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Experimental Study on Subgrade Soil Properties Using Sea Water as Partial Replacement to Fresh Water in Coastal Areas

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ABSTRACT
At present the fresh water availability is very important factor specially in coastal areas the ground water table providing with sea water . If we utilize the waste water nothing but sea water is used as partial replacement to the fresh water for the construction of subgrade soil for flexible pavements ,we will reduce the utilization of fresh water to the construction works as well as economical for transportation of fresh water to construction site. Sub grade is a component which can taken all compression loads from sub base, base and surface courses and transfer to it to below the ground surface. This paper deals with the sub-grade properties using sea water as partial replacement to fresh water in coastal areas. In order to determine the properties of soil by taking various percentages I.e, 10%,20%,30%,40% and 50%of salt water as partially replaced to normal water. In this study, Proctor's compaction tests, core cutter test,Atterberg limits and CBR soaked and un-soaked tests are conducted on locally available soil with sea water to normal water. For this study it is identified that the engineering properties of the soil like void ratio,posrosity,degree of saturation does not loose their characterstics in all conditions. The soil with at optimum value is 40% of sea water has CBR soaked value is obtained 6.83% and un-soaked value is obtained 7.0% is just increased when compared with conventionally soil.

Keywords: CBR-Soaked, Un-soaked,sea water, locally available water, compaction test, atter berg limits

1. INTRODUCTION

1.1 Introduction on Sub grade layer:

The subgrade constitutes the foundation material for the pavement structure as highway pavements ultimately rest on the native soil (subgrade). Hence the performance of the pavement is affected by the characteristics of the subgrade. And one of the major functions of a highway pavement is to reduce the stresses transmitted to the subgrade to a level which the soil will accept without significant deformation. The objective of pavement design is to provide a structural and economical combination of materials to carry traffic in a given climate over the existing soil conditions for a specified time interval. In which subgrade is the lower most layer in the earth's surface which is the nativematerial underneath a constructed road, Generally subgrade is compacted before laying a pavement as it is the lower layer and it should have the bearing capacity to sustain the entire pavement.

1.2 Sea water

Sea water (more commonly known as **salt water**) is water that contains a high concentration of dissolved salts (mainly sodium chloride). On the United States Geological Survey (USGS) salinity scale, saline water is saltier than brackish water, but less salty than brine. The salt concentration is usually expressed in parts per thousand (permille, ‰) and parts per million (ppm). The USGS salinity scale defines three levels of saline water. The salt concentration in slightly saline water is 1,000 to 3,000 ppm (0.1–0.3%); in moderately saline water is 3,000 to 10,000 ppm (0.3–1%); and in highly saline water is 10,000 to 35,000 ppm (1–3.5%). Seawater has a salinity of roughly 35,000 ppm, equivalent to 35 grams of salt per one liter (or kilogram) of water. The saturation level is only nominally dependent on the temperature of the water.[1] At 20 °C (68 °F) one liter of water can dissolve about 357 grams of salt, a concentration of 26.3 percent by weight (% w/w). At 100 °C (212 °F) (the boiling temperature of pure water), the amount of salt that can be dissolved in one liter of water increases to about 391 grams, a concentration of 28.1% w/w.

1.3 Fresh water

Fresh water or **freshwater** is any naturally occurring liquid or frozen water containing low concentrations of dissolved salts and other total dissolved solids. Although the term specifically excludes seawater and brackish water, it does include non-salty mineral-rich waters such as chalybeate springs. Fresh water may encompass frozen and meltwater in ice sheets, ice caps, glaciers, snowfields and icebergs, natural precipitations such as rainfall, snowfall, hail/sleet and graupel, and surface runoffs that form inland bodies of water such as wetlands, ponds, lakes, rivers, streams,as wellas groundwater contained in aquifers, subterranean rivers and lakes. Fresh water is the water resource that is of the most and immediate use to humans.

