GeoSynthetics unit-5

Geosynthetics are artifical fabrics used in Conjuctions with Soil or rock as an integral part of a man-made project. Natural or Artifical products that is used along with Soil in geotechnical Constructions.

Natural occuring geotextile : Coir, jute etc

Artifical Occuring geotextile : polymers ~~and~~ (or) metallic etc.

Why geoSynthetics?

→ They have entirely Changed the way geotechnical engineering is practised.

→ Innovative Solutions to Solve difficult problems economically.

→ It ennables the use of local materials.

→ Unskilled labor can be employed.

→ Installation does not require heavy machinery.

Types of ~~geotextites~~ GeoSynthetics

1. Geotextiles
2. Geo grids
3. Geo nets
4. Geomembranes
5. Geo Cells.
6. GeoComposite
7. PVD (prefabricated Vertical drains)
8. GCL (geosynthetic Clay liners).

Geotextiles: It can be simply defined as "a textile material used in a soil environment" and includes woven and Non woven polymeric materials and natural materials such as jute, manufacture using textile processes.

Polymers: Geotextiles are usually made from one of the 4 synthetic polymers

① polyamide ② polyester

③ polyethylene ④ polyproplyene.

polyamide: The production process and the material properties are influenced by the use of various additives such as

→ Viscosity stabilisers which controls the degree of polymerisation during process.

→ Ageing inhibitors which protects the polymers against the ageing due to light or thermo-oxidation.

→ Colouring i.e carbon black which also has the advantage of increasing the stability of polyamides

Polyester : Additives used in the production of polyester are

(a) Catalysts which increases the Speed of polymerisation.

(b) phosphatic Compounds which reduces thermal degradation during processing in the molten Stage.

(c) Ageing Inhibitors which increases UV resistance.

Polyethylene : 2 main groups are identified

→ low density polyethylene [density 920 -930 kg/m^3]

→ High density polyethylene [density 940 – 960 kg/m^3].

low density polyethylene is produced at high ~~temperature~~ pressures (upto 300 MN/m^2)

High density polyethylene is produced at low pressures (4MN/m^2) and low temperatures.

Polypropylene : (1) The polymerisation of propylene monomers in the presence of Specific ~~gravity~~ Catalysts produces the Crystalline thermoplastic polypropylene (2) It is Very Susceptible to oxidation and additives are required to protect against ageing.

(3) other additives are also used to improve

rmal Stability, UV resistance and underwater resistance.

ypes of geotextiles:

oven Geotextiles.

nWoven Geotextiles.

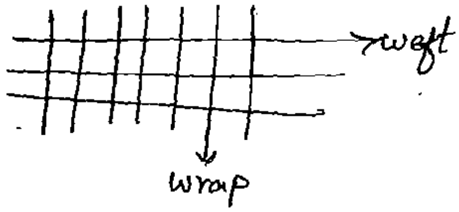
Woven Geotextiles: ① These are developed from Synthetic or natural fibers using weaving techniques.

② The weaving process gives these geotextiles an appearence of two set of parallel threads interlaced at right angles.

③ 'Wrap' runs along the length of the looms

~~④ 'Wraft'~~

④ 'Weft' runs along transverse direction across loom.



⑤ The yarn used to produce a woven geotextile may be monofilament (or) multifilament (or) a Combination of each type.

⑥ The yarn in the wrap direction has to

hstand the action of the loom's reeds Continouslly pulling & shing it apart to make easy for the Shuttle which pulls e Weft yarn through.

on Woven geotextiles: These are formed from filaments or ~~fibres~~ fibres arranged at random and bonded together into a planar Structure.

The filaments or fibers are first arranged into a loose web, then bounder together.

Non woven geotextiles are obtained by following processes:

1. Thermal bonding: (i) These geotextiles are produced by Spraying Continous polymer filaments on to a moving belt which is then passed through heated rollers. (ii) These rollers compress the layers of loose filaments and Cause partial melting of the polymer, leading to the thermal bonding of these filament Cross over points.

thermally bonded geotextiles tends to be relatively this.

The random distribution of the filaments results in a wider range of opening sizes than is found in a woven geotextile.

The absence of any preformed orientation of the filaments results in a more isotropic strength compared to wovens.

Mechanical Bonding: (i) These geotextiles are formed by introducing a fibrous web into a machine equipped with groups of specially designed needles.

(ii) While the web is trapped b/w plates, the needles pushed through it and reorientate the fibres so that mechanical bonding is achieved.

