STRONGER THAN STEEL. DESIGNED FOR 100-YEAR ROAD LIFE.

GFRP Reinforcement for Durable, Low-Carbon Road Infrastructure

IRF – India Chapter | Lecture Series 3.0
Theme: Vision Zero India – Safety, Sustainability
Sopic: Sustainabile Materials & Circular Economy in Road Construction

Dhruv Rathi
Director | Shri Rathi Steel Group | 7 STAR Impex LLP

Roadmap for this presentation...

1. India's Highway Boom
2. Issues with current reinforcement
3. GFRP - What it is, History & Legacy
4. Sustainability Perspective
5. Adoption in Projects
6. Current Challenges in Adoption
7. India's Opportunity

Highway Development in India

Largest Road Network

India will become the **2nd largest highway network globally by 2030**, already at **6.7 million km**.

Highway Investment

MoRTH + NHAI expansion driven by Bharatmala, Expressways & Gati Shakti.

km/day Construction

India holds the **world's fastest highway construction rate**, global record set in 2021.

Bharatmala Phase-1

India's **largest highway development programme** by corridor length.

Expressways Target

Expressway network growing from 3,500 km to **25,000 km by 2027**.

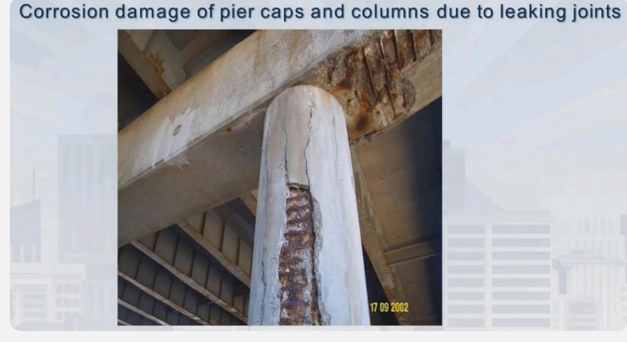
Infrastructure Projects

Rapid scale-up of **bridges, tunnels & strategic corridors** across Himalayan & Northeastern regions.

India's highway expansion is reshaping national connectivity and enabling long-term sustainable infrastructure growth

The Problem With Current Reinforcement

Why Sustainability Is a Challenge Today



The Problem With Current Reinforcement

Why Sustainability Is a Challenge Today

Kolkata's Majerhat Bridge collapses, one dead, many feared trapped

What happened

Portion of a 40+ year old bridge collapsed during peak traffic

Role of corrosion

- Severe **corrosion of steel girders and reinforcement**
- Long-term water ingress and lack of anti-corrosion protection

Long-term corrosion of steel reinforcement and girders led to section loss, concrete spalling, and progressive structural weakening

Sources: *The Times of India, Hindustan Times, Econominc Times, IIT Kharagpur – Structural Audit Report*

Corrosion-Driven Deterioration in Urban Flyovers: Evidence from Chennai (2025)

Why this matters

- Coastal chloride attack
- Direct relevance to **Indian climatic conditions**
- Shows **pre-collapse distress**, not just failures

Root Causes

- Corrosion of Steel Reinforcement
- Inadequate Durability Design
- Water Ingress & Poor Drainage
- Maintenance-Heavy Materials

Repeated distress and accidents underline the need for durability-driven design and corrosion-resistant reinforcement in urban infrastructure.

Sources: *The Hindu (multiple investigative reports), CSIR–SERC Chennai, Tamil Nadu Highways Dept.*

Evolution / History of Rebar

Black Bar – 1920s

First mass-produced steel reinforcement for concrete, prone to corrosion in harsh environments.

Galvanized & ECR – 1970s

Introduced zinc and epoxy coatings to combat corrosion and extend structure lifespan.

Fiberglass Rebar – 1990s

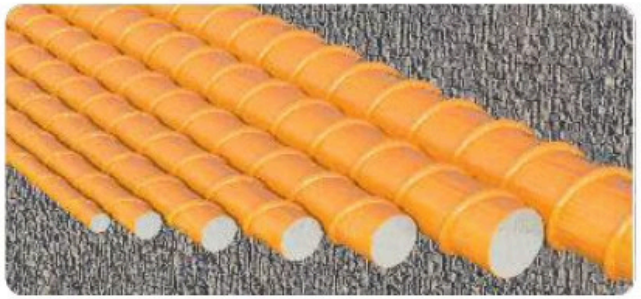
Developed as a non-corrosive, high-strength, lightweight composite alternative to steel.

Sustainability Focus: Progress towards longer-lasting, lower-maintenance, and more durable infrastructure materials.

