

GEOTEXTILE SPECIFICATIONS MADE SIMPLE

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ABSTRACT

Geotextiles are currently specified in many different ways. Engineers specify geotextiles by brand name, mass, type, and/or any mix of properties including strength, puncture resistance, "G" Rating, EOS, and hydraulic properties. However, in Australia, no unified method exists of specifying geotextiles in a simple manner. Some specifications are unnecessarily biased against certain types of geotextiles, particularly wovens. Each State road authority has its' own method. This causes unnecessary confusion and complexity to engineers, manufacturers and contractors alike. This paper presents a case for adopting a simple, unified method of specifying geotextiles. Current Australian specifications are reviewed against worlds best practice.

BACKGROUND

Geotextiles have been used in Australia for over 30 years, beginning with the introduction of Terram, or "Terra-Firma" as it was widely known, imported by ICI many years ago. The key development in the local industry throughout the 1980's was the setting up of a local Bidim non-woven manufacturing facility at Albury by Geofabrics Australasia in July 1987.

Standards Developments

In the late 1980's Standards Australia Committee CE/20 Geotextiles released the Draft Australian Standards for Geotextiles - series AS3706 which addressed general requirements, strength tests, hydraulic tests and durability tests. In 1990 Austroads published its' Guide to Geotextiles (Austroads 1990) which covered topics including Geotextiles Properties and Functions, Applications and Design, Durability, Construction and Testing. Due to lack of interest and funding there has been little further development work by Standards Australia or Austroads to standardize specifications for geotextiles. In Australia only the NSW RTA (Roads & Traffic Authority) has continued work in this area (RTA 1998 R63 Geotextiles, Separation and Filtration). Unfortunately at a time when many new geosynthetic products are being introduced, Australian funding for R&D has been cut across the board so that these products may never be rigorously tested and appropriate specs written for their use. In America AASHTO (the American Association of State Highway Transport Organisations) released its Standard Specification for Geotextiles M 288-96 (Ref.4) recently, which is widely recognised as worlds best practice.

GEOTEXTILES WORLDWIDE

In any given region geotextile specification and usage tends to be driven by the dominant local producer. For example, in Germany the market is dominated by non-woven manufacturers and specifications reflect this. So throughout Europe non-wovens have been predominately used for all applications including roadways, waterways and landfills. Interestingly in Holland woven geotextiles are locally manufactured

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and in this region wovens are used extensively for waterways applications, ie for erosion control beneath rock rip-rap. This is also the case in Asia where woven geotextiles are well accepted and have been used successfully on many major projects. The USA is the largest market for geotextiles and this market is dominated by manufacturers which produce both woven and non-woven geotxtiles. As a result the balance of usage is more even and is reported to be 60% non-woven and 40% woven. The emerging markets of Asia, and particularly China see all kinds of locally produced products used. In China low grade woven geotextiles are commonly used for all applications. Light 100gsm woven geotextiles are even used to construct large sand-filled geotextile tubes.

AUSTRALIAN SPECIFICATIONS

Currently geotextiles are specified in many different ways. Most commonly engineers specify “Product X or equivalent”. There is a general recognition that it is not best practice to restrict the specification to one product only. This argument has been tested with other engineering products, eg. Brifen wire fence. The real difficulty for the engineer is then deciding which other products are “equivalent”, since different geotextiles have very different characteristics, ie between woven and non-woven geotextiles. Often specs allow only non-woven types to be used, which is artificially restrictive since it is generally recognised that both woven and non-woven geotextiles can perform most functions, except cushioning of landfill liners, where non-wovens are most suitable. At least one major Melbourne consultancy specifies polyester non-wovens in preference to other polymer types.

Each State Road Authority has its’ own method of specifying geotextiles. Vicroads uses “G” Ratings to determine mechanical strength and allows woven and non-woven types to be used for separation and only non-woven types allowed for separation and filtration applications. (Vicroads Standard Specifications) Limits to EOS (Equivalent Opening Size) are also set. In applications with specific problems such as very soft soils and/or very high water table, Vicroads have specified composite woven/non-wovens also high strength geotextiles and geogrids have been specified for reinforcement.

The NSW RTA has introduced its’ new R63 which attempts to combine “G” Ratings with the new AASHTO M288-96 Standard Specification for Geotextiles. There have been a number of amendments to this spec prompted by industry comment. Clearly there is a need for standardization of specifications Australia-wide, so that engineers across the country can set specs simply and with confidence. To do nothing leaves a situation akin to the broad gauge / narrow gauge debacle on the railways.

The need to get it right

It may be argued that geotextiles are such a small part of a civil engineering project as to be financially insignificant and therefore not worth spending much time focusing on developing specs or seeking supply quotations. But the implications to long-term performance of a civil engineering structure are far greater than the initial cost of purchase of the geotextile. The failure of a roadway due to rupture of a geotextile or the erosion of a dam wall due to piping of embankment material through a geotextile filter are examples that clearly show the enormous potential financial impact that failure of a geotextile may have on a project.

