

POROMETRY OF WOVEN JUTE GEOTEXTILE- NEED FOR CRITICAL STUDY

TAPOBRATA SANYAL

Geotechnical Advisor,
Jute Manufactures Development Council

1. Introduction

It is well known that criteria for design of geosynthetics for different end-uses, being hardly uniform, do not enjoy universal acceptability. Developed countries in the west have formulated their own criteria based on empirical results. The International Geosynthetics Society (IGS) has attempted at rationalizing various design concepts in vogue for man-made geosynthetics (SGT). There are no internationally accepted design standards for natural geosynthetics (NGT). The manual published by Jute Manufactures Development Council (JMDC) for Jute Geotextile (JGT) is the only one of its kind in respect of NGT.

JGT and, for that matter, NGT still has limited global acceptability, presumably because of other commercial and industrial priorities in the developed countries. Research on geosynthetics has so long been concentrated on SGT. The majority of researchers on SGT is of the view that design considerations, especially in regard to AOS (Apparent Opening Size) for filtration functions, are conservative and should be relaxed (Ogink -1975, Heerten-1982, Knaap-1986). Design of JGT at present follows the approach adopted for designing SGT. Considering the palpable differences in physical features and properties between SGT and JGT, design considerations should not be the same for both.

This paper highlights the salient aspects concerning design of AOS for filtration and emphasizes the need for separate study for deciding on the fabric porometry of JGT based on realistic studies.

2. Porometry of SGT for Filtration

Filtration is by far the most important function of any geosynthetic fabric. It involves two contrasting sub-functions--

- retention of soil particles on which the fabric is laid ("sand tightness")
- &--dissipation of pore water pressure built up within the soil.

The first sub-function i.e. sand tightness, indicative of the fabric's ability to retain soil particles, is controlled by the fabric pore size. Total retention of soil particles by a woven geosynthetics is neither possible nor is it desirable. Understandably, total sand tightness obstructs passage of water across the fabric and as a result

facilitates building up of pore water pressure within soil. It is for this reason a section of researchers on SGT advocates a less conservative approach to design of fabric porometry. The case is different with JGT. Better retention of soil particles in case of JGT does not imply lesser pore water dissipation in as much as high water absorbing capacity of jute impedes, at least partially, building up of pore water pressure.

Be that as it may, stringency or over-conservatism in deciding the aperture size of woven geosynthetics adversely affects filtration. Which is why, it is desirable to optimize its porometric features. Ogink has characterized O_{max} to specify the limit between the fraction of soil particles passing through the fabric and the part retained by it. Ogink has concluded that O_{98} should be the maximum aperture of woven SGT, implying that only 2% of the soil particles would pass through the fabric. O_{98} is a stochastic variable that can assume different values with certain probabilities. Ogink has found that the extent of resistance to migration of soil particles through fabric apertures depends on—

- uniformity of the fabric porometry
- total open area in the fabric per sqm
- thickness and structure of the fabric.

Ogink has shown that for woven SGT with non-uniform pores, the difference between the average and the maximum aperture size is larger compared to woven SGT with uniform pore-size distribution.

Total open area of a woven fabric depends largely on the type and number of yarns per unit length. Thickness and structure of the fabric also contribute to the extent of resistance to movement of soil particles across the fabric.

Particle size distribution of soil i.e. soil grading is a critical determinant of pore size of a woven geosynthetics. If a soil has a uniform grading, pore size will be a low multiple of d_{50} whereas a well-graded soil may require a much larger pore size. It is to be borne in mind that the finest and the coarsest particles in a soil body do not contribute significantly to filtration. Stress should therefore be laid on the fraction that excludes both—the finest and the coarsest portions.

It is felt that adoption of a uniform design procedure for SGT and JGT is not a reasonable proposition. Determination of AOS for JGT should attract separate considerations in view of qualitative difference between fibres and yarns.

