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OPTIMIZATION & IMPROVEMENT IN WIRE ROPE DESIGN

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ABSTRACT:

The specification for the construction of wire rope and the fabrication of the assemblies used for multipurpose The selection of wire rope must be a reasonable .The wire rope of size 6x19 & 6x25 improved plow steel wire rope is used .These type of wire rope is used for counter weight, maintenance , Operating of lifts ,cranes ,suspension bridges & construction purposes . The developments include the ability to produce higher strength drawn – galvanized wires, compacted strength, corrosion inhibitive lubricants and low torque wire ropes .This paper focuses on the importance of an independent wire rope core (IWRC) centre in the construction of any wire rope.

KEY WORDS: Wire, core, plow, specification, inhibitive, IWRC

INTRODUCTION

The competitive nature of the wire rope industry has resulted in a select few viable wire rope producers' .Those remaining producers have realized that quality and performance of their products must continually improve & optimization for an ever-demanding consumer. The wide range of wire rope construction offered today higher breaking forces, greater fatigue properties and better corrosion resistance due to the major advancements in the field of wire rope design and the improved manufacturing technology. This leads to the current specifications by governing the construction of wire rope used in movable bridges. These specification call for a performed 6x19 class improved plow steel wire rope of 6x25 filler wire construction with hard fibre core. With the current technology and manufacturing capabilities available in the wire rope industry these specifications no longer recommend the

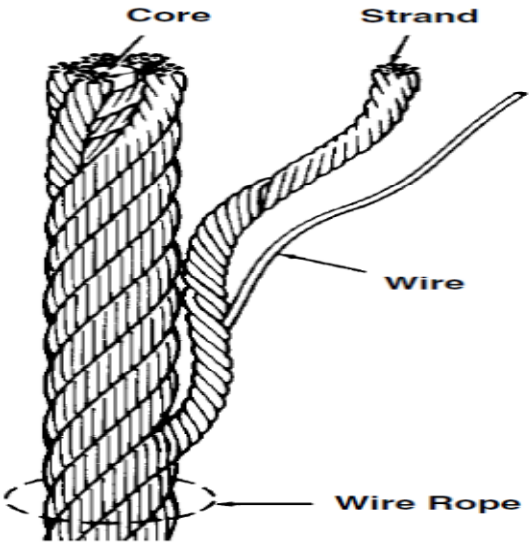
best or most reasonable choice for wire rope selection. The following papers explain the various wire rope constructions. It also explains the importance independent wire rope cores and proper lubrication for good fatigue performance of any wire rope.

MATERIALS

Wire rope may be manufactured from many grades and types of steel and alloys .They may be constructed from nonferrous materials or coated wires .Some of the more common grades with the differing designations are as follows:

(A). Improved plow steel –monitor steel –purple grade –Level 3 steel [1]
(B) Extra improved plow steel –monitor AA grade –purple plus –level 4 steel[1, 2]

CONSTRUCTION

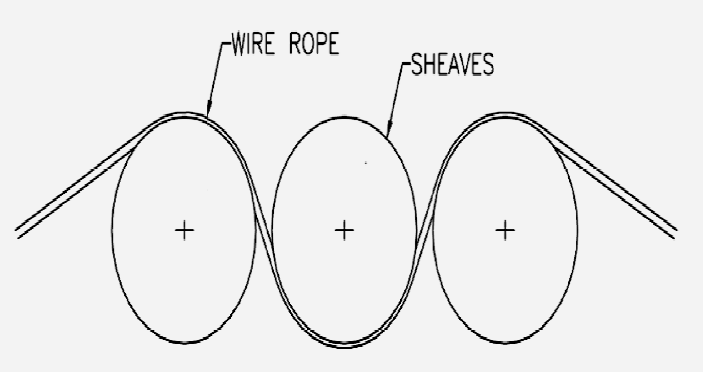


Figure# 1. Three components of wire rope construction

Wires are the basic building blocks of a wire rope .The wire are laid around the "centre" in a specified pattern in one or more layers to form a strand .Wire rope characteristics like fatigue resistance and abrasion resistance are directly affected by the construction of the strands(Fig.1) .Strands with large outer wires will be more abrasion resistant but less fatigue resistant and strands with smaller outer wire are more fatigue resistant but not as abrasion resistant .The outer strands of the wire rope lay around a core .Two types of cores are available .Fibre core (FC)and an Independent Wire Rope Core(IWRC).The fibres making up a fibre core are typically polypropylene but sisal and jute materials are also available along with other man made materials .The ability of the core to support the outer strands will significantly affect the fatigue performance of the rope .The purpose of the core is to provide support for the outer strands and maintain clearances between the strands while the rope bends .The grade of the finished rope also contributes to the performance of the rope .The standard grade wire rope available today is Extra improved Plow steel .This is denoted as EIP or XIP. Higher grades rope are becoming more common

and readily available with advanced manufacturing processes. Higher grade steel allows the rope to better support loads when operating under tensions.

WIRE ROPE FATIGUE



Wire ropes operating over sheaves and drums are subject to bending stresses. These stresses will eventually lead to the fatigue of the wire rope .The amount of the stress depends on the ratio of sheave or drum diameter to that of the rope and the amount of tension in the rope during operation .The ability of the rope's strands and wires to move relative to one another when bending around a sheave or drum is essential for good fatigue life in a wire rope .The movement of the strands and wires compensates for the difference in diameter between the underside and the top side of the rope ,The distance being greater along the top side than the underside next to the surface .The rope service life is adversely affected if the wires cannot move to compensate for this situation .There are typically two types of wire rope fatigue, simple bending fatigue and reverse bending fatigue. Simple bending fatigue is the bending of the rope in one direction around a single sheave.

