Textile Testing Methods for Nets

Document edited from the collaboration with BAYER and Severine HUCHET
Key steps

✓ Define and realize the performance tests on new & used nets

✓ Developed a laboratory protocol to simulate an ageing effect on the new nets

✓ Compare the performance results of new nets, used nets and aged nets in order to adjust the ageing protocol

✓ Validate the protocol with approved nets
1. PERFORMANCE TESTS
   - Tensile Strip test
   - Dynamic nail test
   - Slow nail test
   - Bursting test
   - Abrasion
   - Fire tests

2. AGEING PROCESSES
   - Washings
   - Thermal ageing
   - Bagging test
   - Weather-O-meter

3. RESULTS & COMMENTS
1. Performance tests

1. Bursting Test – 3D burst
2. Dimensional stability after washing – Shrinking test
3. Fire tests: 16 CFR part 1610 (CS 191-153)
4. Dynamic Nail Test – Pendulum test
5. Slow Nail Test – Ripping test
6. Abrasion
7. Fire tests – M Classification
1. Performance tests

1.1 Tensile strip test (ISO 13934-1)

Principle:
A sample of fabric is pulled at a constant rate (speed) until it breaks. The amount of force it takes to stretch it, all the way to breaking it, is recorded.

Limitations:
It is **not** recommended for knitted fabrics because of the stretchability of knitted fabric.
1. Performance tests

1.2 Dynamic nail test (NF G 07-147)

Principle:
A sample of fabric, pierced by a fixed nail and held by his extremity in a clamp connected to the pendulum impact tester, is subjected to a sudden traction.
1. Performance tests

1.2 Dynamic nail test (NF G 07-147)

Pictures of the equipment in IFTH Laboratory

Side view

Front view

(Sample after tearing)
1. Performance tests

1.2 Dynamic nail test (NF G 07-147)

Results:

✓ Maximum strength (N)

Note: For each series, the test is done 5 times in each direction (column and row)

Why doing this test?
✓ Splinter under the matress
✓ Ring/nails tearing the net
✓ Metal wires/wood holding the net + strong pull
✓ Chicken claw
✓ Goat bite or rodent bite
1. Performance tests

1.3 Slow nail test (NF G 07-145)

**Principle:**
With a tensile tester, a sample of fabric, crossed by a nail fixed in the mobile clamp of the dynamometer, is subjected to a traction.

![Diagram of slow nail test](image_url)

- **Clamp**
- **Fixed nail (3mm diameter)**
- **Constant elongation rate**
  
  \[ \text{Constant elongation rate} = (100 \text{ mm} / \text{min} \pm 10 \text{ mm} / \text{min}) \]

- **Torn length** \( L \)
1. Performance tests

1.3 Slow nail test (NF G 07-145)

Pictures of the equipment in IFTH Laboratory

Constant elongation rate

(100 mm / min +/- 10 mm / min)

Note: The mobile part is here the nail and not the clamp, but the test is exactly the same.
1. Performance tests

1.3 Slow nail test (NF G 07-145)

Results:

- Maximum strength (N)
- Force at 1rst peak
- Average of the 3 maximum peaks

Note: For each series, the test is done 5 times in each direction (Column and row)

Why doing this test?

- Same as Dynamic nail test, just in slow motion: Splinter, rings, animals
1. Performance tests

1.4 Bursting test (NF EN ISO 19338-1 : 1999)

**Principle:**
A pressure is applied to a circular region of the fabric via an elastic diaphragm.
The specimen is firmly held round the edge of this circular region by a pneumatic clamping device.
The bursting strength corresponds to the maximum pressure supported by the specimen before explosion.
1. Performance tests

1.4 Bursting test (NF EN ISO 19338-1 : 1999)

There is no direction

Average of 5 bursts

The area tested is 7.3 cm² (larger size available)

Results:

✓ Pressure at burst (kPa)

✓ Distension (height of the bubble at burst in mm)

Why doing this test?

