

**When comfort and
safety go hand in hand.
A new horizon for
protective apparel.**

Twaron® Technora® Teijinconex®

The main focus of protective clothing has always been safety. Yet the importance of comfort cannot be overstated. People working in the petrochemical and electrical industries, for example, are more likely to wear their protective clothing if it is comfortable. This increases productivity and decreases the number of breaks employees take. It also eliminates discontent and increases morale in the workplace. Ultimately it benefits overall safety: the more comfortable protective clothing is, the more likely employees are to wear it, shielding them from unexpected hazards such as flash fires and arc flashes. And the more comfortable employees are, the less distracted and more focused they will be while working, thus reducing the chances of accidents.

Framework for objectively measuring comfort

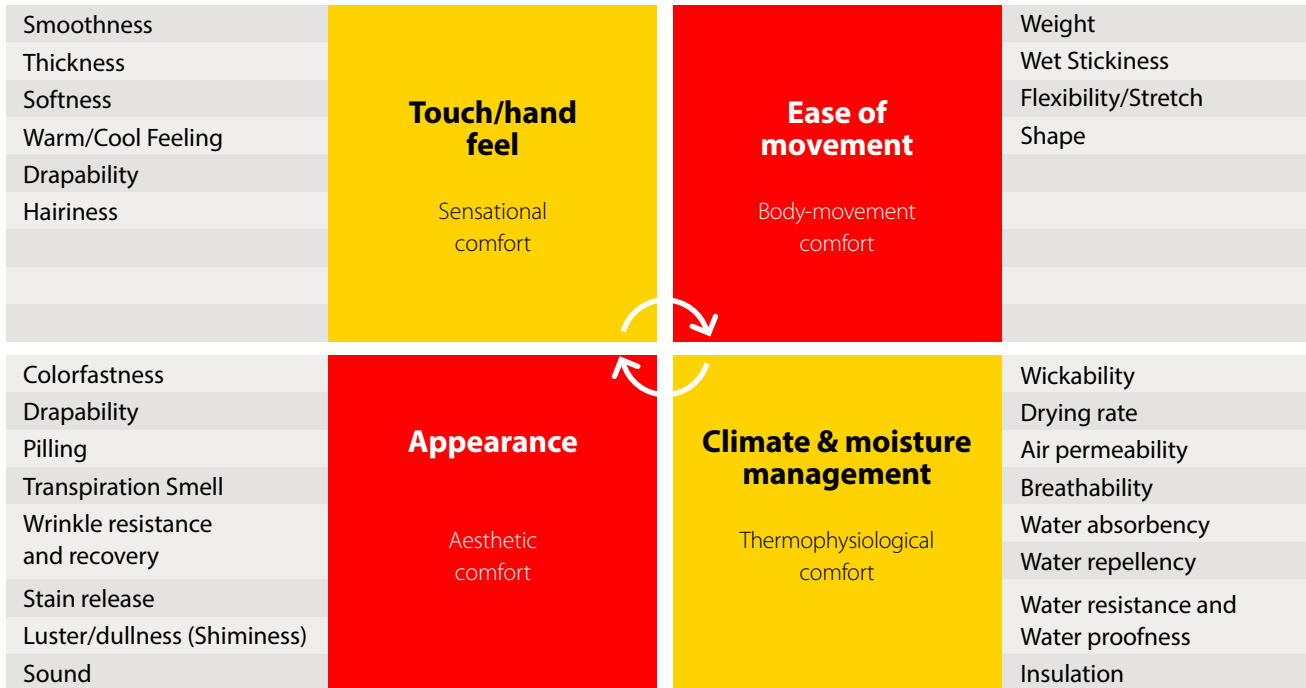


Figure 1

Measuring comfort, the new way

Most people define and measure comfort intuitively, using subjective criteria: they may touch a garment to see how it feels or try it on to see how it wears. New Teijin Aramid research involving end users of protective clothing in Europe has taken significant strides toward defining comfort more objectively, however. Our researchers used scientific and end-user descriptions of comfort to develop a framework (see Figure 1) that will help end users articulate their needs more accurately and include comfort as an objective parameter when selecting a clothing package. As a result, now end users can select clothing for wearing trials that is more in line with their workplace-related comfort requirements. This eliminates unwanted surprises and improves the efficiency of the trials, which remain the ultimate test of comfort.

