

# Significance of the quality of short - link chains for work environment

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**Abstract.** In the article basic elements influencing the quality and safety of the chain are discussed. The conducted analysis clearly indicates that price ought not to be the only determinant to take into account when choosing a supplier – instead, the users of these products should first of all consider certificates and approvals provided with the product by its manufacturer.

## 1 Introduction

Work environment has a big impact on the health and quality of the employee's life as it consists of a number of material and psychosocial factors that the employee deals with when performing or preparing for his/her work. Material factors of work environment include among others: the premises of an enterprise or institution, buildings, rooms, machinery, tools, equipment, but also physical and chemical factors (e.g. microclimate, lighting, vibrations, noise, mechanical factors as well as chemical substances and dust) and biological factors. Psychosocial (non-material) factors of work environment are among others: psychological work requirements, organisational factors, participation of employees, human relations, professional career development and corporate culture [1].

The paper deals with one of work environment elements influencing the employee's safety, namely hoisting equipment in which the chain is an important operating element.

Products such as technical chains, which are used to carry bigger loads, have become irreplaceable in many industrial and economic branches. They are mainly applied as transport chains, which can have short or long links. Short-link chains are used in a number of mechanical devices, mainly as drive chains cooperating with star wheels and auxiliary slings in tractors. Short-link chains are general purpose chains and they are most often applied in the mining industry [2].

The paper focuses on short-link chains, which are mainly used in hoists and winches. These two devices are designed to vertically lift a cargo by means of a rope or chain, using a gripping element, usually a hook, the difference between the two being the way of mounting the load-bearing structure. Depending on the manner of construction, the said devices can be used in various areas, such as: industry, building, automotive branch or forest industry [2]. According to the type of drive, hoists can be divided into: manual, electric and pneumatic, whereas according to the type of strand applied, they fall into two

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categories: chain or rope ones. To lift a cargo, it is necessary to select an appropriate chain for the hoist/chain winch, depending on the construction of the hoist/winch, cargo weight and environment in which it is used. Depending on the type of hoist/winch drive, PN-EN 818-7 standard lists the following types of chain [3]:

T - hoist/winch with a manual drive or jacks with a low-speed motor drive, which do not work in abrasive conditions.

DAT - hoist/winch with a motor drive, which reach high speeds and high work intensity, in places requiring high abrasive resistance due to increased chain life.

DT - hoist/winch with a motor drive, used in abrasive work conditions.

Short-link chains for lifting cargo can be applied in many industrial and economic branches, among others in underground headings of mines, in areas endangered with coal dust or methane explosion.

On the Polish market there are a few producers of these chains, among others: FASING S.A., Pewag Polska Sp. z o.o., Grupa RUD, THIELE, Retezarna a.s.

In the article the authors base on chains manufactured by Retezarna a.s., whose main sales representative in Poland is PPHU "Anima" from Rybnik.

## 2 Requirements to be met by short - link chains

Handling equipment used in the mining industry includes among others hoists with a chain strand, which enable installation of machinery subassemblies and transport of materials. Due to hard operating conditions in limited spaces of excavations and assembly chambers, hoisting equipment for the mining industry, apart from appropriate lifting capacity, must be characterized by high lifting speed, low kerb weight, small dimensions and work safety [2].

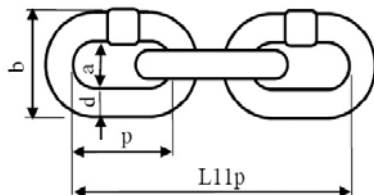
An important operational element in these devices is the chain, which to a large extent determines the safety of the hoist operator. To be safe for the user, the chain must meet a number of technical requirements contained in such standards as:

- PN-G-46732 Mining chain hoists – Calibrated short-link chains,
- PN-EN 818-7:2002+A1:2008 Short-link chains for lifting purposes – Safety – Part 7 – Fine tolerance hoist chain– Grade T (Types T, DAT and DT),
- Safety requirements taking into account the provisions of "Geological and Mining Law" Act dated 9<sup>th</sup> June 2011 (the Journal of Laws of 2017 item 2126, with subsequent changes),
- Regulation of the Minister of Economy of 28<sup>th</sup> June 2002 concerning occupational safety and health, operation and specialist fire-fighting protection in underground mining plants (the Journal of Laws of 2002; No. 139, item 1169),
- The act on general safety of products dated 12<sup>th</sup> December 2003 (the Journal of Laws of 31<sup>st</sup> December 2003),
- PN-EN 10025 Hot-rolled products made of constructional steel,
- PN-EN ISO 643 Steel - Micrographic determination of grain size,
- PN-EN ISO 6507-1 Metals – Vickers hardness test – Part 1 – Testing method,
- Directive 2006/42/CE of the European Parliament and of the Council of 17<sup>th</sup> May 2006 on machinery, amending directive 95/16/CE

Moreover, each producer ensures the fulfilment of its technical conditions for the manufactured chain.

A basic notion characterizing the chain is so-called chain size. This value is defined as the product of the diameter of rod  $d$  that the link is made of and the biggest internal dimension  $p$ , referred to as the scale of link or chain. Moreover, the link is also characterized by such values as  $a$  – internal length of the link measured in the link inside

diameter,  $b$  – external width of the link and  $L11p$  – internal length of the link with 11 links [4]. The above mentioned dimensions of the link have been presented in Fig. 1.



**Fig. 1.** Dimensions of the link/chain. Source: [4].

In its offer Retezarna a.s. has standard chain sizes, which are presented in Table 1. Apart from standard sizes, the company can also produce customised chains, suited to the customer’s needs [4].

**Table 1.** Standard sizes of chains produced by Retezarna a.s. [4].

Size of chain $d \times p$	$d$		$p$	$a$ no less than	$b$ no more than	Mass of 1 m of chain	Nominal length $L = 11 \times p$	Tolerance	Max. diameter of weld
	mm					kg. ca	mm		
<b>4 x 12</b>	4	+/-0.2	12	4.8	13.6	0.35	132	0.6	4.3
<b>5 x 15</b>	5	+/-0.2	15	6.0	17.0	0.54	165	0.8	5.4
<b>6 x 18</b>	6	+/-0.2	18	7.2	20.4	0.8	198	1.0	6.5
<b>7 x 21</b>	7	+/-0.3	21	8.4	23.8	1.1	231	1.1	7.6
<b>8 x 24</b>	8	+/-0.4	24	9.6	27.2	1.4	264	1.3	8.6
<b>9 x 27</b>	9	+/-0.4	27	10.8	30.6	1.8	297	1.4	9.7
<b>10 x 30</b>	10	+/-0.4	30	12.0	34.0	2.2	330	1.6	10.8
<b>11 x 31</b>	11	+/-0.4	31	13.2	37.4	2.7	363	1.7	11.9
<b>12 x 36</b>	12	+/-0.5	36	14.4	47.6	3.1	396	1.9	13.0
<b>13 x 39</b>	13	+/-0.5	39	15.6	44.2	3.7	429	2.1	14.0
<b>14 x 42</b>	14	+/-0.6	42	16.8	47.6	4.3	462	2.2	15.1
<b>16 x 45</b>	16	+/-0.6	45	19.2	54.4	5.6	528	2.5	17.3
<b>18 x 54</b>	18	+/-0.9	54	21.6	61.2	7.0	594	2.9	19.4
<b>20 x 60</b>	20	+/-1.0	60	24.0	68.0	8.7	660	3.2	21.6
<b>22 x 66</b>	22	+/-1.1	66	26.4	74.8	1.5	726	3.5	23.8

Welded chains for Class T hoists and chain winches (T, DAT, DT), must be characterized by high quality, excellent functional advantages and long life. To meet these requirements, they have to be made with the utmost care so as to ensure user’s safety [5,6].

Parameters which decide about the quality and safety when using the chains are among others mechanical properties and loads. In the production process the manufacturers of chains for winches/hoists use steel characterised by mechanical properties compliant with PN-EN 10025 standard [7-9], so that the final product can meet all the requirements imposed by rigorous European standards, in line with PN-EN 818-7 and PN-G-46732 standards. The above standards also oblige the producer to subject the chain to the calibration process. Another important element influencing the chain user’s safety is the quality of workmanship, with particular focus on dimension deviations, which have been contained in Table 1. Moreover, PN-EN 818-7 standard requires that the producer should apply a complex programme of product quality testing in order to ensure operational safety while using the chain. Particular emphasis has been placed on the use of appropriate grades of steel as materials that the elements of a T class short chain are made of [10-13]. Each delivery to the customer must be marked with the producer’s logo and provide information on the chain width, production serial number, chain length and the number of pieces in the

series. At the ends of the chain, with a spacing of 1m, the following information must be placed: producer's logo, year of production, number which stands for month of production and chain class (T, DAT or DT- for 818-7 standard); 5,6 or 8 for PN-G-46732 standard – Fig. 2.



