800	2 X 5.8	A1	775.500	123	4.36	159.9	2.5	11.6	13.784	5.676	7.209	773.596	772.796	768.291	769.012	768.291	5.305

**DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH, ADB TA - 8116 IND  
APPENDIX-B7.1**

**MINOR BRIDGE  
DETERMINATION OF BEARING CAPACITY OF SHALLOW FOUNDATIONS** **CH: 352+800**

**COMPUTATION OF BEARING CAPACITY AS PER IS:6403**

**Location : BH-353/1A**

**1.1 Foundation Details**

Type of Foundation System : Box  
**Thickness of filled-up soil, m** : 0  
 Depth of Foundation below existing ground level in (m) : 0.5  
**Depth of Foundation below natural ground surface** : 0.5  
**Note: 3.0m Soil layer below founding level be replace by well compacted granular soil.**  
 width of foundation in (m) : 6.0

**1.2 Soil Parameters:**

Bearing capacity has been calculated on the basis of average SPT value for the depth of 1.5 times width of foundation, below the base of foundation. The refusal to SPT has been considered when  $N > 100$ . The strata at the site was found to be hard clay. The unconfined compressive strength  $q_u$  is given as  $q_u = kN$  (kPa) where,  $k = 12$  (refer text book of J.E. Bowels 2012 page-165). Therefore,  $C_u = q_u/2 = (12/2) \times N$  (kPa).

Design SPT-value of the Bearing Strata (Refusal, $N > 100$ )	: 10.4	= (7+8+10+12+15)/5
(below the Founding level)	:	
Cohesion, $C_u = 6N$ (kPa)	: 62.4	
Average Shear Strength below base of foundation	:	
Angle of shearing resistance (restricted) $\phi$	: 0	
Unconfined comp. strength $q_u = 12 N$ (kPa)	: 124.8	
Cohesion, $C_u$ (t/m <sup>2</sup> )	: 6.24	
Bulk density of the strata (t/m <sup>3</sup> )	:	
Submerged density of the strata (t/m <sup>3</sup> )	: 1.000	
$N_\phi = \tan^2 (45 + \phi/2)$	: 1.000	

**1.3 Design Parameters:**

Bearing Capacity Factors:	Shape Factors	Depth Factors	Inclination Factors
$N_c = 5.14$	$S_c = 1.1$	$D_c = 1.0$	$i_c = 1.0$
$N_q = 1$	$S_q = 1.1$	$D_q = 1.0$	$i_q = N/A$
$N_\gamma = 0$	$S_\gamma = 0.8$	$D_\gamma = 1.0$	$i_\gamma = N/A$

**Net Ultimate Bearing Capacity:**

$$Q_u = (C_u \cdot N_c \cdot D_c \cdot i_c) + (\gamma \cdot d \cdot (N_q - 1) \cdot S_q \cdot d_q \cdot i_q) + (0.5 \cdot B/2 \cdot \gamma \cdot N_\gamma \cdot S_\gamma \cdot d_\gamma \cdot i_\gamma)$$

$$= 35.87$$

Factor of Safety = 2.5

Net Safe Bearing Cap. = 14.35 t/m<sup>2</sup>

**Settlement Criterial**

The settlement has been obtained from IS:8009 part-I. The immediate settlement is given as follows (Sec.9.2.3.2 of IS:8009).

$$S_i = pB (1 - m^2) \times I/E = 50 \text{ mm (permissible settelement)}$$

$$m = 0.5 \text{ for clays, } I = 0.95, B = 6m$$

$$E = (200 \text{ to } 500) \times C_u \text{ (t/m}^2\text{)} \text{ (J.E. Bowel, 2012 Pg. 127), taking minimum value of E i.e. } 200 \times C_u \text{ (t/m}^2\text{)}$$

$$E = 1248 \text{ (t/m}^2\text{)}$$

Therefore, safe bearing pressure for permissible settlement of 50mm shall be

$$(0.05 \times E) / (0.95 \times B \times (1 - 0.5^2)) \text{ t/m}^2 = 14.59649 \text{ t/m}^2$$

**The Recommended Net allowable Bearing pressure = 10.0 t/m<sup>2</sup>**

**Note: 3.0m Soil layer below founding level be replace by well compacted granular soil.**



**TABLE-B7.1:** RESULT SHEET FOR MINOR BRIDGE AT CH.352+800 ON BH-353/1A

(W.T. = 2.00M)

