IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 22, Issue 2 Ser. 1 (Mar. –Apr. 2025), PP 72-75
www.iosrjournals.org

Modifying the Soil Properties by the Blending of Soil for Clay Core Material of a Zoned Dam

Harendra Prakash[1], Shahid Noor[2], Siddharth Hedaoo[3], Dr. Manish Gupta[4] and Dr. R Chitra[5]

[1]*Scientist 'C', CSMRS, New Delhi, harendra.prakash@gmail.com*
[2]*Scientist 'E', CSMRS, New Delhi, shahidnoor19@gmail.com*
[3]*Scientist 'B', CSMRS, New Delhi, siddharth_hedaoo@rediffmail.com*
[4]*Scientist 'E', CSMRS, New Delhi, manish009@gmail.com*
[5]*Director, CSMRS, New Delhi, chitra009@gmail.com*

ABSTRACT:
The suitability of construction materials to be used for different zones in an earthen dam requires different properties. The core provides impermeable barrier to the dam body and casing provide the support to the core of dam. The material to be used in both the zone have different requirements. Core material should have the characteristics of the low permeability, good shear strength and less compressible, while the casing material should have the high permeability and high shear strength. The geotechnical investigations are carried to determine the potential borrow area for both the materials. The suitability of the material for both the zone, impervious and pervious is defined by BIS specifications IS: 1498 and IS: 8826.

The present paper discuss the geotechnical investigations carried out for the clay material for the core of the zoned dam. Two areas were identified for the clay core material and geotechnical investigations was carried to determine the suitability of both the areas. Based upon the geotechnical investigations, it was found that one borrow area fall under CH (Clay of High Compressibility) type of soil and other area fall under CL (Clay of Low Compressibility) type of soil. IS: 8826 specify the CL type of soil suitable and CH type of soil less suitable as these soil possesses the swell and shrink behaviour. Considering the quantity of the soil required for the clay core, it was decided to mix the both type of the soils to obtain a soil of low/medium compressibility and controlled swell and shrink behaviour and low permeability.

Keywords: *expansive soil, geotechnical investigation, blending, borrow area*

I. INTRODUCTION

The present geotechnical investigations was carried out for a zoned dam at Maharashtra. In case of a zoned dam, there are mainly two zones, impervious zone and pervious zone. The suitability of construction materials to be used for different zones in an earthen dam requires different properties. The core zone provides the impermeable barrier to the dam body and casing zone is the pervious zone and provide the support to the core of dam (Gulati and Datta (2005); Arora (2000); Lambe and Whitman (2000).. The material to be used in both the zone have different requirements. Core material should have the characteristics of the low permeability, good plasticity, good shear strength and less compressible while the casing material should have the property of high permeability and high shear strength. The geotechnical investigations are carried to determine the potential borrow area for both the materials. The suitability of the material for both the zone, impervious and pervious is defined by BIS specifications IS: 1498 and IS: 8826.

The present paper discuss the geotechnical investigations carried out for the clay material for the core of the zoned dam. Two areas were identified for the clay core material and geotechnical investigations was carried to determine the suitability of both the areas. Based upon the geotechnical investigations carried out, it was found that one borrow area fall under CH (Clay of High Compressibility) type of soil and other area fall under CL (Clay of Low Compressibility) type of soil. IS: 8826 specify the CL type of soil suitable and CH type of soil less suitable as these soil possesses the swell and shrink behaviour and has the tendency to increase in volume when saturated and decrease in volume if the water content of the soil is reduced. The shrink-swell behaviour of soil may induces the cracks in the core which is detrimental for a core of the dam. Since the quantity of the soil required for the clay core was large, hence, it was decided to mix the both type of the soils to obtain a soil of low/medium compressibility and controlled swell and shrink behaviour and low permeability.

II. COLLECTION OF SOIL SAMPLES FROM THE BORROW AREAS

The representative/disturbed soil samples were collected from the identified potential borrow areas B1 and B2 by making the trial pits of size 3 m x 3 m x 3 m. the trial pits are evenly distribute in the borrow area. The soil samples were collected in gunny bags and were taken to laboratory for the detailed geotechnical on the collected soil samples to characterize the borrow area material.