Introducing GFRP Bars, Mesh & Bent Elements

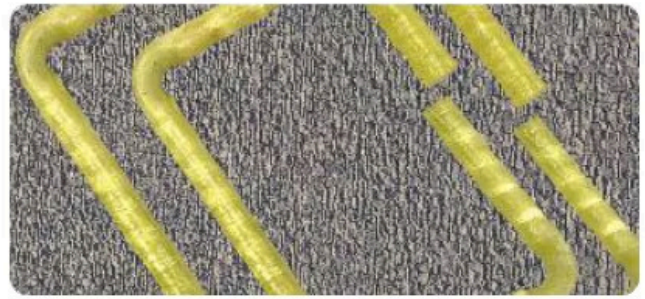
GFRP, or Glass Fiber Reinforced Polymer, is a composite material that has gained significant attention in the construction industry. It is made by reinforcing plastic resin with fine glass fibers, resulting in a lightweight yet durable material. GFRP offers several advantages over traditional construction materials, such as steel, like high strength, corrosion resistance, and design flexibility. It has found application in various structural elements, such as reinforcing bars, grids, panels, and profiles. With its exceptional properties, GFRP is revolutionizing the way we build, providing sustainable and innovative solutions for a wide range of construction projects.

GFRP bars, mesh, and beam elements are key components in the construction industry, revolutionizing the way structures are built. GFRP, or Glass Fiber Reinforced Polymer, is a composite material that combines the strength of glass fibers with the versatility of polymer resins.



GFRP BARS

GFRP MESH



GFRP BENT ELEMENTS

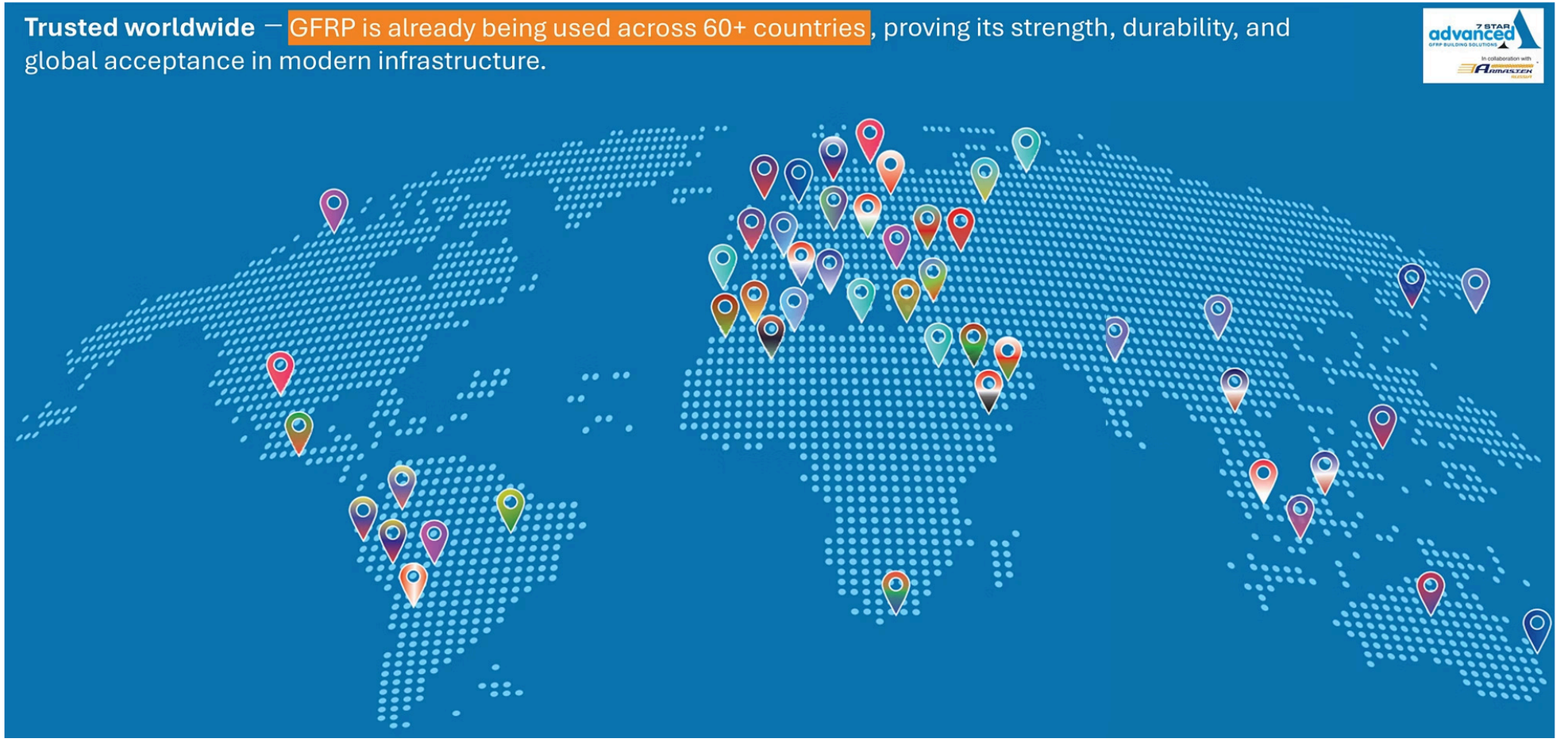
Sustainability & Performance Advantages of GFRP

GFRP demonstrates

✓ Exceptional performance across multiple parameters, from tensile strength to durability in harsh environments.

✓ These properties make it ideal for long-term infrastructure applications.

