Deep dive: Standards to measure textile durability

Technical paper

Authors: Valeria Botta, ECOS; Ebba Magnusson, technical expert

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Summary

In March 2022 the European Commission published its proposal for the Ecodesign for Sustainable Products Regulation. Its objective is to set binding **requirements on how products are designed**, through a specific act for textile products, covering aspects such as "***durability, repairability, fibre-to-fibre recyclability, and mandatory recycled content, minimise and track presence of substances of concern, reduce adverse impacts on climate and environment, microplastic shedding"***. At the same time, the European Commission launched the EU strategy for sustainable and circular textiles, which highlights the same characteristics and adds that *"failures in quality such as* ***colour fastness, tear strength or the quality of zippers and seams*** *are among the main reasons for consumers to discard textiles"*. This report identifies the existing standards and methodologies used for measuring some of those characteristics, assessing whether those are robust and fit for purpose to support minimum requirements. It also highlights shortcomings and challenges.

Binding minimum requirements coupled with a clear target on reducing resources use have the potential to transform the industry towards the vision set up in the EU initiatives. It is important to get them right.

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1 Introduction

In March 2022, the Commission unveiled the **EU strategy for sustainable and circular textiles** and the **Ecodesign for Sustainable Products Regulation (ESPR**[1]). With these two pieces of legislation, the textile sector will be expected to transition towards a climate-neutral, circular economy where products are designed to be more durable, reusable, repairable, recyclable and energy-efficient.

It is urgent to turn this vision into action since the climate, social and environmental impacts of the textile sector continue to grow within the current linear system. This approach should start, first and foremost, with **reducing the volume of textile products** that are put on the market, **bringing production and consumption within planetary boundaries**. The EU strategy for sustainable and circular textiles[2] aims to significantly **improve textile products** placed on the European market. This includes setting **binding ecodesign requirements** targeting the "**durability of textile products** (covered in this brief); *repairability, fibre-to-fibre recyclability, and mandatory recycled content, minimise and track the presence of substances of concern, reduce adverse impacts on climate and environment, microplastic shedding*"[3].

ECOS believes design must ensure clothes are toxic free and long lasting, prioritising life-extending measures such as durability (both functional and emotional), ease of reuse, repair and remanufacturing. Stretching the approach: alongside the positive list of characteristics that the Commission mentioned in the documents published in March 2022, minimum requirements should also consider the most damaging hotspots, such as chemical use and content, water, energy, etc. For truly sustainable products, the EU framework should allow questions about whether the product is necessary in the first place and if we really need a particular finish, coating or dye.

1.1 How to look into textile durability, and where standards play a role

The ESPR framework will allow for setting a range of requirements for textile products, including product durability. It is important to target relevant requirements that can generate the most environmental gains. This means setting up horizontal requirements for textile products overall, and, when needed, considering different conditions for different product groups, as well as setting minimum levels that expose low-quality goods. Moreover, further investigations on which property is relevant for which product groups is essential. For the classification of textile products for which to set minimum requirements, we suggest a selection from broad product groups that have already been the focus of standardisation activities for a long time and where specific standards that account for key characteristics already exist: clothing, footwear, curtains, bath/bed and kitchen textiles, upholstery, mattresses, floor coverings, workwear, and PPE. Targeting

1 https://environment.ec.europa.eu/publications/proposal-ecodesign-sustainable-products-regulation_en

2 https://environment.ec.europa.eu/strategy/textiles-strategy_en

3 https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52022DC0141

clothes and footwear would be key when looking for impact and environmental gains. On the different properties, we suggest keeping in mind the EU Ecolabel requirement for textiles, Nordic Swan, and Blue Angel, with many insights on different horizontal related requirements (see more on this in the Annex).

In order to include relevant requirements in the Ecodesign for Sustainable Products Regulation (ESPR), it is important to **understand the factors influencing the durability properties of textile products: whether the fabric is woven, non-woven, knitted, the impact of fibre choice and test methods available to assess these characteristics.**

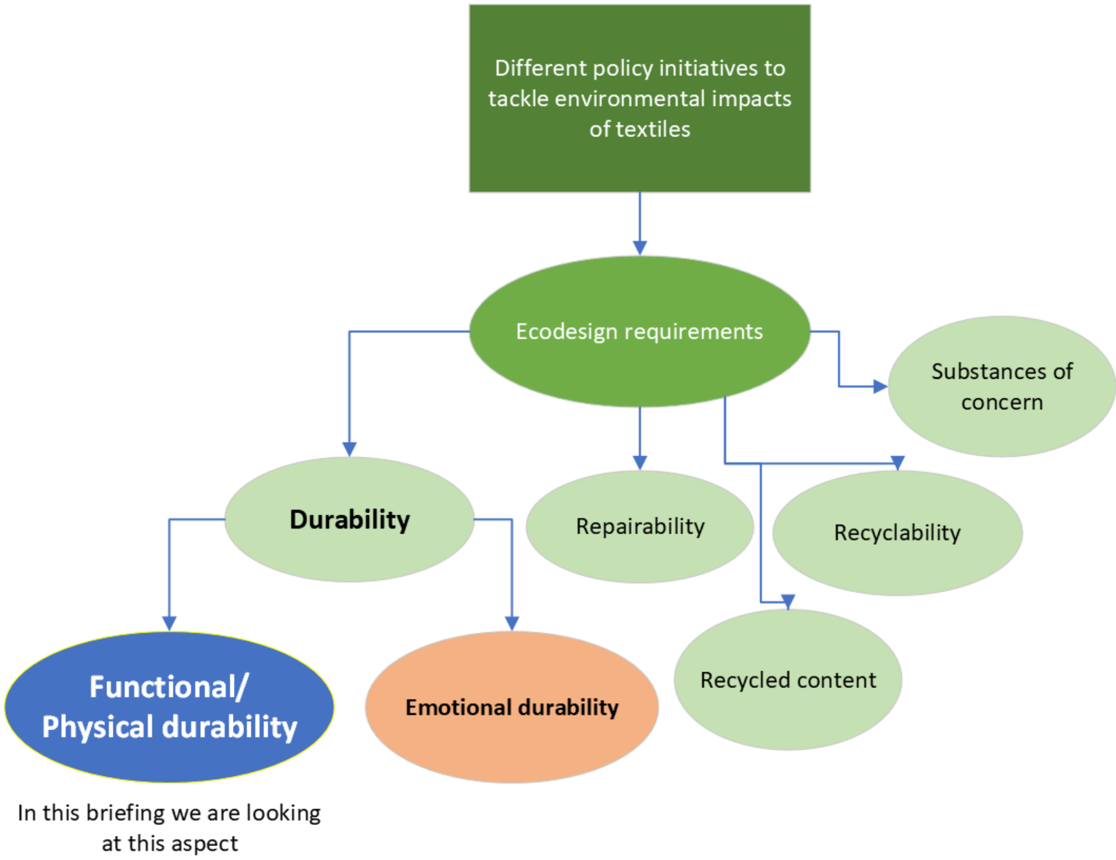

Figure 1: Focus of this briefing – Functional durability

The goal of this paper is to investigate which standards and methodologies are used for assessing textile durability and failures in quality; how different fabrics behave during tests, and which properties may be relevant to include in the ESPR for assessing durability. This needs to be coupled with a clear target on reducing resources used to transform the industry, towards the vision set up in the EU initiatives.

This brief looks into **functional durability**, which is anchored in many characteristics (tear/tensile/seams/bursting strengths, yarns and seam slippage, abrasion resistance, pilling, dimension stability, colour fastness, quality of trimming etc.) Functional durability has specific standards and methods available to assess those characteristics. However, this paper does not cover **emotional durability**.

The textile industry imperatively needs to address the low level of "emotional durability" of textile products, which significantly contributes to the decision to discard clothes after a short period.

Design for durability, thus, needs to account for "emotional durability", considering a product's ability to be desirable long-term, in addition to the "functional" one covered in this brief.

The functional durability of textiles can be described as the ability to maintain their original shape, strength, and appearance after being exposed to wear, washing and other stresses. Durability depends on a variety of factors. **Some properties can be attributed to fibre composition, but the length of fibres, yarn twist, construction (binding, fabric density, etc.), dyes, chemical treatments and finishes also play an important role.** Textile testing indicates if the quality of a product is sufficient and exposes low-quality fabrics and faulty goods. Durability testing often includes the following aspects: [4]

- strength and abrasion resistance (fabric, seams, accessories);
- loss of appearance from use (pilling, colour fading, etc.), and
- effects of laundering (dimension stability, colour loss, water resistance loss, etc.).

