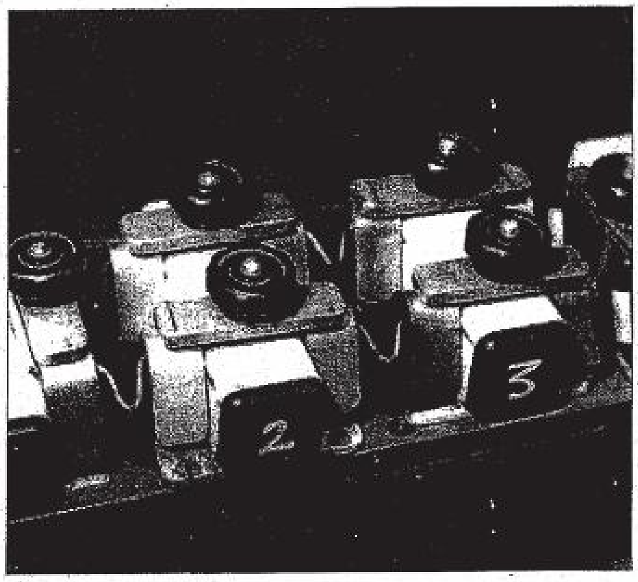
SATRA TECHNOLOGY CENTRE

TEST METHOD: SATRA TM25 (formerly PM25)

VAMP FLEX TEST – RESISTANCE TO CREASING AND CRACKING

MAY 1992



This method is primarily intended to determine the propensity for materials to crack or otherwise fail at flexing creases, but can also be used to assess whether leathers are likely to produce salt spue. In particular the test simulates conditions in the vamp part of footwear during walking. The test can be conducted with either wet or dry specimens at room temperature or with dry specimens at sub zero temperatures. **The method is applicable to all flexible materials and in particular those used to manufacture outers and linings of footwear uppers such as leathers, coated fabrics and textiles.**

1. SCOPE

This method is primarily intended to determine the propensity for materials to crack or otherwise fail at flexing creases, but can also be used to assess whether leathers are likely to produce salt spue. In particular the test simulates conditions in the vamp part of footwear during walking. The test can be conducted with either wet or dry specimens at room temperature or with dry specimens at sub zero temperatures. **The method is applicable to all flexible materials and in particular those used to manufacture outers and linings of footwear uppers such as leathers, coated fabrics and textiles.**

2. PRINCIPLE

A square specimen of the material is folded over two inverted V-shaped clamps. The clamps are able to move relative to one another so that as they become closer the specimen is flexed to produce one downward crease surrounded by four upward creases, (see cover photograph and Figure 1). During the test the clamps oscillate at a constant speed so that the specimen is repeatedly flexed. The test can be carried out with either wet or dry specimens at room temperature, or dry specimens at sub-zero temperatures. After a predetermined number of cycles the test is stopped and the specimen is visually examined for signs of damage or salt spue.

3. REFERENCES

None.

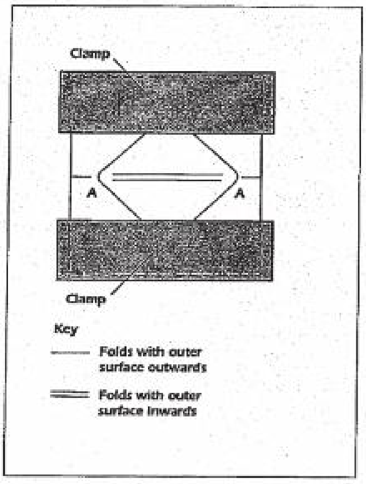


Figure 1 Plan view, Crease pattern formed by flexing

4. APPARATUS AND MATERIALS

4.1 A machine with:

4.1.1 At least four pairs of inverted V-shaped clamps (as shown on the cover photograph). The blocks of each pair should be:

4.1.1.1 Coaxially aligned so that, at both extremes of their movement, the centre line of one block is within ± 2 mm of the centre line of the block.

4.1.1.2 At least 30 mm tall and have a 'V' with an angle of 40 ± 2° and a tip radius of 6.4 ± 0.5 mm.

4.1.2 One V-shaped metal collar for each block (4.1.1) that will hold the test specimen firmly in place over the V-shaped block.

