# COMPACTION CHARACTERISTICS OF STABILIZED SOIL WITH CONSTRUCTION WASTE AND COMBUSTION OF SAWDUST

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## ABSTRACT

*Soil modification is the addition an some waste materials like saw dust ash and construction waste to soil to change its index properties, while soil stabilization is the treatment of soils to enable their density and strength to be improved such that they become totally suitable for construction beyond their original classification. The physical additives such as construction waste and saw dust ash can be mixed with the soil to improve the texture, increasing strength characteristics. The aim of this study is to investigate and to show the potential use of construction waste and saw dust ash as an additive to stabilize a clay soil. This is an experimental studies to determine the concentration of construction waste and sawdust ash as an additive, the development of compressive strength. A laboratory was conducted on soil sample of clay soil stabilized using construction waste and saw dust ash. This paper focuses on the development of compressive strength of clay soil stabilized with construction waste and saw dust at varying percentages such as (5,10,15,20) and (1,1.5,2,2.5,5,10) respectively.The result shows that construction waste and sawdust ash is a waste material. Construction waste is taken from chepauk and sawdust is taken from Neelangarai.It can be used as additives to clay soil and increasing the engineering properties of the soil.*

*Keywords: construction waste,combustion of sawdust,stabilized,compressive strength,density,index properties.*

## INTRODUCTION

Soil modification is the addition of some waste materials like saw dust ash and construction waste to soil to change its index properties, while soil stabilization is the treatment of soils to enable their density and strength to be improved such that they become totally suitable for construction beyond their original classification. The physical additives such as construction waste and saw dust ash can be mixed with the soil to improve the texture, increasing strength characteristics. The aim of this study is to investigate and to show the potential use of construction waste and saw dust ash as an additive to stabilize a clay soil. This is an experimental studies to determine the concentration of construction waste and sawdust ash as an additive, the development of compressive strength. A laboratory was conducted on soil sample of clay soil stabilized using construction waste and saw dust ash. This paper focuses on the development of compressive strength of clay soil stabilized with construction waste and saw dust at varying percentages such as (5,10,15,20) and (1,1.5,2,2.5,5,10) respectively. The result shows that construction waste and sawdust ash is a waste material. Construction waste is taken from chepauk and sawdust is taken from Neelangarai.It can be used as additives to clay soil and increasing the engineering properties of the soil.

## MATERIALS USED

### CONSTRUCTION WASTE

**Construction waste** consists of unwanted material produced directly or incidentally by the **construction** or industries. This includes building materials such as insulation, nails, electrical wiring, and rebar, as well as **waste** originating from site preparation such as dredging materials, tree stumps, and rubble.

### COMBUSTION OF SAWDUST

It is waste from wood.It is a powdery particle.we are converted into ash.

## EXPERIMENTAL WORK:

### 1.INDEX PROPERTIES

Index properties are the properties of soil that help in identification and classification of soil. Water content, Specific gravity, Particle size distribution, In situ density (Bulk Unit weight of soil), Consistency Limits and relative density are the index properties of soil.

**a).SPECIFIC GRAVITY(IS 2720 (PART -3) 1980)**

The specific gravity is the ratio between the density of an soil and a water.

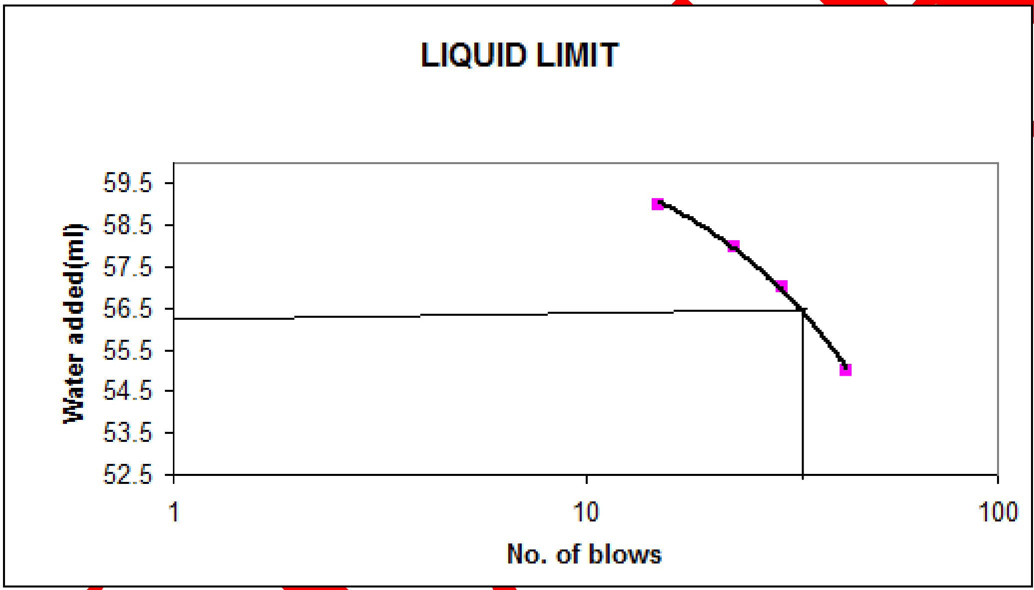
**G =2.85**

**b).ATTERBERG LIMITS**

The Atterberg limits are a basic measure of the critical water contents of a fine-grained soil, such as its shrinkage limit, plastic limit, and liquid limit.

