IJASRM
International Journal of Advanced Scientific Research and Management, Volume 3 Issue 12, Dec 2018
www.ijasrm.com
ISSN 2455-6378

# Effect of Sodium hydroxide treated polypropylene fiber on stabilisation of soil

**Dheeraj Kumar[1], A. K. Singh[2], M. K. Mishra[3] and J. P. Singh[4]**

[1] Research Scholar, Department of Civil Engineering, BIT Sindri, Dhanbad, India

[2]Associate Professor, Department of Civil Engineering, BIT Sindri, Dhanbad, India

[3]Assistant Professor, Department of Chemistry, BIT Sindri, Dhanbad, India

[4]Associate Professor, Department of Civil Engineering, BIT Sindri, Dhanbad, India

**Abstract**

Strength properties of soil can be improved by the process of soil stabilisation with the use of adding some materials like Lime, NaOH, polypropylene, GGBFS, Ferro-chrome slag etc. There is a rapid increase in waste quantity of plastic fiber materials, these waste plastic fiber materials are generally dumped or thrown, which may deteriorate the ecology and environment, because these are non-biodegradable fiber materials. Among these, one of the waste fiber materials is polypropylene fiber materials. In this present work polypropylene fiber has been used as ingredients to increase the properties of natural soil. The soil has been replaced by the polypropylene fiber in certain percentages and tests have been performed. The soil was replaced with varying proportions of polypropylene fiber to find out the optimum quantity of polypropylene fiber. From the experimental results, it has been found that various properties of the soil replaced with 1.0% of polypropylene fiber by weight of soil gives optimum results. The value of Soaked CBR increases from 1.92 to 3.45 corresponding to 1% of PP fiber. And value of Unsoaked CBR increases from 4.09 to 6.42 at 1% of PP fiber, which make clear that we can reduce the thickness of pavement for pavement design, which reduces the cost of construction in highway and railway and therefore for stability of slope we can increases the slope of the pavement.

***Keywords:*** *polypropylene fiber, soil, sodium hydroxide, Unsoaked CBR, soaked CBR .*

## 1. Introduction

Soil is extremely complex, heterogeneous substance which has been subjected to varieties of nature. Properties of soil do not change only with location to location but also with respect to depth, climate and drainage condition of soil [1]. Pavement design and foundation are very important part of any civil engineering construction work. Load of any structure, vehicle is ultimately taken by soil stratum; hence it is very necessary to prepare a sufficient strong base for any structure. In India, a major portion of total land area is covered by clayey soil. Of this, a large proportion is expansive soil. These soils contain minerals such as montmorillonite that are capable of absorbing water. When they absorb water, their volume increases. Structures such as spread footings, highways, railways, airport runways and earth dams etc. constructed over this expansive soil may be severely damaged due to its high swell-shrinkage behaviour. So such soils need to be stabilised to increase its strength, durability and to prevent erosion. Various studies have been carried out on expansive soils to improve its properties [2]. In the ancient time, some natural materials including wood, bamboo, reeds, wheat straw, and rice straw were used to improve the strength of soil. With the advent of synthetic fibers and its rapid development, plenty of synthetic fibers have been employed in many fields as innovative engineering materials, as well as main reinforcement agents for ground improvement, When some fibers geotextile of high

tensile strength is laid in soil, the engineering properties of soil are improved, There is a rapid increase in waste quantity of plastic fibres, These waste plastic fibers are generally dumped or thrown, which may deteriorate the ecology and environment because these are non-biodegradable fiber materials. Among these, one of the waste fiber materials is Polypropylene fiber material which has been used as ingredients for ground improvement. From previous research work it is found that PP fiber does not influence the OMC but decreases the MDD [1],[3],[6],and according to [4],[5] MDD first increases slightly with PP fiber and then decreases. because the reduction of average unit weight of PP fiber in the soil-fiber mixture. and polypropylene fiber increases the unconfined compressive strength indicates that Polypropylene fibre reinforcement is more effective in improving tensile strength than the compressive Strength. Thus PP fibre enhances the ductile behaviour of soils, reducing shrinkage settlements [6] and the reinforced soil is known as fibers-reinforced soil. According to [8] the CBR value of soil in soaked and unsoaked condition increases up to 1.5 % of polypropylene fiber and decreases after 1.5 % of polypropylene fiber.The soil can be treated and stabilised well at a relatively low cost by using this stabilizer [4],[7].In this experimental investigation, the aim was to study the effect of polypropylene fiber reinforcement on the improvement of physical and mechanical properties of a soil sample obtained from BIT Sindri college campus. The experimental program was carried out on compacted soil specimens with 0%, 0.25%, 0.5%, 0.75% , 1% and 1.25% polypropylene fiber additives, and the results of soaked and unsoaked CBR values are found. And compare with the CBR value of natural soil. Despite the difficulties encountered in representative specimen preparation due to random distribution of fiber [6] ,the fiber has been treated with sodium hydroxide solution for their complete dispersion and thus difficulties in specimen preparation is minimised.