Having many different specs in various States causes manufacturers to produce a host of different products unnecessarily. Setting uniform, consistent specs brings economies by allowing manufacturers to focus on producing and stocking fewer grades.

GEOTEXTILE SPECIFICATIONS MADE SIMPLE

It is proposed to adopt M 288 in a simplified form, and to replace the existing five mechanical strength properties - Grab Strength, Sewn Strength, Tear Strength, Puncture Strength and Burst Strength with one parameter - the “G” Rating. Hydraulic parameters may be set simply by the permittivity and EOS

(equivalent opening size), which follows Vicroads method. Both woven and non-woven types may be used for all categories. Application categories may be simplified to only six.

“G” Ratings

As already discussed, Austroads first publicised the “G” Rating in its “Guide to Geotextiles” in 1990. They have been adopted and used widely for over 10 years. The “G” rating is defined as the geometric mean of the Drop Cone and CBR Burst test results. The Drop Cone is carried out by dropping a defined heavy cone on to a sample of fabric held over a frame, like a drum. The test is used as a measure of a geotextiles resistance to puncture from falling rocks. There has been some concern that this test may favour very extensible types of geotextiles, particularly staple-fibre types which have greater "stretch" characteristics and therefore give high test results before puncturing. The standard, AS 3706.5, was modified in 1994 to limit this effect and so gives a fair comparison between different geotextile types, including continuous filament, staple-fibre, thermal bonded and wovens. The CBR test is carried out by forcing a CBR plunger through a sample of fabric that is fixed over a frame. This test measures the resistance of geotextiles to puncturing, eg from aggregate placed and compacted during construction. So these two tests give a good measure of a geotextiles resistance to both dynamic and static puncture.

It may be argued that the “G” Rating alone does not sufficiently define all the possible modes of failure of a geotextile in use. The NSW RTA uses “G” Ratings combined with Grab Tensile and Trapezoidal Tear Strength, however the test limits are set in such a way that Grab and Trap Tear will always govern. As already mentioned Vicroads has, for 10 years, used “G” Ratings alone to define the required strength of a geotextile, without any failures known to the author.

Woven Vs. Non-woven

It is recognised that woven geotextiles have higher strength per unit mass than non-woven geotextiles, and that they are prone to greater damage in the field (Georgia Institute of Technology 1995). M288 reconciles this by having two sets of strength numbers, one set for non-woven and a set with greater values for woven geotextiles. The RTA also has followed this approach in its' R63 in Table R63.1, and the same approach is proposed with G ratings. For example, a typical roadway separation application requires a non-woven type with a “G” Rating of 2000 or woven with a “G” rating of 3000. Uniform minimum hydraulic performance limits are required, defining flow rate, or permittivity, and EOS.

Acceptance Criteria

AASHTO has adopted a concept known as MARV (Minimum Average Roll Value) to define property value limits. This is the value which is exceeded by 97.5% of the test data. The MARV is derived statistically as the average minus two standard deviations. As the term implies, the MARV of a lot of geotextile is found by testing across a number of rolls in a lot. The average value of each tested roll is found and then the minimum of all tested rolls is adopted as the MARV. This compares favourably with the commonly used “Typical” value which refers to the average or mean value, where 50% of the values can be expected to exceed this value and 50% can be expected to fall below this value. MARV and typical values both relate to the variability inherent in geotextile properties. The NSW RTA, in its R63 has adopted a concept known as the “Characteristic Value” which is found by a statistical calculation carried out on a tested roll which is said to be representative of the lot. Koerner has cautioned against this method of running statistical analysis on individual rolls.

Quality Control

A manufacturer must have third party Q.A. accreditation to AS 9002. Manufacturers must publish product data sheets with complete results to all the relevant Australian Standards (A.S.). Geotextiles shall be

stabilised against ultraviolet radiation such that when tested in accordance with AS 3706.11 shall retain at least 70% after the standard period.

Geotextile Strength Requirements

So, in summary, the final result will look like a simplified version of AASHTO's M 288-96, incorporating "G" Ratings to set simple strength limits, refer Table 1.

Table1 : GEOTEXTILE STRENGTH REQUIREMENTS

Geotextile Strength Class	Elongation(1)	G Rating (2)
Class 1	<50%	3000
	>50%	2000
Class 2	<50%	2000
	>50%	1350
Class 3	<50%	1350
	>50%	900

Notes to Table1:

1. As measured in accordance with AS2001.2.3 Wovens will typically have elongation less than 50%.
2. All values MARV.

APPLICATIONS CATEGORIES

It is proposed to follow the application categories of M-288 which covers all the key categories of subsurface drainage, separation (CBR>3%), stabilisation (CBR<3%), permanent erosion control, temporary silt fence and paving fabrics. The RTA's R63 has a more complex system based on application category, degree of filtration required, soil type, rock size and type of structure; however it does not cover the key applications of silt fence and paving fabric. It also places unnecessary restrictions on the use of woven geotextile.