**i)LIQUID LIMIT(IS 2720 (PART -5) 1985)**

The water content at which soil passes from the plastic to the liquid state standard test conditions. The limit is expressed as a percentage of the dry weight of the soil.




**Figure**

**Liquid limit =56.4%**

**ii).PLASTIC LIMIT(IS 2720 (PART -5) 1985)**

Plastic limit is the constant defined as the lowest moisture content and expressed as a percentage of the weight of the oven dried soil at which the soil can be rolled into threads one-eighth inch in diameter without the soil breaking into pieces, also the moisture content of a solid at which a soil changes from a plastic state to a semi solid state.

**Plastic limit = 20%**

**c)Particle sieve distribution(IS 2720 (PART -4) 1985)**

**i)DRY SIEVE ANALYSIS**

Soil at any place is composed of particles of a variety of sizes and shapes, sizes ranging from a microns to a few centimeters are present sometimes in the same soil sample. The distribution of particles of different size determines many physical properties of the soil such as its strength, permeability, density, etc…

| APERTURE SIZE OF SIEVE IN mm | WEIGHT OF SOIL RETAINED (gm) | CUMMULATIVE RETAINED % | WEIGHT % RETAINED | % FINER |
|---|---|---|---|---|
| 4.75 | 38 | 3.8 | 3.8 | 96.2 |
| 2.36 | 12 | 5 | 1.2 | 95 |
| 1.18 | 22 | 7.2 | 2.2 | 92.8 |
| 0.600 | 43 | 11.5 | 4.3 | 88.5 |
| 0.425 | 47 | 16.2 | 4.7 | 83.8 |
| 0.300 | 35 | 19.7 | 3.5 | 80.3 |
| 0.150 | 49 | 24.6 | 4.9 | 75.4 |
| 0.09 | 21 | 26.7 | 2.1 | 73.3 |
| 0.075 | 18 | 28.5 | 1.8 | 71.5 |