Laboratory tests differ from reality

For example, fabric strength: in laboratory equipment one single large force is applied in one direction, while you have many smaller repeating forces and in many different directions during real use.

Other properties that could be connected to the quality of new products are **absorbency, water-vapor resistance, electricity build-up, thermal resistance, or air permeability**. These are often not considered when assessing durability since they are measures of the initial quality and not the possible loss of quality from wear and washing. Lack of comfort or function may, however, also lead to shorter use time.

The relevant scope of properties to determine the durability of a product differs based on the intended use and type of material tested. **Our briefing describes the most common test methods used for assessing durability; what each method aims to assess; which fabrics are relevant to analyse with the respective test method, and what materials can be assumed to perform better or worse.** The Annex investigates and compares the use of those test methods in a selection of ISO Type 1 labelling (EU Ecolabel requirement for textiles, Nordic Swan and Blue Angel) to identify the methods they use, the categorisation, and thresholds already available.

[4] Understanding and Improving the Durability of Textiles, The Textile Institute, ed. by Annis, Patricia A, Woodhead Publishing Limited

2 Test methods for assessing durability

2.1 Tensile strength

Tensile strength indicates the maximum stress fabrics can manage without breaking, the elongation (i.e., the ability to extend during the applied stress) and the elastic recovery.

2.1.1 Procedure and fabrics tested

- The force needed to stretch a fabric until rupture (where many threads break at the same time).
- Elongation at break (expressed in %).
- Yield point: stress the fabric can withstand before irreversible deformation occurs from original shape (0.2% change or more when stress is removed).

The test is used for woven, felted, and nonwoven fabrics. Knitted and highly elastic woven fabrics are tested for bursting strength.

It can either be tested with **strip or grab method:**

- Strip method:
    - Full width of specimen is gripped by jaws in the equipment and pulled until breakage.
    - Two procedures: [5]
        - Cut strip test applied to fabrics which cannot be ravelled such as nonwoven and coated fabrics.
        - Ravelled strip test used for regular woven fabrics.
- Grab method: the larger samples, centre part of the specimen is gripped by jaws in the equipment (edge effects removed)

The results differ between the methods, lower forces are reached for the strip test (due to the lower width of samples) compared to grab. [6] According to OVAM report[7], strip test is the most used method, but this has not been confirmed as the grab test is equally used. If tensile strength is included in the ecodesign criteria for textiles, it is important to decide which method should be used.

The test gives an overall evaluation of the strength of fabrics and expose fragile or low-quality goods, but it does not demonstrate a typical situation that textiles are exposed to during everyday wear (unless extreme cases). It also does not reveal weak spots in the fabric since many threads are exposed at the same time.

[5] https://www.textileadvisor.com/2021/06/fabric-tensile-strength-test.html
[6] https://www.galecommercial.com/en_na/articles/what-is-the-difference-between-the-tensile-testing-methods
[7]https://circulareconomy.europa.eu/platform/sites/default/files/ecodesign_criteria_for_consumer_textiles.pdf

2.1.2 Performance of different fabrics

The fibre type, regularity in diameter, weave pattern and pre-treatment influence the fabric strength. **The longer the fibres, the denser the fabric and the finer the fibres, the higher tensile strength is achieved. Elastic fabrics extend and prevent tearing and breakage.** [8,9]

Low tensile strength can occur after mechanical and chemical processing, such as dyeing and mechanical surface treatments. Other aspects such as weaving faults, exposure to UV, washing and other degrading processes will also lead to losses in strength. [10]

Fabrics consisting of synthetic fibres will normally have higher tensile strength compared to textiles with natural fibres, especially when using filament yarn.

- Synthetic fibres have very good strength properties, high extensibility, and high elasticity.[11] Polyamide is among the strongest fibres. [12]
- Wool fibres have low strength, but high extensibility and elasticity.
- Cotton fibres have high strength but low extensibility and elasticity (high for weft knits). [13] Cotton generally fulfils requirements for garments used under normal conditions but cannot achieve higher stresses needed for specialty garments such as for military use. [14]

2.1.3 Strip method standards

The most common standards are:

- EN ISO 13934-1 Textiles: Tensile properties of fabrics — Part 1: Determination of maximum force and elongation at maximum force using the strip method.
- ASTM D5035-11 Standard test method for breaking force and elongation of textile fabrics (strip method).

Equipment, sample sizes, conditioning time etc. differs between the standards. No information has been found that the relative difference between natural and synthetic fibres change when testing according to ASTM compared to EN ISO.

EN ISO 13934-1 is more commonly used in Europe,

therefore, preferred for the ESPR.

[8] https://www.textileadvisor.com/2021/06/fabric-tensile-strength-test.html
[9] Process Control in Textile Manufacturing, 2013, Woodhead Publishing Limited https://www.sciencedirect.com/science/article/pii/B9780857090270500035#!
[10] Understanding and Improving the Durability of Textiles, 2012, ed. by Annis, Patricia A, Woodhead Publishing Limited
[11] Konstfiber, Textil materiallära, Börje Reis
[12] https://www.textileadvisor.com/2021/06/fabric-tensile-strength-test.html
[13] Naturfiber, Textil Materiallära, Börje Reis
[14] Understanding and Improving the Durability of Textiles, 2012, ed. by Annis, Patricia A, Woodhead Publishing Limited

2.1.4 Grab method, standards

The most common standards are:

- EN ISO 13934-2 Textiles: Tensile properties of fabrics — Part 2: Determination of maximum force using the grab method.
- ASTM D5034-21 Standard test method for breaking force and elongation of textile fabrics (grab test).

No information was found regarding differences between test methods.

> EN ISO 13934-2 is more commonly used in Europe and preferred for the ESPR.

2.2 Tear strength

The tear strength indicates the force needed to propagate a previously started tear in a fabric.

2.2.1 Procedure and fabrics tested

A specimen is prepared with a pre-cut/a tear and mounted between two jaws moving from each other forcing the tear to continue. The measured tear strength is the fabric's resistance to continue tearing when the force is applied.[15]

The test is applicable to woven fabrics but may be used for some nonwovens. It is not applicable for knitted or elastic woven fabrics. [16]

The test is relevant for jeans, jackets, high-performance textiles, etc., but may also be used for other conventional woven products. Tearing can occur when a fabric has been punctured and is then exposed to stress. A single tear may lead to an entire textile product being discarded, either due to failure in functionality or loss of appearance. Hence textile tearing strength is an important measure of textile durability and will demonstrate how warp and weft in a fabric will resist tearing.[17]

2.2.2 Performance of different fabrics

High tear strength is achieved when fabrics are constructed so that yarns can move in the construction and share the load when exposed to tear force. The longer floats[18] in a weave,

[15] https://textilelearner.net/tearing-strength-test-of-fabric/
[16] EN ISO 13937-2
[17] Understanding and Improving the Durability of Textiles, 2012, ed. by Annis, Patricia A, Woodhead Publishing Limited
[18] A "float" in weaving is a skipped thread or threads.

generally the higher tear strength can be achieved (since floats allow yarns to move). This means that **satin usually is stronger than twill, and twill is stronger than plain weave**.[19]

The higher density of the fabric, the lower the tear strength (opposite relation to tensile strength). Dense fabrics lead to immobile yarns, and higher friction creates lower tear strength. The more slippery the yarns/smooth surface of fibres and the longer fibres, the higher the tear strength. **This means that the highest tear strength is most likely achieved by using synthetic filament fibres.** [20]

High tear strength can also be achieved using a ripstop. Ripstop fabrics are plain weaves but constructed with stronger reinforcing yarns in intervals, both in weft and warp creating a checked appearance. If a puncture appears, further tearing is prevented in the ripstop by the reinforcement yarn.

2.2.3 Tear strength standards

- **EN ISO 13937-1 (2000)** Textiles: Tear properties of fabrics – Part 1: Determination of tear force using ballistic pendulum method (Elmendorf).
- **ASTM D1424.**
- **EN ISO 13937-2 (2000)** Textiles: Tear properties of fabrics — Part 2: Determination of tear force of trouser-shaped test specimens (Single tear method).
- **EN ISO 13937-3 (2000)** Textiles: Tear properties of fabrics — Part 3: Determination of tear force of wing-shaped test specimens (Single tear method).
- **ASTM D5587.**
- **EN ISO 13937-4 (2000)** Textiles: Tear properties of fabrics — Part 4: Determination of tear force of tongue-shaped test specimens (Double tear test).
- **ASTM D2261.**

Several methods exist, but EN ISO 13937-1 seems to be the most used one. The differences in methodology should be discussed with a textile testing laboratory.

2.3 Bursting strength

Bursting strength is a measure of the tensile strength and extensibility of knitted and elastic fabric. It is also relevant for weaves which will be subject to multidirectional stretching during use.