III. LABORATORY INVESTIGATIONS

Laboratory investigations was carried out on the collected soil samples as per IS: 2720 and various properties of the soil like grain size distribution, Atterberg's Limits, Maximum Dry Density, Optimum Moisture Content, Shear Strength Parameters, Compressibility Characteristics and Permeability Characteristics of both the soils collected from the two different borrow areas were determined. Based upon the laboratory investigations, it was found that one borrow area (B1) soil fall under CH (Clay of High Compressibility) type of soil and other borrow area (B2) soil fall under CL (Clay of Low Compressibility) type of soil as per Bureau of Indian Standard soil classification system. The grain distribution curve of the both type of soil are presents in Figure1 and other properties of the soils are presented in Table-1. The soil from borrow area B1 have low plasticity index of 12.0 and the soil from the borrow area B2 has very high plasticity index of 42.3. In order to modify the properties of the soil so that it can be used in the clay core of the dam, it was decided to blend both type of the soils to obtain a soil of good characteristics which have good plasticity, good density & good shear strength and low permeability & consolidation properties. The shear strength properties of the soil is presented in Table 2. Both the basic soil B1 & B2 and Mix. of soil which is suitable for the clay core (Mix. 3) as per IS : 8826 has been tested for the Shear strength and presented in Table 2.

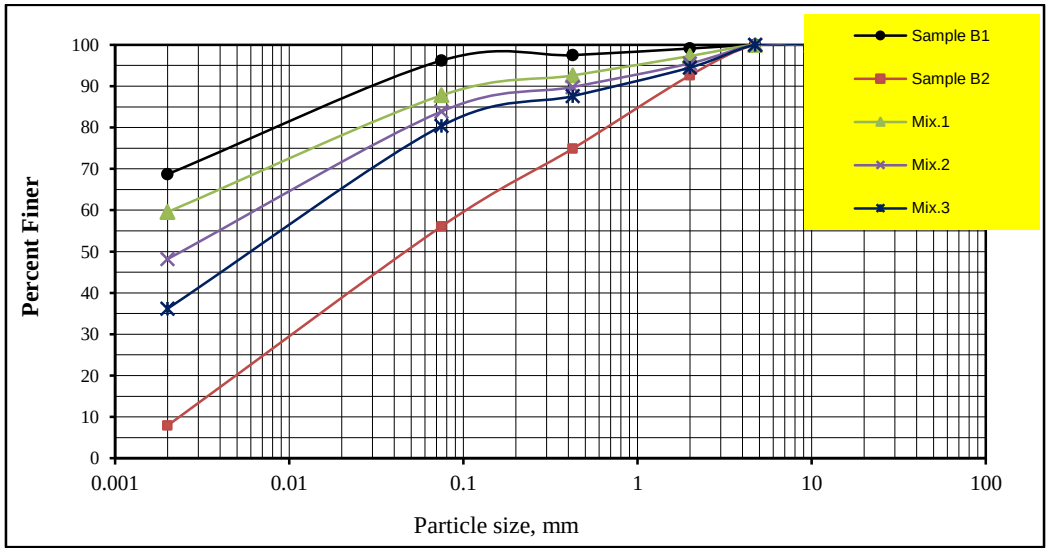

Figure 1: Grain Size Distribution Curves for Basic and Blended Soil

Table 1: Index Properties of Basic Soils

Type of Soil	Liquid Limit	Plastic Limit	Plasticity Index	MDD	OMC	BIS Soil Classification
Soil B1	81.8	38.9	42.3	1.37	25.1	CH
Soil B2	33.0	21.0	12.0	1.76	14.3	CL
Mix. 1	69.2	32.4	36.8	1.46	22.0	CH
Mix. 2	54.8	28.4	26.4	1.58	17.1	CH
Mix. 3	47.2	26.5	20.7	1.71	15.1	CI

Table 2: Shear Strength Properties of Soils

S. No.	Total Cohesion (c), kg/cm^2	Total Angle of Shearing Resistance (ϕ)	Effective Cohesion (c′), kg/cm^2	Effective Angle of Shearing Resistance (ϕ′)
Soil B1	0.32	16.5°	0.25	19.5°
Soil B2	0.18	23.7°	0.12	29.4°
Mix. 3	0.23	19.4°	0.15	23.3°

IV. METHODOLOGY TO MODIFY THE SOIL PROPERTIES:

To modify the soil properties, both the soils B1 and B2 were mixed in the proportion of 75% B1: 25% B2 (Mix. 1), 60% B1 : 40% B2 (Mix. 2) and 50% B1 : 50% B2 (Mix. 3) and subjected to the various laboratory tests Grain Size Distribution, Atterbergs Limits, Standard Proctor Compaction Permeability and Triaxial shear Strength tests. The grain size distribution curves of the Mix. 1, Mix. 2 & Mix. 3 are presented in Figure 1. The Standard proctor Compaction Curves for the Mix. 1, Mix. 2 & Mix. 3 are presented in Figure 2. The Index and other properties of the soil mixes are presented in Table 1 and shear strength properties are presented in Table 2. The Mix. 3 was subjected to the Co-Efficient of Permeability test and the value of Co-Efficient of Permeability was found 2.303×10^{-7} cm/sec.

