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18 GEOSYNTHETICS

18.1 GENERAL REQUIREMENTS FOR ALL GEOSYNTHETICS

18.1.1 Scope

- 1 This part of the specification covers the use of geotextiles and geogrids for the;
 - (a) reinforcement of unbound aggregates for roads, hard standing and airfield pavements
 - (b) reinforcement of embankment foundations over soft or weak soils
 - (c) reinforcement of steep earthwork fills
 - (d) reinforcement of retaining walls and bridge abutments
 - (e) repairs to earthworks embankment failures and landslides
 - (f) for erosion control of slopes
 - (g) for subsoil and sub-base drainage.
- 2 Related Sections and Parts:
This Section
Part 3..... Earthworks
Part 4..... Unbound Pavement Materials

Section 8, Drainage Works

18.1.2 References

- 1 The following Standards and other documents are referred to in this part:
ASTM D 751.....Test Methods for Coated Fabrics
ASTM D 5034.....Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)
ASTM D 5035.....Test Method for Breaking Strength and Elongation of Textile Fabrics (Strip Method)
ASTM D 4533.....Test Method for Trapezoidal Tearing Strength of Geotextiles
BS 2782Method of testing plastics
BS 3502Symbols for plastics and rubber materials
BS 4618Recommendations for the presentation of plastic design data
BS 8006Code of practice for strengthened/reinforced soils and other fills
ISO 10319Geosynthetics
ISO 10321Geosynthetics
DIN 54307CBR Test
DIN 53854Weight Test
DIN 53855Thickness Test
ISO 9001Quality Management and Quality Assurance Standards

Published Document (PD) 6533, Guide to Methods for Assessing the Durability of Geotextiles, British Standards Institute.

18.1.3 Submittals

- 1 The manufacturer shall submit comprehensive test results for the geosynthetic for the designated tests, which shall clearly indicate whether the values are mean values measured in current production or minimum values which the property does not fall below.
- 2 The manufacturer's submittal shall clearly state:
 - (a) the type of material, (whether a polyethylene, propylene or other)
 - (b) its structure whether (a monofilament, multifilament or other)
 - (c) the element of manufacture by one or combination of the following processes:
 - (i) Heat bonding.
 - (ii) Chemical resin bonding
 - (iii) Mechanical bonding.
- 3 If the Contractor wishes to propose a material that has been tested to alternative standards, the Contractor shall submit correlation tests showing the comparable values of the two test methods. These test results shall be comprehensive giving full details of the sample conditioning, preparation, method of test and criteria for assessment.
- 4 The manufacturer shall submit comprehensive information of previous applications of the material in similar conditions and environments. This information shall include the project name, contract details, type/grade of material used, quantity of material used, name of the contract, client, consultant, and main contractor.

18.1.4 Quality Assurance

- 1 The geotextile shall be supplied by a manufacturer who is certified to the ISO 9001. The Contractor shall submit to the Engineer a copy of the ISO 9001 certificate that clearly states the scope of the certification.
- 2 The geotextile shall be supplied by a manufacturer who provides technical assistance on the suitability for the application and installation for the material. For the initial use of the material on site, the Contractor shall arrange for the technical representative of the manufacturer to be present to demonstrate the correct use of the material.
- 3 Where feasible the jointing of geosynthetics shall be as prefabricated joints manufactured under factory controlled conditions. Joints made during the execution of the work shall be kept to a minimum.
- 4 Joints shall be tested by the same test methods used for the main material.
- 5 All joints used in permanent structures designed to carry loads shall be tested in accordance with ISO 10319 Part 1 or ISO 10321.
- 6 In situations where relatively small tensions are developed and, if permitted by the Engineer overlapping joints may be used. These joints shall not be used in the primary tensile direction of reinforced soil structures but can be in secondary tensile directions only.
- 7 Joints where geotextiles are sewn together shall be with one of the methods showing in figure 5 of BS8006. These joints shall meet the performance characteristics shown in Table 8 BS8006.
- 8 Prior to delivery of the material to site the Contractor shall submit a sample of a sewn joint.
- 9 Bodkin joints shall have sufficient cross sectional area and strength to avoid excessive deformation. A bodkin joint shall not be so large so as to distort the material causing stress concentrations, bodkin joints shall be pretensioned prior to loading to reduce joint displacement as the components lock together.

- 10 Any cuts, tears, splits and perforations to geosynthetics during installation shall be made good. The method of remedial work shall be prepared and proposed by the Contractor for approval by the Engineer.
- 11 The geosynthetics shall be suitable for use in the ambient soil temperature in the State of Qatar.
- 12 Geosynthetics that are able to ravel shall be heat treated or bonded with an adhesive tape at the cut. The proposed method of sealing the edges of geotextiles shall be proposed by the Contractor and shall fully identify the geotextile material, type of scene, stitch configuration, stitch density, sowing thread and sowing machine to be used.

18.1.5 Guarantees and Warranties

- 1 The Contractor shall submit a ten-year guarantee for the geotextile material and the workmanship. The guarantee shall be worded to reflect the required performance of the material and shall be approved by the Engineer.

