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WIRE ROPE SPLICING METHODS

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Wire rope splicing methods have often contravened the "Safety Code for Bush Undertakings". While there has been much discussion about the relative merits and strengths of the different types of wire rope splices, no tests have been carried out.

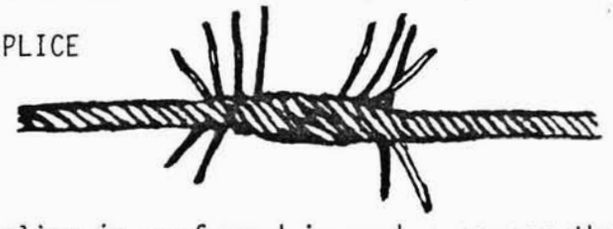
The Department of Labour's concern about the use of short splices prompted N.Z. Forest Products Limited (NZFP) to request Cookes Consolidated Services Ltd. (CCS) to carry out a series of tests to prove the merits or faults of the various methods.

To ensure a fair test for each splice, samples of similar rope were spliced by both NZFP and CCS riggers.

TYPES OF SPLICE TESTED

Tests were carried out on three methods of splicing:

THE BUTT SPLICE

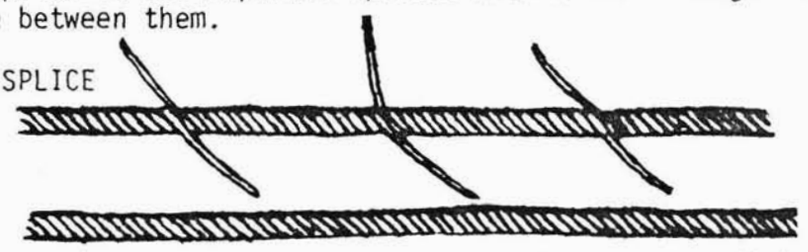


The butt splice is performed in such a manner that both splices run into each other, leaving in effect one splice. It should have a minimum of five tucks either side of the centre.

THE CUT SPLICE

The cut splice is two separate splices with a short length of each rope between them.

THE LONG SPLICE



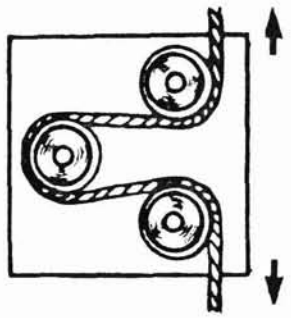
The long splice is difficult to describe briefly. When finished, the rope where spliced, remains the same diameter as the main body of the remaining rope.

TEST PROCEDURE

A total of 19 splices were tested to destruction by three different test procedures:

- a direct tensile pull to determine strength

- a wear test, with three offset sheaves run up and down on the rope with a 4000 kg load imposed



- a wear test for 400 cycles, then the tensile pull test to destruction

Samples of the three splices supplied by NZFP and CCS riggers were subjected to each test.

ROPES TESTED

One sample of butt spliced 28 mm 6 x 31 IWRC was given the tensile strength test. This rope had been in service and the splice and normal rope had been subjected to severe wear.

All remaining tests were carried out using spliced 16 mm 6 x 31 IWRC, in new condition. This size rope was selected as it was compatible with the sheaves in the test rig.

TEST RESULTS

TEST 1: 28 mm 6 x 31 (previously used) butt spliced. Breaking strain (BS) 50,300 kg when new.

Result - Sample broke at 45,735 kg, or 91% of the normal BS of the rope when new. This was a very good result in view of the general poor condition of the rope.

TESTS 2 - 7: Tensile pull tests, 16 mm 6 x 31 IWRC new rope, BS 16,400 kg

2	NZFP	Butt splice	Broke at 14,950 kg
3	CCS	Butt splice	Broke at 15,770 kg
4	NZFP	Cut splice	Broke at 14,300 kg
5	CCS	Cut splice	Broke at 15,416 kg
6	NZFP	Long splice	Broke at 15,000 kg
7	CCS	Long splice	Broke at 15,300 kg

Discussion - all splices broke where the splice terminated in the main body of the rope. This is quite normal. The relatively poor result of the NZFP cut splice was caused by unequal lengths of rope in the short area between the two splices.

