# Improvement of Properties of Highly Swelling Soil by using Waste Paper Sludge

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***Abstract*- The highly swelling soil causes major effect to structures. Due to presence of Montmorillonite mineral soil has high swelling property. Before construction we need to reduce this swelling and shrinkage property of the soil. The main objective of our study is Stabilization of high swelling soil by using of waste paper sludge to reduce high swell at low cost and an eco-friendly method. The proctor tests results indicates that with the increase in waste paper sludge percentage there was an increase in the Optimum Moisture Content (OMC) and reduction in the Maximum Dry Density (MDD). At optimum value 14% we got good results Swelling also reduced.**

***Key Words:* Waste paper sludge, high swelling soil, swelling properties, Index and Engineering properties.**

## I. INTRODUCTION

Soil stabilization refers to the process of changing soil properties to improve strength and durability. There are many techniques for soil stabilization, including compaction, dewatering and by adding material to the soil. This summary will focus on mechanical and chemical stabilization based on Indian standard recommendations. Mechanical stabilization improves soil properties by mixing other soil materials with the target soil to change the gradation and therefore change the engineering properties. It also reduced the index properties. Chemical stabilization used the addition of other by-product materials to improve the soil properties. There a number of industrial waste materials that can be used individually, or mixed with other materials, to achieve soil stabilization. In present study adding waste paper sludge to soil at different percentages 2%

## II. OBJECTIVES

The main objective of the project is to improve strength of soil and decrease the swelling property by using waste paper sludge as an admixture and to decrease the cost of construction.

a) Since, waste paper sludge is a major environmental problem; by using it wastage can be decreased.

## III. EXPERIMENTAL PROGRAM

a) Collection of materials.
b) Determine index and engineering properties of soil.
c) Determine improved properties of soil when the waste paper sludge is added.

## IV. RESULTS

Table 1- Index and Engineering Properties of Untreated Soil

| S. No | Property | Value |
|---|---|---|
| 1 | Grain Size Analysis:<br>-Sand<br>-Clay<br>-Silt | <br>1.85%<br>69.75%<br>28.4% |
| 2 | Specific Gravity | 2.7 |
| 3 | Atterberg Limits:<br>-Liquid limit<br>-Plastic limit<br>-Plasticity index | <br>71.52%<br>28.48%<br>43.52% |
| 4 | Differential Free Swell | 70% |
| 5 | Shear Strength Parameters:<br>-Cohesion<br>-Friction | <br>84 KN/sq.m<br>3 degrees |
| 6 | IS Classification | CH |
| 7 | Compaction Characteristics:<br>-Optimum moisture content<br>-Maximum dry density | <br>18%<br>1.73 gm/cc |
| 8 | Unconfined Compression Test | 100 Kg/ sq.m |

Waste Paper Sludge- Waste paper sludge is the product that is formed during the recycling of paper by removing pins, sands and by delinking the paper. It contains kaolinite which on heating at high temperature becomes metakaoline. This metakaolinite helps to reduce swell as much as possible and increases the soil properties.

Figure-1 Waste Paper Sludge Dry State

The by-product, waste paper sludge is added at different percentages to the soil.

