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STRAIN MEASUREMENT OF STRANDED ROPE SUBJECTED TO BENDING OVER SHEAVE FATIGUE

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Key words: stranded rope, bending over sheave fatigue, strain measurement

Abstract:
In this study, strain variations of 6 x 36 Warrington-Seale stranded rope have been measured in accordance with tensile load and sheave diameter variations. Experimental tests have been done by utilizing bending over sheave fatigue test machine which consists of drive sheave, test sheave, electric motor, leverage and several machine elements helping to run. Three different tensile loads and two sheaves with different diameter have been used to obtain strain variations related to these parameters. Strains fluctuate along with the changes in tensile load magnitude and sheave diameter used.

1. Introduction

Steel wire ropes are one of the main components of elevators, cranes, bridges, mine hoisting systems. Many different kinds of rope constructions are used to perform varied duty expected from them. Generally, steel wire ropes are manufactured by parallel lay strands such as Filler, Warrington, Warrington-Seale and Seale twisted around a fibre or steel core. In the application area steel wire ropes are mostly subjected to bending over sheave fatigue since ropes are generally used as tension member together with sheaves. Rope moved over the sheaves goes from straight to bend when load is carried upward and bend to straight when load is taken down. Therefore in every cycle repeated bending over sheave causes bending over sheave fatigue [1]. One of the commonly used type of rope in the cranes and mine hoistings is 6 x 36 Warrington-Seale rope. In this study, strains occurred on the 6 x 36 Warrington-Seale stranded rope have been measured. Three different tensile loads and two sheaves which have different diameter have been used to obtain strain variations related to these parameters.

2. Bending Over Sheave Fatigue Test Machine

In order to measure strains occurred on 6 x 36 Warrington-Seale rope various tests have been done in the Rope Technology Laboratory of Institute of Mechanical Handling and Logistics (Institut für Fördertechnik und Logistik (IFT), University of Stuttgart, Germany). Test machine used in this study has been depicted in Fig. 1. Rope samples are connected between drive sheave (1) and test sheave (2) by means of lead casting end connections. Motor (3) gives the power on system. A leverage (4) and several weights are used to maintain a constant tensile load *S* on the test sheave to simulate actual operating conditions, in this manner static tensile load *S* can be applied to the rope tested permanently during the test. Actual rope bending over sheave fatigue occurs at contact length with rope that is certain 30.d length (d is diameter of rope) on test sheave [2].

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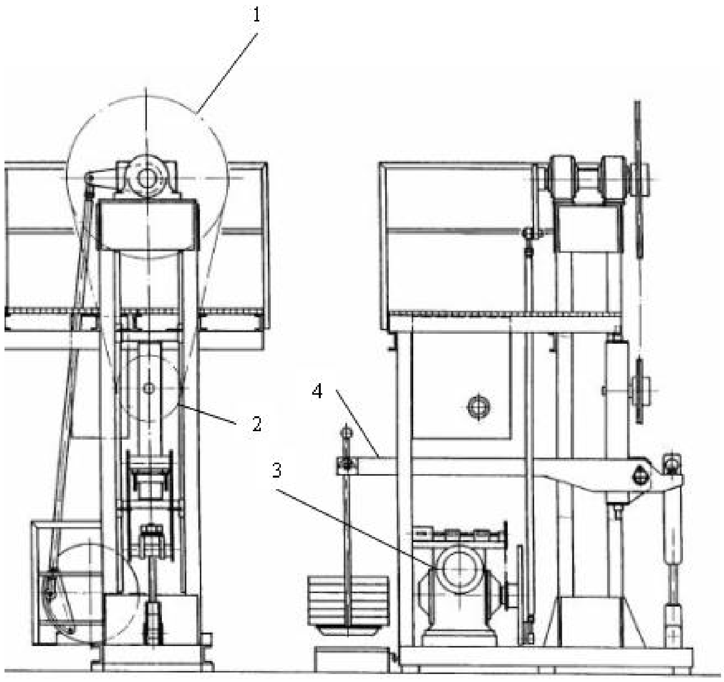

Fig. 1 *Bending over sheave fatigue test machine*

3. Investigated Steel Wire Rope

The steel wire rope used for this investigation is 10 mm in diameter. Rope sample used in this study is 6 x 36 Warrington-Seale stranded rope with Independent Wire Rope Core (IWRC). Technical properties of rope sample have been shown in Tab. 1. In addition it has six strands around a steel core which is a wire rope itself. This kind of rope construction is selected to provide fatigue resistance and relatively crushing resistant. 6 x 36 Warrington-Seale rope can be used mine hoisting, oil industry, cranes etc. Fig. 2 shows cross section of 6 x 36 Warrington-Seale steel wire rope used in this study.

