Society for Development of Composites

Composites Technology Park
#205, Bande Mutt, Kengeri Satellite TownshipBangalore-560 060
☎: 6599 7605, 6558 1005 Fax: 080-2848 2771
Email: drgopalan2003@yahoo.com
Website: www.compositestechnologypark.com

PROJECT CLOSING REPORT

CHARACTERIZATION OF NON WOVEN COIR GEO-TEXTILES COMPOSITES USING ASTM STANDARDS AND EVOLVING INDIAN AND INTERNATIONAL STANDARDS AND PREPARING DRAFT STANDARDS

November 2009

Promoted by

KARNATAKA HOUSING BOARD and RV-TIFAC COMPOSITES DESIGN CENTRE

Supported by

PROJECT CLOSING REPORT

CHARACTERIZATION OF NON WOVEN COIR GEO-TEXTILES COMPOSITES USING ASTM STANDARDS AND EVOLVING INDIAN AND INTERNATIONAL STANDARDS AND PREPARING DRAFT STANDARDS

1.	Project Title	Characterization of Non woven Coir Geo-textiles Composites using ASTM Standards and Evolving Indian and International Standards and Preparing Draft Standards
2.	Broad Subject	Geotechnical Engineering
3.	Sub Area	Civil Engineering
4.	Duration in months	12 months
5.	Total cost	Rs. 9, 65,000.00 (Rupees Nine Lakhs Sixty Five Thousand Only)
6.	Project Category:	Applied Research
7.	Principal Investigator	Dr. R. Gopalan, Executive Director
8.	Name of the Institute	SOCIETY FOR DEVELOPMENT OF COMPOSITES Composites Technology Park, TBI Block, #205, Banda Mutt, Kengeri Satellite Township, Bangalore-560 060 Ph: 65997605 / 65581005 / 2848 2768 Fax:080-28482771 (A non profitable, registered society under the Karnataka Societies Registration Act, Bangalore) in technical collaboration with RV-TIFAC Composites Design Centre Composites Technology Park, #205, Banda Mutt, Kengeri Satellite Township, Bangalore-560 060 Ph: 65997605 / 65581005 / 2848 2768 Fax:080-28482771 (An autonomous body set up by TIFAC / Department of Science & Technology, Govt. of India, National Aerospace Laboratories and the

		RSS Trust, Bangalore) Indian Institute of Science
9.	Date of Start	February 2008
10.	Date of Closing	November 2009

1. INTRODUCTION

A geo-textile is typically defined as any permeable textile material used to increase soil stability, provide erosion control or aid in drainage. More simply put, if it is made of fabric and buried in the ground it's a probably a geo-textile. Geo-textiles have been in use for thousands of years dating back to the Egyptian Pharaohs. These early geo-textile applications were basically natural fibers or vegetation mixed directly with soil.

Modern geo-textiles are usually made from a synthetic polymer such as polypropylene, polyester, polyethylenes and polyamides. Geo-textiles can be woven, knitted or non-woven. Varying polymers and manufacturing processes result in an array of geo-textiles suitable for a variety of civil construction applications.

Non-woven geo-textiles resemble felt and provide planar water flow. They are commonly known as filter fabrics (although woven monofilament filtration fabrics exist). Typical applications for non-woven geo-textiles include aggregate drains, asphalt pavement overlays, and erosion control. Non-woven geo-textiles are multi-purpose fabrics that are felt-like in appearance. There are numerous practical applications for non-woven geo-textiles. Non-woven drainage fabrics are an economical alternative to graded aggregate and sand filters and can eliminate many of the problems associated with using, purchasing and transporting aggregate.

Development of Non-woven Coir Geo-textiles composites for technical textile application.

The project involves building application and standards for the use of CGC products in different fields. The use and application for different grades of product and its development by synchronizing the parameters for producing non-woven coir product and there by converted into Coir Composites geo-textiles in different grades for which different product and process parameters have to be developed and optimized by testing the products as per ASTM standards to the Indian and International Standards Parameters of products for different grades to suit different field applications.

Development of methodologies for rural road construction is an ambitious and important program in rural road network development. It has been a well established fact that the rural road network in India needs to be improved and organized. In many areas in rural India, construction of roads in soft soils needs to be handled. While different methods of ground improvement are available for roads in urban areas which justify the

costs in terms of returns, these methods are expensive for rural roads. Hence it is necessary to develop coir geo-textile composite.

2. OBJECTIVES

Testing of Non Woven CGC as per ASTM Standards for evolving values meeting the requirements of Indian and International Standards and preparing draft standards for the following:

1. Light Weight Non-woven Fabrics
2. Medium Weight Non-woven Fabrics
3. Heavy Weight Non-woven Fabrics

Tensile Strength (ASTM D-4632)
Elongation@ Brake (ASTM D-4632)
Mullen Burst (ASTM D-3786)
Puncture strength (ASTM D-4833)
Trapezoidal Tear (ASTM D-4533)
Apparent Opening size (ASTM D-4751)
Permittivity (ASTM D-4491)

The different types of non-woven coir geo-textile composites has to fabricated in each of the light, medium and heavy with varied mass per unit area and same has to be tested as per international standards and optimized the value by modifying the process and a draft has to be made for varied end uses

2.1 Light Weight Non-woven Fabrics:

Most lightweight non-woven coir geo-textile composites are used as filter fabric in subsurface drainage applications. High flow rates and small openings are what make these non-woven coir geo-textile composites ideal as filter fabrics Wrapping a non-woven coir geo-textile composites filter around the drainage system allows water into the drain while preventing soils from clogging the system.In addition to drainage, lightweight non-woven coir geo-textile composites filter fabrics are often used as landscape fabric, weed barrier or for lightweight separation under pavers. Another use for lightweight non-woven coir geo-textile composites is as asphalt overlay. These particular non-woven coir geo-textile composites are designed to hold tack coat and withstand extreme temperatures. Placing non-woven coir geo-textile composites between the old asphalt and the new overlay reduces reflective cracking and extends the life of the asphalt. A moisture barrier that protects the overlay fabric from water intrusion is created when the non-woven coir geo-textile composites absorbs the tack coat.

- Subsurface drainage
- Filter fabric
- Under drain fabric

- Trench drains
- Landscaping
- Weed barrier
- Landscape fabric
- Lightweight separation
- Under paver walkways and patios

- Paving
- Asphalt overlay

2.2 Medium Weight Non-woven Fabrics:

Medium weight non-woven coir geo-textile composites are most commonly used for erosion control. A non-woven coir geo-textile composite allows water to pass through it while keeping existing soils in place. In addition, non-woven coir geo-textile composites can be used in separation / drainage applications. The non-woven can also used to protect stream crossings, feeding troughs, watering ramps, feedlots and loafing areas. Non-woven coir geo-textile composites as a cow carpet will provide better footing and create a healthier environment for animals.

3. EROSION CONTROL

- Rip rap fabric
- Separation / Drainage
- Stream crossings
- Bovine / Equestrian
- Cow carpet

3.1 Heavy weight non-woven fabric:

Heavy weight non-woven coir geo-textile composites can be used as a geo-membrane cushion. Placing a non-woven geo-textile above or below the geo-membrane helps protect it from punctures.

Heavy weight non-woven fabrics are also used for railroad stabilization. When placed under track, non-woven geo-textiles prevent intermixing of the ballast with the soil

- Geo-membrane cushioning
- Railroad and road separation

4. NEED FOR CHARACTERIZATION OF NON WOVEN COIR GEO-

TEXTILES COMPOSITES USING ASTM STANDARDS AND EVOLVING INDIAN AND INTERNATIONAL STANDARDS AND PREPARING DRAFT STANDARDS

a) Use of Coir for value added products.
b) There is requirement for technical products in geo-textiles
c) There is a need for natural products where in Coir can fill the vacuum.
d) The opportunity for coir for new application as CGC of different grades.

5. WORK DONE UNDER THE PROJECT

5.1 Development of Non-Woven Coir Geo-Textile Fabric and Composites

In order to improve the mechanical properties of the coir geo-textile fabrics. They were impregnated with polymer/resin with varied resin content. Three types of polymers/resins namely: 1. Natural Rubber 2. Polyvinyl Alcohol (PVA) and 3. Acrylic Binder were used for making non-woven coir geo-textile composites.

Natural rubber (without water) was impregnated with non-woven coir geo-textile composites by using 2 techniques a) Spray techniques b) Spray and passed through hot roller to obtained non-woven coir geo-textiles composites. In order further improve/enhance the resin content and mechanical properties of Light, Medium and Heavy weight coir geo-textile fabrics. In addition of natural rubber was mixed with water at a ratio resin : water = 1:1, 1:3 and 1:4 was impregnated with Non-Woven Coir Geo-Textile using spray techniques and converted into coir geo-textile composites.

Similarly PVA was impregnated with light, medium and heavy weight non-woven coir geo-textile fabrics at different resin content by mixing water at ration resin : water = 1:1, 1:2, 1:4, 1:6 and 1:8 was impregnated by brush and sun dried to make coir geo-textile – PVA composites.

Further 3 grades of acrylic resin namely HA 16, HA 20 and HA 24 with different resin content ration namely 1:1, 1:2, 1:4, 1:6 and 1:8 was

impregnated with light, medium and heavy weight non-woven coir geo-textile fabrics.

5.2 Tests and Test methods for characterization of Coir Geo-Textile Fabric and Composites

The Tests required for characterization of the non-woven coir geo-textile fabric and composites are determined based on the already available tests and test method for the woven coir geo-textiles. The list of 15 tests and test methods are shown in Table 1.

All the tests as shown in Table 1 were carried out for light, medium and heavy weight non-woven coir geo-textile composites with natural rubber polymer at CCRI, Cochin as the institute has all the necessary test facilities. The test results are shown Table 5 & Table 13, the geo-textile Fabric and Composite (with out Water) respectively. The other geo-textile composites with resin content 1:1, 1:3, and 1:4 were tested at SDC using the facilities at RV-TIFAC CDC and the results presented in Table 14 – 37.

5.3 Thickness and mass per unit area measurements of non-woven coir geo-textiles

Tests samples of 150 mm X 150 mm, 6 nos. each were cut from the light weight, medium weight and heavy weight non-woven coir geo-textiles fabrics and composites with out water and with water (1:1, 1:3, 1:4) were cut to determine the thickness and density. The thickness was measured using vernier calibers, average value of the specimen were taken and reported.

Density Measurement

The weight of the lightweight, medium weight and heavyweight non-woven coir geo-textile fabrics and composites with out water and with water were measured using electronics weighing scale. The mass per unit area (surface density) of these geo-textiles were determined and found to

be 490grams/ m^2, 660grams/ m^2 and 930 grams/m^2. Similarly, the weight and density calculations were carried out to determine the density of the light weight, medium weight and heavy weight non-woven coir geo-textile composites with out water and with water (1:1. 1:3, 1:4). The data is presented in Tables 1-3 and 4-6 and 7-9, 10-12 and 13-15, 16-18 respectively in the project Closing Report on Development of Non Woven Coir Geo-Textile Fabrics and Composites.

The density and resin content calculation of these composites are presented in Tables 20 – 25 in the Project Closing Report for Development of Non-woven Coir Geo-textile Composites Using Innovative Manufacturing Techniques.

The density and resin content calculation of these composites are presented in Tables 26 – 43 in the Project Closing Report for Development of Non-woven Coir Geo-textile Composites Using Innovative Manufacturing Techniques.

5.4 Tensile Tests of Coir Geo-Textiles Composites

In order to determine the mechanical Properties of Light weight, medium weight, and heavy weight Coir geo textile fabric and Composite. Tensile Strength, Strain(ASTM D 4595-86), Puncture Resistance cone drop test(IS 13132 part 4 :1992) CBR puncture strength (ASTM D 6241 –99) Apparent opening size AOS (ASTM 4751-99A) and Shear stress (IS 13326 part 1 1992) These tests are conducted in CCRI Cochin, and Average test results are shown in Table 5 and Table 13 respectively

Further the natural rubber was taken and mixed with water the ratio of resin to water is 1:1, 1:3, and 1:4. These composite samples are taken and determine the mechanical strength (Tensile Strength) of geo textile composite, a standard test method of ASTM D 4595 –86 as already been specified. However in order to determine the approximate value, tensile test was conducted using computerized tensile testing machine at RV-TIFAC Composite Design Centre. Tables 14- 19, 22-27, and 30-35 show tensile test data for light weight, medium weight, and heavy weight with water (1:1, 1:3, 1:4) non woven coir geo textile composite respectively. Figs 1-2, show the tensile test setup. Figs 3 show the failed specimen of the coir geo-textiles composites. Fig 7 – 12 show the load v/s deflection plot of the Coir Geo Textile Composites.

