Survey on Non-Woven Fabric for Geo Textile Applications

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Abstract- The fabric that is used in civil engineering and geo technical applications is called Geo-textiles. Geo- textiles are used with foundation soil, rock, earth or any other go technical engineering related material as an integral part of a human made project structure or system. They are classified on the basis of their manufacture, raw materials used and by their functions. They are commonly used in civil engineering applications and can be found above and below water behind retaining walls under pavement surfaces and wherever soil is present. In this paper, the survey on non-woven fabric for geo-textile applications is done.

Indexed Terms- Geo-textiles, civil engineering, pavement surfaces and non-woven fabrics.

I. INTRODUCTION

There are various methods of manufacturing fabrics such as weaving, non-woven methods and knitting. Non-woven fabrics are made by different methods such as adhesive bonded, needle punching, spun bonded, hydro entangle process, thermal bonding and stitch bonding. The use of needle punched non-woven fabrics has surged these years as they are extensively used in technical textiles. Also, the versatility of the needle punching process lies in the fact that it is the most suitable technique for producing fabrics from unspinnable fibres. Many publications and books contain valuable information on non-woven fabrics. Initially, polyester, viscose, polypropylene used, but later, jute, coir, sisal, banana and flax were used. The non-woven fabrics are successfully used in many technical applications rather than woven and knitted fabrics due to their simple production stages high efficiency of production, lower cost and disposability. Hearle*et al.* (1968) were the first research workers to report on the properties of needle punched non-woven, the effect of various parameters such as depth of needle penetration and strokes per minute. A theoretical model to predict the properties of needle punched non-woven fabrics was formulated and validated. Debnath (2004) conducted extensive work on the needle punching of jute fibres and published a number of papers. Physical properties of needle punched non-woven fabrics have been investigated by Vengsarkar (1966), Madhusoothanan (1990) and Debnath (2004). An extensive study of the properties of thermal bonding process has been done by Batra and Dharmadhikary (1995). Spun lace is another way of producing non-woven fabrics.

II. PREVIOUS RESEARCH ON NON-WOVEN FABRICS

Many tests, namely tensile, static puncture, air permeability and thermal conductivity, bending, compression and abrasion resistance have been conducted. A finite element model is developed to achieve a model for the non-uniform deformation of the spun bonded fabrics during uni-axial tensile test Bais-Singh *et al. (1998)*. Liao *et al. (1997)* used the finite element method to calculate the numerical solution of stress and strain distributions in different regions of the sample during tensile deformation. Hearle and Stevenson (1963) conducted studies for investigating anisotropy behaviour of non-woven fabrics. Cusick*et al. (1963)* have reported on the mechanical properties of many types of non-woven fabrics such as adhesive bonded, spun bonded and stitch bonded non-woven fabrics produced from different fibres. His paper is very useful to have a comprehensive knowledge of non-woven fabrics. The stress-strain behaviour of spun bonded, needle punched spun bonded, heat sealed and staple fibre needle punched non-woven fabrics have been investigated by Patel and Kothari (2001). They developed a model to predict the creep behaviour of non-woven fabrics using creep data and structural parameters of fabrics. A network structure of the constituent fibre of non-woven fabric was compared.

An artificial neural network has been applied to needle punched non-woven fabrics to predict their stress-strain characteristics (Debnath and Madhusoothanan 2008).

Thermal conductivity of non-woven fabrics produced from polypropylene before and after calendering has shown considerable changes Kopitar*et al. (2014)*.

Fidelis *et al. (2013)* have highlighted the importance of cross sectional area which has an important role.Comparable values of the tensile properties of sisal and coir as 468MPa and 175MPa were obtained by Girisha*et al. (2012)*.Wambua*et al. (2013)* have quoted that natural fibres have high demand in composites. Naito (2013) has reported on tensile properties of the carbon and other fibres. Yu *et al. (2006)* have quoted tensile strength of carbon fibres using Weibull modulus.

III. STUDIES ON NATURAL FIBRE, CHEMICAL TREATMENT OF NATURAL FIBRES AND TENSILE BEHAVIOUR OF NATURAL FIBRES

Fibre characteristics are very important in deciding the fabric properties. This is true in case of non-woven fabrics also. Fibre length, fibre diameter, tensile strength and elongation are few properties which have significant influence on the next process. In this survey, studies related to the measurement of tensile properties such as tensile strength and elongation were analyzed and their influences on the yarn and fabric properties are also discussed.

Further, the chemical treatments such as enzyme and alkali also have a significant effect on their characteristics. Therefore, studies related to the above treatment were also included in this section. In many studies in order to quantify the variation in fibre properties the statistical tool Weibullmodeling has been used.

A review of literature on natural fibres was presented by Senthilkumar and Anbu malar (2015). They have reviewed elaborately on the utilization of natural fibres in composites to produce automobiles and construction materials. The properties of sisal fibre compared favorably with that of other fibres.

A paper by Beladdi*et al. (2014)* discusses the thermo chemical and statistical mechanical properties of forty natural sisal fibres. Fibre tensile properties are found to depend on fibre diameter. The numbers of tests are found to affect Weibull parameters. Tensile strength and Young's modulus have been evaluated by four different estimation methods from two and three parameter Weibull distribution statistics. A comparison of the scatter of the mechanical properties with the results obtained by other research workers has been made.

Motaung*et al. (2015)* have studied the effect of silane treated sugar cane bagasse on the mechanical, thermal and crystallization studies of recycled polypropylene. They highlighted the interaction of silane treated sugar cane bagasse which has led to an improvement in mechanical properties.