TESTS 8 - 13: Bend cycles to destruction, 4,000 kg loading

8	NZFP	Butt splice	576 cycles to destruction
9	CCS	Butt splice	600 cycles to destruction
10	NZFP	Cut splice	543 cycles to destruction
11	CCS	Cut splice	531 cycles to destruction
12	NZFP	Long splice	136 cycles to destruction
13	CCS	Long splice	524 cycles to destruction

Discussion - the NZFP cut and butt splices bedded in well under working conditions and gave a very acceptable result. The NZFP long splice, however, was incorrectly performed and failed when one tail came out of the rope and caught in the sheaves.

TESTS 14 - 19: 400 bend cycles then destruction.

For these remaining tests, there were insufficient NZFP splices available so splices were performed by CCS riggers using the same dimensions and tucking sequences as used by NZFP.

14	NZFP	Butt splice	Broke at 15,400 kg
15	CCS	Butt splice	Broke at 15,325 kg
16	NZFP	Cut splice	Broke at 14,900 kg
17	CCS	Cut splice	Broke at 14,950 kg
18	NZFP	Long splice	No result
19	CCS	Long splice	Broke at 13,700 kg

Discussion - the cut and butt splices bedded in well and gave good results, as did the CCS long splice. The NZFP long splice failed for the same reason as Test 12.

CONCLUSIONS

BUTT SPLICE: Performed well on tests to destruction and simulated working conditions. All samples broke at the end of the splice.

CUTT SPLICE: Also performed well on tests to destruction. The lower figures for the destruction test after working, were caused by inter-strand cutting in the double area of rope between the splices, which cabled up during the in-service tests. Test numbers 4 & 5 broke at the end of the splice, while test numbers 10, 11, 16, & 17 all failed in the area between the splices.

LONG SPLICE: The NZFP long splice was obviously well below standard for various reasons:

- the splice was only 5 metres long against a recommended minimum of 19.2 metres.
- the core of a rope represents 40% of the rope diameter and the strands 30%. The tails in the splice had not been straightened out when they were tucked inside to replace the straight core, and they were not built up to the original core diameter. Failure to do this causes the strands to collapse and creates a pig-tail effect in the rope.
- the cross overs at the marry points were not opened to mesh in and allow uniformity. These points were very bulky.
- there were no packers under the marry points.

These comments should not be taken as criticism of the NZFP riggers. Long splicing is a completely different art to their normal splicing duties, and requires considerable expertise and years of experience to perfect. If not done correctly a long splice can be dangerous as well as wasting time and rope. The CCS riggers had 12 years experience in long splicing and this showed up in the better test results.

A further disadvantage of the long splice for logging operations is the length of splice required (38.5 metres for a 32 mm rope). There is also the difficulty of finding a suitable area to perform the splice in the forest. It takes approximately one and a half days to perform this splice, against three hours for a butt splice. The rope is also weakened because the IWRC is removed. On lengths used for skylines and mainlines, the core creeps back from the tail ends leaving a section of rope with no internal support, and allows the strands to collapse and cut each other.

SUGGESTIONS

Although it is not the normal practice of CCS to suggest the use of a butt or cut splice for use around sheaves, the circumstances surrounding logging operations lead us to do so for the following reasons:

- sheaves on logging blocks and carriages are generally wide enough to allow the passage of the bulkier splices without too severe a cutting action
- the tests conducted indicate a high degree of reserve strength even after severe wear (Test No. 1 is a good indication of this).
- a relatively inexperienced person can put a safe splice in a rope using the cut or butt splice
- the cut and butt splices have been in common use in the logging industry for many years and the old adage of tried and true must be of value.

It is recommended that a butt splice be used in preference to a cut splice. Although both gave good results, the butt splice was consistantly better. Finally, it should be remembered that any sort of splice creates a weakness in the rope through distortion, and as such should always be subjected to close inspection at all times.

LIRA COMMENT

Traditionally long splices have been considered the proper and safest splice for running rigging in bush haulers. They were commonly used in skylines, mainropes, and tailropes in native and early large treee exotic logging. It is noteable also that the "Oregon Safety Code", which is used as a model for safe practices in cable logging, specifies that long splices should be used.

Over recent times, however, butt or cut splices have replaced long splices in many operations, but they are prohibited by the "Safety Code for Bush Undertakings". This trial appears to indicate that long splices are not warranted, and that in pratcice, are less safe than the simpler splices. Most sheaves on logging blocks for running rigging have shallow side grooves which allow the bulkier butt and cut splices to pass freely. Consideration should therefore be given to these facts when the "Safety Code for Bush Undertakings" is next revised.

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