Subsurface Drainage

M 288 gives various AOS (Apparent Opening Size which is equivalent to EOS) and permittivity requirements based on the particle size of the soil to be filtered. In practice light-weight non-woven geotextiles, typical mass 140gsm, are mostly used for sub-soil drainage applications. From reviewing many field installations this type of product appears to be generally adequate as an effective filter, although of course the designer may opt for other selection criteria for particular applications.

In this application minimum strength of Class 3 is required, together with a relatively high permittivity of 0.2 s-1 and EOS of between 85 and 230 µm. (as per Vicroads spec).

Roadway Separation (CBR>3%)

This is the classic application of using a geotextile to prevent mixing of a subgrade soil and an aggregate road base. M288 calls up a Class 2 strength geotextile, with minimum permittivity of 0.02 s-1 and maximum EOS of 600µm. This will be met by most mid-weight non-wovens and 155gsm woven geotextiles.

Roadway Stabilisation (CBR<3%)

M288 describes this application as the “use of a geotextile in wet, saturated conditions to provide the co-incident functions of separation and filtration”. This therefore covers applications in drainage blankets which the RTA and Vicroads currently treat as special applications requiring only heavy-weight non-woven geotextiles. There is also a degree of reinforcement taking place. In fact the geotextile requirements are very simple - Class 1 strength, permittivity of 0.05 s-1 and maximum EOS of 430µm. Note that there is no technical requirement for only non-woven geotextiles.

Permanent Erosion Control

This is the application of using a geotextile filter beneath rock rip-rap on an embankment subject to wave action. Again M288 calls up various geotextile properties based on the particle size of the embankment soil to be filtered, and does not allow slit-film (flat tape) woven geotextiles to be used. Again, in practice, mid-weight (around 260gsm) non-woven geotextiles tend to be the most cost effective and widely used product in Australia, however this is not to exclude other type of woven geotextiles, such as mono-filament and fibrillated-tape wovens from consideration. Vicroads specs for this application call up a non-woven type of minimum mass 260gsm. The RTA’s R63 calls up very heavy non-woven geotextiles for this application. I propose strength Class 1 combined with minimum permittivity of 0.2 s-1 and EOS of between 85 and 230µm.

Temporary Silt Fence

The M288 spec is very broad for this application, allowing most woven or non-woven products with adequate strength. Required strength is Class 3 and minimum permittivity 0.05 s-1, together with max EOS of 600µm.

Paving Fabric

The most important performance characteristic of a paving fabric is its bitumen retention. This should be a minimum of 1.2 L/sqm as per M288. A strength Class 3 is required and melting point of 150°C. Most purpose made paving fabrics have a minimum mass of 135 gsm.

Table 2. GEOTEXTILE APPLICATION CATEGORIES

<i>Application</i>	<i>Strength Class</i>	<i>Permittivity</i>	<i>EOS micron</i>	<i>Other</i>
Subsoil Drainage	3	0.2	85-230	
Separation	2	0.05	600 max	

Stabilisation	1	0.05	430 max	
Erosion Control	1	0.2	85-230	
Silt Fence	3	0.05	600 max	
Paving Fabric	3	N/A	N/A	See above

DISCUSSION

This table should be seen as a starting point, or a bench mark for specifying geotextiles. It should be recognised that a geotextile with a MARV "G" Rating of 2000 is a significantly stronger fabric than one with a typical value of 2000, because, by definition, MARV is a 97.5% measure whilst "typical" is only a 50% measure. Of course specific problems will still need to be treated as special design situations. This will include conditions such as oversize rock used in marine beaching applications, or problem soils prone to clogging. Reference may be made to M288 or any of the standard reference texts for guidance (Ref.7,8&9). At the very least I hope that this effort will encourage discussion and debate amongst the engineering fraternity, and prompt a recognition that the design and specification of geotextiles, and geosynthetics more broadly, as important issues. Finally there should be a commitment by groups such as Austroads and Standards Australia to approach this issue on a national level with a view to introducing Australian Standard Specifications for Geotextiles.

SUMMARY

In summary, a method has been produced of specify geotextiles in a simple, concise manner. The method draws on the work of Austroads, together with the NSW RTA R63, Vicroads and AASHTO M 288-96. Geotextiles may be specified by one strength parameter, the "G" Rating and hydraulic performance defined by permittivity and EOS. Application categories may be reduced to only six.

CONCLUSION

Engineers Australia-wide can now look with confidence to one simple, concise guide when specifying geotextiles, a generic specification that is not brand or type specific. Geotextiles may be quickly called up leaving engineers to get on with more important matters than arguing with salesmen over which products are equivalent. The ease of use of this spec will encourage more widespread use of geotextiles, and take the "black magic" out of using geotextiles. The proposed specification will encourage competition amongst manufacturers and let them focus on producing fewer grades.

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