The Good, The Bad, and The Ugly: Steel Mesh
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With the recent incorporation of steel mesh materials into protective safety gloves, many manufacturers and distributors of PPE are touting the potential for strong cut and puncture resistance. Often being overlooked in this new technology are the other factors by which a protective glove is judged: comfort, dexterity, durability, and comprehensiveness of protection.¹

This document serves to provide an in-depth look into the fundamental properties of steel mesh; specifically how it would function when used in hand protection.

The Issues

It is important to note that while steel mesh has demonstrated a high level of cut and puncture resistance when it is incorporated in protective gloves, many other factors come into play when utilizing these gloves — most of which go unaddressed by PPE manufacturers. For example, PPE is often misused or rejected if it cannot meet the specific comfort demands of the wearer. Furthermore, when purchasing PPE, it is important to accurately weigh the durability and life cycle of a particular protective item against its cost. A safety manager must also be confident that PPE will not cause additional problems for the user.

Metal Fatigue and Structural Integrity

The issue with steel mesh being used as a component in hand protection is the rapid speed at which metal fundamentally breaks down. Over a period of time, metals in any form, when subjected to repeated and cyclical stressors, begin to experience structural fatigue.² When placed inside of a glove, the structural fatigue to steel mesh can lead to a number of shortcomings in PPE, such as:

- An accumulation of folding or bunching of material in critical areas
- Creases and tears in the steel mesh protective layer
- A reduction of the protective properties of the steel mesh layer
- Splintering and flaking of metal

As a result of these shortcomings, PPE that utilizes steel mesh as a fabric, especially as the primary source of its protective properties, is subject to the same properties as the steel mesh. If incorporated into protective gloves the user will see a rapid breakdown of the interior layers, including creasing and tearing, eventually resulting in PPE that is both uncomfortable and unsafe, and ultimately unfit for protection. Additionally, these issues may not be visible from the outside of the glove, as the breakdown has occurred on the interior side.

Testing to Identify the Issue

Several tests have been conducted on the steel materials that are currently being made into PPE gloves. The ASTM 6182 Bally Flex Test is the industry standard test used to determine whether the materials are vulnerable to cracking and other damage when flexed during use, and to determine the durability of fabrics when subject to a flexing load.
The results of the ASTM 6182 Bally Flex Test show that the steel mesh fabric, as found in products like Alycore®, failed at 500, 665, 1200, and 2,268 cycles at room temperature. This demonstrates that the steel mesh material could only be flexed, at the best, up to 2,268 times before reaching structural fatigue or failure.

This information can be used to infer the durability of any form of protective equipment that utilizes steel mesh. For example, if an employee were assigned a task, such as a waste or recycle sorting line, which required them to flex their palm and/or fingers well over 20 times per 1 minute, that employee would reach 2,268 cycles (the maximum number of cycles achieved in the testing) in 113.4 minutes, or just under two hours.

The vulnerability of steel mesh to break down rapidly is comparable to that of fiberglass fabrics. Due to the rigid makeup of glass fibers, fabrics composed of these fibers are subject to the same rigidity, and thus have a tendency to fail quickly when flexed repeatedly. Likewise, steel, as a material, is rigid in its composition, and gloves constructed of these steel fibers will share the same rigidity and the same tendency to fail under repeated flexing.

Additionally, it is important to keep in mind that the above test results were conducted with a uniform cycle and with no added stressors. If incorporated into a glove, steel mesh will be subjected to non-uniform flexing patterns, as well as added natural stress. An employee wearing a steel mesh protective glove will undoubtedly flex their hand and/or fingers in varying patterns of motion, increasing the uncertainty as to the failure point of their PPE. Furthermore, users of hand protection will oftentimes subject their gloves to the forces of a weighted load. The combination of these “field elements” may lead to compounded wear and tear on the glove; creases and folds will begin to form around joints and pivot areas, tears will start in critical sections of the hand, and the cut and puncture protection will be diminished in the areas that need it the most.