Figure #3 shows a typical reverse bend schematic .This action accelerates the fatigue of wire rope by compounding the bending stresses on the wires. This action accelerates the fatigue of wire rope by compounding the bending stresses on the wire.

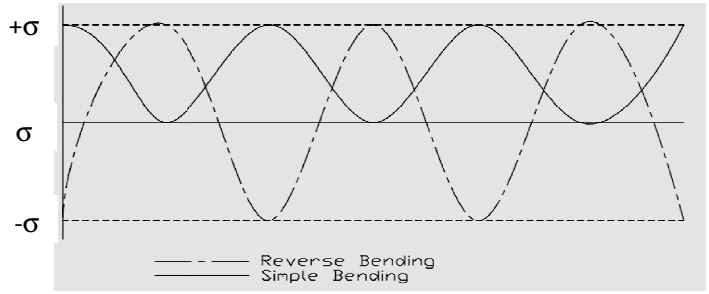


Figure #3 Reverse bending Fatigue Stresses

Graph # 3 shows the amplitude differences of the bending stresses for simple bending fatigue test and the reverse bending fatigue tests. σ in the graph represents the change in stress .The simple bend fatigue line goes from 0 to + σ back to 0 in one cycle .The reverse bend fatigue goes from 0 to -σ in one complete cycle .This represents the double stresses seen by the wires during the testing .The reverse bend fatigue test is the most severe test for running rope constructions.

FATIGUE TESTING OF GENERAL PURPOSE WIRE ROPE

The results presented in this paper were generated from reverse bending fatigue tests conducted at Vikrant Ropes Private Limited Rajnandgaon (C.G.). The tests were conducted with various 19mm (¾") diameter wire ropes in a controlled environment. The sheave diameter used for all of the testing was 457mm (18") in diameter. This results in a sheave to rope (D/d) ratio of 24. A constant tension was applied to the rope during the cyclic testing. These tests were conducted to failure of one strand or the complete failure of the rope. Table 1 shows the test results of four general purpose 19mm (¾") diameter wire ropes tested in reverse bend fatigue. A load of 78.5 KN (17,650 lbs.) was applied to the test samples during the cycling. This tension load is 30% of the minimum breaking force specified for 19mm (¾") diameter XIP IWRC wire rope. Standard lubrication was applied to the samples during the manufacturing process.

Sample #	Rope Description	Avg.RBF Cycles
1	6x25 FWXIP FC IWRC	7,907
2	6x25 FWXIP IWRC	11,880
3	6x25 FWXXIP IWRC	12,086
4	6x36WS XIP IWRC	12,932

TABLE-1

An initial examination of the results in Table 1 clearly shows the wire ropes with independent wire rope cores outperform the fiber core sample #1. Fiber core sample #1 had 33% less average reverse bending fatigue cycles compared to the wire ropes samples # 2 and # 3 with independent wire rope cores and identical outer strand constructions. The poor results of sample #1 are due to the inability of the fiber core to support the outer strands during operation. Once the fiber core has begun to deteriorate the outer strands no longer have the support for proper strand placement. This allows the outer strands to begin nicking and scrubbing against one another accelerating the fatigue. The comparison of samples # 2 and # 3 show a 2% increase in reverse bend cycles. This is due to the increased ability of the XXIP strength wire rope to support the tension load. It is no surprise that the fatigue sample with the best results was sample # 4. Sample # 4 is an XIP grade 36WS strand construction with an independent wire rope core. The 36WS construction is primarily designed to be the most efficient in fatigue resistance and still offer adequate abrasion resistance.

The results of fatigue tests show that a high tensile wire rope with a greater number of wires per strand with an independent wire rope core will outperform a lower tensile wire rope with a fiber core. High tensile wire ropes are more available due to the advancements seen in the quality of high carbon rod. These advancements allow direct drawing of high tensile wires without a loss of torsional properties. The current drawing practices of the wires contribute significantly to the surface finish of the wires which in turn affect the fatigue resistance of the wire rope. Poor surface finish on drawn wires leads to early crack initiation. These cracks propagate under repeated stress cycles until the remaining sound metal fails.

CONCLUSION

Modern tools and technology have brought about substantial improvements in wire rope constructions and quality. These tools in turn increase the durability and service life of the wire rope. The ideas all begin in the design phase of the wire rope. The advent of computer aided drafting software allows conceptual design and analysis of the complete wire rope constructions to ensure proper wire placement and strand clearances. The ability to determine the rope specifications that provide optimum strength and fatigue in hours instead of days greatly enhances turnaround time to meet customer requirements. New and radical designs push the limits for strength and dependability every day. Ropes containing 4 strands to 35 strands allow engineers to dream and design exciting new systems using wire rope. This paper represents a view analysis of rope construction or design. This paper gives the idea on the developments in the field of wire ropes for use as counter weight & operating ropes in various applications. The 6x19 class improved plow steel with a hard fibre core as the recommended Rope. The fatigue test shows the importance of lubrication & independent wire rope cores for stability and good service life.