The tensile tests for light, medium and heavy weight non-woven coir geo-textile composites with PVA polymer with different content namely 1:1, 1:2, 1:4, 1:6 and 1:8 are presented in Tables 38 – 44 respectively. The load v/s deflection plot for light weight and heavy weight non-woven coir geo-textile composites with resin content ratio of 1:1 and 1:8 are presented fig. 14 & 15 respectively.

The tensile tests for light, medium and heavy weight non-woven coir geo-textile composites with Acrylic resin polymer grades HA 16, HA 20 and HA 24 with different content namely 1:1, 1:2, 1:4, 1:6 and 1:8 are presented in Tables 45 – 51 and 52 – 58 and 59 - 65 respectively. The load v/s deflection plot for light weight and heavy weight non-woven coir geo-textile composites with HA 16, HA 20 and HA24 with resin content ratio of 1:1 and 1:8 are presented fig. 16 & 17, 18 & 19 and 20 & 21 respectively.

The Photograph showing coir geo-textile composite specimen with (PVA, HA 16, HA 20 and HA 24) after tensile testing is shown fig: 7

5.5 Permeability Tests (Moisture Absorption Test)

Test samples of 150 X 150mm, 6 samples each were cut from the light weight, medium weight and heavy weight non-woven coir geo-textile fabrics and composites were determine the moisture absorption characteristics. The initial weights of the specimens were taken using electronics weighing scale. The samples were then immersed in water for 24hrs. The samples are removed from the water tank after 24 hrs and the final weight are measured. The increase in weight for each sample was determined and the percentage of moisture absorption for all the specimens were calculated and same is presented in Table 9. Fig 4 – 6 show the tested specimen of coir geo-textile composites.

Similarly the resin was taken and mixed with water ratio of resin to water is 1:1, 1:3, 1:4 the resin was taken and spared in Light weight, medium weight and heavy weight coir geo textile Composite. The samples were immersed in water 24 hrs. the samples are removed from to water tank after 24 hrs and the final weight are determined and the percentage of moisture absorption for all the specimen were calculated and same is presented table 20, 28, 36 respectively and the average complete test results are presented in tables 29 and 37.

6. CONCLUSION

Light Weight, Medium Weight and Heavy Weight Non-Woven Coir Geo-Textile Fabric and Composites developed at SDC were subjected to material characterization by carrying out extensive mechanical testing. The tests and test method for the characterization are finalized based on the data available for woven coir geo-textiles. Light weight, medium weight and heavy weight Coir geo textile fabric and composite (with natural resin). The tests were carried out at RV-TIFAC, Composites Design Centre and also at CCRI Cochin. The test results are tabulated and shown in table 5, 13, 21, 29 and 37. The test results namely thickness, density, tensile strength and strain and permeability for Coir Geo-Textile Composites with natural rubber matrix (1:1, 1:3 and 1:4) carried out at RV- TIFAC CDC are presented in this report.

The tensile tests were carried out on light, medium and heavy weight coir non-woven geo-textile composites with PVA and Acrylic (HA 16, HA 20 and HA 24) resin with varied resin content ratio (1:1, 1:2, 1:4, 1:6 and 1:8) at RV-TIFAC Composite Design Centre. The test results are presented in Tables 38 – 65.

Fig: 1 Tensile Strength Test of Non-Woven Coir Geo-Textile Composites Specimen

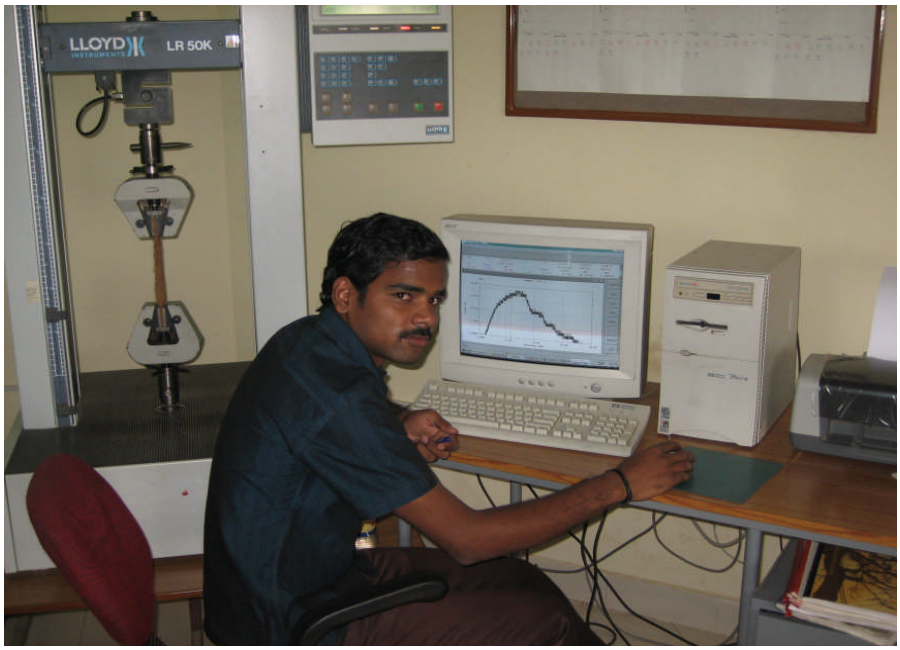

Fig: 2 Tensile Strength Test of Non-Woven Coir Geo-Textile Composites Specimen (load v/s deformation plot)

Fig: 3 Photograph showing the coir geo-textile composite specimen after tensile testing

Fig: 4 Light weight coir geo-textile composites specimen after 24hrs of water immersion

Fig: 5 Medium weight coir geo-textile composites specimen after 24hrs water immersion

Fig: 6 Heavy weight coir geo-textile composites specimen after 24hrs water immersion

Fig: 7 Photograph showing coir geo-textile composite specimen with (PVA, HA 16, HA 20 and HA 24) after tensile testing

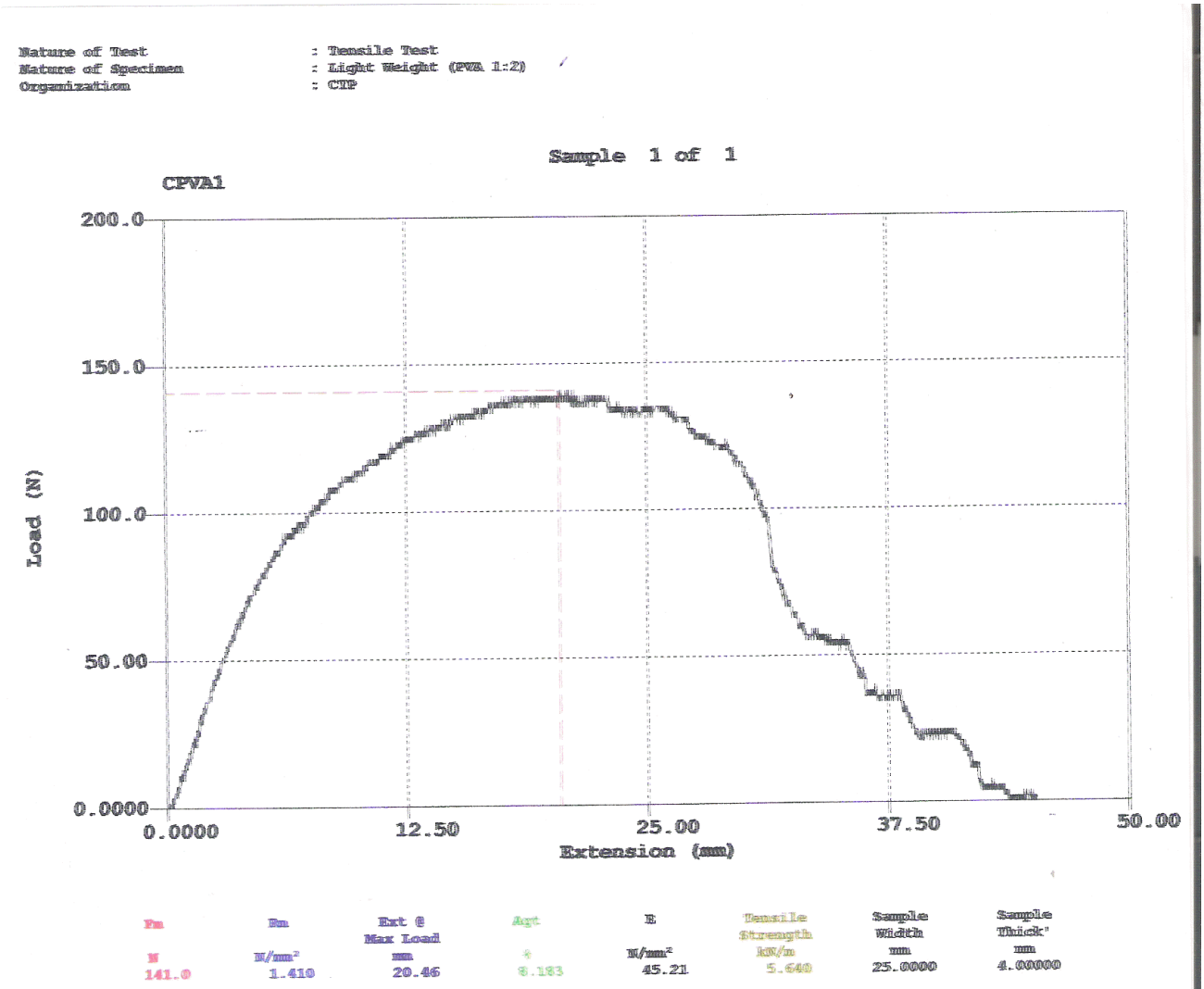

Fig: 14 Load Vs Deflection curve for light weight coir geo-textile composite (PVA) under tensile

