Geotextile specifications: Those vexing qualifiers

Streamlining terminology could minimize costs and confusion.

All geotextiles exhibit some inherent variability, not unlike countless other products that we encounter every day. The extent of this variability differs from manufacturer to manufacturer and depends primarily on the geotextile type and manufacturing technology utilized. With this in mind, geotextile manufacturers set their production process parameters to ensure that target property values are achieved for every roll in a production lot. The resulting property values, called product specifications, are published along with a qualifier—MARV (Minimum Average Roll Value)—implying that the product would meet the claimed value 97.5% of time.

Based on the author's experience, the design engineers are not consistent in the use of qualifiers when preparing project specifications and construction documents. In addition to MARV, project specifications tend to include such qualifiers as Minimum, Maximum, Average and Range. This disparity between geotextile specification requirements is the subject of this article.

Definitions

Figure 1 provides a graphical interpretation of MARV, Minimum, Average, Maximum and Range (modified from Koerner 1998). If X^1, X^2, X^3...X^N are individual property values in a sample of size N, then these qualifiers can be determined using the equations on page 25 ("Equations for determining Average, Standard Deviation, MARV, Minimum, Maximum and Range").

Qualifiers and project specifications

Fifty projects were selected at random from a large database of 2000-2001 landfill projects to assess the current use of geotextile qualifiers in project specifications. **Table 1** (p. 25) exhibits a typical geotextile specification included in project construction documents. **Figure 2** (p. 26), prepared on the basis of this sample, indicates that only 46% of projects currently use MARV for all properties with the exception of Apparent Opening Size (AOS). For AOS, only 32% of projects specify MARV as the qualifier. This suggests that there is little consensus in the engineering community as to which qualifier should be used in project specifications.

Qualifiers and design

Typically, geotextile index property values included in project specifications are based either on survivability criteria, like AASHTO M288, or manufacturers' published values. In either case, MARV is

Figure 1: Graphical interpretation of various qualifiers.

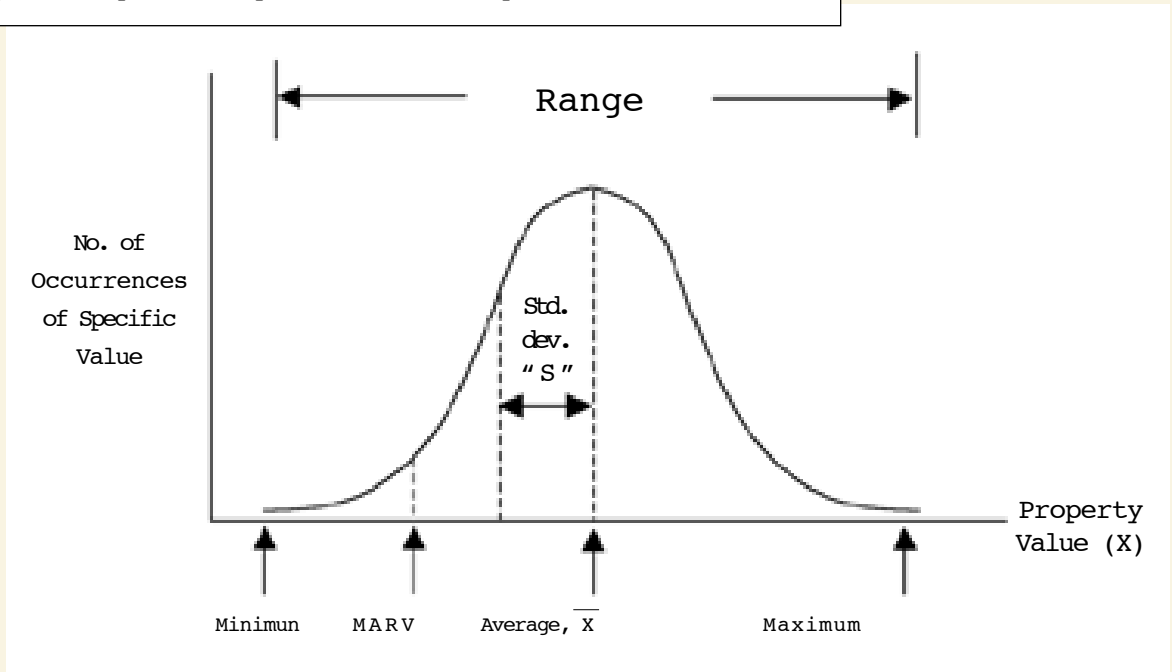

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Table 1: Typical geotextile specifications table with MARV as a qualifier.