[19] Tensile and tearing strength of woven fabrics: some studies, Chellamani, K.P. et al, 2013, Asian Textile Journal https://www.tib.eu/en/search/id/tema%3ATEMA20140102845/Tensile-and-tearing-strength-of-woven-fabrics-Some/

[20] The Effect of Weave Construction on Tear Strength Of Woven Fabrics, S. H Eryuruk & F Kalaoglu, 2015, Autex Research Journal https://www.sciendo.com/article/10.1515/aut-2015-0004

2.3.1 Procedure and fabrics tested

During the test procedure, the specimen is exposed to stress in all directions. A circular sample is clamped (all around) in a bursting equipment. Increasing pressure is applied to the centre of the specimen causing the fabric to expand. When the fabric reaches a pressure limit a rupture occurs. [21]

Bursting strength can also be tested with a ball burst test, where a metallic ball is pushed through the fabric, expanding the material until breakage.

2.3.2 Performance of different fabrics

Weak spots in fabrics are exposed during the test procedures. **Fabrics consisting of uniform fibres and yarns have higher bursting strength.**

Filament fibres have higher strength compared to staple fibres (favouring synthetic fabrics). Compact yarns have higher bursting strength (and pilling resistance) compared to ring spun yarns.[22]

The more elastane in fabric – the higher bursting strength. Fibres without stretchability will burst first.[23]

Synthetic fibres have higher bursting strength, but the construction of the fabric also plays an important role. **A higher fabric count increases bursting strength (as for tensile strength). Consequently, the longer the knit stitches, the lower the bursting strength.**

Light-coloured swimwear (polyamide) is one example of fabric losing strength after exposure to seawater and sun.

2.3.3 Bursting strength, standards

- EN ISO 13938-1 Textiles: Bursting properties of fabrics - Part 1: Hydraulic method for determination of bursting strength and bursting distension (ISO 13938-1:2019).
- ASTM D3786/D3786M-18 Standard test method for bursting strength of textile fabrics - Diaphragm bursting strength tester method:[24]
    - Hydraulic or pneumatic diaphragm bursting tester.

[21] https://www.textileadvisor.com/2020/04/testing-of-fabric-bursting-strength.html
[22] Bursting strength and extension for jersey, interlock and pique knits, Chowdary et. Al, 2017, https://crimsonpublishers.com/tteft/pdf/TTEFT.000506.pdf
[23] Understanding and Improving the Durability of Textiles, 2012, ed. by Annis, Patricia A, Woodhead Publishing Limited
[24] https://www.astm.org/d3786_d3786m-18.html

- **EN ISO 13938-2** Textiles: Bursting properties of fabrics — Part 2: Pneumatic method for determination of bursting strength and bursting distension.
- **ASTM D3787-16** Standard test method for bursting strength of textiles – the constant rate of traverse (CRT) Ball burst test.
- **ISO 9073-5**: nonwovens, determination of resistance to mechanical penetration (ball burst procedure).
- **ASTM D 6797** Standard test method for bursting strength of textiles – the constant rate of extension (CRT) Ball burst test.

> The test procedures do not give the same results. **The test methods using hydraulic or pneumatic seem more commonly used compared to the ball burst test.** This should be further discussed with a textile laboratory.

2.4 Seam strength

Seam strength is the strength of seam assembly in a garment. Seam strength depends on seam type, the stitch type, stitch density, fabric strength, thread strength, and the tension of thread which is applied in the seam.

2.4.1 Procedure and fabrics tested

Low seam strength a prevalent reason for garment failure. A ruptured seam may lead to the whole product being discarded even though the overall product is still in good condition.

The test procedure for determining seam strength is similar to tensile strength. The seamed sample is pulled until breakage. The method can only be used for straight seams and is mainly applicable for woven fabrics.[25]

2.4.2 Performance of different fabrics

Seam strength is affected by **stitch type, the material composition of sewing thread and the sewing machine** (feeding mechanism and needle). [26]

Synthetic fibres are most commonly used in sewing thread due to the higher strength achieved compared to cotton sewing threads.

[25] https://www.iso.org/standard/60678.html
[26] Understanding and Improving the Durability of Textiles, 2012, ed. by Annis, Patricia A, Woodhead Publishing Limited

2.4.3 Seam strength standards

- **EN ISO 13935-1:2014** Textiles: Seam tensile properties of fabrics and made-up textile articles - Part 1:
    - Determination of maximum force to seam rupture using the strip method
- **ASTM D1683** Standard test method for failure in sewn seams of woven fabrics:
    - Comparison between unseamed fabric (reference) and seamed fabric (test sample).
    - Each specimen is pulled until breakage. The strength at the rupture of the seam is divided with the strength of the reference. If the unseamed specimen fails prior to the seam, the sample is graded to have "100% seam efficiency".[27]
- **EN ISO 13935-2:2014** Textiles: Seam tensile properties of fabrics and made-up textile articles - Part 2:
    - Determination of maximum force to seam rupture using the grab method
- **ASTM D751** Standard test method for coated fabrics:
    - Includes several sections with test methods for coated, mainly rubber-coated fabrics.
    - Determination of seam strength sections 71-76.

> The maximum force is evaluated with the ISO 13935 standard. **Comparison between seamed and unseamed sample does not seem to be included.** Seam efficiency as tested with the ASTM method, relates to the fabric strength. **For the ESPR, absolute values should be required both for seam strength and tensile strength. Therefore, ECOS recommends using ISO 13935.**

2.5 Yarn slippage (seam slippage)

Yarn slippage is caused by tension to seams, where yarns in the fabric slip out from the weave causing a gap (hole, net structure) next to the seam.

2.5.1 Procedure and fabrics tested

Yarn slippage is tested through exposing seams to strong forces and assessing the ease of yarn distortion in the fabric. Only tested on woven fabrics.

[27] https://www.universalgripco.com/astm-d1683

2.5.2 Performance of different fabrics

Yarn slippage is an important parameter to assess in slippery woven garments such as blouses and trousers consisting of finer yarns.

Open structures with smooth threads, or loose structures with fewer threads per square unit, increase the risk for seam slippage.[28] It can also occur if the seam has long stitches or is placed too close to the margin.[29] When yarn slippage occurs it is difficult to repair since parts of the fabric are affected.

Man-made fibres (regenerated and synthetic fibres) should have a higher risk for seam slippage compared to natural ones. due to smoother fibres and finer (often) more uniform yarns.

It would be interesting to assess whether a higher risk for yarn slippage means a lower risk for pilling.

2.5.3 Yarn slippage standards

- ISO 13936 1,2,3: Yarn slippage resistance of yarns at seams in woven fabrics
- ASTM D4034/4034M-19 Standard test method for resistance to yarn slippage at the sewn seam in woven upholstery fabrics

No information was found regarding differences between methods, which needs to be further investigated.

ISO method would apply to any product type.

2.6 Abrasion resistance

Abrasion resistance is the resistance to wear and holes, caused by rubbing during use.

2.6.1 Procedure and fabrics tested

Abrasion resistance is most tested with **Martindale equipment**. The test sample is exposed to rubbing with a standard wool fabric used as an abradant, until two or more threads have been broken. The number of cycles until the rupture is reported. It can also be assessed through calculating the weight loss after a predetermined number of cycles.

[28] Understanding and Improving the Durability of Textiles, 2012, ed. by Annis, Patricia A, Woodhead Publishing Limited

[29] https://www.fibre2fashion.com/industry-article/3439/quality-aspects-of-garment

It is normally performed with a wool standard fabric such as abradant or sandpaper. In EN 343 (Protective garments – protection against rain) abrasion with sandpaper is used as a pre-treatment before testing water resistance.

Abrasion resistance of pile fabrics (pile retention, pile pull out) is determined according to other standards, see below. This method is relevant for velour, fleece, velvet. The specimens are assessed visually after abrasion and rated according to a standard scale.

2.6.2 Performance of different fabrics

The smoother surface and better drape, the higher the resistance to abrasion. Fibre and yarn twist also affect the fabric resistance to abrasion. Surface modification, e.g., finishing and coatings, which lowers the surface friction resistance will lead to higher abrasion resistance.[30]

> High thresholds for abrasion might lead to higher use of chemical finishes.

Wool fabrics with course fibres have high resistance to abrasion, but low resistance to fine wool.[31]

Using sandpaper as an abradant (instead of wool) may be more relevant for garments such as jeans and children's wear, which are more exposed to abrasion during use.

