CHAPTER 4

COIR GEOTEXTILES

4.1 INTRODUCTION

Coir is derived from the exocarp of the fruit of the coconut tree “Cocos nucifera Lynn” grown in the tropical countries mainly for the high oil content of the endosperm (copra). Large production areas, in particular, can be found along the coastal regions in the wet tropical areas of Asia, in the Philippines, Indonesia, India, Sri Lanka, and Malaysia. Total world production of coconut increased substantially from nearly 35 million tons in 1980 to more than 50 million tons today. Yield varies from region to region with an average of 70 to 100 nuts and a maximum of 150 nuts per year. The kernel (copra, coconut water and shell) comprises 65% of the total weight, while the husk contributes only 35%. Despite their low trade value, the fibres provide significant economic support to populations especially to weaker sections in specific areas of the coir producing countries, for example in southern states of India viz., Kerala, Karnataka, Tamilnadu, Andhra Pradesh and also in the west and south of Sri Lanka.

Coir being a biodegradable and environment friendly material is virtually irreplaceable by any of the modern polymeric substitutes. With the diversification of the products and evolvement of new technologies for the production of fibres, the export of coir products has been increased tremendously. Though the demand for coir geotextiles is increasing, the total coir exports from India comprises only less than 3% of it. The close involvement of the local governments, with the support of the public
research institutions and private enterprises is required for innovation, manufacturing and marketing of coir.

4.2 COIR FIBRE

Coir fibres are extracted from the husks surrounding the coconut. There are two distinct varieties of coir fibre based on the extraction process viz., white coir and brown coir. The average fibre yield depends on geographical area and the variety of coconut tree. In southern states of India and in Sri Lanka, where the best quality fibres are produced, the average yield is 80 to 90 grams per husk. Husks are composed of 70% of pith and 30% of fibre on a dry weight basis. The maximum total world production of coir fibre is estimated to be between 5 and 6 million tons per year (Dam, 1999).

4.2.1 Composition of Coir Fibre

Cellulose fibres are obtained from fruit (e.g. coir), seed (e.g. cotton), stem (e.g. sisal), leaf (e.g. banana and pineapple) and so on. Coir – the ‘golden fibre’, is a 100 per cent organic fibre. Coir is a strong cellulose fibre with high lignin content. It is a multi-cellular fibre containing 30-300 or more cells in its cross section, which is polygonal and round in shape. Each cell is made of concentric layers consisting primary wall, outer secondary wall, middle secondary wall and inner secondary wall. In between the primary cell walls is situated the intercellular cementing non-crystalline material comprising of lignin, pectines and hemi cellulose which holds the cells together. (Kulkarni et al. 1983).

Coir fibre is hard and tough and its length ranges from 150mm to 280mm and the diameter from 0.1mm to 0.5mm. It is one of the hardest natural fibres because of its
high lignin content (CSIR, 1960). The chemical composition of coir is given in Table 4.1.

Table 4.1 Chemical composition of coir

<table>
<thead>
<tr>
<th>Content</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lignin</td>
<td>45.84</td>
</tr>
<tr>
<td>Cellulose</td>
<td>43.44</td>
</tr>
<tr>
<td>Hemi cellulose</td>
<td>0.25</td>
</tr>
<tr>
<td>Pectin and related compounds</td>
<td>3.00</td>
</tr>
<tr>
<td>Ash</td>
<td>2.22</td>
</tr>
<tr>
<td>Water soluble</td>
<td>5.25</td>
</tr>
</tbody>
</table>

(Sarma, 1997)

4.2.2 Properties of Coir Fibre

A fibre material would be suitable for geotextile production when it has reasonably good mechanical properties and resistant to microbial attack. Coir fibres are of different types and are classified according to varying degree of colour, length and thickness. The decomposition of coir fibre is generally known to be much less than that of jute due to high lignin content. The engineering properties of coir fibre are given in Table 4.2.