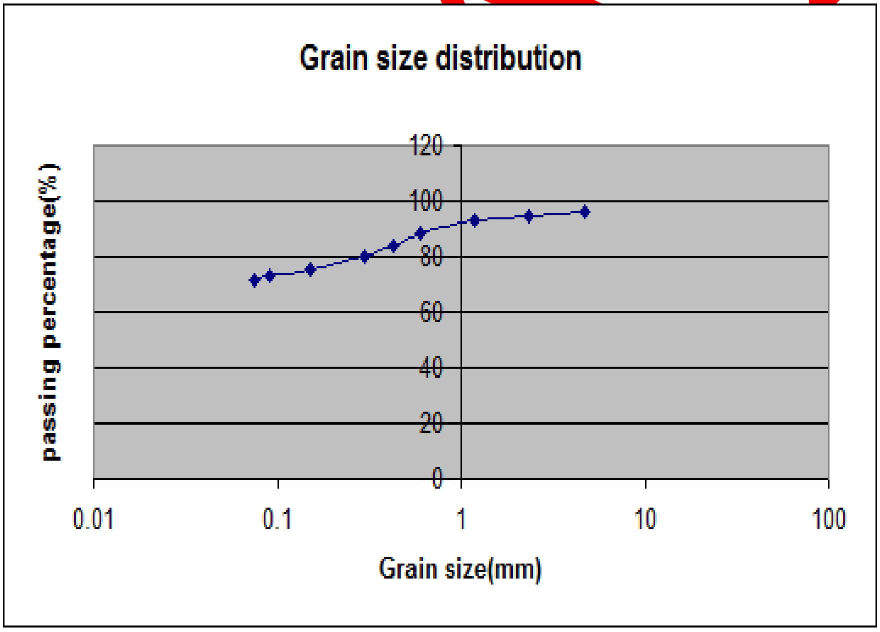



**Figure 2**

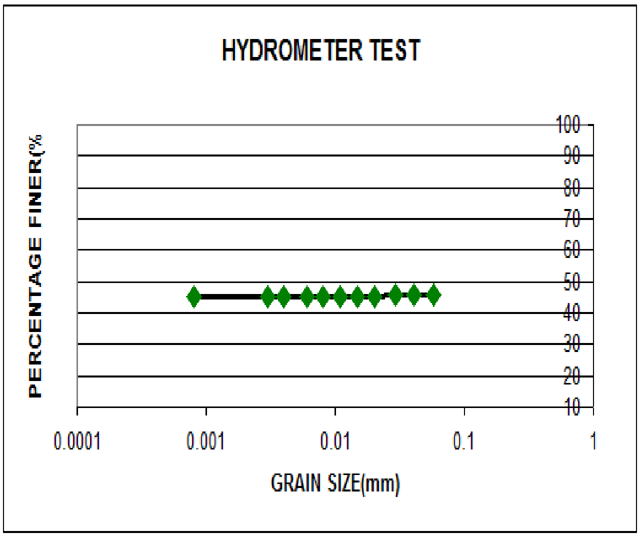
**ii)HYDROMETER TEST**

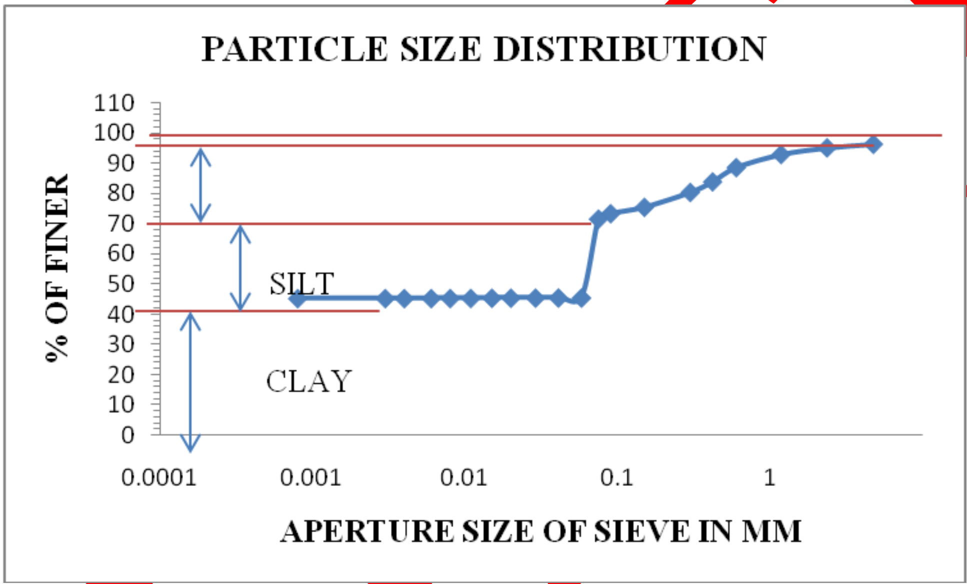
A **hydrometer** is an instrument that measures the gravity of liquids—the ratio of the density of the liquid to the density of water.

A hydrometer is usually made of glass, and consists of a cylindrical stem and a bulb weighted with mercury or lead shot to make it float upright. The liquid to test is poured into a tall container, often a graduated cylinder, and the hydrometer is gently lowered into the liquid until it floats freely. The point at which the surface of the liquid touches the stem of the hydrometer correlates to specific gravity. Hydrometers usually contain a scale inside the stem, so that the person using it can read specific gravity. A variety of scales exist for different contexts.

Hydrometers are calibrated for different uses, such as a lactometer for measuring the density (creaminess) of milk, a saccharometer for measuring the density of sugar in a liquid, or an alcoholometer for measuring higher levels of alcohol in spirits

| TIME (mins) | HYDROMETER READING (cm) | EFFECTIVE DEPTH(cm) | GRAIN SIZE(mm) | $N^1$ | N |
|---|---|---|---|---|---|
| 0 | 37 | 5.7 | | 3.195 | 45.56 |
| 0.25 | 36 | 5.9 | 0.058 | 3.192 | 45.51 |
| 0.5 | 36 | 5.9 | 0.041 | 3.192 | 45.51 |
| 1 | 35.5 | 6 | 0.029 | 3.190 | 45.48 |
| 2 | 35 | 6.5 | 0.020 | 3.188 | 45.46 |
| 4 | 34.5 | 6.7 | 0.015 | 3.187 | 45.44 |
| 8 | 33 | 7 | 0.0109 | 3.182 | 45.37 |
| 15 | 32.5 | 7.5 | 0.008 | 3.181 | 45.36 |
| 30 | 31.5 | 7.5 | 0.006 | 3.178 | 45.31 |
| 60 | 31.5 | 7.5 | 0.004 | 3.178 | 45.31 |
| 120 | 31.5 | 7.5 | 0.003 | 3.178 | 45.31 |
| 1440 | 31.5 | 7.5 | 0.0008 | 3.178 | 45.31 |



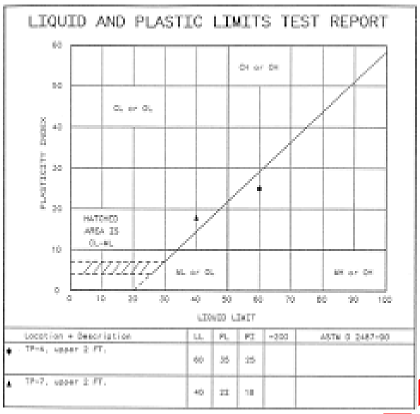

**CLASSIFICATION OF SOIL**

GRAVEL-3.81%

SAND-23.97%

SILT-26.91%

CLAY-45.31%




The soil passes through 75micron is 72.22%.It is greater than 70%. The soil is fine grained soil.
The liquid limit is 56.4% and the plasticity index is 36.6%.from the chart the soil is CH Type.
(CH=Inorganic clay of high plasticity)

## 2.ENGINEERING PROPERTIES

Engineering properties of soil comprises of physical properties index properties strength parameters , permeability characterizes consolidation properties modulus parameters, dynamic behavior etc. while index properties particle size gradation, consistency limits are just part of them.

### i)STANDARD PROCTOR TEST(IS 2720 (PART -7) 1980)

The Proctor compaction test is a laboratory method of experimentally determining the optimal moisture content at which a given soil type will become most dense and achieve its maximum dry density.