3. Features of Jute Fibres/Yarns

Jute is perhaps the most spinnable of all natural fibres. But like all natural fibres, jute fibres exhibit certain irregularities or, to be more precise, lack of uniformity in some of its features. These could affect strength, extensibility, aperture size, permittivity and transmittivity of JGT to be manufactured and used.

Lack of uniformity in jute yarns stems out of—

- arrangement of fibres does not follow any set pattern
- drafting imperfections
- extraneous causes.

Fibres of jute are arranged at random. Lengths of fibres are also at variance. This is a natural feature that can be controlled but cannot be eliminated. Random fibre arrangement of jute increases with the coarseness of the fibres for the same count. The basic irregularity of a jute yarn due to random arrangement of fibres corresponds to a CV% of $130/\sqrt{N}$ where N is the mean number of fibres in the yarn cross section. Better process control can improve the quality.

The length distribution of jute fibres has a bearing on raw jute characteristics and also fibre-machine interaction. Short fibres cause drafting irregularity. Drafting imperfection causes a wave-like variation in yarn thickness (drafting wave). Fibre length variation is the major factor behind drafting wave. Lesser the variation in length of fibres, lesser will be the drafting irregularity.

Besides there are processing factors such as softening, carding that may affect the yarn quality. Presence of foreign matters sometimes causes yarn irregularity.

It is patent from the aforesaid that it is difficult to weave a JGT with uniform pore size. In making a woven JGT one has to decide on the right ends and picks per dm, lay stress on the right fibre quality and ensure proper process control. Considering the entire gamut of the prevailing situation, two features of a woven JGT demands the best of attention—tensile strength and porometry. It is difficult to maintain uniformity in pore size in case of woven JGT and, for that matter, all NGTs.

Experience suggests that obstruction to soil migration across the jute fabric (permittivity) is more than what is expected due to lower pore sizes caused as a result of fibre imperfections and fabric thickness. Hairiness of jute fibres is also likely to cause obstruction, though not significantly. It depends on the number of fibres in a yarn. Due to lack of uniformity in fineness and length of jute fibres, more yarns as ends and picks are often inserted to make up strength deficiency of the fabric.

Obstruction to passage of soil particles in geosynthetics does not deserve to be discouraged provided the other criterion of filtration is fulfilled. JGT will absorb water that is pushed on to it under external loads principally and will transmit the major part of it along its plane. In other words, as transmittivity of JGT will be more pronounced than permittivity, the process of dissipation of pore water pressure will not be adversely affected to the extent anticipated.

It boils down to the fact that though imperfections in jute fibres tend to retain soil particles more than what design porometric features of the fabric allow, hygroscopic properties and drainage capability of JGT are not supposed to impair its filtration function.

4. Conclusion

Pore size is the sole determinant to the extent of permittivity and transmittivity in man-made geosynthetics. In JGT the factor of weight or, for that matter, thickness influences the said two functions. It is necessary to undertake studies to establish a correlation between pore size of the fabric, the fabric weight (gsm) and the extent of permittivity and transmittivity. It also seems relevant to make a comparative study of the extent of retention effected by a woven JGT of specified pore size vis-à-vis that by a man-made geosynthetic fabric with identical AOS. Concurrently the effect of different weave patterns on filtration and drainage should be studied.

References:

1. Investigations on Hydraulic Characteristics of Synthetic Fabrics—
H J M Ogink –publication no 146, May 1975
Delft Hydraulics Laboratory, Holland
2. Dimensioning the Filtration Properties of Geotextiles Considering Long
term Conditions—G Heerten—2nd International Conference on Geotextiles,
Las Vegas, USA, 1982
3. Design Criteria for Geotextiles beyond the Sand tightness Requirement
Knapp et al –3rd International Conference on Geotextiles, Vienna, 1986
4. A Manual on Jute Geotextiles in Civil Engineering—drafted by T Sanyal
- a publication of Jute Manufactures Development Council, Ministry of Textiles,
Govt. of India—2003
5. Understanding Jute Yarn—Dr D Sur (2005)