Reinforcement of High Density Polyethylene Strips and Fibers

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Abstract: The amount of wastes has increased year by year and it is necessary to utilize the wastes effectively. This study presents a simple way of using the recycled plastic waste in the field of civil engineering as reinforcing material. This study describes a comparison on the inclusion of recycled high density polyethylene (HDPE) in the form of strips and fibers with clayey soil at different mixing ratios in percentage by weight respectively. A significant improvement in the strength is observed due to the inclusion of HDPE strips and fibers.

Keywords: Clayey soil, HDPE (High Density Polyethylene), Reinforcement, Strength improvement

1. Introduction

In recent years, plastic containers and bags made of high density polyethylene (HDPE) have been used with increasing frequency for various purposes like storage of materials including food, detergents etc. These containers have only a short span of life since they are often disposed after regular use. As a result, landfills have been continuously filled with an alarming rate of waste plastic. This should be avoided so as to prevent the soil strength degradation and low permeability of soil caused due to the presence of excess plastic waste present in the soil. Nowadays, used HDPE is often collected for reusing and recycling techniques. However, recycled HDPE has a major disadvantage. Since HDPE can be melted at very low temperatures, it is prohibited from manufacturing products that are used for storing food items, drugs or cosmetics. However, these reclaimed HDPE after recycling can’t be discarded hence new methods are being adopted to reuse the recycled plastic wastes so that it can be used in an efficient way. Thus, recycled plastic wastes are therefore used to reinforce weak soils and soft clays.

1.1 Objective of the Study

- Determination of the properties of clayey soil used for the study.
- Study the effect of varying percentage of high density polyethylene strips on the geotechnical properties of clay sample and determination of optimum percentage.
- Study the effect of varying percentage of high density polyethylene fibers on the geotechnical properties of clay sample and determination of optimum percentage.
- Evaluate the influence of HDPE strips and fibers on CBR value of clayey sample.
- Evaluate the unconfined compressive strength of clayey sample reinforced with HDPE strips and fibers.
- Analyze the influence of equal optimum percentage mixtures of HDPE strips and fibers by weight on strength characteristics of reinforced soil.

2. Materials and Methods

2.1 Soil

The soil sample necessary for the thesis work was collected from Akkulam region, Trivandrum. “Fig.1” shows the soil sample.

Table 1: Properties of clayey sample

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sand content</td>
<td>18.1%</td>
</tr>
<tr>
<td>2</td>
<td>Silt content</td>
<td>48.7%</td>
</tr>
<tr>
<td>3</td>
<td>Clay content</td>
<td>33.2%</td>
</tr>
<tr>
<td>4</td>
<td>Specific Gravity</td>
<td>2.46</td>
</tr>
<tr>
<td>5</td>
<td>Liquid Limit</td>
<td>62%</td>
</tr>
<tr>
<td>6</td>
<td>Plastic Limit</td>
<td>32.8%</td>
</tr>
<tr>
<td>7</td>
<td>Plasticity Index</td>
<td>29.2</td>
</tr>
<tr>
<td>8</td>
<td>Optimum Moisture Content (OMC)</td>
<td>32%</td>
</tr>
<tr>
<td>9</td>
<td>Maximum Dry Density(MDD)</td>
<td>1.26g/cc</td>
</tr>
<tr>
<td>10</td>
<td>Void Ratio(e)</td>
<td>0.44</td>
</tr>
<tr>
<td>11</td>
<td>Unconfined Compressive Strength</td>
<td>3.03kg/cm²</td>
</tr>
</tbody>
</table>

2.2 High Density Polyethylene (HDPE)

High Density Polyethylene (HDPE) or polyethylene high density (PEHD) is a polyethylene thermoplastic made from petroleum. With a high strength to density ratio, HDPE is
used in the production of plastic bottles, corrosion resistant piping and geomembranes.

Table 2: Properties of HDPE

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resin Identification code</td>
<td>2</td>
</tr>
<tr>
<td>Density</td>
<td>0.94g/cm³</td>
</tr>
</tbody>
</table>

(a) High Density Polyethylene strips

High Density Polyethylene strips are prepared from cutting down of plastic bags after they are being collected and recycled. The materials are prepared in the form of small strips of width 0.5cm and with varying lengths of 2cm, 4cm and 6cm respectively. The lengths are determined with respective to aspect of ratio of 4, 8 and 12 with respect to the width size.

(b) High Density Polyethylene fibers

Reclaimed waste plastic bottles made up of high density polyethylene are reprocessed in the form of fibers which can be used for reinforcing soil. Fibers used for the reinforcement possesses a diameter of about 1mm was added to the soil in the ratio of about 0, 1, 2, 3 and 4 percentages by weight and the increase in strength was determined.

3. Results and Discussion

After the determination of the basic physical and chemical properties of the soil, tests like Standard Proctor test and California bearing Ratio test were performed to determine the strength parameters for reinforced and un reinforced samples.

‘Chart 1’ shows the effect of addition of HDPE in the form of strips and fibers on the maximum dry density and optimum moisture content of the clayey sample. The maximum dry density was observed to possess a hike of about 22% in case of HDPE strips and 8.7% in case of HDPE fibers when they are included to the soil. A decrease in optimum moisture of about 2% is observed due to the inclusion of HDPE strips and fibers to the clayey sample.

‘Chart 2’ shows the effect of HDPE strips and fibers on the California Bearing ratio of the clayey sample used with and without reinforcement. The test results shows an increment in the CBR value of about 4.6 times in the case of HDPE strips and about 4.03 times in the case of HDPE fibers.
5. Acknowledgment

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References


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Vivek.R received the B.E degree in Civil Engineering from Noorul Islam University 2011 and M.Tech degree in Geotechnical Engineering from St. Thomas Institute for Science and Technology in 2017 respectively.

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