18.2 REQUIREMENTS FOR GEOTEXTILES

18.2.1 General Requirements

- 1 All geotextiles shall be supplied in manageable roll or unit sizes and shall be robust enough to withstand handling and any treatment received during the installation process.
- 2 The geotextile shall comply with the minimum properties for geotextile serviceability in Table 18.1 below. The Engineer will direct as to the category that the geotextile shall meet; i.e., very high, high, moderate or low.

Table 18.1
Minimum Properties for Geotextile Service Ability

Property	Very High	High	Moderate	Low
Grab Strength ASTM D 5034, N	1200	800	600	400
Burst Strength ASTM D751, N, min	500	340	180	135
Trapezoidal Tear ASTM D-4533, N	340	225	180	135

These are the minimum required values below which no test result on production material should fall.

- 3 The Engineer may require the Contractor to carry out tests to different standards, in addition to the test methods designated above or in the following clauses:
 - (a) the manufacturer's recommendations concerning the installation process shall be strictly adhered to
 - (b) all geotextiles shall be suitable for use in the environmental conditions in the State of Qatar
 - (c) geotextiles shall be resistant to deterioration on degradation from acids alkalis, bacteria, brackish or saline water. The manufacturer shall submit comprehensive results of tests carried out to demonstrate the durability of the materials under such conditions. These tests shall involve checking the strength properties of the material before and after prolonged exposure to typical groundwater conditions in the State of Qatar

- (d) all geotextiles shall be protected from direct sunlight by storing inside the building or covering with heavy tarpaulins. Geotextiles shall not be exposed to direct sunlight for a duration longer than 48 h
- (e) joints in Geotextiles shall be sewn where load transfer is required

18.2.2 Drainage Applications

- 1 Geotextiles for drainage applications shall be needled polypropylene and meet the performance specifications given in Table 18.2. The performance shall be assessed based on regular tests on the production material. Unless a permitted variation is stated in Table 18.2, the mean test values shall meet the values in the Table.

Table 18.2

Performance Specifications for Geotextiles for Drainage Applications

International Classification According to CBR Test	1	2	3	4
CBR test (DIN 54307) ISO12236				
mean value \pm 10-% mean value Min. (N)	780	1335	2695	4400
mean value minus standard deviation, Min (N)	700	1200	2450	
deformation % ,Min.	30	50	60	65
Tensile strength (ASTM D 5035)_ISO 10319				
Transverse direction kN/m ,Min	3	7	12	25
longitudinal-direction kN/m, Min	3	8	14	35
elongation at rupture %,Min.	35/45	50/	45/5550/ 60	90/65
Fall cone test hole diameter ISO13433 Max. (mm)	50	32	18	6.5
Permeability H50, ISO 11058 (L/m ² . S), Min.	120	90	80	60
Pore size (unvibrated) ISO 12956				
d 50% (Min. μ m)	80	60	45	30
d 90%(Min. μ m)	110	85	65	40
Weight (DIN 53854) EN 9863-1 g/m ²	100	140	250	500
Thickness (DIN 53855) ASTM D5261mm	0.6	0.95	1.5	3.4

- 2 The manufacturer shall clearly identify to which international classification category the geotextile conforms according to the CBR test.
- 3 The pore size of the geotextile shall be small enough to prevent the significant loss of soil particles from the retained soil, yet have adequate permeability to allow water transmission normal to the plain of the geotextile.

- 4 The manufacturer shall submit test results that demonstrate the ability of the geotextile to avoid clogging during water flow due to fine particles. Test results for the US Corps of Engineers gradient ratio test or similar type of test shall be submitted. The test shall be carried out using soil of the type where the geotextile is to be installed. Gradient ratios derived from the test shall be less than 3.

18.2.3 Earthworks Applications

- 1 Geotextiles for earthworks reinforcement or base use shall be woven polyester multi-filament or multi-filament fabrics with a high rupture strength and low axial strain. The geotextile shall have an adequate high tensile strength in all directions to resist loading imposed by uneven filling.
- 2 The geotextile shall possess the strength for the required design life with minimal increase in strain over time. The average geotextile strain shall be limited to 5 %.
- 3 Where installed between a sub-base and the underlying soil, the geotextile shall prevent the granular material being pressed into the subsoil and also prevent an intrusion of fines from subgrade into the sub-base.
- 4 The water permeability of the geotextile shall prevent build up of water pressure under the separation layer. The short- and long-term permeability of the geotextile must be equal to or greater than that of the subsoil. The geotextile must not become blocked.
- 5 The geotextile shall possess high puncture resistance and a high tearing resistance.
- 6 Where used as base stabilisation for embankments the type of construction equipment used for spreading and compacting initial fill layers shall be suitable so as to avoid damage to the geotextile. The initial layer of fill placed on the geotextile shall be free from sharp angular or pointed material that may puncture the geotextile.
- 7 Trucks shall not be permitted to drive over the geotextile. The laying of the material shall be co-ordinated to ensure that trucks do not damage the material.

