PROJECT

ON

MATERIAL TESTING

LABORATORY

GROUP- 03

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PROBLEM STATEMENT

- Prepare a report incorporating the information about physical characteristics and particle size distribution curve of the soil sample.
- Suggest which of the two sites are better for the purpose with appropriate reasons.
- Suggest an improvement technique if both the sites are found to be inappropriate with proper reasons.

Yellow Soil

Black Soil

THEORY:

Subgrade is an important construction element of the railroad track. In the process of long-term operation, the subgrade is loaded by trains and exposed to natural climatic factors, such as wind and seismic loads, moisture caused by atmospheric precipitations and groundwater, exposure to positive and negative temperatures. At the same time, the subgrade must provide reliability and stable properties of the railway track because its renovations are the most expensive ones among those for the railway track in general.

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Soil texture is determined by the relative proportion of the three kinds of soil mineral particles, called soil separates: sand, silt and clay. At the next larger scale, soil structures called peds or more commonly *soil aggregates* are created from the soil separating when iron oxides, carbonates, clay, silica and humus, coat particles and cause them to adhere into larger, relatively stable secondary structures.

Property/behavior	Sand	Silt	Clay
Water-holding capacity	Low	Medium to high	High
Aeration	Good	Medium	Poor
Drainage rate	High	Slow to medium	Very slow
Soil organic matter level	Low	Medium to high	High to medium
Decomposition of organic matter	Rapid	Medium	Slow

Warm-up in spring	**Rapid**	**Moderate**	**Slow**
Compactability	**Low**	**Medium**	**High**
Susceptibility to wind erosion	**Moderate (High if fine sand)**	**High**	**Low**

A.(1). Physical characteristics of soil sample collected:

Site A

- ☐ Yellow color
- ☐ Rough texture
- ☐ Silty soil

Site B

- ☐ Gray color
- ☐ Smooth texture
- ☐ Clay soil

(2-a). Water content of soil sample(Site A):

OBSERVATION TABLE

Weight of container with lid (W1)	15.229gm
Weight of container with lid + wet soil (W2)	26.60gm
Weight of container with lid + dry soil (W3)	26.523gm

Moisture content= (W2-W3)/(W3-W1)*100
= (26.60-26.523)/(26.523-15.229)*100
= 0.68%

(2-b).Water content of soil sample(Site B):

OBSERVATION TABLE

Weight of container with lid (W1)	19.581gm
Weight of container with lid + wet soil (W2)	29.001gm
Weight of container with lid + dry soil (W3)	28.492gm

Moisture content= (W2-W3)/(W3-W1)*100
= (29.001-28.492)/(28.492-19.581)*100
= 5.71%

(3-a). Specific gravity (Site A):

OBSERVATION TABLE

Weight of density bottle (W1)	35.94 gm
Weight of density bottle + dry soil (W2)	46.41 gm
Weight of density bottle+ dry soil+ water (W3)	93.26 gm
Weight of density bottle + water (W4)	87.20 gm

G= (W2-W1)/(W4-W1)-(W3-W2)*GL
= {(46.41-35.94)/[(87.20-35.94)-(93.26-46.41)]}*1
= 2.37

(GL= specific gravity of water)

(3-b). Specific gravity (Site B):

OBSERVATION TABLE

Weight of density bottle (W1)	35.35 gm
Weight of density bottle + dry soil (W2)	49.27 gm
Weight of density bottle+ dry soil+ water (W3)	93.83 gm
Weight of density bottle + water (W4)	86.51 gm

G= (W2-W1)/(W4-W1)-(W3-W2)*GL
= {(49.27-35.35)/[(86.51-35.35)-(93.383-49.27)]}*1
= 2.11

(GL= specific gravity of water)

B. Particle size distribution of both the curve:

1. **Hydrometer Analysis:**

Hydrometer No.	2	Wt of oven dried soil in suspension(Ws)	50g
Vol. of Hydrometer	54.89cm^3	Wt. of soil for sieve analysis(W)	1000g
C/S Area of Jar(A)	30cm^2	Wt. passing from 0.075mm sieve(Wf)	100g
SG of soil solid(Gs)	2.45	Type of hydrometer	151H