Trusted worldwide — GFRP is already being used across 60+ countries, proving its strength, durability, and global acceptance in modern infrastructure.



✓ GFRP is being successfully infra project adopted across the globe, from North America to Europe & is accepted readily across asian nations as well.

✓ This adoption at global level is a clear marker for a proven and time-tested product performace ⇒ ensuring long term durability across claimatic conditions and applications.

**Sources:Market data*

From the First GFRP Bridge to 500+ Installations in North America — A Proven Technology

World's First Vehicular Bridge Reinforced with GFRP-Over 28 years, Zero Repairs

McKinleyville, WV (USA) | Built in 1996 | No Corrosion. No downtime. Proven Performance.

As of 2016 more than 500 Bridges are made with FRP in North America including Canada

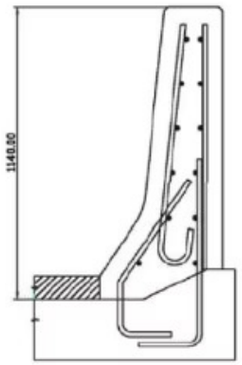
The McKinleyville Bridge

- ✓ First vehicular bridge in the U.S. to be constructed with a concrete deck reinforced with FRP rebar.
- ✓ The bridge is 177 ft. long and 30 ft. wide and accommodating two lanes of traffic.
- ✓ Original surface, no repairs required for 20 years.

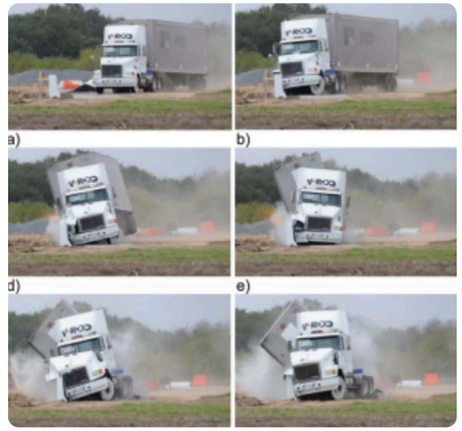
**Source :https://fdot.gov/*

TL-5 Performance Validation of crash barrier made using GFRP

Cost-Effective PL-3 Concrete Bridge Barrier with GFRP Reinforcement: A Safer, Smarter Solution



GFRP CRASH BARRIER TEST



Crash Test Summary

A full-scale crash test was performed at Texas Transportation Institute (TTI) following MASH Test Level 5 (TL-5) standards. A 36,000 kg tractor-trailer impacted the barrier at 79 km/h and 14.60degrees.

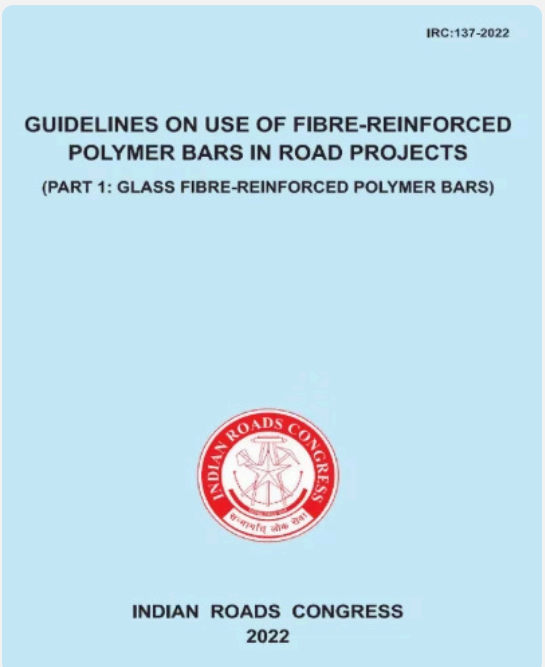
**Source : NRC Research Press | Development of cost-effective PL-3 concrete bridge barrier K. Sennah and H.R. Khederzadeh*

From Gadkari Ji's Vision to IRC Guidelines — GFRP Is Now Mainstream

What Sh. Nitin Gadkar has to say about GFRP rebars?

"We will give priority for use of Glass Fiber Bar in Road Construction and Bridges"

Codal Provision allowing for the use of GFRP



GFRP Adoption across India in various road Projects - NHAI & MoRTH

Mapping done basis the publically available data

GFRP - Now Appoved by MoRTH, PWDs & Metros Across India

- MoRTH
- Madhya Pradesh PWD
- Maharashtra PWD
- Maharashtra Water Resources Department
- Mumbai Metro
- Gujarat PWD
- DMRC
- Chennai Metro
- Surat Metro
- Rajasthan PWD
- Karnataka PWD

GFRP: Academic & BIS Validation

Media Release

IIT Hyderabad Researchers Propose Use of GFRP Rebar

It is a robust solution with lower life cycle cost for increasing the longevity of many civil infrastructure applications, said Prof Murty, Director, IIT Hyderabad.