**PROJECT :** DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 10.12.2013

Completion date : 13.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Description	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
1.0	2	3	3	6	CLAYEY SAND (SC) MIXED WITH GRAVELS	13.02	43.64	8.67	34.67	26.4	18.0	-	2.72	-	-	-	26.0	-
3.0	3	4	5	9														
4.0	2	3	4	7	MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND	1.67	25.90	15.94	56.50	46.3	24.6	-	2.68	-	-	-	33.0	-
5.0																		
6.0	3	4	4	8														
7.0																		
8.0	3	4	6	10														
9.0	4	5	7	12		4.50	28.50	13.40	53.60	42.0	23.0	-	-	-	-	-	25.0	-

\* = Consolidation Test, c<sub>c</sub> = Compression Index, DFS = Differential Free Swell, —v = Water Table, Sp = Swelling Pressure

**TABLE-B7.1: RESULT SHEET FOR MINOR BRIDGE AT CH.352+800 ON BH-353/1A**

(W.T. = 2.00M)

**PROJECT : DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH****ADB TA - 8116 IND**

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 10.12.2013

Completion date : 13.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content, % (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Description	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
10.0	5	6	9	15	<b>MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND</b>	1.67	24.63	14.74	58.96	38.5	21.8	-	2.71	-	-	-	27.5	
11.0																		
12.0	5	7	10	17														
13.0																		
14.0	6	9	12	21														
15.0	8	12	14	26														
16.0																		
17.0	9	13	15	28														
18.0	10	16	21	37														

\* = Consolidation Test,

c<sub>c</sub> = Compression Index,

DFS

= Differential Free Swell,

—v = Water Table,

Sp = Swelling Pressure

**TABLE-B7.1:** RESULT SHEET FOR MINOR BRIDGE AT CH.352+800 ON BH-353/1A

(W.T. = 2.00M)

**PROJECT :** DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH

ADB TA - 8116 IND

Size of Hole : Nx Size

Type of Bit : TC / Diamond

Starting date : 10.12.2013

Completion date : 13.12.2013

Depth (m)	N - value				IS Classification	Sieve Size Analysis with hydrometer test				Atterberg Limits		Natural Moisture content,% (Sr, %)	Specific Gravity	Bulk Density (t/m <sup>3</sup> )	Shear Parameter		DFS %	* C <sub>c</sub>
	15	30	45	N	Soil Descreption	Gravel %	Sand %	Silt %	Clay %	Liquid Limit %	Plastic Limit %				c t/m <sup>2</sup>	ø deg.		
19.0	9	16	20	42	HIGHLY PLASTIC CLAY (CH) MIXED WITH SAND	3.00	22.33	16.43	58.25	52.9	24.8	-	-	-	-	-	30.0	
20.0																		
21.0	11	20	26	46		1.07	22.37	15.31	61.25	53.0	22.7	-	2.69	-	-	-	32.0	
22.0	12	19	29	48														
23.0																		
24.0	13	21	28	49														
25.0																		
26.0																		
27.0																		

