

Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte
Band: 82 (1999)

Artikel: Damping characteristics of carbon fiber composite cables for application in cable-stayed bridges
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DOI: <https://doi.org/10.5169/seals-62156>

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Damping Characteristics of Carbon Fiber Composite Cables for Application in Cable-Stayed Bridges

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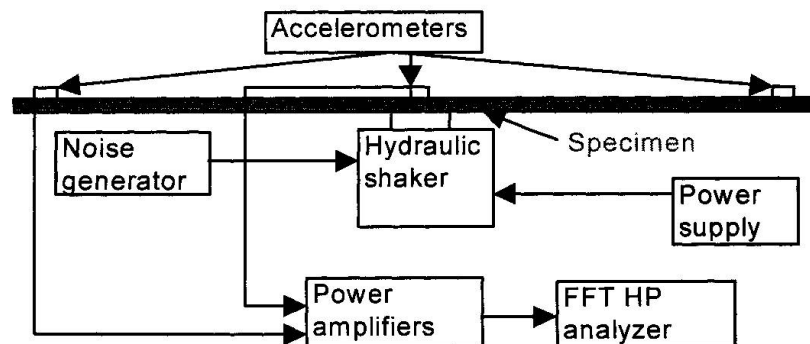
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Abstract

The paper presents the results of experimental and analytical studies on the loss factor of CFRP and prestressing steel tendons when subjected to out of-plane loading. Damping characteristics are then estimated from the loss factor. Aluminum samples were first used as control specimens to calibrate the accuracy of the setup. Several CFRP tendons with different lengths and diameters were subjected to forced vibrations using a hydraulic shaker to apply white noise (up to 20Khz) on the double cantilever system. Accelerations were measured using "piezoelectric accelerometers" and the data is obtained through a fast fourier transform (FTT) analyzer. The setup of the experiment is shown in the given schematic.



Schematic of the test apparatus for measurement of response of double cantilever specimens.

The results are presented as graphs expressing the relation between the loss factor, length, and the eigenvalues of different mode shapes. Similar tests have been performed also on steel strands, which are commonly used as cables for CSB. The results are presented as graphs expressing the relation between the loss factor, length, and the eigen values of different mode shapes (fig.1). Analysis of the experimental results is performed using both the half power band width, and the resonance dwell technique to obtain the loss factor of the specimens at different frequencies, the shape function, and the relation between loss factor and the ratio between acceleration at the cantilever tip to the support movement.

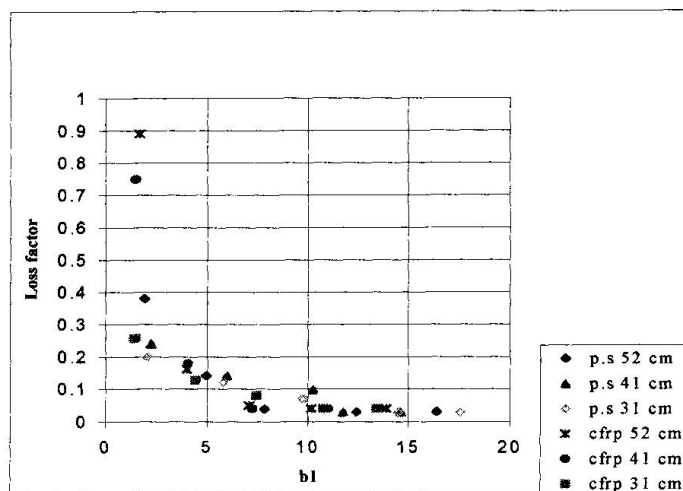


Fig. 1: Loss factor for 12.5mm diameter CFRP and prestressing steel Specimens.

The results of the experiments are used in calculating the damping ratio of CFRP and prestressing steel cables with different length (table 1), which shall be used afterwards in the computer analysis of different CSB cables subjected to different cases of loading (wind,..etc.). Axial damping and fatigue characteristics for CFRP tendons are currently tested and results may be available in the near future.

Material	Horizontal Projection (metres)	Cable length (metres)	Sag ratio	Strain energy ratio	Damping ratio
Steel	330	465	0.0026	0.01	.005 μ
	440	622	0.0035	0.02	.01 μ
	660	933	0.005	0.05	.025 μ
CFRP	330	465	0.001	0.002	.001 μ
	440	622	0.0015	0.004	.002 μ
	660	933	0.0022	0.01	.005 μ

Table 1: Damping ratio for CFRP and PS cables as a function of loss factor.