Meniscus Correction(Cm)	0.5	Date of Testing	09/11/2022
Dispersion Correction(Cd)	0.5	Tested by	Group- 3
Dispersing Agent Used	Na(PO3)6 +Na2CO3	Sample No.	03

Elapsed Time t (min.)	Observed Hydrometer Reading in suspension (Rh)	Correction for meniscus and dispersion	Corrected Hydrometer Reading (Rc)	Effective Depth (He)	Value of K	Particle Size	% Finer (N’)	% Finer on Total Wt. (N)
1/2	23	23	24	10.7	0.01388	0.0643	81.10	8.11
1	22.5	22.5	23.5	10.86	0.01388	0.0457	79.41	7.941
2	21.5	21.5	22.5	11.1	0.01388	0.0327	76.03	7.603
4	19.5	19.5	20.5	11.58	0.01388	0.0236	69.27	6.927
8	16.5	16.5	17.5	12.3	0.01388	0.0172	59.14	5.914
16	13	13	14	13.14	0.01388	0.0126	47.31	4.731
30	11.5	11.5	12.5	13.5	0.01388	0.0093	42.24	4.224
1 hr	9	9	10	14.1	0.01388	0.0067	33.79	3.379
4 hr	5.1	5.1	6.1	15.036	0.01388	0.0035	20.61	2.061
8 hr	4	4	5	15.3	0.01388	0.0025	16.89	1.689
24 hr	2	2	3	15.78	0.01388	0.0014	10.14	

Hydrometer Data Calculation:

For Black Soil

D10 =0.001 , D30 = 0.006 , D60 = 0.0175

Cu = D60/D10 = 0.0175/0.001 =17.5

Cc= D30*D30/(D60*D10) = 0.006 * 0.006/(0.0175*0.001)
=2.057

2.Sieve analysis

a. Sieve analysis of soil sample (Site A)

Sieve size(mm)	Mass retained on each sieve(gm)	Percentage retained on each sieve(%)	Cumulative % retained on each sieve	% finer
4.75	11	1.1	1.1	98.9
2	38	3.8	4.9	95.1
1	43	4.3	9.2	90.8
0.6	49	4.9	14.1	85.9
0.3	608	60.8	74.9	25.1
0.212	171	17.1	92	8
0.15	35	3.5	95.5	4.5
0.075	38	3.8	99.3	0.7
pan	7	0.7	100	0

Calculation:

A. Yellow soil

Cu = 0.47/0.22

= 2.136

Cc = 0.32 *0.32/0.47*0.22

= 099

b. Sieve analysis of soil sample (site B)

Sieve size(mm)	Mass retained on each sieve(gm)	Percentage retained on each sieve (%)	Cumulative % retained on each sieve	% finer
4.75	5	0.5	0.5	99.5
2	18	1.8	2.3	97.7
1	20	2	4.3	95.7
0.6	17	1.7	6	94
0.3	594	59.4	65.4	34.6
0.212	139	13.9	79.3	20.7
0.15	111	11.1	90.4	9.6
0.075	84	8.4	98.8	1.2
pan	12	1.2	100	0

Calculation:

B.Grey soil

Cu= D60/ 2.136D10

=.38/.16

=2.375

Cc= D30*D30/D60*D10
= 0.28*.28/.38*.16
= 1.289

RDSO GUIDELINES

1.***Soil Exploration and survey**:* Objective of constructing a stable formation can only be achieved if soil exploration is undertaken in earnest.