(iii) In this process the fabrics obtained have high density, considerable bulk and thick.

Chemical Bonding: (i) They are produced by spraying polymer filaments on to a moving conveyor and then spraying a acrylic resin into or onto the fabric web.

(ii) After Curing or rolling, Strong bonds are formed b/w the filaments.

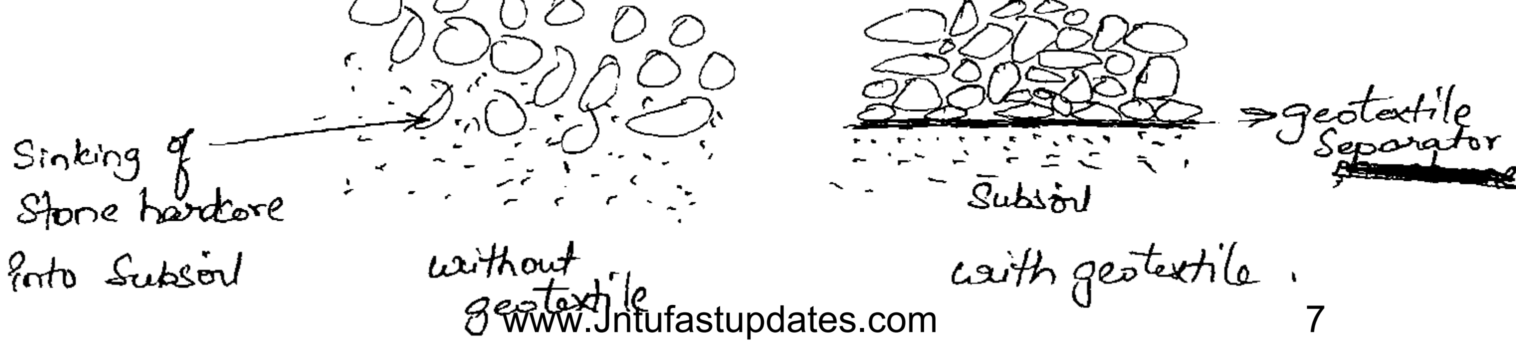
(iii) A forced-air drying operation is required to establish the open pore Structure fabrics.

Functions of Geotextiles:

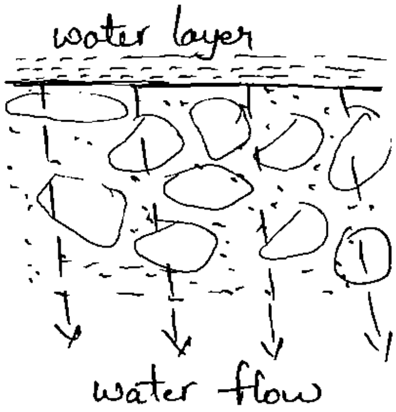
four basic functions of geotextile are

(i) Seperation
(ii) filtration
(iii) Drainage.
(iv) Reinforcement.

Seperation: A geotextile placed b/w a fine Soil and a Coarse material to prevents the two materials from mixing. with the introduction of this barrier the dissimilar materials are each able to function properly.

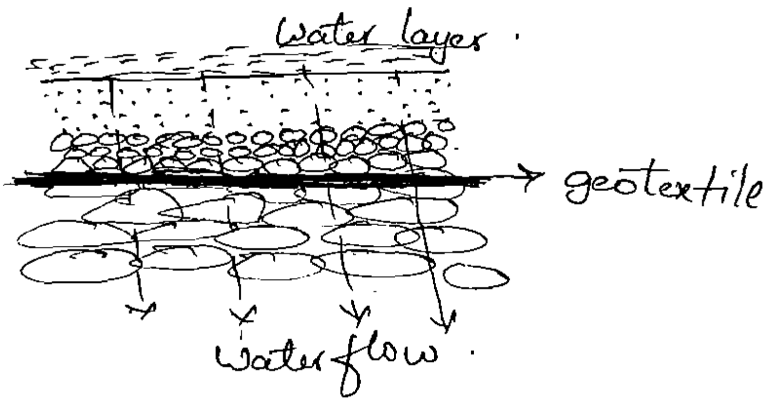


filteration: A geotextile placed in contact with a Soil, it allows water to pass through while preventing the passage of soil particles. Both adequate permeability and soil retention are required simultaneously over the design life of such application.



Without Geotextiles

(Here fines are washed away)



with geotextile

(Here fines are retained).

