

# Tyfo® Fibrwrap® Systems for Transportation Infrastructure bridges, airports, other highway structures

- Strengthening for new load ratings
- Seismic retrofit of structural components
- Rehabilitation of corroded or distressed members
- Emergency repairs



## FYFE COMPANY PROFILE

The Fyfe Group is comprised of engineers, designers, material specialists, material manufacturers and project support personnel. Working together, this team provides innovative construction products and technical support to meet the needs of engineers, contractors and owners.

Fyfe Co LLC specializes in the Tyfo<sup>®</sup> Fibrwrap<sup>®</sup> Advanced Composite Systems for the strengthening, protection and repair of structures. These systems are comprised of carbon, glass and aramid fiber reinforced polymer (FRP) materials.

Fyfe Company also offers other innovative construction products and structural systems. Among these are disc bearings, expansion joints, concrete repair products, blast mitigation and ballistic products.



Tyfo® SEH System Uni-directional glass composite





Tyfo® SAH System Uni-directional aramid composite



Tyfo® WEB System Bi-directional glass composite (0°/90°)



Tyfo® CWEB System Bi-directional carbon composite (0°/90°)





Tyfo® BCC System Bi-directional carbon composite (±45°)



Tyfo<sup>®</sup> FRB System FRP reinforcing bars



Tyfo® UC Strip (Pre-formed) System FRP laminate strips

## TYFO<sup>®</sup> FIBRWRAP<sup>®</sup> SYSTEMS

The Tyfo® Fibrwrap® Systems are comprised of specialized fabrics and resins, which in unique combination, create tested and proven composites. Carbon, glass or aramid reinforcing fibers are combined with high quality resins to produce a multitude of high performance FRP strengthening systems, which gives design engineers a wide range of options to meet the individual needs of a project.

Our Tyfo<sup>®</sup> FRP Systems have a successful performance record with nearly two decades of use. This includes extensive testing as well as performing as designed during seismic events on three continents.

Data sheets available upon request or at our website www.fyfeco.com

## COLUMNS

The Tyfo® Fibrwrap® Systems can be used to increase the strength and ductility of concrete columns.



Six-foot diameter Test Column



Wrapping of Test Column





#### Column Testing Analysis Data



Fort Belvoir, Virginia



I-70 Ohio, Flared Columns



Caltrans Highway 2 & 5 Post-Northridge Earthquake



Arroyo Seco, Caltrans

## HISTORIC BRIDGES

The Tyfo® Fibrwrap® Systems can be used to strengthen Arch Bridges. This lightweight, low-profile strengthening system preserves the original shape of the member.



Castlewood Canyon Bridge, Colorado - before FRP repair



Castlewood Canyon Bridge - completed retrofit



Woodland Viaduct Bridge, New York - during construction



Woodland Viaduct Bridge - completed FRP retrofit

BEAMS

The Tyfo® Fibrwrap® Systems have been used to strengthen concrete and steel beams.





Ferry Street Bridge, Oregon DOT

Vandenberg Air Force Base Bridge, California

## **BEAM-COLUMN CONNECTIONS**

Tyfo® Fibrwrap® Systems can be used to add shear and moment strength to beam-column connections.



Mason Street Bridge, Green Bay, Wisconsin DOT



Brule County Bridge, South Dakota DOT

## PIER CAPS



The Manette River Bridge (Washington State DOT)







Installation on the Manette River Bridge

## WALL APPLICATIONS

The Tyfo® Fibrwrap® Systems can be used to strengthen walls. Often, Tyfo® Composite Anchors are used in conjunction with the wall application.



FDR Drive, New York was installed in 2005-2006.



Installation of Tyfo<sup>®</sup> Carbon composite on box girder

## **SLABS/SOFFITS**

The Tyfo® Fibrwrap® Systems are used to provide additional flexural strength to slabs and soffits.







Quintin Bridge - Cook County

## **CORROSION APPLICATIONS**

The Tyfo® Fibrwrap® Systems are used to repair corrosion damage and extend the life of the structure.



Friendship Trail Bridge, Florida (2003)



