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EVALUATION OF FORCE DROP-DOWN FOR 50 MM WEB-LASHING USED FOR LOAD SECURING

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1 Introduction

Load securing by web-lashing is a common lashing method to secure a cargo by lashing. Web-lashing is elastic lashing equipment which can compensate settling of lashed cargo to some extent. The aim of the paper is to study how the tension force is decreasing after the tensioning of the webbing. The paper compares the tensioning with hydraulic piston with the manual tensioning by ratchet tensioners.

2 Measurement procedure and equipment

Testing stand to test lashings is used to perform required tests. Hydraulic piston is used to increase the tension force in steps from 0,05 LC (lashing capacity) to 0,5 LC. Another method is a method used in practice of manual tensioning of webbing by ratchet tensioner. The force is measured by a load-cell. Lashing straps with the width of 50 mm and lashing capacity LC of 2500 daN are used for tests.

Fig. 1: Testing stand to test tension forces in lashing equipment

3 Web-lashing used in tests

Web-lashing commonly used in load securing was selected for tests. Web-lashing of width 50 mm and lashing capacity LC of 2500 daN is to be tested. Technical parameters of selected web-lashings are given in table below. Testing length of webbing was around 3,5 meters. Eight web-lashings of four different manufacturers were used in tests. Two samples of each manufacturer were tested.

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Table 1: Technical parameters of tested web-lashings

Test marking	Thickness [mm]	Length [m]	LC – lashing capacity [daN]	0,05 . LC [daN]	Material	Elongation at LC max. [%]	No. of stripes	Webbing colour
TL1	2,81	10	2500	125	PES	<7	5	orange
TL2	2,82	10	2500	125	PES	<7	5	orange
HL1	2,31	12	2500	125	PES	<7	5	orange
HL2	2,38	12	2500	125	PES	<7	5	orange
DL3	2,80	7,5	2500	125	PES	5	5	orange
DL5	2,75	7,5	2500	125	PES	5	5	orange
VL1	2,683	7,5	2500	125	PES	5,78	5	red
VL2	2,63	7,5	2500	125	PES	5,78	5	red

Key: PES...polyester

First test series is performed with hydraulic pistons from around 125 daN to around 1250 daN. Then the piston has been stopped and the tension force decreased immediately due to the webbing relaxation (see next figure). Force after 30 seconds and 5 minutes was recorded. Then hydraulics was used again to release the tension force to 0,05 LC. After the hydraulics was stopped the force increased immediately due to the webbing relaxation.

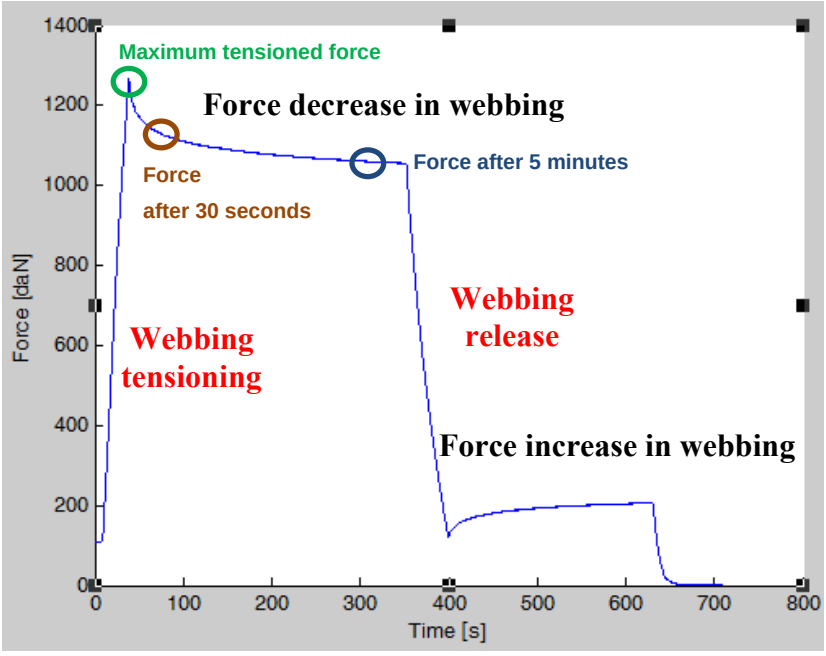

Fig. 2: Force-time diagram of tensioning test with hydraulic piston

Second test series were performed with hydraulic piston where the tension force was increased in steps for force levels around 125, 250, 500, 750, 1000 and 1250 daN. Here the force decrease was recorded after 1,5 minute.

