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SECTION 25. Technologies of materials for the light and textile industry.

ANTISLIP RELIEF OF RUNNING SOLE'S SURFACE

Abstract: *The relief of running sole's surface with high antislip properties was considered. The relief consists from well-known antislipping elements and the elements have been developed by authors. These elements are particularly arranged and placed at the running surface to provide increased antislip properties of soles. The experiments proved high antislip properties of running soles surface were carried out.*

Key words: *running surface, antislip elements, antislip properties, breaking effect, coefficient of sliding friction, ground surface, supporting surface, bump and potholes of the ground.*

Language: *English*

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Introduction

To prevent the falling of a person walking on the slippery surface various of removable [1-3] and fixed [4-5] footwear devices have been developed and are being improved.

However their application for casual shoes is limited because the removable devices have to be put on the footwear and then take to be taken off (for example, when entering the room). As for fixed devices user should activate or deactivate them when needed. Therefore, it is reasonable to develop the appropriate relief of running sole surface with antislip properties for casual winter footwear. There are relatively few such running sole's surface structures [6], besides their antislip properties are insufficient.

At this paper we consider the running sole's surface, consisting of well-known antislipping elements and the elements have been developed by authors. These elements are particularly arranged and placed at the running surface to provide increased antislip properties of soles [7]. The figure shows one of the following anti-slip running sole's relief. Many casual (as well as sports and touristic) winter footwear soles have so-called protectors, with small corrugated supporting surface. At the proposed design of antislip relief the protectors form closed cuvettes 1, divided by grooves 4. The cuvettes can have different dimensions and shape that determine the design of running surface relief. The round rods 11 with a diameter 1.5-2.0 mm were arranged in staggered order in the cuvettes and were made flush with the supporting protectors surface (see figure a,b).

The groups of cuvettes are framed by borders 2 and 3 separated by grooves 5 and 6 at the toe and waist parts as well as the border of the heel. The surface of the small corrugated borders at the toe and heel parts is extended and there are crescent-shaped hollows 7 and 8 in this area. At the same time the sides of the protectors, borders and hollows have V-shaped grooves 10, 12, 13, 14 and 15 (see figure b, c).

Let's consider the antislip properties of these elements of the running soles reliefs. First of all, it should be noted that the surface of pavements and roads (asphalt, paving tile, etc.) have bump and potholes. They can be both large enough (height of the protrusion, h > 1,0 mm) and small (h<1,0 mm), and the number of small protrusions significantly greater than larges one [8] on any surface.

The breaking effect of the soles protectors is well-known from the walking process on the slippery supporting bearing surface. It is less known that the effectiveness of protector breaking actions significantly depends on the height of ground protrusion. The experiments have shown that large ground protrusions cause significant breaking effect due to the engaging edge and corrugated protector surface when samples of running sole's surface slip on the ground. Small protrusions practically don't interact with protectors and their multiplicity reduces the real contact area of the running surface with ground. As a result, small protrusions in a contact with protectors cause a little breaking effect on don't have it at all [9].

