

**LOCAL GOVERNMENT DEPARTMENT
GOVERNMENT OF SINDH**

**MALIR RIVER EXPRESSWAY
KARACHI
(SOIL INVESTIGATION
ALONG ROAD ALIGNMENT)
VOLUME-II**

APRIL, 2018

**Consultants:
EA Consulting (Pvt) Ltd**

**MALIR RIVER EXPRESSWAY
KARACHI
SOIL INVESTIGATION
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A P P E N D I X

**MALIR RIVER EXPRESSWAY
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1. INTRODUCTION:

Local Government Department, Government of Sindh has embarked the construction of 38-kilometre-long Malir Expressway as the shortest alternative route to connect the Super Highway with the city centre. It will be a four-lane expressway along the Malir River starting from Hino Chowk and ending at the Super Highway (M-9) near Kathore.

Volume-II of the report deals with Soil Investigation along Road Alignment.

M/s EA Consulting (Pvt.) Limited are the consultants for the project.

In order to obtain information about the subgrade, a program of subsoil investigation was undertaken in March, 2018.

The program of investigation consisted of executing 20 test pits carried to a depth of 1.50m below existing ground level.

Selected soil samples were sent to the laboratory of 'Geotechnical Services', Karachi, for the evaluation of geo-engineering characteristics.

This report presents a review of subsurface investigation performed at the Expressway Site. The report gives program of investigation, review of subgrade characteristics and presents a discussion of laboratory test results. The report incorporates testpit logs & field / laboratory test results. The report also discusses the possibility of using subgrade material as backfill.

2. SOIL INVESTIGATION ALONG THE ALIGNMENT:

2.1 Program of Investigation:

Twenty testpits were manually excavated. Testpits were taken down to 1.50 m depth below existing level. Bulk samples were extracted from tests pits for performing classification, compaction and CBR tests. These samples were transported to the laboratory of Geotechnical Services, Karachi.

Table 2.1 gives details of test pits:

T A B L E 2.1

DETAILS OF TEST PITS

Boring No	Chainage	Co-ordinates		Depth (m)
		Northing	Easting	
TP-1	0+000	24.8320597	67.0869323	1.50
TP-2	1+800	24.8474482	67.0892302	1.50
TP-3	3+600	24.864303	67.097275	1.50
TP-4	5+400	24.8666190	67.1139480	1.50
TP-5	7+200	24.8702107	67.1291040	1.50
TP-6	9+000	24.8735324	67.1466019	1.50
TP-7	10+800	24.8715480	67.1639903	1.50
TP-8	12+600	24.8656670	67.180545	1.50
TP-9	14+400	24.8645819	67.1979968	1.50
TP-10	16+200	24.8702777	67.2146050	1.50
TP-11	18+000	24.879324	67.2290128	1.50
TP-12	19+800	24.8918281	67.2408979	1.50
TP-13	21+600	24.904714	67.2517523	1.50
TP-14	23+400	24.9175992	67.2626088	1.50
TP-15	25+200	24.9290755	67.2751492	1.50
TP-16	27+000	24.9398554	67.284849	1.50
TP-17	28+800	24.9506342	67.3018229	1.50
TP-18	30+600	24.96094019	67.3100630	1.50
TP-19	32+400	24.9721886	67.3285060	1.50
TP-20	34+200	24.9828085	67.3419878	1.50

2.2 Laboratory Testing:

The laboratory program included the following:

- Sieve Analysis AASHTO T-80
- Liquid Limit, Plastic Limit AASHTO T-90
- Moisture-Density Relationship (Modified AASHTO) AASHTO T-180
- Three Point CBR (Soaked) AASHTO T-193

The results of laboratory tests are appended to this report.

3. SUBSURFACE CHARACTERISTICS & DISCUSSION OF TEST RESULTS:

3.1 Classification:

These comprised the performance of particle size analysis and Atterberg limits (liquid & plastic limits) on subgrade samples.

Table 3.1 gives classification of subgrade as per AASHTO on the basis of particle size analysis and Atterberg limits.

TABLE 3.1

CLASSIFICATION OF SUBGRADE

Pit No	Chainage	Description	AASHTO Classification	Rating as Subgrade
TP-1	0+000	Sandy SILT	A-4	Fair
TP-2	1+800	Fine to medium SAND, little silt	A-2-4	Good
TP-3	3+600	Organic fill with garbage	-	-
TP-4	5+400	Fine to medium SAND, little silt	A-2-4	Good
TP-5	7+200	Clayey SAND / sandy CLAY	A-4	Fair to poor
TP-6	9+000	Fine to coarse SAND, little silt	A-2-4	Good
TP-7	10+800	Silty, fine to coarse SAND	A-2-4	Good
TP-8	12+600	Fine SAND, trace silt	A-3	Fair to good
TP-9	14+400	Coarse SAND, little gravel	A-1-b	Excellent
TP-10	16+200	Clayey SILT, some sand	A-4	Fair
TP-11	18+000	Fine to medium SAND, some silt	A-2-4	Good
TP-12	19+800	Fine to medium SAND, some silt	A-2-4	Good
TP-13	21+600	Sandy SILT	A-4	Fair
TP-14	23+400	Silty / clayey, fine to medium SAND	A-4	Fair
TP-15	25+200	Silty / clayey, fine to medium SAND	A-4	Fair
TP-16	27+000	Medium to coarse SAND, trace gravel	A-1-b	Excellent
TP-17	28+800	Medium to coarse SAND, little gravel	A-1-b	Excellent
TP-18	30+600	Medium to coarse SAND, little gravel	A-1-b	Excellent
TP-19	32+400	Silty SAND / sandy SILT	A-4	Fair
TP-20	34+200	Medium to coarse SAND, little gravel	A-1-b	Excellent

* In TP-5, top 1.4m comprise of organic fill. This is underlain by clayey SAND/sandy CLAY deposit.

