Field Application of Carbon Fiber Composite Cable Post-Tensioning System

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Projects of Carbon Fiber Composite Cable in US

	DOT		Name of the project or bridge	construction	application	
1	Michigan DOT	1	Bridge Street Bridge	2001	 Unbonded Transverse Post tensioning 	
					•Externally Draped Longitudinal Post tensioning	
		2	●M-39	2011	 Unbonded Transverse Post tensioning 	
		3	●M-50	2012	 Unbonded Transverse Post tensioning 	
		4	• M-102 (Eastbound)	2013	 Longitudinal Prestressing strands 	
					Deck reinforcement Stirrups	
		5	 M-102(Westbound) 	2014	 Longitudinal Prestressing strands 	
					Deck reinforcement Stirrups	
		6	●I−94(Eastbound)	2014	 Unbonded Transverse Post tensioning 	
		7	●I-94(Westbound)	2015	 Unbonded Transverse Post tensioning 	
		8	• M-100	2015	 Longitudinal Prestressing strands 	
		9	 M-66 over the West Branch River 	2015	 Longitudinal Prestressing strands 	
2	Maine DOT	10	●Little Pond Bridge	2012	 Unbonded Transverse Post tensioning 	
		11	 Kittery Overpass Bridge 	2014	 Longitudinal prestressing strands 	
3	Virginia DOT	12	• Nimmo Parkway	2012/2013	 PC piles (Strands and spirals) 	
		13	 RTE 49 over Aaron's Creek 	2015	 Longitudinal Prestressing strands 	
					• Stirrups	
4	Florida DOT	14	Research project	2013	 PC piles (Strands and spirals) 	
		15	Halls River Bridge Replacement Project	2016	• PC piles (Strands and spirals) and sheet pile	
5	Louisiana DOTD	16	●I-10 Littlewoods	2014	•External Post tensioning	
6	North Carolina DOT	17	Research project	2014	 Longitudinal Prestressing strands 	
			(Cored Slab)			
7	Kentucky Transportation	18	 Taylor County Bridge 	2014	 Longitudinal Prestressing strands 	
	Cabinet					
8	Ohio DOT	19	• HAS 700	2016	Longitudinal Prestressing strands	



Deterioration of Bridge





Rupture of Prestressing Strands



Spalling of Concrete

Beam Reinforcement Damage due to Corrosion in Salt Environment at Longitudinal Cracks



Solution: **<u>Replacement</u>** of **<u>Steel reinforcements</u>**

with non-corroding FRP reinforcements



has the performance as Reinforcements

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I. What is CFCC?

II. Application of CFCC

- CFCC is Carbon Fiber Composite Cable.
- CFCC is a stranded CFRP. → FLEXIBLE
- CFCC consists of PAN (Polyacrylonitrile) based continuous carbon fibers,

with epoxy resins used

- as a binding material
 - HIGH CORROSION RESISTANCE
 - HIGH TENSILE FATIGUE
 - PERFORMANCE
- \rightarrow HIGH TENSILE STRENGTH
 - HIGH TENSILE



1×7 5.0¢

5.06

Load - Elongation Curve



Guaranteed breaking load of CFCC is equivalent to steel strand.

Relaxation



Relaxation of CFCC is 1/2 compared with steel strand

Bond strength

Displacement gauge



CFCC has twice bond strength of steel strand.

Type of CFCC

Tendon

Pre-tensioning cables
Post-tensioning cables

Non-prestressing reinforcement

- Bars
- Stirrups
- Spirals

Pre-tensioning cables or Reinforcement bars

Post-tensioning cables





Stirrups





Spirals





CFCC REINFORCEMENT CAGE → Light weight

Easy to carry around by people



Anchoring systems of CFCC



Post-tension procedure



Table of Contents

I. What is CFCC?

II. Application of CFCC

II. Applications of CFCC



There are about 161 applications. (by 2014)

II. Application of CFCC

No.	Category	Number of Application
1	Concrete Structures (Reinforcement)	73
2	Cable for Bridges (Stay or Main Cable)	3
3	Ground Anchor	77
4	Other	8
	161	

Poinforcomont)

World's first PC bridge using CFRP tendon

Shinmiya Bridge Oct. 1988 in Japan

Hourai chou,

Ishikawa,

JAPAN





Sea of Japan

PACIFIC OCEAN

Poinforcomont

Former Bridge [After-construction 20 years]





New Shinmiya Bridge [After-construction 20 years]





Hanshin Expressway in Japan

Reinforcement of the existing bridge







External cable



Hisho Bridge (Free cantilever erection cables) May. 1993 in Japan









2. Cable for Bridge (Stay

Stay Cable Bridge May. 1999 in Denmark





Bridge Street Bridge May. 2001 in Southfield, Michigan

Funded by FHWA and MDOT United States's first bridge constructed using CFRP







External Cables



2. Cable for Bridge (Stay

Penobscot Narrow Bridge July. 2007 in Maine







1. Concrete Structures (Transverse Post-tensioning)

M-50 Bridge over NSRR Jun. 2012 in Jackson, Michigan









1. Concrete Structures (Transverse Post-tensioning)

Little Pond Bridge Aug. 2012 in Fryeburg, Maine









I-94 BRIDGE OVER LAPEER RD. Jun. 2014 in Michigan



Transverse post-tension Cable : CFCC $1 \times 3740.0\varphi$ East bound (14 box beams) : 59' - 2" × 20 cables West bound (15 box beams) : 63' - 3.5" × 20 cables









I-10 New Orleans East Girder Repairs May. 2014 in Louisiana





3. Tendon for Ground

Anchor

Hakone in Japan

Hot Spring Area → Strong acid-related environment Steel materials are unusable

🗱 TOKYO ROPE MFG.CO.,LTD.



Configuration of CFCC Ground Anchor



3. Tendon for Ground

Anchor

Beppu in Japan

Hot Spring Area



Deterioration of sampled specimens (Tendons at Year 3)

🙀 TOKYO ROPE MFG.CO.,LTD.



CFCC No detrioration



Steel strand Crumbles by rust



3. Tendon for Ground

Anchor

Sazanami in Japan

Sea coast salt water area



Ako in Japan

Prevention of the water pollution





Thank y ou