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Recent evolution in ISO standardization for mechanical testing of geotextiles

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ABSTRACT : Nowadays geotextiles are worldwidely used. National Committees try to standardize tests on the basis of local experiences.
The Internationalization of the market of geotextiles makes essential the harmonization of tests procedures.
In 1985, I.S.O. (International Standard Organization) decided to create a sub-committee for the standardization of test procedures on geotextiles : I.S.O. TC 38/SC 21.
The working group 3 has the responsability of the study of the mechanical test procedures on geotextiles. The purpose of this paper is to present the recent evolulion of the activity of this working group.

1 INTRODUCTION

In 1985, I.S.O. decided to set up a technical sub-committee for the standardization of test procedures on geotextiles : ISO TC 38/SC 21. The first plenary meeting was held in Manchester in June 1985. France held the chairmanship and the secretaryship of this committee.
It was decided to set up 5 working groups in order to prepare the technical bases for the plenary sessions. The 5 working groups and the chairmen are :
- WG 1 : terminology - J. Perfetti (France)
- WG 2 : sampling - M. Mortensen (Denmark)
- WG 3 : mechanical tests - J.M. Rigo (Belgium)
- WG 4 : hydraulic tests - B. Myles (United Kingdom)
- WG 5 : durability - to be appointed.

The second plenary meeting of the ISO sub-committee TC 38/SC 21 was held in Paris in March 1987. After this second meeting, we can say that a lot of work has been done. So far, this conference is a good occasion to present the major results obtained by our working group.

Very active experts from United Kingdom, West Germany, Austria, Denmark, Belgium, Canada, France, Italy, Netherlands, Switzerland and United States of America constitue the WG 3. The names of these experts are given at the end of this paper.

The goals of WG 3 are to prepare ISO-standards for :
- conditioning atmosphere;
- tensile tests;
- tensile tests on geotextile junctions;
- tear tests;
- friction tests.

2 CONDITIONING ATMOSPHERE

WG 3 proposed and the plenary Assembly adopted (Paris 1987) that the conditioning atmosphere would include these three groups of conditions already recommended by different ISO standards :
- 20 ± 2°C; 65 ± 5 % of relative humidity;
- 23 ± 2°C; 50 ± 5 % of relative humidity;
- 27 ± 2°C; 65 ± 5 % of relative humidity.

These different conditioning atmospheres take into account the various local weather conditions in the world.

3 TENSILE TESTS

A great number of different tensile tests exists nowadays : the wish of WG 3 is not to elaborate new test procedures but to lead the experts to define a general philosophy for choosing a common test procedure on geotextiles. The best way in order to obtain this result is based on the principle of the value analysis; balancing the relevant factors and finally making a choice : it was presented by Leflaive at a R.I.L.E.M. 47-SM committee meeting on

geotextiles tests (Milano, November 1985). Following this presentation, each test procedure is estimated by a quotation coefficient, function of 8 criteria :

1. applicability to various uses of geotextiles;
2. direct relation between the test procedure and the geotextile's function;
3. applicability to all the different types of geotextiles;
4. accuracy;
5. reproductibility;
6. cost;
7. time before getting a response;
8. possible extension according to the market trend.

Each of these 8 criteria is graded from 1 to 5. Each grade is adjusted by a factor depending on the purpose of the test :
- quality control test;
- identification test (or acceptance test);
- design test.

The sum of these 8 factors is fixed to 20. By this way the final grades are rated up to 100.

A quality control test is a mean to check the production regularity of a type of geotextile. The producer is responsible in the choice of that method. The results of these control tests can be confidential. An external body might interact with this procedure :

1°) to recommend to follow through certain types of parameters because they seem to be significant; and this within the scope of a recommendation;

2°) for an approval procedure or quality attestation, in order to check wether or not the procedure has all the know-how and the materials needed for this qualification.

An acceptance test or an identification test is intended to identify the product if it meets the accepted specification
- the raw material;
- the production procedure;
- the physical characteristics of the components and final products.