1.4 Differences between sea water and freshwater

Sea water	**Fresh water**
Colour less	Colourless
Higher viscosity	lower viscosity
Higher Density	Lower Density
Lower freezing point(-1.9)	Higher freezing point(0)
Higher boiling point(103)	Lower boiling point(100)
Ph value-7.7-8.3	Ph value-6.5-8.5

Table1 Differences between sea water and freshwater

1.5 Objectives of Present Study:

The objectives of the project are:

1. To determine the properties of soil and fresh water.
2. To evaluate the performances of fresh water with soil.
3. To study the effects of soil and engineering properties of soil using twotypes of normal water and sea water.
4. To evaluate the performances of soil using partial replacement of sea water to normal water.

2. Tests on Materials:

The following parameters are studied in experimental work

2.1Specific gravity of soil

Specific gravity of soil with sea water is-2.7

Specific gravity of soil with fresh water is-2.64

2.2Atterberg limits

Liquid limit, plastic limit, plasticity index

Table :4Atterberg's Limit of soil and sea water

Properties	+)sw	+ %)sw	Soil+ (20%) sw	Soil+ (30%) sw	Soil+ (40%) sw	Soil+ (50%) sw
WL (%)	35.23	34	30	28.2	25.00	26.00
WP (%)	21.00	20.05	17.00	16.00	15.25	16.00
P.I (%)	14.23	13.95	13.00	12.22	9.75	10

