

Standard Operating Procedure

Snag Strength Test for Insecticide-Treated Nets (ITNs)

1. Scope

This document describes the equipment and the test method for assessing the snag strength of open mesh fabric structures such as those used in Insecticide-treated Nets (ITNs).

2. Referenced Documents

The following referenced documents are useful for the application of this document.

ISO 139:2005 Textiles – Standard atmospheres for conditioning and testing.

BS EN 15598: 2008 Textiles – Terry fabrics. Test method for the determination of the resistance to pile loop extraction.

BS EN ISO 13934-2:2014 Textiles – Tensile properties of fabrics – Part 2: Determination of maximum force using the grab method.

3. Terminology

Open mesh textile: A textile, which due to its inherent structure consists of a large number of closely spaced apertures.

Aperture: An opening in the open mesh textile structure that is larger than 1 mm.

Snag: Yarn pulled or plucked from the surface of the fabric resulting in yarn breakage.

Hole: An opening in a textile which is not part of its inherent structure and is the result of breakage or displacement of yarns.

Course-wise: In knitted fabrics courses are defined as rows of loops across the width of a flat knitted fabric¹, as shown in Figure 1. Course-wise refers to the plane in the course direction.

Wale-wise: In knitted fabrics wales are defined as columns of loops along the length of the fabric, as seen in Figure 1. Wale-wise refers to the plane in the wale direction. In warp knitting, the yarn is looped in the machine direction, i.e. the wale-wise direction. In weft knitted fabrics, the yarn is looped in the cross direction (width direction), i.e., the course-wise direction.

¹ The Textile Institute, 1995, Textile terms and definitions, 10th Edition, The Textile Institute: Manchester

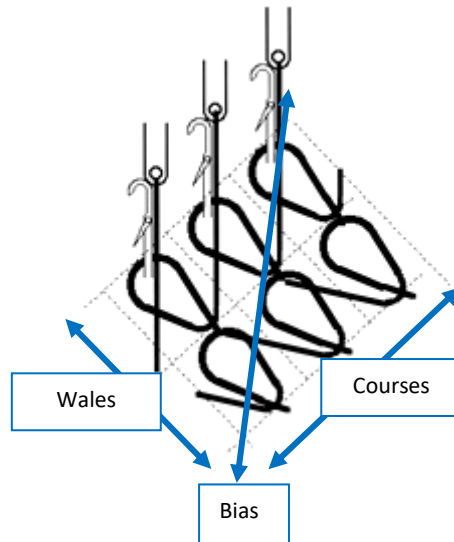


Figure 1 Directional properties of warp knit structures.

4. Summary of Test Method

This test method has been modified from ISO 13934-2:2014 Textiles – Tensile properties of fabrics – Part 2: Determination of maximum force using the grab method. A hook is used to catch the fabric and causes yarn breakage (failure).

This test method measures the resistance to yarn breakage after being caught on a solid protuberance (snag).

The test specimen (minimum size: 120 X 100 mm) is folded lengthways and mounted in the lower jaws of the tensile tester so that the loose ends of the fabric are clamped together.

The end of a metal latch needle, is clamped vertically in the upper jaws of the tensile tester so that the hook of the needle points downwards towards the middle of the folded specimen. The hook is then inserted between two adjacent apertures in the middle of the folded specimen so that it catches the yarns in both sides of the fabric. The test specimen in which the hook is caught is then extended at a rate of 100 mm/min by constant movement of the upper jaw of the tensile tester. This causes the yarns and surrounding fabric to extend in the region of the hook until the specimen fails. Failure means yarn breakage at the hook. The force required to fail the specimen is recorded. The load reading is zeroed after each test.

5. Significance and Use

This test is used to assess the force required to break yarns during snagging of an open mesh textile and is designed to reflect conditions that an ITN will be exposed to during normal use. This has

particular significance for ITNs, because once yarn breakage occurs, a hole is created that could enable insects to penetrate the structure leading to the potential transmission of diseases such as malaria.

6. Apparatus and Materials

Tensile testing equipment is required capable of recording force at break at a crosshead (upper jaw) speed of 100 mm/min. The clamp size should be between 60 – 100 mm width and 20 – 30 mm depth.