These characteristics are given by the producer, under his responsibility and presented on technical sheets. These data may be checked easily by the contractors. Obviously a good accordance between the test procedures used by the contractors and the producers must exist.

A designing test is intended to the selection of a product for a given application. In each case, the choice of a test procedure depends on :
- the function(s) fulfilled by the geotextile. The test must give appropriate informations in relation with this (these) function(s);
- the design procedure (empirical, semi-empirical, analytical at different levels).

Experts found not less than ten different methods for the tensile test; these are :
- classical tensile test : 5 cm wide (ISO 5081);
- Grab test (DIN 53858);
- CBR test (DIN 54307);
- wide strip test : 50 cm wide (NF G 38-014);
- wide strip test : 20 cm wide (ASTM 4595-86);
- Sison test (SN 64 0550);
- St-Brieuc test (-);
- burst test (ASTM D 3786);
- biaxial test (-);
- tensile test with soil (-).

According to Leflaive's presentation described above, experts of WG 3 decided to adopt the following procedure as first step :
- the test procedure basis principle must be the wide strip tensile test;
- the 20 cm wide strip test is chosen as reference and basic test for ISO standard (ISO, first part);
- possibility is given if an improvement of the product characteristics is noticed, to use the 50 cm wide strip test (ISO second part);
- for all these tests the reference length is 10 cm;
- it's proposed for tests on geogrids (outside the centre of interest of ISO TC 38/SC 21, but viewed here for more convenience) to adopt a variable width for the samples and closed as possible to 20 cm width, including a whole number of elements. The length of these samples must also include a whole number of elements.

The tensile test on 50 cm wide samples calls for notion of equivalent strain to evaluate the strain under the maximum load. This is the strain of a piece of a geotextile that would be submitted at the moment of maximum load when lateral strains during the test are prevented.
This value of the strain is given by the following formula proposed by Rigo and Perfetti (1980) :

$$\varepsilon_R = \varepsilon_1 + \varepsilon_2 + \frac{\varepsilon_1 \varepsilon_2}{100} \qquad (1)$$

where ε_1 and ε_2 parameters are evaluated by the following expressions, according to figure 1

$$\varepsilon_1 = (\ell_r - \ell_o) / \ell_o \qquad (2)$$

$$\varepsilon_2 = (b_r - b_o) / b_o \qquad (3)$$

Recent investigations led by French experts (Leclercq, 1987 and Perrier, 1987) showed that it was possible to evaluate ε_R by measuring ε_1 in the sample central zone provided that there is no lateral contraction in that zone. Indeed (figure 2), it's possible to show that during a tensile test on wide sample, the value of ε_1 is not constant from one clamp to the other.

From the comparison (figure 3) between the values of ε_1 measured in the central zone and ε_R, it can be concluded that there is a good agreement in the case of the 50 cm wide samples.

This fact still has to be confirmed in the case of 20 cm wide samples. If the tests on 20 cm wide turn out to be convincing, the ISO test procedure could be simplified and consider only one width, namely 20 cm.

4 MEASUREMENT OF ε_R AND ε_1 IN THE CENTRAL ZONE

In order to contribute to the validation of this concept, tests were carried out at the Civil Institute of the State University of Liege. These results are given in Table 1.

The following products were considered : two thermobonded and two needle-punched non-woven geotextiles. Two widths were considered, namely 20 and 50 cm. The tests were carried out on the longitudinal direction and at the same rate of displacement, namely 50 mm per minute.

The following parameters were measured :

ε_1 = the longitudinal strains in the sample central zone

ε_1 is the sample strains determined from the displacement between the two clamps

ε_r is the lateral strain

ε_R was calculated by the formula (1).

For the measure of ε_1, an infra-red pulsed extensometer was used.

This apparatus was used to follow control markers 6.0 cm apart at the start.