4.1.3 A means of setting the *minimum* distance between the two clamps in each pair to 9.5 ± 1.0 mm.

4.1.4 A method of applying a simple harmonic reciprocating action to repeatedly change the distance between the two clamps in each pair between the limits of the minimum distance (4.1.3) and the minimum distance (4.1.3) + 19 ± 1.5 mm at a speed of oscillation of:

- 300 ± 30 flexes/minute for tests conducted in an environment of either 23 ± 2°C / 50 ± 2% rh or 20 ± 2°C / 65 ± 2% rh.
- 90 ± 9 flexes/minute for tests conducted in an environment of -5 ± 2°C or below.

4.1.5 A method of counting the total number of flexing cycles. Alternatively, if the flexing speed is accurately known and is constant then measurement of time can be used to estimate the number of cycles flexed.

4.1.6 For conducting cold tests, a cabinet capable of maintaining an internal atmospheric temperature of -5 ± 2°C, and large enough to contain the test machine. If required temperatures down to -30°C can be used.

Suitable machines available from SATRA are given in Table 1.

Table 1 - The range of SATRA Vamp flexing machines

Model number	Number of stations	Flexing speed (cycles/min)	Additional notes
STM 101	12	300	
STM 436	4	300	(1)
STM 101F	16	90	(2)

Notes:

(1) The STM 436 is capable of being adjusted to operate with a reduced throw of 9.5 mm for testing stiff materials. However, if the reduced throw is used this makes the test non-standard and no correlation or reference to PM25 should be made.

(2) The STM 101F is supplied inside a low temperature cabinet capable of controlling the test environment to -5 ± 2°C. The latest SATRA STM 101F machines are capable of maintaining a temperature down to -30°C.

4.2 A square press knife 64 ± 1 mm x 64 ± 1 mm is useful, enabling test specimens to be quickly and accurately cut out.

4.3 For testing wet specimens:

4.3.1 A pipette with a capacity greater than 1 cm^3.

4.3.2 A clean hard flat water resistant surface greater than 65 mm x 65 mm.

4.3.3 A glass rod or scraper.

4.3.4 Distilled or deionised water.

4.4 An optical magnifier or stereoscopic microscope with a magnification of approximately 10 times.

5. TEST SPECIMENS

Cut out the required number (see Table 2) of square test specimens 64 ± 1 mm x 64 ± 1 mm using the press knife (4.2) if available. One side of each specimen should be parallel with the principal (or "along") direction of the material (backbone direction for leather and selvedge (warp) direction for synthetic materials).

The test specimens should be taken from a range of positions across the full usable width and length of the sheet material. For a material with a woven structure this should prevent any two specimens containing the same warp or weft threads.

6. PROCEDURE

6.1 Mark on the back of each test specimen the principal direction of the material and determine the required testing conditions. The normal range of tests used by SATRA is given in Table 2.

Table 2 - *Standard test conditions and number of test specimens used by SATRA*

	Testing conditions		
Type of material being tested	**Dry 23 or 20°C**	**Wet 23 or 20°C**	**Dry -5°C**
Grain leather	2	2	-
Coated leather	2	2	2
Suede	-	2	-
Coated fabric	4	-	4
Fabric	4	-	-

Notes:

(1) "-" means that the test is not normally conducted.

(2) Outer materials should be tested face up and lining materials face down.

6.2 If possible, place all the test specimens in a standard controlled environment of either 23 ± 2°C / 50 ± 2% rh or 20 ± 2°C / 65 ± 2% rh for at least 48 hours prior to test. Include details of the conditions used in the test report.

6.3 Place any test specimens that are to be tested wet onto the surface (4.3.2) with their reverse face uppermost. Spot 1 cm^3 of distilled water from a pipette (4.3.1) on the reverse surface of the specimen and use the glass rod (4.3.3) to work it uniformly into the material, to within 5 mm of the edge of the test specimen. It usually takes between 1 and 2 minutes for the water to be absorbed. When testing leather, two of the four specimens should normally be tested wet.

6.4 If conducting a cold test, ensure that the environment surrounding the flexing machine (4.1) is at the required temperature (usually -5 ± 2°C) and place all the test specimens into this environment. Flexing of the test specimens should commence 10 ± 1 minutes after they are placed in the cold environment. Therefore the procedure in sections 6.5 to 6.7 should not take longer than 11 minutes.

6.5 Load each specimen as follows:

6.5.1 Set the V-shaped clamps on the test machine (4.1) so they are as far apart as possible, and remove the upper V-shaped part from each clamp.

6.5.2 Determine the orientation of the test specimen - For normal testing conditions, specimens of outer material should be loaded with their reverse surface facing downwards whereas specimens of footwear lining material should be loaded with their reverse surface facing upwards.

