SUITABILITY FOR SERVICE OF FRP

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The FRP Reliability Experts
Fibreglass Reinforced Plastics

- Used widely in corrosion applications
- Tanks, Pipe, Scrubbers, etc.
- Corrosion Resistant
- Used for: Chlorine compounds, acids, wastewater, etc
- Key Ingredients: Engineering; Resin/Matrix, Reinforcement (glass); Shop Methods
Corrosion Barrier Life Cycle Inspection

New Equipment
Corrosion Barrier Life Cycle Inspection

In-service Equipment
Corrosion Barrier Life Cycle Inspection

- Next....
Corrosion Barrier Life Cycle History

![Graph showing CB Resin Hardness over years from 1994 to 2010.](image)
In the extreme.....

- Vessel had Corrosion Barrier inspections annually for 13 years
- Failure of structural laminate was at structural repairs made when new
- Not detectable from internal or external visual inspections.
In our experience......

- Little direct relationship between condition of corrosion barrier or outer surface and FRP structural condition.
- Condition of CB can be misleading about condition of the FRP as a whole
“Can we generate a curve to allow us to plan repair & replacement of FRP vessels as for metal vessels?”
Suitability for Service Calculations

- **Metals:**
  - Corrosion causes material loss.
  - Thickness (t) reduces.
  - Elastic modulus and strength remain constant.

- **Mathematically:**
  - \( t \times \text{Material Strength} \geq (\text{Maximum Load})/\text{width} \)
  - Or \( t \times \text{Strength} \geq \text{Constant} \)
Suitability for Service Calculations

- **FRP**
  - Loss of strength has been observed.
  - Thickness is generally constant.

- Mathematically:
  - \( t \times \text{Material Strength} \geq \frac{(\text{Maximum Load})}{\text{width}} \)
  - Or \( t \times \text{Strength} \geq \text{Constant} \)
Destructive Test Results for the same tank as Corrosion Barrier history earlier

\[ PDS = \frac{\text{Current Modulus}}{\text{Design Modulus}} \]
FRP Service History

PDS History

Percentage of Design Strength (PDS)

Year


0.5m Elev

At Crack

0% 20% 40% 60% 80% 100% 120%

0.5m Elev

At Crack
Parameters

1. **Critical PDS:**
   - Minimum allowable value of PDS for equipment operation.
   - Intent to set where the actual current Design Factor=2
   - For new Design Factor=10, Critical PDS=20%
   - For new Design Factor=6, Critical PDS=33%
   - For new Design Factor=5, Critical PDS=40%

2. **Half Life PDS (PDS\textsubscript{50})**
   - Value of PDS at 50% of FRP lifespan to Critical PDS.

3. **Engineering Review Recommended**
   - To determine whether parameters are still valid.
   - Triggers at about ¾ of the calculated lifetime.
FRP Suitability for Service Curve

PDS History

- 0.5m Elev
- At Crack
- PDS50
- Eng Review
- Critical PDS
- Min Life Projection

Year:
- 1995
- 2000
- 2005
- 2010
- 2015
- 2020

Percentage of Design Strength (PDS): 0% to 120%
FRP Strength Determination

- Must be:
  - Repeatable
  - Verifiable
  - Non Destructive

- Rocket Science
  - 1960’s: NASA starts investigating ultrasonic testing (UT) for flaw detection in composite aircraft parts
  - Also detected changes in strength using ultrasonic testing
  - Further work has produced a system that meets the criteria
Destructive vs. Non Destructive Results

- Normalized Destructive Test Results
- UTComp™ PDS
Applications

- Can be used for:
  - Vessels, Tanks, Scrubbers
  - Duct
  - Pipelines

- Principles of API 653 are generally applied.
Application

- Tank with repair

![Graph showing the percentage of design strength over years for different elevations and design scenarios.](image-url)
Application

- Wet Chlorine Gas Headers

![Remaining Service Life Header A & B 24"

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<th>Year</th>
<th>Lower Life Estimate</th>
<th>Upper Life Estimate</th>
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<th>Nozzle Wall Failure</th>
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Conclusions

- Non Destructive Strength data for FRP can be used for Suitability for Service and Remaining Service Life reporting.
Questions?