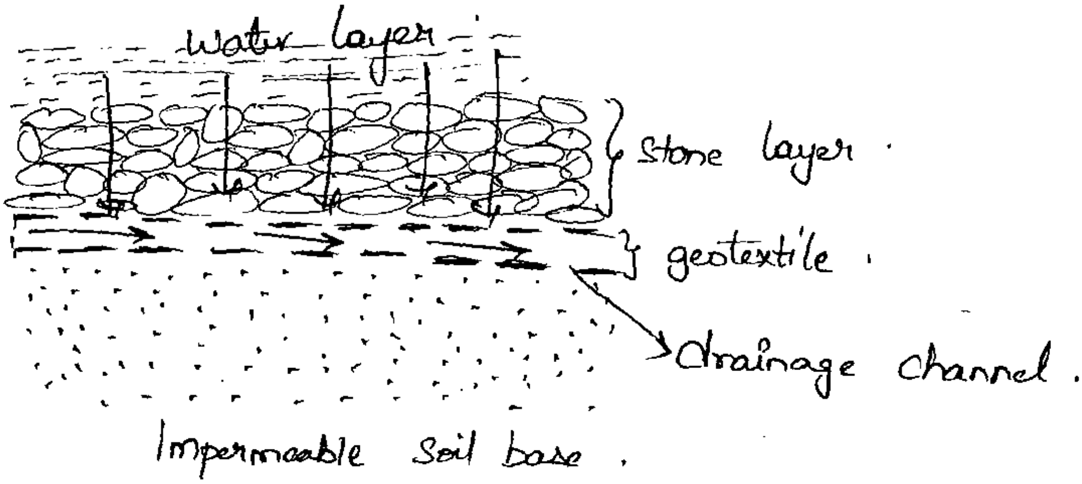
Drainage: A geotextile collects a liquid and conveys it towards an outlet. All fabrics can provide such a function, but a thin woven fabric obviously has less capacity than a thick needle punched non-woven.

However, the capacity of fabrics is limited &

eocomposites drains have been developed to provide increased

capacity.

The flow of water into the drains is controlled by the geotextiles which must also perform a filter function to prevent loss of capacity due to the soil entry into the drain.



Reinforcement: A geotextile used to improve the mechanical properties of an earth structure by interacting with soil through interface shear.

Properties of Geotextiles:

1. physical properties.
2. Mechanical properties.
3. Hydraulic properties.

...sical properties:

...ass/unit area: (1) The mass per unit area is determined by cutting from a roll a minimum of 10 ~~Specif~~ Specimens, each at least 100 mm^2, and then weighing the Specimens on an accurate balance.

(2) This test is used to determine quality of ~~geotextile~~ geotextile & helps in identify the material.

(3) Cost of material is related to mass/unit area.

...) Normal thickness/ Dimensions: (1) normal thickness is determined by placing a Sample of geotextile on a plane reference plate and applying a pressure of 2 kN/m^2. through a ~~dus (Ci~~ Circular pressure plate with a C/s area of 2500 mm^2.

(2) Vernier gauge measures the thickness b/w pressure plate & reference plate.

(3) This test is for determining quality, ~~Cost~~ & Classification of geotextile.

(Ap)parent pore Size distribution by dry Sieving:

The pore Size distribution of the fabric is determind by Sieving dry Spherical glass beads for a Specified time at a Specified frequency of vibration and then measuring the amount retained by the fabric Sample.

This test provides Information on the pore Size distribution which is an important parameter to be used in assessing a geotextile Soil filtration Capability.

% Open Area determination for woven ~~geo~~ geotextiles:

A Small Section of the fabric is held within a Standard Slide Cover, inserted into a projector and the magnified image traced on to a Sheet of paper. using planimeter, the magnified open Spaces can be measured & expressed as ~~an~~ % of whole area.

- This test is applicable to monofilament woven fabrics.
- This test provides Information on pore Size openings Which ~~deter~~ is used for determining Soil filtration Capacity.

Mechanical properties:

tensile properties using a wide width strip:

A specimen of the geotextile at least 200mm wide is clamped within the compressive jaws of a tensile testing machine which is capable of applying the loads at a constant rate of strain. During loading a load-strain curve is plotted and from this the max load, breaking load & the secant modulus at any specified strain may be determined.

This test is useful for quality control & can also be used for design purpose.

puncture strength of geotextiles:

A specimen of the fabric is clamped, without tension, over a empty cylinder, and a solid steel rod is pushed through the fabric. A load indicator attached to the rod measures the force required to cause rupture. A CBR (soil) testing apparatus may be modified ~~as~~ for this test.