2.6.3 Abrasion, standards

- ISO 12947-2 (2016): "Textiles — Determination of the abrasion resistance of fabrics by the Martindale method — Part 2: Determination of specimen breakdown".
- ASTM D3884 Standard Guide for Abrasion Resistance of Textile Fabrics (Rotary Platform Abrader Method).
- ASTM D3885 Standard Test Method for Abrasion Resistance of Textile Fabrics (Flexing and Abrasion Method) (woven or nonwoven fabrics).
- ASTM D3886 Standard Test Method for Abrasion Resistance of Textile Fabrics (Inflated Diaphragm Apparatus) (both wet and dry/conditioned samples).
- ASTM D4966 Standard Test Method for Abrasion Resistance of Textile Fabrics (Martindale Abrasion Tester Method).
- ASTM D4158 Standard Guide for Abrasion Resistance of Textile Fabrics (Uniform Abrasion).

[30] Abrasion resistance of textiles: Gaining insight into the damaging mechanisms of different test procedures, Textor et. Al. 2019, https://journals.sagepub.com/doi/full/10.1177/1558925019829481
[31] Naturfiber, Textil Materiallära, Börje Reis

ISO 12947-2 seems to be most used in Europe.

Other:

- **ASTM D4685/D4685M-15** Standard test method for Pile fabric abrasion
- **CEN EN 13770 (2002) Textiles:** Determination of the abrasion resistance of knitted footwear garments

2.7 Pilling

Pilling is the formation of small knots on the surface of fabrics caused by wear and rubbing. When pilling occurs, this leads to a fuzzy, picky surface and the textile product will have a less appealing appearance.

2.7.1 Procedure and fabrics tested

Assessment of pilling is performed mainly according to the following methods:

- In Martindale equipment, where the test material is rubbed flat against a wool fabric, or/and rubbed against itself, under pressure. The surface is assessed visually after a predetermined number of cycles. The final assessment is performed after 7000 cycles.[32]
- With ICI Pilling box –Samples are sewn into tubes, mounted on rubber tubes, and then exposed to tumbling (rubbing) in a rotating box lined with cork, to simulate wear.
- Random tumble tester –Three test samples were tested in one test run. Samples are placed in a chamber, lined with a slightly abrasive material, and tumbled. Cotton fibres/lint is added to the box to resemble real wear.[33]
- Elastomeric pad (USA, not common as in Europe and not described further)

The appearance of the surface, based on pills/knots appearing, is graded according to a 5-graded scale after the rubbing procedure (5-no pilling, to 1-very severe pilling).

Knitted fabrics are most relevant to assess regarding pilling, but it can also occur on woven (especially if staple fibres are used).

2.7.2 Performance of different fabrics

Pilling results from fibres projecting from the fabric surface, entangling each other during wear/abrasion and forming a knot. **The weaker and shorter the fibres, the easier pilling will occur.** However, the weaker the fibres, the easier the knot will also break off. **Natural fibres therefore**

[32] https://www.ri.se/sv/vad-vi-gor/tjanster/pilling-och-luddbildning-hos-textil-enligt-ss-en-iso-12945-2

[33] https://www.slideshare.net/88azmir/compare-among-pilling-tester

have a higher tendency to form knots, but stronger fibres such as synthetics will lead to pilling remaining on the surface in the long run. [34] Fabrics (especially knits) consisting of synthetic staple fibres pose a high risk for pilling.

> Pilling: blended fabrics, consisting of a strong and a weak fibre, are the most problematic.

The weak fibre can easily break and form a knot which will then be kept to the surface by the stronger fibre. Synthetic fibres mixed with wool are for example, not recommended if pilling is to be avoided.

Other properties that influence pilling:

- **The denser the fabrics – the less pilling occurs**. Open structures such as knits tend to result in higher pilling rates, while woven structures with highly interlaced yarns in tight structures hold the fibres and prevent knots from forming on the surface.
- **Optimal yarn twist enhance resistance to pilling.** Various treatments can be used to manage pilling properties, such as singeing (exposing to a flame), cropping, waxing, silicone treatments, etc. Softeners and fabric lubricants may, however, increase pilling.[35] The use of finishes/binders that fix the fibres may include problematic substances.

2.7.3 Pilling standards

- **EN ISO 12945-1:2020 Textiles**: Determination of fabric propensity to surface pilling, fuzzing or matting — Part 1: Pilling box method.
- **EN ISO 12945-2 Textiles:** Determination of fabric propensity to surface fuzzing and pilling — Part 2: Modified Martindale method.
- **EN ISO 12945-3:2020 Textiles**: Determination of fabric propensity to surface pilling, fuzzing or matting — Part 3: Random tumble pilling method.

Several sources indicate high differences based on which test method is used.[36]

The highest pilling occurs when using the Martindale method. Pilling box and tumbler create less pilling (pilling is approximately equal for these two methods).[37]

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[34] https://www.tandfonline.com/doi/abs/10.1080/19447027.1956.10750392
[35] Physical testing of textiles, B P Saville, 1999, Woodhead Publishing
[36] https://www.testextextile.com/comparisons-and-evaluation-of-test-methods-for-fuzzing-and-pilling-resistance/
[37] Comparative study on pilling resistance standard methods, Fatima Esteves, et. Al. 2004, https://core.ac.uk/download/pdf/55603166.pdf

It might be relevant to have different methods for different types of textile products/end uses.[38]

> Martindale method seems to be the most repeatable method, and the test procedure is the most distinct pilling. It should be further investigated.

2.8 Dimension stability

Dimension stability is a measure of how textiles change in length and width after being washed and dried.

2.8.1 Procedure and fabrics tested

The dimensional change is determined according to ISO 5077, calculating the percent changes.

The washing procedure is performed according to ISO 6330 for domestic washing, using a program relevant to the product (according to fabric wash instructions or as agreed between interested parties). If the textile product is intended for industrial purposes, EN ISO 15797 is used.

2.8.2 Performance of different fabrics

Dimensional change is influenced by fibre type, construction, yarn and finishes.

Hydrophilic fibres (cotton, regenerated fibres, wool, flax, etc.) have the highest tendency to shrink, but the construction of the fabric also plays an important role. Hydrophobic fibres, such as polyester, will not swell during laundering and therefore have a high resistance to shrinkage and deformation.[39]

Longer fibres increase dimension stability. Shorter floats (plain weaves) also shrink less compared to looser constructions with longer floats (satin).

2.8.3 Dimension stability, standards

- EN ISO 5077 Textiles: Determination of dimensional change in washing and drying.

Connected standards:

- EN ISO 3759 Textiles: Preparation, marking and measuring of fabric specimens and garments in tests to determine the dimensional change.
- EN ISO 6330 Textiles: Domestic washing and drying procedures for textile testing.

[38] Fabric testing, 2008, Woodhead Publishing Limited, https://www.sciencedirect.com/science/article/pii/B9781845692971500061

[39] Effects of laundering on the surface properties and dimensional stability of plain knitted fabrics, Quaynor, et. Al, 2000, https://journals.sagepub.com/doi/pdf/10.1177/004051750007000105

- **EN ISO 15797 Textiles**: Industrial washing and finishing procedures for testing of workwear.

> ISO standards 5077 and 6330: main standards used for determination of dimension stability.

2.9 Crease recovery

During wear and laundering, fabrics are exposed to bending and deformation forces which can lead to wrinkles appearing (the garment folds, bends or deforms during usage or wash). If the fabric cannot regain its original shape after the wrinkles have occurred, the garment can appear to be less appealing. [40]

2.9.1 Procedure and fabrics tested

During the test procedure, the fabric is wrinkled/creased under pressure in a standardized crease device. After a predetermined time, pressure is removed, and the sample is allowed to recover/recondition. The crease recovery is then determined through assessing the remining creases/wrinkles in the fabric. The test can also be performed to determine the minimum ironing temperature.

The test is applicable to most fabrics and fibre types.

2.9.2 Performance of different fabrics

The crease resistance is affected by the choice of fibre, yarn and fabric construction, but also temperature, humidity, etc. during wear. **Wool and polyester have good crease recovery. Cotton, viscose and linen have low crease recovery.**

Furthermore, the higher the possibility for yarns to move in the construction, the less wrinkles occur. Hence, knits have higher wrinkle resistance compared to weaves, and weaves with longer floats have higher resistance compared to plain weaves. [41]

> **Wrinkle resistance** is improved by easy-care finishes (e.g., polyurethane, silicone or formaldehyde-based chemicals). **If crease resistance is included in the ESPR, it may lead to higher usage of easy-care finishes. Crease recovery is therefore not recommended to be included in the ESPR.**

[40] Textiles and fashion, 2015, Woodhead publishing limited https://www.sciencedirect.com/science/article/pii/B9781845699314000283?via=ihub

[41] Textiles and fashion, 2015, Woodhead publishing limited https://www.sciencedirect.com/science/article/pii/B9781845699314000283?via=ihub

2.9.3 Test methods

- **AATCC test method 128**: Wrinkle recovery of fabrics.
- **AATCC test method 66.**
- EN 22313.
- ISP 2313.