Tab. 1 *Technical properties of 6x36 Warrington-Seale rope*

Strand number	6
Construction	6 x (1-7-7+7-14) + IWRC
Diameter	10 mm
Wire grade	1960 N/mm^2
Lay type	Right regular lay (sZ)
Filling factor	0.58
Minimum breaking load (MBL)	70.4 kN

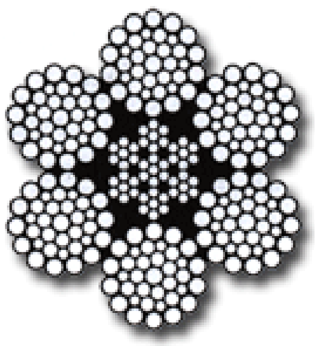

Fig. 2 *Cross sections of 6 x 36 Warrington-Seale with IWRC*

4. Bending Over Sheave Fatigue Tests and Strain Measurements

Bending over sheave fatigue tests have been done by test rig depicted in Fig. 1. Two different sheaves with different diameters which are 100 mm and 250 mm have been mounted as test sheave to the test rig. Rope sample lengths became 1.2 m and 1.45 m respectively considering sheaves with 100 mm and 250 mm diameters. Samples were made with lead casting cones moulded on each end and connected to backing rope in order to form a loop necessary for the test [3]. We have conducted bending over sheave fatigue tests by using three different static tensile loads that are 15 kN, 20 kN and 25 kN. Final elongations occurred on 6 x 36 Warrington-Seale rope have been measured when at least one outer strand of the rope broken. Strains can be easily calculated after data are gathered.

5. Experimental Results

In this study, bending over sheave fatigue tests have been performed in compliance with DIN 15020-2 standard [4]. The final elongations of rope samples when at least one outer strand of rope broken have been gathered. Fig. 3 shows percentage breaking strains (%e) versus three different tensile loads when sheave with 250 mm diameter is used. In case tensile load becomes 15 kN percentage breaking strain becomes 2.73. In case tensile load becomes 20 kN percentage breaking strain becomes 1.95. In case tensile load becomes 25 kN percentage breaking strain becomes 2.33. Percentage breaking strain results indicate that maximum strain have occurred as tensile load becomes 15 kN. In addition percentage breaking strains show descent tendency when tensile loads are increased.

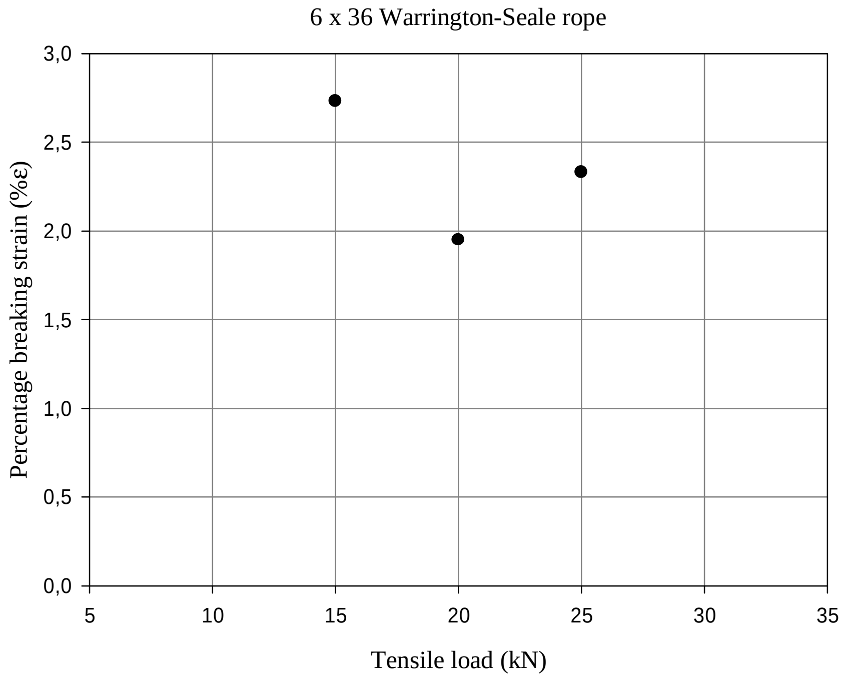

Fig. 3 *Strain* variations *versus tensile load* variations *for 6 x 36 Warrington-Seale rope (D=250 mm)*