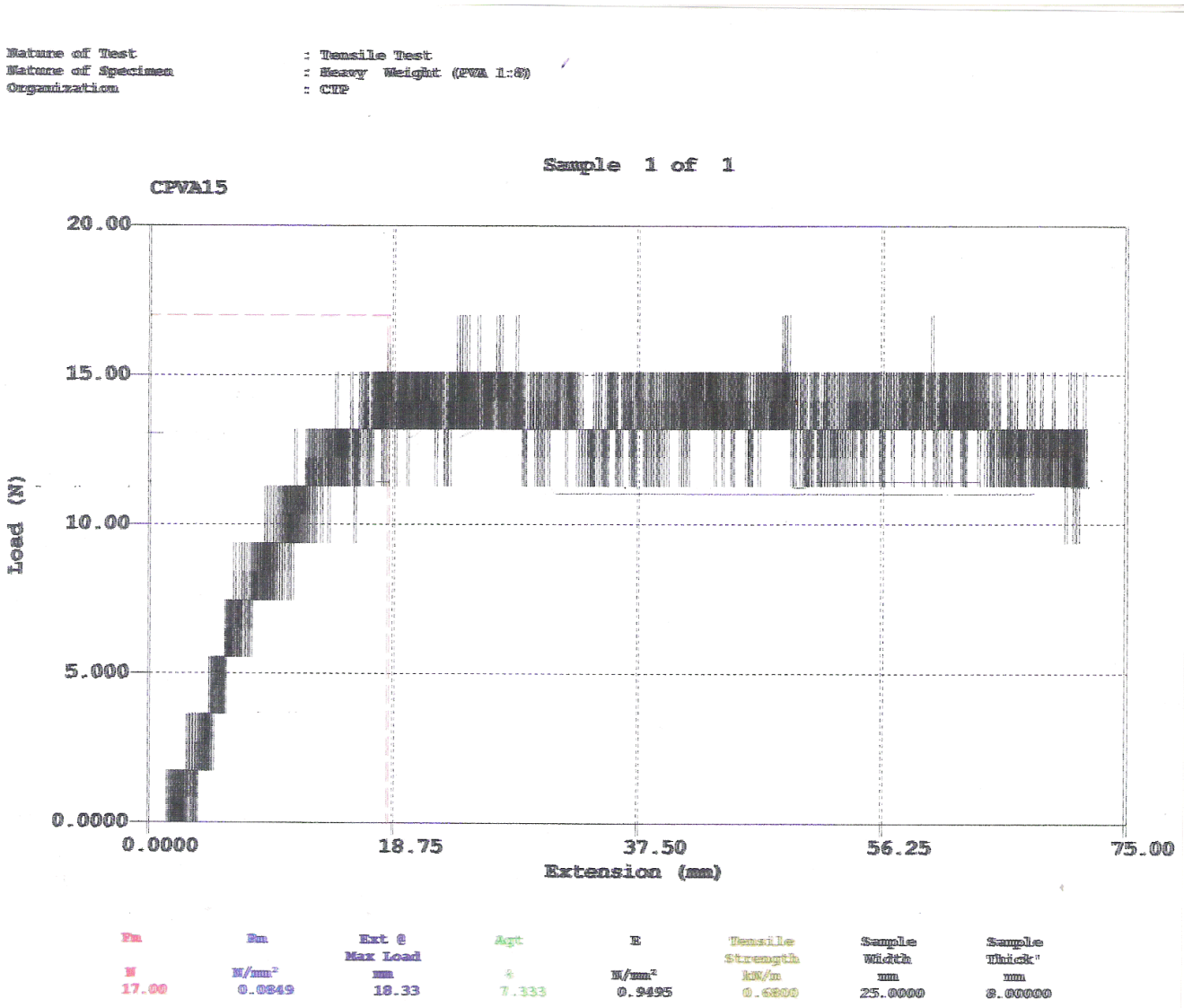

Fig: 15 Load Vs Deflection curve for light weight coir geo-textile composite (PVA) under tensile

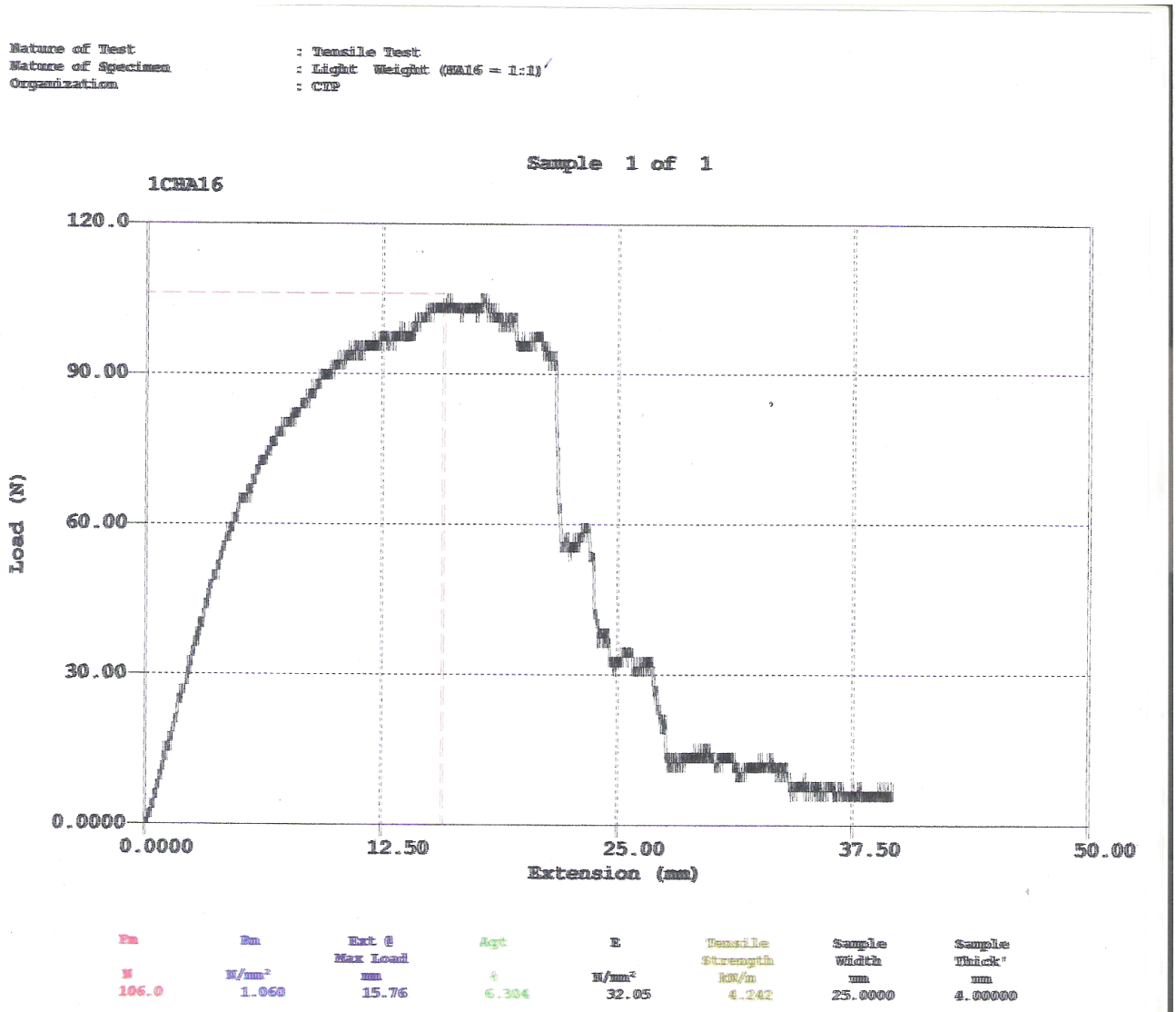

Fig: 16 Load Vs Deflection curve for light weight coir geo-textile composite (HA 16) under tensile

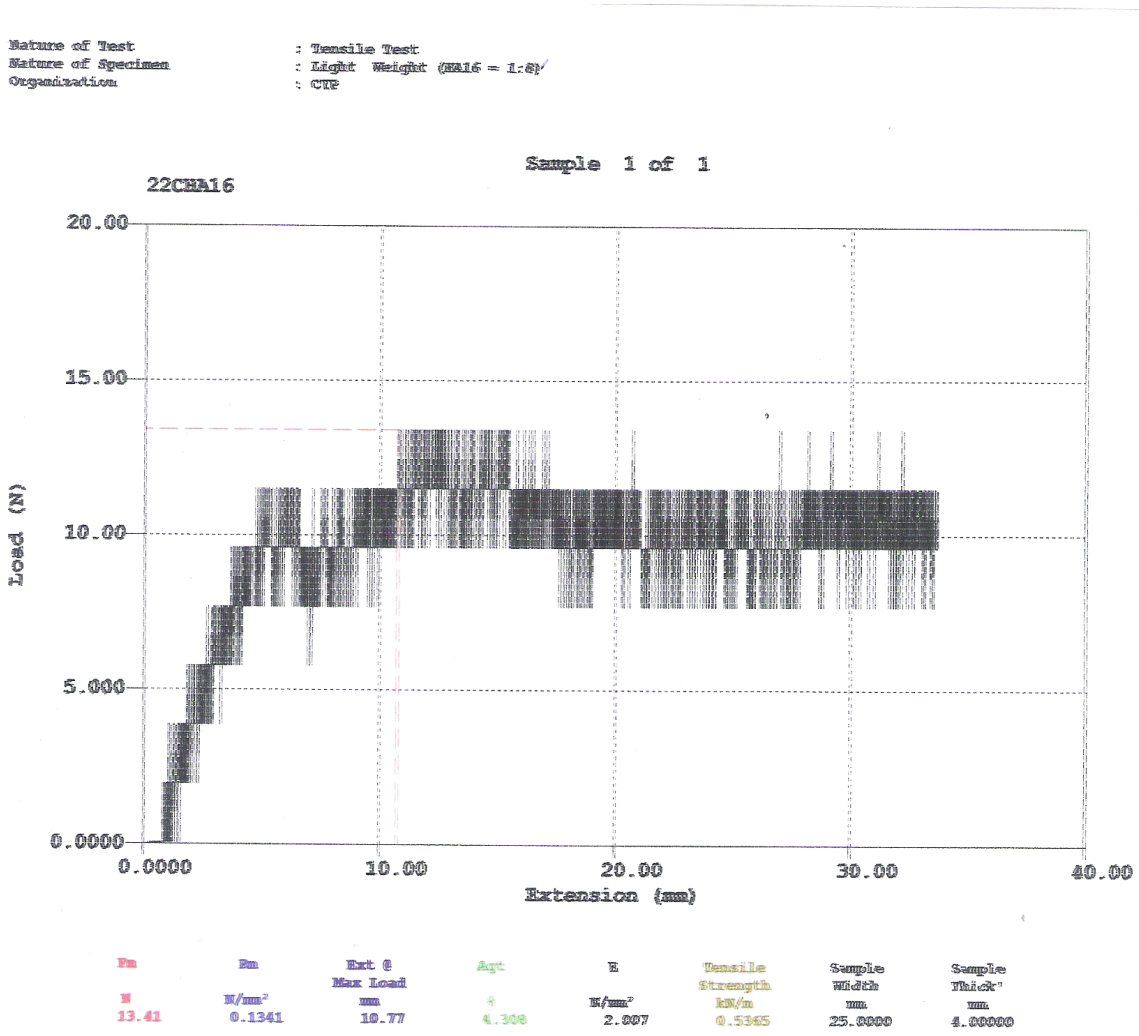

Fig: 17 Load Vs Deflection curve for light weight coir geo-textile composite (HA 16) under tensile

