OWENS CORNING®

INNOVATIONS FOR LIVING®

COMPOSITE SOLUTIONS

Composites and the Future of Society:

Preventing a Legacy of Costly Corrosion with Modern Materials

September 15, 2010

OCV™ Reinforcements | OCV™ Technical Fabrics | OCV™ Non-Woven Technologies

Preventing Corrosion with Modern Materials

Courtesy www.pitsafrp.com

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Preventing a Legacy of High Corrosion Cost

- **The cost of corrosion in the developed world today is substantial**
- **Without using new materials and fabrication processes to resist corrosion, rapidly developing countries are destined to follow the same path as the developed world and face substantial costs in the future for repair and replacement, and resource waste**
- **It is imperative that infrastructure projects use modern, corrosion-resistant materials to avoid creating another a costly legacy of repair and replacement**

A Legacy of Corrosion

- **The worldwide annual direct cost of corrosion today exceeds 12.2 trillion Yuan (US$1.8 trillion; €1.4 trillion)**
- **For industrialized countries, corrosion costs 3 to 4 percent of GDP[1]**
- **A 2001 report estimated the cost of corrosion in China at 498 billion Yuan (US$ 61 billion)[2]**
- **That put China's cost higher than industrialized nations at 5.2 percent of GDP**
- **An estimated 25 to 30 percent of the annual cost of corrosion can be avoided by using optimum corrosion management practices[1]**

[1] *Global Needs for Knowledge Dissemination, Research, and Development in Materials Deterioration and Corrosion Control* by Gunter Schmitt, May 2009, The World Corrosion Organization

[2] Chinese Industry Corrosion Status and Market Development, presentation by En-Hou Han, Institute of Metal Research, Chinese Academy of Sciences

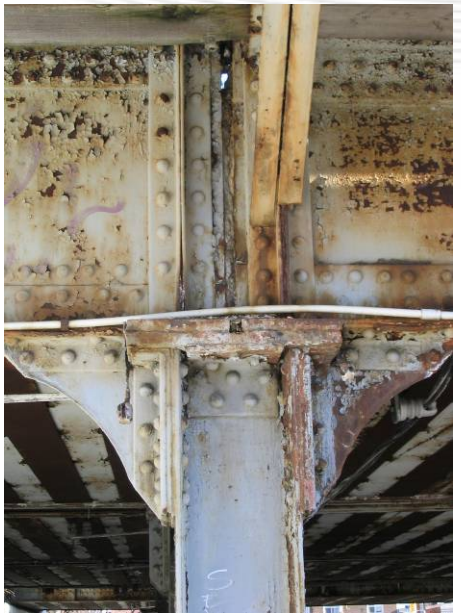
Saving 2.4 trillion Yuan

- **In 17 years, China could have the world's largest economy[1]**
- **If current construction practices are continued, China's annual cost of corrosion could then be more than 6.8 trillion Yuan (US$ 1 trillion)[2]**
- **By employing optimum corrosion management practices today, including greater use of composites, China's annual savings could then be as much as 2.4 trillion Yuan (US$ 347 billion)[3]**

[1] The Long-Term Outlook for the BRICs and N-11 Post Crisis, Jim O'Neill and Anna Stupnytska, Goldman Sachs, Dec. 4, 2009
[2] Owens Corning calculations based on publicly available data
[3] Ibid