**Fig. 2.** Mark placed at the chain ends, with a spacing of 1 m.

Chains produced at Retezarna a.s. fulfil the requirements imposed by standards for particular products. To emphasise high quality and safe use, chains manufactured by this company are marked with H45 (Producer's identifier) granted by the certifying authority DGUV Deutsche Gesetzliche Unfallversicherung, which guarantees the product's compliance with PN-EN 818-7 standard. Fig. 4 shows a quality mark on the chain link.



**Fig. 4.** Quality mark H 45 on the chain link.

In Poland supervision over the production and quality of the discussed products is exercised by KOMAG Institute of Mining Technology.

### **3 Requirements to be met by suppliers**

Requirements to be met by the supplier providing the customer with the product are contained in PN-EN ISO/IEC 17050 standard, which imposes on the supplier the duty to provide a certificate of compliance together with the product [14]. PPUH Anima, being one of the major distributors of products manufactured by Retezarna a.s. in Poland, with each delivery provides a certificate of conformity, which contains such information as: name of supplier, name of product, declaration of the product's compliance with the requirements imposed by legal acts and standards, such as: Geological and Mining Law as well as PN-EN 818-7 and PN-G-46732 standards, technical specification extract, certificates,

instructions for use, reports on tests provided with the product as well as a statement on accepting responsibility for the quality and safety of the offered product.

With every delivery of the chain, the buyer receives an audit certificate 3.1. In the case discussed in the article this is a certificate (approval) according to ČSN EN 10 204-3.1 standard, which contains producer's data, product identification data, information on the quantity, dimensions and test results.

## 4 Requirements to be met by recipients

An important element influencing safe use of the chain applied in hoists/winches is also the procedure to be followed by the user himself. For this reason Anima company, together with the delivered product, provides the operation and maintenance manual so as to ensure safe and long operation of the chain. The elements that influence proper operation include observing the load capacity for a particular grade of the chain as well as using a suitable chain, adjusted to the type of winch drive. Attention should also be paid to environmental conditions in which the device works, i.e. temperature (over 200°C the chain must be removed from service) and acidic environment, having an adverse impact on the product.

Due to safety reasons, it is also necessary to properly use the chain and observe the OSH regulations, among others such as [15]:

- No chain overloading.
- The chain must be placed on and removed from chain wheels in a straight position, without twists.
- The load must be well fastened on the hook to prevent it from sliding off.
- The chain mustn't be jerked sharply.
- The chain mustn't be used when it is deformed or torn.
- The chain mustn't be used for suspending by reeving or using a loop.
- The chain must be stored in a dry dust-free location.

An important element is also an inspection of the chain before its first use, on-going monitoring and checking the technical condition with as often as it is necessary in particular working conditions.

The chain should be treated as an element of machinery. In particular, it is recommended that the chain is not dragged on the ground or exposed to weathering. It is forbidden to overload the chain and carry out unprofessional repairs.

## 5 Summary

Development of mechanization in various branches of industry, including mining, necessitates the use of auxiliary equipment to support assembly, servicing or transport works. Handling of increasingly bigger weights requires the application of equipment characterized by better technical parameters. Such devices, belonging to so-called "moving equipment", are chain hoists and winches. Apart from technical and constructional parameters of these devices, work and safety are influenced by the chain by means of which goods are being handled. Therefore, from the point of view of work safety, the quality of the chain is extremely important. The article draws attention only to basic elements and determinants influencing the chain quality. This analysis clearly indicates that when selecting a chain, one should take into account the mechanical properties of the material that the chains are made of as well as the quality of their manufacture. The quality of the material used and the chain workmanship is confirmed by the producer's certificate, provided with the product.

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