SYNTHETIC SUPPORT PENNANTS FOR STRUCTURES

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INTRODUCTION

Innovative structures have been designed and built around the world incorporating advanced synthetic support cables. Typically, they are deployed on assets in two types of environments. First, where inspection and maintenance are difficult to execute, for example, hard to reach remote areas where corrosion needs to be eliminated. And secondly, where weight reduction is required, coupled with continuous cyclic strain and high creep requirements. Traditional materials cannot provide the same long term, maintenance free performance. Synthetic cables provide the structural engineer with the ability to optimize designs due to the reduced weight of the suspension cables and additional benefits summarized in this poster.

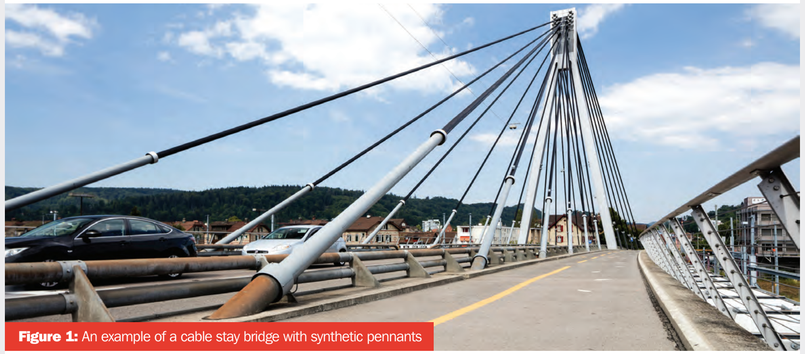


Figure 1: An example of a cable stay bridge with synthetic pennants

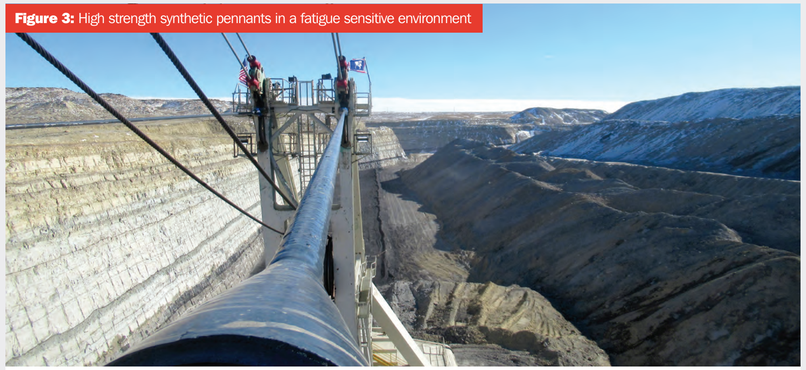
SYNTHETIC SUPPORT PENNANTS

Of the many types of high performance fibers available, Para-Aramids, are particularly relevant to bridge and structural applications. Aramids exhibit high tenacity and creep resistance, even in elevated temperatures. Additional benefits are extremely low elongation characteristics over time and a high stiffness after pre-tensioning.

In comparison to steel, conventional high strength synthetic fiber cables are up to 1/5 of the weight. Table 1 below lists the Minimum Breaking Force (MBF) of synthetic and steel ropes along with the weight per foot of each product. The two products are compared showing the drastic differences in weight. Further weight savings and diameter reduction can be achieved by selection of specific fibers and terminations – these are not shown in the table below.

Figure 2: Custom terminations with synthetic support pennants

Figure 3: High strength synthetic pennants in a fatigue sensitive environment



INDICATIVE VALUES[1]							
MBF			Synthetic weight	6x36 Bridge steel rope	Weight Saving	Diameters	
MBF T (2000 lb)	MBF (lb)	MBF (kN)	lb/ft	lb/ft	%	Synthetic[2]	Steel
300	600,000	2,669	2.15	11.62	542%	2-5/8	2-1/4
343	685,000	3,047	2.75	12.74	463%	2-3/4	2-3/8
366	732,000	3,256	3.25	13.90	428%	3-1/4	2-1/2
500	1,000,000	4,448	4.49	21.00	467%	4-1/2	3
780	1,560,000	6,939	5.97	28.50	478%	6	4-1/8

Table 1: Cable Minimum Breaking Force and Weight Comparison

1) Specifications are approximated and require explicit verification
2) Diameter measures larger, in part due to the protective cover braided around the rope.

STRUCTURAL ADVANTAGES

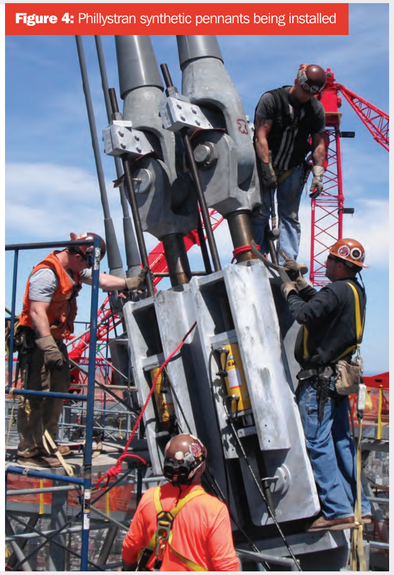
In static structural applications, synthetic fibers have been shown to improve the vibration dampening characteristics of structures. Although a slightly larger diameter rope may be required to match the stiffness and strength of steel rope, the synthetic fibers can provide superior resistance to tension-tension fatigue and have negligible creep effects. An estimated Modulus of Elasticity of 9.2 x 10^6 psi for synthetic cables is close to the elasticity range of steel wire rope. Since 1980, they have been deployed in heavy duty markets. Innovation has continued to reduce pennant cost and maintenance. Today, synthetic fiber's technical and commercial advantages are an on-going source of new product - market combinations.

A synthetic cable is approximately 1/5th of the weight of a steel cable, allowing weight reduction for total bridge design optimization. Even higher weight savings are achievable by selecting specific fibers and terminations.

MAIN ADVANTAGES OF FIBER PENNANTS:

- **No corrosion**
- **Fatigue resistance higher than steel**
- **High stiffness**
- **Higher natural frequency**
- **Vibration absorption relieves contact and bearing points**
- **Easier installation and removal for remote and hard to reach areas**
- **Reduction of overall design weight**
- **High creep resistance**
- **No WiFi / Radio / Cellular network interference**
- **Non-conductive**
- **Recyclability of fibre at end of service life.**

Figure 4: Phillystran synthetic pennants being installed



CONCLUSION

So far, the bridge engineering community has only scratched the surface of the potential offered by synthetic fiber cables. Prospective applications in cable stayed bridges include temporary suspension, greenfield developments and retrofitting existing structures as steel cable needs replacing.

As the span length of a new suspension bridges increases, the weight of the cables required increases in relation to the total weight of the suspended structure. This is applicable to both the main cable and the suspension cables. A higher percentage of the cable stress is, therefore, related to the self-weight of the cables themselves. The use of lightweight synthetic support pennants or cables can greatly reduce the stress in the overall system dynamics, allowing for lighter structures that are capable of longer spans.