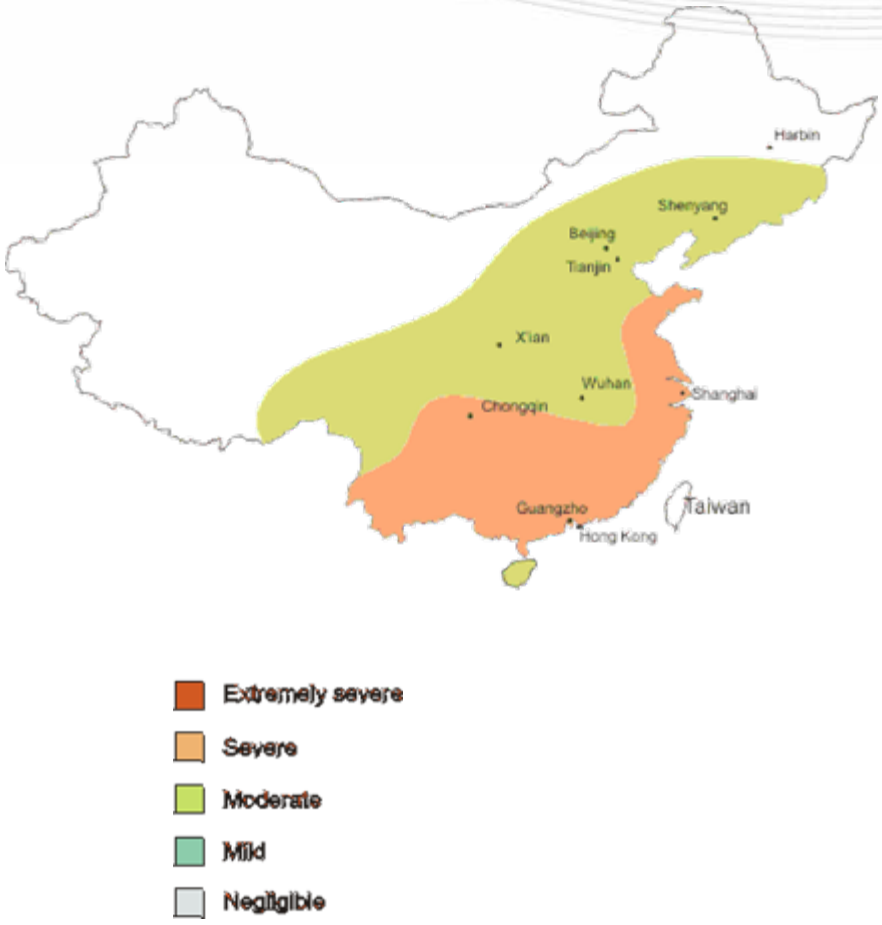
Defining Corrosion

- **Corrosion is a process that occurs as refined metals return to a more stable compound**
- **Given sufficient time, oxygen and water, any iron mass eventually converts entirely to rust and disintegrates**



Corrosive Conditions

- **Corrosion depends on the nature of soil and other environmental factors, such as the availability of moisture and oxygen**
- **Soils with high moisture content, high electrical conductivity, high acidity and high dissolved salts will be most corrosive**
- **Unfortunately, those conditions exist in much of the world today, including large areas of China**



Source: Corrosion, Vol. 55, No. 1, page 66

Preventing and Slowing Corrosion

- **There are many ways to fight corrosion**
  - **Special alloys**
  - **Metal coatings**
  - **Surface treatments**
- **In many situations, a better result can be achieved with composite materials**
  - **Fiberglass-reinforced polymer (FRP)**
  - **Fiberglass-reinforced concrete (FRC or GFRC)**

Courtesy U.S. Composite Pipe South

Composites Outperform Traditional Materials in Corrosive Conditions

Composites are safe and reliable solutions, able to face corrosive conditions in various environments and have outperformed traditional materials for many years.

Composites offer:

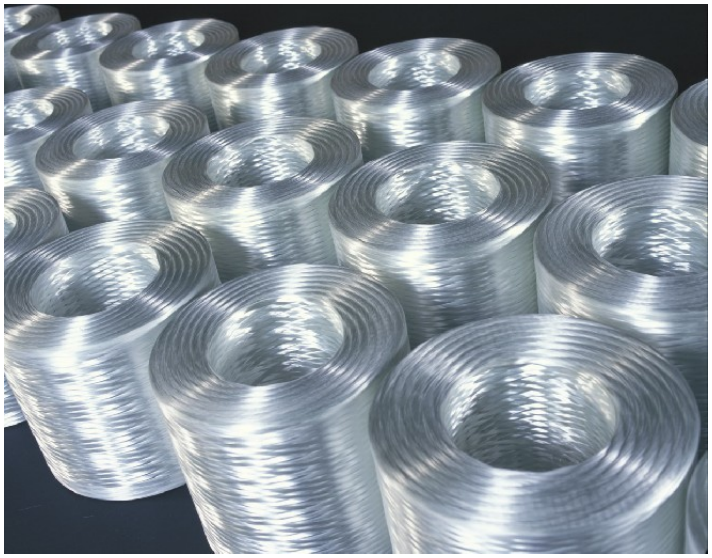
- **High strength**
- **Light weight**
- **Durability**
- **Cost savings**

Markets:

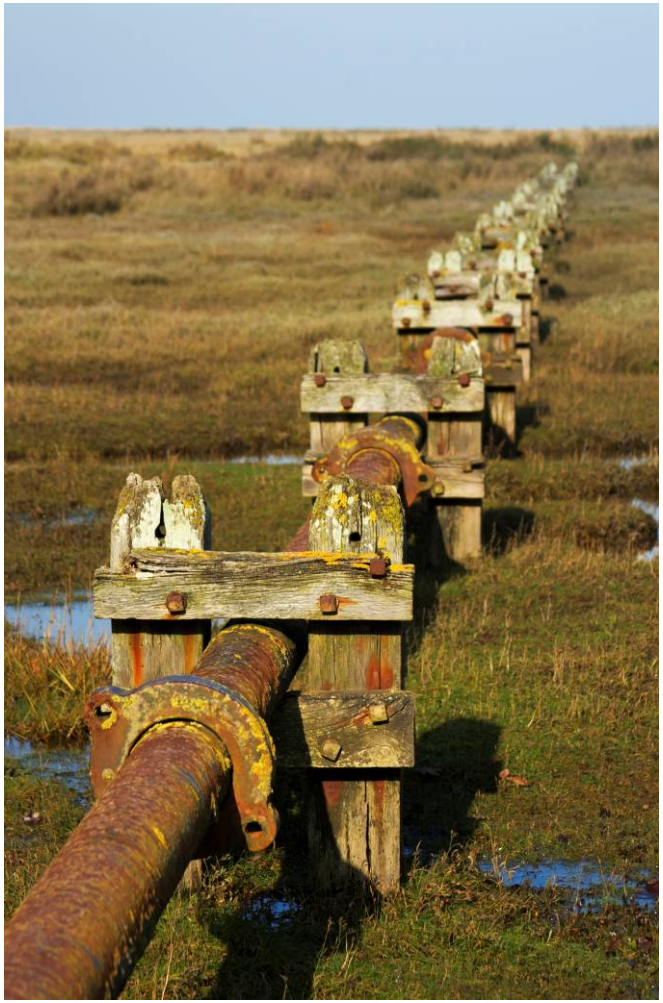
- **Chemical**
- **Petroleum & Mining**
- **Power & Energy**
- **Marine**
- **Water & Sewage**
- **Industrial**

Composites

- **FRP composites consist of polymer resin and fiber reinforcement**
- **About 95 percent of composites are reinforced with glass fiber**
- **The combination can produce some of the strongest materials for their weight ever developed**
- **FRP composites gain their strength from glass fibers set within a resin matrix**
- **Fibers carry the load while the resin spreads the load imposed on the composite and both impact corrosion resistance**



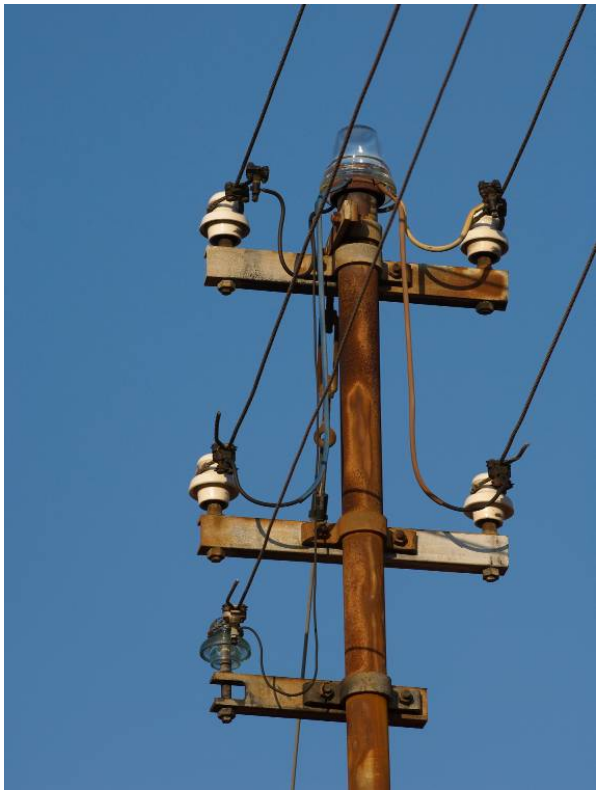
Composite Applications



Courtesy NOV Fiber Glass Systems

Composite pipe is used to transport petroleum and other chemicals all over the world, including areas with a fragile ecology that can't afford failures

Composite Applications



Courtesy CMT Worldwide

Engineered poles made with fiberglass-reinforced polymer or concrete offer other important performance benefits in safety, cost and ease of use

Composite Applications

Courtesy U.S. Composite Pipe South

Corrosion-resistant FRP pipe transports life-sustaining water to urban areas where it is needed by a growing population; FRP helps wastewater pipe and tanks resist the corrosive chemicals in sewage

Composite Applications

Corrosion-resistant FRP is an attractive material for industrial facilities, especially for flue gas desulphurization (FGD) with wet acid and high chloride environments

