

Tyfo® **Fibrwrap®** Systems

Fyfe Company LLC

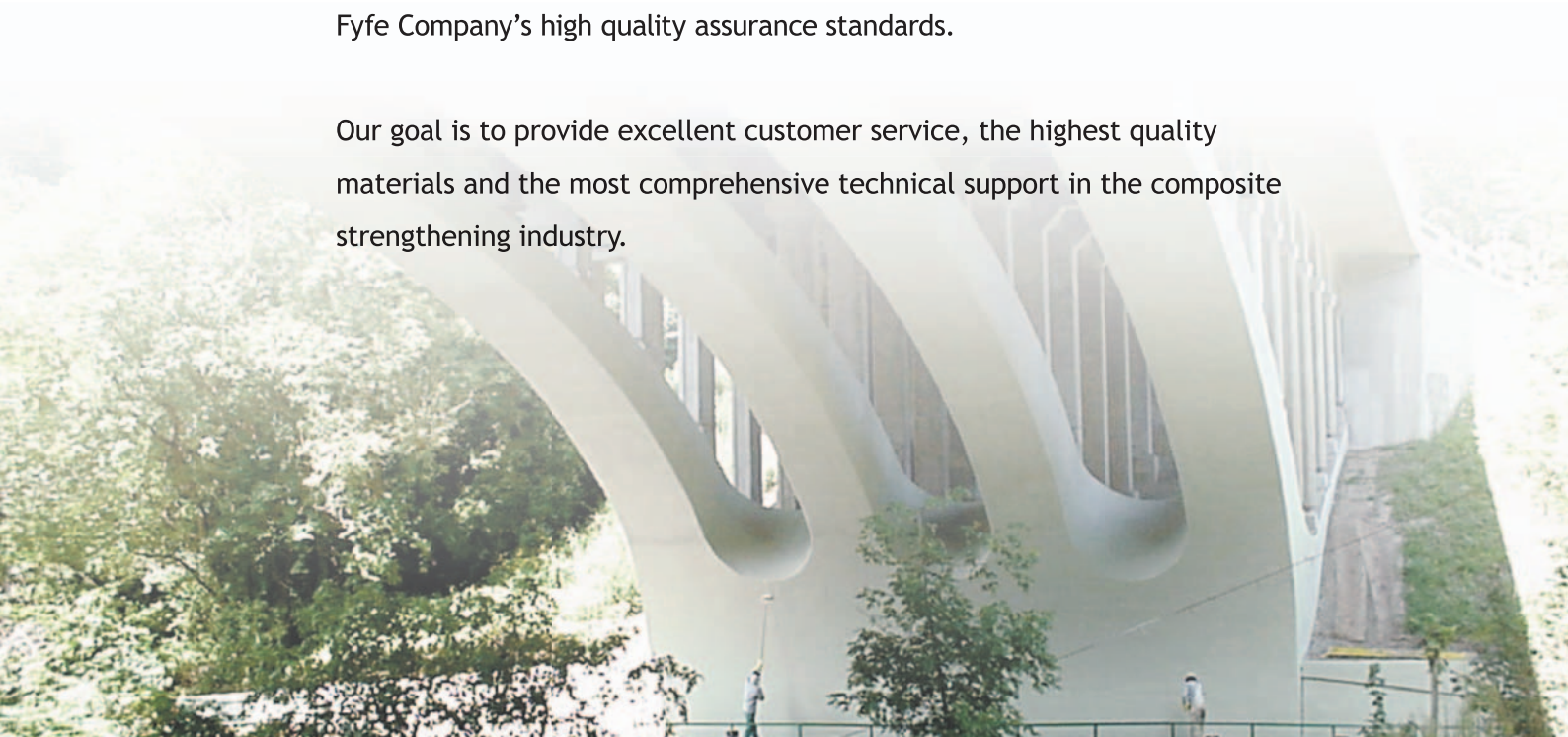
PROVIDING CREATIVE SOLUTIONS FOR TODAY'S STRUCTURAL PROBLEMS SINCE 1988

Fyfe Co. LLC

was founded by Edward R. Fyfe to research and develop the use of advanced composite materials for the engineering and construction industries. Since 1988 our patented Tyfo® Fibrwrap® Systems have been used to strengthen over ten thousand structural elements on projects throughout the world. In addition, our Tyfo® Systems have been tested at over fifty universities and private institutions. This research includes full-scale structural testing, long-term durability studies, fire resistance testing and blast mitigation research. Our research and development program is on-going. We are continually developing new materials and techniques to provide the best solutions for reinforcing structures.