4.2.3 Fibre Production

The traditional production of fibres from husk is a laborious and time-consuming process. After manual separation of the nut from the husk, the husks are processed by various retting techniques. This is generally done in ponds of brackish waters for three to six months or in salt backwaters or lagoons for 10 to 12 months. By retting the
fibres are softened and can be decorticated and extracted by beating, which is usually
done by hand. After hacking, washing and drying in shade the fibres are loosened
manually and cleaned. Traditional practices of this kind yield the highest quality of
white fibre for spinning and weaving

Table 4.2 Engineering properties of coir fibre *

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (mm)</td>
<td>15 - 280</td>
</tr>
<tr>
<td>Density (g/cc)</td>
<td>1.15 - 1.4</td>
</tr>
<tr>
<td>Tenacity (g/tex)</td>
<td>10.0</td>
</tr>
<tr>
<td>Breaking elongation (%)</td>
<td>30.0</td>
</tr>
<tr>
<td>Diameter (mm)</td>
<td>0.1 - 1.5</td>
</tr>
<tr>
<td>Rigidity modulus (dynes/cm²)</td>
<td>1.8924</td>
</tr>
<tr>
<td>Swelling in water (diameter)-(%)</td>
<td>5.0</td>
</tr>
<tr>
<td>Moisture at 65% RH (%)</td>
<td>10.5</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>1.15</td>
</tr>
<tr>
<td>Young's modulus (GN/m²)</td>
<td>4.5</td>
</tr>
<tr>
<td>Specific heat</td>
<td>0.27</td>
</tr>
</tbody>
</table>

(* Ayyar et al., 2002.)

Alternatively, mechanical process using either defibering or decorticating equipment
needs only five days of immersion in water to process the husks. Crushing the husks
in a breaker opens the fibres. By using revolving drums the coarse long fibres are
separated from the short woody parts and the pith. The stronger fibres are washed,
cleaned, dried, hackled and combed. The quality of the fibre is greatly affected by
these processes.

New environment friendly novel methods of fibre production have developed by
Central Coir Research Institute (CCRI) using a biotechnological approach with
specific microbial enzymes. This has substantially reduced the retting time to as low as three to five days. High quality production has been maintained (Coir Board, 1996).

4.3 COIR GEOTEXTILES

Coir geotextiles with its Indianised connotation “Coir Bhoovastra”, a generic member of the geosynthetic family, are made from the coconut fibre extracted from the husk of the coconut fruit as explained in the following section. Like their polymeric counterparts, coir geotextiles can be synthesised for specific applications in geotechnical engineering practice. Coir geotextiles is not a consumer product, but a technology based product. A range of different mesh matting is available, meeting varying requirements.

Coir fibres can be converted into fabric both by woven and non-woven process. Coir mesh matting of different mesh sizes is the most established coir geotextiles. Mesh matting having different specifications is available under quality code numbers H2M1 to H2M10. These qualities represent coir geotextiles of different mesh sizes ranging from 3.175mm to 25.4mm. Several types of non-woven geotextiles also exist. Most of the non-woven mats are made from loose fibres, which are interlocked by needling or rubberising. Non-woven geotextiles are available in several dimensions and have a minimum thickness of 2mm.

4.3.1 Terminology

_Cross machine direction_: Direction of the geosynthetic in a direction perpendicular to its long manufacturing or machine direction.

_Ends_: The threads, which lie along the length of woven fabric
**Machine direction:** Direction of the geosynthetic in a direction of its long manufacturing.

**Permittivity:** the amount of water moving across a geotextile in unit time through unit area at unit head.

**Picks:** Weft or filling yarn, which lies across the length of a fabric.

**Runnage:** It is the length of the yarn in metres to weigh one kilogram.

**Scorage:** It is the indication of thickness or thinness of yarn. It is the number of strands that can be accommodated in a span of (900mm) 36 inches without overlapping divided by 20.

**Secant modulus:** The ratio of change in load per unit width to a stated value of strain, usually 10%.

**Staple:** Short fibres in the range of 7mm to 70mm.

**Tenacity:** The fibre strength as force per linear density.

**Tex:** This is the universal unit for yarn count; it is the weight in grams per kilometer of yarn.

**Transmittivity:** the product of water permeability along the geotextile plane and thickness of the geotextile.

**Warp:** Set of yarns running length-wise of a fabric.

**Weft:** Set of yarns running width-wise of a fabric.
4.3.2 Production

After fibre is produced, the process of spinning extracts yarns. This can be done by wheel spinning, by mechanical spinning or by hand spinning. Wheel spin yarns are of uniform good quality. The quality of yarn is judged by the thickness, colour, appearance, uniformity in twist, strength, fineness, texture, etc. Yarns are named after the places of production like Anjengo, Vycome, Aratory, etc.