AATCC Test Method 124 (ISO 7768) smoothness after laundering (easy care, minimum ironing) same procedure to assess wrinkle recovery, but different pre-treatment (washing, drying, ironing).

2.10 Colour fastness properties

Colour fastness is measured as the change in colour after being exposed to rubbing, water, UV-light, etc. and/or the staining of colour to other fabrics (e.g., colour bleeding to other fabrics).

2.10.1 Procedure and fabrics tested

Wet staining (water, sweat, saliva, washing) is measured using multifibre strips or adjacent standardized reference fabrics.

Colour change and colour staining is visually assessed after test procedure according to a grey scale or with a spectrophotometer determining the colour change and staining instrumentally.

Colour fastness to saliva and perspiration is tested according to Oeko-Tex Standard 100, Class 1 (children 3 years or younger), but this test procedure is not described in an ISO standard. (ISO 20701 exists for colour fastness to saliva for leather.)

The most common tests to determine colour fastness are:

- To laundering (domestic and commercial) – relevant for all textiles which will be laundered.
- To perspiration – relevant for textiles used close to skin.
- To perspiration and saliva – relevant for children's wear.
- To rubbing, wet and dry – relevant to all textile products which will be exposed to rubbing (fabric to fabric contact) during use (not relevant for curtains and similar products).
- To water – not as relevant as colour fastness to laundering, perspiration, and rubbing. May be relevant for certain applications, should be further investigated.
- To light – relevant for curtains, swimwear, outer garments, and other textile products which will be exposed to UV light.
- To sea water – swimwear, etc.
- To chlorinated water (swimming pool) - swimwear, etc.

2.10.2 Performance of different fabrics

Colour fastness properties are influenced by the molecular structure of dye, fibre type, dyeing process and depth of colour. [42] **Direct colours, used for cellulosic fibres, have very limited wet colour fastness (washing, water, etc.), while reactive, azoic, sulfur and vat dyes have good fastness to washing. Reactive dyes also have good rubbing properties.**

Wool and polyamide (dyed with acid dyes) have varying colour fastness. **Polyester (disperse dyes) and acrylic (cationic dyes) generally have very good colour fastness properties.**

For denim it is often desired for the garment to lose colour from wear, hence these products can have poor colour fastness to rubbing, water, perspiration and washing.

2.10.3 Colour fastness, standards

The full list of parts included in ISO 105 can be found here. The following method is mainly relevant for the ESPR:

General principles:

- **Part A01 – A 11:** General principles of testing, grey scales, instrumental assessment.

Colour fastness to light and weathering:

Note: Full list included, ***the most relevant methods for the ESPR needs to be further discussed***

- **Part B01:** Colour fastness to light: Daylight.
- **Part B02:** Colour fastness to artificial light: Xenon arc fading lamp test.
- **Part B03:** Colour fastness to weathering: Outdoor exposure.
- **Part B04:** Colour fastness to artificial weathering: Xenon arc fading lamp test.
- **Part B05:** Detection and assessment of photochromism.
- **Part B06:** Colour fastness and ageing to artificial light at high temperatures: Xenon arc fading lamp test.
- **Part B07:** Colour fastness to light of textiles wetted with artificial perspiration.
- **Part B08:** Quality control of blue wool reference materials 1 to 7.
- **Part B10:** Artificial weathering — Exposure to filtered xenon-arc radiation (under development).

Colour fastness to washing and laundering:

[42] Understanding and Improving the Durability of Textiles, 2012, ed. by Annis, Patricia A, Woodhead Publishing Limited

- **Part C06:** Colour fastness to domestic and commercial laundering.
- **Part C12:** Colour fastness to industrial laundering.

Colour fastness to dry cleaning:

Note: Full list included, ***the most relevant method to be included (both or neither) needs to be further discussed.***

- **Part D01:** Colour fastness to dry cleaning using perchloroethylene solvent.
- **Part D02:** Colour fastness to rubbing: Organic solvents.

Colour fastness to aqueous agents:

- **Part E01:** Colour fastness to water.
- **Part E02:** Colour fastness to sea water.
- **Part E03:** Colour fastness to chlorinated water (swimming-pool water).
- **Part E04:** Colour fastness to perspiration.

Standard adjacent fabrics:

- **Part F01-F10:** Specification for adjacent fabrics.

Measurement of colour and colour differences:

- **Part J01-J03:** Principles for measurement of surface colour.

> The ISO 105 serie of methods are the most commonly used and is recommended for the ESPR. However, which test methods are most relevant to include, and for what type of material, should be further discussed.

2.11 Quality of trimmings

Material that are required to make up a textile product that are other than the main fabrics, are called trimmings. Those include zippers, button, sewing thread, label, motif, lining etc.

2.11.1 Quality of zippers

The quality of zippers depends on several components: **the strength of the chain, the slider, the slider lock and the top and bottom stop**. The test methods most commonly used evaluate.[43] [44]

[43] https://www.sbs-zipper.com/blog/8-main-physical-properties-of-zipper-strength/

[44] https://www.ykkfastening.com/quality/methods.html

- Chain crosswise strength – the zipper is pulled crosswise to determine the strength of the chain. The procedure is similar to the tensile strength and seam strength test.
- Crosswise strength of separating unit – pulling the bottom stop/separating unit to determine the strength of this component.
- Slider lock strength – measures the locking strength of the slider when the open chain is pulled transverse the slider/outwards in opposite directions.
- Top stop holding strength – pulling the slider to assess that the top stop manages to keep the slider in the zipper, and that it will not slide off during use.
- Bottom stop holding strength – Test to determine the strength of the bottom stop of the zipper.
- Slider pullers pull-off strength – test to determine that the strength of the puller (which is attached to the slider), is sufficient.

Test methods:

- **ASTM D2061:** Standard test methods for strength tests for zippers.
- **JIS S3015**: Methods for Measuring Zipper Dimensions Standard Test Methods for Strength.
- **EN 16732**: Slide fasteners (zips) – Specifications.

The ASTM and ISO standards include more methods for zippers and zipper parts than described above and mentions that **not all methods are suitable for all zipper types**. Further information regarding JIS standard not found.

> Producers of zippers seem to refer more often to ASTM compared to the ISO standard. More research is needed into whether there are any differences between the standards and which to include in the ESPR.

2.11.2 Quality of buttons, press buttons, rivets, eyelets

Quality of buttons is influenced by the strength of the sewing thread, the fabric it is attached to, etc. If a failure occurs for a button attached with sewing thread, it most often only leads to the button falling off (but it can also result in a fabric tear).

In the case of using press buttons or rivets, a failure of the button will however be more difficult to repair.

> Test methods for assessing fabric failure caused by rivets, eyelets and press buttons should be further investigated.
> EU standard on safety of children's clothing should be further investigated to see if any tests of trimmings is also relevant for the ESPR.

2.12 Other properties

2.12.1 Water resistance after aging

The ability for waterproof textile products (rain garments, tents, etc.) to retain their water resistance after wear and wash, will affect the durability of the product. Water resistance after aging, as measured in EN 343, may therefore be interesting to include in the ESPR for waterproof textile products.

> This may lead to higher usage of water resistance chemicals, it is key to approach this excluding problematic chemicals and looking into alternatives. At this stage, it is not recommended to include water resistance in the ESPR.

2.12.2 Thermal resistance after washing

Thermal resistance is a measure of the insulation properties of textiles. It is most often tested at lined garments, sleeping bags, quilts, etc. If the lining collapses during the wash, **the thermal resistance will decrease, and the product will lose its insulating properties. This property is possibly relevant to include for sleeping bags, quilts etc.**

Washing performed X number of cycles according to e.g., ISO 6330. Thermal resistance determined according to ISO 11092 before and after wash.

2.12.3 Absorbency and wicking

Absorbency and wicking are relevant for garments worn close to skin, to get a measure of comfort properties. If a garment has low absorbency and does not transport sweat from the skin, it will possibly not be used throughout its potential lifetime. Absorption capacity is a measure of how textiles transport water into the construction. Low water absorbency of fibres may lead to garments being perceived as "sweaty" since the fibres cannot capture any sweat emitted from the body. [45] Synthetic fibres have low or no absorption, while biobased fibres can absorb water (different capacity based on fibre type).