Highlights:

- GFRP rebars find applications in Road construction, Dams, Bridges, Rail Structures and Foundations of Buildings and Bridges.
- Research at IITH helps the Bureau of Indian Standards (BIS) develop standards for promoting GFRP bars in various infrastructure applications.
- GFRP rebars are an attractive alternative to conventional steel rebars for concrete construction, being cost-effective in many applications compared to steel when the overall life cycle cost is considered.
- Combined use of discrete fibres and GFRP rebars can alleviate the ductility issues related to GFRP rebars.

Hyderabad, December 01, 2023: A recent report from the International Zinc Association (IZA) reveals that India incurs a loss of 5-7% of its GDP yearly due to steel corrosion. India, with its vast 7,500 km coastline and big metropolitan centres in the coastal regions, faces substantial hurdles in protecting steel reinforcement of concrete buildings and bridges from corrosion. Glass Fiber-Reinforced Polymer (GFRP) rebar is increasingly being used as an alternative to steel reinforcement because it doesn't corrode, is lightweight and is non-conductive. These characteristics make GFRP rebars durable in corrosive environments, easy to transport and install, and beneficial for applications in electrical environments such as MRI Rooms, Rail Structures and Foundations of Transformers and Thyristors. Promoting sustainable infrastructure is essential as part of the 17 Sustainable Development Goals (SDGs) of the United Nations (UN). One such solution is using GFRP rebars in concrete construction, which can result in reduced maintenance, extended lifespan, and lower replacement costs.

भारतीय मानक
Indian Standard

IS 18256 : 2023

कंक्रीट प्रबलन के लिए काँच रेशा प्रबलित पॉलिमर (जीएफआरपी) के ठोस गोल सरिए — विशिष्ट

Solid Round Glass Fibre Reinforced Polymer (GFRP) Bars for Concrete Reinforcement — Specification

ICS 83.120; 91.100.30

© BIS 2023

भारतीय मानक
Indian Standard

IS 18256 : 2023

कंक्रीट प्रबलन के लिए काँच रेशा प्रबलित पॉलिमर (जीएफआरपी) के ठोस गोल सरिए — विशिष्टि

Solid Round Glass Fibre Reinforced Polymer (GFRP) Bars for Concrete Reinforcement — Specification

Validated through academic research by IIT Hyderabad and formally standardized by the Bureau of Indian Standards under IS 18256:2023, establishing GFRP rebars as a scientifically proven and nationally recognized reinforcement material.

Sustainability Benefit #1: Eliminates Corrosion ⇒ Extends Life

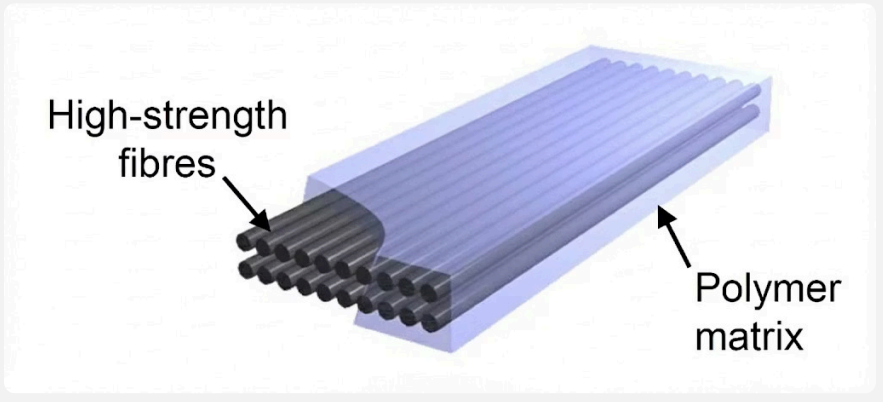
GFRP Bars

GFRP is a composite material, not a metal.

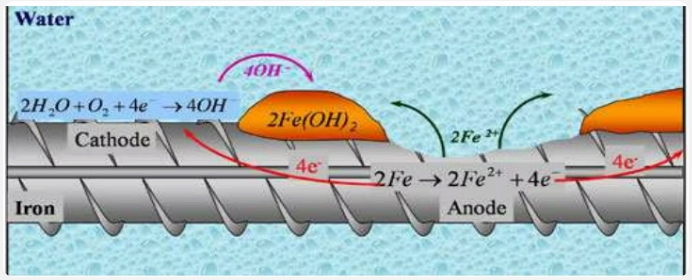
Made of high-strength glass fibres and a protective polymer resin.

Inherent material properties prevent electrochemical corrosion.

No metallic components to oxidize or rust.



TMT Bars



Steel corrodes because it is a metal exposed to moisture and oxygen.

Steel undergoes electrochemical corrosion, accelerated by moisture and chlorides, making deterioration inevitable.

Rust expands 6–10× in volume, causing concrete cracking, spalling, and loss of bond between steel and concrete.

Progressive corrosion reduces steel cross-section and load capacity, leading to premature and often hidden structural failure.