Coir geotextiles are manufactured from mainly four types of coir yarn viz., Aratory, Anjengo, Vycome and Beach. The yarn is wound on bobbins and transferred to a creel. Warping is done between sticks or by means of a peg board, the yarn from the bobbins being passed on to the warping drum and the requisite width is prepared by warping the sections on a weavers beam. Weaving is similar to the pit loom weaving without the fly shuttle arrangement. Two treadle, three treadle, four treadle or multi treadle weaving can be done. The photograph of a fully automatic power loom is shown in Fig. 4.1. Constructional details of coir geotextiles are given in Table. 4.3.

![Fig. 4.1 Fully automatic power loom](image)
### Table 4.3 Constructional details of coir geotextiles*

<table>
<thead>
<tr>
<th>Designation</th>
<th>Type of warp yarn</th>
<th>Storage Ends Per dm</th>
<th>Type of weft yarn</th>
<th>Picks Per dm</th>
<th>Mass (g/m²)</th>
<th>Mesh size (mm x mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H2M1</td>
<td>Anjengo</td>
<td>14</td>
<td>9.0</td>
<td>Vycome</td>
<td>8</td>
<td>650</td>
</tr>
<tr>
<td>H2M2</td>
<td>Beach</td>
<td>9</td>
<td>8</td>
<td>Beach</td>
<td>7</td>
<td>700</td>
</tr>
<tr>
<td>H2M3</td>
<td>Aratory</td>
<td>15</td>
<td>14</td>
<td>Aratory</td>
<td>14</td>
<td>875</td>
</tr>
<tr>
<td>H2M4</td>
<td>Anjengo</td>
<td>12</td>
<td>19</td>
<td>Aratory</td>
<td>11</td>
<td>1400</td>
</tr>
<tr>
<td>H2M5</td>
<td>Vycome</td>
<td>13</td>
<td>9.0</td>
<td>Vycome</td>
<td>8</td>
<td>740</td>
</tr>
<tr>
<td>H2M6</td>
<td>Vycome</td>
<td>12</td>
<td>4.6</td>
<td>Vycome</td>
<td>4</td>
<td>400</td>
</tr>
<tr>
<td>H2M7</td>
<td>Beypore</td>
<td>12</td>
<td>4.0</td>
<td>Beypore</td>
<td>6</td>
<td>1250</td>
</tr>
<tr>
<td>H2M8</td>
<td>Anjengo</td>
<td>12</td>
<td>11</td>
<td>Aratory</td>
<td>7</td>
<td>700</td>
</tr>
<tr>
<td>H2M9</td>
<td>Anjengo</td>
<td>11</td>
<td>13</td>
<td>Aratory</td>
<td>7</td>
<td>900</td>
</tr>
<tr>
<td>H2M10</td>
<td>Anjengo</td>
<td>11</td>
<td>18</td>
<td>Anjengo</td>
<td>9</td>
<td>1300</td>
</tr>
</tbody>
</table>

(*Coir Board)

### 4.3.3 Properties of Coir Geotextiles

Testing and evaluation of coir geotextiles is a key issue, which can answer the question of successful performance in the field. Most of the properties of coir geotextiles are obtained in the same way as that of polymeric geotextiles. No separate testing procedures have evolved so far. Again, though coir geotextiles are classified based on the type of yarn and other parameters, standardisation of coir geotextiles is yet to be evolved. The properties of geotextiles can be grouped into five categories as given below (Mandal and Divshikar, 2002).

1. **Physical Properties**
   - Mass per unit area
• Thickness
• Specific gravity

2. Mechanical Properties

• Strip tensile strength
• Wide width tensile strength
• Trapezoidal tear strength
• Grab tensile strength
• Drop cone penetration resistance
• Puncture resistance
• Burst strength
• Interface friction
• Pull out resistance
• Sewn seam strength

3. Hydraulic Properties

• Cross plane permeability (Permittivity)
• In plane permeability (Transmittivity)
• Apparent opening size
• Porosity

4. Endurance Properties

• Creep
• Gradient ratio (Clogging)

5. Degradation Properties

• Biological degradation
• Ultraviolet degradation
Among the above properties, physical, mechanical and hydraulic properties play major role in design of reinforced soil structures.

4.4 APPLICATION OF COIR GEOTEXTILES

Coir geotextiles find application in a number of situations in geotechnical engineering practice. Coir geotextiles can be used as an overlay or interlay, the former protecting the surface from run off and the latter performing the functions of separation, reinforcement, filtration and drainage. Soil bio - engineering with coir geotextiles finds effective application in the following field situations.

- Separation application in unpaved roads, railways, parking and storage areas
- Shore line stabilisation
- Storm water channels
- Slope stabilisation in railway and highway cuttings and embankments
- Water course protection
- Reinforcement of unpaved roads and temporary walls
- Providing sub base layer in road pavement
- Filtration in road drains and land reclamation
- Mud wall reinforcement
- Soil stabilisation

Some of the major application areas are detailed below.

4.4.1 Unpaved Roads

Unpaved roads are mainly low volume roads constructed in rural areas. The unsatisfactory performance of roads arises mainly from two factors, namely, the poor quality of subgrades and the insufficient thickness and quality of sub base and base
courses. All these factors can be mitigated by the use of coir geotextiles either alone or in conjunction with other products/materials. In cohesionless soil lateral confinement by coir geotextiles can improve the shear resistance and the bearing capacity of the subgrade soil and consequently reduces the thickness of the pavement material. In cohesive soils adequate drainage of the subgrade can be achieved by depressing the water table by use of coir geotextile drains. In very poor soil the use of coir geotextile composite blankets, and strip drains can help in quickening the consolidation of non-expansive clays and reducing the construction time of high embankments. Coir geotextiles can also be used in pavement layer to reduce thickness, increase fatigue resistance and reduce reflection cracking due to traffic.

4.4.2 Embankments and Slopes

Constructions of bunds in marshy areas pose the problem of inadequate shear strength of soil to support the soil fill for the required height. Coir geotextiles can be used both for the foundation support and also within the fill, particularly for filter and separation function, so that the erosion of the sides can be prevented. Use of coir geotextile in protecting natural slopes is well established. Coir fibres are effective in preventing failures due to reversal of pore pressures, through drainage without removal of soil particles. Also with the provision of reinforcements, the stabilisation of the side faces can be improved which otherwise would be very difficult to maintain the slope.

4.4.3 Retaining Walls

Retaining walls are conventionally built to withstand lateral pressure of soil fill through the action of gravity, which involves additional vertical force on soil. This necessitates a strong foundation or large base width and hence costly. Coir geotextiles can be used in the fill itself so that no additional facing wall is required to resist the
lateral pressure. This is particularly suited to walls having low height and where foundation soil is weak. The use of coir geotextiles is not advisable for construction of tall retaining walls because of their low tensile strength.

4.4.4 French Drains

These are drainage measures for subgrade soil to lower the water table to protect road formations without the use of slotted pipes to take the collected water. Coir geotextiles with high transmittivity like needled felt with mesh core can be used in the place of pipes and thicker layers can be used to reduce the quantity of pervious sand surrounding the drain.

4.4.5 Vertical Drains

Construction of embankment over soft and sensitive clays requires accelerated consolidation. Several methods such as sand drains, metal drains, geosynthetic prefabricated vertical drains (PVD) etc., are used for this purpose. Instead of this, coir geotextile drains can be used. Two types of such drains are investigated and documented in this report. In such cases, even if the coir decays in course of time, the initial period helps in consolidation and long-term stability is not affected due to the presence of fibres.

4.5 REVIEW OF PREVIOUS INVESTIGATIONS

Coir geotextiles can perform functions viz., separation, reinforcement, filtration, erosion control, pore fluid transmission and dissipation of pressure. Most of the previous works in the field deals with bearing capacity and slope stability / erosion control aspects. A few studies have been reported in the area of subgrade stabilisation and durability aspects also.
Ramaswamy and Aziz (1982 and 1983) have conducted some studies on jute geotextiles and their applications. The laboratory test results conclusively showed that the stress-strength characteristics of the soil are better with the jute fabric than without it. The study also showed the beneficial effects of natural jute geotextiles for subgrade stabilisation.

Prasad et al. (1983) have studied treatment of coir fibres for coir polyester composites. It was reported that the tensile strength of fibres was increased by 15% when fibres were soaked in 5% sodium hydroxide aqueous solution at 28°C for 72 to 76 hours and thereafter showed a reduction in strength.

Beena (1986) and Ayyar et al. (1988) conducted model studies on reinforced sand bed using coir rope reinforcement along with bamboo strips as anchorages. A parametric study was conducted to determine the effect of horizontal spacing, number of reinforcing layers, region of confinement and pattern of reinforcement. Depending on the arrangement, it was found that BCR could be increased up to 2.5.