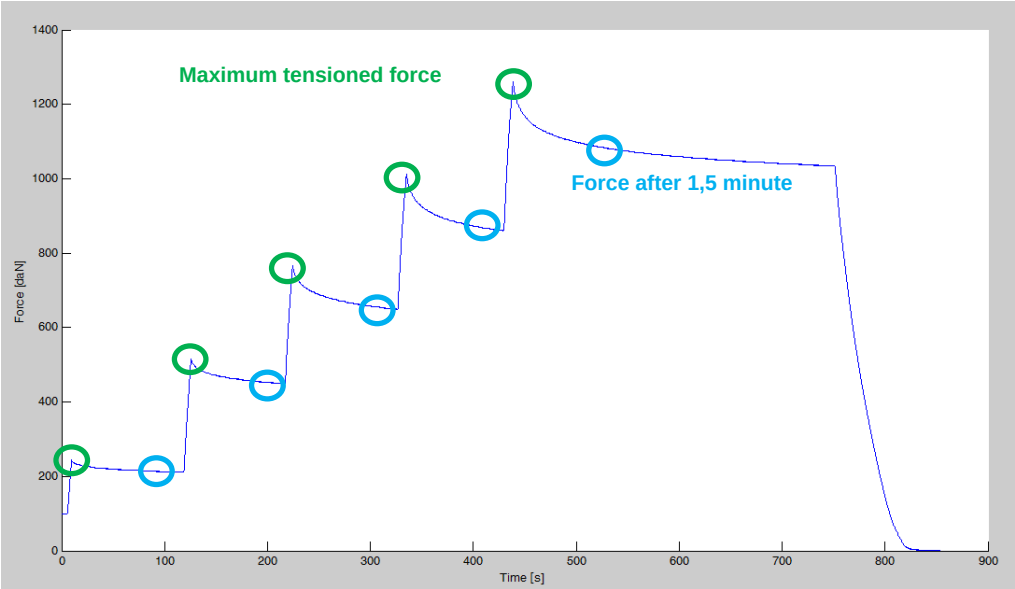

Fig. 3: Force-time diagram of tensioning test with hydraulic piston in steps

Third test series were performed by manual tensioning by ratchet tensioner where the tension force was increased in steps of each tooth of ratchet winch. The force was recorded after 1,5 minute again.

