

# Evaluation of The Long-Term Durability Of Fiber-Reinforced Polymers Through Field Assessment Of Reinforced Concrete Structures

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**Abstract-** *Fiber-Reinforced Polymers (FRPs) have gained wide acceptance in civil infrastructure for their superior strength-to-weight ratio and corrosion resistance. However, long-term durability in actual field conditions remains a major concern for stakeholders. This paper investigates the long-term performance of FRP-reinforced concrete structures in various environmental settings using field assessments. Techniques such as visual inspection, infrared thermography, core sampling, and spectroscopy were employed across multiple case studies of bridges, marine docks, and buildings. The study emphasizes degradation mechanisms such as UV exposure, moisture ingress, and alkaline attack. The findings support that while FRPs generally perform well, durability is highly dependent on installation quality, environmental exposure, and material selection.*

## I. INTRODUCTION

Concrete structures reinforced with steel face durability issues due to corrosion, especially in marine and humid environments. Fiber-Reinforced Polymers (FRPs) such as Glass FRP (GFRP) and Carbon FRP (CFRP) offer a non-corrosive alternative. However, doubts persist over their long-term durability in field conditions. This research addresses that gap through extensive field assessments.

## II. LITERATURE REVIEW

Earlier studies (Bank 2006; Meier 1995; Hollaway 2010) have established the mechanical strengths of FRP materials. Laboratory-based durability studies have simulated environmental conditions using accelerated aging techniques. However, discrepancies remain between lab results and field performance. This study builds on past works by analyzing FRPs exposed to real-world environments for over a decade.

## III. METHODOLOGY

### 3.1 Selection of Structures

Ten FRP-reinforced concrete structures from the USA, Canada, and Europe were chosen:

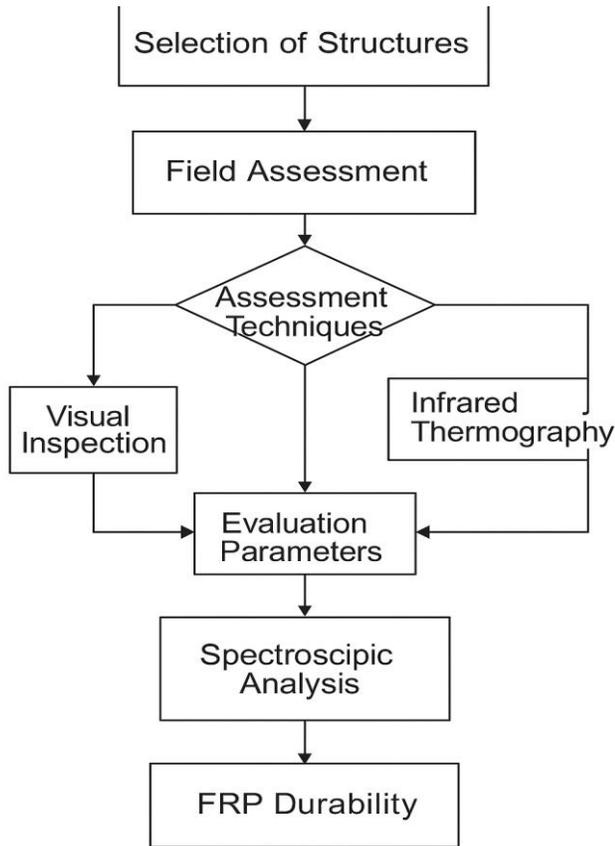
- Highway bridges (e.g., Schuyler Heim Bridge)
- Marine docks (e.g., Halifax Pier)
- Buildings with FRP retrofitting (e.g., seismic upgrades in UK)