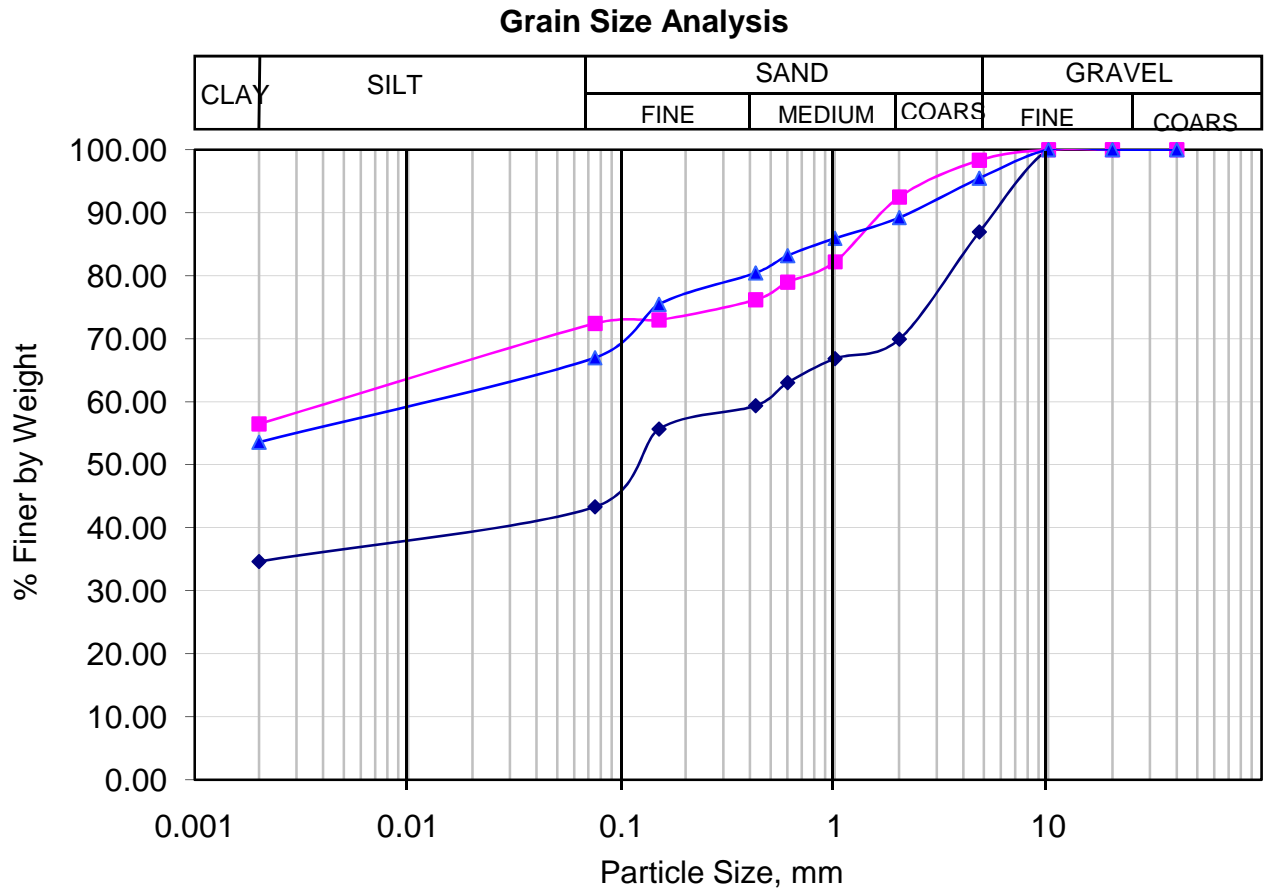
\* = Consolidation Test, c<sub>c</sub> = Compression Index, DFS = Differential Free Swell, —v = Water Table, Sp = Swelling Pressure

# PNT DESIGNS PVT. LTD., KOTA

PROJECT - DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH,  
ADB TA - 8116 IND

Determination of Grain Size Analysis Test as per IS:2720-Part 4-1985

MNB AT CH: 352+800 (353/1A)



Symbol	BH No.	Depth,m	Soil description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
◆	BH-353/1A	1.50	SC*	13.02	43.64	8.67	34.67
■	BH-353/1A	3.00	CI*	1.67	25.90	15.94	56.50
▲	BH-353/1A	9.00	CI*	4.50	28.50	13.40	53.60

