TOKYO ROPE USA, INC.

CFCC®

CARBON FIBER COMPOSITE CABLE

BENEFITS OF CFCC®

LIGHT WEIGHT
About 1/5 the weight of steel strand with a specific gravity of 1.5

CORROSION-FREE
High acid and alkali resistance

NON-MAGNETIC

LOW LINEAR EXPANSION
The coefficient of linear expansion is approximately 1/20 that of steel

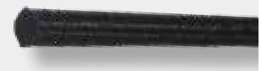
HIGH TENSILE STRENGTH
Better than that of PC steel strand

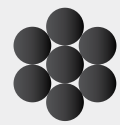
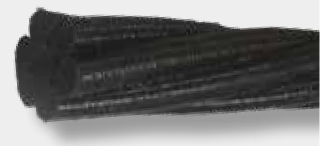
FLEXIBILITY
The stranded configuration of the cables allows them to be easily coiled

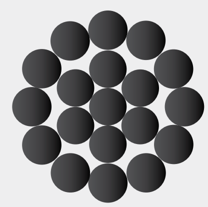
HIGH TENSILE MODULUS
Similar to that of PC steel strand

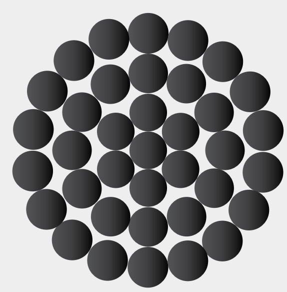
HIGH TENSILE FATIGUE PERFORMANCE
The fatigue performance of CFCC is superior to the PC steel strand

LOW RELAXATION LOSS
The relaxation performance of CFCC is nearly the same as low-relaxation PC steel strand


CFCC U



CFCC 1x7



CFCC 1x19



CFCC 1x37


CFCC (Carbon Fiber Composite Cable) is a cable used for reinforcement of concrete structures, developed with composite technology utilizing carbon fibers and thermosetting resins, and forming into a stranded cable.

Due to the exceptional properties of carbon fiber, CFCC exhibits superior characteristics than any other cable in terms of high tensile strength, high tensile modulus, light weight, corrosion free, non-magnetic interact and low linear expansion.

The stranded construction of CFCC allows for ease of handling and shaping. CFCC PC strand is coiled on a reel and accommodates applications that require long lengths. CFCC features provide the opportunity to create concrete structures with an exceedingly longer service life amongst many other benefits for multitudes of applications.

CFCC is patented in 10 countries world-wide.

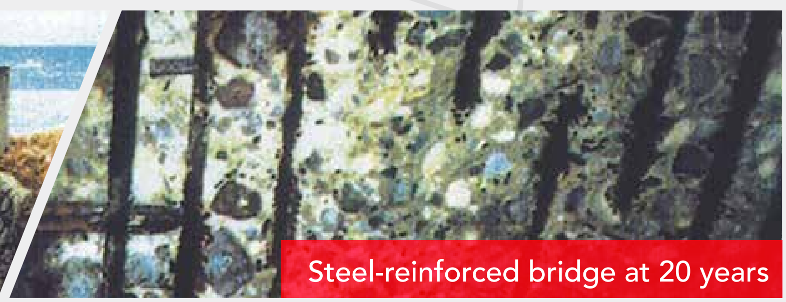
FLEXIBLE / LIGHT

CFCC Is flexible and can be wound on a reel due to its stranded-wire structure. At 1/5 the weight of steel, it is easy to transport and install without the use of large, heavy machinery.

NON-MAGNETIC

CFCC is non-magnetic and therefore does not negatively affect communication equipment, automated conveyor systems, etc. This feature also eliminates the demagnification process sometimes needed when steel reinforcement is used.


