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Verification method of material stability of fire-resistant slings for holding and positioning against an open flame

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Verification method of material stability of fire-resistant slings for holding and positioning against an open flame

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Abstract. In the introduction of this work, the problem of the lack of test methods for personal protective equipment against falls from a height (hereinafter PPE), used in the areas associated with direct contact of PPE components with sources of elevated temperatures, is disclosed. The experience of the fire sector was adopted with fire tests for the impact of materials used in the production of PPE products in contact with an open flame. A number of tests were carried out on refractory slings for holding and positioning and the results obtained with a positive approbation of the method. The purpose of this work is to improving overall safety when working at height, to identify weak zones of protection of components of safety systems from various external factors that negatively affect them. Work was carried out and conclusions have been drawn about the application of this method on refractory slings for holding and positioning. One of the important requirements of customers of these slings in production is the resistance of materials of safety systems to the interaction of components in an environment of high temperatures. The conclusion of this work is the relevance of the application of this technique to the PPE sector, in particular to refractory slings for holding and positioning.

1. Introduction

The need to introduce and test new techniques for personal protective equipment against falls from a height [1-4] is due to a very wide range of application of high-rise work [5-9] at construction sites, production, maintenance and inspection of high-rise buildings and work with the use of potentially dangerous equipment or in conditions where the manufacturing sector is directly related to the location of the user near sources, low or high temperatures.

In this work, a number of test tests were carried out on refractory slings for holding [10-12], taking into account the requirements and using the methodology of clause 9.9 of "GOST R 53268-2009 Fire fighting equipment. Fire rescue belts General technical requirements. Test methods ". This method simulates a situation when a situation of contact with hazardous thermal factors may arise when the user works in areas associated with direct contact with heat sources. For example, on construction sites, a waterproofing carpet is laid using thermal heating of a roll material (roofing material). For each test required by the method, three samples are required. This approach minimizes test errors and increases the reliability of the values obtained, so the objectivity of the results obtained increases. The necessity and pedantry of this approach instills a culture of laboratory testing, research and the reliability of the results obtained, and this increases the safety when the user works at height [13-18]. Below, we consider the adaptive requirement and test test methodology.

The purpose of this work: improving safety when working at height in potentially hazardous sectors of industry, construction and other types of work, where increased protection of safety components during work with gas and electric welding is necessary, as well as the stability of materials of components interacting near sources of elevated temperatures.

The task of this work: application and approbation of the technique from clause 9.9 "GOST R 53268-2009 Fire fighting equipment. Fire rescue belts" on fireproof slings for holding and positioning.

2. Materials and methods

2.1. Requirements:

The duration of the residual combustion and smoldering of the material of the refractory sling for holding and positioning should not exceed 2 seconds after exposure to it for at least 15 seconds with an open flame, and the value of the breaking force after exposure to an open flame will be at least 7.5 kN.

2.2. Method for testing the resistance of the material of a refractory retention and positioning lanyard to an open flame

The static breaking load of a refractory sling for holding and positioning, after exposure to it for at least 30 seconds with a metal rod heated to a temperature of (450 ± 10) ° C, should be at least 7.5 kN.

2.2.1. Test object.

- Fire-resistant positioning lanyard with length adjuster, code 001;

Minimum static strength - 15 kN;
The sample is made of aramid material;
Sling diameter 16 mm.

- Double fire-resistant lanyard for holding, with code 002;

Minimum static strength - 15 kN;
The sample is made of aramid material;
Sling diameter 16 mm.

2.2.2. Sampling

The test is carried out on three specimens of a refractory lanyard.

2.2.3. Test equipment:

a) a metal ruler with a graduation of 1 mm;
b) stopwatch with an error of no more than 1.8 seconds in 60 minutes;
c) ethyl alcohol in accordance with GOST 18300 or GOST 17299;
d) a cylindrical container for fuel with a diameter of 61 mm;
e) a tensile testing machine - must ensure the measurement of force with a relative error of not more than 1%, the minimum distance between the clamps is 300 mm. Moving clamp movement speed no more than 200 mm / min.