18.3 GEOGRIDS

18.3.1 General Requirements for Geogrids

- 1 The geogrid shall be identified as either uniaxial for single dimension loading or biaxial for two dimensional loading.
- 2 The design of all geotextiles or geogrid applications shall be based on an appropriate in soil temperature for the state of Qatar.
- 3 The type of geogrid to be used shall be as shown on the drawings or as described elsewhere in the contract documents.
- 4 The type of polymer used in the manufacture of the geogrid shall be clearly stated.
- 5 The design shall take into account any possible damage to the material during site installation and a factor shall be introduced into the design.
- 6 Prior to installing the geosynthetic the Contractor shall prepare a construction trial outside of the permanent works. The construction trial shall utilise similar ground conditions from materials and other factors as the permanent works.
- 7 If directed by the Engineer the Contractor shall arrange for geotechnical investigation to be carried out in the area where the geosynthetics are to be installed. The range and details of the tests and investigations to be performed shall be directed by the Engineer.

18.3.2 Material Requirements for Geogrids

- 1 Geogrids shall be manufactured from a continuous sheet of polyethylene or polypropylene which is punched with a regular pattern of holes. The sheet shall be heated and stretched so that randomly orientated long chain molecules are drawn into an order and align state to increase tensile strength and tensile stiffness.
- 2 The bars or ribs of the geogrid transverse to the direction of primary loading shall provide a series of bearing points or anchors such that stress is transferred to the grid by surface friction and also interaction.
- 3 The ribs of the geogrid in both the longitudinal and transverse direction shall be manufactured to a near vertical face to provide good bearing surface for interlocking fill particles.
- 4 Geogrids shall be resistant to deterioration by aqueous solutions of acids, alkalis and salts, petrol, and diesel fuel.
- 5 Geogrids shall not be susceptible to hydrolysis, environmental stress, cracking or micro biological attack.
- 6 The manufacturer shall supply test results for load against strain for the material identifying all test conditions including strain rate and temperature of materials tested and test method.
- 7 The Contractor shall submit full technical details of the geogrid proposed for use in the works. These details shall include the following:
 - (a) grid dimensions
 - (b) thickness of longitudinal and transverse ribs
 - (c) strength of the material determined as stress strain, at strains of 2 and 5% both
 - (d) transverse and longitudinally in accordance with ISO 10319
 - (e) weight in kilograms per metre squared for material
 - (f) the supplied roll of dimensions
 - (g) the minimum amount of carbon black tested in accordance with BS 2782 Part 4
 - (h) the approximate peak strain , expressed as a percentage
 - (i) the creep of the material under load determined in accordance with ISO 10319 for strain shall not exceed 10%
 - (j) the cross sectional shape of the ribs and of the rib joints.

All test results shall be expressed as a lower 95% conference limit in accordance with ISO 2602.

- 8 The Contractor shall submit test results for the durability of geogrids. Tests shall be in accordance with PD 6533, - Guide To Methods for Assessing the Durability of Geotextiles.
- 9 The Contractor shall submit laboratory test results for prolonged exposure tests at similar temperatures.
- 10 For each batch or delivery of the geosynthetic the Contractor shall submit the production quality control test results shall be clearly related to batches delivered to site.

18.3.3 Installation of Geogrids

- 1 Prior to placing geogrids the Contractor shall prepare a detailed method statement for the sequence of operations.

- 2 The methods employed shall ensure that the geosynthetic does not suffer deterioration during placing and that any joints are formed effectively.
- 3 The handling and placement and installation of geogrids shall be carried out strictly in accordance with the manufacturer's recommendations.
- 4 Where the geogrid has been protected by a wrapping resistant to ultraviolet lights attack no further protection against sunlight is necessary.
- 5 For geogrids, jointing shall be by a bodkin whereby two overlapping sections are coupled together using a bar passed through the aperture of the grid. Joints shall be formed at the highest mechanical and durability efficiency possible.
- 6 If necessary the Contractor shall construct a temporary access road to the site location at a convenient location close to the works, the Contractor shall prepare a clean working platform in storage area to accommodate geosynthetic materials.
- 7 The geogrid shall extend across the full width of the embankment or area being treated in one continuous piece and no part bits of rolls shall be used. This shall be accommodated by increasing the lap lengths.
- 8 Prior to installation of the geogrid , the site shall be cleared in accordance with part 2 of this specification
- 9 Before placing geogrid any abrupt changes in ground profile should be levelled.
- 10 Any regulating layer of fill placed shall not impair the vertical hydraulic conductivity of the natural ground.
- 11 Geogrids supplied in rolls shall be supported at a minimum of 2 points to prevent excessive bending unless a central steel tube is used for support.
- 12 Site handling of geogrids shall ensure that damage to the product such as surface abrasions, splitting, notching or tearing is prevented.
- 13 The installation of the geogrid shall be consistent with the direction of major stress.

END OF PART