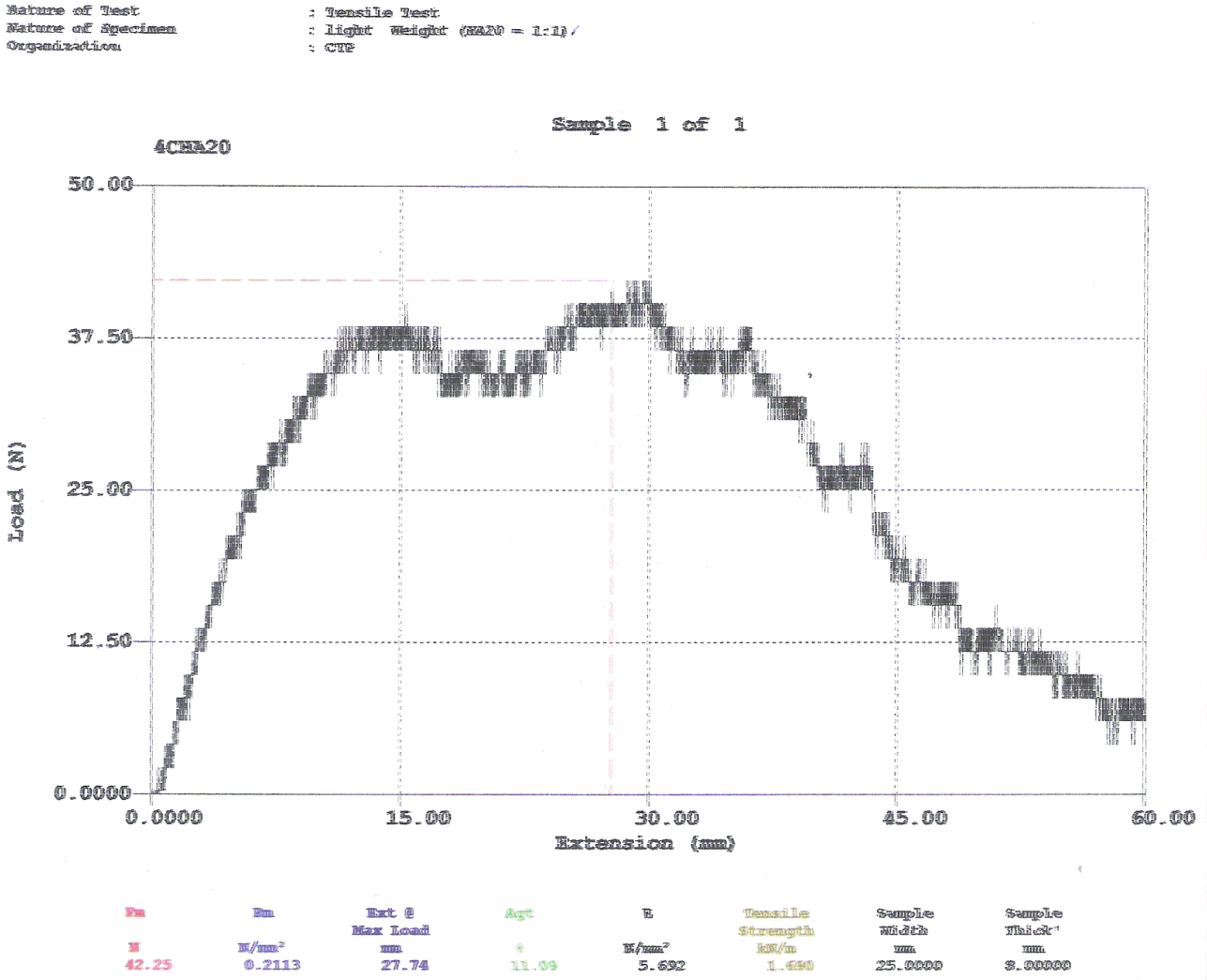

Fig: 18 Load Vs Deflection curve for light weight coir geo-textile composite (HA 20) under tensile

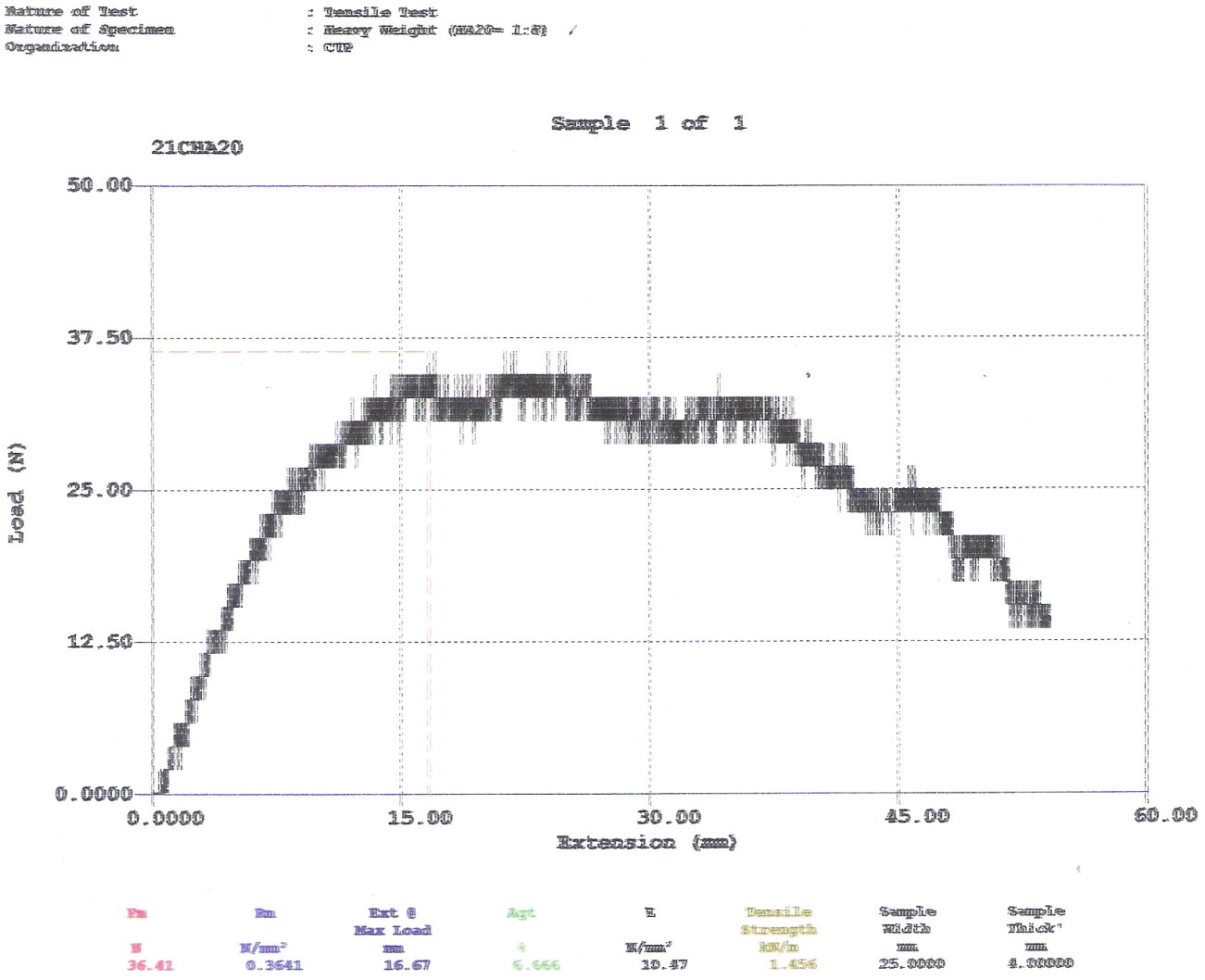

Fig: 19 Load Vs Deflection curve for light weight coir geo-textile composite (HA 20) under tensile

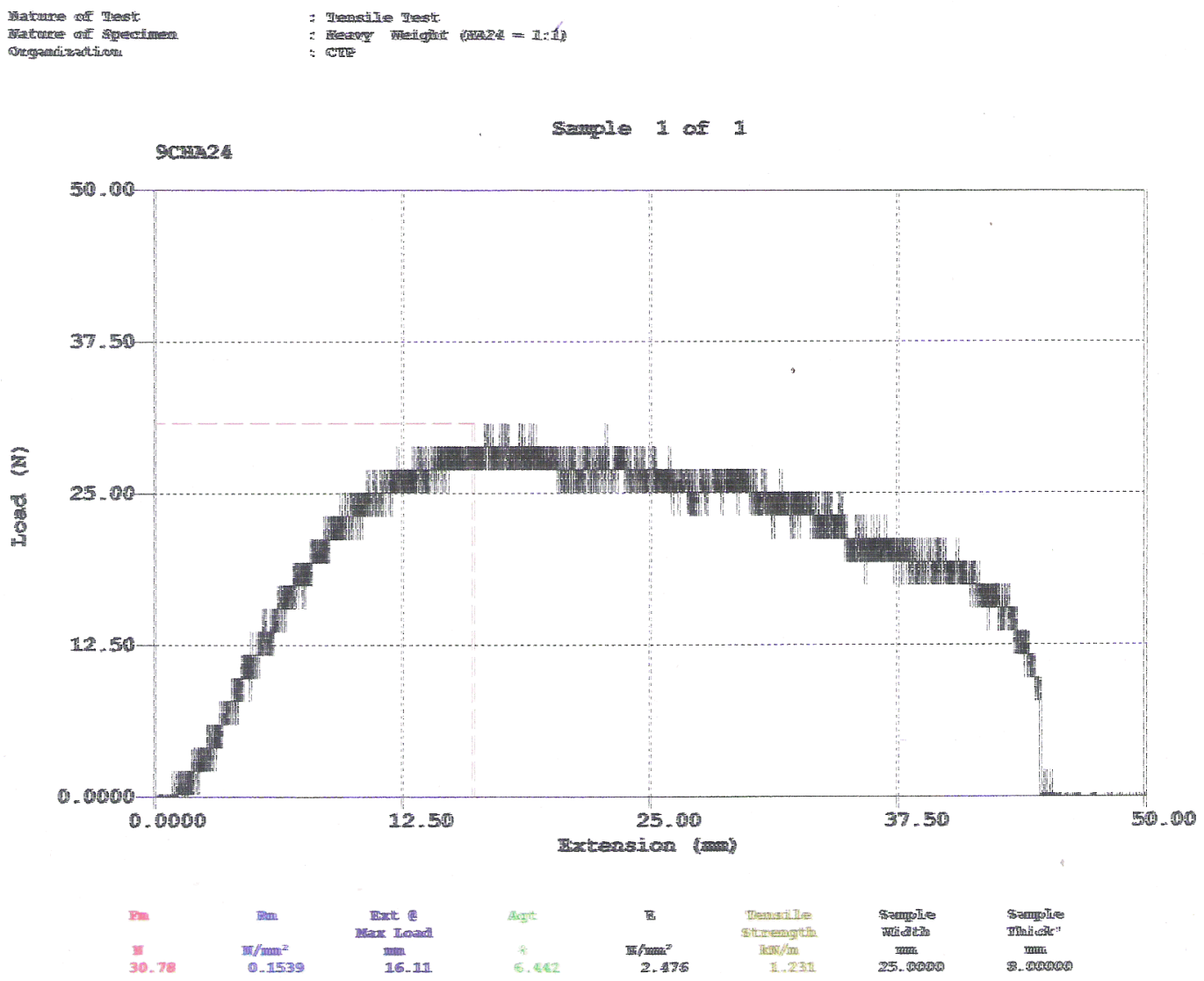

Fig: 20 Load Vs Deflection curve for light weight coir geo-textile composite (HA 24) under tensile

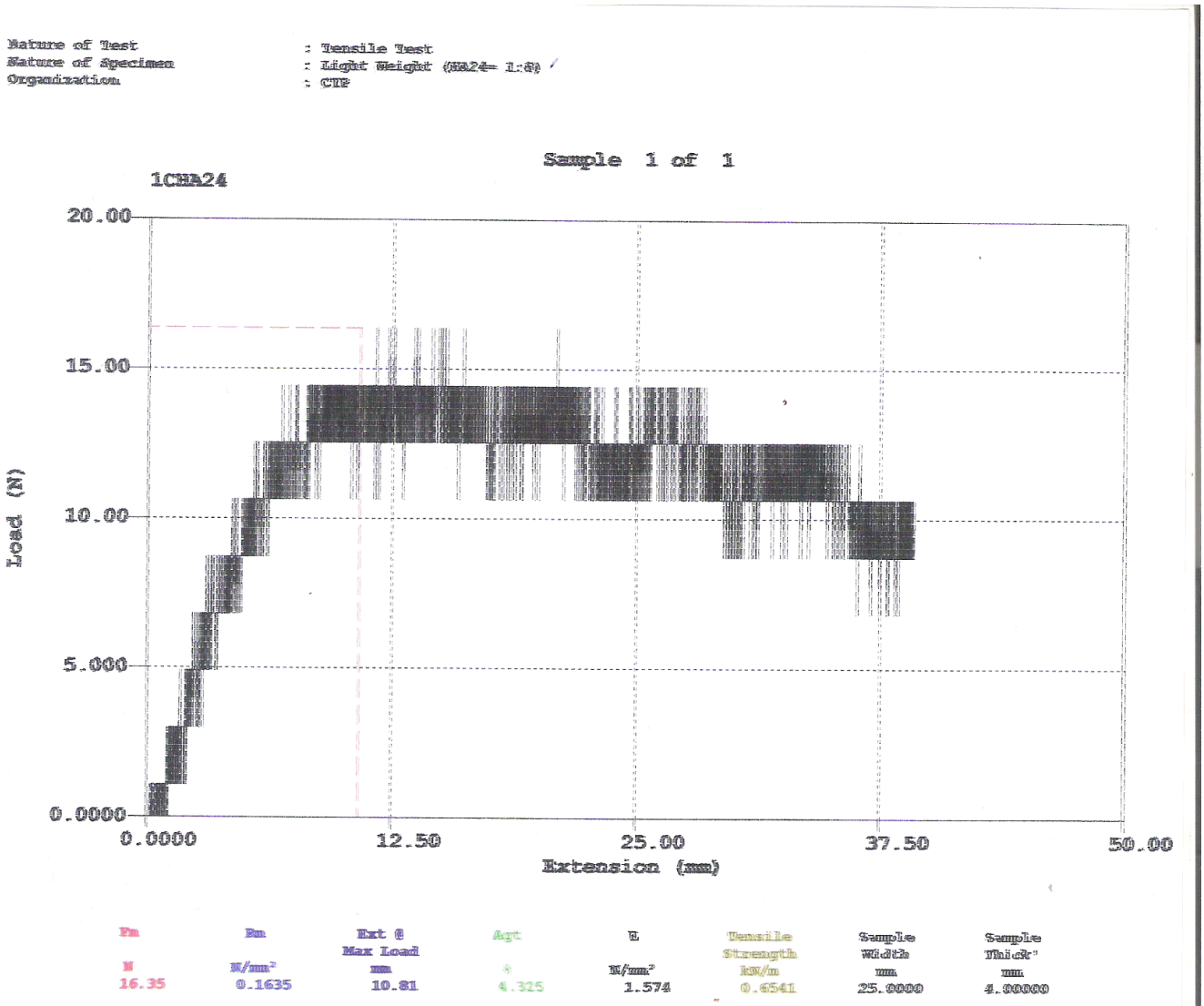

Fig: 21 Load Vs Deflection curve for light weight coir geo-textile composite (HA 24) under tensile

Table 1. List of Tests to be carried out on Non-Woven Coir Geo-Textile Fabrics and Composites and the test methods.