Composite Applications

Courtesy Strongwell

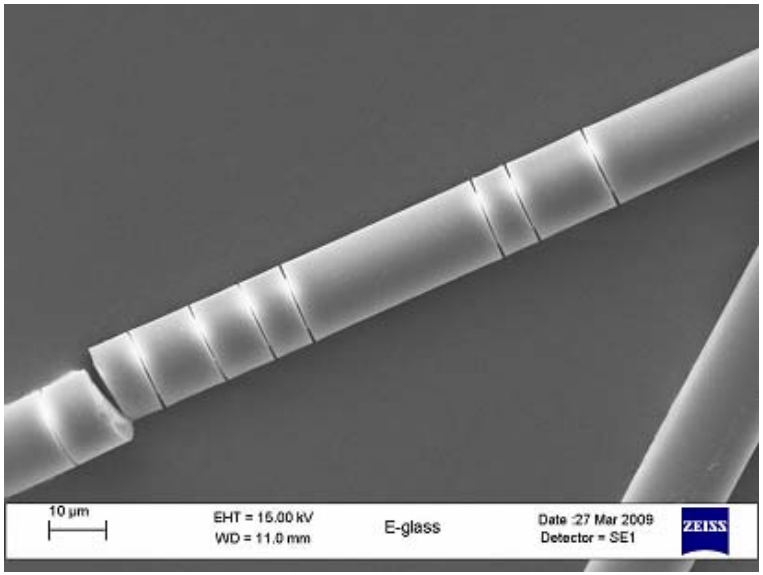
Composite piers, decking and handrail are long-lasting solutions for corrosive saltwater marine environments

Modern Composite Enhancements

- **Design and process improvements**
- **New resins offer superior corrosion resistance**
- **Alkali-resistant (AR) glass fibers for concrete**
- **Boron-free E-CR glass for use with polymers in corrosive environments**
- **Advantex® □□® glass is both an E-glass and corrosion-resistant E-CR glass, developed for:**
  - **Increased mechanical properties compared to E-glass**
  - **Improved corrosion resistance compared to E-glass**