These tests show that for non-woven geotextiles, no difference between the measure of ε_1 in the central zone and ε_R calculated by the formula (1) was observed for both sample widths of 20 and 50 cm.

The values of ε_1 obtained in both 20 and 50 cm wide samples are about the same.

The concept presented in the previous paragraph seems to be confirmed. More investigations are in progress.

Table 1. Comparison between ε_R and ε_1 from tensile tests on nonwoven geotextiles with different widths (20 and 50 cm) : two specimens for each width tested only in longitudinal direction at the same displacement rate

Type of product	μ (g/m2)	Specimen width (cm)	ε_1 (%)	ε_2 (%)	ε_R (%)	ε_1 (%)
NW TB PP CF	190	20	88 85	22 20	65 65	58 58
		50	77 83	10 10	67 73	63 60
NW TB PP CF	160	20	86 86	15 15	71 71	68 65
		50	80 55	6 5	70 43	71 40
NW NP PP CF	180	20	105 128	45 45	60 82	63 81
		50	109 86	17 17	92 69	48 52
NW NP PS CF	160	20	65 75	35 33	35 42	38 46
		50	75 65	16 15	47 40	50 40

NW : nonwoven - NP : needle-punched
TB : thermo-bonded
CF : continous filament
PP : polypropylene
PRS : polyester

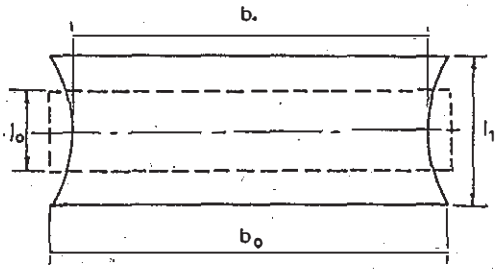

Figure 1 : Dimensions of a sample for a tensile test

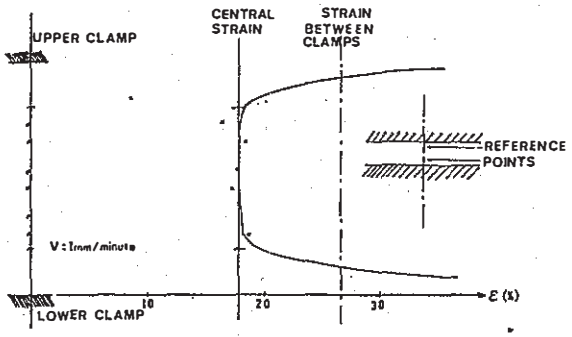

Figure 2 : Evolution of ε_1 in P.P. woven geotextile sample

5 TENSILE TESTS ON GEOTEXTILE JUNCTIONS

This subject of work was appointed to WG 3 in Paris (March 1987) and must be solved easily and rapidly after the adoption of a final resolution for the tensile test procedure.
ASTL has, so far, adopted a tensile test procedure with 20 cm sample, presenting the junction to be tested in the central part of the sample.
The shape of the sample is given in figure 4. An over-width is necessary to make possible the sewing thread anchorage. The test results have to be compared to those obtained with the tensile test on 20 cm wide samples.

6 TEAR TEST

It's proposed to go closely into the different following aspects of the tear phenomenon :
- initiation of the tear process;
- tear propagation;
- residual resistance after damping.

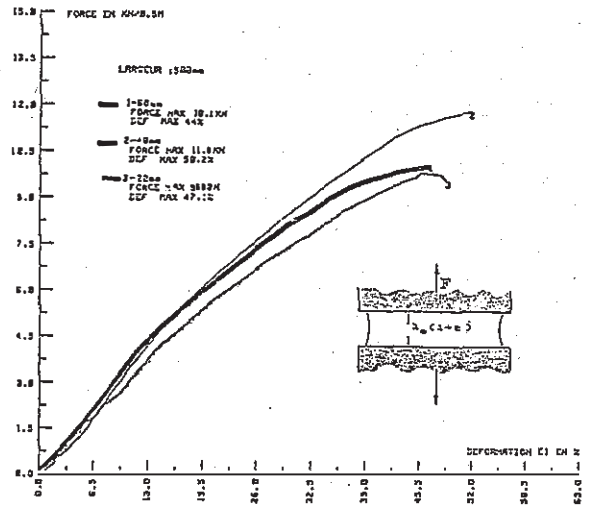

Figure 3 : Comparison between ε_1 measured in the central zone of the sample and ε_R (Perrier)