Figure 2 shows the metal latch needle used for the testing. The hook forms part of a 3.5 gauge metal latch needle used by the knitting industry. Hooks should be regularly checked and if they are damaged, should be replaced. Related dimensional parameters are: hook height: 5.65 mm, working length: 101.9 mm, and butt height: 12 mm. The inner width of the hook should measure 1.1 mm +/- 0.20 mm. The latch needle can be purchased from Groz-Beckert, using the reference specifications shown in Figure 3.



Figure 2 A 3.5 gauge metal latch knitting needle and hook.



Figure 3 Reference details for the 3.5 gauge metal latch needle.

7. Sampling and Test Specimens

Sampling

A total of 5 specimens per ITN sample are tested. The 5 specimens measuring 120 X 100 mm (L x W) are taken from each of the four side panels of the ITN and the roof panel as shown in the areas illustrated in Figure 4.

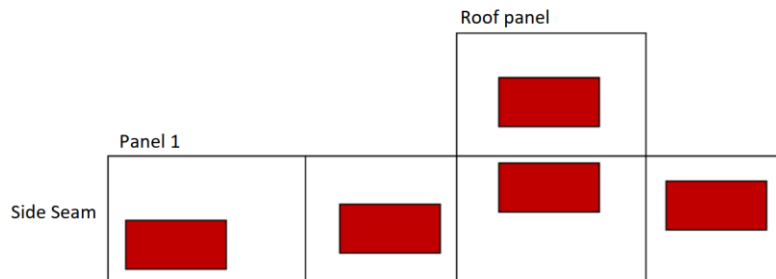


Figure 4 Example of sampling method.

A minimum of three different ITN samples is required for testing. A total of 15 specimens are therefore measured. When taking the specimens for testing it is important to ensure that they do not share wale yarns.

Specimens

Specimens measure 120 X 100 mm (L x W). Specimens are folded lengthwise in half to measure 60 X 100 mm. 15 specimens are required in order to test the strength in the course-wise (CW) and 15 specimens are required for the wale-wise (WW) directions of the fabric.

Specimen A: 120 mm edge parallel to the course-wise (CW) direction

Specimen B: 120 mm edge parallel to the wale-wise (WW) direction

8. Conditioning

The atmospheres for preconditioning, conditioning and testing are as specified in ISO 139:2005.

9. Procedure

Test parameters

The test parameters for ITNs testing are given in Table 1.

Table 1 Testing parameters for snag strength testing of ITNs.

| | |
|-----------------------------|---|
| Test parameters | Cross Head Speed: 100 mm/min |
| End of Test | Force Shutdown Threshold: 80% of Maximum Force (termination when force decreases to 80% of maximum force at Break) |
| Parameters to record | Maximum Force at Break (N) |

Equipment set up

Figure 5 demonstrates the equipment set-up. As highlighted, the knitting needle is clamped widthways in the upper jaws, with the top of the jaws aligned with and extending just beyond the needle butt.

Jaw to jaw distance: 105 mm*

Clamped Hook length: 78 mm*

Mounted specimen length: 30 mm

*Distance is based on a 20 mm jaw depth.