Wicking properties are the moisture transporting properties; transport through the garment, from inside to outside. This is generally tested on synthetic fabrics used for sports garments, etc. where it is desirable to transport sweat from the body but without leading to the garment closest to the skin being wet (since the absorption is low).[46]

2.12.4 Electrostatic propensity

Synthetic fibres have very low water absorption which may lead to a static electricity-build up in the material, especially during winter when the air humidity is low. If a textile builds up static

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[45] https://www.intechopen.com/online-first/80660

[46] https://www.intertek.com.hk/textiles-apparel/wicking/

electricity, this leads to unease during use, and may lead to the textile being discarded, or unused, even if the functionality is still intact. **A textile product's ability to withstand frictional charging can, therefore, be interesting for some applications, for example where electrostatic propensity affects the comfort during wear or use.**

3 Conclusion

After investigating and analising which standards and methodologies are used for assessing textile durability; how different fabrics behave, and which properties may be relevant to include in the ESPR for assessing durability; we can conclude that **the assessment of different properties relating to durability of textiles indicates that there are shortcomings for fabrics made of natural and biobased fibres, compared to synthetic and man-made ones.**

The differences do not seem to be related to different test procedures in case of competing test methods. Synthetic fibres generally have higher strength, lower risk for dimension changes and higher crease resistance compared to biobased options. However, they can pose a higher risk for pilling and yarn slippage. Many properties can be improved by altering the construction of the fabrics, such as increasing density, choosing weaves with longer floats, etc. **Some properties conflict with each other**: for example, higher density increases tensile and bursting strength but lowers the tear strength, longer floats increase tear strength but increase the risk for shrinkage in washing and knitted or woven products will mostly behave differently.

If you want to know more...:

- ECOS Textile Report – Durable, Repairable, Mainstream: How Ecodesign can make our textiles circular
- Wardrobe Change Campaign position paper
- ECOS textile webpage

4 ANNEX – Deep dive EU Ecolabel, Nordic Swan, Blue Angel

We looked closely into a selection of ISO Type 1 Ecolabels for textiles (EU Ecolabel, Nordic Swan and Blue Angel) to identify consistencies in using specific standards for accounting for the same characteristic. The Nordic Swan (2022) seems to be the most comprehensive label: the one that presents the most methods and tests for different properties. A few important properties are assessed by all the labels (e.g., Fabric resistance to pilling and abrasion, dimensional changes during washing and drying, colour fastness) although differences exist and some properties are not assessed by any label (e.g., bursting strength, quality trimming). Based on those comparison, some criteria and thresholds seem to be implementable if taken up in ESPR for textiles.

	This report	EU ECOLABEL (2014)	NORDIC SWAN (2022)	BLUE ANGEL (2017)
Tensile Strength				
Method	Strip method: • EN ISO 13934-1 Textiles: Tensile properties of fabrics — Part 1: Determination of maximum force and elongation at maximum force using the strip method. • ASTM D5035-11 Standard test method for breaking force and elongation of textile fabrics (strip method). Grab method: • EN ISO 13934-2 Textiles: Tensile properties of fabrics — Part 2: Determination of maximum force using the grab method. • ASTM D5034-21 Standard test method for breaking force and elongation of textile fabrics (grab test).	N/A	ISO 13934-2	N/A

Product type & Threshold	The test is used for **woven, felted, and nonwoven fabrics. Knitted and highly elastic woven fabrics are tested for bursting strength.**		Expressed in dekanewtons (daN) • Trousers, shorts, skirts: 18 daN • Jackets and coats: 15 daN • Sportswear, ski clothing and other outdoor wear: 18 daN • Lingerie, pyjamas, and other nightwear: 12 daN • T-shirts, blouses, shirts, and dresses: 12 daN • Swimwear: 15 daN • Bed linen and sheets: 12 daN • Towels: 12 daN	
Tear Strength				
Method	• EN ISO 13937-1 (2000) Textiles: Tear properties of fabrics – Part 1: Determination of tear force using ballistic pendulum method (Elmendorf). • EN ISO 13937-2 (2000) Part 2: Determination of tear force of trouser-shaped test specimens (Single tear method). • EN ISO 13937-3 (2000) Part 3: Determination of tear force of wing-shaped test specimens (Single tear method). • EN ISO 13937-4 (2000) Part 4: Determination of tear force of tongue-shaped test specimens (Double tear test). • ASTM D1424 • ASTM D5587 • ASTM D2261	N/A	ISO 13937-1	N/A

Product type & Threshold	The test is applicable to **woven fabrics but may be used for some nonwovens**. It is not applicable for knitted or elastic woven fabrics.	N/A	Expressed in dekanewtons (daN) • Trousers, shorts, skirts: 1,5 daN • Jackets and coats: 1,2 daN • Sportswear, ski clothing and other outdoor wear: 1,2 daN • Lingerie, pyjamas, and other nightwear: 0,8 daN • T-shirts, blouses, shirts, and dresses: 0,8 daN • Swimwear: 1,0 daN • Bed linen and sheets: 0,8 daN • Towels: 0,8 daN	N/A
Bursting Strength				
Method	• EN ISO 13938-1 Textiles: Bursting properties of fabrics - Part 1: Hydraulic method for determination of bursting strength and bursting distension (ISO 13938-1:2019). • EN ISO 13938-2 Part 2: Pneumatic method for determination of bursting strength and bursting distension. • ASTM D3786/D3786M-18 Standard test method for bursting strength of textile fabrics - Diaphragm bursting strength tester method: Hydraulic or pneumatic diaphragm bursting tester. • ASTM D3787-16 Standard test method for bursting strength of textiles – the constant rate of traverse (CRT) Ball burst test. • ISO 9073-5: nonwovens, determination of resistance to	N/A	N/A	N/A

	mechanical penetration (ball burst procedure). • ASTM D 6797 Standard test method for bursting strength of textiles – the constant rate of extension (CRT) Ball burst test.			
Product type & Threshold		N/A	N/A	N/A
Seam Strength				
Method	• EN ISO 13935-1:2014 Textiles: Seam tensile properties of fabrics and made-up textile articles - Part 1: Determination of maximum force to seam rupture using the strip method • EN ISO 13935-2:2014 Part 2 ASTM D1683 Standard test method for failure in sewn seams of woven fabrics • ASTM D751 Standard test method for coated fabrics	N/A	ISO 13935-2	N/A
Product type & Threshold		N/A	Woven fabrics • The seam in the lining: 80N • Textile with fabric weight <220g/m2: 150N • Textile with fabric weight >220g/m2: 200N • Backpacks and bags: 200N	N/A
Yarn Slippage (seam slippage)				
Method	• ISO 13936 1,2,3: Yarn slippage resistance of yarns at seams in woven fabrics	N/A	EN-ISO 13936-1 or EN-ISO 13936-2	N/A

Product type & Threshold	Only tested on **woven fabrics.**	N/A	*EN-ISO 13936-1* • Trousers, shorts, skirts: 4 mm at 14 daN load • Jackets and coats: 4 mm at 14 daN load • Sportswear, ski clothing and other outdoor wear: 4 mm at 14 daN load • Lingerie, pyjamas, and other nightwear: 4 mm at 10 daN load • T-shirts, blouses, shirts, and dresses: 4 mm at 11 daN load • Swimwear: 4 mm at 14 daN load • Bed linen and sheets: 4 mm at 10 daN load *EN-ISO 13936-2* • Trousers, shorts, skirts: 12 daN load at 3 mm • Jackets and coats: 12 daN load at 4 mm • Sportswear, ski clothing and other outdoor wear: 12 daN load at 4 mm • Lingerie, pyjamas, and other nightwear: 6 daN load at 3 mm • T-shirts, blouses, shirts, and dresses: 6 daN load at 3 mm • Swimwear: 6 daN load at 3 mm • Bed linen and sheets: 6 daN load at 3 mm	N/A