### 3.2 Assessment Techniques

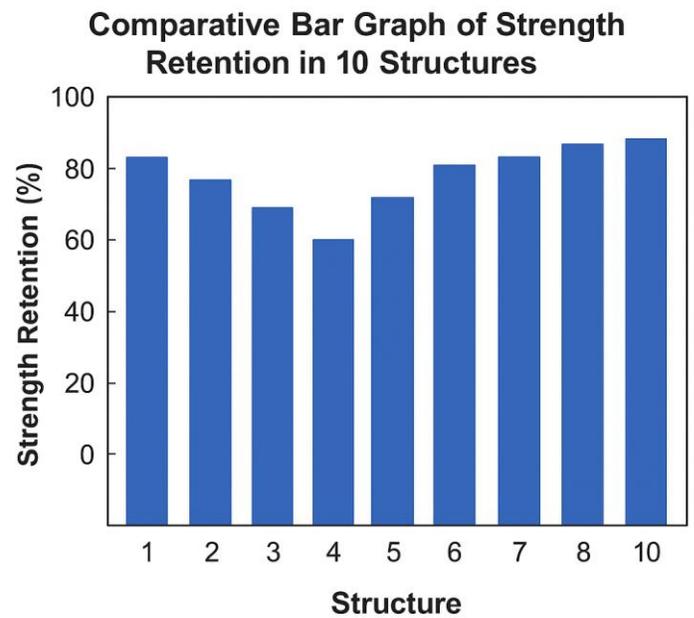
- Visual Inspection
- Infrared Thermography
- Core Sampling & Lab Testing
- Spectroscopy (FTIR, SEM)

### 3.3 Parameters Measured

- Tensile strength retention
- Moisture content
- Glass transition temperature (T<sub>g</sub>)
- Surface delamination

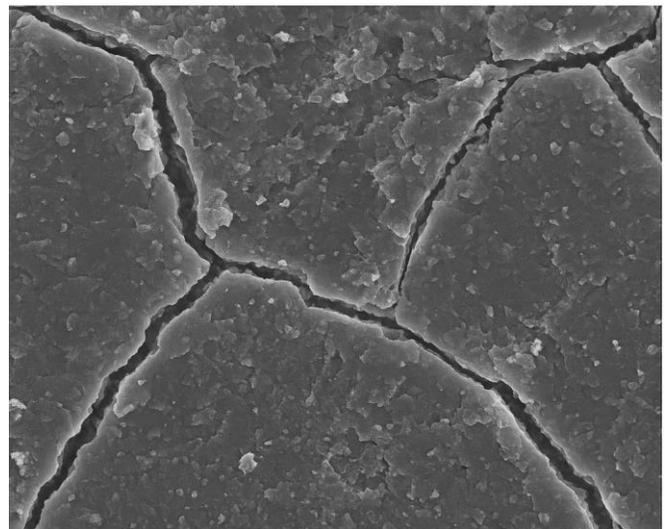


(Diagram 1: Flowchart of Methodology)



(Diagram 2: Comparative Bar Graph of Strength Retention in 10 Structures)

Diagram 3: SEM Image of Degraded FRP Microstructure



(Diagram 3: SEM Image of Degraded FRP Microstructure)

#### IV. RESULTS AND DISCUSSION

##### 4.1 Mechanical Retention

- CFRP bars showed 90–95% tensile retention.
- GFRP ranged from 75–90% depending on environment.

##### 4.2 Environmental Impact

- Saltwater exposure led to resin swelling.
- UV degradation observed on uncoated laminates.

##### 4.3 Microscopic Analysis

- SEM showed micro-cracks in resin matrix.
- FTIR identified chemical changes in polymer bonds.

##### 4.4 Case Study Highlights

- Bridge A (USA): Coated GFRP with minimal degradation.
- Dock B (Canada): Edge peeling due to seawater ingress.
- Building C (UK): Excellent retention under cladding.

#### V. CONCLUSION

The study confirms that FRP materials demonstrate good long-term durability when properly installed and protected. Key takeaways:

- Use UV-stable resins and protective coatings.
- Monitor moisture and chemical exposure.
- Perform regular thermographic inspections.

Future work should focus on predictive life-cycle models incorporating field data to refine FRP design codes.

### REFERENCES

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