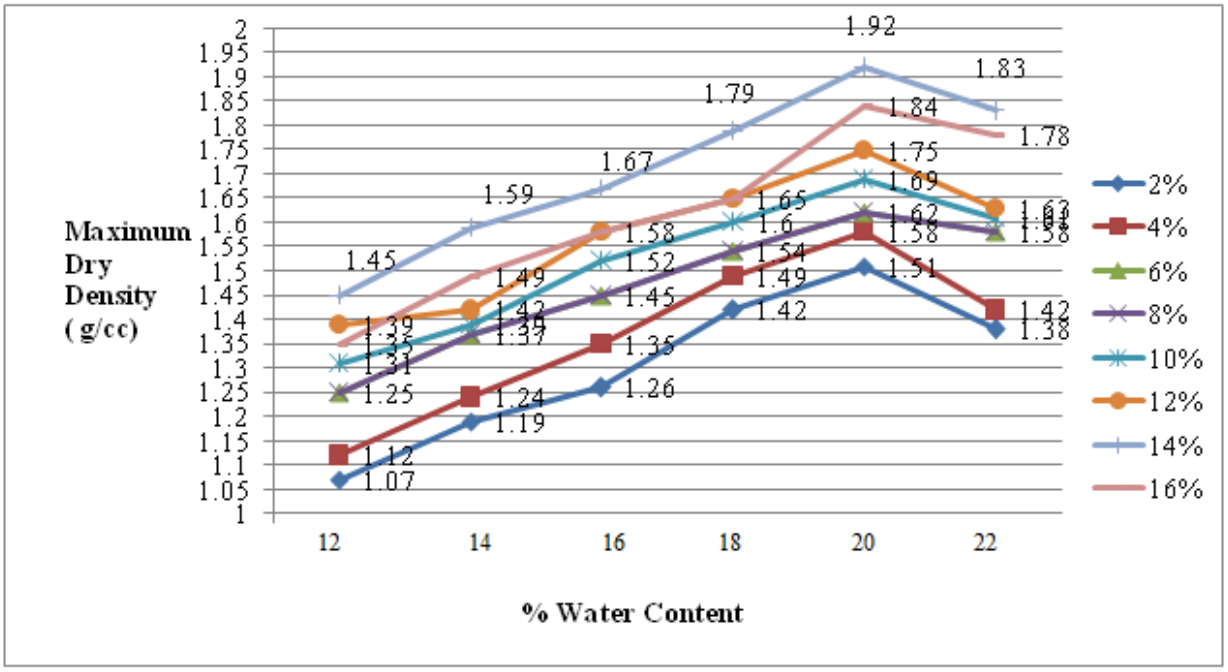


Figure 2- The Maximum Dry Density of the Soil When Treated With Waste Paper Sludge

| S. No | Property | 2% | 4% | 6% | 8% | 10% | 12% | 14 |
|---|---|---|---|---|---|---|---|---|
| 1 | Liquid Limit (%) | 69.52 | 66.45 | 62.15 | 56.21 | 49.05 | 43.46 | 34.3 |
| 2 | Plastic Limit (%) | 27.91 | 27.05 | 26.75 | 25.57 | 24.29 | 23.31 | 22.48 |
| 3 | Plasticity Index (%) | 41.61 | 39.40 | 35.40 | 30.64 | 24.76 | 20.15 | 11.82 |
| 4 | Free Swell Index (%) | 68 | 55 | 43 | 31 | 25 | 17 | 6 |

Table 2- Index Properties of Soil Treated With Waste Paper Sludge at Different Percentage

Table 3- Properties of the Soil after Treating With Waste Paper Sludge

| S. No | Property | Value |
|---|---|---|
| 1 | Grain Size Analysis:<br>-Sand<br>-Clay<br>-Silt | <br>1.85%<br>76.95%<br>21.2% |
| 2 | Specific Gravity | 2.65 |
| 3 | Atterberg Limits:<br>-Liquid limit<br>-Plastic limit<br>-Plasticity index | <br>34.3%<br>22.48%<br>11.82% |
| 4 | Differential Free Swell | 6% |
| 5 | Shear Strength Parameters:<br>-Cohesion | <br>80 KN/sq. m |

| | | |
|---|---|---|
| | -Friction | 4 degrees |
| 6 | Compaction Characteristics:<br>-Optimum moisture content<br>-Maximum dry density | <br>21.8%<br>1.92 g/cc |
| 7 | Unconfined Compression Test | 170 kg/sq. m |

## V. CONCLUSION

The properties of the black cotton soil have improved by the addition of Waste Paper Sludge at optimum percentage of 14% Waste Paper Sludge is low cost material compared to other additives. So in economic point of view it is better to stabilize large area.

Liquid Limit has been reduced to 34.3% when treated with Waste Paper Sludge compared with untreated soil. Plastic Limit has been reduced to 22.48% when treated with Waste Paper Sludge compared with untreated soil.

Plasticity index has been reduced to 11.82% when treated with Waste Paper Sludge with untreated soil.

Differential swelling index has been reduced to 6% when treated with Waste Paper Sludge compared with untreated soil.

The dry density has been increased to 1.92 g/cc when treated with Waste Paper Sludge.

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