Our staff is comprised of engineers, designers, material specialists, material manufacturers, and in-field technicians. Fyfe Company places an emphasis on Quality Assurance. This extends from the manufacturing of our materials, through our engineering staff, as well as to the actual use and application of our Tyfo® Systems. Our Tyfo® Systems can only be installed by Fyfe Company Trained and Certified Applicators. Our Certified Applicator Program ensures that every project is completed according to Fyfe Company's high quality assurance standards.

Our goal is to provide excellent customer service, the highest quality materials and the most comprehensive technical support in the composite strengthening industry.



The Tyfo® Fibrwrap® Systems

Tyfo® Fibrwrap®

The Tyfo® Fibrwrap® Systems are lightweight, high-strength systems for reinforcing concrete, masonry, steel, and timber structures. Fyfe Company has taken technology used by the aerospace industry for over fifty years and adapted it for civil engineering uses.

The Tyfo® Systems consist of carbon, e-glass and aramid fabrics that are impregnated with high quality resins to form a laminate that is externally bonded to the element to be strengthened.



Tyfo® Fibrwrap® has been rigorously tested to prove its long-term viability. In addition, the Systems have performed as designed during major earthquakes in Los Angeles, El Salvador, Taiwan and Seattle.

Tyfo® Fibrwrap® is applied to the existing element

by hand. Due to its lightweight nature and ease of installation, no heavy machinery or major demolition is necessary. This provides for a rapid construction schedule and minimal disruption to an operating facility.

An Introduction to Tyfo® Materials

Fyfe Company offers a wide variety of options for engineers who are incorporating composite reinforcement into their projects. This wide selection of Tyfo® Systems allows for the proper material to be specified depending on the required performance

and type of application. For assistance in determining which Tyfo® System is best suited for a particular use, please refer to the Fyfe Company Design Manual or consult with our engineering staff at no obligation.



Tyfo® Fibrwrap® Systems



Tyfo® E-Glass Based Systems

Tyfo® SEH, WEB and BC Systems are comprised of high-grade continuous strand e-glass fabrics that are impregnated with Tyfo® epoxies.

Tyfo® SEH-51A, the most commonly used Tyfo® System. It is a unidirectional, e-glass fabric. **Tyfo® SEH-51**, e-glass/aramid fiber hybrid with similar properties to SEH-51A in the primary fiber direction.

Tyfo® SEH-25A, unidirectional, e-glass fabric used for light reinforcement.

Tyfo® WEB, lightweight, bidirectional e-glass fabric with primary strength in the +/- 90 degree directions used for light reinforcement, stabilization of masonry elements and as an aesthetic finish fabric.

Tyfo® BC, bidirectional custom fabric with the primary strength in the +/- 45 degree directions used to transfer forces from one element to another and for general strengthening.

Tyfo® UG Strips, pre-impregnated e-glass laminates available in a variety of widths and thicknesses.

Tyfo® Tile-Hold, lightweight, open-mesh e-glass system for the stabilization of building facades.

Tyfo® Carbon Based Systems

Tyfo® SCH Systems are comprised of unidirectional and bidirectional carbon fabrics that are impregnated with Tyfo® epoxies as well as pre-impregnated plates.

Tyfo® SCH-41B, unidirectional carbon fabric.

Tyfo® SCH-41B-7, very lightweight, unidirectional carbon fabric.

Tyfo® SCH-41B-11, lightweight, unidirectional carbon fabric.

Tyfo® SCH-41B-22, unidirectional carbon fabric.

Tyfo® SCH-41, unidirectional carbon fabric.

Tyfo® SCH-41S, unidirectional carbon/aramid fabric with similar properties to SCH-41 in the primary direction.

Tyfo® SCH-7UP, unidirectional carbon fabric two-thirds the weight of SCH-11UP fabric.

