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STUDY OF TRAILER LASHING MECHANICAL PROPERTIES IN TERMS OF TRANSPORT SAFETY

Abstract This paper pointed out the risks resulting from both improper cargo securing and trailer lashings material properties. Paper presents method used for strap testing of under different environmental conditions. Obtained results confirm initial authors assumption that there is a relationship between the humidity and straps mechanical and rheological properties. Effects of the work will be used to build a numerical model and to simulate the behaviour of straps under different climatic, road and utility conditions.

Key words: lashing, transport safety, securing influence.

Описано ризики, спричинені неправильним кріпленням вантажу та властивостями матеріалів для кріплення причепів. Наведено метод, який використовується для тестування пасків у різних умовах навколишнього середовища. Отримані результати підтверджують початкові припущення авторів про те, що існує зв'язок між вологістю і механічними та реологічними властивостями пасків. Результати роботи буде використано для побудови цифрової моделі та моделювання поведінки пасків у різних кліматичних, дорожніх і комунальних умовах.

Ключові слова: кріплення, транспортна безпека, вплив кріплення.

Introduction

Development of the world economy is increasingly dependent on the dynamics of trade. This generates an intense increase in the amount of goods moved by various means of transport. Therefore, improvement of operations safety is essential for stable economic development . One of the most important factors affecting safety of the transport of goods is to secure cargo in a manner to prevent displacement of the loading units . This issue applies to all kinds of transport means - freight cars, rail and aircraft . Core of European transport and logistics are road freight . Modern economy requires not only effective but also safe road transport. According to the police, and the institute of road transport in 2011 there was on the Polish roads more than 40,000 accidents with more than six thousand were accidents involving freight vehicles. In these cases, 1,130 were killed and nearly eight thousand were wounded [1].

One of the main causes of accidents involving heavy vehicles is the lack of adequate securing of transported goods. It is estimated that approximately 25% of accidents involving trucks is the result of inadequate cargo securing, and in case of many more it caused intensification of accidents effects [2].

Due to the viscoelastic properties of the polymeric materials of which webbing is made, value of force derived from the residual pretension is not constant as a function of time. This may lead to a reduction in capacity of restraining cargo, and to its displacement during transportation. Key factors determining lashings ability to restrain cargo are: ambient temperature, humidity, and the amplitude of pretension force. These factors are affecting mechanical properties of the lash, especially for its ability to maintain a constant restraining force, and also lashings dimensional stability that can significantly contribute to the deterioration of cargos safety [3,4,5,6].

Trailer lashings – key features and application

Most important task of all safety devices used for cargo restraining, is to transfer such values of restraining forces that in the typical, reasonably foreseeable conditions, there is no possibility of potentially dangerous cargo displacement. Most commonly used protective devices are trailer lashings made of polymeric fibres - mainly polyester tapes of high strength, as well as polyethylene and polypropylene. A typical trailer lashing is shown in Figure 1

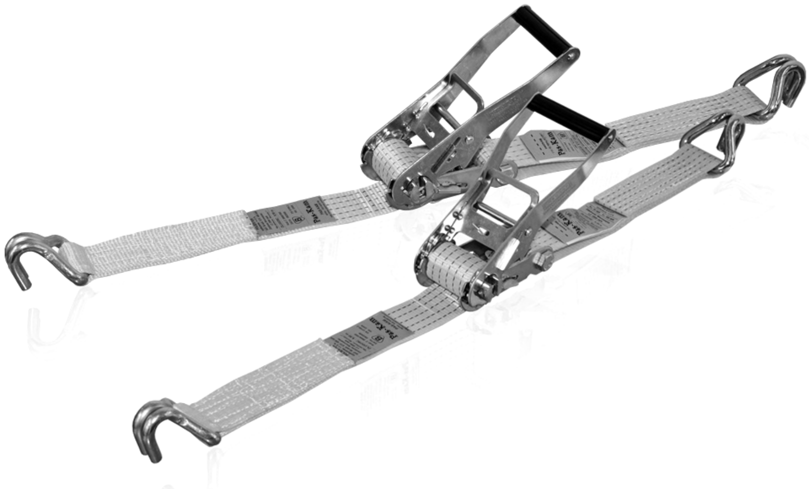

Fig. 1. A typical trailer lashing [7]

Trailer lashings authorized for use in professional cargo transport must comply with the requirements of EN 12195, specifying strength requirements, marking and way they are used. Moreover, the standard does not specify in detail the relationship between time and the value of the restraining force. Available on the market are also tie-down straps and luggage straps that do not meet any standards whose properties and requirements set down for them are not clearly defined.