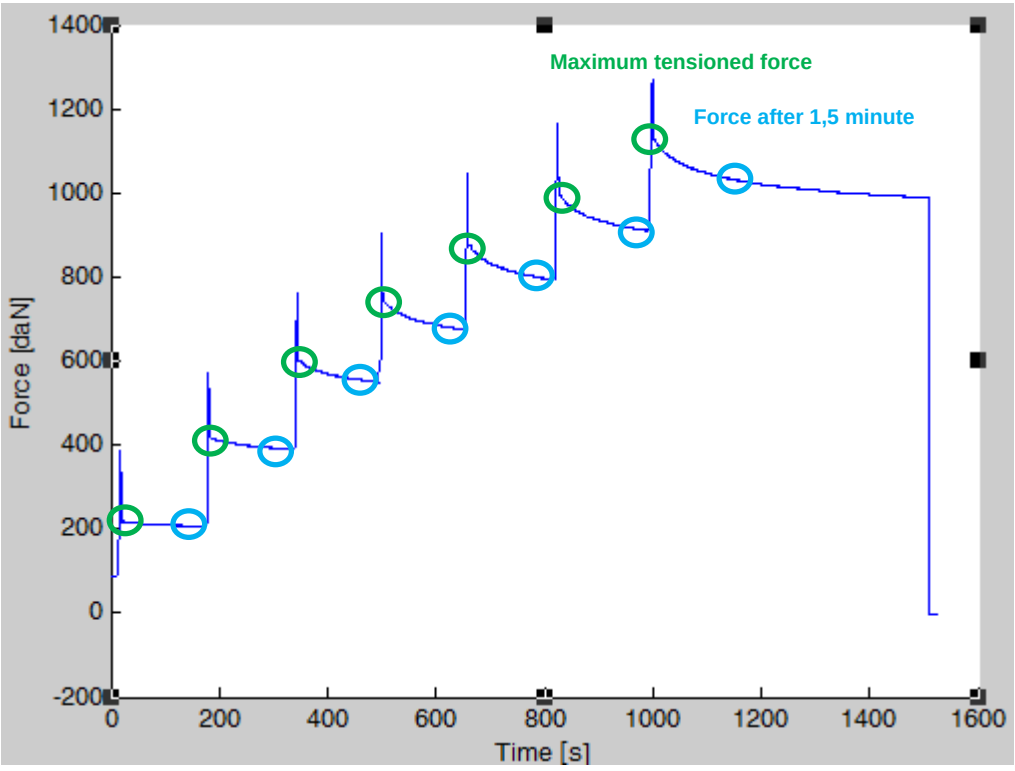

Fig. 4: Force-time diagram of tensioning test with ratchet tensioner in steps

Test series of tensioning in steps has showed that the higher the tension force the bigger the force decrease.

4 Test results

For the first test series each lashing was tested 5 times. Minimum, maximum and mean force drop down is evaluated in table below.

Table 2: Test results for the first test series

Webbing	Maximum dF [daN]	Minimum dF [daN]	Mean dF [daN]
DL3	**210**	**115**	**158,375**
30sec	130	115	123,5
5min	210	174	193,25
DL5	**256**	**131**	**186,2**
30sec	160	131	143
5min	256	211	229,4
HL1	**189**	**115**	**151,5**
30sec	117	115	116,4
5min	189	186	186,6
HL2	**202**	**105**	**155,7**
30sec	125	105	118
5min	202	189	193,4
TL1	**244**	**133**	**191,4**
30sec	151	133	146
5min	244	217	236,8
TL2	**248**	**145**	**196,5**
30sec	155	145	149,6
5min	248	238	243,4
VL1	**241**	**130**	**182,3**
30sec	148	130	140
5min	241	212	224,6
VL2	**240**	**132**	**180,9**
30sec	146	132	137,4
5min	240	213	224,4