MTA Light Rail Bridge, Maryland









NASSCO Berths 5 & 6 Piles, California



Haw River Bridge, North Carolina - completed in 2003

## SELECTED LIST OF TEST REPORTS (see Fyfe Company Library of Reports)

Title	Author	
High Strength fiber circular lap splice flexural test proj.	Seqad Consulting / UCSD	
Retrofitting bridge columns w/ fiberglass epoxy	UCSD	
High strength fiber rectangular column shear & no-lap splice flexural test	UCSD	
Rectangular shear column test (box & shelve)	Seqad Consulting / UCSD	
Flexural Test of Rectangular Columns w/ Fiberglass/epoxy composite Jacket	Seqad Consulting / UCSD	
Seismic Performance of Bridge Columns retrofitted with fiberglass/epoxy Jackets	Seqad Consulting / UCSD	
Repair of shear column using fiberglass/Epoxy Jacket (box & shelve)	Seqad Consulting / UCSD	
High strength fiber/rectangular flexural test	Seqad Consulting / UCSD	
Axial Load Characteristics of Rectangular Columns Wrapped w/ Tyro S Jackets	Seqad Consulting	
Strength Enhancement of Concentrically Loaded Reinforced Concrete Columns using Tyfo S Fibrwrap Jackets	University of Canterbury, NZ	
USACERL Tests of PC Concrete Joists	US Army Corps of Engineers	
Seismic Performance of a full scale bridge column as built and as repaired	UCSD	+• F
Strengthening of Simple and Continuous Girders using CFRP and GFRP sheets	Lawrence Tech University	
Laterally loaded circular concrete columns externally reinforced w/ fiberglass-epoxy jackets	University of Canterbury	
Shear Strengthening of the Maryland Bridge Using CFRP sheets - SCH 41	ISIS / University of Manitoba	
Behavior of Concrete Box Culverts & Their Strengthening by FRP	University of Toronto	
Durability of steel stringers reinforced with CFRP Plates	Sherbrooke Canada	
Fiber Column Wrap-Seismic Retrofit System	Pennsylvania Dept. of Transportation	
Aerospace Qualifications for Seismic Retrofitting of Bridge columns using composites	Aerospace Corporation	
Durability of Fiber Reinforcement Polymers used in Concrete Structures	University of Toronto	
Experimental Testing of Aluminum Truss Joint Repaired Using CFRP	North Carolina State University	
Fatigue Behavior of CFRP Strengthened Reinforced Concrete Bridge Guiders	University of South Carolina	
Seismic Behaviour of Square Concrete Columns retrofitted glass Fibre Reinforced Polymers	University of Toronto	The state
Retrofit of Split Bridge Columns	Washington Dept. of Transportation	101 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1
Fatigue Behaviour of Prestressed Concrete Bridge Girders Strengthened withVarious CFRP Systems	North Carolina State University	
The Use of Mechanical Anchorage in FRP Strengthening of Reinforced Concrete Beams	UCSD	
Seismic Retrofit of Two-Column Bents with Diamond Shape Columns	University of Nevada	
A Study on Mechanical Anchorage for Shear Rehab of RC Structures	Schuman	
Effects of Traffic Loads during FRP Bridge Strengthening	University of Alabama	
FRP Composite Column Wrap Durability Evaluation for HITEC (Vol 3-5)	UCSD	anto P
Assessment of FRP Composite Strengthened Reinforced Concrete Structures at the Component and Systems Level through Progressive Damage and NDE	UCSD	
Repair of Impact Damaged Prestressed Bridge Girders Using CFRP Materials	North Carolina State University	
Report Pertaining to Evaluation of Tyro SCH 41S System (HITEC Beams)	UCSD	
Summary of Results Pertaining to the Evaluation of Durability of Fyte FRP (HITEC - Columns)	UCSD	
Field and Laboratory Performance of Bridge Columns Repaired with Wrapped Glass Fibre Rein- forced Polymer Sheets	University of Toronto	
Flexural Test of High Strength Fiber Retrofitted Column	Seqad Consulting	
Seismic assessment & retrofit of bridge columns	Seqad Consulting / UCSD	
Flexural Behavior of Aged Pre-stressed Concrete Girders Strengthened with Various FRP Systems	North Carolina State University	

## SELECTED LIST OF PROJECT REFERENCES

(see www.fyfeco.com for more extended lists)

Project Name	Location	Authority	Type of Application	Date Installed
Caltrans 07-115994 I-5 & Hwy 2	Los Angeles, CA	Caltrans	12 Columns (6' dia.) - Seismic	1991
Caltrans Highway 05-377704	101 North - Santa Barbara, CA	Caltrans	Columns Seismic Retrofit	1992
Sparks	I-80 at Nugget Hotel - Sparks, NV	NDOT	96 Columns (3' dia.) Plastic Hinge Zone	1993
FDR Drive near Manhattan Bridge	New York, NY	City of New York	2 Columns (2' x 4') - Corrosion Repair	1994
Wisconsin Rock Co. I-90 over Route 14E	Janesville, WI	Wisconsin DOT	10 Columns (30" dia.) 15 ff. tall Corrosion Repair	1994
North 21st Bridge	Tacoma, WA	City of Tacoma	8 Columns (40' tall) (4' x 4' or 4' x 7.5') 8 Pedestals - Seismic Historic Finish	1995
Rte. 29 Bridge over Rapidan River	Ruckersville, VA	Virginia DOT	15 Columns - Flood Repair	1995
I-10 & San Jacinto River	Houston, TX	Texas DOT	5 Columns - Provide Ductility	1996
Arroyo Quemado	Los Angeles, CA	Caltrans	12 Columns - Seismic Strengthening	1997
Rockville Center Station-Long Island Railroad	Long Island, NY	Long Island Railroad	Concrete Pile Rehabilitation along railroad	1997
Akron Arch Bridge	Akron, OH	Ohio DOT	One Arch & 4 Columns - Strengthening	1997
Horsetail Creek Falls	Historic Columbia River Hwy, OR	Oregon DOT	Beam - Repair, New Load Demand	1998
Eads Bridge	St. Louis, MO	Missouri DOT	Beams - Strengthening & Repair	1999
Rainbow Bridge	USA/Canada Border	New York DOT / Ontario MOT	Beams - Shear	1999
Arroyo Seco Bridge	Pasadena, CA	Caltrans	Columns - Seismic Retrofit	2000
Route 17	South Carolina	SCDOT	6 Columns - Concrete Repair System	2000
Joseph A. Russo Memorial Bridge	New York, NY	New York DOT	Arches - Ductility	2000
Tennessee DOT Contract 1454	Memphis, TN	Tennessee DOT	Columns - Strengthening & Repair	2001
Summit Street Arch Bridge	Columbus, OH	Ohio DOT	Underside of concrete arch - Strengthening & Repair	2002
WI DOT Project #1077-05-60	Monroe County, Oakdale, WI	Wisconsin DOT	Bridge columns - Strengthening & Repair	2003
Cosgrave Interchange	Reno, NV	Nevada DOT	Beams & Columns - Seismic Retrofit	2004
Natchez Trace Parkway	Mississppi	National Park Service	Bridge - Vehicular Collision Repair	2006
Bridge 51 VT DOT	Vermont	Vermont DOT	Bridge columns - Strengthening	2006



### For additional information, design assistance or questions about a potential project, please contact us ...

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