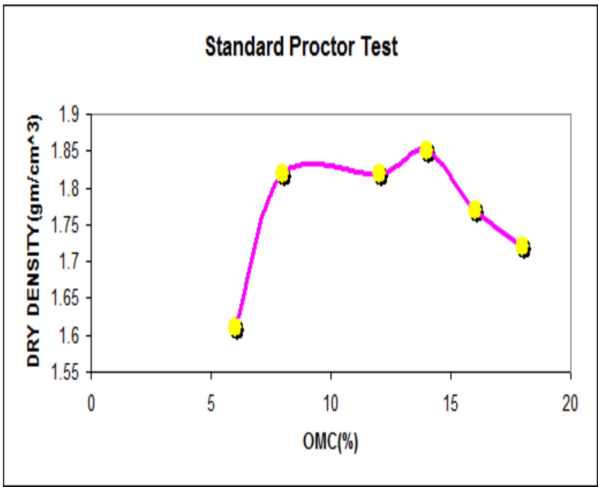
## CALCULATION:

Dia of the mould, d =10cm

Volume of the mould, v =942.47$cm^3$

Height of the mould, h =12cm
Weight of the mould without collar,$w_1$ =4035g
Initial moisture content, w =0
**3000g soil**

| Weight of the mould without collar , $w_1$ | Weight of the mould with soil without collar, $w_2$ | Water added (%) | Weight of the soil, $w_3 = w_2 - w_1$ | Wet density , $\gamma = w_3/v$ | Dry density $\gamma_d$ / (1+w) | ρ | $\rho_d$ |
|---|---|---|---|---|---|---|---|
| 4069 | 5654 | 6 | 1619 | 1.71 | 1.61 | 16.77 | 15.79 |
| 4069 | 5893 | 8 | 1858 | 1.97 | 1.82 | 19.32 | 17.85 |
| 4069 | 5958 | 12 | 1923 | 2.04 | 1.82 | 20.01 | 17.85 |
| 4069 | 6037 | 14 | 2002 | 2.12 | 1.85 | 20.79 | 18.14 |
| 4069 | 5984 | 16 | 1949 | 2.06 | 1.77 | 20.20 | 17.36 |
| 4069 | 5950 | 18 | 1915 | 2.03 | 1.72 | 19.91 | 16.87 |




**5% construction waste**

| Weight of the mould without collar , $w_1$ | Weight of the mould with soil without collar, $w_2$ | Water added (%) | Weight of the soil, $w_3 = w_2 - w_1$ | Wet density , $\gamma = w_3/v$ | Dry density = $\gamma_d$ / (1+w) | ρ | $\rho_d$ |
|---|---|---|---|---|---|---|---|
| 4069 | 5709 | 4 | 1674 | 1.74 | 1.67 | 17.06 | 16.38 |
| 4069 | 5781 | 6 | 1746 | 1.85 | 1.74 | 18.14 | 17.06 |
| 4069 | 5892 | 8 | 1857 | 1.97 | 1.82 | 19.32 | 17.85 |
| 4069 | 6005 | 10 | 1970 | 2.09 | 1.9 | 20.50 | 18.63 |
| 4069 | 6037 | 12 | 2002 | 2.12 | 1.89 | 20.79 | 18.54 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4069 | 6017 | 14 | 1982 | 2.10 | 1.84 | 20.60 | 18.05 |
| 4069 | 5953 | 16 | 1918 | 2.03 | 1.75 | 19.91 | 17.16 |

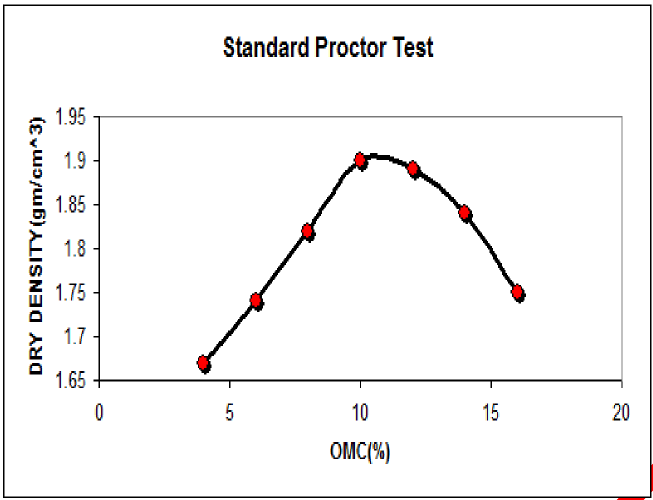



**Figure 6**

**10% construction waste**

| Weight of the mould without collar , $w_1$ | Weight of the mould with soil without collar, $w_2$ | Water added (%) | Weight of the soil, $w_3 = w_2 - w_1$ | Wet density , $\gamma = w_3/v$ | Dry density = $\gamma_d$ / (1+w) | ρ | $\rho_d$ |
|---|---|---|---|---|---|---|---|
| 4069 | 5629 | 4 | 1594 | 1.69 | 1.62 | 16.57 | 15.89 |
| 4069 | 5774 | 6 | 1739 | 1.84 | 1.73 | 18.05 | 16.97 |
| 4069 | 5945 | 8 | 1910 | 2.02 | 1.87 | 19.81 | 18.34 |
| 4069 | 6030 | 10 | 1995 | 2.11 | 1.91 | 20.69 | 18.73 |
| 4069 | 6129 | 12 | 2094 | 2.22 | 1.98 | 21.77 | 19.42 |
| 4069 | 6035 | 14 | 2000 | 2.12 | 1.85 | 20.79 | 18.14 |
| 4069 | 6001 | 16 | 1966 | 2.08 | 1.79 | 20.40 | 17.55 |
| 4069 | 5966 | 18 | 1931 | 2.04 | 1.72 | 20.01 | 16.87 |