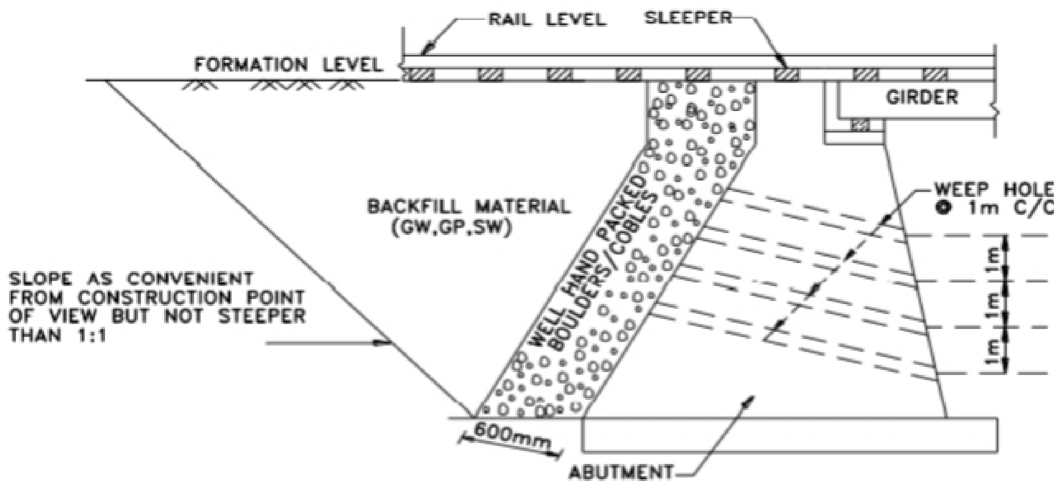
<u>Objective of exploration:</u>

a. To determine soil type with a view to identify their suitability for earthwork and to design the foundation for other structures.

b. To avoid known troublesome spots,unstable hillside,swampy areas,soft rock areas etc.

3. To determine the method of handling and compaction of subgrade.

2*. Execution of earthwork:* Before taking up actual execution of work,detailed drawings need to be prepared for the entire length of the project to give alignment,formation width at ground level to facilitate smooth execution at site.



NOTE:-
1. BEHIND ABUTMENTS, WING WALLS AND RETURN WALLS, BOULDER FILLING AND BACKFILL MATERIALS SHALL BE PROVIDED UPTO FULL HEIGHT.
2. THE BOULDER FILLING SHALL CONSIST OF WELL HAND PACKED BOULDERS & COBBLES TO THICKNESS NOT LESS THAN 600mm WITH SMALLER SIZE TOWARDS THE BACK. BEHIND THE BOULDER FILLING, BACKFILL MATERIALS, SHALL CONSIST OF GRANULAR MATERIALS OF GW, GP, SW GROUPS AS PER IS: 1498-Latest Edition

	R. D. S. O.
	COMPREHENSIVE GUIDELINES AND SPECIFICATIONS FOR RAILWAY FORMATION
	DETAIL OF BACKFILL BEHIND BRIDGE ABUTMENT
NOT TO SCALE	DRG. NO. GE/SD/0006/Rev.2/2020

3.***Soil Quality***: For design of railway formation,the soil for their use in Indian railway embankment has been grouped based on percentage and fines present in the soil.

Description w.r.t fine particles(less than 75 micron)	Soil quality class
Soil containing fines> 50%	SQ1
Soil containing fines from 12%-50%	SQ2
Soil containing fines< 12%	SQ3

Sandy and gravel soil: a moisture content of 3 to 5 % would be suitable.
Cohesive soil: Moisture content about 12 to 16% below the plastic limit of the soil should be suitable.

4. ***Thickness of formation layer:*** The railway formation may be constructed with a single layer system and two layer system based on the availability of local soil on economic consideration.
The specifications and thickness of blanket layer,prepared subgrade,sub soil are tabulated below for 25T and 32.5T axle load.