This test is used to determine fabric resistance ~~aggai~~ against aggregate penetration.

fabric friction test: This is an adaption of the direct shear test, in this the fabric is frimly fixed to the top half of the Shear box and a standard laboratory soil is used in the bottom half.

The force required to cause sliding b/w the fabric & Soil is determined for different normal Stresses and the Shear Strength parameters are obtained.

This test is not a suitable test for assesing the parameters to be used for the analysis for reinforced soil. for reinforced Soil application the proposed fill material should be used in the test.

Hydraulic properties:

Water permeability of geotextile (permithivity method):

This test measures the quantity of water which can pass through a geotextile. The permeability may be measured either in a Constant head or falling head method.

Constant head method is more common due to the high flow rates through geotextiles.

Sinces there are geotextiles of various thicknesses available it is better to evaluate them in terms of permithivity, which relates the quantity of water passing

rough a geotextile under a given head over a particular
?/s area.

This test is useful in classifying geotextiles & for Comparing the in isolation water permeability of geotextiles

Constant head hydraulic transmissivity: This method may be used to estimate the in plane permeability of a geotextile or a Composite drain. The Sample is Confined, at varying normal Stresses and the flow under a Constant head is measured.

This test is useful for Classifying geotextiles and geocomposite drains & will provide information to allow Comparisions of in plane permeability to be made.

International testing Standards for geotextiles.

BS - British Standards
EN - European Norms.
ISO - International Standards organisation.
ASTM - American Society of testing materials.

all provide testing methods for geotextiles & related products.

British standards:

BS 6906 : part 1 : 1987	wide width tensile test [BSENISO 10319, ASTM D4585 : 1988]
BS 6906 : part 2 : 1989	Determination of apparent pore size distribution by dry sieving. [ISO 12 956, ASTM D4751 : 1993]
BS 6906 : part 3 : 1989	Determination of water flow normal to the plane of geotextiles under a constant head [ISO 11058, ASTM D4491 : 1992]
BS 6906 : part 4 : 1987	Static pressure test (CBR) [BSENISO 12236, ASTM D 4833 : 1988]
BS 6906 : part 5 : 1991	Determination of Creep (ISO 13341, ASTM D5262 : 1992)
BS 6906 : part 7 : 1990	Determination of in plane waterflow. (ISO 12958, ASTM D4716 : 1987)
BS 6906 : part 6 : 1990	Dynamic perforation test. (BSEN 198, ISO 13 433, ASTM D4833 : 1988)
BS 6906 : part 8 : 1991	Determination of sand geotextile frictional behaviour by direct shear (ISO 12957 part 1, ASTM D4886 : 88

American Society of testing materials:

ASTM D 3786: 1987: hydraulic bursting strength of knitted goods & nonwoven fabrics.

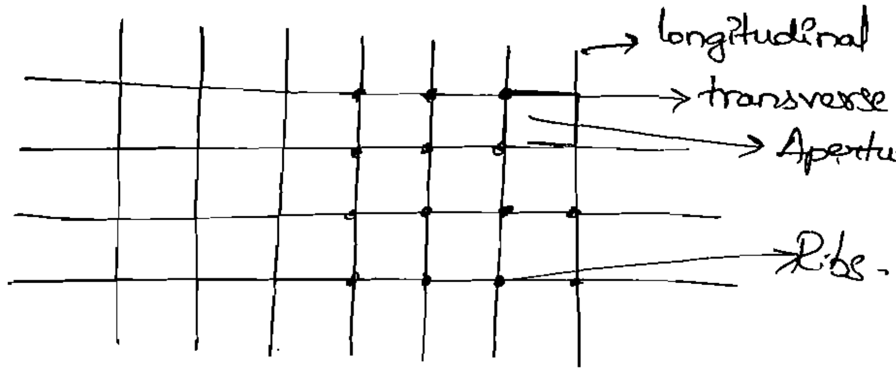
ASTM D4354: 1989: Sampling and preparation of test specimens (BSEN963, ISO 9862:1990)

ASTM D4491: 1992: determination of water flow normal to the plane of geotextile under a constant head (ISO 11058, BS 6906: part 3: 1989).

Geogrid: A geosynthetic material consisting of Connected parallel Set of intersecting ribs with apertures of Sufficient Size to allow Strike through of Surrounding Soil, Stone, or other geotechnical materials.