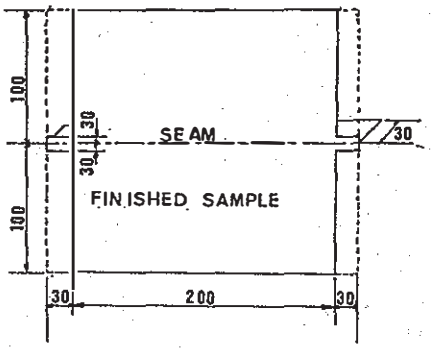

Figure 4 : Tensile test on geotextile junctions (from ASTM draft)

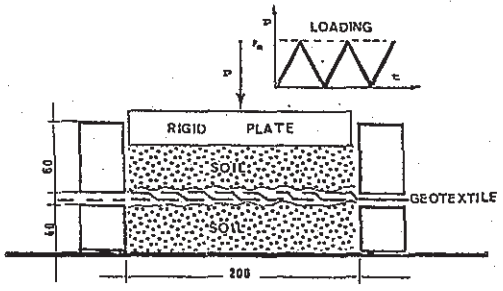

Figure 5 : Geotextile damaging before tensile test (Perrier, C.E.T.E.)

For the initiation of the tear process, future studies will be brought in order to examine the different possibilities of puncture tests on geotextiles. Information will be available in the new issue of the I.G.S. inventory on tests on geotextiles.

The following parameters will be taken into account :

- type of test (statical or dynamical);
- sample dimension;
- piston shape.

For the tear propagation, if the sample width for the tear propagation test. It is possible to continue the works on the basis of the Italian standard which already consider that width for the tear samples (Cazzuffi and al., 1986).

For the damaging effects on geotextiles, Perrier showed recently a method used and developed at C.E.T.E. laboratory.
A geotextile (figure 5) is placed between two layers of soil in a box 200 mm wide, 600 mm long and 100 mm high. The soil is a 0/40 gravel, a mix of river and crushed gravels. A rigid metallic plate allows to apply a vertical force on the "soil-geotextile" system.
Triangular loadings are applied 20 times with maximum value of 200 kPa. After that type of damaging, the geotextile is removed and is submitted to tensile tests, using 50 cm wide samples. This damaging method will be used as a reference for the works of the WG 3.

7 FRICTION

The subject of this study was intrusted to WG 3 in Paris in March 1987. No precise decision has been taken so far about the procedure and the test method. Contacts will be taken with ISO TC 183 (Soil Mechanics) having soil friction tests in its scope of duty.

8 CONCLUSION

The WG 3 is set up in Manchester in 1985, devoted to mechanical tests on geotextiles and has for goal to propose to plenary ISO sessions test methods in matter of conditioning atmosphere, tensile test, tensile test on junctions, tear and friction tests. These works make progress rapidly. The conditioning atmospheres were approved by the plenary session in Paris (1987) and the works concerning tensile tests and tensile tests on junctions are to be concluded.

The experts appointed by different national standardization institutes and actively participating in the activity of WG 3 are :

Mercer and Robinson	(U.K.)
Frobel	(U.S.A.)
Schneider	(A)
Mortensen	(DK)
Martin and Tonus	(CH)
Kristmann and Willemsen	(D)
Den Hoedt	(NL)
Delmas, Gourc and Leflaive	(F)
Rowe	(CND)
Cazzuffi	(I)
Rigo	(B)

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