Abrasion Resistance				
		Fabric resistance to pilling and abrasion		Fabric resistance to pilling and abrasion
Method	• ISO 12947-2 (2016): "Textiles — Determination of the abrasion resistance of fabrics by the Martindale method — Part 2: Determination of specimen breakdown". • ASTM D3884 Standard Guide for Abrasion Resistance of Textile Fabrics • ASTM D3885 Standard Test Method for Abrasion Resistance of Textile Fabrics (Flexing and Abrasion Method) (woven or nonwoven fabrics). • ASTM D3886 Standard Test Method for Abrasion Resistance of Textile Fabrics (Inflated Diaphragm Apparatus) (both wet and dry/conditioned samples). • ASTM D4966 Standard Test Method for Abrasion Resistance of Textile Fabrics (Martindale Abrasion Tester Method). • ASTM D4158 Standard Guide for Abrasion Resistance of Textile Fabrics (Uniform Abrasion). • ASTM D4685/D4685M-15 Standard test method for Pile fabric abrasion • CEN EN 13770 (2002) Textiles: Determination of the abrasion resistance of knitted footwear garments	1. ISO 12945-1 Pill box method 2. ISO 12945-2 Martindale method 3. ISO 12945-2 Martindale method	EN ISO 12947-2 or an equivalent standard	1. ISO 12945-1 Pilling box method 2. ISO 12945-2 Martindale method
Product type & Threshold	It is normally performed with a wool standard fabric such as abradant or sandpaper. In EN 343 (Protective	1. **Non-woven fabrics** and knitted garments, accessories and blankets made of wool, wool	Limit value expressed in number of rubs/abrasions (Martindale)	1. For **knitted and nonwoven materials**: Nonwoven fabrics and knitted garments,

	garments – protection against rain) abrasion with sandpaper is used as a pretreatment before testing water resistance. Abrasion resistance of pile fabrics (pile retention, pile pull out) is determined according to other standards. This method is relevant for **velour, fleece, velvet.**	blends and polyester (including fleece ≥3 2. **Woven cotton fabrics** used for garments ≥3 3. Polyamide **tights and leggings** ≥2	*Textiles for professional use* • Commercial upholstery: 50.000 • Work wear for outdoor use (only woven fabric): 30.000 • Work wear for indoor use (only woven fabric): 20.000 *Textiles for consumers* • Domestic upholstery: 30.000 • Trousers, shorts, skirts: 20.000 • Jackets and coats: 16.000 • Sportswear, ski clothing and other outdoor wear: 20.000 • Lingerie, pyjamas, and other nightwear: 10.000 • T-shirts, blouses, shirts, and dresses: 12.000 • Swimwear: 20.000 • Bed linen and sheets: 10.000 • Knit: 8.000	accessories and blankets made of wool, wool mixes and polyester (including fleece), must resist pilling up to a minimum rating of 3. 2. **Woven fabrics**: Woven cotton fabrics used for garments must resist pilling up to a minimum rating of 3. Polyamide tights and leggings must resist pilling up to a minimum rating of 2.
Pilling				
		*Fabric resistance to pilling and abrasion		*Fabric resistance to pilling and abrasion
Method	• EN ISO 12945-1:2020 Textiles: Determination of fabric propensity to surface pilling, fuzzing or matting — Part 1: Pilling box method. • EN ISO 12945-2 Part 2: Modified Martindale method. • EN ISO 12945-3 Part 3: Random tumble pilling method.	1. ISO 12945-1 Pill box method 2. ISO 12945-2 Martindale method 3. ISO 12945-2 Martindale method	EN ISO 12945-2 **or an equivalent standard**	1. ISO 12945-1 Pilling box method 2. ISO 12945-2 Martindale method

Product type & Threshold	Knitted fabrics are most relevant to assess, but it can also occur on weaves. The appearance of the surface, based on pills/knots appearing, is graded according to a 5-graded scale after the rubbing procedure (5-no pilling, to 1-very severe pilling). In Martindale equipment, where the test material is rubbed flat against a wool fabric, or/and rubbed against itself, under pressure. The surface is assessed visually after a predetermined number of cycles. The final assessment is performed after 7000 cycles.[47]	1. **Non-woven fabrics and knitted garments**, accessories and blankets made of wool, wool blends and polyester (including fleece ≥3 2. **Woven cotton fabrics** used for garments ≥3 3. **Polyamide tights and leggings** ≥2	• Clothing - woven fabric: 4 (1000 rubs) • Clothing - woven fabric with raised surface 2-3: (1000 rubs) • Clothing – knit: 2-3 (1000 rubs) • Fleece: 4 (5000 rubs) • Upholstery for private use: 3-4 (5000 rubs) • Upholstery for professional use: 4 (5000 rubs) • Upholstery of wool or wool blends for professional use: 3-4 (5000 rubs)	1. **For knitted and nonwoven materials**: Nonwoven fabrics and knitted garments, accessories and blankets made of wool, wool mixes and polyester (including fleece), must resist pilling up to a minimum rating of 3. 2. **Woven fabrics**: Woven cotton fabrics used for garments must resist pilling up to a minimum rating of 3. Polyamide tights and leggings must resist pilling up to a minimum rating of 2.
Dimension stability (Dimensional changes during washing and drying)				
Method	• EN ISO 5077 Textiles: Determination of dimensional change in washing and drying. Connected standards: • EN ISO 3759 Textiles: Preparation, marking and measuring of fabric specimens and garments in tests to determine the dimensional change.	Domestic washing: EN ISO 6330 in combination with EN ISO 5077 shall be used as follows: three washes at temperatures as indicated on the product, with tumble drying after each washing cycle.	EN ISO 6330 "Textiles – Domestic washing and drying procedures for textile testing", combined with ISO 5077 "Textiles – Determination of dimensional change in washing and drying".	EN ISO 6330 and EN ISO 5077 taking into account the following modification: three washes at temperatures indicated on the end product with tumble drying after each washing cycle, insofar as no other drying processes are indicated on the end product.

47 https://www.ri.se/sv/vad-vi-gor/tjanster/pilling-och-luddbildning-hos-textil-enligt-ss-en-iso-12945-2

	• EN ISO 6330 Textiles: Domestic washing and drying procedures for textile testing. • EN ISO 15797 Textiles: Industrial washing and finishing procedures for testing of workwear.	Commercial washing in industrial laundries: ISO 15797 in combination with EN ISO 5077 shall be used at a minimum of 75oC or as indicated in the standard for the fibre and bleaching combination. Drying shall be as indicated on the product label.	For professional textiles intended for industrial laundry, the standard ISO 15797 Textiles – "Industrial washing and finishing procedures for testing of workwear", combined with EN ISO 5077. Testing procedure: - 10 washes for 100% wool textiles/ 1 wash for other textiles - Temperature, laundry program and detergent as stated on the care label - Drying as stated on the care label	
Product type & Threshold		• Knitted fabrics +/- 4.0 % • Chunky knit +/- 6.0 % • Bathroom linen, including terry towelling and fine rib fabrics +/- 8.0 % • Interlock +/- 5.0 % • Washable and removable woven upholstery: - Curtains and furniture fabric +/- 2.0 % - Mattress ticking +/- 3.0 % • Woven fabrics: - Cotton and cotton mix +/- 3.0 % - Wool mix +/- 2.0 % - Synthetic fibres +/- 2.0 % • Non-woven fabrics: - Mattress ticking +/- 5.0 % - All other fabrics +/- 6.0 % • Socks and hosiery +/-8.0 %	• Curtains and upholstery covers that are removable and can be washed ± 2% • Woven textiles for duvets and pillows, in accordance with EN 13186 ± 5% • Bedding, tablecloths, and napkins ± 5% • Terry towels and washcloths ± 7% • Woven products of wool blend and synthetic fibres ± 2% • Woven textiles not covered by the categories above ± 3% • Knitwear/hosiery ± 5% for • Wool knitwear (after 10 washes) ± 10% for 100%	• Knitted fabrics +/- 5 % • Chunky knit +/- 6 % • House and home textiles +/- 8 % Woven fabrics: • Cotton and cotton mix +/- 3 % • Linen, flax and silk +/- 3 % • Cotton and cotton mix for bedding +/- 5 % • Wool mix +/- 2 % • Synthetic fibres +/- 2 % • Bathroom linen, including terry towelling and fine rib fabrics +/- 8 % • Socks and hosiery +/- 8 %