Source: *Corrosion Free Reinforcement System for Sustainable Concrete Infrastructure - Opportunties and Challenger (2020) - Dr. S. Suriya Prakash, Department of Civil Engineering, IIT - Hyderabad*

Field Evidence Confirms Long-Term Durability of GFRP Rebars

University of Manitoba | ISIS Canada – Field Demonstration Studies

Study Background

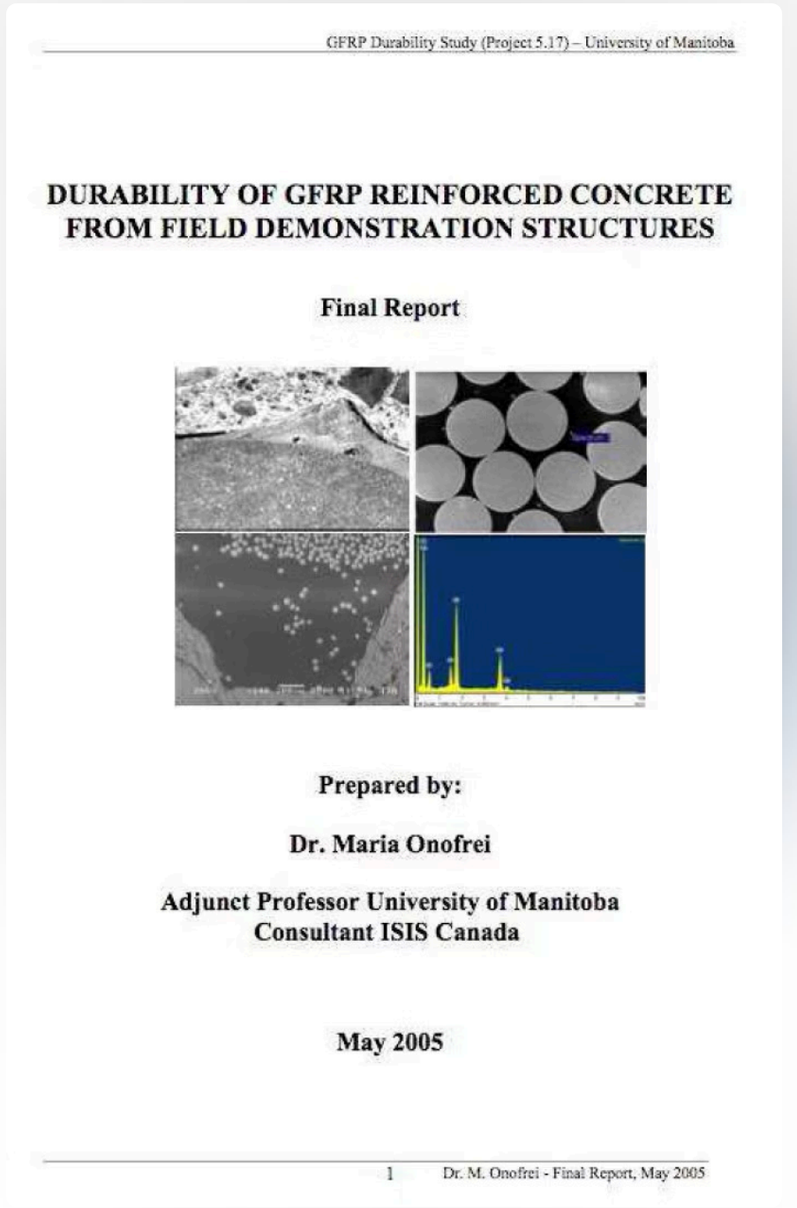
- Field evaluation of GFRP-reinforced bridge decks after **15–20 years** in service
- Exposed to traffic, moisture, chlorides, and harsh environmental conditions

Key Field Findings

- **No corrosion** observed in GFRP reinforcement
- **No loss in tensile strength or stiffness**
- Fibre–matrix integrity fully maintained across exposure conditions

No degradation of GFRP bars was found after long-term field exposure

Source: *University of Manitoba | ISIS Canada Research Network, Onofrei, M. (2005) – Durability of GFRP Reinforced Concrete from Field Demonstration Structures | Corrosion Free Reinforcement System for Sustainable Concrete Infrastructure - Opportunties and Challenger (2020) - Dr. S. Suriya Prakash, Department of Civil Engineering, IIT - Hyderabad*


GFRP Durability Study (Project 5.17) – University of Manitoba

DURABILITY OF GFRP REINFORCED CONCRETE FROM FIELD DEMONSTRATION STRUCTURES

Final Report

Prepared by:

Dr. Maria Onofrei

Adjunct Professor University of Manitoba
Consultant ISIS Canada

May 2005

1 Dr. M. Onofrei - Final Report, May 2005

Sustainability Benefit #2: Lower Carbon Footprint

LEED Certified Product

Used and implemented

Lower CO_2 Emissions

LCA studies show GFRP emits ~17% less CO_2 per kg over its full lifecycle compared to steel

2X Design Life

With double design life (100-year vs 50-year), CO_2 emissions eliminated for every maintenance cycle