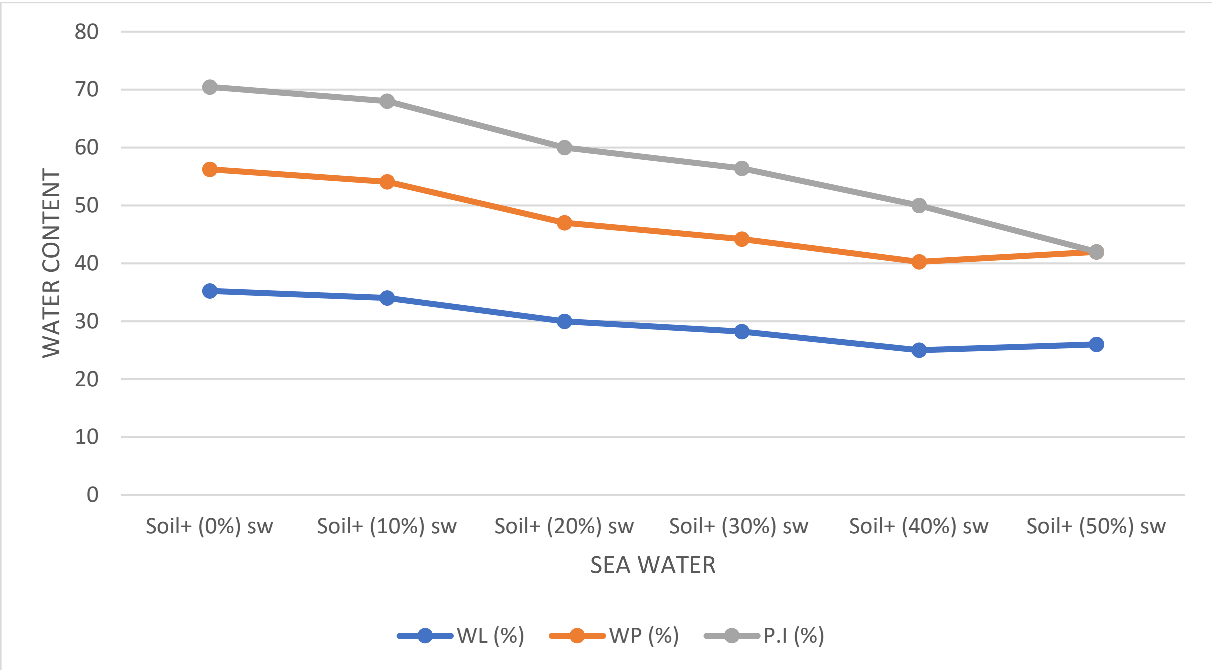

Figure 3: Atterberg's Limits for sea water

2.3 Compaction characteristics of soil

Compaction of soli with partial replacement of sea water to fresh water

Table 5: Effect of percentage of sea water on Compaction characteristics

water(%)	Water content(%)	Dry density (gm/cc)
0	18.3	1.694
10	19.61	1.722

20	20.97	1.89
30	21.66	1.95
40	23.52	2.329
50	20.48	2.30

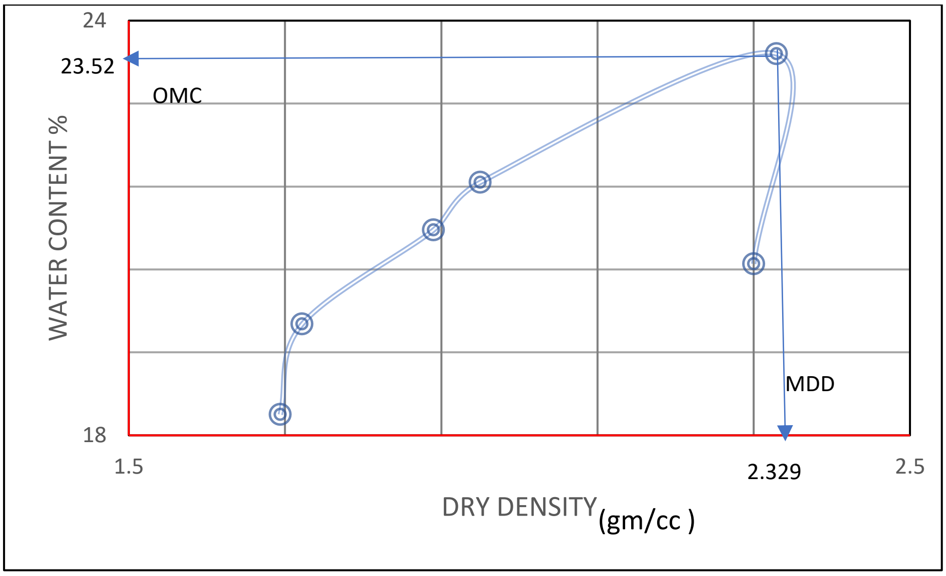

Figure 4: Proctor's Compaction graph with partially replaced sea water

2.4 CBR Test:

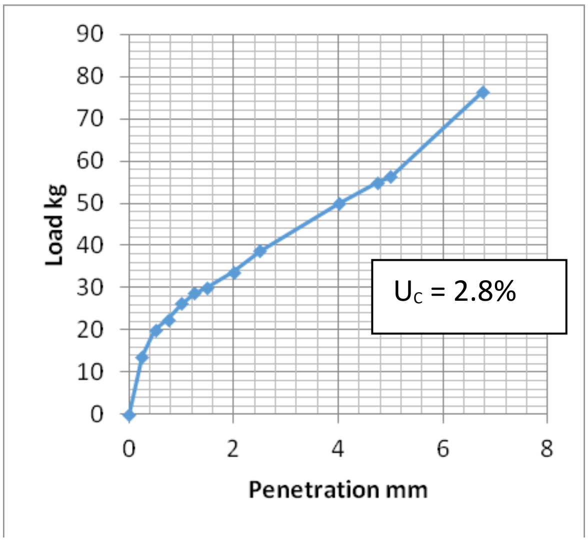

Figure 5 (Un-soaked) CBR curve for soil

C.B.R. = (Test load/Standard load) x 100

Standard load at 2.5 mm penetration = 1370kg, 5.0mm penetration = 2055kg. Test load at 2.5 mm penetration = 39.4kg, 5.0mm penetration = 36.1kg.

CBR (Un-soaked) at P2.5 = 2.8% P5.0=1.74%

Table 6: Effect of percentage of sea water on (Un-soaked) CBR

Soil+FW+SW	**ked CBR values**
100+0%SW	3.6
90+10%SW	4.02
80+20%SW	5.98
70+30%SW	6.12
60+40%SW	7.05
50+50%SW	6.09