Geotextile Property	Test Method	Unit	Qualifier	Value
Mass per Unit Area	ASTM D-5261	gram/m^2	MARV	270
Thickness	ASTM D-5199	m m	MARV	2.2
Grab Tensile Strength	ASTM D-4632	N	MARV	970
Grab Elongation	ASTM D-4632	%	MARV	50
Puncture Strength	ASTM D-4833	N	MARV	600
Mullen Burst Strength	ASTM D-3786	kPa	MARV	2800
Trapezoidal Tear Strength	ASTM D-4533	N	MARV	420
Apparent Opening Size	ASTM D-4751	m m	MARV	0.2
Permittivity	ASTM D-4491	sec^{-1}	MARV	1.5

used as the qualifier. Even for properties like permittivity or AOS, which may be calculated on the basis of project requirements, there is no concern with using MARV as the qualifier except that the design conditions may dictate the use of MaxARV (Koerner 1998) for the latter in some cases.

Qualifiers and quality assurance

Typically, quality assurance is performed during manufacture and installation of geotextiles. A common issue relating to qualifiers is interpretation. For instance, when specifications require a minimum mass per unit area of 270 gram/m^2, the individual checking the material will compare the reported value to the MARV in manufacturer's specifications. In this case, the individual is unknowingly using MARV as the acceptance criteria although project documents specify minimum criteria. In many cases, using any qualifier other than MARV in project documents would require special care during conformance testing as there could be disconnect between product specifications, project specifications, manufacturers quality control test data and conformance test data.

Qualifiers and geotextile production

Figure 3 (p. 26) provides hypothetical normal distribution curves for mass per unit area of a geotextile with standard deviation S = 16.5 g/m^2 (0.5 oz./yd.^{2}). The mass per unit area ranges from 218 g/m^2 (6.5 oz./yd.^{2}) to 370 g/m^2 (11 oz./yd.^{2}) depending on the qualifier used. The actual range may vary depending on the product and manufacturer.

Confronted with the dilemma of different qualifiers in project specifications, geotextile manufacturers face three difficult options:

(1) A manufacturer can develop, manufacture and market three products under each mass denomination, one for each of MARV, Minimum and Typical qualifiers. This requires approximately three times the inventory, testing, marketing and administration cost. Considering the current sale price of geotextiles, this alternative is cost prohibitive.

(2) For every project with a qualifier other than MARV, a manufacturer can

Equations for determining Average, Standard Deviation, MARV, Minimum, Maximum and Range.

$$\text{Average, } \bar{X} = \frac{X_1 + X_2 + X_3 + \ldots\ldots X_N}{N}$$

$$\text{Standard Deviation} = \sqrt{\frac{(X_1 - \bar{X})^2 + (X_2 - \bar{X})^2 + \ldots\ldots + (X_N - \bar{X})^2}{N - 1}}$$

$$MARV = X - 2 * S$$

$$Minimun = X - 3 * S$$

Figure 2: Current use of qualifiers in project specifications (a) for all properies except AOS, and (b) for AOS.