The framework covers four aspects of comfort: the touch and hand feel of the fabric, the ease of movement, the appearance, and the climate and moisture control. We grouped an impressive array of measurable parameters, such as softness, breathability, wickability, wrinkle resistance, colorfastness, pilling resistance, weight, and stretch, into these four aspects. Because each of these parameters can be objectively measured, end users can now pinpoint which factors are important for their work environment, and they can pre-select the garments that best meet their requirements.



Touch and hand feel

A garment has to feel right. You may be one of the many people who are sensitive to wool, for example. Imagine having to work in a woolen sweater. How productive would you be if you were constantly irritated by the coarse fibers of the wool? People need to feel at home in their clothes to do their job properly. Some of the parameters associated with the touch and hand feel of a garment include smoothness, softness, thickness, warm/cool feeling, drapability, and hairiness.

- **Smoothness:** How smooth a garment feels against your skin is related to surface friction, which ranges from slippery to harsh. Wool can feel harsh, for example, whereas garments made with Teijinconex® X-Fire Technology score high on smoothness. Our researchers determined smoothness with the friction force test (see Figure 2), which measures the resistance to the sliding of two surfaces in contact (ISO 8295, ASTM D1894).
- **Softness:** The more pliable the garment, the softer and less stiff it will feel. The softness of a garment can be determined by measuring how easily it bends, ranging from pliable at one end of the spectrum to stiff on the other end. Our researchers used the cantilever stiffness test (Figure 3) to determine softness (ISO 53362).

Figure 2 **Friction force test to measure smoothness**

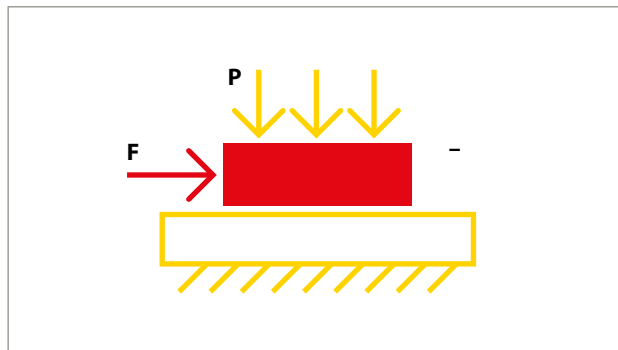
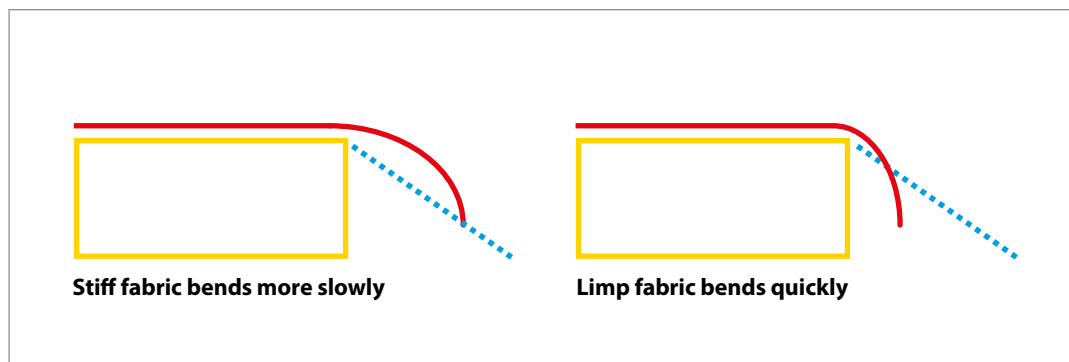