3.2 Compaction & California Bearing Ratio (CBR):

Three point soaked CBR tests were performed on the 12 subgrade bulk samples. Table 3.2 gives details of compaction and CBR tests. The CBR values are being presented for 95% & 98% maximum dry density.

TABLE 3.2**COMPACTION / CBR TEST RESULTS**

Pit No	Chainage (km)	Classification	Max Dry Density (gm/cc)	Optimum Moisture Content (%)	CBR @ 95% MDD (%)	CBR @ 98% MDD (%)
TP-1	0+000	A-4	1.952	8.15	9.40	9.40
TP-2	1+800	A-2-4	1.807	8.16	14.00	14.75
TP-4	5+400	A-2-4	1.924	7.91	16.92	17.78
TP-5	7+200	A-4	2.041	8.10	3.57	3.92
TP-7	10+800	A-2-4	2.112	6.25	19.70	21.40
TP-8	12+600	A-3	1.794	11.92	8.55	8.92
TP-10	16+200	A-4	1.884	10.46	4.55	4.90
TP-11	18+000	A-2-4	2.055	7.12	18.60	19.67
TP-13	21+600	A-4	1.918	8.25	10.10	10.78
TP-16	27+000	A-1-b	2.119	5.92	25.00	27.40
TP-17	28+800	A-1-b	2.158	5.76	32.00	34.48
TP-20	34+200	A-1-b	2.126	6.08	28.05	29.54

4. CONCLUSIONS:

4.1 Grain Size Analysis:

The grain size analysis of soil samples along the alignment shows following ranges with regard to percent passing sieve Nos. 4, 10, 40 and 200:

Sieve No.	Percent Passing	Average
#4	70 to 100 %	89.35
#10	66 to 100 %	86.40
#40	19 to 100 %	54.80
#200	01 to 83 %	29.05

It is seen that the material is fine to coarse grained throughout the alignment.

4.2 Atterberg Limits:

The Atterberg limits show following ranges with regard to liquid limit and plasticity index:

Test	Range	Average
Liquid Limit	17 to 22 %	18.80
Plasticity Index	05 to 07 %	5.40

15 samples have been found to be non-plastic.

4.3 Soil Classification:

It is evident that 07 soil samples along the alignment belong to A-4 group of AASHTO Soil Classification System. However 06 samples belong to A-2-4 group and 05 samples belong to A-1-b while one sample belongs to A-3 group of the AASHTO System.

Fine Aggregate:

The SAND present in testpits TP-9 & TP-16 belong to A-1-b group of AASHTO Soil Classification System. It is suggested that this SAND deposit can be used as construction sand in RCC works.

4.4 California Bearing Ratio:

Three point soaked CBR test was performed on bulk samples. Average results of CBR @ 95 & 98 % MDD are being presented for different AASHTO group categories:

A-1-b Group

- CBR @ 95% Compaction 28.35 %
- CBR @ 98% Compaction 30.58 %

A-2-4 Group

- CBR @ 95% Compaction 17.31 %
- CBR @ 98% Compaction 18.40 %

A-3 Group

- CBR @ 95% Compaction 8.55 %
- CBR @ 98% Compaction 8.92 %

A-4 Group

- CBR @ 95% Compaction 6.91 %
- CBR @ 98% Compaction 7.25 %

4.5 Suitability as Fill Material:

A study of Table 3.1 shows that 05 pit samples (TP-9, 16, 17, 18 & 20) belong to A-1-b group of AASHTO Classification System. These materials possess excellent compaction & CBR Characteristics. Hence they can be used both as embankment fill material as well as sub-base in the pavement construction.

Moreover, 06 soil samples (TP-2, 4, 6, 7, 8, 11 & 12) belong to A-2-4 group of AASHTO Classification System. Compaction characteristics and engineering properties of these material are suitable for use as select fill material in the Expressway Embankment..

It is important to note that in TP-3 & TP-5 (near DHA Karachi, Interchange-1) organic fill with garbage has been encountered upto 1.4-1.50 m depth. It is recommended that this organic material / garbage must be removed and replaced with well graded fine to coarse SAND belonging to A-1-b or A-2-4 groups of AASHTO Classification System.

It shall be placed in layers of 150-200mm thickness and compacted to minimum 90-95% of the maximum density obtained in accordance with ASTM Designation D-1557. The moisture content of fill material shall be controlled within $\pm 2\%$ of optimum values. Field density tests (ASTM D-1556) shall be performed on each layer to control the degree of compaction.

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