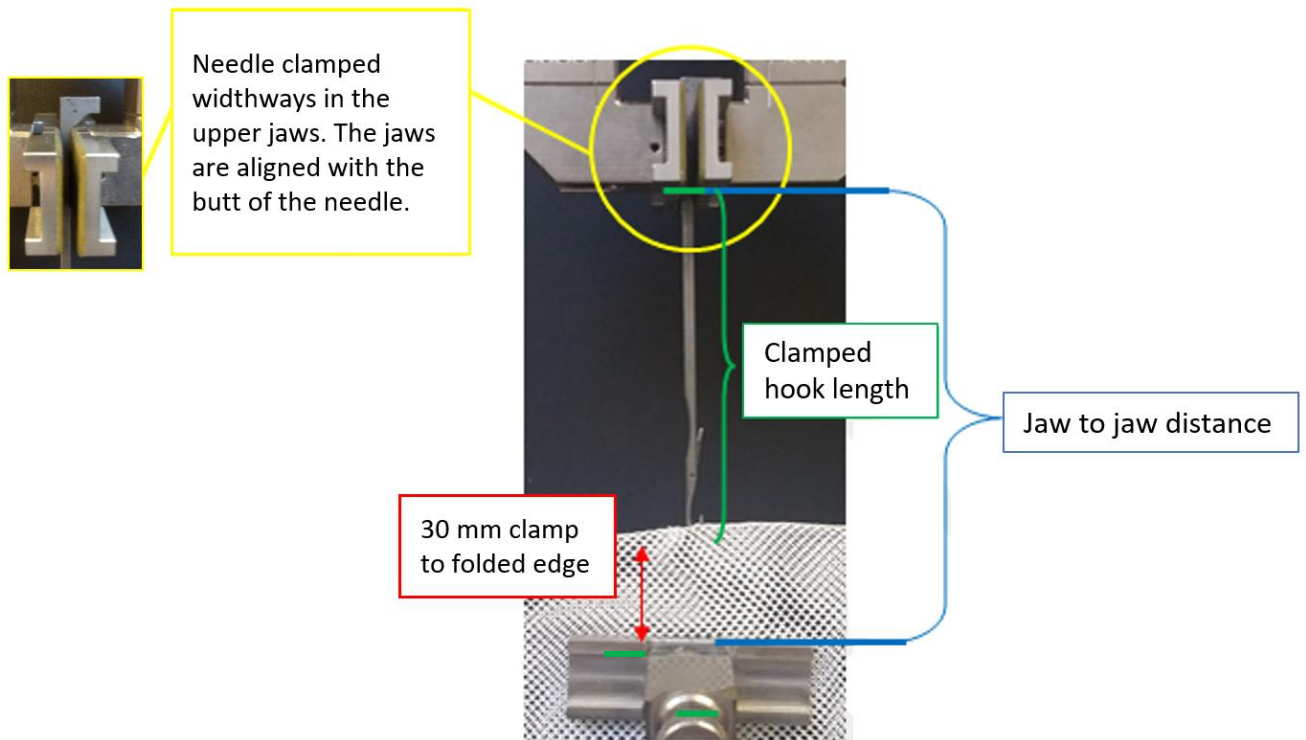


Figure 5 Example of Equipment set up.

Test procedure

Figures 6a-6c illustrate common ITN fabric structures and their respective course and wale directions.

1. Mount the folded specimen in the lower jaws with the folded edge running parallel to the jaws at a distance above of 30 mm.
2. Bring the jaws into the test position.
3. Insert the hook through the apertures of the test specimen as outlined in Figures 6a-6b.
4. Undertake the test and record the maximum force at break in Newtons (N).

| Course-wise | | | |
|--|--|---|--|
| Wale-wise | | | |
| <p>Figure 6a: ISO 8388:2003; 3.5.52 Tulle</p> <p>Warp knitted fabric with hexagonal openings produced by pillar stitches alternating with tricot stitches. Both stitches are reinforced by inlay threads. Can also be referred to as a Raschel knit structure.</p> | <p>Figure 6b: ISO 8388:2003; 3.5.50 Traverse Net</p> <p>Warp knitted fabric with diamond shaped openings in which each stitch in the fabric consists of only one thread. Can also be referred to as an Atlas structure.</p> | <p>Figure 6c: ISO 8388:2003; 3.5.56 Marquisette</p> <p>Warp knitted fabric with square openings obtained by pillar stitches that are reinforced by two sets of inlay threads lapped in opposition.</p> | |
| Typical shapes & tips for quick identification: | | | |
| <p>The two <u>parallel edges</u> of the polygon shape are vertically oriented in the wale-wise direction.</p> <p>Some ITNs use a modification of this knitted structure in which the polygon is shorter in the wale-wise direction.</p> | <p>This knitted structure forms a diamond shape. The length of the diamond is oriented in the <u>wale-wise direction</u>.</p> | <p>This knitted structure forms a square shaped mesh. The loops are formed in the <u>wale-wise direction</u>. Leading to an appearance of thicker and more intricate mesh sides in the wale-wise direction.</p> | |
| <p>— Yellow line denotes a Course-Wise mount</p> <p>— Green line denotes a Wale-Wise mount</p> | | | |
| <p>REMEMBER: The test occurs in the direction opposite to that of the area mounted, i.e. if the specimen is folded along the course-wise (CW) direction of the knitted fabric, the force will be measured in the wale-wise (WW) direction due to the pulling direction.</p> | | | |

Mounting sample

Figures 7a and 7b illustrate the area of the ITN net structure that is mounted in the hook for testing.

