# Effect of Acidic Water Quality on Subgrade layer of Flexible Pavement

[1]Dipal Mehta, [2]Mrs. Vrundani Vaidya, [3]Mr.Shrinath Karli
[1]PG Student of Master of Transportation, HGCE- Vehlal , Ahmedabad, Gujarat, India
[2]Head of the Civil Engineering Department HGCE-Vehlal,Ahmedabad, Gujarat,India
[3]Assistant Professor of the Civil Engineering Department HGCE-Vehlal, Ahmedabad Gujarat, India

***Abstract :*** To accommodate seasonal and environmental changes in pavement material properties, design procedures have been based upon empirical relationships between measurable soil and material parameters and observation of field performance. The Indian road congress (IRC), Ministry of road and Transport for Highway (MORTH) and American Association of State highway and Transportation Officials ( AASHTO ) guide for the design of pavement structures based upon the results of material and road tests conducted. The analyses indicated that there was a significant difference in pavement behaviour with respect to changes in material characteristics. Industrialization and urbanization play a key role in economy of a country. Industrialization and urbanization of the country though lead to a rapid growth of industries is prone to produce certain spillovers like contamination of land and water streams through improper treatment practices. Contamination of land is a serious issue as it modifies index and engineering properties of soils. Modification of soil properties from industrial wastes results in foundation failures, structural damage in light industrial buildings .Safe disposal of wastes is one of the important factors that has become the present paramount. On the other hand in many situations, soils in its natural state do not present adequate geotechnical properties to be used as foundation layers and road service layers..

***IndexTerms*** **– Soil Index Property, CBR Value , Density Parameter**

## I. INTRODUCTION

Due to increase in population and industrialization, there is increase in construction activities in the cities and industrial area leaving very little locations of good soils for new projects. There are some open plots of land which are filled by liquid and solid wastes coming from municipal and industrial areas. The fill material, decayed organic soils and soils having continuous contact with sanitary fill environment loose their desired geotechnical properties. The specific gravity of polluted soil is decreased due to decay of lighter weight particles present in the soil. Organic matters have broken down to the smaller size particles of the soil and thus increasing clay size particles. This has resulted in increased plasticity of polluted soil. Liquid limit of polluted soil increases due to more number of smaller size particles present in the soil. Dry density of polluted soil is decreased due to decay of lighter weight organic matters present in the soil. Shear strength parameters of polluted soil also decreased. Angle of internal friction depends on void ratio and shape of particles, decay of organic matters and other pollutants to make the soil particles more granular. It reduces the angle of internal friction but increases the cohesion of the soil. Waste water affects the agricultural properties of the soil. Proper land filling increases the space for extra land filling. Using dynamic compaction light weight construction can be done on filled area. Taking into consideration all these factors, before starting a new civil engineering construction projects on polluted soil, study of changes in properties of soil due to disposal of waste is very essential.

## II. OBSERVATION

Due to massive increase in population and industrialization there are increased road construction activities in the cities and in industrial area, leaving very little locations of good soils to construct on. Lands in the periphery of town which are open to environment are filled by liquid and solid wastes coming from municipal and industrial areas. This is happening due to limited dumping space for the pollutants or lack of proper environmental planning. Various decomposed organic materials and most of the time industrial pollutants also come into contact of surrounding soil mass due to unlined drainage systems. These

wastes may find their way to shallow depth of soil and react with the same. The fill material, decayed organic soils and soils having continuous contact with sanitary fill environment lose their desired geotechnical properties. Soil in contact with pollutants becomes plastic, compressible and show comparatively lower shear strength and hence have low bearing capacity values. Organic soils due to decay of organic materials show unpredictable settlement. To utilise effectively even the poorest type of soil for supporting the structures to be constructed over it, efforts of geotechnical engineers are directed to develop technically viable and economically feasible solutions. As already discussed in the present study soil samples for each industry were collected from two locations one from polluted area and another in the vicinity but unpolluted area. When the soil is to be used for supporting the foundation standard Proctor test and shear strength parameters are important. Similarly for classification of fine grained soil Atterberg's limit are important When soil is to be used for supporting the road soaked C.B.R. value of soil is important. Hence, with these considerations the different geotechnical tests such as specific gravity, liquid limit, plastic limit, maximum dry density, optimum moisture content, shear strength parameters *i.e.* cohesion and angle of internal friction were determined for all cases. For cases *i.e.* **Construction chemical industries** in addition to this soaked C.B.R. values were determined.

## III . OBJECTIVE

Soil-water interaction can affect almost the properties of soils. Though the effects of pollutants on soils are complex, they may be better understood if the various factors are isolated and considered independently. These factors are primarily due to ion exchange or mature of pore fluid. The effects may different for different types of soils. The effect on clayey soils by different pollutants are considered on

1. Index properties
2. Density parameter
3. Permeability
4. CBR Value
5. Free Swell Index

## IV . DATA COLLECTION

### MATERIAL PROPERTIES OF SOIL USED

The soil used for this investigation is obtained from near Changodar GIDC by doing trial pit up to 0.60 to 1.0m depth. The dried and pulverized material passing through I.S.4.75 mm sieve is taken for the study. The properties of the soil are given in Table.1. The soil is classified as "SC" as per I.S. Classification (IS 1498:1970) indicating that it is clayey sand. It is expansive in nature as the Differential Free Swell Index (DFSI) is about 55%