## 2. Materials used

For stabilisation of soil using polypropylene fiber, materials are described in table1.

**Table: 1 Materials used**

| S.N. | Name of materials | Source of material/supplier |
|---|---|---|
| 1. | Soil | B.I.T Sindri campus |
| 2. | Polypropylene (PP) | Waltar enterprises, Navimumbai |
| 3. | Sodium hydroxide | E-Merck Worli Mumbai |
| 4. | Distilled water | |
| 5. | Sodium carbonate | Pallav Chemicals &Solvents Pvt. Ltd. Tarapur, Boisar |
| 6. | Sodium hexametaphosphate | E-Merck Worli Mumbai |

### A. SOIL

The soil sample used in this study has been collected from B.I.T. Sindri campus from a depth of 1m to 1.5 m below the ground surface by open excavation, the soil was dried and pulverized to perform the various experimental studies.

Table: 2 Properties of the natural soil [9], [10],[11],[12],[13],[14].

| S. No. | Parameters | Values |
|---|---|---|
| 1. | Specific gravity | 2.47 |
| 2. | OMC | 15.53 % |
| 3. | MDD | 1.74 g/cc |
| 4. | Liquid limit | 39.21% |
| 5. | Plastic limit | 21.96% |
| 6. | Plasticity index | 17.25% |
| 7. | UCS | 3.24kg/cm$^2$ |
| 8. | Soaked CBR | 1.92% |
| 9. | Unsoaked CBR | 4.09% |
| 10. | Percentage finer(clay + silt) | 63.5% |
| 11. | Classification of soil | CI |

### B. Polypropylene fiber

Polypropylene fibers is a thermoplastic polymer. It has high melting point of 160°c, high ignition point of 590°c, low thermal and electrical conductivity and hydrophobic and chemically inert nature which does not absorb or react with soil moisture or leachate, and its cost is low. And when mixed with soil it acts as reinforcement in the soil and increases the soil property and also increases the ductility of the soil and due to its hydrophobic and chemically inert nature it does not absorb the water and does not react with the water and soil particles. These fibers remain as it is after many more years it does not leach out .and from previous literatures it was observed that Polypropylene fiber is a good stabilising material. These polypropylene (PP) fibers are of 12 mm length. These micro fibers prevent crack formation and provide reinforcement. They are mainly used in mortar where thickness of plaster is 10 mm or more. They are suitable for waterproofing or repair of structures. Hence this fibre is suitable for the stabilisation of soil.

IJASRM International Journal of Advanced Scientific Research and Management, Volume 3 Issue 12, Dec 2018
www.ijasrm.com
ISSN 2455-6378

Figure:1 Polypropylene fibre


Figure:2 Polypropylene fibre showing 12 mm average size

## Specification of polypropylene fiber

Table: 3: specification of PP fibre

| | |
|---|---|
| Material | 100% virgin polypropylene (pp) |
| Length | 12.0+/- 0.25mm |
| Diameter | 24 micron (approx.) |
| Aspect ratio | 500 (approx.) |
| Melt point | 162°C |
| Specific gravity | 0.91 |
| Thermal and electric conductivity | Low |
| Alkali resistance | 100% alkali proof |
| Acid and salt resistance | High |

## 3. Sample preparation

### Treatment of PP fibre

PP Fiber is hydrophobic in nature they do not absorb any moisture content, these fibers are not dispersed properly in water. Thus NaOH is used for complete dispersion of PP

.