Lower Transport Emissions

Lighter weight results in 70–75% savings in transport emissions

100% Recyable

Can be crushed along with concrete

Does Not Act as Thermal Bridge

GFRP is thermally non-conductive

Product Compatibility Evaluation – LEED® - NC USGBC

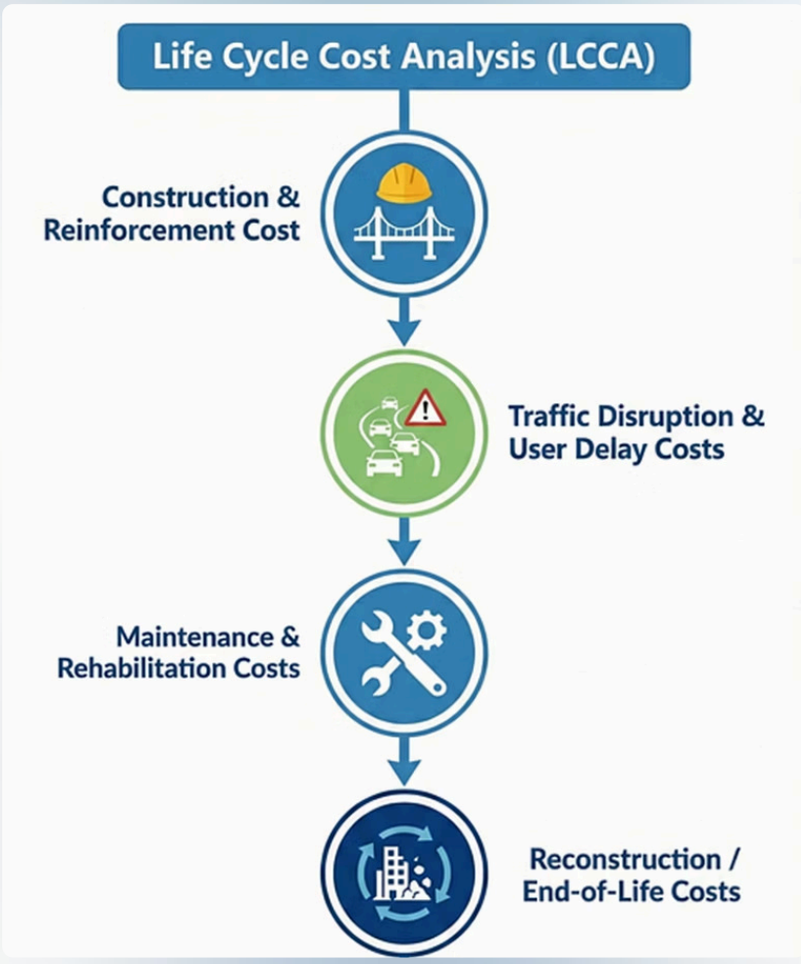
GA Product Evaluation No. **09-004-V01** Date of Evaluation: **December 2009**

Product Name: **TUF-BAR™** Product Type: **Fibrous Reinforcing**
Manufacture Name: **BP Composites Ltd** Master Format Code: **03 24 00**

Product Description:
TUF-BAR™ is a glass fibre reinforced polymer rebar that is light, strong, corrosion resistant, acts as a thermal and electrical insulator, and is ideal for a project with non-magnetic requirements. Please visit www.bpcomposites.com for further information.

Product Evaluation:
The information on the form is applicable internationally. The product data has been evaluated and verified as of the date on this form by an independent green product data verifier; 'Green Alberta'.

USGBC-aligned LEED®-NC validated GFRP rebars as a green reinforcement contributing to Energy, Materials, and Innovation credits.



Sustainability Benefit #3: Upfront & Lifecycle Savings

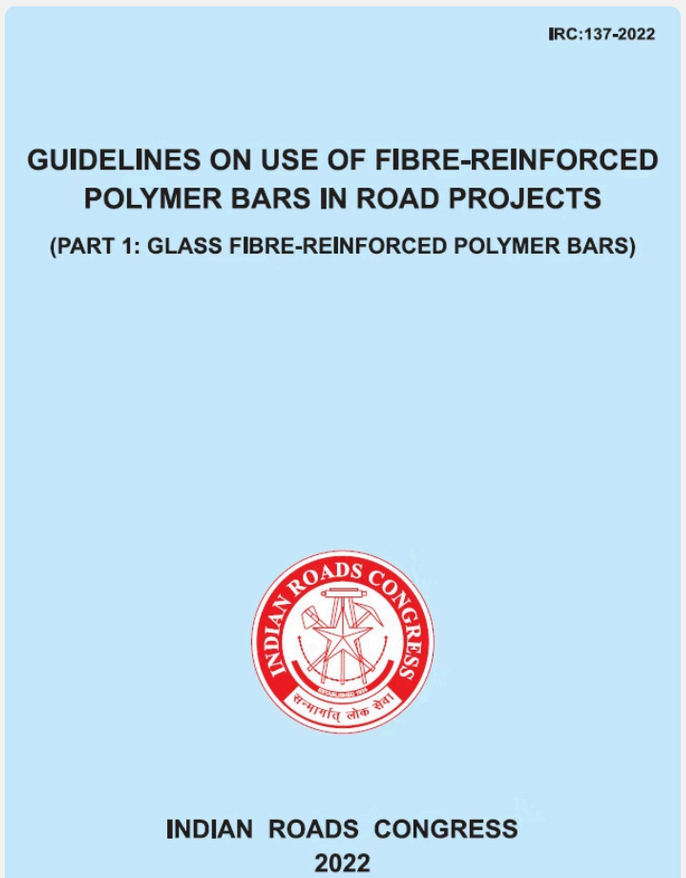
Construction & Reinforcement Cost
- 30–60% lower total reinforcement cost
- Lightweight → faster installation, lower handling cost