**Table:1 Properties of Natural soil**

| Sl.No. | Property | Value |
|---|---|---|
| 1. | Grain size distribution | |
| | (a)Gravel (%) | 3 |
| | (b)Sand (%) | 65 |
| | (c)Silt +Clay (%) | 32 |
| 2. | Atterberg Limits | |
| | (a)Liquid Limit (%) | 50 |
| | (b)Plastic Limit (%) | 29 |
| | (c)Plasticity Index (%) | 21 |
| 3. | Differential Free Swell Index (%) | 45 |

| | | |
|---|---|---|
| 4. | Swelling Pressure (kg/cm$^2$) | 0.11 |
| 5. | Specific Gravity | 2.67 |
| 6. | pH Value | 9.20 |
| 7. | Compaction characteristics | |
| | (a) Maximum Dry Unit Weight (g/cm$^3$) | 1.83 |
| | (b) Optimum Moisture Content(%) | 12.4 |
| 8. | California Bearing Ratio Value (%) at | |
| | (a)2.5mm Penetration | 7.98 |

**MATERIAL PROPERTIES OF WATER USED**

Construction chemical effluent is a colored liquid and soluble in water. The chemical properties of the effluent are shown in **Table. 2**

**Table. 2: Chemical Composition of Construction chemical Effluent**

| .No. | PARAMETER | VALUE |
|---|---|---|
| 1. | Color | Blackish Brown |
| 2. | pH | 3.15 |
| 3. | Suspended Solids | 250 mg/l |
| 4. | Chlorides | 200 mg/l |
| 5. | Sulphates | 52.8 mg/l |
| 6. | Total Hardness | 520 mg/l |
| 7. | TDS | 2230 mg/lit |
| 8. | Calcium | 180 mg/lit |
| 9. | Magnesium | 120 mg/lit |

**V. LABORATORY TEST RESULTS OF LIQUID LIMIT OF SOIL WITH ACIDIC WATER**

| Sr.no. | Description | Result of soil sample with distilled water | Result of soil sample with construction chemical effluent |
|---|---|---|---|
| 1 | Penetration Value (D) | 21 | 20.5 |
| 2 | Weight of wet soil in gm | 30.7 | 30.2 |
| 3 | Weight of dry soil in gm | 21.047 | 21.85 |
| 4 | Moisture Content (Wn) | 45.86 | 38.22 |
| 5 | Liquid limit (WL) = (Wn)/0.77 logD | 45.04 | 37.84 |

**VI. LABORATORY TEST RESULTS OF PLASTIC LIMIT AND PLASTICITY INDEX OF SOIL WITH ACIDIC WATER**

| Sr.no. | Description | Result of soil sample with distilled water | Result of soil sample with construction chemical effluent |
|---|---|---|---|
| 1 | Weight of Wet thread in gm | 7.668 | 7.433 |
| 2 | Weight of dry thread in gm | 6.156 | 6.049 |
| 3 | Moisture Content (Wp) | 24.56 | 22.88 |
| 4 | Plastic Limit (PL) = (Wp) | 24.56 | 22.88 |
| 5 | Plasticity Index (WL-Wp) | 20.48 | 14.96 |

**VII. LABORATORY TEST RESULTS OF FREE SWELL INDEX OF SOIL WITH ACIDIC WATER**

| Sr.no. | Description | Result of soil sample |
|---|---|---|
| 1 | Volume of Specimen in distilled water(Vo) | 15 |
| 2 | Volume of Speciment in Construction chemical effluent(Vc) | 13 |
| 4 | Volume of Specimen in Kerosene ( Vk) | 10 |
| 5 | Free Swell Index with distilled water (%) (Vo-Vk)/Vk*100 | 50 |
| 6 | Free Swell Index with distilled water (%) (Vc-Vk)/Vk*100 | 30 |

**VIII. LABORATORY TEST RESULTS OF PROCTOR DENSITY OF SOIL WITH ACIDIC WATER**

| Sr.no. | Description | Optimum Moisture content (%) | Maximum Dry Density in gm/cc |
|---|---|---|---|
| 1 | Soil with Distilled water | 12.2 | 1.85 |
| 2 | Soil with Construction chemical effluent | 8.5 | 1.93 |

**IX. LABORATORY TEST RESULTS OF CBR VALUE OF SOIL WITH ACIDIC WATER**

| Sr.no. | Description | CBR Value at 2.5mm Penetration at NMC | CBR Value at 2.5mm Penetration at SSD Condition |
|---|---|---|---|
| 1 | Soil with Distilled water | 7.1% | 6.4% |
| 2 | Soil with Construction chemical effluent | 8.5% | 7.5% |

## X.LABORATORY TEST RESULTS OF PERMEABILITY OF SOIL WITH ACIDIC WATER

| Sr.no. | Description | Permeability Co-efficient at MDD in cm/sec |
|---|---|---|
| 1 | Soil with Distilled water | $3.25*10^{-3}$ |
| 2 | Soil with Construction chemical effluent | $4.01*10^{-4}$ |

## XI. CONCLUSION

- The index property of soil is found higher with acidic water than the distilled water.
- The free swell index of soil is found higher with acidic water than the distilled water.
- The proctor density is found higher with acidic water than the distilled water and optimum moisture content is found lesser with acidic water than the distilled water.
- The CBR value of soil is found higher with acidic water than the distilled water.
- The permeability of soil is increase with acidic water than the distilled water.

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