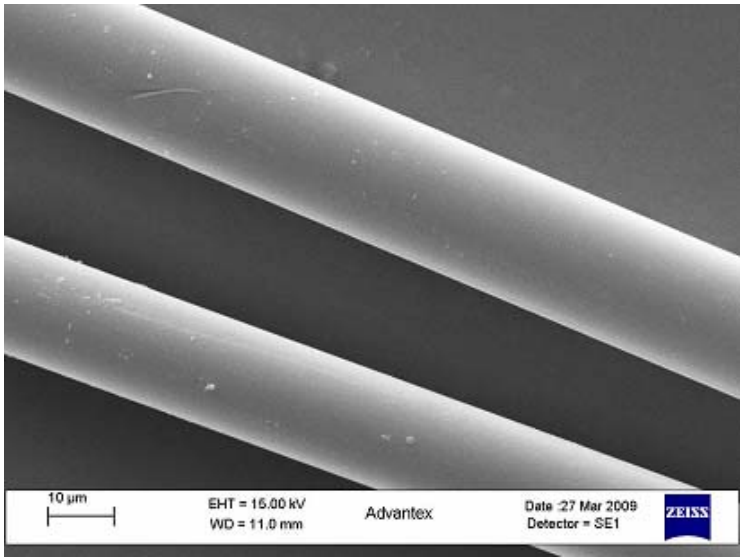
Bare glass comparison

E-Glass



4 hours in 5% HCl @ 95°C

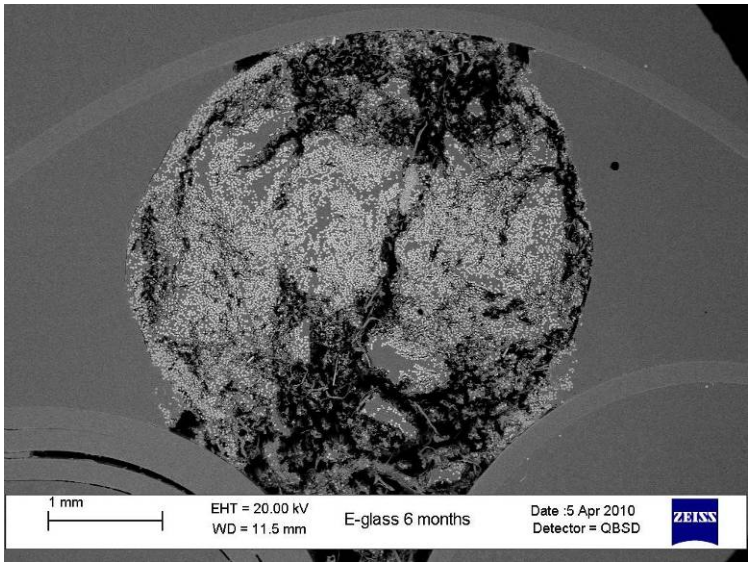
Advantex® □□® glass



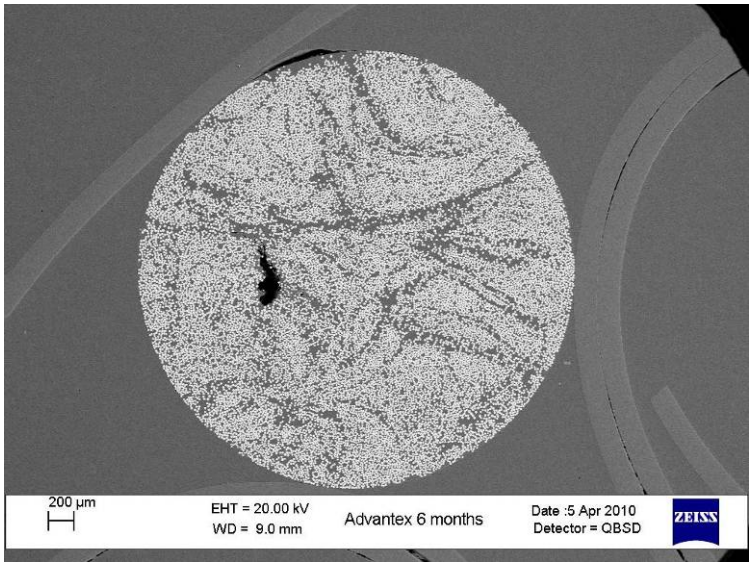
4 hours in 5% HCl @ 95°C

Composite Comparison After Six Months

E-glass



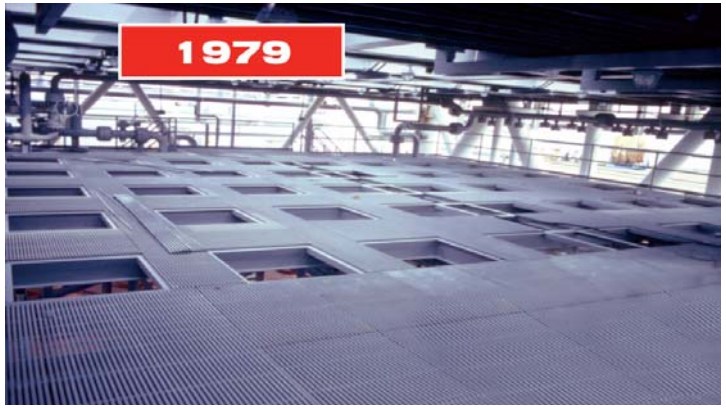
Advantex® □□® glass



- **Advantex® □□® glass rod shows no adverse effects**
- **E-glass rod shows considerable damage**
- **Deformation of rod occurred as the E-glass deteriorates**

Composites Winning Against Corrosion

- **Composite grating continues to perform after 30 years' service on an oil platform in the Pacific Ocean**



Photos courtesy Strongwell

Composites Winning Against Corrosion

- **Composite handrail continues to perform after 12 years in a U.S. coal facility; the environment caused significant deterioration of carbon steel within two years and stainless steel in less than six years**

Photos courtesy Strongwell

Composites Winning Against Corrosion

- **Composite oil field pipe is still in service after 40 years in Canada; steel lines there have been replaced in as little as six or eight months due to corrosion[1]**
- **A field service study of five glass fiber-reinforced concrete bridges after eight years' service found much less deterioration than similarly built structures using traditional materials and reinforcements[2]**

[1] Western Fiberglass Pipe Sales Ltd., Red Deer, Alberta, Canada
[2] University of Sherbrooke GFRP Durability Study Report, Brahim Benmokrane and Patrice Cousin, April 2005

Preventing a Legacy of High Corrosion Cost

- **In 2010, real infrastructure industry growth in China is expected to be 25 percent, reaching 1.1 trillion Yuan (US$168.5 billion)[1]**
- **Let's invest in modern, corrosion-resistant materials so China can avoid the path of the developed world in building a legacy of corrosion that wastes resources and requires expensive infrastructure repair and replacement**

1 *China Infrastructure Report Q3 2010*, Business Monitor International, May 2010

Thank you!

www.owenscorning.com/composites