SC\* = CLAYEY SAND (SC) MIXED WITH GRAVELS

CI\* = MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND

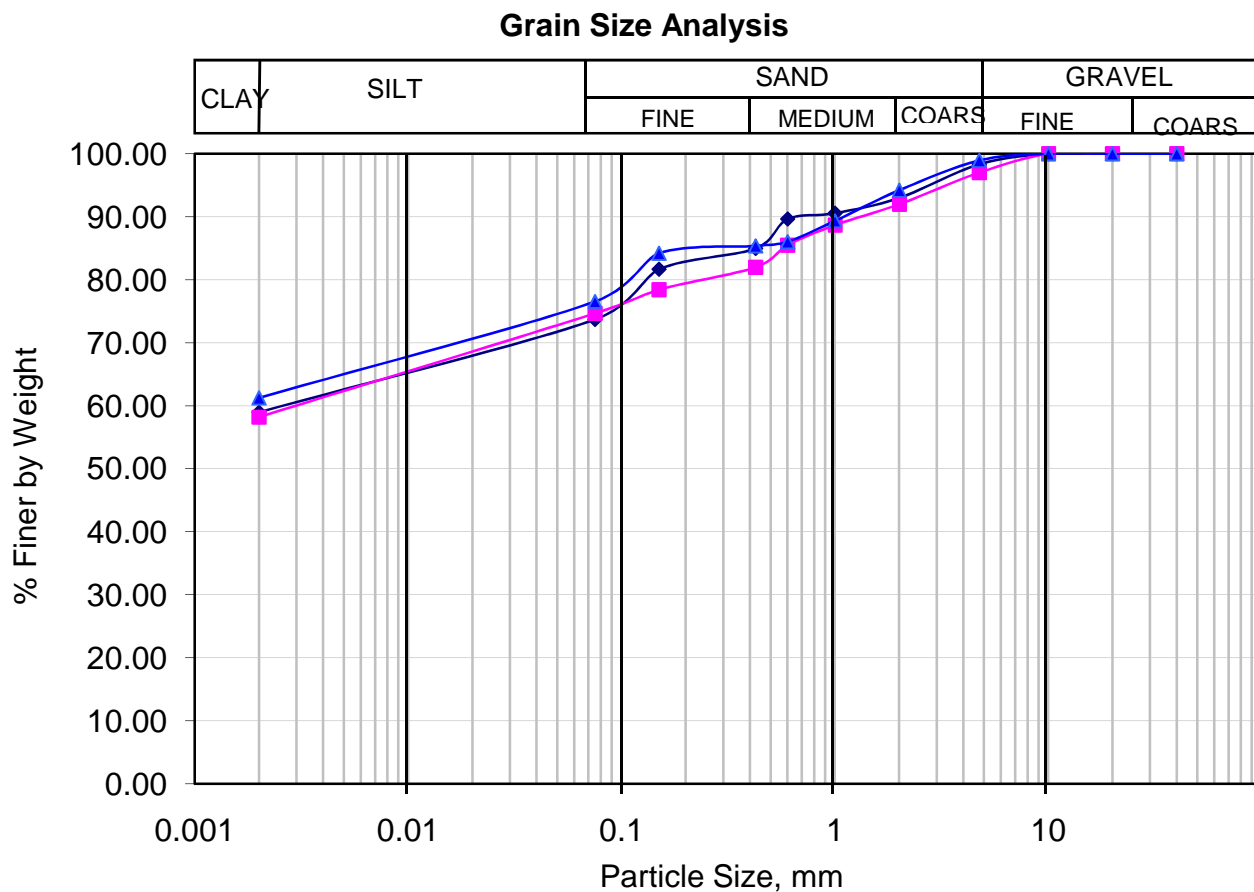
Depth = 1.50 Weighted Mean Dia,  $d_m$  = 1.67 mm,  $f = 2.28$

# PNT DESIGNS PVT. LTD., KOTA

PROJECT - DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION FROM IMPHAL TO MOREH,  
ADB TA - 8116 IND

Determination of Grain Size Analysis Test as per IS:2720-Part 4-1985

MNB AT CH: 352+800 (353/1A)



Symbol	BH No.	Depth,m	Soil description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
◆	BH-353/1A	12.00	CI*	1.67	24.63	14.74	58.96
■	BH-353/1A	18.00	CH*	3.00	22.33	16.43	58.25
▲	BH-353/1A	21.00	CH*	1.07	22.37	15.31	61.25

CI\* = MEDIUM PLASTIC CLAY (CI) MIXED WITH SAND

CH\* = HIGHLY PLASTIC CLAY (CH) MIXED WITH SAND

SILT FACTOR CALCULATION BASED ON COHESION OF SOIL  
MNB AT CH.352+800

Location : BH-353/1A

Depth : 1.80m-18.0m

In order to determine maximum score depth the silt factor of the bad material is required to be determined. The silt factor ( $K_{sf}$ ) depends upon the average size of bed material and given by Lacey equation as follows:

$$K_{sf} = 1.76 \sqrt{d_m} \quad \dots\dots 1$$

Where  $d_m$  = the weighted mean diameter in millimeter

Also, in case of soil having  $\phi < 15^\circ$  and  $c$  (cohesion of soil)  $> 0.2 \text{ kg/cm}^2$ , ' $K_{sf}$ ' calculated as follows :

$$K_{sf} = F (1 + \sqrt{c}) \text{ where } c \text{ is in } \text{kg/cm}^2 \quad \dots\dots 2$$

where  $F = 1.50$  for  $\phi > 10^\circ$  and  $< 15^\circ$

$= 1.75$  for  $\phi > 5^\circ$  and  $< 10^\circ$

$= 2.00$  for  $\phi < 5^\circ$

The strata at this location found to be Medium Plastic Clay (CI). The silt factor has been calculated on the basis of undrained cohesion ( $c$ ) of the soil using equation (2) above. The undrained cohesion has been obtained from SPT data recorded at the site. The calculation of silt factor is as follows :