Tyfo® SCH-7UP Hi-Mod, very lightweight, unidirectional carbon fabric with a high modulus of elasticity.

Tyfo® SCH-11UP, lightweight, unidirectional carbon fabric.

Tyfo® BCC, bidirectional carbon fabric with fibers oriented in the +/- 45 degree direction.

Tyfo® UC Strips, pre-impregnated carbon laminates available in a variety of widths and thicknesses.

Tyfo® CWEB, lightweight, bidirectional carbon fabric.



Tyfo® Aramid Based Systems

The Tyfo® SAH and WAB Systems are comprised of unidirectional and bidirectional aramid fabrics that are impregnated with Tyfo® epoxies.

Tyfo® SAH, unidirectional aramid fabric.

Tyfo® WAB, lightweight, bidirectional aramid fabric.



Tyfo® Anchor Systems

Tyfo® Fibrwrap® Anchors are fiber-based and become embedded within the Fibrwrap® System during installation. They are used to increase bond durability and design efficiency in beam, slab, pipe and wall applications.

Tyfo® Fibrwrap® Super Anchors are a hybrid glass/carbon based system used to provide structural connections between elements.

The following chart displays Typical Test Values for the most commonly used Tyfo® Systems. For Design Values please consult with the Fyfe Company Design Manual or the Fyfe Engineering Staff. All values are determined per ASTM D-3039.

| Laminate Properties | | | | | |
|---------------------------|---|---|---|---|--|
| Tyfo® Systems | Tyfo® SEH-51A | Tyfo® SCH-41 | Tyfo® WEB | Tyfo® BC | Tyfo® UC Strips |
| Ultimate Tensile Strength | 575 N/mm ² (83,400 psi) | 876 N/mm ² (127,000 psi) | 309 N/mm ² (44,800 psi) | 279 N/mm ² (40,500 psi) | 2.79 kN/mm ² (405,000 psi) |
| Modulus of Elasticity | 26.1 kN/mm ² (3.79x10 ⁶ psi) | 72.4 kN/mm ² (10.5x10 ⁶ psi) | 19.3 kN/mm ² (2.80x10 ⁶ psi) | 19.0 kN/mm ² (2.70x10 ⁶ psi) | 155.1 kN/mm ² (22.5x10 ⁶ psi) |
| Ultimate Elongation | 2.2% | 1.21% | 1.6% | 1.5% | 1.8% |
| Laminate Thickness | 1.3mm (0.05 in.) | 1.0mm (0.04 in.) | 0.25mm (0.01 in.) | 0.864mm (0.034 in.) | Varies |



Applications of the Tyfo® Systems

Columns

The Tyfo® Fibrwrap® Systems are designed to add strength and ductility to existing columns by providing additional confinement. Fyfe Company has conducted full-scale structural testing to demonstrate the system's effectiveness.

Tyfo® Fibrwrap® Systems can be designed to:

- Increase the shear and flexural strength of columns.
- Increase column ductility. Tests have shown displacement ductilities increase of 8+.
- Increase the vertical load capacity by increasing the compressive strength of the concrete.
- Contain corrosion stresses and seal the column from the intrusion of chlorides, moisture and oxygen.

Due to the low profile of the Tyfo® materials, the architectural shape of the column can be maintained. This includes circular, square, rectangular, hexagonal, oblong flared and other shaped columns. The typical system thickness is less than 6mm (0.25").



Malibu, California

Beams and Slabs

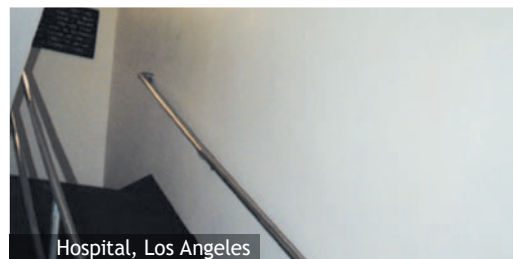
The Tyfo® Systems can be used for strengthening both beam and slab elements subjected to increased loading or to enhance the performance of under-reinforced elements. The Tyfo® Systems can also be used as alternatives to conventional strengthening options such as shotcrete or steel plate bonding. Tyfo® Fibrwrap® Anchors provide greater bond durability and design efficiency.