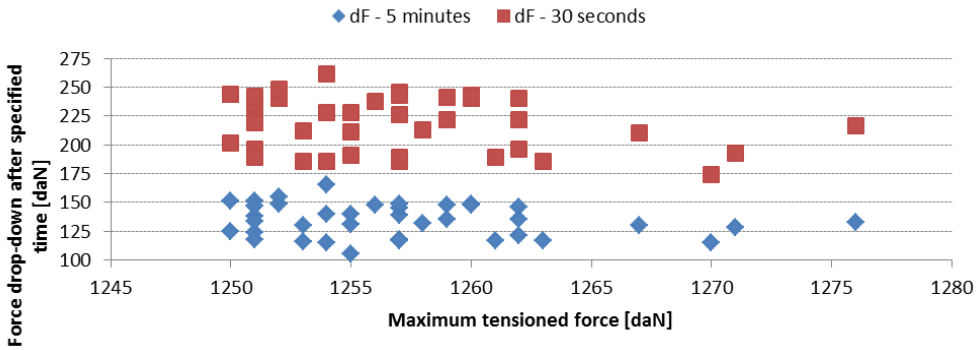

Fig. 5: Test results of first test series for all samples

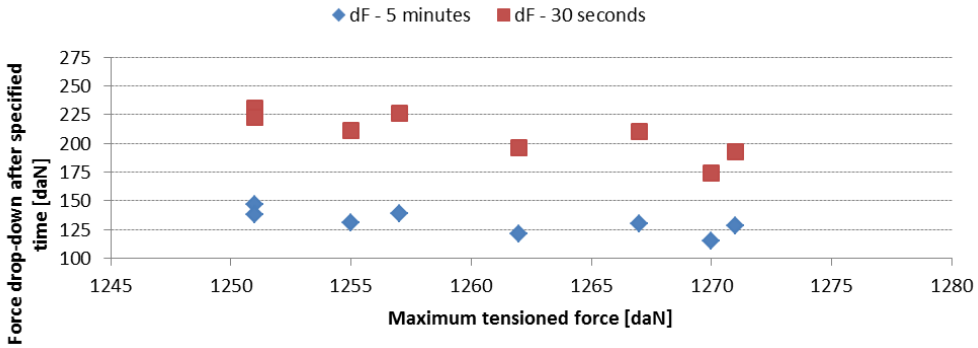

Fig. 6: Test results of first test series for DL3, DL5 samples

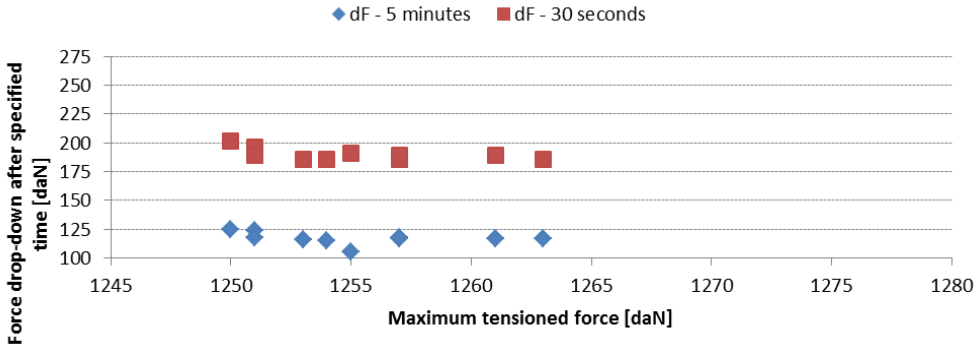

Fig. 7: Test results of first test series for HL1, HL2 samples

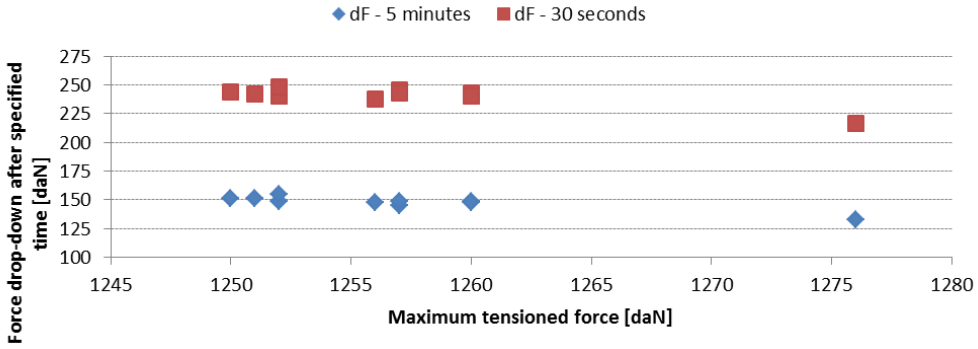

Fig. 8: Test results of first test series for TL1, TL2 samples

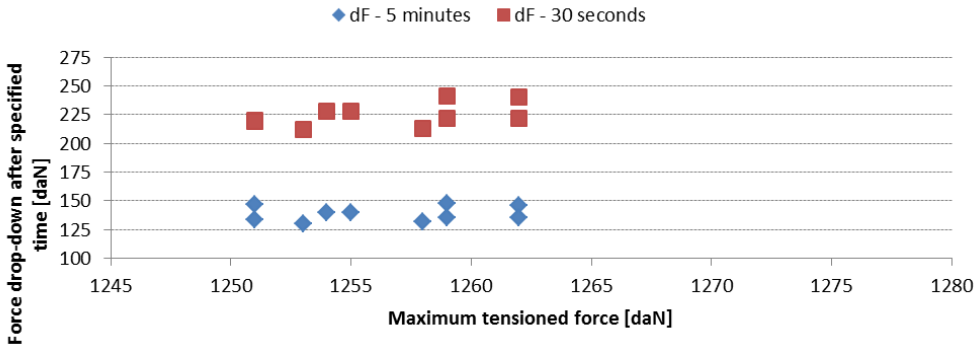

Fig. 9: Test results of first test series for VL1, VL2 samples

Around 60 % of force was lost after 30 seconds when compared to force loss after 5 minutes. This means that the force decreases rapidly immediately after the tensioning is stopped (average 4,5 daN/s for 30 sec.). When we use webbing for direct lashing methods

cargo movement is tensioning the webbing during sliding or tilting. But when the cargo stops the force in webbing is not stable but decreases rapidly which means that the webbing is not tensioned constantly with maximum force after cargo movement.