Sl. No	Property	Test Method
	Material	
1	Thickness	IS 13162 (part 3)
2	Mass per unit area (min)	IS 12503 (part 1)
3	Wide width tensile strength Dry (Minimum) MD CD	IS 13162 (part 5)
4	Strain – Dry MD CD	IS 13162 (part 5)
5	Wide width tensile strength wet (Minimum) MD CD	IS 13162 (part 5)
6	Strain – Wet MD CD	IS 13162 (part 5)
7	Puncture resistance cone drop test (Min), (mm)	IS 13162 (part 4)
8	Trapezoidal Tearing strength (KN), (Min) MD CD	IS 14293
9	Shear Stress (Kg/cm^2) 0.5 1.0 1.5 2.0	IS 13326 part 1
10	Permeability (See[1]), (Min)	IS 14324
11	Bursting Strength (Kg/si), (Min)	IS 1966
12	Apparent opening size (AOS)mm(Min)	Annexure B
13	No of Picks	IS 12503 (part 1)
14	No of Ends	IS 12503 (part 1)
15	Slope	

Table 2. Tensile test for Light weight non-woven coir geo-textile fabric (450-500 g/m²)

Sl No.	Length mm	Width mm	Thickness mm	Area mm²	Load @ Break (N)	Tensile Strength (KN/m)	Load @ max def. mm	Strain %
1	250	25	2	50	10.16	0.4064	74.94	29.98
2	250	25	4	100	9.763	0.3905	43.60	17.44
3	250	25	3.5	87.5	11.33	0.4531	71.67	28.67
4	250	25	3.5	87.5	15.43	0.6172	40.61	16.24
5	250	25	3.5	87.5	14.54	0.5812	92.43	36.97
Avg.	**250**	**25**	**3.3**	**82.5**	**12.24**	**0.489**	**64.65**	**25.86**

Table 3. Tensile Test for Medium weight non-woven coir geo-textile fabric (650-700 g/m²)

Sl No.	Length mm	Width mm	Thickness mm	Area mm²	Load @ Break (N)	Tensile Strength (KN/m)	Load @ max def. mm	Strain %
1	250	25	7.5	187.5	11.94	0.4775	25.64	10.26
2	250	25	7.5	187.5	13.66	0.5463	42.78	17.11
3	250	25	7.5	187.5	11.49	0.4597	37.75	15.10
4	250	25	7.5	187.5	11.66	0.4664	34.03	13.61
5	250	25	7.5	187.5	13.62	0.5449	45.17	18.07
Avg.	**250**	**25**	**7.5**	**187.5**	**10.47**	**0.498**	**37.07**	**14.83**

Table 4. Tensile Test for Heavy weight non-woven coir geo-textile fabric (900-950 g/m²)

Sl No.	Length mm	Width mm	Thickness mm	Area mm²	Load @ Break (N)	Tensile Strength (KN/m)	Load @ max def. mm	Strain %
1	250	25	10	250	13.15	0.5261	25.61	10.24
2	250	25	10	250	8.164	0.3266	17.84	7.136
3	250	25	10	250	11.10	0.4439	28.46	11.38
4	250	25	10	250	11.33	0.4536	26.70	10.68
5	250	25	10	250	13.06	0.5225	25.48	10.19
Avg.	**250**	**25**	**10**	**250**	**11.36**	**0.4614**	**24.81**	**9.925**

Table 5. Physical and mechanical properties of Non- Woven Coir Geo Textile Fabrics

SL. No.	Property		Tested values	Tested Values	Tested values	Test method
	Material		Light Weight	Medium Weight	Heavy Weight	
1.	Thickness (mm)		6.8 mm	8.44mm	14.57mm	ASTM D 5199-01
2.	Mass per unit area (g/m²)		480	630	950	ASTM D 5261-92
3.	Wide Width Tensile Strength (Dry)	Warp	0.5	0.61	0.72	ASTM D 4595-86
		Weft	0.38	0.616	0.50	"
4.	Wide Width Tensile Strength (wet)	Warp	0.42	0.48	0.55	"
		Weft	0.30	0.33	0.44	"
5.	Strain % (Dry)	Warp	32	37.06	36.93	"
		Weft	14.6	14.26	21.86	"
6.	Strain% (Wet)	Warp	37.0	20.0	23.33	"
		Weft	8.20	14.60	13.33	"
7.	Puncture Resistance Cone Drop Test)(min) (mm)		15.66	16	-	IS 13132 (Part 4): 1992
8.	CBR Puncture Strength (Kgf)		27	21.7	59.8	ASTM D 6241-99
9.	Apparent Opening Size (AOS) (mm)		1.15	0.65	1.18	ASTM D 4751-99A
10	Shear Stress (Kg/cm²)	0.5 Kg/cm²	0.467	0.476	0.523	IS13326 (Part 1): 1992
		1 Kg/cm²	0.644	0.775	0.766	"
		1.5 Kg/Cm²	1.037	0.999	0.953	"

		2 Kg/cm²	1.36	1.22	1.261	“
11.	Trapezoidal Tearing Strength (KN), (Min)		-	-	-	-
12.	Permeability (see’), (min)		-	-	-	-
13.	Bursting Strength (Kg/si), (min)		-	-	-	-
14.	No of picks		-	-	-	-
15.	No of ends		-	-	-	-
16.	Slope		-	-	-	-

Table 6. Tensile Test for Light Weight Coir Geo-Textile Composite sprayed with natural rubber, with out water

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Ext.@ Max. Load (mm)	Strain %
1	250	24.0	2.5	60.00	18.86	0.8405	22.41	6.177
2	250	23.3	2.5	58.33	15.40	0.6608	12.94	5.177
3	250	24.0	3.0	72.00	9.262	0.4824	9.262	3.705
4	250	25.0	3.0	75.00	12.24	0.6894	14.43	5.774
5	250	24.0	3.0	72.00	16.26	0.6774	22.98	9.192
Avg.	**250**	**24.0**	**2.8**	**67.46**	**14.46**	**0.6704**	**16.40**	**6.005**

Table 7. Tensile Test for Medium Weight Non-Woven Coir Geo-Textile Composite with natural rubber with out water

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Ext.@ Max. Load (mm)	Strain %
1	250	25.0	5.0	125.0	16.71	0.6685	2.704	6.759
2	250	24.66	5.0	123.3	21.81	0.8842	6.620	16.55
3	250	25.0	5.0	125.0	21.01	0.8741	6.420	37.08
4	250	24.0	5.0	120.0	25.86	1.0780	4.548	11.37
5	250	24.25	5.0	121.25	37.70	1.3480	6.986	17.46
Avg.	**250**	**24.58**	**5.0**	**122.91**	**23.61**	**0.970**	**5.455**	**17.842**

Table 8. Tensile Test Result for Heavy Weight Non-Woven Coir Geo-Textile Composite sprayed with natural rubber with out water

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Ext.@ Max. Load (mm)	Strain %
1	250	25	8.5	212.5	20.67	0.8269	8.206	20.92
2	250	25	8.5	212.5	17.35	0.6939	9.843	25.10
3	250	25	8.5	212.5	18.49	0.7395	12.03	30.68
4	250	25	8.5	212.5	16.60	0.6662	8.784	22.40
5	250	24	8.5	204.0	19.00	0.7917	12.94	32.99
Avg.	**250**	**24.8**	**8.5**	**210.8**	**18.22**	**0.7436**	**10.36**	**26.41**

Table 9. Water Absorption Test of Non-Woven Coir Geo-Textile Composites

Sl No.	Type of Geo-Textile	Sample Size (mm)	Initial Weight (grams)	Immersion Period	Final Weight	% of moisture absorption
1	Light Weight	150X150	16.84	24 hrs	27.29	62.05
2	Medium Weight	160X145	25.31	24 hrs	40.77	61.08
3	Heavy Weight	165X140	29.86	24 hrs	50.17	68.07

Table 10. Tensile test for Light weight non-woven coir geo-textile composite after 24hrs cold water immersion.

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Load @ max def. mm	Strain %
1	250	25	4	100	29.17	0.5833	56.39	22.56
2	250	25	4	100	27.11	0.5422	29.44	11.78
3	250	25	3.5	87.5	21.41	0.4463	21.41	8.563
4	250	25	3.5	87.5	19.16	0.3832	16.33	6.533
5	250	25	4.0	100.0	28.33	0.5665	33.58	13.43
6	250	25	5.0	125.0	27.85	0.5570	33.19	13.28
Avg.	**250**	**25**	**4.00**	**100**	**25.50**	**0.5130**	**31.72**	**23.69**

Table 11. Tensile test for Medium weight non-woven coir geo-textile composite after 24hrs cold water immersion.

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Load @ max det. mm	Strain %
1	250	25	7	175	29.64	0.5929	15.85	6.340
2	250	25	7	175	17.66	0.3532	16.28	6.513
3	250	25	7	175	30.00	0.6000	12.11	4.842
4	250	25	7	175	32.32	0.6464	18.62	7.449
5	250	25	7	175	22.57	0.4513	11.95	4.780
6	250	25	7	175	24.98	0.4996	15.14	6.055
Avg.	250	25	7	175	26.195	**0.5239**	14.99	5.996

Table 12. Tensile test for Heavy weight non-woven coir geo-textile composite after 24hrs cold water immersion.