✓ Because it is the only appropriate test for knitted fabrics to measure “strength”

✓ WHO min requirement of 250kPa
1. Performance tests

1.5 Abrasion (Norm NF EN 343 + A1 / NF EN 530)

**Principle:**
This test method covers the determination of the abrasion resistance of textile fabrics. The end point is reached for a knitted fabric when a hole appears.
1. Performance tests

1.5 Abrasion (Norm NF EN 343 + A1 / NF EN 530)

**Conditions:**
The load can be 9 kPa or 12 kPa. The abrasive fabric has to be adapted regarding the product tested.

**Sample:** The samples sizes mustn't be under 150 x 150 mm (There is no direction).

**Results:**
Number of cycles to have the opening of a hole.
1. Performance tests

1.6 Fire test (16 CFR part 1610 (CS 191-153) – Class 1)

Flame applied during 1s and then removed

The time for the flame to reach 127mm of displacement is recorded.

To pass the **Class 1** classification this time should be greater than **3.5 s**
1. Performance tests

1.6 Fire test (M classification)

This classification is for building materials:

**NF P 92-501:** Radiation test used for rigid materials, or for materials on rigid substrates

**NF P 92-503:** Electrical burner test used for flexible materials with a thickness smaller or equal to 5 mm

**NF P 92-504:** Flame persistence test and speed of the spread of flame

**NF P 92-505:** Test used for thermal melting materials. Dripping test

**NF EN ISO 1716:** Determination of upper calorific value

**NF P 92-507:** Ranking of the materials according to their fire reaction

===> M Classification
1. Performance tests

1.6 Fire test - classification is for building materials (NF P 92-503)

Class M1:
Inflammation $\leq$ 5sec

Class M2:
Inflammation > 5sec and average of the length destroyed $<$ 350mm or M1 with burning drops

Class M3:
Inflammation > 5sec, average of the length destroyed $<$ 600mm, average of the width destroyed $<$ 90mm between 450 and 600mm or M2 with burning drops

Class M4:
Materials which are not in the previous categories or M3 with burning drops and propagation speed $\leq$ 2mm/sec according to NF P 92-504

Unclassified:
M4 with propagation speed $>$ 2mm/sec according to NF P 92-504.

For fusible materials, if inflammation of the cotton wool during NF P 92-505 $\Rightarrow$ Class M4
1. Performance tests

1.6 Fire test - classification is for building materials (NF P 92-504)

If there is a hole appearing during the NF P 92-503 test ==> NF P 92-504

The flame is applied during 5s and follows the fusion of the product

Class M1: No flame persistence (inflammation ≤ 2sec)
Class M2: Flame persistence ≤ 5sec or M1 with burning drops.
Class M3: Flame persistence > 5sec or propagation speed ≤ 2mm/sec or M2 with burning drops.
Class M4: M3 with burning drops or inflammation of the cotton wool during NF P 92-505

No classification: Propagation speed > 2mm/sec
1. Performance tests

1.6 Fire test - classification is for building materials (NF P 92-505)

If there is an inflammation of the cotton wool, the product is downgraded to Class M4.
1. Performance tests

1.6 Fire test - classification is for building materials (NF P 92-504)

Examples of net behavior
2.

Ageing processes
2. Ageing processes

2.1 Washings

**Principle:**

The samples are washed in standard washing machine at a controlled temperature.

**Conditions:**

Number of washings and temperature can be adjust to the needs

- Temperature: 40°C and 70°C
- Repeat: 5, 10, and 20 times

Flat dry at the end of the washings

**WHO specifications:**

The WHO test is less stringent: one single wash at 30°C.
The WHO specifications allow shrinkage/expansion of no more than 5%.
2. Ageing processes

2.2 Thermal ageing (Norm NF EN 12280-3)

**Principle:**
The samples are exposed to well defined conditions of humidity and temperature.

**Conditions:**
Temperature: 70°C
Relative Humidity: 95%
Time: 1 week and 2 weeks
2. Ageing processes

2.3 Bagging (Norm NF G 07-213)

**Principle:**
A number of "compression-slackening" cycles are applied on a circular sample, at a regular speed, with a spherical object.