King Abdul Aziz University

Concrete and Masonry Walls

Many concrete walls or masonry structures of brick, clay tile or concrete block require strengthening to increase both in-plane and out-of-plane performance. The Tyfo® Systems can be used to add the required additional capacity. Tyfo® Fibrwrap® Anchors provide greater bond durability and design efficiency.



Hospital, Los Angeles

Underwater

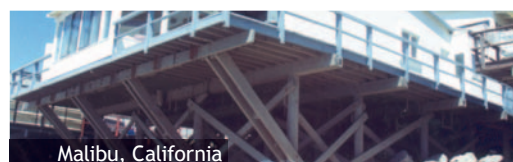
Using specially formulated Tyfo® SW-1 resins, the Tyfo® Fibrwrap® System can be used to reinforce underwater elements such as bridge and pier columns and piles.



Fort Mason, San Francisco

Wood

The Tyfo® Systems can be used to retrofit existing wooden elements such as piles, poles, glulam beams, and more.



Malibu, California

Blast Mitigation

Tyfo® Systems are ideal for many blast hardening and mitigation applications. The large strain capacities of Tyfo® materials provide ductility with the addition of only a few millimeters of additional element thickness. Potential applications include mitigating explosions in industrial and petroleum facilities as well as protecting facilities from munitions or terrorist attacks. The Tyfo® Blast-Flex System, a spray-applied elastoplastic material, can also be used for blast mitigation applications.



Pipes

Pipes, both exposed and underground, deteriorate over time. The Tyfo® Systems can be used to repair and reinforce existing pipes. In some situations, the materials can be installed by manhole access with no excavation needed. Due to the low profile of the System, there is negligible loss in capacity for interior applications. Tyfo® PWC, potable water coating, is available as a final protective coat.



Fire-Resistant Systems

The Tyfo® FC/F System is a two-part, fire-resistant system applied in conjunction with the Tyfo® Fibrwrap® System. Tyfo® FC/F provides insulation against fire and increases a two-hour fire rating as per ASTM E-119. The newly developed Tyfo® VG/EI-R Fire Protection System is used to protect structural elements that have been reinforced with Tyfo® Fibrwrap® while they are under load.



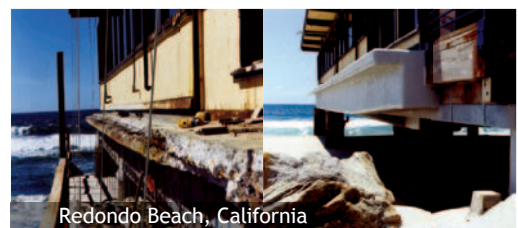
Chimneys, Stacks and Tanks

Tyfo® Systems can be applied to the interior or exterior surfaces of chimney, tank and stack structures to increase shear strength, flexural strength and integrity.



Corrosion

The Tyfo® Fibrwrap® Systems can be used to repair and protect concrete elements from corrosion. In conjunction with Tyfo® Fibrwrap®, Tyfo® CIS Corrosion Inhibitors can be used to treat concrete and reinforcing steel.



For additional Fyfe Company products and services, such as Forced Entry Systems, concrete repair materials or Tyfo® equipment and safety supplies, please contact a Fyfe Company representative.

For additional information on our Tyfo® products, please visit our website www.fyfeco.com

Fyfe Co. LLC

Nancy Ridge Technology Center
6310 Nancy Ridge Drive Suite 103
San Diego, CA 92121 USA
Tel. +1.858.642.0694
Fax +1.858.642.0947
info@fyfeco.com



California, USA

Fyfe Asia Pte.Ltd.

10 Toh Guan Road #03-10 T.T.
International Tradepark
608838 Singapore
Tel. +65.6898.5248
Fax +65.6898.5181
fyfeasia@singnet.com.sg



Korea

Fyfe Europe Ltd.

28 Aristippou Street
Glyfada, 166 74
Athens, Greece
Tel & Fax: +30.210.964.3402
fyfe.europe@mail.gr



Thessaloniki, Greece

www.fyfeco.com

Authorized Fyfe Company Representative: