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TECHNICAL NOTE TN-20

STRENGTH REDUCTION OF WIRE ROPE - PIN CONNECTIONS

INTRODUCTION

When a wire rope is bent around a pin the strands of the rope slide past each other to adjust themselves. As the bend is increased (that is smaller diameter pin), this movement of strands increases, particularly in the outer layers. The point where the wire strands are restricted is termed the critical diameter. At the critical diameter the wire rope's outer fibres become bound and unable to move, and this results in a reduction in the overall strength of the rope.

BENDING STRESS

Bending a wire rope causes individual wires in the rope to be subjected to a combination of tension, compression and shear forces. The force that is necessary to bend a rope around the object must be added to the total load on the rope. That is, the amount of useful load that can be handled by the rope is reduced.

CONNECTION STRENGTH

A wire rope connection (such as an eye splice) will only support a load that is a proportion of the rope's own breaking load. The ratio of the breaking strength of the connection to the total breaking strength of the wire rope, expressed as a percentage is called the efficiency of the wire rope connector (this may be close to 100%). Factors which affect connector efficiency include diameter and shape of the wire rope connector itself, the rope construction and the rope class.

This reduction in strength may be insignificant relative to the reduction in strength of the rope caused by it being forced around a small diameter connector.

Figure 1 - Wire rope-pin connection, with the wire rope deformed

A good example of this issue is if a wire rope is forced around a small pin or shackle (Figure 1). This causes a corresponding decrease in rope strength due to the bending stresses induced. A thimble should always be used in these situations to increase the diameter of the object the rope is being bent around.

Ratio R	% Strength
0.5	29
1	50
1.5	59
2	65
2.5	68
3	71
3.5	73
4	75
4.5	76
5	78
6	80
7	82
8	83
9	85
10	86

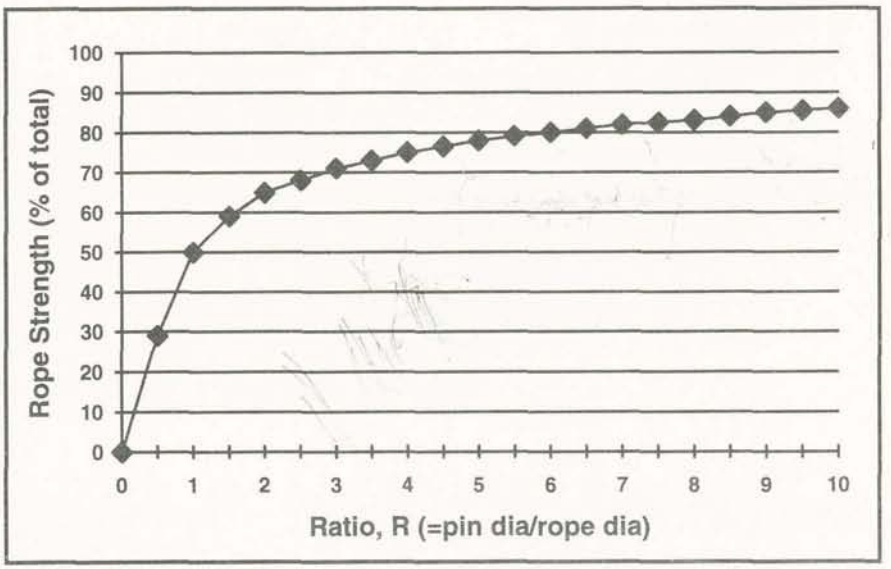

Figure 2 - Wire rope strength efficiency Table and Graph (from MacWhyte Wire Rope Catalogue G-18, 1982)

Figure 2 is a table and graph of the loss of wire rope strength caused by bending. The ratio R is the pin, thimble or sheave diameter divided by the rope diameter. The rate of decrease in overall rope strength increases dramatically after an R value of 4.

EXAMPLE

If we had a 19mm (RHOL 6 x 19) wire rope forced around a shackle with a 19mm pin, the overall strength is reduced by:

First calculate R, = 19/19 = 1.0

Then from Figure 2, when R = 1, the total rope strength is 50%.

From the manufacturer's specifications, the wire rope strength = 34.2 tonnes.

Total rope strength =
34.2 x 0.5 = 17.1 tonnes

Therefore, the effect of using a pin the same size as the wire rope is to lower the overall strength by half.

It is important to remember this is the breaking strength, to get the safe working load we still need to divide by 3.

Safe working load = 17.1 / 3 = 5.7 tonnes.

CONCLUSION

The breaking strength of a wire rope bent around connectors (such as pins) decreases as the ratio of the pin diameter to the rope diameter decreases.

With pin diameters less than four rope diameters, the breaking strength of the rope will be reduced by over 25%. In these situations, it is important to use thimbles to increase to diameter of the object the rope is being bent around.

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