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Load @ max det. mm	Strain %
1	250	25	10	250	19.01	0.3802	19.65	7.859
2	250	26	10	260	13.28	0.2555	27.56	11.02
3	250	24	10	240	22.01	0.4586	29.49	11.80
4	250	24	10	240	19.06	0.3970	35.04	14.02
5	250	25	10	275	15.29	0.3057	23.79	9.515
6	250	25	10	250	17.05	0.3110	31.70	12.68
Avg.	**250**	**24.83**	**10**	**252.5**	**17.61**	**0.3513**	**27.87**	**11.14**

Table 13. Physical and mechanical properties of Non- Woven Coir Geo Textile Composites

SL. No.	Property		Tested values	Tested Values	Tested values	Test method
	Material		Light Weight	Medium Weight	Heavy Weight	
1.	Thickness (mm)		9.80	14.77	13.40mm	ASTM D 5199-01
2.	Mass per unit area (g/m²)		660	970	1240	ASTM D 5261-92
3.	Wide Width Tensile Strength (Dry)	Warp	1.61	2.13	2.27	ASTM D 4595-86
		Weft	0.64	1.13	1.72	“
4.	Wide Width Tensile Strength (wet)	Warp	1.38	1.00	0.97	“
		Weft	0.917	1.22	0.86	“
5.	Strain % (Dry)	Warp	15	22	38	“
		Weft	23.32	1.13	22.64	“
6.	Strain% (wet)	Warp	39.08	36	32	“
		Weft	19.32	22	18.67	“
7.	Puncture Resistance Cone Drop Test)(min) (mm)		8.8	2.33	2.66	IS 13132 (part 4) :1992
8.	CBR Puncture Strength (Kgf)		54.4	87	81.6	ASTM D 6241-99
9.	Apparent Opening Size (AOS) (mm)		0.75	0.57	0.46	ASTM D 4751-99A

10	Shear Stress (Kg/cm^2)	0.5 Kg/cm^2	0.476	0.420	0.336	IS13326 (Part 1): 1992
		1 Kg/cm^2	0.663	0.476	0.448	"
		1.5 Kg/Cm^2	0.822	0.803	0.596	"
		2 Kg/cm^2	1.317	1.439	1.180	"
11.	Trapezoidal Tearing Strength (KN), (Min)		-	-	-	-
12.	Permeability (see'), (min) Moisture Absorption Test		62.05	61.08	68.07	-
13.	Bursting Strength (Kg/si), (min)		-	-	-	-
14.	No of picks		-	-	-	-
15.	No of ends		-	-	-	-
16.	Slope		-	-	-	-

Table 14. Tensile Test for Light Weight Coir Geo-Textile Composite sprayed with natural rubber mixed with water – 1:1

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Strain %	Ext.@ Max. Load (mm)
1	250	25	5	125	18.47	0.7389	17.46	43.64
2	250	25	5	125	12.19	0.4877	12.84	32.11
3	250	25	5	125	14.96	0.5984	23.60	59.12
4	250	25	5	125	21.98	0.8591	17.56	43.16
5	250	25	5	125	12.21	0.4882	11.20	28.01
6	250	25	5	125	13.87	0.5550	17.00	42.51
Avg.	**250**	**25**	**5**	**125**	**15.53**	**0.6212**	**16.56**	**41.42**

Table 15. Tensile Test for Medium Weight Coir Geo-Textile Composite sprayed with natural rubber mixed with water – 1:1

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Strain %	Ext.@ Max. Load (mm)
1	250	25	7	175	22.58	0.9031	2.680	6.701
2	250	25	7	175	27.01	1.080	4.667	11.17
3	250	25	7	175	36.34	1.453	3.076	13.90
4	250	25	7	175	24.54	0.9817	4.122	10.53
5	250	25	7	175	22.28	0.8911	4.398	10.99
6	250	25	7	175	21.13	0.8991	3.984	9.734
Avg.	**250**	**25**	**7**	**175**	**25.64**	**1.184**	**3.736**	**9.469**

Table 16. Tensile Test for Heavy Weight Coir Geo-Textile Composite sprayed with natural rubber mixed with water – 1:1

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Strain %	Ext.@ Max. Load (mm)
1	250	25	10	250	19.42	0.7766	14.87	37.19
2	250	25	10	250	22.03	0.8812	13.90	34.75
3	250	25	10	250	21.17	0.8470	9.456	13.90
4	250	25	10	250	31.28	1.251	19.84	16.70
5	250	25	10	250	23.32	0.9329	11.00	27.50
6	250	25	10	250	38.04	1.521	17.67	44.17
Avg.	**250**	**25**	**10**	**250**	**25.87**	**1.0349**	**14.456**	**36.143**

Table 17. Tensile Test for Light Weight Coir Geo-Textile Composite sprayed with natural rubber mixed with water – 1:1 after 24hrs coldwater immersion

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Strain %	Ext.@ Max. Load (mm)
1	250	25	5	125	11.18	0.2236	7.521	18.80
2	250	25	5	125	13.92	0.2783	11.42	28.55
3	250	25	5	125	13.38	0.2676	8.597	21.34
4	250	25	5	125	11.56	0.2313	10.05	25.12
5	250	25	5	125	14.63	0.2927	14.17	35.92
6	250	25	5	125	8.765	0.1741	5.50	13.75
Avg.	**250**	**25**	**5**	**125**	**12.22**	**0.2446**	**9.543**	**23.91**

Table 18. Tensile Test for Medium Weight Coir Geo-Textile Composite sprayed with natural rubber mixed with water – 1:1 after 24hrs coldwater immersion

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Strain %	Ext.@ Max. Load (mm)
1	250	25	7	175	11.61	0.2322	27.96	69.91
2	250	25	7	175	10.75	0.2151	12.03	30.07
3	250	25	7	175	11.70	0.2340	18.37	45.93
4	250	25	7	175	11.66	0.2333	20.80	51.99
5	250	25	7	175	12.06	0.2405	12.81	32.03
6	250	25	7	175	12.41	0.2482	15.51	37.78
Avg.	**250**	**25**	**7**	**175**	**11.698**	**0.2338**	**17.91**	**44.78**

Table 19. Tensile Test for Heavy Weight Coir Geo-Textile Composite sprayed with natural rubber mixed with water – 1:1 after 24hrs coldwater immersion

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Strain %	Ext.@ Max. Load (mm)
1	250	25	10	250	11.38	0.2277	17.38	43.45
2	250	25	10	250	13.71	0.2743	18.08	45.19
3	250	25	10	250	12.85	0.2590	12.44	31.10
4	250	25	10	250	12.54	0.2507	8.393	20.98
5	250	25	10	250	15.54	0.3107	20.87	52.19
6	250	25	10	250	12.75	0.2550	10.59	26.47

Avg.	**250**	**25**	**10**	**250**	**13.128**	**0.26255**	**14.62**	**36.56**

Table 20. Water Absorption Test of Non Woven Coir Geo-Textile Composite Ratio: Rubber – Water 1:1

Sl No.	Type of Geo Textile	Sample Size (mm)	Initial Weight (g)	Immersion Period hrs	Final Weight (g)	% of Moisture Absorption
1	Light Weight	150X150	12.73	24	20.56	61.50
2	Medium Weight	150X150	19.55	24	35.11	79.59
3	Heavy Weight	150X150	26.18	24	48.18	84.03

Table 21. Physical and mechanical properties of Non- Woven Coir Geo Textile Composite Ratio Rubber – Water: 1:1

SL No.	Property	Tested Values	Tested Values	Tested Values	Test Method
	Material	Light Weight	Medium Weight	Heavy Weight	
1.	Thickness	5.0 mm	7.0 mm	10 mm	IS 13162 (part 3)
2.	Mass per unit area (min)	450-500 g/m²	650-700 g/m²	900-950 g/m²	IS 12503 (part 1)
3.	Wide With Tensile Strength (with out rubber)	0.489 KN/m	0.498 KN/m	0.461 KN/M	IS13162(part5)
4.	Strain	25.86 %	14.83 %	9.92%	IS 13162 (part 5)
5.	Wide With Tensile Strength (With Rubber Dry)	0.0.6212 KN/m	1.184 KN /m	1.0349 KN/m	IS 13162 (part 5)
6.	Strain –Dry	16.56%	3.736%	14.456%	IS 13162 (part 5)
7.	Wide With Tensile Strength (after 24 hrs Cold water)	0.2446 KN/m	0.2338 KN/m	0.26255 KN/m	IS 13162 (part 5)
8.	Strain	9.543%	17.91 %	14.62 %	IS 13162 (part 5)
9.	Puncture Resistance Cone Drop Test (min)(mm)	-	-	-	IS 13162 (part 4)
10	Trapezoidal Tearing Strength (KN), (Min)	-	-	-	IS 14293
11.	Shear Stress	-	-	-	IS 13326 Part 1
12.	Permeability (see'), (min)	61.50	79.59	84.03	Is 14324
13.	Bursting Strength (Kg/ si), (min)	-	-	-	IS 1966
14.	Apparent Opening size (aos) mm (min)	-	-	-	Annexure B
15.	No of picks	-	-	-	IS 12503 (part 1)
16.	No of ends	-	-	-	IS 12503 (part 1)
17.	Slope	-	-	-	

Table 22. Tensile Test for Light Weight Coir Geo-Textile Composite sprayed with natural

rubber mixed with water – 1:3

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Strain %	Ext.@ Max. Load (mm)
1	250	25	4	100	9.471	0.3788	18.73	46.82
2	250	25	4	100	10.78	0.4313	10.66	26.65
3	250	25	4	100	13.99	0.5576	26.90	67.24
4	250	25	4	100	10.84	0.4335	16.09	40.22
5	250	25	4	100	11.46	0.4583	26.56	66.40
6	250	25	4	100	20.19	0.8054	24.39	60.99
Avg.	**250**	**25**	**4**	**100**	**12.78**	**0.5108**	**24.39**	**51.38**

Table 23. Tensile Test for Medium Weight Coir Geo-Textile Composite sprayed with natural rubber mixed with water – 1:3

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Strain %	Ext.@ Max. Load (mm)
1	250	25	7	175	23.05	0.9221	9.055	29.07
2	250	25	7	175	13.93	0.5573	8.063	20.16
3	250	25	7	175	13.90	0.5559	9.436	23.59
4	250	25	7	175	15.01	0.6002	4.495	11.24
5	250	25	7	175	14.94	0.5977	7.571	18.93
6	250	25	7	175	13.70	0.5479	5.516	13.79
Avg.	**250**	**25**	**7**	**175**	**15.75**	**0.6301**	**7.356**	**18.39**

Table 24. Tensile Test for Heavy Weight Coir Geo-Textile Composite

sprayed with natural rubber mixed with water – 1:3

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Strain %	Ext.@ Max. Load (mm)
1	250	25	10	250	26.28	1.051	14.21	35.54
2	250	25	10	250	21.96	0.8784	12.00	29.99
3	250	25	10	250	16.45	0.6580	13.42	33.55
4	250	25	10	250	21.97	0.8789	11.50	28.95
5	250	25	10	250	21.02	0.8409	12.78	31.96
6	250	25	10	250	21.96	0.8784	12.00	29.99
Avg.	**250**	**25**	**10**	**250**	**21.60**	**0.8642**	**12.65**	**31.66**

Table 25. Tensile Test for Light Weight Coir Geo-Textile Composite sprayed with natural rubber mixed with water – 1:3 after 24hrs coldwater immersion

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Strain %	Ext.@ Max. Load (mm)
1	250	25	4	100	9.150	0.3660	10.45	26.19
2	250	25	4	100	15.90	0.6391	11.01	27.53
3	250	25	4	100	16.11	0.6443	20.22	50.56
4	250	25	4	100	13.25	0.5300	41.16	102.9
5	250	25	4	100	12.13	0.4852	13.63	34.07
6	250	25	4	100	15.61	0.6243	14.82	37.06
Avg.	**250**	**25**	**4**	**100**	**13.70**	**0.5481**	**18.55**	**46.36**

Table 26. Tensile Test for Medium Weight Coir Geo-Textile Composite sprayed with natural rubber mixed with water – 1:3 after 24hrs coldwater immersion

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Strain %	Ext.@ Max. Load (mm)
1	250	25	7	175	15.11	0.6069	11.63	29.07
2	250	25	7	175	12.34	0.4937	6.600	16.50
3	250	25	7	175	12.40	0.4959	8.357	20.89
4	250	25	7	175	15.41	0.6164	12.76	31.90
5	250	25	7	175	12.93	0.5173	8.031	20.08
6	250	25	7	175	14.36	0.5744	11.74	29.35
Avg.	**250**	**25**	**7**	**175**	**13.75**	**0.5413**	**9.853**	**24.63**

Table 27. Tensile Test for Heavy Weight Coir Geo-Textile Composite sprayed with natural rubber mixed with water – 1:3 after 24hrs coldwater immersion

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Strain %	Ext.@ Max. Load (mm)
1	250	25	10	250	18.85	0.7541	11.40	28.50
2	250	25	10	250	11.61	0.4642	5.303	13.26
3	250	25	10	250	18.31	0.7326	7.906	19.77
4	250	25	10	250	15.06	0.6025	7.223	18.06
5	250	25	10	250	19.08	0.7713	24.00	60.00
6	250	25	10	250	15.06	0.6025	7.223	18.06
Avg.	**250**	**25**	**10**	**250**	**16.32**	**0.6545**	**10.50**	**26.27**