Following steps to be carried out for the treatment of fibre

- Solution of 2% NaoH was made
- PP fibres were weighed and dispersed for 10-20 hours
- PP fibers were taken out and washed in distilled water
- Oven dried for 20-24 hour at temperature of $65^0$C-$70^0$C
- And again fibres were weighed to ensure that there is no weight gain in fibres and the fibres so obtained is treated and is ready for use as reinforcement in soil.

Figure:3 Dispersion of PP fibre in NaOH solution

**Dosing:**

Different %ge of PP fiber i.e. 0.25%,0.5%,0.75%,1.0% and 1.25% of PP fiber by weight of soil are used.

**Mixing:**

Treated PP fibers are then mixed with soil by hand properly to get uniform mix and added water as per requirement.

Figure:4 mixing of PP fiber with soil

**Sample preparation for Testing of soil**

For experimental study different samples have been prepared with different proportions of polypropylene fiber, which have been given in the table:4.

IJASRM
International Journal of Advanced Scientific Research and Management, Volume 3 Issue 12, Dec 2018
www.ijasrm.com
ISSN 2455-6378

Table:4 Sample preparation

| S.N. | Percentage of soil (by weight) | Percentage of PP (by weight) |
|---|---|---|
| 1. | 100 % | 0% |
| 2. | 99.75% | 0.25% |
| 3. | 99.5% | 0.50% |
| 4. | 99.25% | 0.75% |
| 5. | 99.0% | 1.0% |
| 6. | 98.75% | 1.25% |

## 4. Experimental section

The California Bearing Ratio (CBR) is a penetration test for measure of the mechanical strength of ground surface , subgrades, and base courses beneath new carriage way construction. It was developed by the California department of transportation before world war II.

CBR test is performed by measuring the pressure required to penetrate soil or aggregate with a plunger of standard area. The CBR test was developed for measuring the load bearing capacity of soil used for building roads.

In this experimental section CBR test is done in two conditions soaked and unsoaked condition. This test may be conducted in remoulded or undisturbed soil sample. Test consists of causing a cylindrical plunger of 50 mm diameter to penetrate a pavement component material at 1.25mm/minute.

The load for 2.5mm and 5mm are recorded. This load is expressed as a percentage of standard load value at a respective deformation level to obtain CBR value.

The aim of this test is to determine the CBR value of the subgrade soil.

## 5. Results and Discussion

## Test results of modified soil

The results obtained from the soaked CBR and unsoaked CBR test have been analysed to study the effect of polypropylene fibers on the behaviour of soils. During the investigation ,it was observed that the CBR value of fiber reinforced soil at optimum moisture content increased with increasing amount of fiber content up to 1.0 % by dry weight of soil and then decreases for more than 1.0 % of Polypropylene fiber. The variation of CBR values with PP fiber are discussed below.

### 1.0 Unsoaked CBR

CBR values of the soil samples mixed with different percentages of PP fiber in unsoaked condition and its variation with natural soil have been tabulated below

Table 5: Values of Unsoaked CBR Test results

| S.N. | SOIL (%) | PP (%) | UNSOAKED CBR (%) |
|---|---|---|---|
| 1. | 100 | 0 | 4.09 |
| 2. | 99.75 | 0.25 | 4.57 |
| 3. | 99.50 | 0.5 | 5.13 |
| 4. | 99.25 | 0.75 | 5.45 |
| **5.** | **99.0** | **1.0** | **6.42** |
| 6. | 98.75 | 1.25 | 5.70 |