The second and third test series are more suitable to prove correlation between the maximum tensioned force and force drop-down due to tensioning in steps.

Tests in second and third test series were performed with same web-lashings and each sample was tested twice.

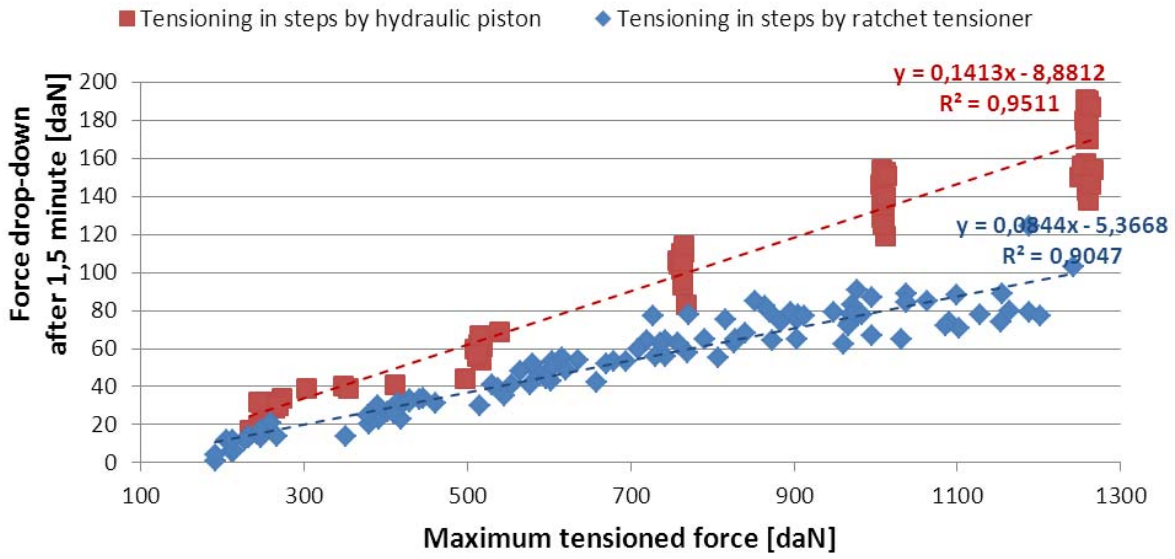

Fig. 10: Test results of second and third test series for all samples

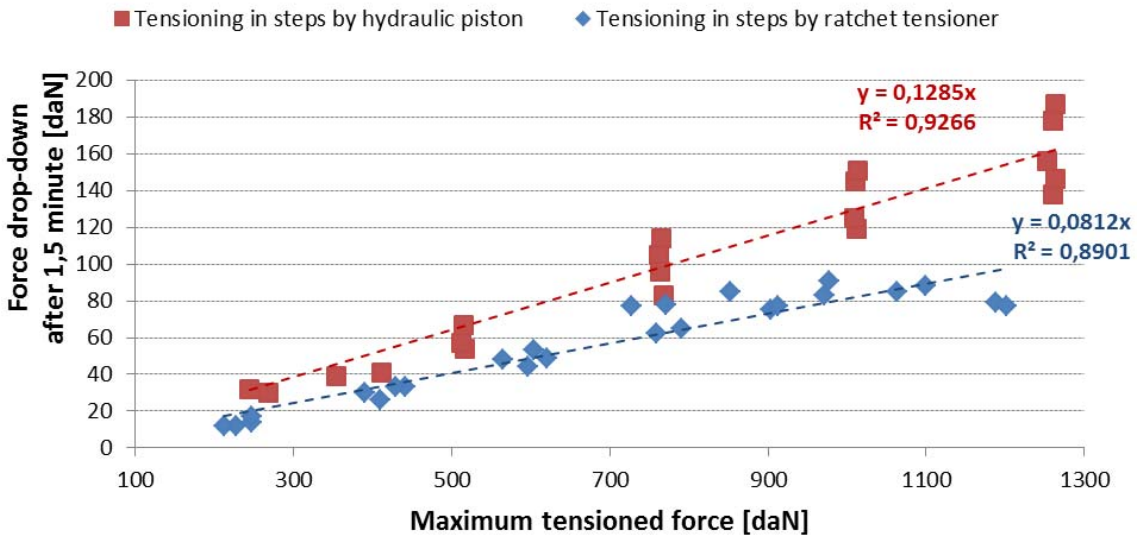

Fig. 11: Test results of second and third test series for DL3, DL5 samples

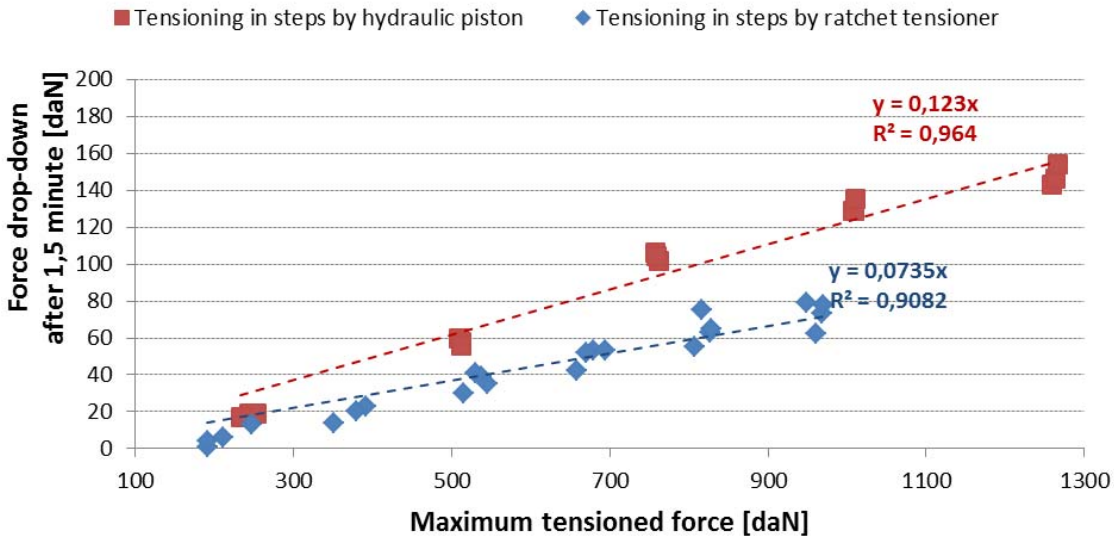

Fig. 12: Test results of second and third test series for HL1, HL2 samples

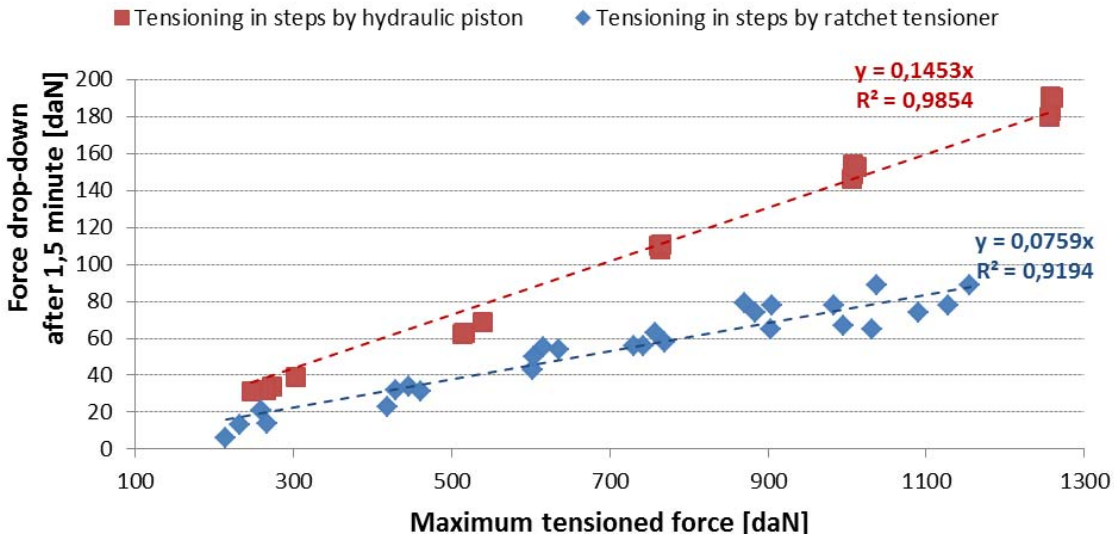

Fig. 13: Test results of second and third test series for TL1, TL2 samples

