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**ІННОВАТИКА В НАУЦІ: СТАН ТА ВИКЛИКИ ВИКОРИСТАННЯ РІПСТОПУ
В УМОВАХ ВОЄННОГО ЧАСУ**

Анотація. У цій статті розглядається інноваційне застосування тканини рипстоп під час війни, підкреслюючи її довговічність, легкі властивості та універсальність. Незважаючи на його переваги, залишаються проблеми щодо виробництва, постачання матеріалів та адаптації до конкретних військових потреб. У дослідженні розглядається нещодавня література та визначаються прогалини в дослідженнях, які перешкоджають повному використанню технології рипстопу в контексті оборони.

Ключові слова: тканина рипстоп, інновації військового часу, військове застосування, матеріалознавство, довговічність, легкі матеріали, текстильні технології.

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**INNOVATION IN SCIENCE: STATUS AND CHALLENGES OF USING RIPSTOP
IN WARTIME CONDITIONS**

Abstract. This article examines the innovative application of ripstop fabric during the wartime, highlighting its durability, lightweight properties, and versatility. Despite its advantages, challenges remain in terms of manufacturing, material sourcing, and adaptation to specific military needs. The study reviews recent literature and identifies gaps in research that hinder the full exploitation of ripstop technology in defense contexts.

Keywords: ripstop fabric, wartime innovation, military applications, material science, durability, lightweight materials, textile technology.

Introduction. During World War II, there was a pressing need for lightweight, durable materials that could withstand the rigors of parachuting. Traditional fabrics like silk were expensive and difficult to source in large quantities, leading to the development of new, synthetic materials. This is when ripstop fabric was born [1].

Ripstop weaving was introduced in a research capacity during the 1940s because it increased fabric durability without sacrificing the porosity of the fabric.

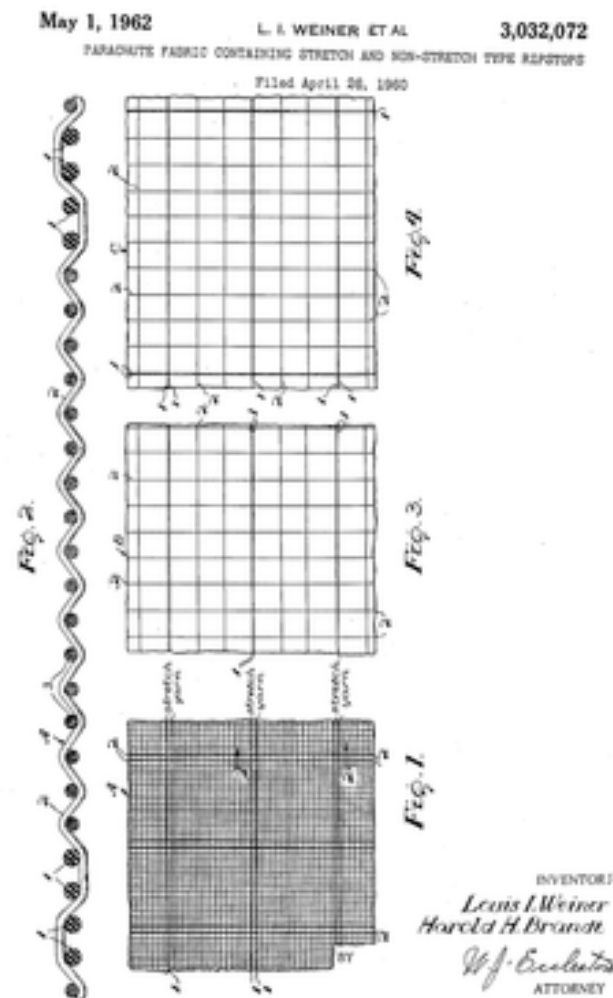
However, in April of 1960, inventors Louis Weiner and Harold H. Brandt filed a patent with the U.S. Patent and Trademark Office titling their filing as “Parachute Fabric Containing Stretch and Non-Stretch Type Ripstops.” Since, the weaving technique has been used globally by many militaries and also has commercial applications. Many hot air balloons, recreational camping tents and clothing use the ripstop weave [2].

Scientists and engineers experimented with different weaving techniques and materials to create a fabric that could resist tearing and ripping, while still being lightweight and strong. They developed a unique grid-like weave pattern using thicker threads, which provided the fabric with its signature tear-resistant quality [1].

Exploring the structure of ripstop helps us better understand this fabric.