**Fraying Along the Edges**
Because the protection is comprised of a varying number of layers of a fine mesh screen, the layers of protection will begin to fray at the edges, causing a potential hazard for the wearer. This fraying occurs even prior to the first usage of the gloves. This fraying will create sharp, serrated edges on the materials, which could begin wearing the PPE out from the inside. Not only do frayed edges often lead to tears within the material, but users will have the added risk of skin irritation due to the frequent contact with the frayed steel wires.

**Folding and Material Memory**
As discussed prior, any materials made of metal have a natural tendency to retain folds and creases. Because of the amount of motion of a hand this becomes a significant problem with steel mesh materials. Continued use causes the creation of folds and creases within the structure of the glove. These folds cause two issues. First, they make the gloves uncomfortable to wear as ripples form under areas where the glove is flexing. Second, these memory folds work to make the glove smaller and tighter over time, with no ability to stretch out.
Electrical Conductivity

When selecting PPE, it is always important to consider the applications for which it will be used. It becomes especially so in the case of steel mesh PPE, due to the nature of metal and its ability to conduct electrical charges through its surface. In any application that may potentially encounter offset or stray electrical charges, steel mesh PPE will serve to increase the hazard of an accidental shock to the wearer. This type of PPE is not recommended for any use with the potential of stray currents.

Particulates and Splinters

As a result of the rapid breakdown of steel mesh, users may find the remnants, or particulates, of the material on their skin and within the actual lining of the glove. These particulates can be nearly microscopic in size and unnoticeable to the user, which potentially leads to contact with the mouth, face, or eyes, at which point these steel particulates become serious health risks. Prolonged and consistent skin contact with these particulates can lead to rash, dermatitis or infection on the hands and arms. Additionally, the small slivers of the material that break off can easily work their way into the hand, wrist and arm of the user. During field testing, users showed small slivers visible beneath the skin surface, which proved extremely difficult to remove by regular means. Additionally, a worker rubbed his eye after wearing a glove, transferring a metal shaving into his eye. These slivers are not only a discomfort, but also compromise the integrity of the skin, allowing bacteria or other harmful elements to enter the body. This severely limits the applications of this type of PPE.

The Bottom Line

While steel mesh technologies such as Alycore® show promise in lab testing for cut and fine puncture, they are not a suitable solution for use within hand and arm PPE. The material has too many fundamental problems to be a trusted solution when worker’s safety is involved.

Due to the inherent protective properties of steel mesh, its use in PPE should not be overlooked. Until such technologies are perfected, evaluators and purchasers of hand and arm PPE should invest in alternative protective materials. Many different gloves and arm guards are able to provide the necessary level of cut, puncture, and needle resistance, without the negative qualities found in steel mesh. It should be noted that a single layer of steel mesh, as compared to a single layer of any other product, has not shown industry-leading cut or puncture characteristics by means of any test. Safety managers are encouraged to evaluate the specific application of their hand and arm PPE, and the necessary levels of protection, effectively avoiding the dangers generated by steel mesh PPE products.

The HexArmor® Solution

Since its creation, HexArmor® has sought to be the trusted advisor in the safety glove industry. By this mission, HexArmor® tested and reviewed steel mesh technology, as an option to provide cut and puncture protection for which the brand name is known. As it stands, HexArmor® deems the safety risks involved with steel mesh PPE too great, at this time, to release a protective glove for use by our clients.
SuperFabric® technology has delivered the industry's highest cut, puncture, and needle resistance since its incorporation, with absolutely none of the issues faced by steel mesh products such as Alycore®, and has a proven track record of tens of millions hours of use. SuperFabric® brand material is a HexArmor® exclusively licensed solution for the Industrial PPE Market.

- SuperFabric® has withstood the ASTM 6182 Bally Test up to 1,000,000 cycles, at -20°C, with no reported wear or tear
- HexArmor® products are available in varying levels of protection, many with ANSI/ISEA levels A5 to A9 and CE level 5 puncture protection

HexArmor® has become an industry leader in hand protection for a reason beyond top-quality products; we work in cooperation with safety professionals in a never-ending effort to provide the most complete protection for any given hazard, application, or task. We believe collaborative solution development is our competitive advantage. We encourage all safety managers, regardless of their industry or application, to consult one of our qualified Solution Specialists.

Let's begin solving problems together.