Table 28. Water Absorption Test of Non Woven Coir Geo-Textile Composite Ratio: Rubber – Water 1:3

Sl No.	Type of Geo Textile	Sample Size (mm)	Initial Weight (g)	Immersion Period hrs	Final Weight (g)	% of Moisture Absorption
1	Light Weight	150X150	12.51	24	20.75	65.86
2	Medium Weight	150X150	15.80	24	26.09	65.12
3	Heavy Weight	150X150	23.41	24	43.64	86.41

Table 29. Physical and mechanical properties of Non- Woven Coir Geo Textile Composite Ratio Rubber – Water: 1:3

SL No.	Property	Tested Values	Tested Values	Tested Values	Test Method
	Material	Light Weight	Medium Weight	Heavy Weight	
1.	Thickness	4.0 mm	7.0 mm	10 mm	IS13162(part3)
2.	Mass per unit area (min)	450-500 g/m²	650-700 g/m²	900-950 g/m²	IS12503(part1)
3.	Wide With Tensile Strength (with out rubber)	0.489 KN/m	0.498 KN/m	0.461 KN/M	IS 13162 (part 5)
4.	Strain	25.86 %	14.83 %	9.92%	IS 13162 (part 5)
5.	Wide With Tensile Strength (With Rubber Dry)	0.5108 KN/m	0.6301 KN /m	0.8642 KN/m	IS 13162 (part 5)
6.	Strain –Dry	24.39%	7.356%	12.65%	IS 13162 (part 5)
7.	Wide With Tensile Strength (after 24 hrs Cold water)	0.5481 KN/m	0.5413 KN/m	0.6545 KN/m	IS 13162 (part 5)
8.	Strain	18.55%	9.853 %	10.50 %	IS 13162 (part 5)
9.	Puncture Resistance Cone Drop Test (min)(mm)	-	-	-	IS 13162 (part 4)
10	Trapezoidal Tearing Strength (KN), (Min)	-	-	-	IS 14293
11.	Shear Stress	-	-	-	IS 13326 Part 1
12.	Permeability (see'), (min)	65.86	65.12	86.41	Is 14324
13.	Bursting Strength (Kg/ si), (min)	-	-	-	IS 1966
14.	Apparent Opening size (aos) mm (min)	-	-	-	Annexure B
15.	No of picks	-	-	-	IS 12503 (part 1)
16.	No of ends	-	-	-	IS 12503 (part 1)
17.	Slope	-	-	-	

Table 30. Tensile Test for Light Weight Coir Geo-Textile Composite sprayed with natural rubber mixed with water – 1:4

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Strain %	Ext.@ Max. Load (mm)
1	250	25	5	125	10.48	0.4191	6.645	16.61
2	250	25	5	125	10.31	0.4125	8.653	21.41
3	250	25	5	125	10.61	0.4244	5.559	13.90
4	250	25	5	125	10.71	0.4282	6.678	16.70
5	250	25	5	125	9.363	0.3745	7.246	18.11
6	250	25	5	125	13.53	0.5414	10.15	25.38
Avg.	**250**	**25**	**5**	**125**	**10.87**	**0.4333**	**7.473**	**18.68**

Table 31. Tensile Test for Medium Weight Coir Geo-Textile Composite sprayed with natural rubber mixed with water – 1:4

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Strain %	Ext.@ Max. Load (mm)
1	250	25	7	175	10.48	0.4461	8.761	21.90
2	250	25	7	175	9.318	0.3965	8.707	21.77
3	250	25	7	175	9.001	0.3601	5.146	12.87
4	250	25	7	175	9.728	0.3891	4.599	11.50
5	250	25	7	175	10.23	0.4093	10.66	26.64
6	250	25	7	175	5.761	0.2305	4.179	10.45
Avg.	**250**	**25**	**7**	**175**	**9.091**	**0.3719**	**7.008**	**17.52**

Table 32. Tensile Test for Heavy Weight Coir Geo-Textile Composite sprayed with natural rubber mixed with water – 1:4

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Strain %	Ext.@ Max. Load (mm)
1	250	25	10	250	12.03	0.4812	17.89	44.71
2	250	25	10	250	16.84	0.6735	33.62	84.06
3	250	25	10	250	15.78	0.6311	21.75	54.38
4	250	25	10	250	16.62	0.6649	11.01	27.52
5	250	25	10	250	18.34	0.7334	19.75	49.39
6	250	25	10	250	14.38	0.5932	20.66	51.64
Avg.	**250**	**25**	**10**	**250**	**15.665**	**0.6295**	**20.78**	**51.95**

Table 33. Tensile Test for Light Weight Coir Geo-Textile Composite sprayed with natural rubber mixed with water – 1:4 after 24hrs coldwater immersion

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Strain %	Ext.@ Max. Load (mm)
1	250	25	4	100	12.29	0.4898	13.12	32.81
2	250	25	4	100	15.20	0.6106	13.91	34.77
3	250	25	4	100	11.78	0.4712	5.532	13.83
4	250	25	4	100	14.94	0.5975	8.151	120.38
5	250	25	4	100	12.89	0.5155	8.539	21.35
6	250	25	4	100	13.65	0.5459	7.571	18.93
Avg.	**250**	**25**	**4**	**100**	**13.45**	**0.5384**	**9.463**	**23.67**

Table 34. Tensile Test for Light Weight Coir Geo-Textile Composite sprayed with natural rubber mixed with water – 1:4

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Strain %	Ext.@ Max. Load (mm)
1	250	25	7	175	13.81	0.2762	4.564	11.41
2	250	25	7	175	16.38	0.3275	4.141	10.35
3	250	25	7	175	13.51	0.2703	5.120	12.80
4	250	25	7	175	16.14	0.3228	5.702	14.26
5	250	25	7	175	14.65	0.2931	6.371	15.93
6	250	25	7	175	13.88	0.2776	3.221	8.051
Avg.	**250**	**25**	**7**	**175**	**14.72**	**0.2945**	**4.853**	**12.133**

Table 35. Tensile Test for Heavy Weight Coir Geo-Textile Composite sprayed with natural rubber mixed with water – 1:4 after 24hrs coldwater immersion

Sl No.	Length mm	Width mm	Thickness mm	Area mm^2	Load @ Break (N)	Tensile Strength (KN/m)	Strain %	Ext.@ Max. Load (mm)
1	250	25	10	250	9.630	0.1926	13.71	34.27
2	250	25	10	250	9.633	0.1927	11.95	29.84
3	250	25	10	250	13.19	0.2688	12.66	31.64
4	250	25	10	250	12.79	0.2559	23.45	58.63
5	250	25	10	250	12.05	0.2410	18.05	45.13
6	250	25	10	250	9.806	0.1961	19.90	49.76
Avg.	**250**	**25**	**10**	**250**	**11.18**	**0.2236**	**16.62**	**41.54**

Table 36. Water Absorption Test of Non Woven Coir Geo-Textile Composite Ratio: Rubber – Water 1:4

Sl No.	Type of Geo Textile	Sample Size (mm)	Initial Weight (g)	Immersion Period hrs	Final Weight (g)	% of Moisture Absorption
1	Light Weight	150X150	11.95	24	18.97	58.74
2	Medium Weight	150X150	15.51	24	28.43	83.30
3	Heavy Weight	150X150	22.56	24	41.80	85.28

Table 37. Physical and mechanical properties of Non- Woven Coir Geo Textile Composite Ratio Rubber – Water 1:4

SL No.	**Property**	**Tested Values**	**Tested Values**	**Tested Values**	**Test Method**
	Material	Light Weight	Medium Weight	Heavy Weight	
1.	Thickness	4.0 mm	7.0 mm	10 mm	IS13162(part3)
2.	Mass per unit area (min)	450-500 g/m²	650-700 g/m²	900-950 g/m²	IS12503(part1)
3.	Wide With Tensile Strength (with out rubber)	0.489 KN/m	0.498 KN/m	0.461 KN/M	IS13162(part5)
4.	Strain	25.86 %	14.83 %	9.92%	IS13162(part5)
5.	Wide With Tensile Strength (With Rubber Dry)	0.4333 KN/m	0.3719 KN /m	0.6295 KN/m	IS 13162 (part 5)
6.	Strain –Dry	7.473%	7.008%	20.78%	IS 13162 (part 5)
7.	Wide With Tensile Strength (after 24 hrs Cold water)	0.5384 KN/m	0.2945 KN/m	0.2236 KN/m	IS 13162 (part 5)
8.	Strain	9.463%	4.853 %	16.62 %	IS13162(part5)
9.	Puncture Resistance Cone Drop Test (min)(mm)	-	-	-	IS13162(part4)
10	Trapezoidal Tearing Strength (KN),(Min)	-	-	-	IS 14293
11.	Shear Stress	-	-	-	IS 13326 Part 1
12.	Permeability (see'), (min)	58.74	83.30	85.28	Is 14324
13.	Bursting Strength (Kg/ si), (min)	-	-	-	IS 1966
14.	Apparent Opening size (aos) mm (min)	-	-	-	Annexure B
15.	No of picks	-	-	-	IS12503(part1)
16.	No of ends	-	-	-	IS12503(part1)
17.	Slope	-	-	-	

Table 38. Tensile Test for Coir Geo Textile Composites Applied PVA Mixed With Water -1:1

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	3	75	45.38	1.815	10.10	4.038
2	Medium Weight	250	25	7	175	37.61	1.504	4.247	3.699
3	Heavy Weight	250	25	8	200	144.7	5.790	13.37	5.348

Table 39. Tensile Test for Coir Geo Textile Composites Applied PVA Mixed With Water- 1:2

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	141	5.640	20.46	8.813
2	Medium Weight	250	25	7	175	29.30	1.172	10.06	4.024
3	Heavy Weight	250	25	8	200	57.69	2.308	14.82	5.927

Table 40. Tensile Test for Coir Geo Textile Composites Applied PVA Mixed With

Water -1:3

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	32.88	1.315	6.693	2.677
2	Medium Weight	250	25	7	175	55.41	2.216	17.28	6.910
3	Heavy Weight	250	25	8	200	39.53	1.581	13.99	5.597

Table 41. Tensile Test for Coir Geo Textile Composites Applied PVA Mixed With Water -1:4

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	50.16	2.007	9.263	3.705
2	Medium Weight	250	25	7	175	25.61	1.025	17.39	6.954
3	Heavy Weight	250	25	8	200	55.51	2.220	13.29	5.316

Table 42. Tensile Test for Coir Geo Textile Composites Applied PVA Mixed With

Water -1:6

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	13.11	0.5244	21.60	8.641
2	Medium Weight	250	25	7	175	12.91	0.5166	15.82	6.328
3	Heavy Weight	250	25	8	200	20.74	0.8297	17.71	7.082

Table 43. Tensile Test for Coir Geo Textile Composites Applied PVA Mixed With Water- 1:8

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	20.13	0.8053	18.94	7.514
2	Medium Weight	250	25	7	175	16.39	0.6557	25.42	10.17
3	Heavy Weight	250	25	8	200	17	0.6800	18.33	7.333

Table 44 .Physical and Mechanical Properties of Non-Woven Coir Geo Textile

Composites (after applied PVA mixed with water)