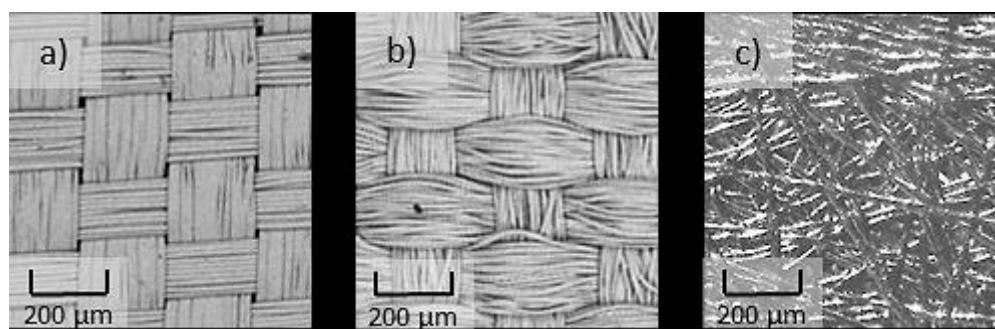
Like many common fabrics, ripstop has two distinct planes or dimensions: horizontal and vertical.

Technically, ripstop is what the textile industry refers to as a “plainweaver”. But it’s more accurate to say that ripstop employs a special variant of plainweaving construction. This construction entails “simple” up and down alternating cross-hatches always intertwined with two fibres.



Source: [2].

Рис. 1. The weaving technique of ripstop



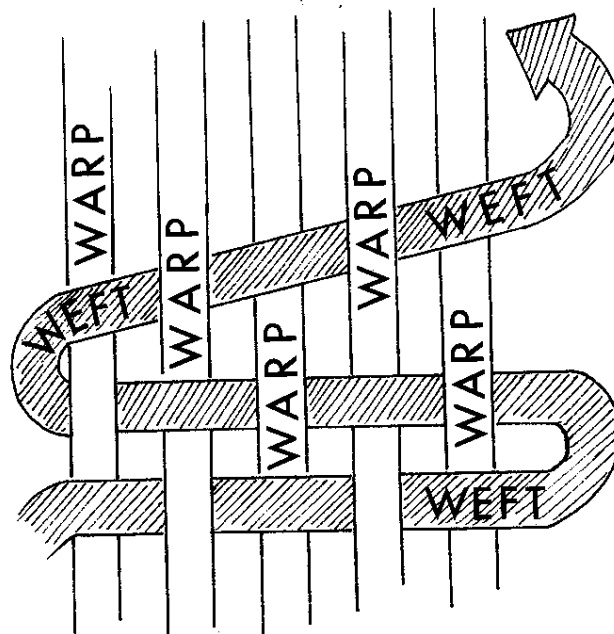
Source: [9].

Рис. 2. Microscope images of three fabrics: ripstop (a), plain weave (b) and nonwoven (c)

The image above demonstrates this construction and compares it to two others. If you were to examine under a microscope a piece of ripstop, you'd immediately notice the crisp lines and uniform spacing of the construction. Then, if you viewed a piece of material from a regular t-shirt, you'd see a significantly less crispness and uniformity.

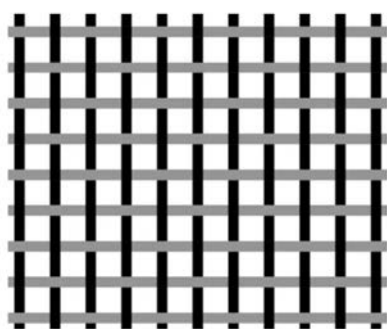
The structure of a fabric is also impacted by its warp and weft. Think of warp as the fabric fill-in while the weft is the yarn woven in between. The image below makes that a bit more comprehensible.

One other very important structural characteristic of ripstop is the thing that allows it to stop rips. That thing is its yarn thickness (which also happens to correlate with weave technique). In a ripstop fabric, thicker yarn is placed at intervals of 5 mm to 8mm (or 0.2 to 0.3 inches).

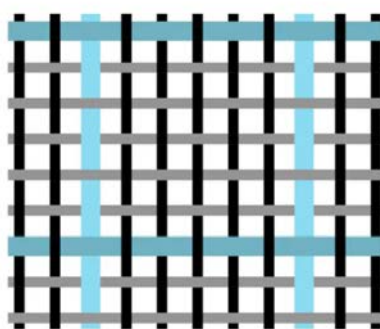


Source: [10].

Рис. 3. The structure of a fabric



Typical fabric weave



Ripstop fabric weave

Source: [11].

Рис. 4. The difference between typical and ripstop fabric weave

In the illustration above, the thicker yarn (depicted in blue) serves as a reinforcing thread – or rib – that’s much higher in tensile strength than the threads adjacent it. These ribs increase the fabric’s tear-propagation resistance strength.

(For the record, we at UF PRO use double these yarns in order to even further increase the ability to stop tears from spreading).

Higher strength (and greater durability) is also achievable by more closely spacing the construction of the main pattern. However, this denser construction also increases the weight of the fabric.

One caveat we always keep in mind is that the structure doesn’t reveal much about the base fibres of the yarns used. Indeed, NyCo ripstop nomenclature can mean different things in different scenarios.

Let's look at an example of NyCo ripstop to see how this can play out.

The fact that you have NYCO (nylon-cotton blend) ripstop tells you about the structure, but nothing about the nylon's denier nor about the cotton's quality – both of which significantly affect the performance of the final product [3].