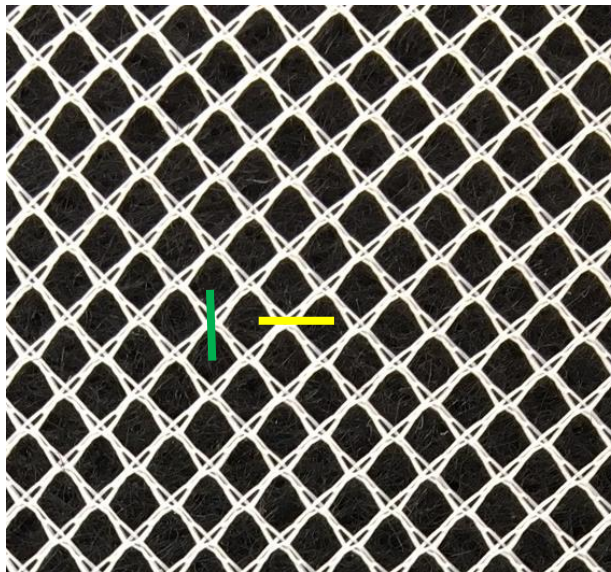


Figure 7a Example of the area of the specimen to be mounted in the hook.

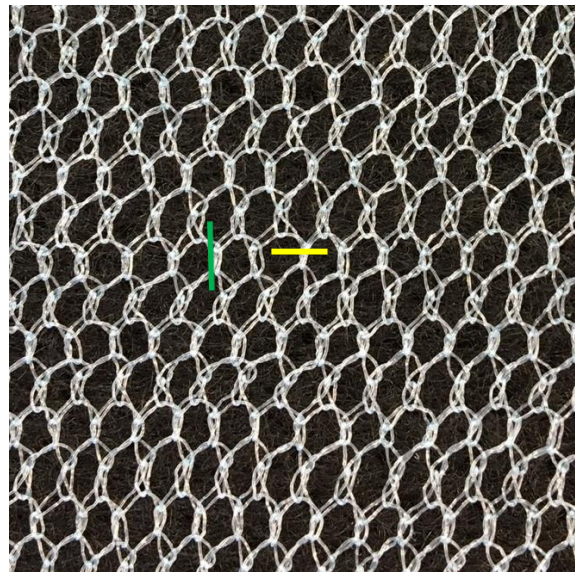


Figure 7b Example of the area of the specimen to be mounted in the hook.

Figures 8a-9b show examples of how the ITN structure is mounted in the wale-wise (WW) and course-wise (CW) directions.

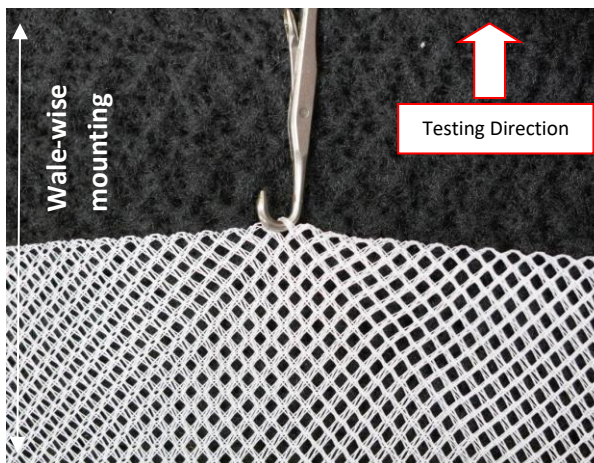


Figure 8a Example 1 of WW mounting for TESTING in the CW direction.

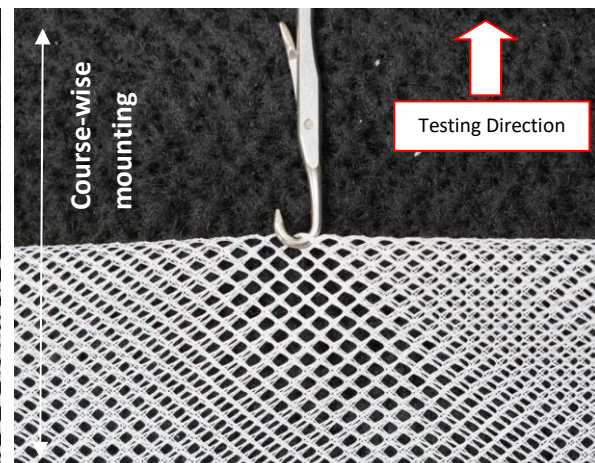


Figure 8b Example 2 of CW mounting for TESTING in the WW direction.