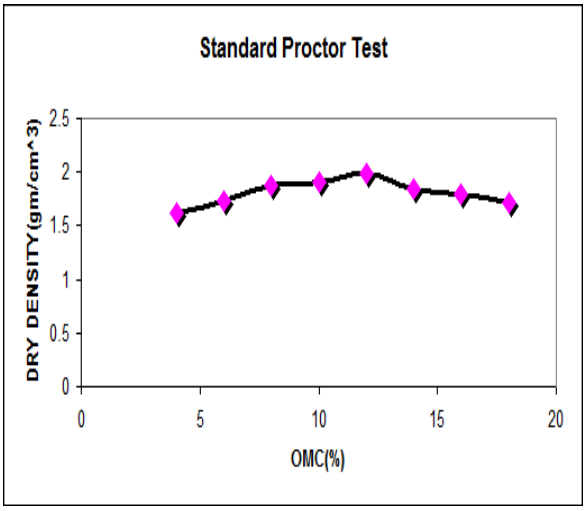
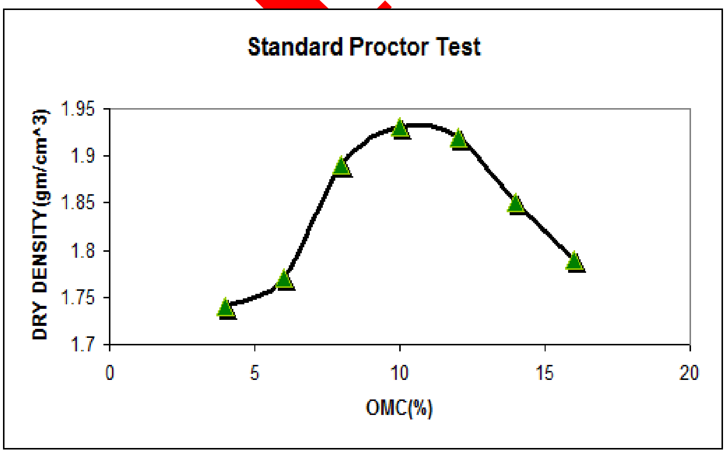



**Figure 7**

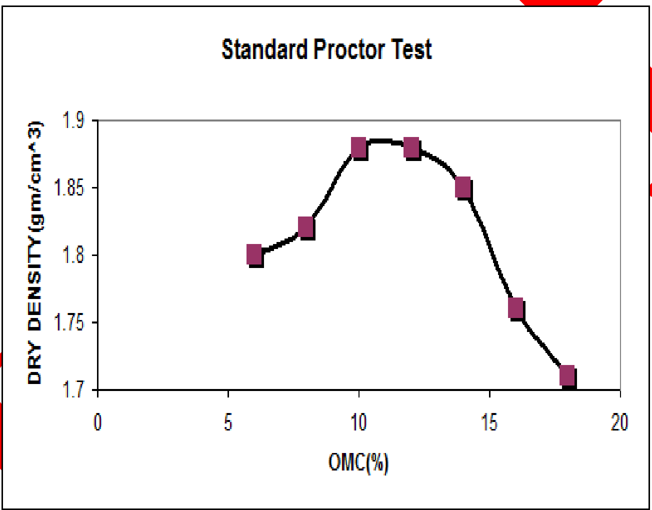
**15% construction waste**

| Weight of the mould without collar , $w_1$ | Weight of the mould with soil without collar, $w_2$ | Water added (%) | Weight of the soil, $w_3 = w_2 - w_1$ | Wet density , $\gamma = w_3/v$ | Dry density = $\gamma_d / (1+w)$ | ρ | $\rho_d$ |
|---|---|---|---|---|---|---|---|
| 4069 | 5737 | 4 | 1711 | 1.81 | 1.74 | 17.75 | 17.06 |
| 4069 | 5807 | 6 | 1781 | 1.88 | 1.77 | 18.44 | 17.36 |
| 4069 | 5964 | 8 | 1938 | 2.05 | 1.89 | 20.11 | 18.54 |
| 4069 | 6042 | 10 | 2016 | 2.13 | 1.93 | 20.89 | 18.93 |
| 4069 | 6065 | 12 | 2039 | 2.16 | 1.92 | 21.18 | 18.83 |
| 4069 | 6024 | 14 | 1998 | 2.11 | 1.85 | 20.69 | 18.14 |
| 4069 | 5990 | 16 | 1964 | 2.08 | 1.79 | 20.40 | 17.55 |