In modern warfare, the demand for lightweight, durable materials is paramount. Ripstop fabric, known for its unique weave that prevents tearing and ripping, presents significant potential for military applications. However, challenges such as production scalability, cost-effectiveness, and adaptability to diverse environments hinder its widespread adoption.

Recent studies have highlighted ripstop fabric's advantages in various military applications, including tents, uniforms, and gear. Research indicates that advancements in synthetic fibers and weaving techniques have enhanced ripstop's properties, making it more suitable for extreme conditions. However, limited research addresses its performance in diverse wartime scenarios, such as urban warfare and extreme climates.

Despite the promising attributes of ripstop fabric, several unresolved issues remain, including:

- Limited understanding of long-term durability under combat conditions.
- Insufficient exploration of cost-effective production methods.
- Lack of comprehensive studies on the environmental impact of ripstop manufacturing.

Statement of the Task. The purpose of this research is to evaluate the current status of ripstop fabric innovations in military applications and to identify the challenges that must be addressed to enhance its effectiveness and usability during the wartime.

Research Results. Ripstop is widely used in military and law enforcement applications due to its exceptional strength and durability. Uniforms made from Ripstop are designed to withstand extreme conditions and harsh environments, while providing optimal protection to soldiers and agents. Ripstop backpacks and other tactical gear are also popular because they can handle heavy loads and resist wear and tear well. For example, Ripstop body armor is able to protect officers while remaining lightweight and flexible, which is crucial for field interventions. Additionally, Ripstop can be treated to provide additional properties, such as waterproofing or flame resistance, making this fabric indispensable for field operations [6]. The material used in ripstop fabric can significantly impact its properties, such as strength, durability, water resistance, and breathability. Here, we'll explore the most common materials used in ripstop fabric:

Nylon Ripstop: Nylon is a synthetic polymer known for its strength, durability, and lightweight nature. Nylon ripstop fabric is highly resistant to abrasion and tears, making it ideal for applications where durability is a priority. Additionally, nylon is inherently water-resistant, although it can be further treated to enhance this property.

Polyester Ripstop: Polyester, another synthetic polymer, is also used in ripstop fabric production. Polyester ripstop fabric offers excellent water and UV resistance, making it a popular choice for outdoor applications exposed to the elements. It is also highly resistant to wrinkles, mildew, and abrasion. However, it may not be as breathable as some other materials.

Cotton Ripstop: Cotton, a natural fiber, can also be used in ripstop fabric production. Cotton ripstop fabric is more breathable than its synthetic counterparts, providing a comfortable and natural feel. While it may not be as strong or durable as nylon or polyester ripstop, it still offers a decent level of tear resistance due to its reinforced weave pattern.

Other Materials: Apart from the materials mentioned above, ripstop fabric can also be made from other materials like polypropylene, polyethylene, and even high-performance fibers like Kevlar and Dyneema. These materials can offer additional properties, such as increased strength, chemical resistance, or heat resistance, depending on the specific application [1].

The analysis of ripstop fabric reveals several key findings:

Material Properties: Ripstop fabric stands out among other fabrics because of its strength and durability. From the name itself, the fabric is rip-resistant. It is commonly used in outdoor gear and military gear that require resistance to tear.

The fabric was first used for military purposes. It was used in parachutes during World War II. Parachutes made of traditional fabrics were prone to tearing. This posed significant risks for soldiers in combat situations. The ripstop fabric became a solution to this problem.

The advancements in technology have further enhanced the properties of the fabric [1].

The ripstop fabric has its own advantages and disadvantages. Below are the key points that you should consider:

Advantages.

Tear resistant.

Lightweight quality despite its strength.

Excellent moisture-wicking properties.

Highly versatile.

Disadvantages.

Limited stretch.

Rustling or crinkling sound when in motion (undesirable in situations where silence or discretion are important).

Not waterproof.

Limited airflow [4].

It is important to note that ripstop itself is not water-repellent or waterproof, but steps can be taken to make them so thanks to lamination and other techniques.

Ripstop fabric is inexpensive for the amount of protection it provides. It is strong, durable, and is the kind of high-performance fabric you need in the most crucial situations [8].

Ripstop fabrics are designed to be tear-resistant yet maintain a lightweight quality, making them suitable for applications where strength is needed without excessive weight.

Research into electroconductive ripstop fabric demonstrates its capacity to endure lightning currents, highlighting its potential in outdoor lightning protection systems.

While ripstop fabrics are not inherently waterproof, they can be treated to improve water resistance.

Some ripstop fabrics are also treated with UV-resistant coatings to protect against sunlight damage.

Ripstop fabrics, especially those made from natural fibers like cotton, offer breathability, making them comfortable for wear in various conditions [7].

Conclusions. Ripstop fabric represents a significant innovation in military materials, offering advantages in terms of durability and weight. The ripstop fabric has a good balance of functionality and durability. However, addressing the challenges of manufacturing scalability, cost-effectiveness, and environmental impact is essential for its broader implementation in the wartime. Future research should focus on optimizing production methods and exploring sustainable alternatives.

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