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PARAMETRIC SERIES OF NON-METALLIC FLEXIBLE LOAD-HANDLING DEVICES

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Abstract
The article presents the positive qualities of non-metallic round-row slings that are used in rigging work. Thanks to the development of the production of high-strength synthetic fibres, the use of textile slings has become available for both large factories and small enterprises. Currently, textile slings are becoming more and more popular load-grabbing devices. The lightness, flexibility and high load capacity of this type of sling allow you to solve many tasks in the field of lifting and moving cargo, which until recently were considered impossible. In some cases, they are the only possible device for strapping and strapping cargo. To a greater extent, this applies to goods that need careful handling.

Keywords: rigging works, lifting devices, textile sling, synthetic fibres, rope properties, rope elongation, empirical parameters, twisted ropes.

Introduction

When mounting and storing prefabricated elements of multi-storey industrial and civil buildings, multi-branch load-handling devices are used, of which universal and special rope slings equipped with sling hooks are the most widely used [1]. This standard applies to cargo rope slings, consisting of connecting elements (rope branches, links) and grippers (hooks, carabiners) and used in construction for slinging cargo.

The widespread introduction of slings with non-metallic branches (NMB) in our country and abroad contributes to the improvement of the culture of rigging work [2-4].

In Russia, NMB-based slings are made in accordance with the requirements of RD 24-СЗК-01-01 “General-purpose cargo slings on a textile basis” from tapes of their production or imported [5]. Popular textile slings "Sevkanat", GUMP "Research Institute of Parachuting", Inka Ou (Finland), Certex (USA), SpanSet, Industrial Products, Gehontund Hebetechnik, CarlStahl GmbH, Geron (Germany), LANEXCZ, Spol. Sro (Czech Republic), Lemmens (Holland), etc. [6]. However, to reduce their cost, many companies sew slings with a carrying capacity of 0.5 ÷ 20 tons in their workshops. from SVM of foreign production. Among such companies are the Moscow LLC NPP Polypron and the Oryol production division of the holding CJSC Promstal. They produce all types of these products with a carrying capacity of up to 15 tons. and up to 20 m long made of polyester and polyamide [7, 8].

In the last decade, branches of slings made of steel ropes are mainly used in Uzbekistan, they make up 98% of the total number of all used slings. And in Russia, this figure is 70%, while in Germany, their share during this time is sharply reduced and amounts to 30%. Today in Germany, steel rope slings are practically not found anywhere (chain slings are used), the use of textile slings is increasing here every year [9-12]. This is also proved by the many manufacturers of textile slings in Germany, listed in the text above.

It is not recommended to use slings to work with loads weighing more than the declared load capacity for slings. The safety factor is necessary to prevent damage or breakage of the sling under the influence of a dynamic load, which can exceed the static load by several times (for example, when one of the branches of a multi-branch sling is abruptly lifted or broken). With a sufficiently long operation of the sling, fatigue of the material from which they are made accumulates - this is a consequence of repeated repetition of lifting and transport operations, leading to gradual loosening of the material, the appearance of cracks and crumples at the points of contact of the sling with the load. Non-metallic slings are more likely to be damaged by third-party objects or cargo elements, while their destruction occurs gradually, which makes it possible to detect damage at an earlier stage. Therefore, the safety margin of the slings should be sufficient for early detection of material failure and safe descent of the load, in case the destruction began when the load was lifted [13-15].

Methods

When working with loads weighing more than the carrying capacity of the slings, we reduce the service life of the slings by several times and increase the likelihood of their destruction and breakage. The selection of slings must be made by taking into account the mass and dimensions of the load being lifted, as well as taking into account the method of slinging. Do not use slings that are excessively long and with an excessive carrying capacity due to inconvenience when lifting, transporting and lowering the load.

Flexible, light, safe HMB can largely replace steel rope slings. Now the question of a possible parametric series of NMBs used instead of steel ones is relevant [16-18].

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When choosing a parametric series, one should take into account the influence on the choice of the following factors:

- Repeatability of mounting elements of the same weight group;
- The possibility of forming the design of slings from existing unified elements and the feasibility of developing new elements;
- Economic efficiency of using a limited number of standard sizes of slings.
- We will consider one of these factors.

Results

The transition to LMW in a multi-branch load-handling device requires checking the suitability for LMW of all unified elements (thimbles, hooks and other links), as well as analysing the entire structure of the load-handling device for possible excess weight.

Below are the results of comparing the parameters of steel and non-metallic elements of slings and unified links. The initial data are taken in accordance with GOST 25573-82 "Cargo rope slings for construction", GOST 30055-93 "Ropes made of polymeric materials and combined. Specifications". Advertising brochures of foreign and domestic firms specializing in the production of non-metallic slings were used [19-22].