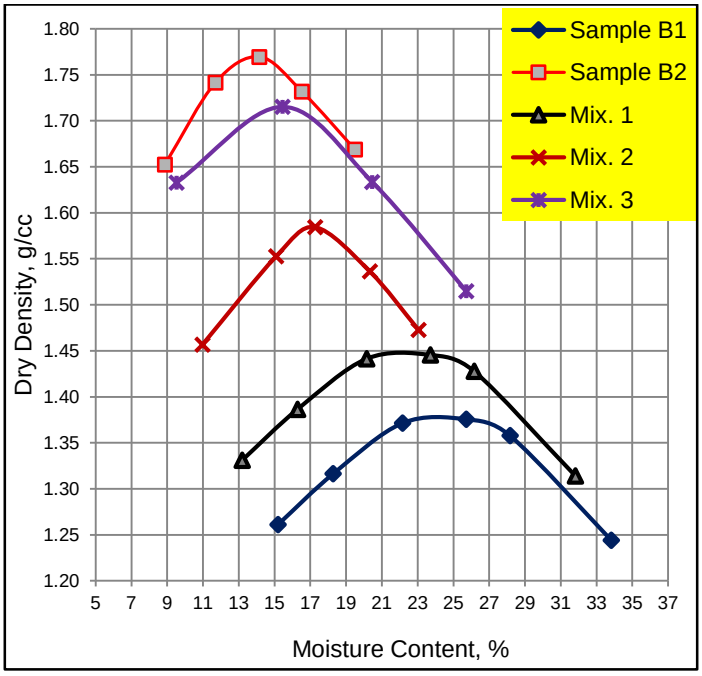

Figure 2: Standard Proctor Compaction Curves

V. DISCUSSION OF TEST RESULTS

Based upon the laboratory investigations carried out on the Mix. 1, Mix. 2 and Mix. 3, it is concluded that

a) As the percentage of the of the Soil B2 increases in the Mix. (from 25 % to 50 %), the clay percentage reduces.
b) With the percentage increase of coarser soil (B2), the Liquid Limit and Plasticity Index reduces appreciably.
c) Based upon the Grain Size Distribution and Atterbergs Limits, Mix. 1 and Mix. 2 fall under CH (Clay of High Compressibility) group and Mix. 3 falls under (Clay of Medium Compressibility) group as per (Clays with Medium Compressibility) group as per Bureau of Indian Standard soil classification system.
d) The Mix. 3 soil, CI (Clay of Medium Compressibility) falls under suitable category of soil for clay core of zoned dams as per IS: 8826.
e) The value of the MDD and OMC of the Mix. 1, Mix. 2 and Mix. 3 are 1.46, 1.58 & 1.71 and 22.0, 17.1 & 15.1 respectively.
f) The values of the MDD of the soil Mixes. Indicate that as then percentage of the coarser soil increases, the density of the Mix. also increases and OMC decreases.

g) The Mix. 3 is capable to achieve the good compaction density.
h) The co-efficient of permeability value evaluated from The Laboratory Permeability Test is found to be 2.303×10^{-7} cm/sec.
i) Based upon the Laboratory Permeability Test, it is concluded that the tested Soil Mix. 3 possess impervious drainage characteristics.
j) The total shear strength parameters, total cohesion (c) and total angle of shearing resistance (ϕ) of the most suitable, Mix.3 were 0.23 kg/cm^2 and 19.4° respectively. The effective shear strength parameters, effective cohesion (c') and effective angle of shearing resistance (ϕ') of the Mix. 3 were 0.15 kg/cm^2 and 23.3° respectively.
k) Based on the results of Triaxial Shear tests conducted on the soil Mix. 3, it is inferred that the tested soil Mix. are likely to exhibit medium shear strength characteristics.

VI. CONCLUSION

In the present day scenario, finding a good construction material in the vicinity of hydro- electric project is the biggest challenge. Moreover the economy and design of the dam is governed by the characteristics of the locally available materials. Based on the present geotechnical investigations carried out for the clay core material for a zoned dam in which soil samples were collected from two from two different borrow areas. Based upon the laboratory investigations carried out on the soil samples, it was found that one borrow area (B1) soil fall under CH (Clay of High Compressibility) type of soil and other borrow area (B2) soil fall under CL (Clay of Low Compressibility) type of soil as per Bureau of Indian Standard soil classification system. To modify the properties of soil so as meet the requirement of clay core material as per IS:8826 and meet the quantity requirement, both the soil B1 and B2 were mixed in different proportions (75% B1: 25% B2 (Mix. 1), 60% B1 : 40% B2 (Mix. 2) and 50% B1 : 50% B2 (Mix. 3)) and tested for the engineering properties. Based upon the laboratory investigations carried out on the soil mix. samples Mix. 3 was found most suitable and recommended for the clay core of the zoned dam.

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