Fighting fatigue

Wire rope expert Roland Verreet, based in Aachen, Germany, has developed a new wire rope test machine which overcomes all the flaws of conventional bending fatigue testers. He spoke to EUAN YOUDALE about the new machine

A criticism held by Roland Verreet is that typical wire rope bending fatigue test machines only use a single test sheave. “If you have a bad rope, you want your test machine to tell you that it is a bad rope,” explains Verreet, “If, for example, the rope was manufactured with incorrect back twist, which will create problems on a crane over time, the conventional test machine will not detect this problem. The looseness will be milked out of the test zone, and then the machine will test a good rope.”

The reeving system on a crane, however, often has many sheaves, continues Verreet, if one sheave tries to move the problem forward to the next sheave, it will milk the looseness back to the previous sheave. “This way the looseness will stay in the system, and the rope will deteriorate prematurely.”

Using Verreet’s new test machine the rope travels over a number, typically five, test sheaves. The rope runs through the reeving system with no fleet angle. “After installing the rope, you just press a buttom to start the test. Then an hydraulic cylinder will put the rope under the required tension, and the rope will be cycled back and forth through the reeving system until the rope finally breaks. Only then the analysis of the rope begins,” says Verreet.

Close analysis

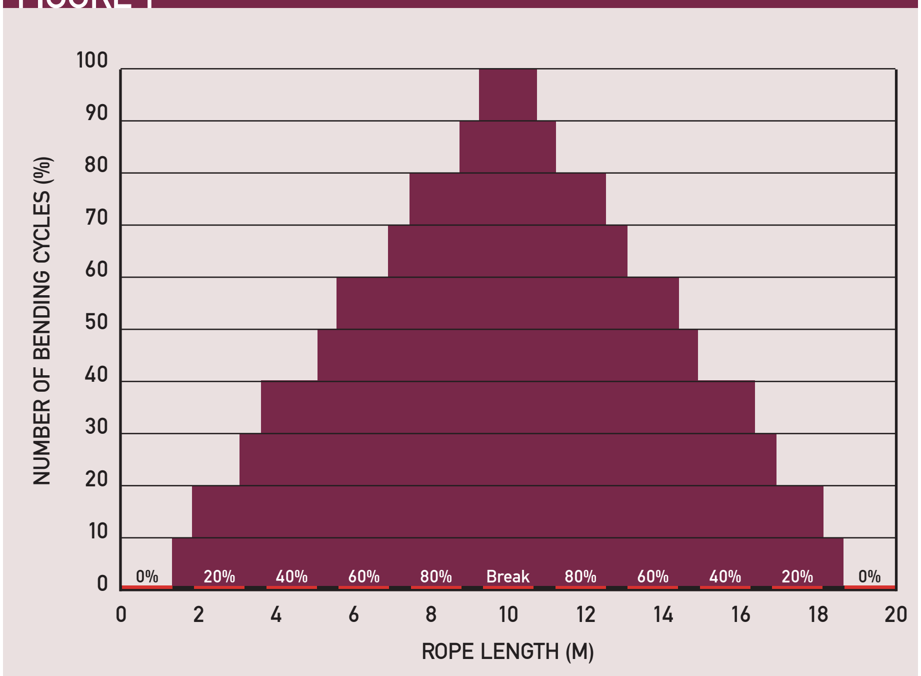
An important part of the test is that one section of rope will travel back and forth over all five sheaves and, therefore, make 10 bending cycles during one machine cycle – this is the rope section that will finally break. “On both sides of this section, you will find two sections of rope, for example, 1.5 metres long, which, during every machine cycle, will only travel over four sheaves and back and never will make it to the fifth,” explains Verreet. “Regardless what the test result will be, this section will always only make 80% of the number of cycles to failure.

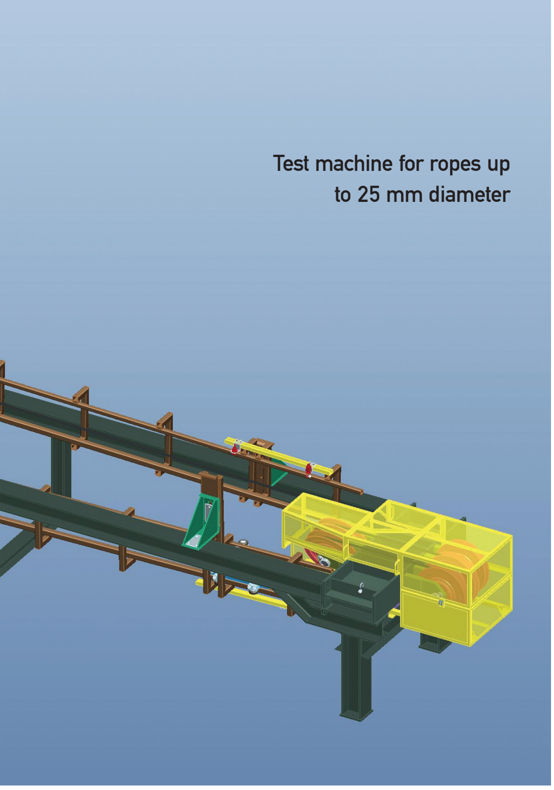
“So, if you want to know how many wire breaks will be visible on the outside of the rope on a reference length of 30 times the rope diameter at 80% of the cycles to failure, all you have to do is analyse this section of rope,” adds Verreet, “If you want to know how many internal wire breaks this rope will have after 80% of the cycles to failure, all you have to do is take this rope apart and analyse the internal condition.”

Without stopping the test, it is possible to analyse what the remaining strength in the wire rope will be after 80% of the cycles to failure by carrying out a break test with the other section that has only made 80% of the cycles to failure.

In a similar way there will be sections that only travel over three sheaves, two sheaves or one, making 60%, 40% and 20% of the cycles to failure (Figure 1). “This means, that by analysing these sections, you will get a perfect understanding of your wire rope,” says Verreet, “The sections will tell you how the external wire breaks develop with the increasing lifetime of the rope, how the internal wire breaks develop over time, how your plastic infill looks at different stages of the rope life and which elements start to deteriorate first. This last point is very important because it can help you improve the product design after only one single test.”

FIGURE 1





Test machine for ropes up to 25 mm diameter

Lifetime test

This single test will also provide the user with an insight into how the strength of the rope develops over its lifetime (Figure 2).

A steel wire rope with a new breaking strength of 100% should have a strength greater than 100% up to about 50% of the number of cycles to failure, explains Verreet. Then the wire rope will deteriorate and finally break under the test load.

Verreet's tester has two wireless load cells, installed in the line, which transmit line pull data to a recorder. It means that during the test the friction loss of five sheaves can be continuously measured.

Verreet says there are already global industry and university-based customers for the machine around the world, including Switzerland-based rope manufacturer Verope which has two units in its laboratories.

One of the first tests Verreet made using the new test machine was for NASA in the USA. The NASA engineers were operating the space station assembly crane with unlubricated steel wire ropes, says Verreet. Lubricated wire ropes were forbidden because the lubricant might have dropped down from the crane and contaminated the goods that were loaded into the cargo bay of the space shuttles. The NASA engineers wanted to know whether the standard discard criteria was applicable to unlubricated wire ropes. Verreet answered in the negative, because the discard number of wire breaks found in the standard criteria is based on a great number of tests which were all made with lubricated wire ropes. So NASA decided to have some bending fatigue tests made with unlubricated ropes.

"Of course, the test results showed that the fatigue life was lower than that of lubricated wire ropes," says Verreet, "But the evolution of rope strength over the life time of the ropes was very surprising: The ropes showed an increase in strength which was far greater than the increase found with lubricated wire ropes, and the rope sections, which had made 60% and 80% of the cycles to failure had breaking strengths which were still better than the strength of the brand new rope." Verrett concludes, "This means that an unlubricated rope will be stronger than when it was new for about 90% of its lifetime, but then it will very suddenly lose strength and fail catastrophically."

Wider research

But why is an unlubricated rope so much stronger at 80% of its number of cycles to failure than a lubricated wire rope? Verreet explains, "With an increasing number of cycles, more and more wire breaks will occur within the wire rope. This should weaken the wire rope more and more. But due to the helical shape of the individual wires, friction builds up along the length of the strand, similar to the way it can build up force by wrapping a rope around a capstan."