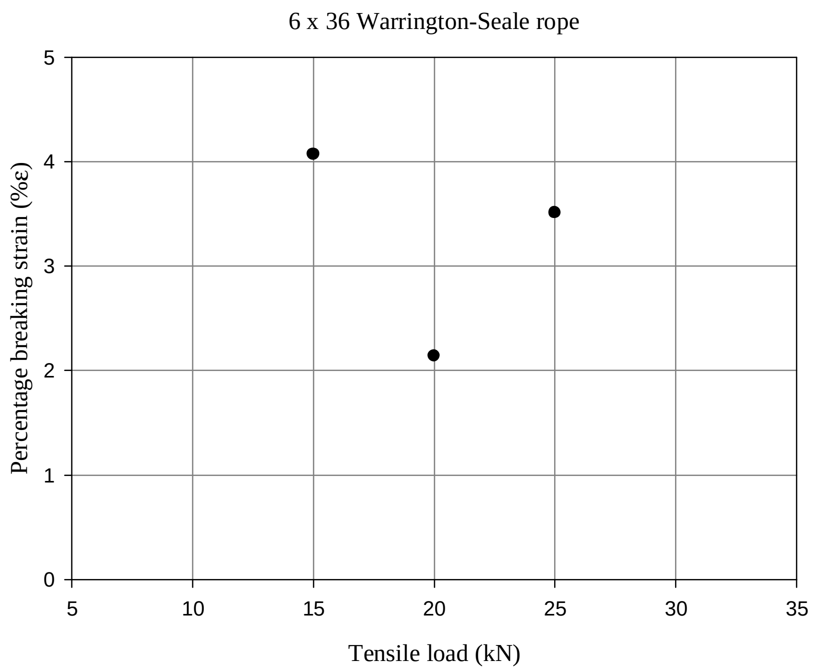

Fig. 4 *Strain* variations *versus tensile load* variations *for 6 x 36 Warrington-Seale rope (D=100 mm)*

Fig. 4 shows percentage breaking strains (%e) versus three different tensile loads when sheave with 100 mm diameter is used. In case tensile load becomes 15 kN percentage breaking strain becomes 4.07. In case tensile load becomes 20 kN percentage breaking strain becomes 2.14. In case tensile load becomes 25 kN percentage breaking strain becomes 3.51. Percentage breaking strain results indicate that maximum strain have occurred as tensile load becomes 15 kN. In addition percentage breaking strains show descent tendency when tensile loads are increased.

Tensile loads have been selected as identical for experimental tests which two sheaves with different diameter were used. Percentage breaking strain is 1.49 times bigger when sheave with 100 mm diameter is used for 15 kN tensile load. Percentage breaking strain is 1.09 times bigger when sheave with 100 mm diameter is used for 20 kN tensile load. Percentage breaking strain is 1.50 times bigger when sheave with 100 mm diameter is used for 25 kN tensile load. Strains have been found bigger at each tensile load when sheave with smaller diameter (D=100 mm) was used.

6. Conclusions

In this study, strain measurements of 6 x 36 Warrington-Seale stranded rope have been done with respect to tensile load and sheave diameter changes. Experimental tests have been done by utilizing bending over sheave fatigue test machine. Maximum percentage breaking strain has been found as 2.73 that tensile load was 15 kN when sheave with 250 mm diameter was used. Maximum percentage breaking strain has been found as 4.07 that tensile load was 15 kN when sheave with 100 mm diameter was used. Strains have been found bigger at each tensile load when sheave with smaller diameter (D = 100 mm) was used.

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Recenzia/Review: *Ing. Janka Šaderová, PhD.*