Design SPT-value of the Strata (Refusal, $N > 100$ )	:	9.2	= (9+7+8+10+12)/5
(below the Founding level)	:		
Cohesion, $C_u = 6 \text{ N (kPa)}$	:	55.2	
Angle of shearing resistance (restricted) $\phi$	:	0	
Cohesion, $C_u (\text{kg/cm}^2)$	:	0.552	
The silt factor shall be as follows :	:	$K_{sf} = F (1 + \sqrt{c})$	
Where :	F	: 2	
	$K_{sf} =$	: $2 * (1 + \sqrt{0.552})$	
		: <b>3.49</b>	

### SILT FACTOR CALCULATIONS

**MNB AT CH: 352+800 (353/1A)**

Total Weight of Dry Soil Taken =

500

Depth =

1.5

Sieve Size in mm	Average Size (mm)	Weight Retained in g	% Weight Retained	Cumulative % Retained	% Finer (N)	Weighted % weight retained
1	2	3	4	5	6	7 = (2X3)
80		0	0.00	0.00	100.00	0.000
40		0	0.00	0.00	100.00	0.000
20	30	0	0.00	0.00	100.00	0.000
10	15	0	0.00	0.00	100.00	0.000
4.75	7.375	65.1	13.02	<b>13.02</b>	<b>86.98</b>	96.023
2	3.375	85.2	17.04	30.06	69.94	57.510
1	1.5	15.5	3.10	33.16	66.84	4.650
0.6	0.8	19	3.80	36.96	63.04	3.040
0.425	0.5125	18.3	3.66	40.62	59.38	1.876
0.15	0.2875	18.4	3.68	44.30	55.70	1.058
0.075	0.1125	61.8	12.36	56.66	43.34	1.391
PAN	0.0375	216.7	43.34	100.00	0.00	1.625
		Sum =	100.00			167.172

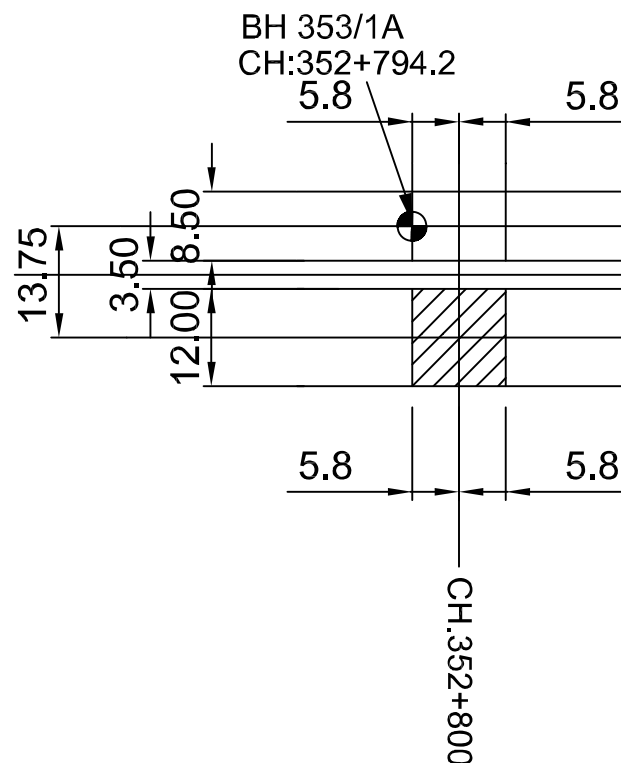
Sum of Weighted % Weight retained on each seive

Mean Dia meter, dm = -----

Cumulative % retained

$$\begin{aligned}
 dm &= 167.172 / 100 &= & 1.67 \\
 \text{Silt Factor, } f &= 1.76 \text{ Sqrt (dm)} &= & 2.28
 \end{aligned}$$

# BOREHOLE LOCATION PLAN FOR MINOR BRIDGE AT CH: 352+800 (Khongjom)



Proposed Span Arrangements  
(2 x 5.8)

Existing Span Arrangements  
(2 x 5.8)

(The borehole locations are given for  
Existing chainage)

## LEGEND:

## PROJECT

Design Consultant :



Borehole Location



Existing Bridge

DETAILED PROJECT FOR INDO MYANMAR ROAD SECTION  
FROM IMPHAL TO MOREH, ADB TA - 8116 IND



SHELADIA ASSOCIATES INC., USA

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