The speed of recovery for the wire depends on the co-efficient of the friction. "The more friction, the less impact a wire break will have on the strength of the rope. And, of course, an unlubricated rope will

ROLAND VERREET

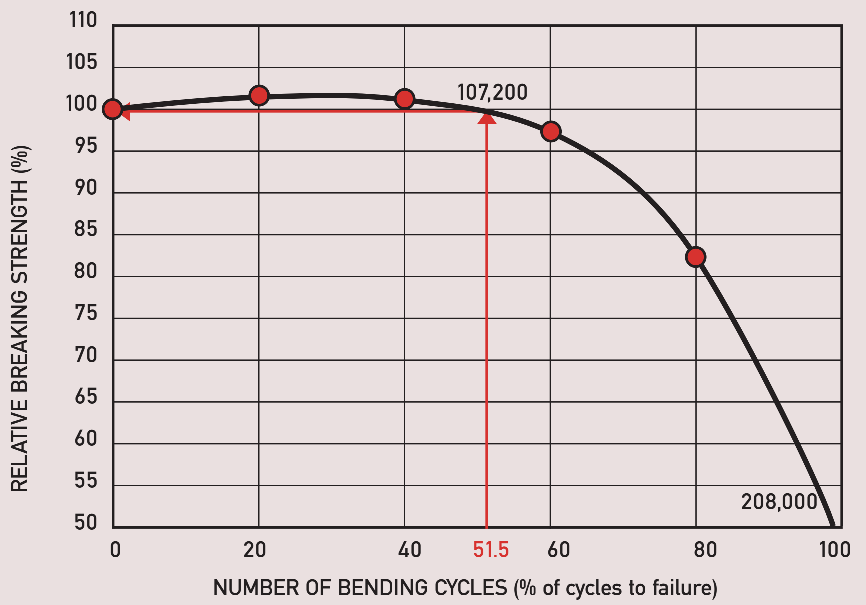
Roland Verreet has worked in the field of wire rope for 37 years and is a former president of OIPEEC, the international organisation for the fatigue study of ropes. He has his own company Wire Rope Technology Aachen which specializes in steel wire rope failure analysis. Verreet also designs steel wire ropes as well as working as a consultant to steel wire rope manufacturers and users, mainly in the crane and mining industries. In addition, he lectures on ropes and reeving systems at the University of Clausthal, Germany, the town in which wire rope was invented in 1834. For more information see his website www.ropetechnolgy.com

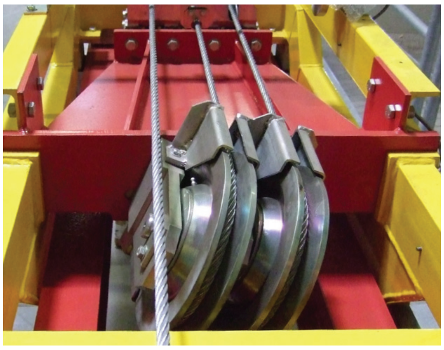
have more friction between the wires and, therefore, it will have more strength with the same number of wire breaks than a lubricated rope," explains Verreet.

This discovery holds a valuable lesson for crane users around the world: if your rope shows corrosion and a greater number of wire breaks, do not make the mistake of lubricating it. "The friction caused by the corrosion is probably the only thing that holds this wire rope together. By lubricating the rope you might reduce the friction so much that the wire rope will break at the next loading," states Verreet.

"What you should do instead is continuously lubricate your wire rope to avoid such a condition to occur. But, if it occurs, do not try to lubricate the rope to hide the problem, just replace the old rope with a new one," Verreet advises.

FIGURE 2





Verreet's wire rope testing machine in operation

In addition, when designing reeving systems with a great number of sheaves, an accurate knowledge of rope efficiency is very important. Verreet's machine supplies this data not only for a new rope, but for the different stages of the rope's lifetime.

"If the static line pull on the machine is set to 10 tonnes, the line pull will increase going in the one direction because the rope is pulling against the efficiency loss of five sheaves, if the other side is pulling, the linepull will go below 10 tonnes because now the other side is pulling against the efficiency loss of five sheaves."