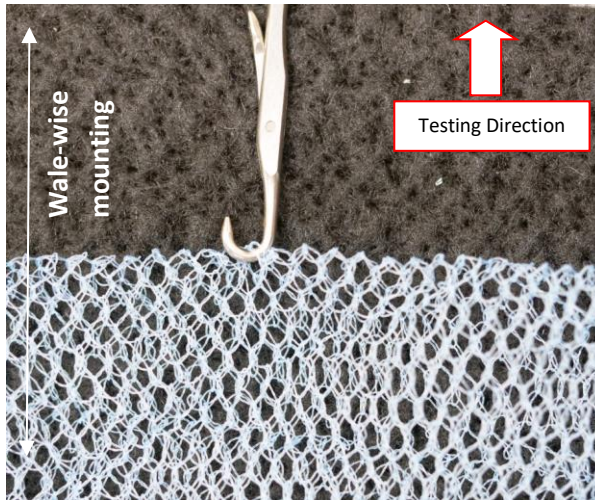


Figure 9a Example 1 of WW mounting for TESTING in the CW direction.

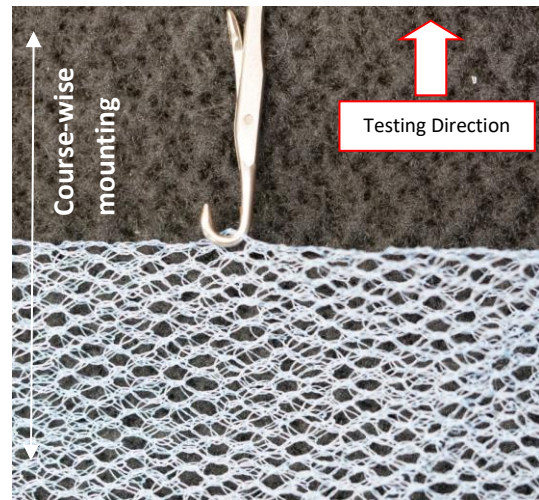


Figure 9b Example 2 of CW mounting for TESTING in the WW direction.

End of test

At the end of the test, record the maximum force at break in Newtons. Remove the specimen and re-zero and re-set the starting test position.

10. Assessment

For each specimen, examine the break to ensure that one or more yarns have been broken. It is sometimes possible for filaments to be displaced from the structure and not break. If this occurs, it is necessary to repeat the test.

Ensure the following parameters are recorded:

- Maximum force at break (N).

Table 2 shows an example of how the raw data for a sample should be recorded.

Table 2 Example of test data.

| Specimen Number | Wale-Wise Direction | Course-Wise Direction |
|-----------------|----------------------------|----------------------------|
| | Maximum Force at Break (N) | Maximum Force at Break (N) |
| 1 | 51.71 | 37.09 |
| 2 | 46.84 | 36.85 |
| 3 | 45.62 | 36.11 |
| 4 | 47.24 | 34.78 |
| 5 | 48.64 | 35.99 |
| 6 | 44.45 | 36.93 |
| 7 | 49.24 | 36.39 |
| 8 | 49.11 | 36.77 |
| 9 | 46.59 | 36.03 |
| 10 | 50.39 | 36.21 |
| 11 | 48.25 | 35.84 |
| 12 | 52.47 | 36.92 |
| 13 | 48.08 | 41.14 |
| 14 | 46.77 | 36.52 |
| 15 | 45.28 | 37.45 |
| Average | 48.05 | 36.73 |

11. Test Report

The test report should include:

- Sample details and identity.
- Date the test is conducted.
- Tensile testing equipment manufacturer and model.
- The test operator.
- The location and laboratory.
- The conditions of testing if outside standard testing conditions outlined in this document.
- The test results as outlined in Section 10 Assessment.