The properties and durability of coir geotextiles can be increased by several means. Datye (1988) has reviewed the various methods of treatments such as: a) impregnation with water and oil preservatives, b) impregnation with synthetic polymers, c) coating with cold setting liquid resins, d) coatings with synthetic melts, and e) encasement in concrete when used for reinforcement.

With regard to natural geotextiles, durability is not a matter of concern where a short service life is required, as for drainage and consolidation of soft compressible deposits (Datye and Gore, 1994). Usually, if the geotextiles survives the construction-induced stresses, it will also withstand the in-service stresses (Bonaparte et al, 1988).
A geosynthetic vertical drain, using organic fibres from jute and coir, to improve thick soft clay deposits, known as fibre drain has been developed by Lee et al. (1994). In addition, it was required to withstand the application of high-energy impact on surface fills constructed as part of improvement works. The study showed that the axial and filter permeability of this drain were more than $10^{-4}$ m/s and $10^{-5}$ m/s, respectively, for consolidation pressure up to 100 kN/m$^2$.

Banerjee (1996) has developed a machine to manufacture strip drains by braiding jute yarns enclosing coir yarns. An important feature of the braided jute sheath is its swelling nature resulting in a clog resistant drain. The discharge capacities of these drains were less than that of synthetic drains, however, it does satisfy the requirements.

Coir geotextiles are produced from naturally occurring coir fibre, which is available at relatively low cost in tropical countries. These are found to last for four to six years within the soil environment depending on the physical and chemical properties of the soil and pore fluid (Ramakrishna, 1996).

Ayyar and Dipu (1997) conducted studies on the effect of coir composites on the bearing capacity of sand. It was shown that the coir fabrics could be used economically for improving bearing capacity of sand subgrade significantly.

A study on coir reinforcement for stabilising soft soil subgrade has been carried out by Rajagopal and Ramakrishna (1998). The test results clearly indicated the capability of coir geotextiles in improving the stiffness and bearing capacity of soft subgrade. They concluded that the coir geotextiles are suitable for cost effective field applications.
Use of coir geotextiles in erosion control measures has been reported by Cammack (1988) and Lekha (2004). North American experiences with coir geotextiles for bank stabilisation have reported by Lanier (1991) and White (1991).

In a study carried out by Ayyar and Girish (2000) for finding the possibility of improving the durability of soil reinforcement system, load penetration test and plate load test were done on sand beds reinforced with coir-needled felt, with and without treatments. It was observed that there exist increased strength and durability with the use of coir.

The use of coir products on ground improvement have been studied by Sheeba et al. (2000). Two aspects were mainly considered in their work, one was to examine the load deformation behaviour of needled felt in clays, and the other was to examine the durability of coir in sandy subgrade. While the cement-coated non-woven felt is seen to be the most effective among fabrics studied, even the plain-needled felt improved the resistance of clay slope.

A comprehensive summary of the production, properties and applications of coir geotextiles were provided by Rao and Balan (2000) and Ayyar et al. (2002). The biggest advantage of coir geotextiles is its availability, economic price range, and eco compatibility. It can be tailor made to end users' technical requirements like porometry, permittivity, strength, etc. (Rao and Balan, 2000).

Sampath Kumar et al. (2000) reported the development of jute – coir braided PVD. It was reported that the core prepared out of more number of thin coir yarns showed better performance than a smaller number of thick yarns.
Coir is an abundantly available and renewable resource, which is more durable than jute as its lignin content is higher. Under water, coir has been shown to retain its strength for about 8 to 10 years. Though the survivability concept is more important in the case of geotextile functions, studies indicate that, in most of the separation applications, the critical period in the life of a geotextile is during the construction, rather than during the service life (Koerner, 2005).

4.6 CASE STUDIES

Though less in number compared to polymeric geotextiles, coir geotextiles have been tried for different civil engineering applications. A few case studies are described below.

4.6.1 Protection of Mine Waste Dumps in Goa

Mine waste dumps of iron ore mines in Goa are a perennial problem faced by all mines in Goa. Severe surface erosion takes place along the open mine waste dumps during the monsoon season and creates a lot of environmental problems in the surrounding area. Hillocks are being made, using the mine waste dump of very loose density. Once rainfall starts, small gullies will be formed along the slope, which will lead to large gullies in the subsequent rain, and even deep-seated slope failure may take place. In order to prevent the surface erosion and to increase the slope stability of the dumps coir geotextiles were tried (Ayyar et al., 2002).