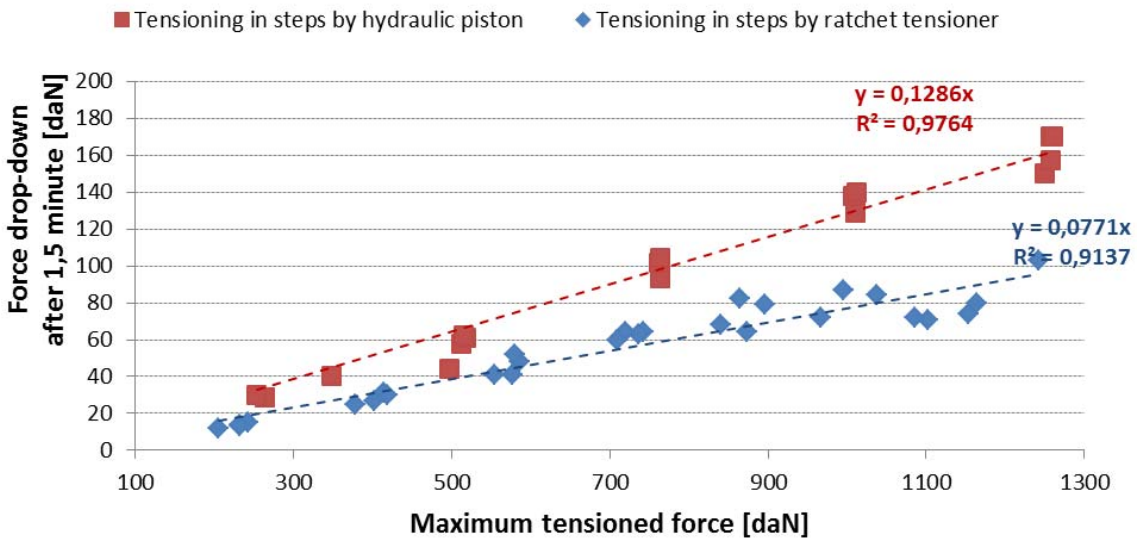

Fig. 14: Test results of second and third test series for VL1, VL2 samples

The force decrease is higher when tensioning in steps with hydraulic piston compared to ratchet tensioner (compare Fig.2 and 3). This is because of the principle of tensioning by ratchet tensioner. Maximum tensioned force by ratchet tensioner is the force after the handle release. This is not the absolute maximum achieved force. Such force is achieved when the hand force is acting on handle. But due to the handle release the whole ratchet rotates back which creates force drop-down from maximum achieved force to maximum tensioned force (residual tension force immediately in webbing after handle release).

Conclusions

When we use webbing for direct lashing methods cargo movement is tensioning the webbing during sliding or tilting. But when the cargo stops the force in webbing is not stable but decreases rapidly which means that the webbing is not tensioned constantly with maximum force after cargo movement. Tensioning in steps by hydraulic piston or by ratchet tensioner has proved that higher the maximum tensioned force higher the force drop-down from this force during time. Load settling, accelerations and vibrations have also influence on the tension force in lashings. Therefore the tension force in lashings varies in time. Further tests can also prove the influence of webbing length on force-drop down which could be considered.

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