**20% construction waste**

| Weight of the mould without collar , $w_1$ | Weight of the mould with soil without collar, $w_2$ | Water added (%) | Weight of the soil, $w_3 = w_2 - w_1$ | Wet density , $\gamma = w_3/v$ | Dry density = $\gamma_d$ / (1+w) | ρ | $\rho_d$ |
|---|---|---|---|---|---|---|---|
| 4069 | 5830 | 6 | 1804 | 1.91 | 1.8 | 18.73 | 17.65 |
| 4069 | 5885 | 8 | 1859 | 1.97 | 1.82 | 19.32 | 17.85 |
| 4069 | 5977 | 10 | 1951 | 2.07 | 1.88 | 20.30 | 18.44 |
| 4069 | 6021 | 12 | 1995 | 2.11 | 1.88 | 20.69 | 18.44 |
| 4069 | 6025 | 14 | 1999 | 2.12 | 1.85 | 20.79 | 18.14 |
| 4069 | 5961 | 16 | 1935 | 2.05 | 1.76 | 20.11 | 17.26 |
| 4069 | 5938 | 18 | 1912 | 2.02 | 1.71 | 19.81 | 16.77 |




**1% of s.w**

| Weight of the mould without collar , $w_1$ | Weight of the mould with soil without collar, $w_2$ | Water added (%) | Weight of the soil, $w_3 = w_2 - w_1$ | Wet density , $\gamma = w_3/v$ | Dry density = $\gamma_d$ / (1+w) | ρ | $\rho_d$ |
|---|---|---|---|---|---|---|---|
| 4069 | 5426 | 6 | 1357 | 1.43 | 1.35 | 14.11 | 14.02 |
| 4069 | 5455 | 8 | 1386 | 1.47 | 1.36 | 14.42 | 13.34 |
| 4069 | 5486 | 10 | 1417 | 1.50 | 1.36 | 14.74 | 13.34 |
| 4069 | 5408 | 12 | 1439 | 1.52 | 1.36 | 14.97 | 13.34 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4069 | 5471 | 14 | 1402 | 1.48 | 1.30 | 14.58 | 12.75 |
| 4069 | 5459 | 16 | 1390 | 1.47 | 1.27 | 14.45 | 12.45 |

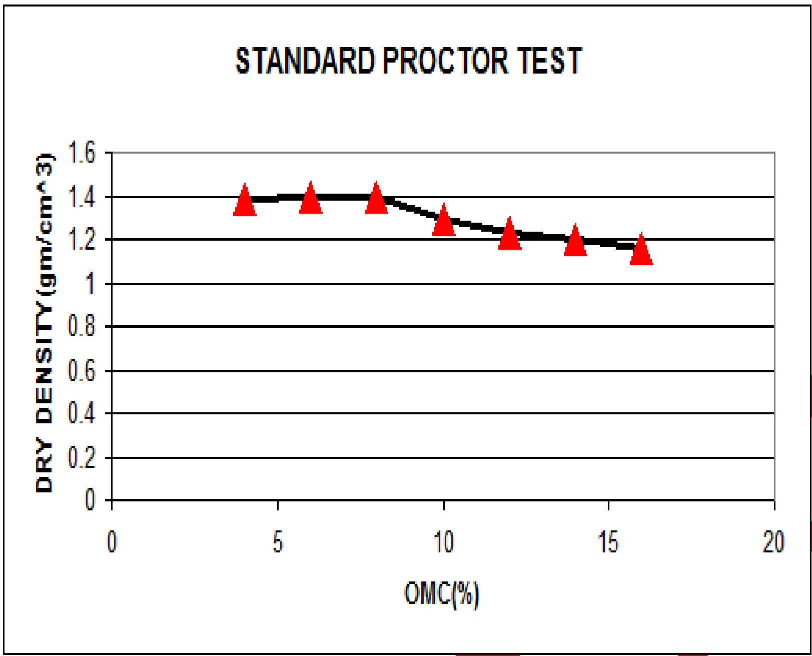



**Figure 10**

**1.5% of s.w**

| Weight of the mould without collar , $w_1$ | Weight of the mould with soil without collar, $w_2$ | Water added (%) | Weight of the soil, $w_3 = w_2 - w_1$ | Wet density , $\gamma = w_3/v$ | Dry density = $\gamma_d$ / (1+w) | ρ | $\rho_d$ |
|---|---|---|---|---|---|---|---|
| 4069 | 5624 | 4 | 1555 | 1.61 | 1.61 | 16.48 | 15.79 |
| 4069 | 5648 | 6 | 1579 | 1.71 | 1.61 | 16.77 | 15.79 |
| 4069 | 5525 | 8 | 1456 | 1.58 | 1.46 | 15.49 | 14.32 |
| 4069 | 5503 | 10 | 1434 | 1.55 | 1.40 | 13.73 | 13.73 |
| 4069 | 5480 | 12 | 1411 | 1.53 | 1.36 | 13.34 | 13.34 |
| 4069 | 5472 | 14 | 1403 | 1.52 | 1.33 | 13.04 | 13.04 |
| 4069 | 5450 | 16 | 1381 | 1.50 | 1.29 | 12.06 | 12.65 |