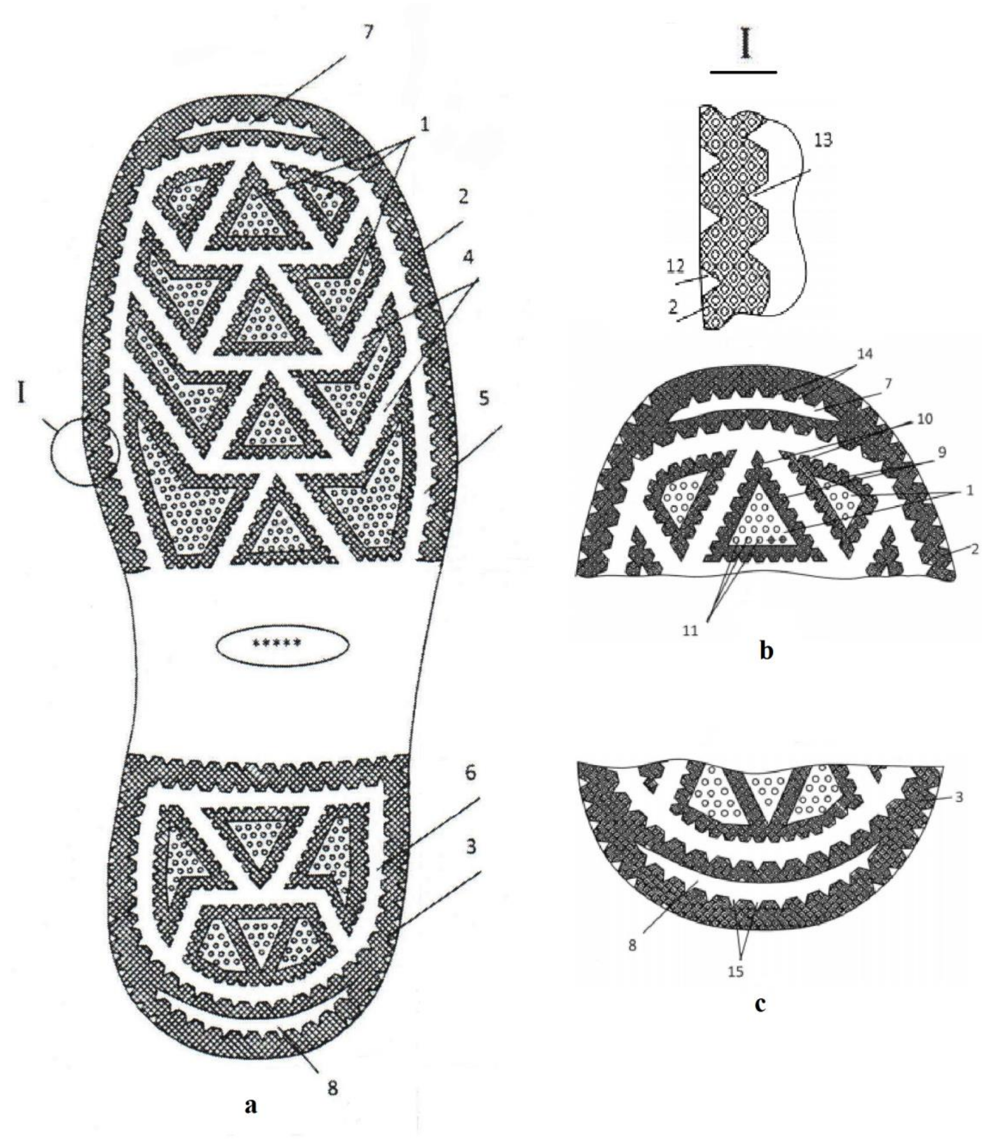

Figure 1 - Running surface of the soles.
a – general view; I– border; b, c - fragments of relief in the toe and heel portions, respectively.

In order to increase the breaking action of the numerous small protrusion we have suggested to perform flexible bars on the running sole surface. The bars can engage with large and small protrusions. These antislip elements are to be arranged in staggered order (see figure) to increase probability of engagement with ground protrusions.

A distinctive feature of the suggested running surface relief structure is the presence of crescent-shaped hollows 7 and 8, V-shaped grooves on the side of borders 2 and 3, protectors 9 and aforementioned hollows at the toe and heel parts (see figure b,c) . The purpose of the grooves is "jamming" of the engaged supporting surface protrusions that leads to a high increase of breaking effects. Figuratively speaking, hollows are the traps for the protrusions of ground surface and they are capable to prevent or reduce the effect of sliding soles while walking on slippery ground.

During the walk on the slippery surface, including ice-covered, footwear slip is possible in any directions and at any phase of the step. However it is the most dangerous and lead to the fall at the first and final phases of step. At the first phase (the phase of making step at the back side of the heel) the sliding of footwear is more likely towards to the direction of movement and at the final step (the phase of pushing off and lifting the sole toe part off the bearing surface) – in the opposite direction [10]. Therefore to create conditions for “jamming” of the protrusions supporting surface the points of the V-shaped grooves, located in the crescent-shaped hollows 8 are directed to the edge of the heel but in the crescent- shaped hollows 7 they are directed to the front of the sole (see figure). As regards to the grooves on the sides of the protectors and borders they are arranged in different directions. Nevertheless their significant part is focused for prevention of slipping sole along the movement’s direction.

Let’s note two additional features of the relief element arrangement to increase the antislipping sole properties.

The first feature regards to the cuvettes form and their arrangement on the running surface. This aspect due to the availiability large-scale order protrusions (h>>1.0 mm) on the support surface. They are in contact with soles will most likely turn out into cuvettes while deforming the flexible rods. When sliding of the sole such protrusions run into the side of cuvettes and are able to “jamming” in it. To increase of “jamming” protrusions the sharp corners of cuvettes are located into the toe part and they are directed mainly to the front edge of the sole. The sharp corners of the heel parts cuvettes – to the falling edge of the heel. The arrangement of the cuvettes increases breaking effects for running sole surface at the first and final steps by walking on the ground with large protrusions.

The second features of the antislip elements arrangement apply to the hollows configuration between cuvette’s walls. During sliding soles on the support surface in any directions the comparatives shift of the ground protrusions along the hollows are limited the rectilinear length parts of the hollows. Let’s explain, that this distance is limited bi size of the sides cuvettes (see Figure). Therefore during sliding sole the relative moment of the ground protrusions are likely only a rectilinear part of the hollows, and further they run into the protectors or borders. They are able to get into the grooves. It is increase common breaking effects of the running surface.

The estimate of the breaking effects considering elements of antislip running surface are carried out according to the GOST 12.4.083 – 80. The samples of the thermoelastomer soles with dimensions 50x50x10 mm were made. There were four kind of samples: the samples with rectangular cuvettes, the samples with the same cuvettes with a bars inside them, smooth samples with grooves on the flank and smooth without antislip elements (reference samples). The experiments were carried out by means of updated laboratory bench, equipped thermostatic cell for provision with negative temperature and with sliding friction force recording attachment [11]. At the same time the sliding frictions coefficients of the mentioned sample groups on the ice-covered surface of asphalt, paving tile and on the ice at the temperature of -10...-12 C were determined. The experiment’s result are presented in the table.

Table 1

The coefficient of sliding friction for the saples of the running sole’s surface on the supporting surface.

Sliding surface	Coefficient of sliding friction		
	on ice-covering surface		on ice
	asphalt	paving tile	
Smooth (without antislip elements)	0,130	0,115	0,073
Smooth with grooves on the flank	0,164 (26,2)*	0,138 (20,0)*	0,082 (12,3)*
With protectors making cuvettes (without protrusions)	0,183 (40,8)*	0,145 (26,1)*	0,096 (31,5)*
With protectors and protrusions inside cuvettes	0,238 (30,1)**	0,176 (21,4)**	0,116 (20,8)**

Note: *The percentage shows the increacing factor over factor for samples with smooth supporting surface (*) and comprising protectors without protrusions (**).*

Out of the table it’s follows that examined anti-slip elements have considerably breaking effects for sliding soles on support surface. At the same time combined breaking effects of running sole’s surface numerous elements make sure to considerable antislip effects when walking on slippery surfaces.

LLC “Obuv Rossii” (Novosibirsk) manufactured a lot of soles with presented running surface relief for winter man’s shoes. Experimental using were organized and all users noted perfect antislip charactericties of the using shoes.

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