Bridge reinforced with steel rebar


Steel-reinforced bridge at 20 years


Bridge reinforced with CFCC


CFCC-reinforced bridge at 20 years

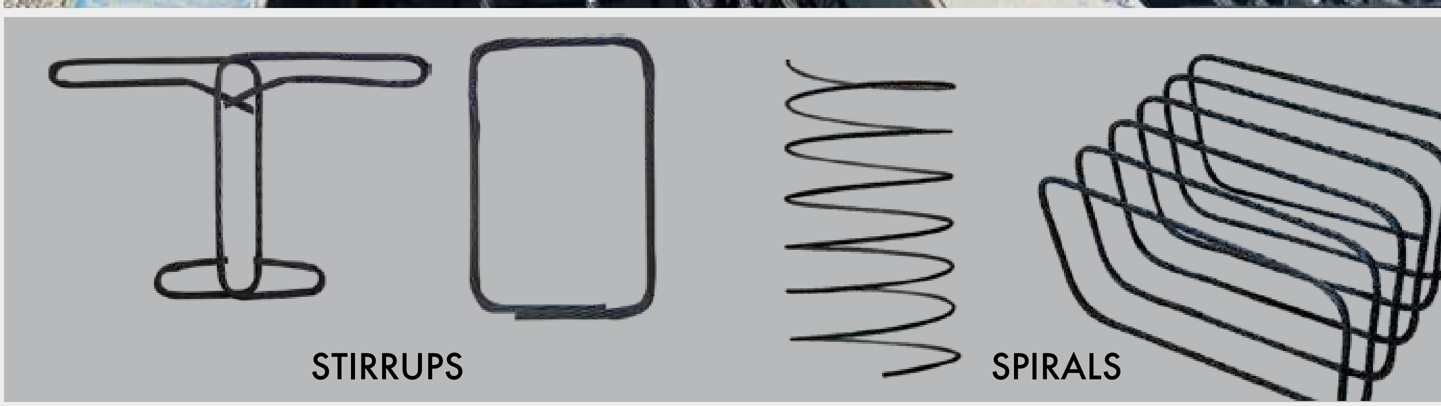
Shinmiya Bridge, Ishikawa Pref., Japan

NON-CORROSIVE

CFCC has high corrosion resistance and strong resistance against acids, alkalis, and chemicals while exhibiting outstanding resistance in marine environments and areas with substantial acidity.

APPLICATIONS

CFCC is used in many piles and girders. The absolute reliability of CFCC against corrosion, especially in coastal areas and areas that use deicing salt on the roadways, has led to its adoption in numerous projects.



CFCC is used as reinforcement because of its high modulus of elasticity and its ability to be freely shaped. The superior modulus, as compared to other FRPs, allows for the use of CFCC reinforcement with smaller diameters, therefore reducing the quantity of concrete, weight of reinforcement, and overall weight of the concrete product.

GROUND ANCHOR

CFCC's non-corrosive property and excellent strength and durability make it ideal for use as a ground anchor in harsh environments. CFCC is also light weight which allows for ground anchors to be installed without using heavy machinery.

POST-TENSION

CFCC is also used in the post-tensioning system, taking advantage of its unique terminal technology.

CFCC SPECIFICATIONS

Cross Section	Designation		Diameter inch	Cross Section Area mm²	in²	Guaranteed Capacity kN	kip	Nominal Mass Density g/m	lb/ft	Tensile Elastic Modulus kN/mm²	ksi	Pre-Tension	Post-Tension
	CFCC U	5.0 Ø	0.20	15.9	0.025	40.4	9.1	30	0.020	167	24,221		✓
	CFCC 1x7	7.9 Ø	0.31	31.1	0.048	79.3	17.8	60	0.040	155	22,481		✓
	CFCC 1x7	10.8 Ø	0.43	57.8	0.090	147.2	33.1	112	0.075	155	22,481		✓
	CFCC 1x7	12.5 Ø	0.49	75.6	0.117	192.5	43.3	146	0.098	155	22,481	✓	✓
	CFCC 1x7	15.2 Ø	0.60	115.6	0.179	294.4	66.2	223	0.150	155	22,481	✓	✓
	CFCC 1x7	17.2 Ø	0.68	151.1	0.234	385.0	86.6	292	0.196	155	22,481	✓	✓
	CFCC 1x7	19.3 Ø	0.76	186.7	0.289	475.6	106.9	360	0.242	155	22,481		✓
	CFCC 1x7	26.2 Ø	1.03	339.2	0.526	864.1	194.3	655	0.440	155	22,481		✓
	CFCC 1x7	28.9 Ø	1.14	412.5	0.639	1051	236.3	796	0.535	155	22,481		✓
	CFCC 1x19	34.3 Ø	1.35	567.0	0.879	1342	301.7	1,095	0.736	145	21,030		✓
	CFCC 1x37	40.9 Ø	1.61	798.7	1.238	1765	396.8	1,544	1.038	145	21,030		✓