Thus geogrids are matrix like materials with large openings called apertures, which are typically 10 to 100mm b/w ribs that are called longitudinal & transverse respectively. The Ribs themeselves Can be manufactured from a ~~rubber~~ number of different materials, and the ribs Cross-over joinings (or) junction bonding methods can vary.

The primary function of geogrids is clearly reinforcement:



types: Axial & Biaxial

properties: ① Geogrid tests are unique in a number of aspects when Compared with geotextiles.

② properties relating to Seperation, filtration, drainage, and barrier, applications are not included since geogrids always serve the primary function of reinforcement.

physical properties:

Many of the physical properties of geogrids - Including the type of Structure, rib dimensions, junction type, aperture ~~and~~ size and thickness can be measured directly and are relatively straightforward.

Other properties like ① mass/unit area varies over a tremendous range from 200 to 1000 g/m².

② % open area which varies from 40 to 95%.

Density: ① The density (or) Specific gravity of a geogrid depends upon the polymer from which it is made.

② Homogeneous geogrids are made from HDPE (or) PP and density can be measured using ASTM D792 (or) D1505 codes. & Values obtained will be < 1.

③ Rod (or) Strap geogrids made from PET can use the same test methods and the resulting Value will be > 1.

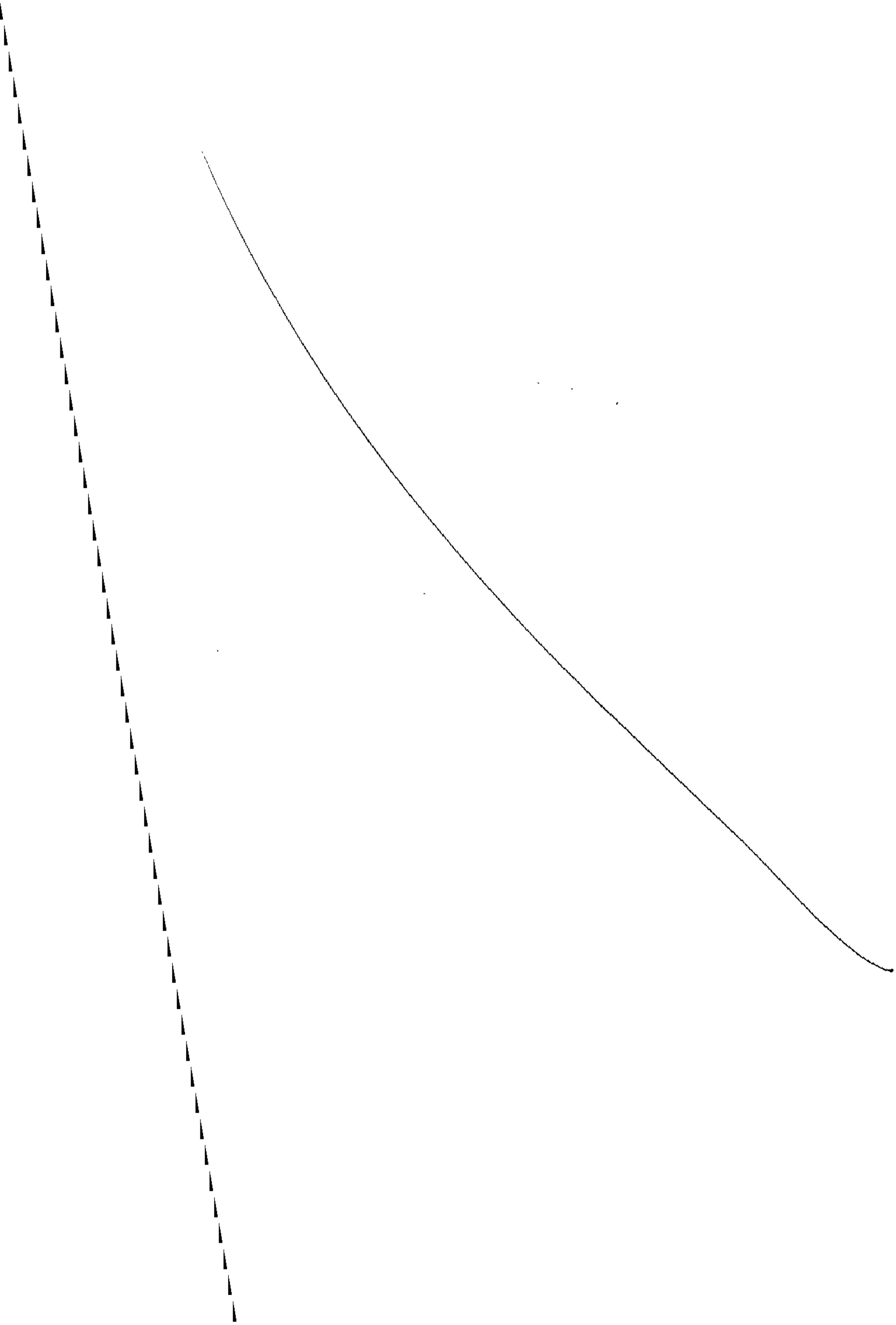
Out of plane bending Stiffness: This test (Bending Stiffness) can be measured using ASTM D1388, a test for flexural rigidity. This test method slides a geogrid test Specimen hanging over a inclined plane measuring an angle of 41.5° with the horizontal. When the geogrid bends and eventually touches the Surface of the inclined plane, its distance is measured and then related to the mass/unit area.