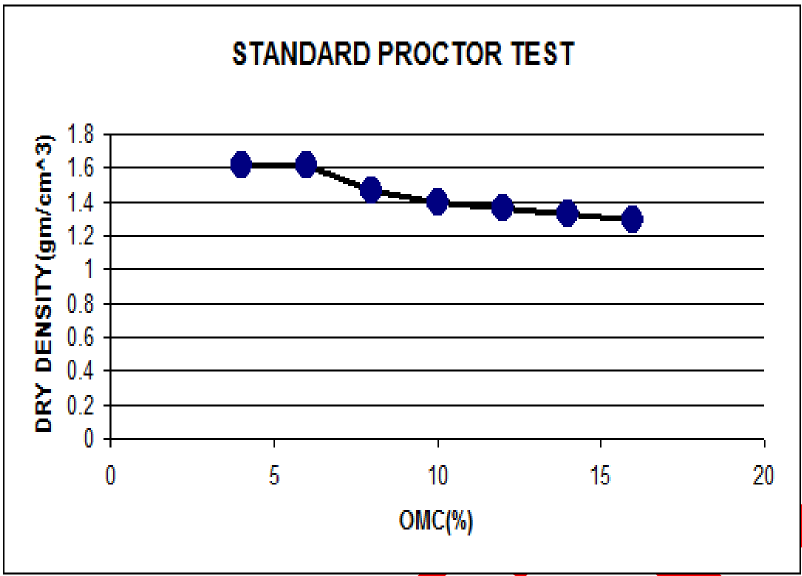



**Figure 11**

**2% of s.w**

| Weight of the mould without collar , $w_1$ | Weight of the mould with soil without collar, $w_2$ | Water added (%) | Weight of the soil, $w_3 = w_2 - w_1$ | Wet density , $\gamma = w_3/v$ | Dry density = $\gamma_d$ / (1+w) | ρ | $\rho_d$ |
|---|---|---|---|---|---|---|---|
| 4069 | 5458 | 4 | 1389 | 1.50 | 1.44 | 14.71 | 14.12 |
| 4069 | 5573 | 6 | 1504 | 1.63 | 1.53 | 15.99 | 15 |
| 4069 | 5543 | 8 | 1474 | 1.60 | 1.48 | 15.69 | 14.51 |
| 4069 | 5509 | 10 | 1440 | 1.56 | 1.44 | 15.30 | 14.12 |
| 4069 | 5487 | 12 | 1418 | 1.54 | 1.37 | 15.10 | 13.43 |
| 4069 | 5459 | 14 | 1390 | 1.51 | 1.32 | 14.81 | 12.94 |
| 4069 | 5428 | 16 | 1359 | 1.47 | 1.26 | 14.42 | 12.36 |

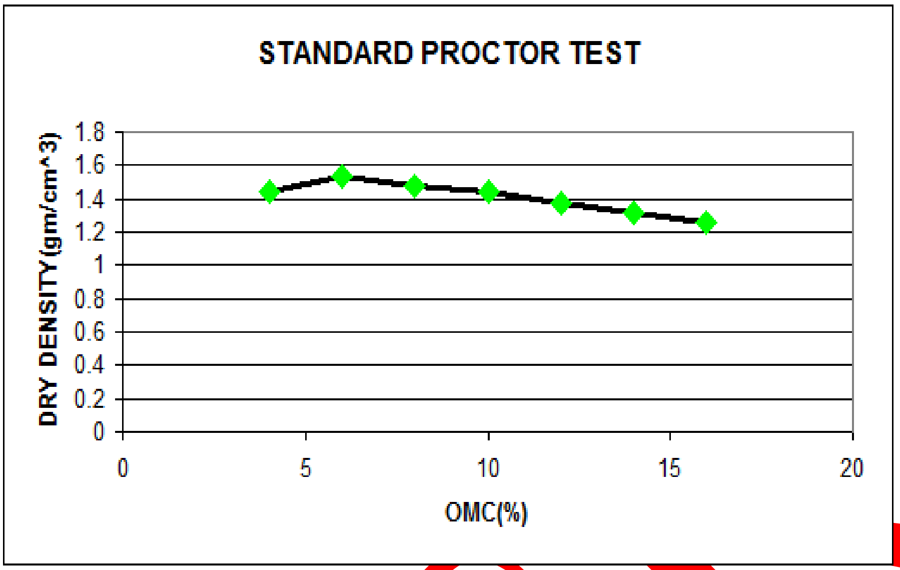



Figure 12

**2.5% sawdust ash**

| Weight of the mould without collar , $w_1$ | Weight of the mould with soil without collar, $w_2$ | Water added (%) | Weight of the soil, $w_3 = w_2 - w_1$ | Wet density , $\gamma = w_3/v$ | Dry density = $\gamma_d$ / (1+w) | ρ | $\rho_d$ |
|---|---|---|---|---|---|---|---|
| 4069 | 5716 | 6 | 1681 | 1.78 | 1.67 | 17.46 | 16.38 |
| 4069 | 5863 | 8 | 1828 | 1.93 | 1.78 | 18.93 | 17.46 |
| 4069 | 5961 | 10 | 1926 | 2.04 | 1.85 | 20.01 | 18.14 |
| 4069 | 5949 | 12 | 1914 | 2.03 | 1.81 | 19.71 | 17.75 |
| 4069 | 5930 | 14 | 1895 | 2.01 | 1.76 | 19.71 | 17.26 |