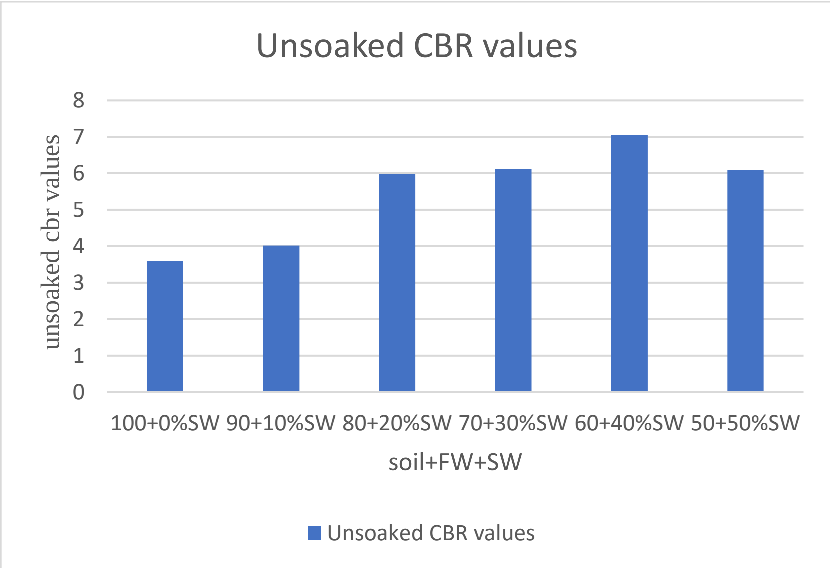

Figure 6: Variation of (Un-soaked) CBR value with different percentage of sea water

Description of graph:

2.6 Effect of percentage of Sea water on Dry density and CBR:

Table 7: Effect of percentage of Admixtures on Dry density and CBR

mixture(%)	**Dry density (gm/cc)**	**Soaked CBR values**
/+SW	**FW+SW**	**FW+SW**
100+0%SW	1.694	1.91
90+10%SW	1.722	2.97
80+20%SW	1.89	4.59
70+30%SW	1.95	5.68
60+40%SW	2.329	6.59
50+50%SW	2.30	5.89

C.B.R. = (Test load/Standard load) x 100

Standard load at 2.5 mm penetration = 1370kg, 5.0mm penetration = 2055kg. Test load at 2.5 mm penetration = 24.2kg, 5.0mm penetration = 23.6kg.

CBR (soaked) at P2.5 = 1.74% P5.0=1.14%

mixture(%) /+SW	Dry density (gm/cc) FW+SW	Soaked CBR values FW+SW
100+0%SW	1.694	1.91
90+10%SW	1.722	2.97
80+20%SW	1.89	4.59
70+30%SW	1.95	5.68
60+40%SW	2.329	6.59
50+50%SW	2.30	5.89

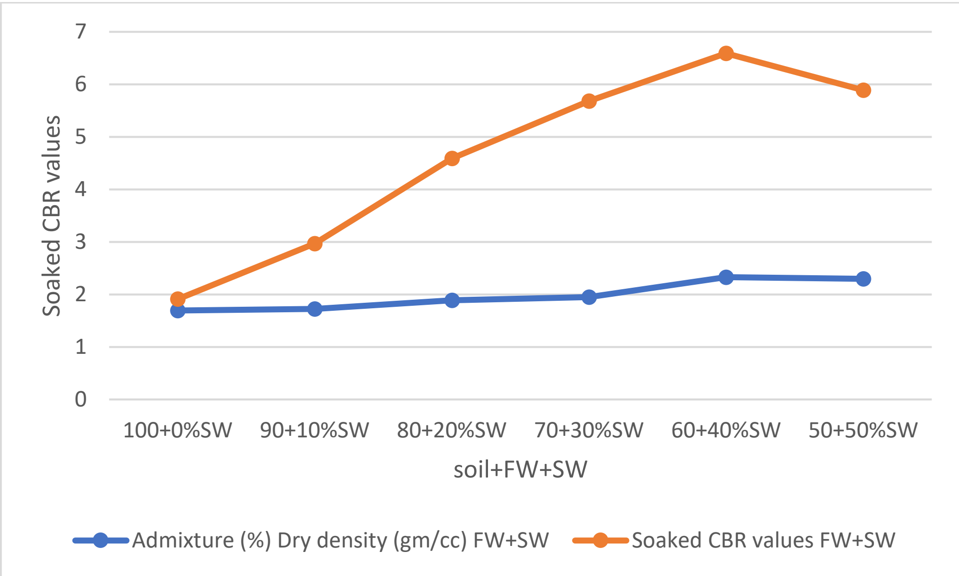

Figure 7: Variation of (Soaked) CBR value with different percentage of sea water

3. Conclusions

Conclusions that are studied from the course of study include the following:

1. The Liquid limit of soil with partial replacement of sea water gradually decreases from 5% to 25% when comparedwith soil with zero percentage of sea water.
2. The plastic limit of soil with partial replacement of sea water gradually decreases from 5% to 25% when compared with soil with zero percentage of sea water.
3. The plasticity index of soil with sea water gradually decreases from 5% to 25% when compared with soil with zero percentage of sea water.
4. The water content of soil with sea water gradually decreases from 5% to 25% when compared with soil with increase in percentage of sea water. The optimum moisture content was attained at 20% with 23.52%.
5. The dry density of soil with sea water gradually increases from 5% to 25% when compared with soil with increase in percentage of sea water. The MDD is attained at 20%. i.e, 2.329
6. The un-soaked CBR value with soil gradually increased with addition of sea water from 5% to 25%,
7. The un-soaked CBR value with a soil gradually increased with addition of sea water from 5% to 25%..
8. CBR studies were done and it was osbserved that both Soaked and Un-soaked has been improved with admixtures.

9. Finally the economical cost also reduced by using sea water for subgrade preparation for WBM roads

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- California bearing ratio (CBR) of soil.
  Specific gravity of soil with sea water is-2.7
- Specific gravity of soil with fresh water is-2.64

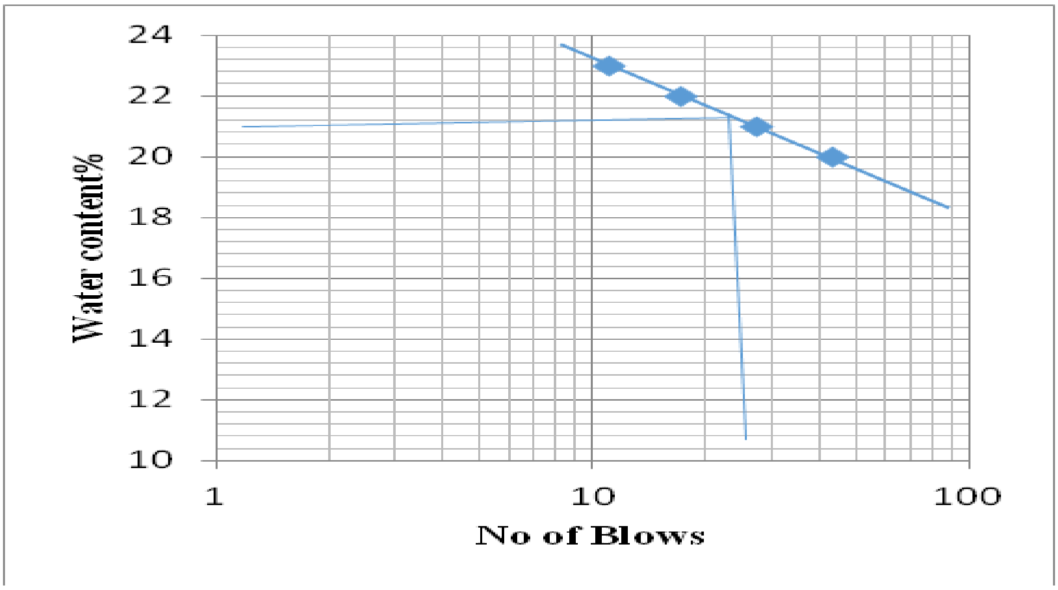

Table 1: Properties of Soil :

Properties of soil	Sea water	Normal water
Specific gravity	2.67	2.65
WL(%)	14.25	21.05
WP(%)	8.01	12.01
P.I (%)	6.28	9.09
γd (kN/m³)	22.72	20.56
WO (%)	14.3	10.6
SC(%)	1.74	1.67
UC (%)	2.8	2.6