Anjali Karolia and Bhoj (2016) have made a comparative study on the effect of chemical and enzyme treatments on the softening of sisal fibre. They reported that following the treatment with enzyme, the fibre became smooth and showed higher elongation. The strength of the fibre did not show any drop. The yarns prepared from the enzyme treated fibres were found to be uneven, and fabrics made from enzyme treated fibres were found to be harsh.

IV. STUDIES ON TENSILE STRENGTH OF NON-WOVEN FABRICS

The tensile strength of the needle punched non-woven fabrics, decides the durability of the fabric in its Geo-textile applications. Higher the tensile strength of the fabric, the better will be the load bearing capacity of such fabrics. Therefore, it is very important to study the tensile strength of non-woven fabrics to be used as Geo-textiles. ASTM D-4632 is the most commonly used test methods to study the tensile strength.

Rawal*et al.* (2006) have found that various civil engineering applications generally utilize needle punched non-woven as Geo-textiles. These Geo-textiles are expected to perform all functions like separation, drainage and filtration in most of the applications. They have studied the influence of feed rate, strokes frequency and depth of needle penetration on the properties of needle punched Geo-textiles. They have also developed on expert system which prescribes the properties of Geo-textiles for various applications.

Rawal*et al.* (2008) have studied the optimization of process parameters for the production of needle punched non-woven Geo-textiles. In order to impart the required functionality of Geo-textiles including drainage and reinforcement, dimensional and mechanical properties of fabrics are also important while producing non-woven fabrics. Dimensional properties like areal density and thickness and mechanical properties like puncture resistance, tensile strengths in the machine and cross direction of the needle punched non-woven Geo-textiles have been studied with respect to the process parameters like punch density, depth of needle penetration and web area density. The multiple regression technique was used for the above study.

Indu and Senthilkumar (2016) have studied the possibilities of producing low-cost light weight doors using sisal and sisal coir blended needle punched non-woven. They found that the tensile strength values were 576 MPa and 177 MPa for sisal and coir fibres. The thermal resistance of 70/30 sisal coir blend was higher than those of other blends. Air permeability and sound absorption were also more in the above fabric. They concluded that for producing light weight low-cost doors 30/70 sisal and coir blend were more suitable.

Fangueiro*et al.* (2011) have studied the effect of areal mass of non-woven on their mechanical properties. As the areal mass of non-woven increased the tensile strength and puncture resistance also increased while the perforation diameter decreased. They also studied the use of a woven fabric as second layer along with non-woven fabrics. These fabrics showed a better effect on the mechanical properties.

Zornberg (2015) has studied the mechanism of individual function of geo synthetics which would contribute to the better performance of roadways.

Midha and Mukhopadyay (2005) have made a comprehensive review on the bulk and physical properties of needle punched non-woven fabrics. These properties were found to be dependent on the nature of the fibre used and the way in which the fibres are arranged in the structure. Greater the fabric strength would result with the use of longer and finer fibre in the web, fibre consolidation was improved with the increase in needle density and penetration. If any special functionalities were required, finishing operation needed to be given.

Rakshik*et al.* (1990) have studied the physical properties of needle punched non-woven fabrics produced from polyester and polypropylene fibres. They also studied the effect of machine and process parameters on the physical properties. The bulk density increased with the increase in depth of needle penetration and punch density. Subsequently compactness of the fabric also increases, which would result in decrease of air and water permeabilities of the fabrics. As the punch density and depth of needle penetration increased bursting strength and cone puncture resistance decreased.

Dias *et al.* (2017) have studied the mechanical and abrasion resistance of non-woven Geo-textile. They subjected the non-woven polypropylene Geo-textile to mechanical damage, abrasion and successive mechanical damage and abrasion. Tensile, tearing and static puncture test were used to evaluate the damage. It was found that more reduction in mechanical strength of the Geo-textile has been experienced by the successive exposure to both degradation tests.

Rawal*et al.* (2013) have compared wide-width tensile strength to its axis-symmetric tensile strength of hybrid needle punched non-woven Geo-textile. Axis-symmetric loading on Geo-textile may also result due to concentrated forces perpendicular to the plane of Geo-textile. They have formulated one model for axis- symmetric tensile strength of anisotropic hybrid needle punched non-woven Geo-textile. The theoretical and experimental results of axis-symmetric tensile strength of hybrid needle punched non-woven fabric showed a good correlation.

Wang (2001) developed a tensile test for Geo-textile with confining pressure. He developed a test device and a special test method for this purpose. The specimen was placed between two air tight aluminium chambers covered with flexible rubber membranes. The specimen was pressurized under this condition and tested. He installed this confining pressure equipment along with instron and studied the tensile behaviour of Geo-textile. He observed a significant increase in tensile stiffness at 9.02 to 9.7 K Paconfinements.

CONCLUSION

The detailed survey shows that the work conducted in needle punched non-woven fabrics dealt with the use of synthetic fibres such as polyester, polypropylene, viscose and acrylic. Natural fibres such as flax, jute, coir, banana and kenalf were also used. The use of sisal with polypropylene has not been considered so far. And the current study fills up the gap existing in the literature. Machinery design, production speed and quality have shown a significant improvement in needle punching technologies. Work carried out by Cincik (2008) on the needle punched non-woven using polyester and viscose in different proportion is a case in point. The usage of needle punched non-woven in other areas such as medical textile is also a pointer. The simplicity of the machine is also another factor for its consideration. Although the effect of gauge length and strain rate on the fibre strength of various fibres has been studied, the range of gauge length and strain rate used was limited.

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