6.5.3 Fold the test specimen evenly over the pair of V-shaped clamps, and hold in place by fitting the upper V-shaped part of each clamp. Mount half of the test specimens with their along direction running between the clamps and the other half at 90° to this, so that the across direction runs between the clamps.

6.5.4 Fully tighten the clamp at one end, ensure the test specimen is not slack, and then tighten the clamp at the other end, see Figure 2.

6.6 Slowly move the clamps together and watch the specimens to ensure that the centre section of each specimen folds downwards. If this is not the case, apply gentle pressure to the centre of the ridge as the clamps move together to form a downward fold.

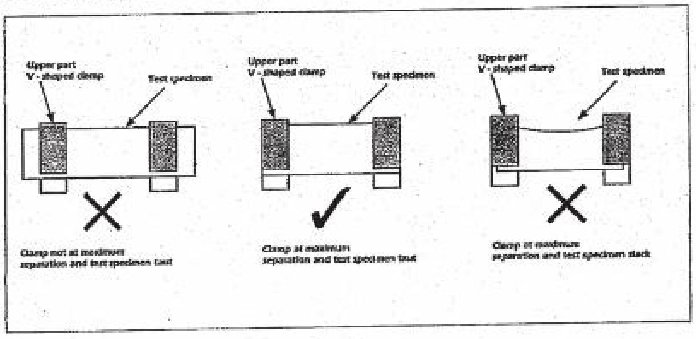


Figure 2 Correct loading of test specimen into test machine

6.7 Run the machine until the first inspection stage, see Table 3. In addition to the normal inspection stages wet test specimens should be removed from the machine after every 20 000 cycles and assessed for salt spue before rewetting by repeating the procedure in section 6.3.

Table 3 Suitable inspection stages

	Dry 23 or 20°C	Wet 23 or 20°C	Sub zero
10,000	X	X	√
25,000	X	X	√
50,000	√	√	√
100,000	√	√	√
250,000	√	X	X
500,000	√	X	X
1,000,000	√	X	X

√ - **Yes**

X - **No**

The exact inspection stages used during each individual test will depend on the total time available for the test and the expected performance of the material.

6.8 Stop the testing machine (4.1) and remove the test specimens. Use both the unaided eye and the optical magnifier (4.4) to assess the flexing damage, see Table 4 and section 8.1. When looking for damage inspect the specimen both flat and folded, as cracks on outward folds and delamination are difficult to see when the test specimens are flat.

Table 4 - Assessment of damage (also see section 8.1)

General appearance

For all test specimens use the following descriptions of the flexing damage:

No effect, or slight creasing or piping
Marked or severe creasing or piping
Slight cracking
Marked cracking
Severe cracking
Complete failure

Also record whether there is any delamination or flaking at any stage.

Salt spue

For leather test specimens which are being assessed specifically for salt spue grade the amount of spue as "light", "marked", or "heavy", as judged by the eye. Figure 3 shows examples of "light" and "heavy" spue on the surface of a full grain black embossed side leather. When it is considered useful the intermediate grades of "light/marked" and "marked/heavy" may be used.

6.9 Replace the test specimens, start the flexing machine, and repeat the procedure in section 6.8 at a number of suitable intervals, see Table 3, throughout the test.

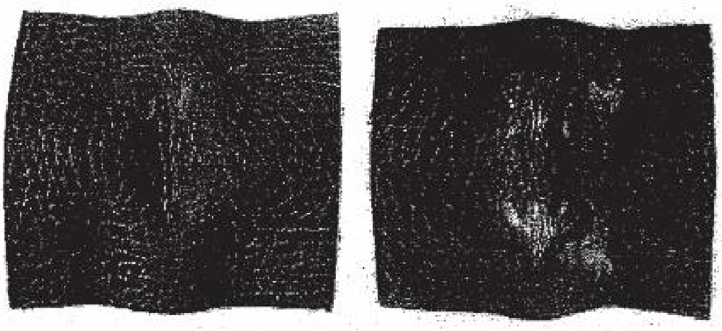


Figure 3 Examples of severity of spue produced by the wet flexing test

6.10 Stop the test when the specimen has been subjected to a maximum of:

- Outer materials (dry 23 or 20°C) 1 000 000 flexing cycles.
- Outer materials (wet 23 or 20°C) 100 000 flexing cycles (1).
- Lining materials 300 000 flexing cycles.
- Cold test (-5 to -30°C) 100 000 flexing cycles.