In practice, there are two ways to restrain the cargo on a vehicle - friction mount, where immobilization is followed by increasing of the friction force between cargo hold and cargo. (Figure 2). And direct mount, where in restraint occurs due to a physical connection between fastening element, cargo and the hold (anchoring - Figure 3) [8]. Due to the nature and characteristics of the spatial forces distribution its vital to ensuring transport safety that for both methods lashings dimensional stability and its ability to maintain constant tension force is preserved. Aim of this study was to analyse the relationship between lashings ability to maintain stable dimensions and its ability to maintain constant tension force under conditions corresponding to an intense rainfall.

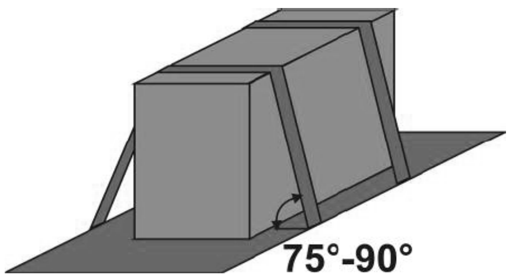

Fig. 2. Friction mount [8]

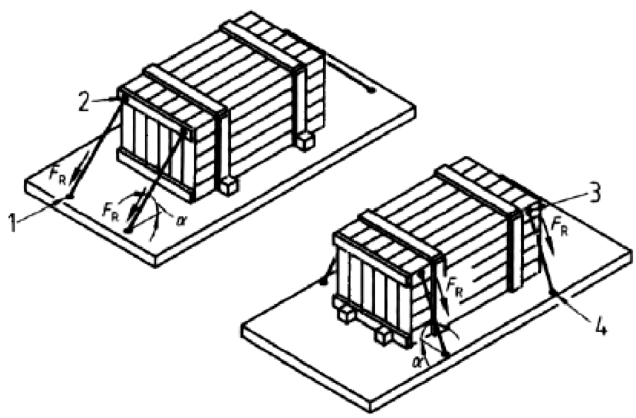

Fig. 3. Direct mount [9]

Research methodology

In order to determine the effect of humidity on the lashings restraining ability a test bench was used (Fig. 4) consisting of:

– Testing machine TIRA TEST 2450,

– Control and recording unit based on PC computer with measurement card.

For testing new trailer lashing was selected Selected lashing was made of polyester tape with a width of 50 mm and a tensile strength 4T. From entire length of the lashing 10 episodes of length 500 mm were collected, thus removing the frayed yarn and making sure that the remaining portion of the tape does not carry any visible signs of damage. All samples were divided into two groups. First of them was not subjected to any additional weathering or conditioning and constituted "control group". The second group of samples was immersed in clear water at room temperature for 5 days.

Value of the tensile force has been set at 8kN which corresponds to the maximum force which can be obtained using a hand ratchet mechanism provided in each trailer lashing. All samples were stretched at a constant speed of 10 mm / min.

