High-tech fibre supports installed on a shovel

Good Vibrations for draglines and shovels

Applied Fiber Manufacturing makes a case for replacing steel cables with high-tech fibres as the material of choice for supporting the massive booms of cranes and draglines. Tests showed their fibre-fitted product reduces vibration that causes damage to surface mine draglines and shovels.

By Jim Pumphrey and Allen Plymon*

Fibre has been providing benefits for rigging solutions across the globe for decades. Applied Fiber combines their termination technology for high-capacity applications (defined as upwards of 1 million pounds minimum breaking load) with Dyneema fibre as the strength member to supply shock damping fibre pendants for electric rope shovels and draglines on surface mines worldwide.

Steel cables have been used for years to support the massive booms for cranes and draglines. The heavy steel strand pendants have been the only product that could take on such a task until DSM developed its latest Dyneema-branded high-tech fibre, DM20. The fibre pendants replace the steel at a higher overall strength value, safety factor and dramatic weight savings per linear foot.

In addition, the fibre pendants provide a benefit that most mine maintenance teams do not consider when they first evaluate its viability – massive reduction in vibration and excellent shock damping properties.

Most manufacturers and operators aim to reduce vibration on heavy equipment. Draglines and shovels are regularly in need of repair due to the damage that vibration and shock loading causes to the machine parts. Reducing vibration extends the life of expensive metal parts and reduces total cost of ownership.

Applied Fiber's advanced termination technology for fibre ropes enables the use of the material for boom support pendants as it provides a robust termination/end fitting on length-matched fibre pendants. The connection eliminates wear at the end points and maximizes the performance of a protected/armored rope in this rugged mining application.

Upon the switch from steel pendant cables to DSM fibre there is a noticeable drop in vibration on the shovels and draglines. This vibration can be felt throughout the equipment.

"One of our operators went from having numb hands at the end of a shift to having no issues – the difference both in the cab and outside the machine is very noticeable. Putting a low-mass dampener into the boom makes all the difference." said Wade Steiger, Manager of Inspection Services at Navajo Transitional Energy Company (NTEC).

Electric rope shovels used in coal, gold and copper mines around the world see substantial fatigue and abuse during their service lives. Metal parts fatigue and wear out; booms, dipper sticks, gantry, and revolving frame components require welding crews to repair cracking and fatigue as a part of regular maintenance routine. Adding more steel or just fixing the cracks is not always the best solution. A preventive maintenance approach with the switch to the lightweight Applied Fiber damping pendants reduces the fatigue and vibration which would lead to much of this routine wear and tear. A big cost saver when downtime can be reduced.

Another large contributor to shovel breakdown and maintenance issues is "boom jacking". Boom jacking is one of the more violent events that a rope shovel can experience in operation. It occurs when the pendants supporting the boom go slack as a result of the boom being driven upward by the dipper. When the shovel reengages, the boom drops freely, slamming downward and severely shock-loading the pendant cables and system overall.

The forces created when this occurs are substantial. Drop testing has shown that peak shock loads are ►

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**Jim Pumphrey is Applied Fiber's vice president, Industrial Products, and Allen Plymon is Category IV Specialist at Plymon Vibration Consultants.*

Fibre-equipped shovel pendants ready to be installed

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reduced up to 50% when fibre is used for the pendants instead of steel. This translates to significantly less impact/damage on the shovel when boom jacking does occur.

A key to the difference in performance is the increased damping provided by the fibre pendants compared to steel. Mine operators are experiencing the difference when they operate the machines, but understandably want more information and support on how to further quantify the difference.

"We know that fibre rope vs steel rope reduces peak shock loads by over 50% in comparative drop tests. Additionally, our clients requested test data on the damping properties of the pendants for their equipment." said Paul Badeau, VP Sales for Applied Fiber.

Applied Fiber performed a vibration and damping comparison between steel and fibre in their manufacturing facility just outside of Tallahassee, Florida. The test compared steel pendant strand vibration with that of fibre pendant strands. Both specimens were axially loaded in tension on Applied Fiber's horizontal Instron tensile test bed.