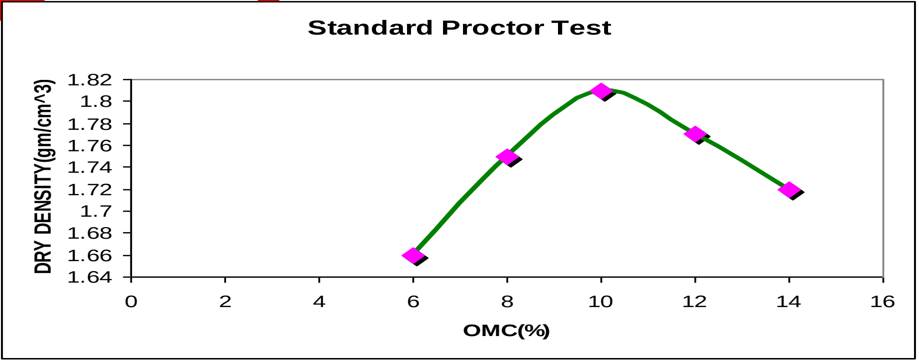



Figure 13

**5% saw dust ash**

| Weight of the mould without collar , $w_1$ | Weight of the mould with soil without collar, $w_2$ | Water added (%) | Weight of the soil, $w_3 = w_2 - w_1$ | Wet density , $\gamma = w_3/v$ | Dry density = $\gamma_d$ / (1+w) | ρ | $\rho_d$ |
|---|---|---|---|---|---|---|---|
| 4069 | 5478 | 6 | 1443 | 1.53 | 1.44 | 15.00 | 14.12 |
| 4069 | 5504 | 8 | 1469 | 1.55 | 1.43 | 15.20 | 14.02 |
| 4069 | 5484 | 10 | 1449 | 1.53 | 1.39 | 15.00 | 13.63 |
| 4069 | 5475 | 12 | 1440 | 1.52 | 1.35 | 14.91 | 13.24 |
| 4069 | 5430 | 14 | 1395 | 1.48 | 1.29 | 14.51 | 12.65 |

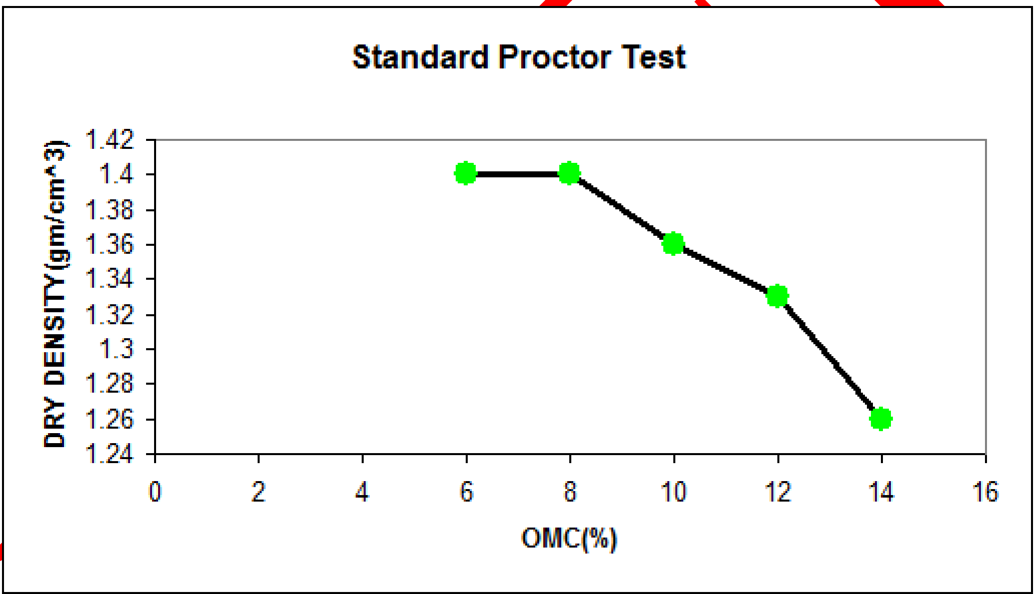



**Figure 14**

## RESULT AND DISSCUSSION:

FOR CONSTRUCTION WASTE:

| CONTENT | OMC | MDD |
|---|---|---|
| SOIL | 14% | 18.15 |
| 5% OF C.W | 10% | 18.63 |
| 10% OF C.W | 12% | 19.42 |
| 15% OF C.W | 12% | 18.93 |

| | | |
|---|---|---|
| 20% OF C.W | 12% | 18.44 |

FOR COMBUSTION OF SAWDUST:

| CONTENT | OMC | MDD |
|---|---|---|
| 1% OF S.W | 8% | 12.75 |
| 1.5% OF S.W | 6% | 15.79 |
| 2% OF S.W | 6% | 15 |
| 2.5% OF S.W | 8% | 14.39 |
| 5% OF S.W | 8% | 13.63 |

## CONCLUSION:

An experimental investigation was carried out to study the improvement in geotechnical properties of soil stabilized with construction waste and combustion of sawdust.

The Maximum dry density increased up to replacement of 10% of construction waste and 1.5% of combustion of sawdust and decreased further. The soil mixed with construction waste resulted in higher maximum dry density values compared to soil mixed with Combustion of sawdust. The results show that soil replaced with construction waste is exhibiting greater optimum moisture content than the soil replaced with Combustion of sawdust.

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