Traffic Disruption & User Delay Costs
- Fewer repairs → minimal lane closures
- Reduced traffic and economic disruption

Maintenance & Rehabilitation Costs
- No corrosion-related repairs
- 60–80% lower maintenance over lifecycle

Reconstruction / End-of-Life Costs
- 100+ year service life
- Delays major reconstruction

Where GFRP Delivers Maximum Sustainability Impact


IRC:137-2022

GUIDELINES ON USE OF FIBRE-REINFORCED POLYMER BARS IN ROAD PROJECTS

(PART 1: GLASS FIBRE-REINFORCED POLYMER BARS)

INDIAN ROADS CONGRESS
2022

Table 3.1. List of permitted concrete components with their applicable standards.

Sr. No.	Components	Applicable Standards
1	Approach Slabs	AASHTO (2018), Section 2.10, FDOT (2021), Section 400-20
2	Bridge Decks and Bridge Deck overlays, Walkways of Foot Over Bridge, Slab Culverts	AASHTO (2018), Section 2.10.1, CSA (2006), S6:19, Section 16.7, Section 16.8
3	Bridge cum Bandhara, including Deck Slabs and Barriers between Piers	AASHTO (2018), Section 2.10.1,CSA (2006), S6:19, Section 16.7, Section 16.8
4	Concrete Roads including Jointed Plain Concrete Pavement, Continuously-Reinforced Concrete Pavements (CRCP) and Short-Panel Concrete Pavements (both cast-in-situ and precast)	Transport for NSW (2020)
5	Retaining Walls	FDOT (2021), Sections 548 & 544
6	Noise Barriers	FDOT (2021), Section 534
7	Box Culverts	FDOT (2021), Section 410
8	Crash Barrier & Bridge Parapets	AASHTO (2018), Section 5
9	Pedestrian Parapets and Railings	FDOT (2021), Section 521
10	Bulkheads and Bulkhead Copings	CSA (2006), S6:19, Section 16.9.4
11	Mechanically Stabilised Earth Wall Panels and Copings	FDOT (2021), Section 548
12	Drainage Structures	FDOT (2021), Sections 436, 440, 443 & 446
13	Plain Concrete Components	ACI 440.1R-15 (2015), Section 9.1

Case Study #1 : Crash Barrier with Friction Slab

GFRP vs TMT: Cost Savings for Crash Barrier with Friction Slab (Per km)

Item	GFRP Bars	TMT Bars
Length	1 Running Km	
Strength of Bar	800 - 1000 Mpa	500 Mpa
Consumption of Rebar (approx.)	21.7 MT	94.5 MT
Wastage %	0%	5%
Wastage (in MT)	0 MT	4.7 MT
Total Rebar Consumption	21.7 MT	94.5 MT
Total Value of Rebar (Approx.)	**₹ 39.35 Lacs**	**₹ 54.72 Lacs**

Additional Advantages (Not Monetized)

- Zero Corrosion
- Lower Dead Weight
- Faster Installation
- Extended Service Life & Reduced Lifecycle Cost

Savings (in ₹): **₹15.37 Lacs / Running Km**
Savings (in %): ≈ **29%**

**T&C Apply*

Case Study #2 : Drains

GFRP vs TMT: Cost Savings for Covered Drains (Per km)

Item	GFRP Bars	TMT Bars
Width	1500 mm	1500 mm
Strength of Bar	800 ~ 1000 Mpa	500 Mpa
Dia of Rebars Used	6mm , 8mm	8mm , 10mm
Consumption of Rebar (per km)	3.72 MT	28.62 MT
Total Cost per KM	**₹ 8.4 Lacs**	**₹ 15.5 Lacs**

Additional Advantages (Not Monetized)

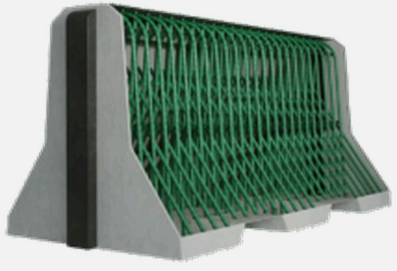
- No corrosion in aggressive environment
- Reduced steel congestion → better concrete compaction
- Lower maintenance & extended service

Savings (in ₹): **₹ 7.10 Lacs / Running Km**
Savings (in %): ≈ **46%**

GFRP reinoffocement for covered drains provides significant cost savings and enhanced durability compared to traditistional TMT bars, a longer, maintenance-free service life.

