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STRUCTURAL INNOVATIONS

FRP

Fiber Reinforced polymers

Carbon Fiber Repair in the Milling industry

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What are Fiber Reinforced Polymers?

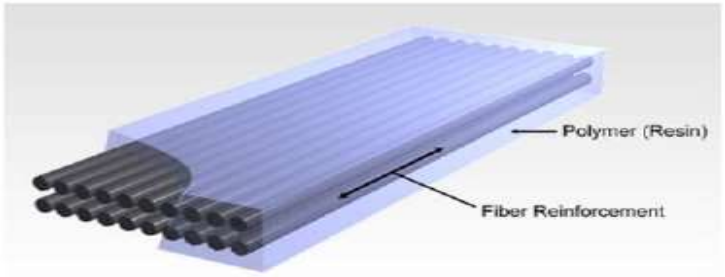
-Glass Fiber

-Carbon Fiber

-Epoxy Coatings

Also known as Composite Strengthening System

- Fiber reinforcement: carbon and E-glass
  - Provides strength and stiffness
- Polymer resin: epoxy
  - Transfers load and protects fibers against deterioration
- Combine to form a fiber-reinforced polymer (FRP) composite



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Carbon Fiber was developed in the late 1980's

NASA

***Carbon Fiber was first used in the space shuttle Program as a super strong, durable, and lightweight exterior for the shuttles**

***Was able to withstand the heat and pressure of re-entry into the atmosphere as well as protect it from any debris that may strike its surface while in orbit.**

Carbon Fiber Today

- Motorcyle Parts
- Auto Body parts
- Sports Equipment
- Protective Gear
- Bullet Proof Jackets
- Armor Plating

Carbon Fiber in the Ag World

Milling Industry

CONCRETE REPAIR

- SILOS, BEAM POCKETS, HOPPERS, PILINGS

METAL REPAIR

- SPOUTING, PIPING, HOPPERS, STEEL BINS

Before

AFTER

MAKING REPAIRS WITH FRP

BENEFITS	EXPLANATION
STRENGTH TO WEIGHT RATIO	*DOES NOT ADD SIGNIFICANT WEIGHT TO OBJECTS WHILE PROVIDING STRUCTURAL REINFORCEMENT
FLEXURAL AND TENSILE STRENGTH	*5-7 TIMES THE STRENGTH OF STEEL
EASE OF INSTALLATION	*NO WELDING, NO HOT WORK PERMIT
CURE TIME	*FULLY CURED IN 6-8 HOURS, MINIMAL DOWNTIIME
ABRASION RESISTANT	*HIGHLY RESISTANT TO ABRASION FROM ALL TYPES OF COMMODITIES
CHEMICAL RESISTANT	*RESISTANT TO LIQUIDS THAT ARE HIGHLY ACIDIC OR ALKALINE (ALL TYPES OF CORROSIVE MATERIAL)
FDA/USDA Approved	

Composite Strengthening System Advantages

- Lightweight
- High tensile strength/stiffness
- Non-corrosive
- Low impact (1/16” per layer)
- Conform to existing shape (fabrics)
- Fast installation
- Cost effective

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Case History: 40 Foot High Grain Elevators Reinforced with Carbon Fiber

PROBLEM

- Reinforcing steel had corroded at the top of each bin
- Spalling concrete threatened to infiltrate the grain inside

Case History: 40 Foot High Grain Elevators Reinforced with Carbon Fiber

CONCLUSION

- The client saved significantly over alternative repair methods or replacement
- The abrasion resistant carbon fiber system will protect the grain bins from any additional abrasion damage

Case History: Reinforced Concrete Silo Repair

SILO REPAIR AT AN AGRIGULTRUAL PLANT
MIDWEST UNITED STATES

In this particular case, the reinforced concrete silos had significant corrosion to the embedded rebar, and significant cracking to the concrete.

Case History: Reinforced Concrete Silo Repair

PROBLEM

- Hoppers rested on a conveyor, undergoing constant vibration
- Internal reinforcing steel expanded and corroded, causing additional cracks
- Replacement would cost approximately 6 months of downtime

Case History: Reinforced Concrete Silo Repair

CONCLUSION

- Installation completed in 6 weeks
- Client saved more than 65% vs. the cost to replace silos, plus downtime

Case History: Grain Silo Patch

PROBLEM

- Abrasive grain flow at speeds up to 60 mph
- Through hole punctured from the inside
- Protective, ceramic liners were only lasting up to 1 month before replacement was needed

Case History: Grain Silo Patch

CONCLUSION

- 3 months after the abrasion-resistant system was installed, more than 750,000 tons of grain has passed through the silo at aggressive speeds
- There has been no visible wear to the system, and it will be monitored each month for any changes

More Applications

- Seismic retrofit
  - Shear strengthening
  - Displacement/ductility
  - Life safety
- Load rating upgrade
  - Increased loads
  - New equipment
  - Change of use
- Damage repair
  - Deterioration/corrosion
  - Blast/vehicle impact
  - New openings

- Defect remediation
  - Size/layout errors
  - Low concrete strength
- Blast Mitigation
  - Hardening
  - Progressive collapse

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What Information do we need to know for creating a system for you?

- Existing drawing details
  - Section dimensions and span length
  - Steel reinforcing layout
  - Material properties (steel yield and concrete compressive strengths)
- Loads and Capacities
  - Existing factored capacity (kips or kip-ft, accounting for any corrosion)
  - New ultimate demand (kips or kip-ft)
  - Service dead load and live load demands (kips or kip-ft)

Design of Fiber Reinforced Polymers CSS

- American Concrete Institute (ACI)
  - 440.2R-08: Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures
  - 440.7R-10: Guide for the Design and Construction of Externally Bonded Fiber-Reinforced Polymer Systems for Strengthening Unreinforced Masonry Structures
- American Association of State Highway and Transportation Officials (AASHTO)
  - Guide Specifications for Design of Bonded FRP Systems for Repair and Strengthening of Concrete Bridge Elements
- Canadian Standards Association (CSA)
  - S806-12: Design and Construction of Building Structure with Fibre-Reinforced Polymers
  - S6-06 Ch. 16: Canadian Highway Bridge Design Code, Fibre-Reinforced Structures

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