CFCC CHARACTERISTICS

	Items		Value	Remarks	Test Method
Dynamic Characteristics	Relaxation Rate	(%)	0.8	1,000 hr	JSCE-E534
			1.5	1,000,000 hr	
	Creep Rupture Strength	(%)	96	3 months	ASTM-D7337
	Coefficient of Linear Expansion	(x10-6/°C)	0.6	20~200°C (68~392°F)	JISK-7197
	Bond Strength *2	(Ksi)	1.16	0.002 inch slipped	JSCE-E539
		(N/mm2)	8.0	0.05 mm slipped	
	Transfer Length	(inch)	2.56 x d	d:CFCC diameter	–
		(mm)	65 x d		
	Fatigue Strength (Stress Range) *3	(Ksi)	87	2,000,000 times	JSCE-E535
		(N/mm2)	600		
	Bending Point Strength *4	(%)	57	Retension rate from maximum load *1	JCI-SCF3
	Harped Tensile Strength *5	(%)	95		JSCE-E532
Durability	Alkali Resistance *6	(%)	94	Retension rate from maximum load *1	ASTM-D7705
	Acid Resistance *7	(%)	100		–
	Heat Resistance *8	(%)	75		–
	Cold Resistance	(%)	100		–
	Water Resistance	(%)	100		–
	Ultraviolet Resistance	(%)	100		–
	Salinity Resistance	(%)	100		–

⋆ 1 : Remaining percentage of strength when the maximum tensil load is set as 100%

⋆ 2 : Concrete compressive strength 45 Mpa

⋆ 3 : Average stress is 70% of guarantee strength

⋆ 4 : R/d=3.3, R=radius, d=diameter

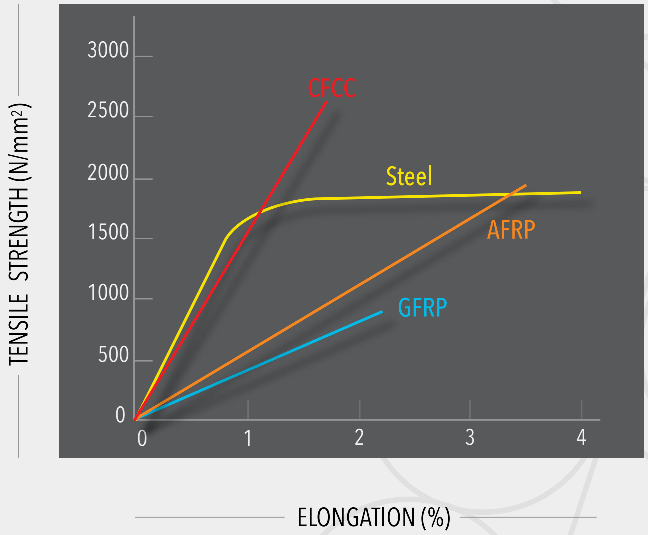
⋆ 5 : D/d=65.8, 2θ=10°, D=bending diameter of deflector, d=diameter, θ=bending angle

⋆ 6 : PH12.8, 122°F, Estimated retension value by Arrhenius method

⋆ 7 : PH3~4, 176°F, 5 years exposed

⋆ 8 : Test temperature is 212°F, Retention of tensile strength is 100% when returned to room temperature after heating