Table-3.2: For 32.5 T Axle Load

S. No.	Soil type Category in Sub-grade	Prepared Sub-grade		Recommended Blanket Thickness (mm)	Remarks
		Soil Type	Thickness (mm)		
1.	SQ1	SQ1*	--	700	Single layer
2.	SQ1	SQ2	500	550	Two layer
3.	SQ1	SQ3	500	450	Two layer
4.	SQ2	SQ2*	--	550	Single layer
5.	SQ2	SQ3	350	450	Two layer
6.	SQ3	SQ3*	--	450	Single layer

* Subgrade soil is continued upto blanket layer

Table-3.1: For 25 T Axle Load

S. No.	Soil type Category in Sub-grade	Prepared Sub-grade		Recommended Blanket Thickness (mm)	Remarks
		Soil Type	Thickness (mm)		
1.	SQ1	SQ1*	--	550	Single layer
2.	SQ1	SQ2	500	400	Two layer
3.	SQ1	SQ3	500	300	Two layer
4.	SQ2	SQ2*	--	400	Single layer
5.	SQ2	SQ3	350	300	Two layer
6.	SQ3	SQ3*	--	300	Single layer

* Subgrade soil is continued upto blanket layer

5. *Suitability of subsoil:* Field tests are required to be conducted on subsoil strata.

Strengthening of subsoil,including cutting shall be required as:

a. Ev2 < 20Mpa
b. Cu< 20Mpa
c. N-Value < 5

6. *Quality control of earthwork:* It shall be controlled through exercise of checks on the borrowed material,compaction process,drainage system.

The details of quality control is given in table:

(ii) Finished earthwork					
(Subgrade /Prepared Subgrade/ Blanket)	(i) Ev_2	Top of final finished surface of Blanket/ Prepared subgrade & Subgrade	DIN 18134 – 2012	One test per Km (*)	Acceptance Criteria as specified in Para 3.10 of Chapter 3
	(ii) Compaction	Every compacted layer	IS: 2720 (Part-28/29) or NMDG(as per Procedure issued by RDSO)	As per note given below	
	(iii) Density Index (Relative Density if fines are upto 5%)	Every compacted layer	IS: 2720 – Part-14		Minimum 70%

CONCLUSION

Both soil samples (soil at site A and soil at site B) are not appropriate for railway track construction work.

- Soil at site B satisfies this range as it has moisture content of 5.71,moisture content should be appropriate not exceeding or less.
- According to RDSO, coefficient of curvature (Cc) in sieve analysis should be in the range of 3 to 7, but we obtained Cc value for soil sample at site A is 0.99 and for soil at site B is 1.289.

Since both the soils are not appropriate for railway track construction work, therefore some of the soil quality improvement technique has been discussed as following.

SOIL IMPROVEMENT TECHNIQUES

1.Vibro Technique:

This procedure can be utilized for treating delicate firm soils with profundity vibrators. It includes Vibro Compaction and Vibro Replacement strategies.

2.Vibro Compaction:

In this strategy the particles of non-strong soil, for example, sand and rock can be adjusted by vibrations. T

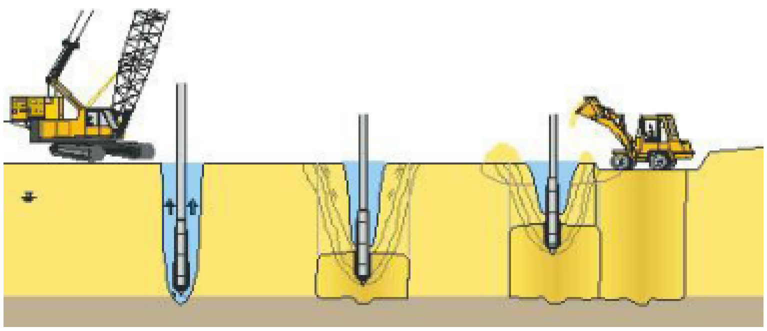


Fig.1 Schematic showing Vibro Compaction

The essential procedure is to briefly decrease the bury molecule erosions and revamping in denser state.

3.Vibro Replacement (Stone Columns):

This technique is widely utilized for sandy soils with high fine substance (>15%) and strong soils, for example, residue and earth. Stone sections are introduced in the delicate ground utilizing profundity vibrator.