Utilizing diagnostic tools and software, Plymon Vibration Consultants performed third party testing to provide data analysis and comparative observation. Plymon assists companies in building predictive maintenance schedules for heavy machinery and guidance on improving systems reliability.

The physical test placed accelerometers along the length of the fibre rope and steel wire strand, A calibrated impact hammer was used to apply equal force to both specimens. Measurements were captured to measure how the fibre and steel behave.

During these tests, fibre showed 10 to 20 times more damping in comparison. The fibre absorbs this energy as it materially dampens the impact load applied.

"We routinely work with and measure vibration on steel machines, turbines and shafts to help us better predict replacement and maintenance cycles for critical components," said Allen Plymon of Plymon Vibration Consultants. "I have never worked with this fibre material before and was amazed with its damping properties. Vibration is a large contributor to fatigue and failure in the systems we analyse. It's clear from these results that the fibre rivals some of the best materials to mitigate industrial vibration and damage to equipment and machines."

"We are thrilled to have this data to further support what operators have been telling us about the performance." said Applied Fiber's Badeau. "While we set out to design a product that was lighter weight and would allow users to add capacity and extend life of the pendants,

this data supports that the pendants also provide a much needed damper in the load path. It's like adding a shock absorber to the boom and provides benefits for both draglines and, even more importantly, electric rope shovels."

NTEC mines have been operating Marion 8200 and Bucyrus 1570 draglines with Applied Fiber pendants for several years, and inspection services manager Steiger said: "On the 1570, the dragline is running much smoother with significantly less fatigue. We would typically see regular cracks in boom nodules #8, #10, and #14… creating 1-2 weeks downtime a year. Since installing fibre pendants two years ago – we have yet to have cracks in this region. We estimate that we gained 1-2 weeks production in the first year of operation alone with the same in the second year."

In all, NTEC has been running three machines for a combined 9 years without fatigue cracks and additional welding required.

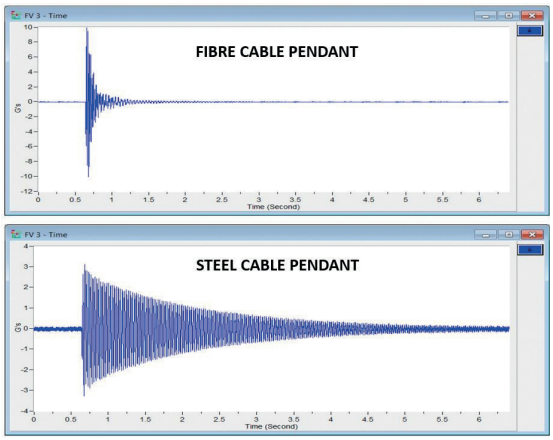
NTEC has seen a substantial return on investment. While they initially purchased the pendants to increase machine capacity, the benefits to maintenance and reduction in cracking on the boom exceeded expectations. Their draglines are moving more payload while running smoother with less stress overall.

Applied Fiber installed its first set of fibre dragline main pendants over four years ago on a Marion 8200 Dragline at NTEC's Antelope mine, and the pendants are proving more benefits than initially planned. It is the driving reason why the company has converted its dragline fleet to the fibre pendants.

"The Applied Fiber pendants are a true step change in dragline technology. We converted a Marion 8200 in 2016, an 8200 in 2017, and a BE1570 in 2018 – all of which have nearly eliminated fatigue cracks and welding while smoothing out the machine operation." said NTEC's Steiger.

Reducing risk and increasing returns are the key factors for operators to make the conversion to synthetic. The fibre pendants are proven and tested at Applied Fiber's manufacturing facility. All the cables are proof loaded and measured at tension on Applied Fiber's test bed handling proof loads up to 500 tonnes.

"Applied Fiber's pendant adoption is accelerating now with years of proven success on draglines and shovels. Additionally, our innovative inspection and monitoring technology coupled with increased safety factors facilitates the mine's transition away from steel pendants and the sometimes unreliable steel inspection methodologies," added Applied Fiber's vice president for Industrial products, Jim Pumphrey.



Graph showing the damping effect of fibre pendants compared with conventional steel cable