2.2.4. Testing

A sample of a refractory lanyard is mounted on a fire test fixture in accordance with Figure 1.

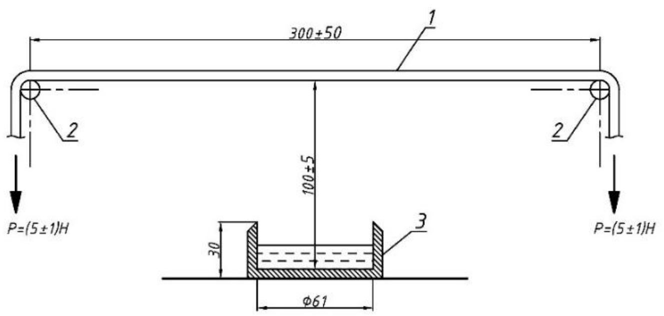

Figure 1. Schematic of open flame testing of a refractory sling. 1 - sling sample; 2 - supports; 3 - container for fuel; P-weight (510 ± 10) g.

3. Results and discussion

This method reflects a direct relationship and simulates the contact of the safety system components at height, with a direct source of thermal contact - an open flame. As required by the method, it is necessary to place a test piece 100 mm above a container which was filled with ethyl alcohol. Next, the ethyl alcohol is ignited and the sample is kept for 15 seconds. The self-ignition temperature of ethyl alcohol is 400 °C. After holding the sample over an open flame, according to the requirement, the sample should withstand a static test of 7.5 kN.

The specimen is placed between two supports spaced 300 ± 50 mm apart (see Figure 2-3).

A weight P weighing (510 ± 10) g is applied to each edge of the sample. The sample is positioned at a distance of (100 ± 5) mm above the container, which is filled with ethyl alcohol in an amount of (10 ± 1) ml at a temperature of (20 ± 5) ° C.

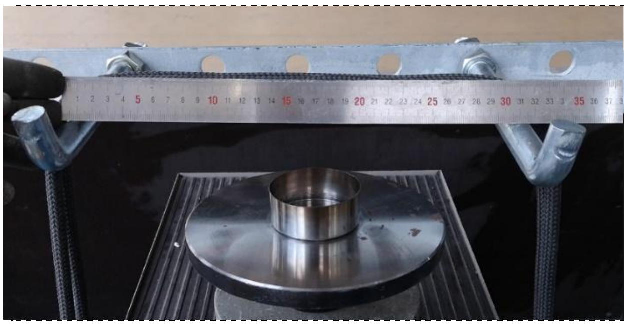

Figure 2. Measurement of the distance between the stand supports.

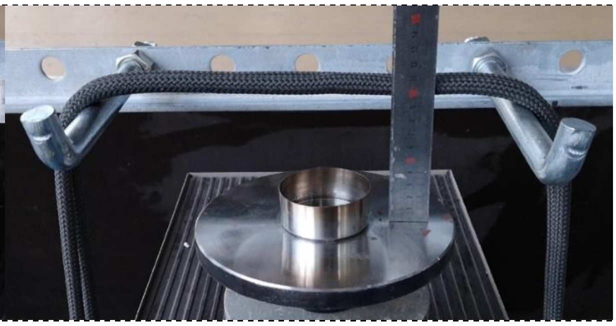

Figure 3. Measurement of the distance from the test piece to the base of the container.

The ethyl alcohol is ignited, and the sample is kept under the influence of an open flame for at least 15 s. (see Figure 4).

Figure 4. Exposure of a test specimen to an open flame.

This procedure is repeated with the rest of the samples. Then, alternate loading of three samples is carried out until destruction according to the schemes indicated in Figures 5-6.