7. TEST REPORT

Include in the test report:

7.1 Reference to this test method SATRA TM25: 1992.

7.2 A full description of the material tested.

7.3 For each test specimen record:
- Whether it was tested wet or dry.
- The temperature and if relevant, the humidity of the surrounding environment.
- The testing direction and whether face up or face down.
- The severity of flexing damage or salt spue and total number of flexing cycles at each inspection stage.
- The total number of flexes.

7.4 Any deviations from this standard test method.

SATRA can help members to interpret the results from this test method.

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(1) If carrying out the wet test to investigate salt spue on leather specimens the test should be stopped as soon as the "heavy" spue stage is reached.

8. ADDITIONAL NOTES

8.1 Assessment of damage

Flexing damage may originate at either of the two surfaces of the material or within the thickness of the material. Spue will appear as a white salt deposit on the surface of the leather. Damage is usually assessed only at the main flexing creases, See Figure 1.

8.1.1 Damage to the outer surface

The assessment of damage to the outer surface of a material is a very subjective process and the way in which each individual material is assessed will depend on a number of factors. In each case it is important to know as much as possible about the proposed application of the material.

- Aesthetics
  If there is a considerable difference between the colour, shade or texture of the material's coating and its substrate then any cracking may be very unsightly. Consequently if the material serves mainly a decorative purpose, for example fashion articles, any visible cracking may be judged to be more serious than similar cracking on a material which is purely functional (see below).

- Strength
  It may be useful to take into account the effect of the surface cracking produced by the test on the material's overall strength. For instance, if the material is likely to experience high forces in the finished product and the surface coating contributed significantly to the material's overall strength then surface cracking must be considered more serious than for materials with a relatively thin surface coating for use in non-structural applications.

- Functionality
  For instance, if the surface coating is designed to protect the material substrate and/or wearer from hazardous substances, then any fine cracking should be judged more severely than if the material is to be used in decorative applications or as a lining.

For fabric, where it is feasible to do so, count and record the number of broken yarns and state whether the yarns were warp or weft and whether the damage was on inward or outward folds.

Heavy coatings, such as PVC or PU, may suffer severe cracking which started at the edge of the test specimen. This should be noted separately to the record of cracking at the main flexing creases.

8.1.2 Damage to the back of the material

This is not as frequent as damage to the outer surface but it should always be looked for and recorded when it occurs.

8.1.3 Damage within the material

Delamination is the most common type of damage within a material, and is most likely to occur in certain types of lightweight coated fabrics, non-woven materials having a low laminar strength, and coated leathers, for example patent.

Delamination is sometimes evident when the test is in progress because of a lifting of the coating in the flexing creases.

In addition, at the end of the test, check for delamination by making one or more cuts through the material. Usually, the most informative position for such a cut is along a line at right angles to the central inward fold and at a distance of 5-10 mm in from point A (of Figure 1). Record in which layer the delamination occurred, its position relative to the flexing creases and its extent.

Occasionally, an internal hole or partial breakdown of the structure can occur in fibrous materials without the damage breaking through to either surface. When this occurs it is usually located close to point A in Figure 1. The presence of internal weakening is usually indicated by very localised looseness of the material, especially when it is flexed. Patent leather with a thick stiff coating may fail in this way. If one such test piece shows localised severe flexing damage at point A which more resembles a hole than surface cracking, check whether there is internal damage of this type in any of the other test pieces.

8.1.4 Salt spue

With some leathers it may be found that as the test proceeds the severity of spueing decreases. This can be caused by dry salt crystals on the surface of the leather being dislodged by the flexing action or by simple mechanical loss during the rewetting procedure. This is why it is best not to continue the test if the 'heavy' spue stage is reached.

There is no simple way of deriving an overall spue assessment from the recorded observations at the various inspection times but normally it is the amount of spue early in the test which is of most significance.

8.1.5 Cold flexing

In the cold flexing test it sometimes happens that cracking is produced along the edge of the two clamps or from the sides of the material (ie away from the main flexing creases). This is probably because these parts of the test specimen are a few degrees cooler than the flexing creases and the materials which show this type of damage are ones which are particularly sensitive to the effect of cold conditions. When this special type of cracking occurs, record its position and severity, but keep this information separate from the record of cracking at the main flexing creases. Only the cracking at the main flexing creases (See Figure 1) must be taken into account when assessing the performance of a material.

8.2 Related tests

BS 3424: Part 9 - Testing coated fabrics, Method 11C SATRA method.
BS 6159: Part 1 - PVC boots - Appendix C.
ISO 4643 - PVC boots - Annex C.

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