The Strap geogrids are quite stiff and are Characterized by having flexural rigidity values >1000g-cm.

The woven or knit yarn geogrids are quite ~~flexurable~~ flexible and are characterized by having ~~flexural~~ flexural rigidity Value less than (<) 1000g-cm In this test.

In plane torsional Stiffness: In this test a bidirectional geogrid test Specimen is clamped in a rigid frame and firmly gripping the Central node.

A torque is applied and the angular rotation Versus the geogrid resistance is measured. The resulting plot shows a near linear performance for the Stiff geogrids



for the flexiable geogrids the response is Initially slow, but after 5 to 10° rotation, the resisting force Increases

This test is applicable for bidirectional geogrid reinforcement in pavement base Courses & Soil foundation Stabilizations.

Mechanical properties:

Wide wide tensile Strength: geogrid is clamped to a testing plate. Clearly the wide width tensile Strength of a geogrid, in its machine direction for unidirectional geogrids and in both machine and cross machine directions for bidirectional geogrids. The resulting data gives Strength of a geogrids in units of force per unit width. which is calculated by using the repeat distance of actual geogrid Structure.

Obviously there is an extremely wide range in product behaviour depending on type of polymer, its Structure, Spacing of ribs, and So on.

There are 2 procedural test methods used to evalute the wide width tensile Strength of geogrids. One Choice is to use ASTM D6637.

which has a provision for measuring single rib strength. or multiple rib strength.

Shear strength: The geogrid is fixed to a block and is forced to slide over stationary soil in a shear box while being subjected to normal stress. The maximum shear stress, its shear strength is obtained. Then a new test with a replicate geogrid specimen and soil is conducted. This process is repeated sufficiently often to develop a set of shear strength versus normal stress points.

ENDURACE properties:

Installation damage: geogrids undergo damage during the construction process.

→ The amount of damage depends upon the type of aggregate, level of compaction, type of compaction equipment & construction practices.

→ The installation damage factor is specified after extensile field test for site specific.

Conditions :

→ ASTM 5818 recommends that the results from atleast 20 tests Should be used to determine the Installation damage factor.

typical damage factors are

1. for use ~~of~~ ~~in~~ gravels / aggregates 1.1 to 1.2 .
2. for use in fine soils 1.05 to 1.1
3. for use in railway tracks the damage factor could be much higher because of the larger angular ~~practic~~ particles.

Tension Creep behavior: A major endurance property involving geogrids is their sustained - load deformation or tension "Creep". Since all polymers used in the manufacturing of geogrids consist of long-chain molecules arranged in crystalline regions with interspersed amorphous regions, the creep response reflects upon the percent crystallinity and the glass transition temperature.

Creep Rupture Behavior: A variation of the tension creep test just described is the creep rupture ~~prod~~ procedure presented ~~by~~ by Ingold. In this procedure higher stresses are imposed on the test specimens, causing failure to occur in a relatively short time. Upon performing a number of such test, a graph of load-versus-log time can be generated. When extrapolated out to the desired service lifetime an acceptable load can be obtained. When normalized to the short term value, the inverse of this ratio becomes the reduction factor to be applied on ultimate strength.

21/9/17:

2, 5, 6, 9, 10, 14, 19, 21, 23, 24, 25, 26, 27, 30, 33, 35, 38, 39, 40, 41, 42, 43, ~~44~~, 47, 48, 49, 50, 54, ~~5~~. L-2, 4, 7, 8, 11, R-150.