Colour fastness				
Method	•Part A01 – A 11: General principles of testing, grey scales, instrumental assessment. Colour fastness to light and weathering: •Part B01: Colour fastness to light: Daylight. **•Part B02: Colour fastness to artificial light: Xenon arc fading lamp test.** •Part B03: Colour fastness to weathering: Outdoor exposure. •Part B04: Colour fastness to artificial weathering: Xenon arc fading lamp test. •Part B05: Detection and assessment of photochromism. **•Part B06: Colour fastness and ageing to artificial light at high** temperatures: Xenon arc fading lamp test. •Part B07: Colour fastness to light of textiles wetted with artificial perspiration. •Part B10: Artificial weathering — Exposure to filtered xenon-arc radiation (under development). Colour fastness to washing and laundering:	Colour fastness to light ISO 105 B02 Colour fastness to washing - Domestic washing: ISO 105 C06 (single wash, at temperature as marked on the product, with perborate powder). - Commercial washing in industrial laundries: ISO 15797 in combination with ISO 105 C06 shall be used at a minimum of 75oC or as indicated in the standard for the fibre and bleaching combination. Colour fastness to perspiration (acid, alkaline) - ISO 105 E04 (acid and alkaline, comparison with multi-fibre fabric) Colour fastness to wet rubbing - ISO 105 X12 - Clarification of key points of Criterion 20: Amendments to the criterion from 2017: The colour fastness to wet rubbing shall be at least level 2-3. A	Colour fastness to light - EN ISO 105 B02 or equivalent Colour fastness to washing or dry cleaning - Test method for wash: ISO 105 C06 (a single wash at the temperature stated on the product), or equivalent. - Test method for dry cleaning: ISO 105 D01 Colour fastness to perspiration and saliva - ISO 105 E04 (both acid and alkaline, plus comparison with textile of blended fibres) or equivalent. If only level 3 is met, it must be declared that the standard depth is >1/1 according to ISO 105-A06. Colour fastness to rubbing (wet) - ISO 105 X12 or equivalent.	Colour fastness to light - DIN EN ISO 105-B02 Colour fastness to washing - DIN EN ISO 105-C06 (single wash, at temperature marked on the product, with perborate powder). Colour fastness to perspiration (acid, alkaline) - DIN EN ISO 105-E04 (acid and alkaline, comparison with multi-fibre fabric) Colour fastness to rubbing - DIN EN ISO 105-X12

	•**Part C06: Colour fastness to domestic and commercial laundering.** •Part C12: Colour fastness to industrial laundering. Colour fastness to dry cleaning: •Part D01: Colour fastness to dry cleaning using perchloroethylene solvent. •**Part D02: Colour fastness to rubbing: Organic solvents.** Colour fastness to aqueous agents: •**Part E01: Colour fastness to water.** •Part E02: Colour fastness to sea water. •Part E03: Colour fastness to chlorinated water (swimming-pool water). •**Part E04: Colour fastness to perspiration**.	level of 2 is allowed for dark coloured denim and a level of 1 for all other denim colour shades Colour fastness to dry rubbing - ISO 105 X12 - Clarification of key points of Criterion 21: Amendments to the criterion from 2017: The colour fastness to dry rubbing shall be at least level 4. A level of 3-4 is allowed for dark coloured denim and a level of 2-3 for all other denim colour shades.	Colour fastness to rubbing (dry) - ISO 105 X12 or equivalent Colour fastness to water (leather) - ISO 11642 or equivalent. Colour fastness to wear (leather) - ISO 11640 or equivalent, with 20 repetitions for wet wear and 50 repetitions for dry wear. The results are to be assessed using ISO 105-A02 and ISO 105-A03 or equivalent.	Colour fastness to saliva and perspiration - §64 of the LFGB (German Food and Feed Code), BVL B 82.10-1 in combination with DIN 53160 Parts 1 and 2
Product type & Threshold		Colour fastness to washing - At least level **3-4** for colour change and at least level **3-4** for staining This criterion does not apply to: Products labelled “dry clean only” or equivalent; White products; Products that are neither dyed nor printed; non-washable furniture fabrics Colour fastness to perspiration (acid, alkaline)	Colour fastness to washing or dry cleaning - For colour change: **level 3-4** - For discolouration: **level 3-4** The requirement does not concern white products and products that are neither dyed nor printed, nor furniture textiles that are not intended for removal and washing or dry cleaning.	Colour fastness to washing - at least levels **3-4** according to ISO 105 (grey scale A 03). Not apply: Products labelled “dry clean only”, indigo dyed denim, white products, end products that are neither dyed nor printed, or to non-washable furniture fabrics. Colour fastness to perspiration (acid, alkaline)

		- At least level **3-4** (colour change and staining). - A level of **3** is nevertheless allowed when fabrics are both dark coloured (standard depth > 1/1) and made of regenerated wool. This criterion does not apply to white products; products that are neither dyed nor printed; furniture fabrics, curtains or similar textiles intended for interior decoration.	<u>Colour fastness to perspiration and saliva</u> Levels for colour fastness: For discolouration: **level 4** For staining: **level 4** **Level 3** is, however, permitted for textiles that are dark in colour (standard depth >1/1 according to ISO 105-A06) and/or made from recycled wool. Underwear, sportswear, and t-shirts must as a minimum meet the following levels for colour fastness to perspiration. And Baby clothes (0-36 months) must as a minimum meet the following levels for colour fastness to saliva.	at least levels **3-4** according to ISO 105 (grey scale A 03) (colour change and staining). A level of **3** is nevertheless accepted when fabrics are both dark coloured (standard depth > 1/1) and made of regenerated wool or contain more than 20% silk. This requirement does not apply to white products, end products that are neither dyed nor printed, furniture fabrics, curtains or similar textiles intended for interior decoration. <u>Colour fastness to saliva and perspiration</u> The textile materials must be colour fast to the effects of saliva. The remaining dyed materials must be colour fast to the effects of saliva and perspiration. This corresponds to **level 5** of the currently valid standard DIN 53160 Parts 1 and 2. This requirement applies to babies and children up to 36 months old.

		<u>Colour fastness to wet rubbing</u> at least level **2-3.** A level of 2 is allowed for dark coloured denim and a level of 1 for all other denim colour shades. This criterion does not apply to: white products; products that are neither dyed nor printed.	<u>Colour fastness to rubbing (wet)</u> at least level **3-4.** The requirement does not concern white products or products that are neither dyed nor printed. Dark and medium coloured denim are exempt from requirement level of 3-4. Dark coloured denim must instead document that level 1-2 is met. Medium coloured denim must instead document that the level 2-3 is met. When using this exemption, the product must be accompanied by information that the textile's dye may cause cross-staining. For dark and medium denim, documentation must be submitted to include information on the product that the fabric's colour may be contaminated.	<u>Colour fastness to rubbing</u> at least levels **2-3** according to ISO 105 (grey scale A 03). Level 2 is accepted for indigo dyed denim. This requirement does not apply to white products or end products that are neither dyed nor printed. The colour fastness to dry rubbing must be at least level 4 according to ISO 105 (grey scale A 03). Level 3-4 is accepted for indigo dyed denim. This requirement does not apply to white products, end products that are neither dyed nor printed, curtains or similar textiles intended for interior decoration.
		<u>Colour fastness to dry rubbing</u> **at least level 4.** A level of 3-4 is allowed for dark coloured denim and a level of 2-3 for all other denim colour shades. This criterion does not apply to: white products; products that are neither dyed nor printed; curtains or similar textiles intended for interior decoration.	<u>Colour fastness to rubbing (dry)</u> **at least level 4.** The requirement does not apply to white textile products, textile products that are neither died nor printed, curtains or other equivalent home furnishing textiles. Dark coloured denim is exempted from the requirement for a minimum of level 4. Dark coloured denim must instead achieve at least a level 3. When using this exemption, the product must be	

		Colour fastness to light Fabrics intended for furniture, curtains or drapes which are both light coloured (standard depth < 1/12) and made of more than 20 % wool or other keratin fibres, or more than 20 % linen or other bast fibres: at least **level 4.** Other fabrics intended for furniture, curtains or drapes: at least **level 5** All other products: at least **level 4**.	accompanied by information that the textile's dye may cause cross-staining. Colour fastness to light For textiles for outerwear, swimwear, and UV protective clothing: **level 5** For textiles for furniture, curtains, and drapery: **level 5** **Level 4** is permitted for textiles for furniture, curtains, or drapery, if the textile is both lightly dyed (standard depth <1/12 in accordance with 105 A06) and consists of blends with more than 20% wool or other keratin fibres, or of blends with more than 20% linen or other bast fibres. Colour fastness to water (leather) - at least **level 3** for leather that is dyed or has a surface finish. Colour fastness to wear (leather) - at least **level 3** for leather that is dyed or has a surface finish. For vegetable tanned leather where no finishing is carried out, colour fastness is accepted for wet and dry wear of at least 2.	Colour fastness to light at least **level 5** according to ISO 105 (grey scale A 03). For all other products, the colour fastness to light must be at least **level 4.** **Level 4** is accepted if furniture, curtains or drapes are both light coloured (standard depth < 1/12) and made of more than 20% wool or other keratin fibres, or more than 20% silk or more than 20% linen or other bast fibres.
Quality of trimming				
Method	• **ASTM D2061**: Standard test methods for strength tests for zippers.	N/A	N/A	N/A

	• **JIS S3015**: Methods for Measuring Zipper Dimensions Standard Test Methods for Strength. • **EN 16732**: Slide fasteners (zips) – Specifications. The ASTM and ISO standard include more methods for zippers and zipper parts than described above and mentions that not all methods are suitable for all zipper types.			
Product type		N/A	N/A	N/A