**T&C Apply*

Case Study #3 : New Jersey Crash Barrier



GFRP vs TMT: Cost Savings for New Jersey Crash Barrier (Per km)

Item	GFRP Rebars	TMT Bars
Width	610 mm	610 mm
Height	800 mm	800 mm
Length	1 km	1 km
Total Reinforcement Quantity (approx.)	3.66 MT	22.39 MT
Total Cost per km	**₹5.83 Lacs**	**₹10.52 Lacs**

Additional Advantages (Not Monetized)

- Zero corrosion → ideal for exposed highway barriers
- Significantly lower reinforcement weight
- Reduced maintenance & longer service life

Savings (in ₹): **₹ 4.69 Lacs / Running Km**
Savings (in %): ≈ **45%**

GFRP reinforcement for New Jersey Crash Barriers provides significant cost savings and enhanced durability compared to traditional TMT bars, a longer, maintenance-free service life.

**T&C Apply*

Case Study#4 : Precast Boundary Wall

GFRP vs TMT: Cost Savings for Boundary Wall (Per km)

Item	GFRP Rebars / Mesh	TMT Bars
Width	300mm at Base with Precast Panel of 75mm width	
Height	GL+1500mm	
Length	1 running KM	
Reinforcement Used	**GFRP Rebars / Mesh**	TMT Bars
Total Reinforcement Quantity (approx.)	7.555 MT	39.164 MT
Cost per MT	₹2,25,000	₹55,000
Total Cost per km	**₹15.11 Lacs**	**₹21.54 Lacs**

Additional Advantages (Not Monetized)

- Zero corrosion → ideal for boundary and compound walls
- Lower reinforcement quantity & faster installation
- Improved durability and lifecycle performance

Savings (in ₹): **₹ 6.43 Lacs / Running Km**
Savings (in %): ≈ **30%**

GFRP reinforcement for boundary walls provides significant cost savings and enhanced durability compared to traditional TMT bars, a longer, maintenance-free service life.

**T&C Apply*

Current Challenges with GFRP Adoption

- **Design Familiarity & Codal Interpretation**
- **Material Selection & Specification**
- **Execution & Workmanship**
- **Assurance, Testing & Approvals**

Despite its advantages GFRP adoption faces customer-level challenges in design, integration, execution practices, and regulatory approvals.

I have a
very special
Gift for you !

This “Gift” is something NO OTHER GFRP SUPPLIER in the WORLD can offer you…

A **Complete System**,
A **Proven Method**,
and a **Guaranteed Roadmap** to **Achieving Zero-Error GFRP Success**.

INTRODUCING

S·T·A·R FRAMEWORK

360° SUPPORT SYSTEM

30% SAVINGS | 80% FASTER EXECUTION

SUPPORT | TRUST | ASSURANCE | RELIABILITY

WORLD'S 1ST & ONLY SUPPORT SYSTEM FOR 100% GFRP SUCCESS

THE S·T·A·R FRAMEWORK

S ⇒ Support

Design Audit, Design Assistance, Product Range, On-Site Training, Regulatory Guidance

T ⇒ Trust

Certified Product Quality, Provide Buyer's Guide, Global Partnership

A ⇒ Assurance

Engineered Assurance, Design Validation, Mock-Up Testing

R ⇒ Reliability

Standards Compliance, Batch Traceability, Continuous R&D, Legacy Backing

Framework Purpose: The STAR Framework bridges the critical gap between codal intent and on-ground execution, ensuring that the transition from steel to GFRP is technically sound, operationally seamless, and aligned with India's sustainability and circular economy objectives.

Clients Speak: How the S·T·A·R Framework Transformed Their GFRP Experience

SHIVALAYA

> **"By applying the S·T·A·R Framework, our design was optimised… and our GFRP consumption dropped by *50%* without losing strength."**
> *— Shripal Agarwal (CMD), Shivalaya Construction Limited*

> **"We finally understood how to verify REAL GFRP quality… The S·T·A·R Framework taught us the exact checks to choose a *reliable* supplier."**
> *— Ankur Jain (Director), Shree Riddhi Siddhi Buildwell Ltd*

SHREE RIDDHI SIDDHI
Building Concrete Relationships

PCV infrastructure pvt ltd

> **"The S·T·A·R Framework showed us a full mock-up before execution… and trained our team so well that GFRP installation became *smooth and error-free*."**
> *— V Karmegam (MD), PCV Infrastructure Private Limited*

☆ S·T·A·R Framework ☆
Guaranteed Success of GFRP Adoption

India's Opportunity: Sustainable Roads for 100+ Years with GFRP

Proven Material

Validated by global codes, LCA, and deployments.

Circular Economy

Supports circular economy via durability and reduced consumption.

UN SDG Alignment

Aligns with UN SDGs for sustainable infrastructure.

Regulatory Support

IRC:137 enables systematic GFRP integration.

TICK By strategically GFRP adoption, India can carve its journey in sustainable infrastructure
TICK Achieving long-life roads with high impact and low incremental cost.

7 STAR advanced
GFRP BUILDING SOLUTIONS

in collaboration with

ARMASTEK RUSSIA

Manufactured by
7 Star Impex LLP
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contact@7stargfrp.com | https://www.7stargfrp.com

Thank You!

We look forward to your guidance and collaboration.

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Please feel free to reach out with any questions or to discuss next steps.

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