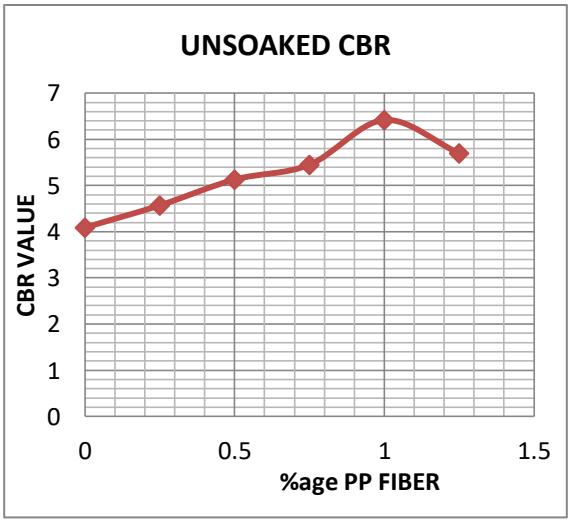


Fig 5: Variation of Unsoaked CBR with % of PPF

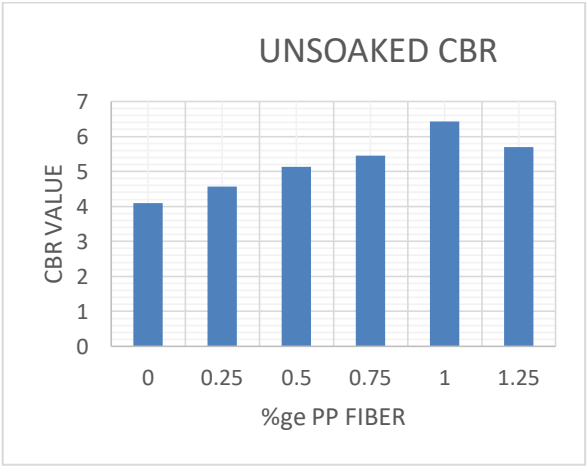


Fig 6: Bar chart Variation of Unsoaked CBR

### 2.0 Soaked CBR

CBR values of the soil samples mixed with different percentages of PP fiber in soaked condition and its variation with natural soil have been tabulated below.

**Table 6: Values of Soaked CBR Test results**

| S.N. | SOIL (%) | PP (%) | SOAKED CBR (%) |
|---|---|---|---|
| 1. | 100 | 0 | 1.92 |
| 2. | 99.75 | 0.25 | 2.24 |
| 3. | 99.50 | 0.5 | 2.64 |
| 4. | 99.25 | 0.75 | 2.89 |
| **5.** | **99.0** | **1.0** | **3.45** |
| 6. | 98.75 | 1.25 | 2.81 |

IJASRM International Journal of Advanced Scientific Research and Management, Volume 3 Issue 12, Dec 2018
www.ijasrm.com
ISSN 2455-6378

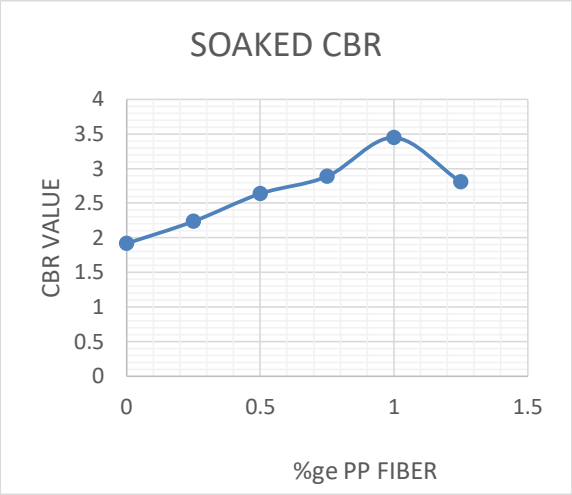


Fig 7: Variation of Soaked CBR

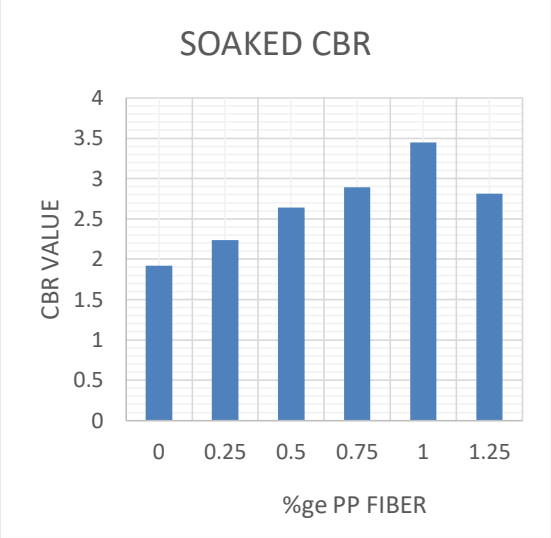


Fig 8: Bar chart Variation of Soaked CBR

Table 7: Comparison of Soaked and Unsoaked CBR

| S.N. | SOIL (%) | PP (%) | SOAKED CBR (%) | UNSOAKED CBR (%) |
|---|---|---|---|---|
| 1. | 100 | 0 | 1.92 | 4.09 |
| 2. | 99.75 | 0.25 | 2.24 | 4.57 |
| 3. | 99.50 | 0.5 | 2.64 | 5.13 |
| 4. | 99.25 | 0.75 | 2.89 | 5.45 |
| **5.** | **99.0** | **1.0** | **3.45** | **6.42** |
| 6. | 98.75 | 1.25 | 2.81 | 5.70 |