The residual deformation (in mm), which is the bagging, is recorded.

**Caption**

1. Top fixation
2. Spherical object
3. Sample
4. Ring
5. Threaded clamp
6. Sample support
7. Lower fixation
2. Ageing processes

2.3 Bagging (Norm NF G 07-213)

Conditions:
Low impact: 10N pressure, 10 cycles with a speed of 100 mm/min (norm)
Higher impact: 250N, 100 cycles with a speed of 100 mm/min
(in house conditions to visually see an impact on net)

Sample: circular sample with a diameter of 145 mm.
2. Ageing processes

2.4 Weather-O-meter (Norm ISO 4892-2:2006)

**Principle:**

The samples are exposed to well defined conditions of humidity, temperatures and UV exposure.

**Conditions:**

Temperature: 65°C (with black panel)

Relative Humidity: 65%

Cycle of 18 min watering et 102 min without watering, continuous.

Duration of exposure depends on product: from 50h to 360h (red cross tents exposure level).
3. Results

- Find a performance test showing a significant difference between a new net and an old used net

- Use this performance test to show that a lab aged net has equivalent results as an old used net
3. Results

3.1 Bursting test: New vs natural ageing (1-3 years)

Objective:
reach a decrease of the bursting resistance for nets aged in laboratory.
3. Results

3.2 Washing effect

Results: Washing has no influence on bursting strength
3. Results

3.3 Dynamic nail tests on new nets and old nets

No difference between new and old → not a good performance test
3. Results

3.4 Slow Nail Test

- Results coherent with the Dynamic nail tests but also no difference between new and old → not a good performance test
3. Results

3.3 and 3.4 Dynamic & slow nail tests

Here the nail tears the rows threads.

Here the nail tears the columns threads.

"Diagonal breaking"

"Tongue breaking"

Columns direction

Nail position

Tearing way
3. Results

3.5 Thermal ageing effect: 70°C 95%RH

Results: Exposure to temperature and humidity has no influence on bursting strength
3. Results

3.6 Bagging effect: 100 cycles x 250N

STD NF G 07-213 :
100 mm/min

<table>
<thead>
<tr>
<th>Displacement in mm</th>
<th>Product 1</th>
<th>Product 2</th>
<th>Product 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>New</td>
<td>291</td>
<td>502</td>
<td>492</td>
</tr>
<tr>
<td>Bagging</td>
<td>322</td>
<td>510</td>
<td>492</td>
</tr>
</tbody>
</table>

Results: No influence on bursting strength
3. Results

3.7 Cumulative effect

Thermal ageing: 1 week at 70°C 95%RH
Washings: 5 washings at 40°C
Bagging: 100 cycles at 250N

<table>
<thead>
<tr>
<th></th>
<th>Product 1</th>
<th>Product 2</th>
<th>Product 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>New</td>
<td>291</td>
<td>502</td>
<td>492</td>
</tr>
<tr>
<td>All three</td>
<td>294</td>
<td>489</td>
<td>478</td>
</tr>
</tbody>
</table>

Results: No influence on bursting strength
3. Results

3.8 Weather o meter effect: 65°C, 65%RH

Results:
- UV and rain have a great influence on nets
- Exposure of tropical climate do decrease the strength of all nets
3. Results

3.9 Conclusion

For the performance tests, we looked at:

– Bursting strength
– Dynamic nail test
– Slow nail test
– Tensile strip test
– Abrasion

Only bursting showed a significant difference between a new and an old used net.
4. Conclusions and Comments

- Bursting strength is the performance test, a target value can be fixed to mimic used nets (a few years in the field).

- The Weather-o-meter showed a significant decrease of bursting strength on different nets. Exposure to UV and rain seem to be one way to decrease artificially the bursting strength the nets (polymer degradation). However the results showed an uneven decrease across the nets, and it is a polymer degradation.

- Measuring the bursting strength after a mechanical regular damage (stonewashing ?) could be a more representative ageing as the used nets showed very few polymer degradation but many mechanical damages (small holes).
Thank you for your attention.

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