SL.No.	Property	Tested Values	Tested Values	Test Values	Test Method
	Material	Light weight	Medium Weight	Heavy Weight	
1.	Thickness(after applied PVA)	4.0 mm	7.0 mm	8.0 mm	IS 1362 (part3)
2.	Wide With Tensile Strength(with PVA 1:1)	1.815	1.504	5.790	IS 13162 (part5)
3.	Strain (with PVA 1:1)	4.038	3.699	5.348	IS 13162 (Part5)
4.	Wide With Tensile Strength(with PVA 1:2)	5.640	1.172	2.308	IS 13162 (part5)
5.	Strain (with PVA 1:2)	8.183	4.024	5.927	IS 13162 (Part5)
6.	Wide With Tensile Strength(with PVA 1:3)	1.315	2.216	1.581	IS 13162 (part5)
7.	Strain (with PVA 1:3)	2.677	6.910	5.97	IS 13162 (Part5)
8.	Wide With Tensile Strength(with PVA 1:4)	2.007	1.025	2.220	IS 13162 (part5)
9.	Strain (with PVA 1:4)	3.705	6.954	5.316	IS 13162 (Part5)
10.	Wide With Tensile Strength(with PVA 1:6)	0.53	0.52	0.83	IS 13162 (part5)
11.	Strain (with PVA 1:6)	8.641	6.328	7.082	IS 13162 (Part5)
12.	Wide With Tensile Strength(with PVA 1:8)	0.8053	0.6557	0.6800	IS 13162 (part5)
13.	Strain (with PVA 1:8)	7.574	10.17	7.333	IS 13162 (Part5)

Table 45. Tensile Test for Coir Geo Textile Composites Applied HA16 Mixed With

Water -1:1

SL.No.	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	106	4.242	15.76	6.304
2	Medium Weight	250	25	7	175	15.97	0.6389	22.12	8.849
3	Heavy Weight	250	25	8	200	68.46	2.738	8.696	3.478

Table 46. Tensile Test for Coir Geo Textile Composites Applied HA16 Mixed With Water -1:2

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	13.90	0.5561	14.35	5.740
2	Medium Weight	250	25	7	175	21.18	0.8471	9.079	3.632
3	Heavy Weight	250	25	8	200	27.00	1.080	15.71	6.282

Table 47. Tensile Test for Coir Geo Textile Composites Applied HA16 Mixed With Water -1:3

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	22.86	0.9064	10.15	4.058
2	Medium Weight	250	25	7	175	15.99	0.6394	11.95	4.778
3	Heavy Weight	250	25	8	200	11.11	0.4445	8.649	3.460

Table 48. Tensile Test for Coir Geo Textile Composites Applied HA16 Mixed With

Water -1:4

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	19.04	0.7618	16.44	6.577
2	Medium Weight	250	25	7	175	21.97	0.8788	17.09	6.837
3	Heavy Weight	250	25	8	200	17.24	0.6895	24.35	9.741

Table 49. Tensile Test for Coir Geo Textile Composites Applied HA16 Mixed With Water -1:6

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	28.69	1.147	8.543	3.417
2	Medium Weight	250	25	7	175	25.04	1.002	20.52	8.208
3	Heavy Weight	250	25	8	200	21.80	0.8721	29.01	11.60

Table 50. Tensile Test for Coir Geo Textile Composites Applied HA16 Mixed With Water -1:8

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	13.41	0.5365	10.77	4.302
2	Medium Weight	250	25	7	175	13.02	0.5207	31.49	12.60
3	Heavy Weight	250	25	8	200	14.31	0.5725	30.50	12.20

Table 51 .Physical and Mechanical Properties of Non-Woven Coir Geo Textile

Composites (after applied HA 16 mixed with Water)

SL.No.	Property	Tested Values	Tested Values	Test Values	Test Method
	Material	Light weight	Medium Weight	Heavy Weight	
1.	Thickness(after applied HA16)	4.0 mm	7.0 mm	8.0 mm	IS 1362 (part3)
2.	Wide With Tensile Strength(with HA16- 1:1)	1.242	0.6389	2.738	IS 13162 (part5)
3.	Strain (with HA16 -1:1)	6.304	8.849	3.478	IS 13162 (Part5)
4.	Wide With Tensile Strength(with HA16 -1:2)	0.5561	0.8471	1.080	IS 13162 (part5)
5.	Strain (with HA16 -1:2)	5.740	3.362	6.282	IS 13162 (Part5)
6.	Wide With Tensile Strength(with HA16 -1:3)	0.9064	0.6394	0.4445	IS 13162 (part5)
7.	Strain (with HA16- 1:3)	4.058	4.778	3.460	IS 13162 (Part5)
8.	Wide With Tensile Strength(with HA16 -1:4)	0.7618	0.8788	0.6895	IS 13162 (part5)
9.	Strain (with HA16 -1:4)	6.577	6.837	9.741	IS 13162 (Part5)
10.	Wide With Tensile Strength(with HA16- 1:6)	1.147	1.002	0.8721	IS 13162 (part5)
11.	Strain (with PVA16 -1:6)	3.417	8.208	11.60	IS 13162 (Part5)
12.	Wide With Tensile Strength(with HA 16-1:8)	0.5365	0.5207	0.5725	IS 13162 (part5)
13.	Strain (with HA16- 1:8)	4.308	12.60	12.20	IS 13162 (Part5)

Table 52. Tensile Test for Coir Geo Textile Composites Applied HA20 Mixed With

Water -1:1

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	42.75	1.690	27.14	11.09
2	Medium Weight	250	25	7	175	75.13	3.005	24.27	9.709
3	Heavy Weight	250	25	8	200	24.49	0.9797	17.71	7.082

Table 53. Tensile Test for Coir Geo Textile Composites Applied HA20 Mixed With Water -1:2

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	70.50	2.820	25.74	10.30
2	Medium Weight	250	25	6	150	46.11	1.844	13.65	5.458
3	Heavy Weight	250	25	8	200	54.73	2.189	41.47	16.59

Table 54. Tensile Test for Coir Geo Textile Composites Applied HA20 Mixed With Water- 1:3

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	30.30	1.212	10.02	4.008
2	Medium Weight	250	25	7	175	21.41	0.8562	37.05	14.82
3	Heavy Weight	250	25	8	200	41.55	1.662	48.87	19.55

Table 55. Tensile Test for Coir Geo Textile Composites Applied HA20 Mixed With

Water -1:4

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	46.28	1.851	16.46	6.584
2	Medium Weight	250	25	6	150	14.95	0.5981	25.78	10.31
3	Heavy Weight	250	25	8	200	48.49	1.940	16.97	6.789

Table 56. Tensile Test for Coir Geo Textile Composites Applied HA20 Mixed With Water -1:6

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	51.40	2.056	11.92	4.768
2	Medium Weight	250	25	6	150	37.73	1.509	15.54	6.214
3	Heavy Weight	250	25	8	200	20.74	0.8298	13.29	5.316

Table 57. Tensile Test for Coir Geo Textile Composites Applied HA20 Mixed With Water -1:8

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	36.41	1.456	16.67	6.666
2	Medium Weight	250	25	6	150	48.55	1.942	14.47	5.789
3	Heavy Weight	250	25	8	200	50.92	2.037	12.28	4.912

Table 58 .Physical and Mechanical Properties of Non-Woven Coir Geo Textile Composites (after applied HA 20 mixed with Water)

SL.No.	Property	Tested Values	Tested Values	Test Values	Test Method
	Material	Light weight	Medium Weight	Heavy Weight	
1.	Thickness(after applied HA24)	4.0 mm	7.0 mm	8.0 mm	IS 1362 (part3)
2.	Wide With Tensile Strength(with HA20- 1:1)	1.690	3.005	0.9797	IS 13162 (part5)
3.	Strain (with HA20-1:1)	11.09	9.709	7.082	IS 13162 (Part5)
4.	Wide With Tensile Strength(with HA20 -1:2)	2.820	1.844	2.189	IS 13162 (part5)
5.	Strain (with HA20-1:2)	10.30	5.458	16.59	IS 13162 (Part5)
6.	Wide With Tensile Strength(with HA20-1:3)	1.212	0.8562	1.662	IS 13162 (part5)
7.	Strain (with HA20- 1:3)	4.008	14.82	19.55	IS 13162 (Part5)
8.	Wide With Tensile Strength(with HA20 -1:4)	1.851	0.5981	1.940	IS 13162 (part5)
9.	Strain (with HA20 -1:4)	6.584	10.31	6.789	IS 13162 (Part5)
10.	Wide With Tensile Strength(with HA20- 1:6)	2.056	1.509	0.8298	IS 13162 (part5)
11.	Strain (with PVA20 -1:6)	4.768	6.214	5.316	IS 13162 (Part5)
12.	Wide With Tensile Strength(with HA 20-1:8)	1.456	1.942	2.037	IS 13162 (part5)
13.	Strain (with HA20- 1:8)	6.666	5.789	4.912	IS 13162 (Part5)

Table 59. Tensile Test for Coir Geo Textile Composites Applied HA24 Mixed With Water -1:1

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	12.24	0.4896	13.06	5.224
2	Medium Weight	250	25	7	175	12.98	0.5191	15.45	6.181
3	Heavy Weight	250	25	8	200	30.78	1.231	16.11	6.442

Table 60. Tensile Test for Coir Geo Textile Composites Applied HA24 Mixed With Water- 1:2

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	31.39	1.256	8.423	3.369
2	Medium Weight	250	25	6	150	14.59	0.5838	19.13	7.652
3	Heavy Weight	250	25	8	200	26.46	1.058	23.75	9.500

Table 61. Tensile Test for Coir Geo Textile Composites Applied HA24 Mixed With Water -1:3

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	19.36	0.7746	17.08	6.833
2	Medium Weight	250	25	7	175	15.94	0.6377	23.86	9.544
3	Heavy Weight	250	25	8	200	20.26	0.8104	25.63	10.25

Table 62. Tensile Test for Coir Geo Textile Composites Applied HA24 Mixed With

Water -1:4

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	14.64	0.5854	26.61	10.64
2	Medium Weight	250	25	6	150	14.06	0.5625	11.61	4.645
3	Heavy Weight	250	25	8	200	16.96	0.6786	23.05	9.218

Table 63. Tensile Test for Coir Geo Textile Composites Applied HA24 Mixed With Water -1:6

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	17.61	0.7042	29.09	11.64
2	Medium Weight	250	25	7	175	15.78	0.6311	21.98	8.793
3	Heavy Weight	250	25	8	200	5.013	0.2005	5.773	2.309

Table 64. Tensile Test for Coir Geo Textile Composites Applied HA24 Mixed With Water- 1:8

SL.No	Particular	Length mm	Width mm	Thickness mm	Area mm2	Load @ Break N	Tensile Strength KN/m	Deformation @ Max. Load	Strain %
1	Light Weight	250	25	4	100	16.35	0.6541	10.81	4.325
2	Medium Weight	250	25	6	150	10.96	0.4382	17.21	6.884
3	Heavy Weight	250	25	8	200	15.64	0.6257	8.273	3.309

Table 65 .Physical and Mechanical Properties of Non-Woven Coir Geo Textile

Composites (after applied HA 24 mixed with Water)

SL.No.	Property	Tested Values	Tested Values	Test Values	Test Method
	Material	Light weight	Medium Weight	Heavy Weight	
1.	Thickness(after applied HA24)	4.0 mm	7.0 mm	8.0 mm	IS 1362 (part3)
2.	Wide With Tensile Strength(with HA24- 1:1)	0.4896	0.5191	1.231	IS 13162 (part5)
3.	Strain (with HA24-1:1)	5.224	6.181	6.442	IS 13162 (Part5)
4.	Wide With Tensile Strength(with HA24 -1:2)	1.256	0.5838	1.058	IS 13162 (part5)
5.	Strain (with HA24-1:2)	3.369	7.652	9.500	IS 13162 (Part5)
6.	Wide With Tensile Strength(with HA24-1:3)	0.7746	0.6377	0.8104	IS 13162 (part5)
7.	Strain (with HA24- 1:3)	6.833	9.544	10.25	IS 13162 (Part5)
8.	Wide With Tensile Strength(with HA24 -1:4)	0.5854	0.5625	0.6786	IS 13162 (part5)
9.	Strain (with HA24 -1:4)	10.64	4.645	9.218	IS 13162 (Part5)
10.	Wide With Tensile Strength(with HA24- 1:6)	0.7042	0.6311	0.2005	IS 13162 (part5)
11.	Strain (with PVA24 -1:6)	11.64	8.793	2.309	IS 13162 (Part5)
12.	Wide With Tensile Strength(with HA 24-1:8)	0.6541	0.4382	0.6257	IS 13162 (part5)
13.	Strain (with HA24-1:8)	4.325	6.884	3.309	IS 13162 (Part5)