Usually the erosion problems in mine waste dumps were addressed by traditional bio-engineering techniques such as planting of acacia plants or cashew plants over a small cover of lateritic soil. However this traditional solution becomes very difficult owing to the high transportation cost for movement of lateritic soils to the dump areas.
Application of new generation coir erosion control blankets with special design features could be an effective alternative to provide solutions and to speed up the vegetation process.

Non-woven coir geotextiles with medium thick polypropylene net on top and bottom were used to protect the surface of the dump. The tensile strength of the non-woven coir geotextile was 3.5 kN/m. Geotextiles were kept in position using wooden planks of 25mm thick and having a length of more than 1000 mm (Fig. 4.2). Length of the planks was so selected that it has to cut the probable slip circle at top and bottom region of the slope. The sites treated with the blankets are performing satisfactorily with stabilisation of the slopes, controlling the soil loss and reduction in pollution.

![Fig. 4.2 Mine waste dumps in Goa](image)

4.6.2 Pullangode Estate Erosion Control

One of the important field studies carried out successfully using coir fabrics has been reported by Rao and Balan (2000). The work was carried out in 1994 and was stable enough for vegetation to grow till the matting degrades, which was expected in one year. The location of the site was a rubber plantation near Nilambur in Kerala. The
site consists of an area of 583 m$^2$ abandoned plantation over a length of 50 m with side slopes of 49° - 66° suffered severe erosion with formation of wide gullies presented an ideal area for the study.

Coir mattings were chosen and two varieties of white coir yarns manufactured by Aspinwall, H2M8 and H2M6, were used. Rolls of the coir matting were first anchored in the top trench and then unrolled along the slope. Overlaps of 15 cm minimum between adjacent ones were given. The anchoring of the matting was made with mild steel staples spaced to form a grid of 2 m x 2 m. Coir ropes of 20 mm diameter were used to tie the coir matting in a criss cross pattern at 90°, making a grid of 1 m x 1 m size. Steel staples were driven at each joint in the rope. Type A matting (915 g/m$^2$) was used on the upper half of the slope of 66° while type B matting (440 g/m$^2$) was used for the lower half of the slope of 49° since the thicker matting helped in preventing rain splash.

The highlight of this study is the fact that the soil protected is lateritic. Peniseltum purpureum grass was adopted, which is suitable for high elevations and steep slopes. Also coir mesh matting of smaller aperture was more effective than the areas with coarse openings.

4.6.3 Muvattupuzha Canal Protection

Sarma (1997) reported the details of this project which is situated on the 23.20 km of the left bank main canal of the Muvattupuzha Valley Irrigation Project (MVIP) near the main central road crossing between Muvattupuzha and Koothattukulam in Kerala state. This stretch of canal was one of the most highly eroded stretches due to high stream velocity in the major rainy season. Turfing grass protection was unsuccessful since the time taken for grass to take root was more than successive monsoon periods.
The soil is also acidic with pH 4.3. The details of the coir netting are not reported but it is mentioned that there is sufficient space for proper growing of grass. Possibly it is a coarser net and the monitoring of the strength of net showed 50% decrease in six months. It was assumed that complete degradation would take place in five years. Lemon grass having roots 45cm long was found to be the choice of vegetation in the area and the coir fabric was very conducive to its growth. The case has been reported as a success story for control of erosion. The photograph of a short stretch is shown in Fig. 4.3.

![Muvattupuzha canal protection](image)

**Fig. 4.3 Muvattupuzha canal protection**

### 4.7 NEED FOR PRESENT STUDY

The review of literature shows that the polymeric geotextiles is a versatile material with attractive characteristics and advantages, and as a result, this material is now being used abundantly all over the world. At the same time, these materials have got the disadvantages that it is non-biodegradable, petroleum based and is costly. The review here also shows that, the use of natural geotextiles has not gained popularity.
even though some studies have been reported in this area. Though India produces large quantities of coir geotextile, their use for geotechnical and highway engineering applications has not gained confidence due to limited studies undertaken. An elaborate and systematic study, covering different aspects and functions of coir geotextiles, in the context of unpaved roads and embankments is lacking and so also the design methods and procedures for the range of materials having properties that of coir geotextiles. It is in this context, that an in-depth study in the utilisation of coir geotextiles for unpaved roads and embankments are deemed necessary and hence attempted herein.