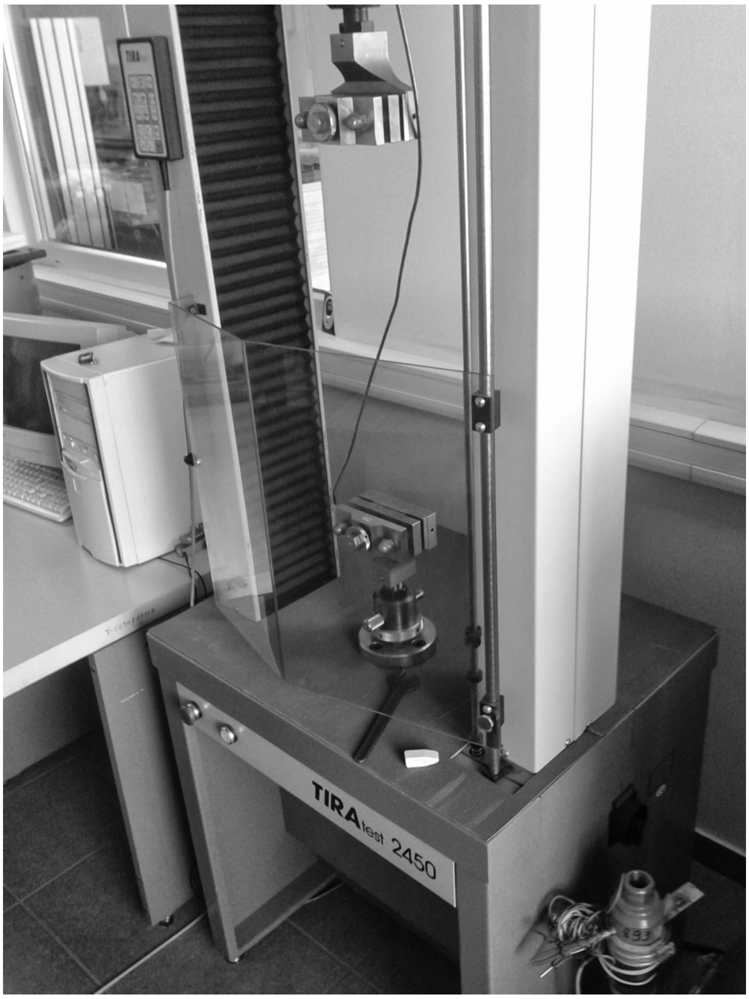

Fig. 4. Photography of used test bench

Test results

5 attempts to both groups of samples were carried out, consisting of 15 cycles of alternating loading and unloading of a lash to determine value of resulting permanent plastic deformation in the material. Measurement results were subjected to statistical processing and presented in the form of plots shown in Figures 4-7.

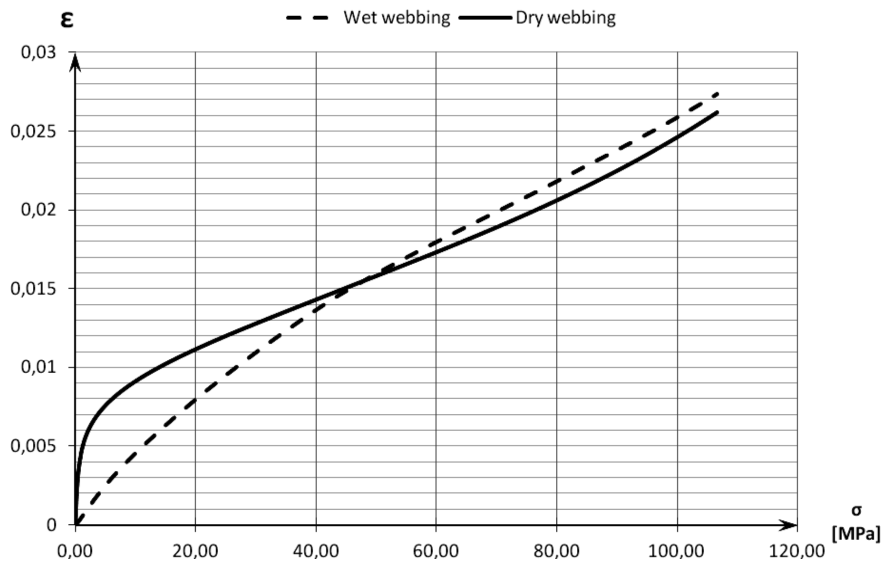

Fig. 5. Strain – stress characteristics under 8kN load for first loading cycle

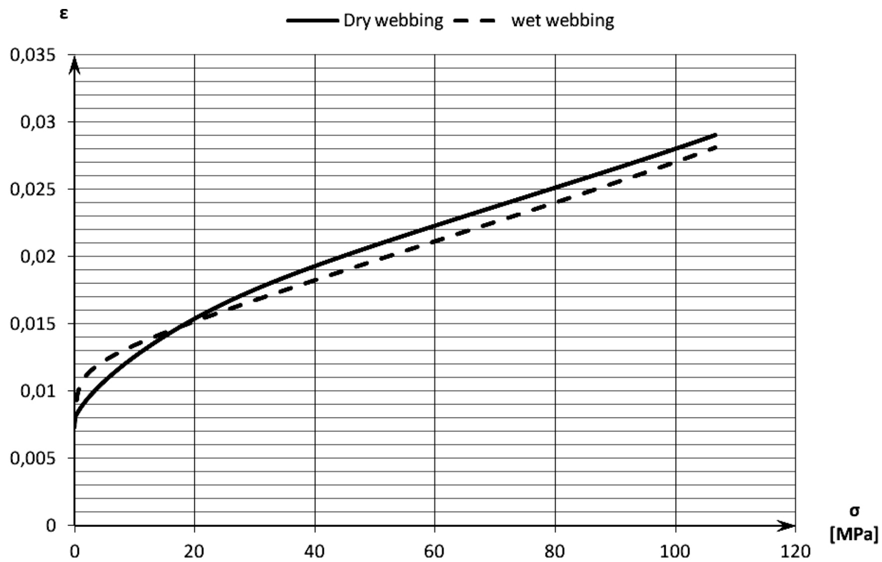

Fig. 6. Strain – stress characteristics under 8kN load for fifteenth loading cycle