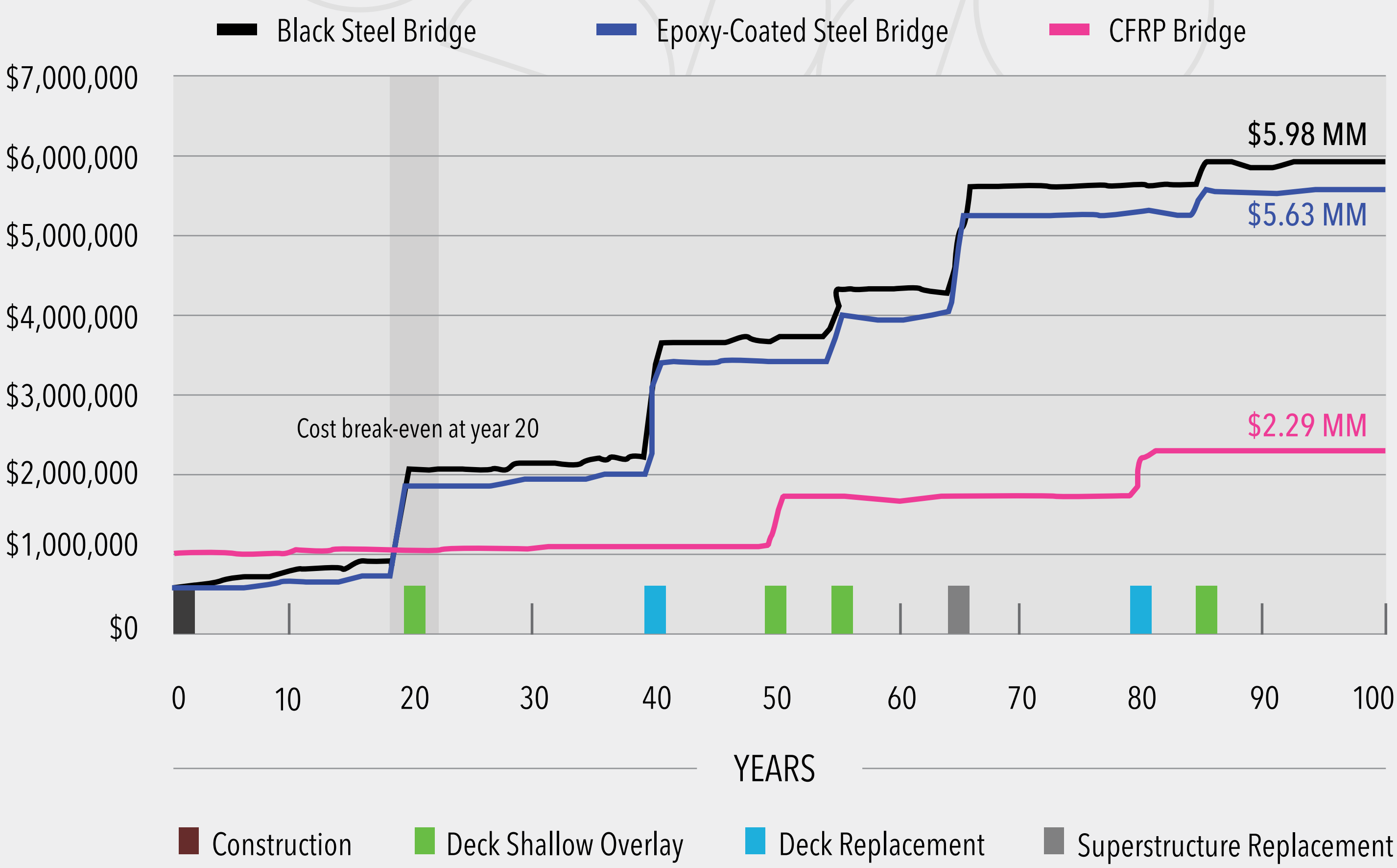
LOAD-ELONGATION CURVE



MATERIAL COMPARISON

		CFCC	AFRP	GFRP	Steel Strand
Density	lb/in³	0.0542	0.0470	0.0614~0.0686	0.284
	g/cm³	1.5	1.3	1.7~1.9	7.85
Tensile Strength	ksi	319~370	160~276	87~131	247~276
	N/mm²	2200~2550	1100~1900	600~900	1700~1900
Elastic Modulus	ksi	21030~23931	7252~10153	4351~7252	29008
	N/mm²	145~165	50~70	30~50	200
Relaxation	%	1.5	11~18	–	1.5~5

LIFE-CYCLE COSTS: COMPARISON OF VARIOUS STRAND AND REINFORCEMENT MATERIALS IN THE GIRDERS AND DECKING



Life-Cycle Cost Analysis of Carbon Fiber-Reinforced Polymer Reinforced Concrete Bridges
- ACI Structural Journal

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