Figure 3 **Cantilever stiffness test to measure softness**



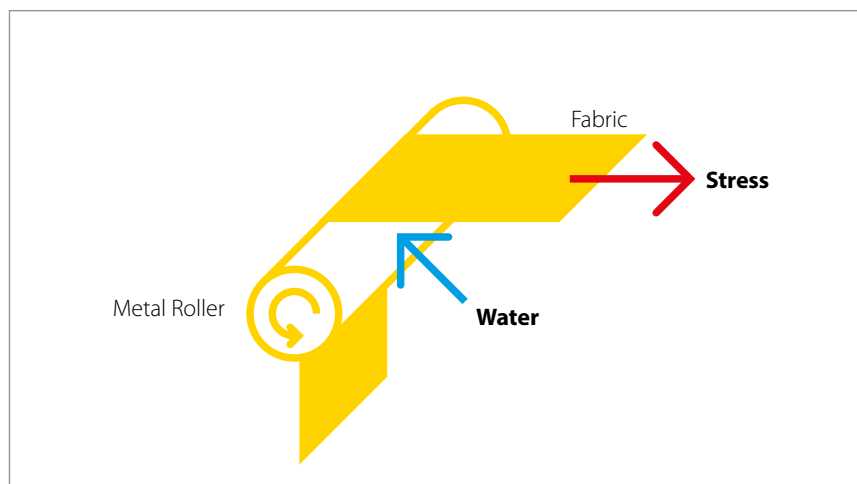


Ease of movement

It's crucially important that the work clothes employees wear give them enough freedom to do their jobs with absolute confidence. If clothing restricts their mobility, it will also restrict their ability to perform well. That could lead to mistakes and ultimately accidents in the workplace. Conversely, it's also important that work clothes demonstrate sufficient resistance and strength, even after repeated washes, as nobody likes their trousers to tear while climbing. The following four clothing parameters fall under ease of movement:

- **Weight:** The heavier a garment, the more of a burden it is for the person wearing it. So it stands to reason that light clothing gives employees greater freedom of movement. The weight can be measured by determining the mass per unit length and mass per unit area (ISO 3801).
- **Stretch:** A piece of clothing needs to be able to be sufficiently flexible to accommodate body movement and then return to its shape. If this is not the case, it will restrict employees' mobility or end up looking like a pair of pajamas. Teijinconex® Coolnex Stretch Technology addresses this very problem: garments made with this innovative technology enjoy a combination of flame-resistant protection and optimal elasticity and flexibility. Teijinconex® Coolnex Stretch was developed at our Japanese textile competence center and objectively measured by testing the textile's ability to extend under tension and then recover relatively quickly and fully to its original dimensions (some methods for measuring stretch include JIS L 1906 Method B, ASTM D3107-07 and ISO 9073-7).
- **Wet stickiness:** We all know the feeling of a wet T-shirt clinging to our skin after being caught in a heavy rain shower. Imagine working in a wet T-shirt. Work clothing needs to be moisture-free to eliminate friction with the skin. As there was no objective international method available to measure wet stickiness, Teijin textile engineers at our textile competence center in Matsuyama, Japan developed a new method that determines the stickiness of textiles by measuring the force required to move a textile fiber over a wet surface (Figure 4).
- **Shape:** Shape is the only parameter that needs to be designed at the garment level. That's why textiles need to produce a compressive force that, in addition to the design of the garment, provides the right fit and comfort for the wearer. This parameter is best tested in a wearing trial.

Figure 4 **Measuring the stickiness of textiles**





Appearance

Appearance may seem somewhat superficial compared to more functional aspects such as ease of movement, but that's not the case at all. The clothes your employees wear are the business card of your company. You want them to wear your company's clothing with pride. For that to happen, clothing needs to score high on parameters such as colorfastness, pilling, and wrinkle resistance.

- **Colorfastness:** Protective clothing is used in harsh environments, so you want clothing that can maintain its full color despite exposure to light, abrasive wear and rubbing. We determined colorfastness by subjecting clothing to washing (ISO 105-C10), light (ISO 105-B02), perspiration (ISO 105-E04), and rubbing (ISO 105-X12).
- **Wrinkle resistance and recovery:** Much like color fading, wrinkles can ruin the appearance of protective clothing. A textile should be able to resist bending and the formation of wrinkles, or at least have the ability to return to its original flat state. Recovery from wrinkling can be determined by measuring the angle of recovery (ISO 2313).

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Àngels Cornellana Morros | Global Product Marketing Manager
Teijin Aramid



Climate and moisture control

Most of us have experienced the feeling of cold wind blowing on a sweaty T-shirt once we have stopped running. Chances are that T-shirt was made of cotton, once the fabric of choice for sportswear. And though comfortable, once you perspire your cotton T-shirt stays wet. This can lead to chafing in hot weather and hypothermia in cold weather. High performance polyester fibers, which have overtaken cotton as the most popular material for sports clothing, are much better at wicking moisture. Similarly, well-designed aramid blended textiles used in protective clothing score high on parameters such as wickability, and drying rate.

Teijin has a pool of textile engineers who rotate jobs to increase their added value for the company. At a certain point, engineers who work on high performance textile solutions for leading sports companies were transferred to the Aramid Division. There, they started to take “comfort” parameters into account when designing protective textiles with athletic performance, such as wickability, drying rate, air permeability, and water absorbency. One example is our Teijinconex® X-Fire Technology, which dries significantly quicker and has faster wickability than other aramid solutions, next to being light.