Table 1. Results of the analysis of the parameters of the branches of metal and synthetic ropes

No. p/n	admit May load, kg.	Branches of steel ropes					Branches from non-metallic ropes					Hooks		Weight of one 3m branch, kg	
		rope Ø, mm	Ø thimble, mm	Thimble weight, kg	Hook hole Ø, mm	Hook weight, kg.	rope Ø, mm	Ø thimble, mm	Thimble weight, kg	Hook hole Ø, mm	Hook weight, kg.	Size Requirements	Load capacity requirements	steel rope	Non-metallic rope
1.	290	4,6	15	0,025	18	0,10	10,0	40	0,150	25	0,25	K-0,5	K-0,32	0,353	0,744
2	300	5,7	20	0,035	18	0,10	10,0	40	0,150	25	0,25	K-0,5	K-0,32	0,559	0,796
3.	400	7,0	25	0,035	20	0,15	13,0	45	0,200	30	0,46	K-0,8	K-0,4	0,760	1,190
4.	500	8,6	30	0,058	20	0,15	13,0	45	0,200	30	0,46	K-0,8	K-0,5	1,370	1,190
5.	800	10,2	34	0,110	25	0,41	19,0	56	0,400	32	0,71	K-1,0	K-0,8	2,010	2,050
6.	1250	12,5	40	0,150	25	0,41	22,0	63	0,550	36	0,81	K-1,25	K-1,25	2,440	2,690
7.	1600	15,5	45	0,200	30	0,46	26,0	75	0,970	40	1,25	K-1,60	K-1,60	3,510	4,180
8.	2000	18,5	56	0,400	32	0,71	29,0	85	1,320	45	1,52	K-2,0	K-2,0	5,410	5,690
9.	3200	22,0	63	0,550	36	0,81	40,0	120	4,000	65	5,12	K-5,0	K-3,2	7,470	15,370
10.	5000	25,5	75	0,970	40	1,25	48,0	130	4,700	75	7,23	K-6,3	K-5,0	10,360	20,230

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The graph (Fig. 1) shows the dependence of the diameters of metal and non-metal rope branches on the working load. The discrepancy in the curves is due to the safety factor Ks = 8 for non-metallic slings.

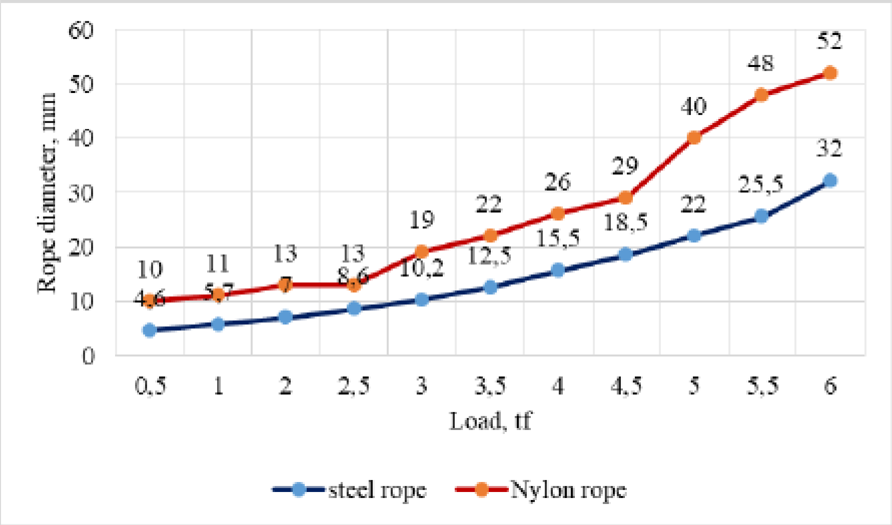

Fig.1. Graph of the dependence of diameters on the material of the rope and the working load on the branch

From the table, in particular, it can be seen that the rapid (according to the increase in the load on the branch) increase in the diameters of non-metallic ropes does not allow the full use of unified elements, such as thimbles, hooks, etc., provided for branches of the corresponding load capacity made of steel ropes.

It should be noted that all types of slings have a certain margin of safety relative to breaking load. So for textile slings, the safety factor must be at least 7, for rope slings - 6, and for chain slings - 4. However, this does not mean that loads weighing 7 tons can be lifted with a single-colour textile sling.

Synthetic slings made of HMW can be successfully used in loading and unloading operations with the required safety factor in the production of rigging, while it is necessary to take into account the range of weight characteristics of the transported goods [23,24]. When wrapping a transported load with a synthetic rope with a protective cover (in the absence of mounting loops), it does not scratch the surface, as happens when using a steel cable. This property is relevant when moving objects made of soft materials or with a finishing layer.

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Conclusion

As a result of the analysis, the following conclusions can be drawn:

According to the criterion of the mass of one strand, the number of standard sizes of load gripping devices with NMB is limited by the possibility of using unified elements designed for steel ropes. From the condition of relative closeness of the values, and the weight of the branches, the permissible load on one branch of the NMB cannot exceed 2 tons (pos. 1 - 8 of the table). At a load above 2 tons, the mass of the non-metallic branch increases sharply, which makes the use of NMB unacceptable.

It is necessary to carry out relevant research for the widespread use of NMB and develop GOST for cargo slings made of non-metallic ropes with new unified elements.

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