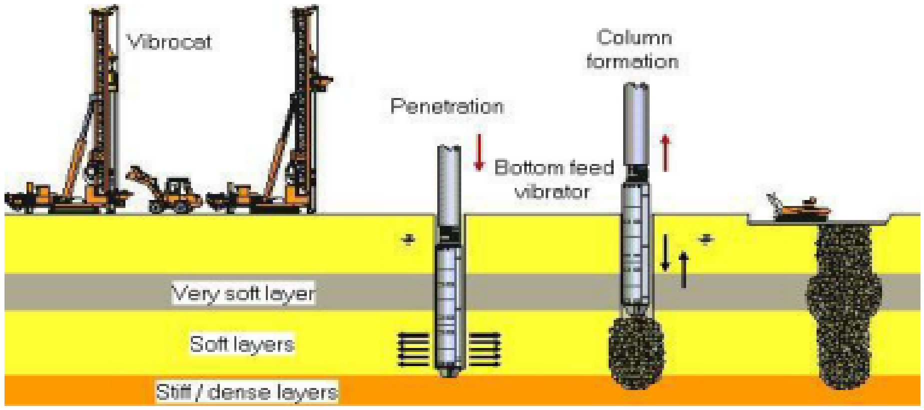


Fig.2 Schematic showing Vibro Replacement

4.Vibro Concrete Columns:

This strategy includes the establishment of an unbending heap-like establishment component. In this strategy concrete is filled straightforwardly to the tip of the base bolster vibrator to frame the segment. The procedure is exhibited in Fig.4. Because of the development of base and its entrance into compacted bearing strata making the sections as end bearing segments and can bolster high bearing burdens.

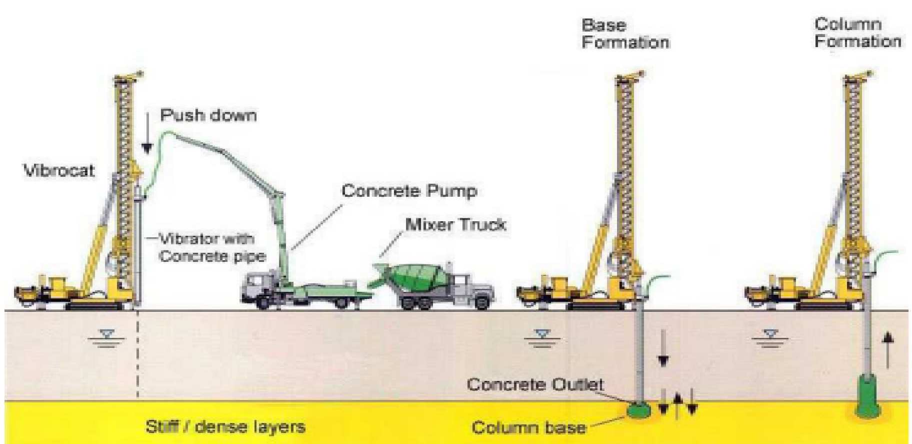


Fig.4 Schematic showing the installation of Vibro Concrete Columns (VCC)

5.Using CNS material

Using a layer of Cohesive Non-Swelling soil(CNS) is one of the effective methods of ground improvement in expansive soils. CNS layer shall be provided below the bottom layer of Embankment fill in case of Embankment and below subgrade/prepared subgrade level in case of cuttings, of suitably designed thickness and width, compacted to 97% of MDD at optimum moisture content(OMC).

6.Use of Prefabricated vertical drain (PVD):

Prefabricated vertical drains consist of channeled synthetics core wrapped in Nonwoven geotextile fabric known as filter(Fig-2.7). Prefabricated Vertical Drains are used where preloading alone is not sufficient. Prefabricated Vertical drains in soft clay accelerate the primary consolidation of clay since they bring about rapid dissipation of excess porewater pressure.Therefore, the structures orEmbankments can be puttouse earlier than it would be possible otherwise.