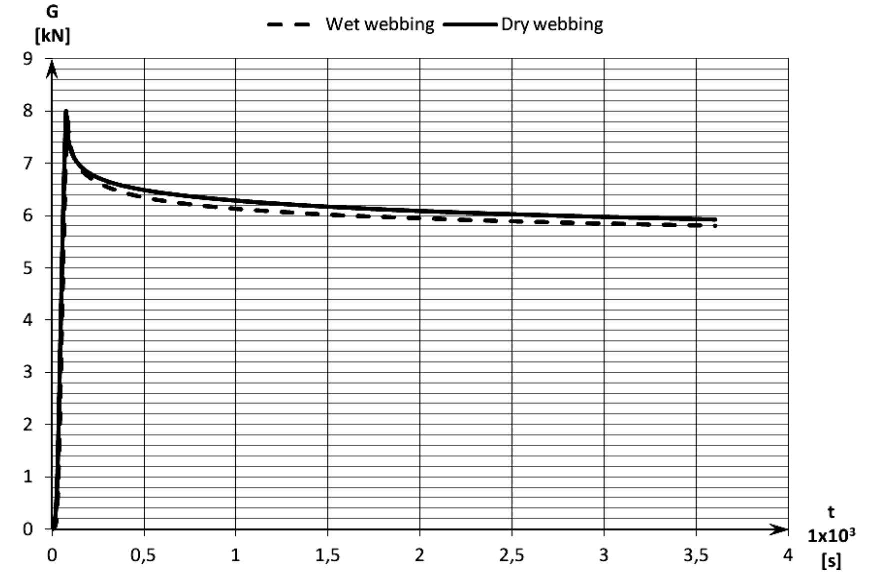

Fig. 7. Relation between residual restraining force and time

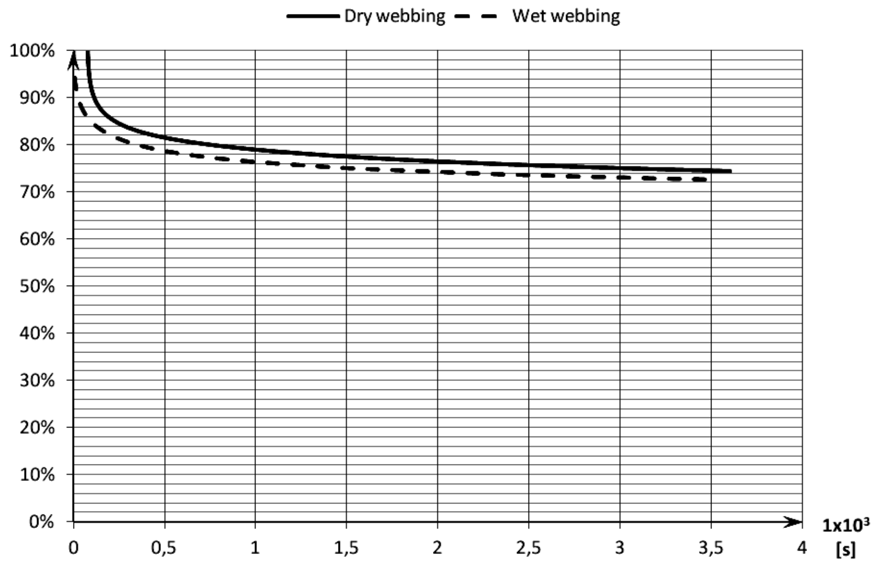

Fig. 8. Residual restraining force value shown as percentage of initial value

Summary

Obtained experimental results indicate a relationship between the humidity and the mechanical properties of trailer lashing, and thus its ability to reliably fix and immobilize cargo. Conducted research and verbal reports from lashing users indicate existence of a relationship between the humidity of the strap from which lashing is made and its ability to efficiently immobilize cargo. Resulting from measurements a seemingly small difference of 3 %, between initial and residual force in case of dry and wet lashing in certain circumstances, may lead to an increased cargo security risk. This forces the user to control the state of cargo securing at regular intervals, especially in the case of rain or high air humidity.

Fundamental problem with all the strength tests of strap-type elements, is suitable mounting of the sample on testing machine. Use of conventional grips commonly used in the studies testing machine is creates a risk sample slippage and falsification of obtained by recording a reduction in the level of force not associated with a phenomena occurring in the material. In case presented in this article no such phenomenon results were observed. Previously conducted preliminary studies have shown that sliding out of the sample, occurs just above the level of the load corresponding to the force of about 14 kN..

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