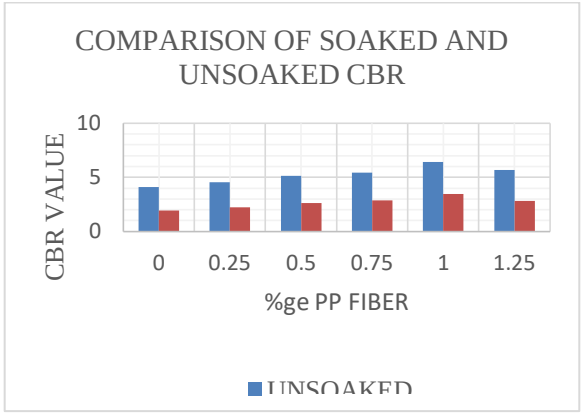


Fig 9: Comparison of Soaked and Unsoaked CBR

## 6. Conclusions

From the experimental results, it has been found that various properties of the soil replaced with 1.0% of PP fiber by weight of soil gives optimum results. the value of Soaked CBR increases from 1.92 to 3.45 corresponding to 1% of PP fiber. And value of unsoaked CBR increases from 4.09 to 6.42 at 1% of PP fiber, which make clear that we can reduce the thickness of pavement for pavement design, which reduces the cost of construction in highway and railway and therefore for stability of slope we can increases the slope of pavement.

## References

[1] Shish pal, Vinod kumar Sonthwal, Jasvir S Rattan, "Soil stabilisation using Polypropylene as waste fibre material", IJIRSET, issn:2319-8753,vol. 4,issue 11, November 2015.

**[2]** A. S.Soganci, "The effect of polypropylene fibre in the stabilisation of expansive soil", world academy of science , engineering and technology, international journal of environmental, chemical, ecological, geological and geophysical engineering vol.9,no:8,2015.

[3] Ali Sinan Soganci, "The effect of polypropylene fibre in the stabilisation of expansive soil", ICGSE, Paris, France, August 27-28, 2015.

[4] C.M. Sathyapriya, S. Archana, A. Bichu albert, A.D. Deeraj, "stabilisation of clayey soil using polypropylene fiber", IRJET, issn:2395-0056,vol. 04,issue: 04/apr-2017.

[5] Jesna Varghese, Remya U.R.Snigdha. V.K., "The effect of polypropylene fibre on the behaviour of soil mass with reference to the strength parameter", IJERT, issn:2278-0181. Vol.5 issue 03,march 2016

[6] Mona malekzadeh, Huriyebilsel, "effect of polypropylene fibre on mechanical

behaviour of expansive soils",EJGE, vol. 17 [2012], bund. A.

[7] Muske Srujan Teja, "soil stabilization using polypropylene fibre materials", IJIRSET,issn:2319-8753, vol. 5,issue 9,september 2016.

[8] Sabat, "Effect of polypropylene fiber on engineering properties of rice husk ash-lime stabilised expansive soil", EJGE, Vol.-17,2012, Bund.E

[9] Veerubhotla Seshasai, M. Ramakrishna M.E.,B.V. Sasi kumar, "stabilisation of expansive soil using fibers", IJTRE, issn:2347-4718, vol. 4, issue 4, December 2016.

**[10]** IS:2720-Part 10-1991, Determination of Unconfined Compressive Strength.

**[11]** IS:2720-Part 16-1987, Laboratory determination of CBR.

**[12]** IS:2720-Part 4-1985, Grain Size Distribution.

[13] IS:2720-Part 5-1985, Determination of Liquid limit and Plastic limit.

[14] IS: 2720-Part III-1980,Determination of Specific gravity.

[15] IS: 2720-Part 7-1980, Determination of water content- Dry density relation using light compaction .