- **Wickability:** A garment’s ability to wick moisture is desirable in hot environments, where people perspire more easily. Wet clothing clings to the wearer’s skin and makes it harder to move. It also rubs against the skin, causing irritation. Wickability is the spread of water through a fabric by capillary action. We used methods that tested both vertical and horizontal wickability (ISO 17617).
- **Drying rate:** The quicker a fabric dries the better, because the longer it remains wet the more it cools down the body. The drying rate is the time needed for a fabric to dry, which we determined using the test method specified in ISO 17617.
- **Air permeability:** Air permeability allows clothing to breathe, heat and moisture to escape, and helps to prevent the fabric from remaining wet. Our researchers determined the degree to which a fabric allows air to pass through its construction using the method of testing specified in ISO 9237.
- **Water absorbency:** Fabrics that absorb water swell during wicking. This reduces the size of the capillary pores and decreases the wicking rate. A garment’s ability to absorb water internally into its fibers can be determined by the water absorption time and water absorption capacity of the fabric (ISO 20158). For instance, cotton absorbs up to 25 times its weight in water, and takes an exceptionally long time to dry.

Delivering our insights to the world

We presented our research findings at the Safety Summit in Belgium in 2018. What makes this research exciting is that in addition to identifying parameters of comfort, together with end-users, our researchers have created a framework for testing these parameters. “The fact that we can now objectively measure comfort is a real eye-opener for the different players in the protective clothing value chain,” says Product Marketing Manager Protective Apparel Àngels Cornellana Morros. “This framework makes it easier for safety and health engineers, who are ultimately the people who decide what a company’s employees will wear, to express the requirements for their clothing in terms of both safety and comfort.”

The common perception was always that people need to make a trade-off between comfort and safety. But that perception is a thing of the past now. Thanks to our textile engineers in Japan and the Netherlands, Teijin can combine the best of both worlds: the high level of safety provided by inherent fire-resistant aramid solutions, with great comfort (by translating the engineers’ knowledge on sports textile technology into protective clothing). Teijinconex® Coolnex Stretch is a case in point. It provides comfort and mobility without compromising on fire-resistant protection or durability. “The protective garment sector is increasingly moving in the direction of the lifestyle clothing sector,” Àngels says. “People want their protective clothing to offer the same level of comfort as normal clothing, such as jeans with stretch.”

In fact, the needs of the market and end users were the starting point of this research. We joined our textile engineers’ experience with end users in the sports clothing world with the knowledge of protective apparel experts. We decided to involve end-users from the start so they could help steer the process. “End-user representatives were actively involved in defining the comfort parameters that matter, and they also provided us with samples of the major fabrics used in safety wear in Europe,” Àngels explains.

“We tested these fabrics to see how they performed in terms of safety and the different comfort parameters. We discussed the findings with the end-user representatives, and I think it’s now safe to say that we’ve moved beyond the idea that aramids are not comfortable. With the right textile technology, you can use aramids to create garments that are both safe and comfortable. This has made it easier for end users to define their needs and select a clothing package that suits their specific working conditions without needing to compromise.” At Teijin, our innovations are not limited to aramid fibers. Our team of textile experts can create customized textile solutions that blend Teijin Aramid’s fibers with other fibers, such as Solotex®, to meet end-users’ specific safety and comfort requirements. The “comfort framework” has made it easier for end users to define their needs, whereas the availability of innovations that offer both the highest protection and the best-in class comfort help select a clothing package without compromise.

Be sure.

At Teijin Aramid, everything we do is guided by our ambition to shape a better future for generations to come. Day after day, we move forward, continuously improving our processes, our technology and ourselves. As market leaders, we drive progress through collaboration and set new standards for high performance. We connect with our customers at every level, wherever they are in the world. Because we believe that, together, we can be something bigger. Together, we can challenge conformity.

From automotive and oil & gas, to civil engineering, ballistic protection and beyond, our products are empowering excellence in diverse markets and applications around the globe. By enabling lighter, stronger and more resistant materials. And by taking durability, protection and efficiency to new levels. Whether you choose Twaron®, Teijinconex®, Technora® or Endumax®, our high-performance materials are an enduring guarantee of reliability. You can be sure of that.



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