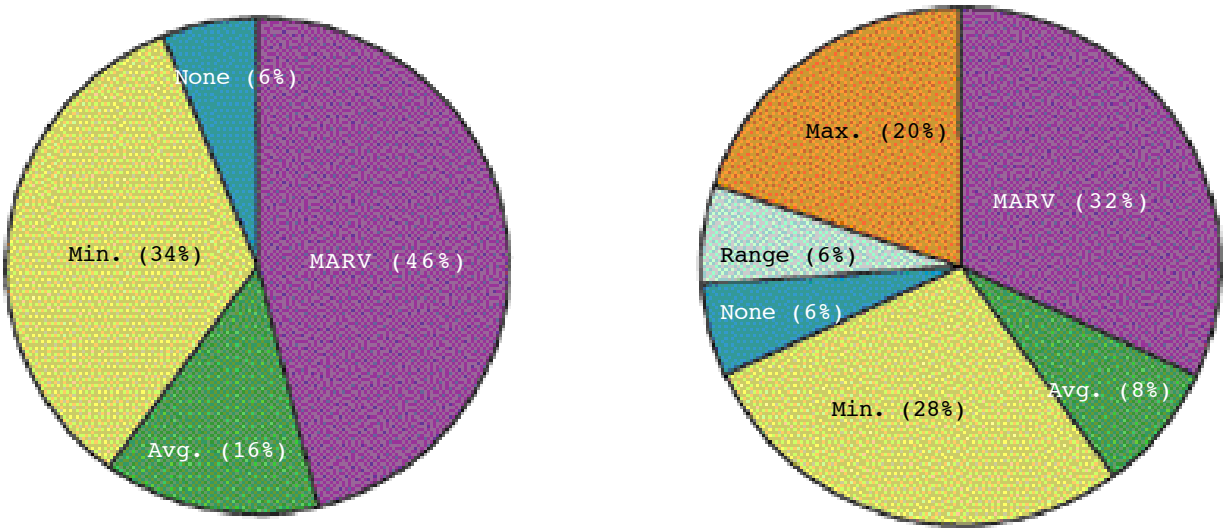
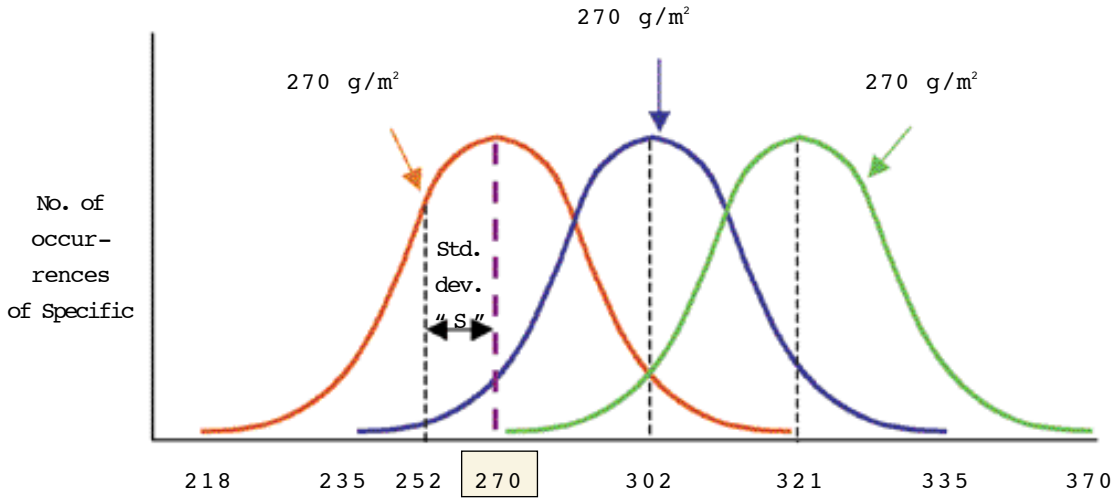


Figure 3: Hypothetical normal distribution for geotextiles with the same mass but three different qualifiers.



approach the project engineer and request that the qualifier to be changed to MARV. Obviously, altering project specifications is not a simple matter in most cases, given the considerable time and effort involved.

(3) Manufacturers can produce one product meeting all three qualifiers - Minimum, MARV and Average - for each mass denomination. However, this approach has two flaws: first, this would make products unnecessarily heavy without any engineering justification; second, since hydraulic properties—permittivity and AOS—vary inversely with mass, a heavier product meeting all the qualifiers for physical and mechanical properties would still not meet the requirements for hydraulic properties.

Each manufacturer has its own preference when preparing bid documents as to which of the above options to use. For example, the author's company chooses option (2) in most cases.

Recommendations

Project specifications should include no other qualifier but MARV except for AOS where MaxARV may be necessary in some cases. This would lead to less number of geotextile products resulting in cost savings for everyone involved in the process. For design engineers, the use of MARV would result in better communication with manufacturers, lower number of change requests, and simpler and economical designs.

References

Koerner, R.M. 1998. Designing with Geosynthetics. 4th Edition, Prentice-Hall.

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