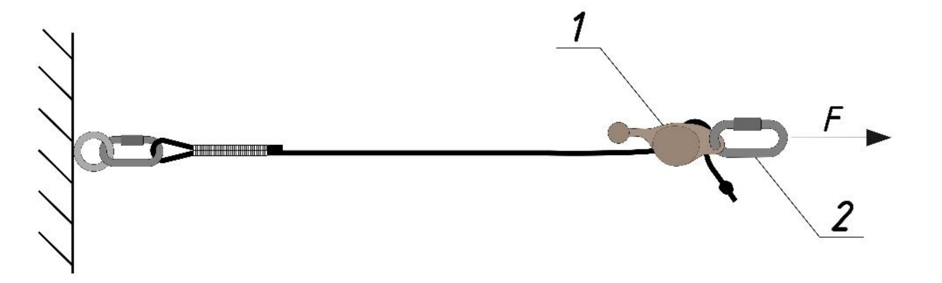

Figure 5. Schematic of static load testing of a sling with a length adjuster. 1 - length control element; 2 - connecting element; F - static load.

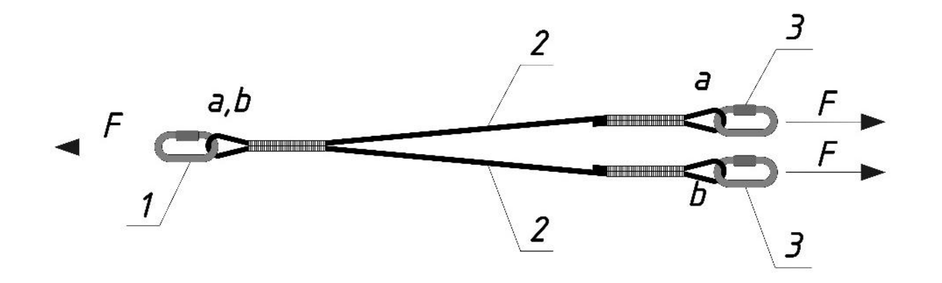

Figure 6. G Schematic of a static load test for a holding sling. 1,3 - end connection of the sling; 2 - free ends of a two-shoulder sling; a - connection points for test 1 (between a and a); b - connection points for test 2 (between b and b); F - static load.

The breaking force after the open flame (Table 1-2).

Table 1. Refractory positioning lanyard with length adjuster, code 001.

№ sample	The breaking force, kN
1	15.52 kN
2	15.78 kN
3	15.21 kN

Table 2. Double refractory lanyard for holding, with code 002.

№ sample	The breaking force, kN
1	22.42 kN
2	23.01 kN
3	22.45 kN

You can familiarize yourself with the original methodology and requirements in GOST R 53268-2009 Fire fighting equipment. Fire rescue belts General technical requirements. Test methods".

4. Summary

If we consider the work done, we will conclude that the trend of movement and the development of personal protection testing methods affects the general culture of working at height, in combination, increasing its safety. A highly specialized sector of work at height directly related to the hazards encountered in the construction, industrial, and defense industries, where the direct contact of PPE components with an open flame is a dangerous factor. At the moment, there is the urgency of the problems associated with the high-altitude sector with the contact of components of safety systems with an environment with high and ultra-low temperatures. This method of checking the resistance of a material to an open flame was tested on refractory slings for holding and positioning and has shown its efficiency and correctness of the results obtained. When finalizing and testing the technique, it is possible to extend it to other personal protective equipment against falls from a height that are in contact in the immediate environment, near sources of high temperatures, which can affect the integrity and structure of PPE materials. The main reason of accidents on construction sites is the fall of users and objects from a height. These reasons are an integral part of work, research and testing of new techniques. Only when working in dialogue with building complexes, factories, and areas where high-rise work is used, can the level of overall integrated safety be increased. Development, testing, borrowed experience from other areas and implementation in regulatory documents will reduce the percentage of accidents when working at height. The ultimate goal of our work is a well-built working system to ensure safety when working at height, which is responsible for the safety of each employee performing work at height.

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