

## **GFRP VS Black Steel Rebars**

### **GR. 40 Plain Black Steel versus Fiberglass Rebar (GFRP)**

Black steel is inexpensive and plentiful. It's a great reinforcement to use if you are not responsible for the long-term maintenance of a concrete structure.

As you can see from this photo (green bars are GFRP) black steel essentially has no corrosion resistance, frequently it comes to the job site already rusting. Often even excessively rusted rebar is sold to the end user. Rust has been called concrete's cancer; it degrades frequently and ugly rust stains often appear on surfaces of structures reinforced with it.

Structures built with black steel generally need some rehabilitation in as little as 5 to 10 years and frequently need major rehabilitation within 20 years.

No corrosion effect has been detected on GFRP; conservative estimates indicate fiberglass reinforced concrete structures will last longer than 50 to 100 years. Properly reinforced GFRP concrete slabs exposed to heavy fatigue loads (like driveways, bridge decks) will have less cracking and are projected to last up to 20 times longer than similar structures reinforced with conventional black steel.



*Rusted new rebar versus unruined GFRP form ties*

The prime reason for using GFRP is for concrete longevity. While black steel is inexpensive, it will eventually destroy your concrete. Using dirty oil in your new vehicle makes no sense... nor does it make sense to inject cancer cells into a healthy body. Many governments, municipalities and businesses have concluded that they can no longer afford

the short or long term costs associated with black steel. Placing unprotected, rusty rebar in new concrete structures is being questioned and eliminated in many parts of North America.

## Life Cycle Costs

Many life cycle costs studies comparing black steel to GFRP have been completed. The consistently conclude that the cost to protect, preserve and repair black steel in concrete is very high. So high, in fact, that even free black steel rebar still has a higher installed cost than GFRP in some applications.

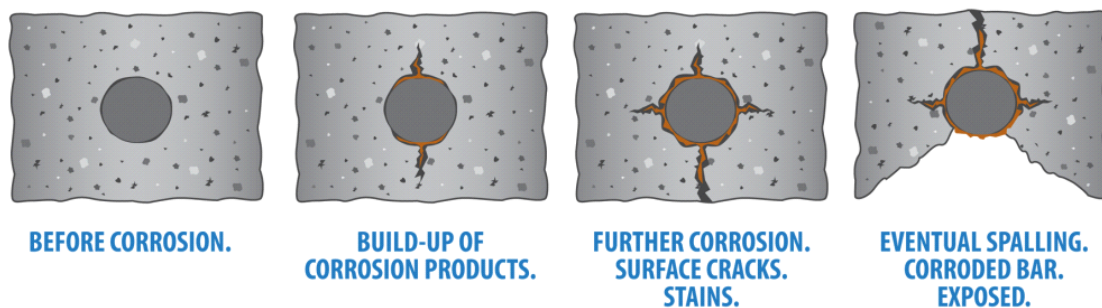
## How can this be?

Consider our garage pad example. If the owner wanted to extend life of the concrete he has a number of options open and they are expensive:

- \* More concrete cover going to a thicker slab
- \* High performance concrete
- \* Concrete corrosion preventative additives
- \* Add a protective membrane

Cracking is difficult to control in any structure. The risk of the measures used to protect black steel failing if cracks occur in the concrete is very high. As soon as these measures fail the steel corrosion cycle starts again.

Although proven to extend the life of concrete when intact. Commercial membranes are not usually used in garage pads because of the expense.

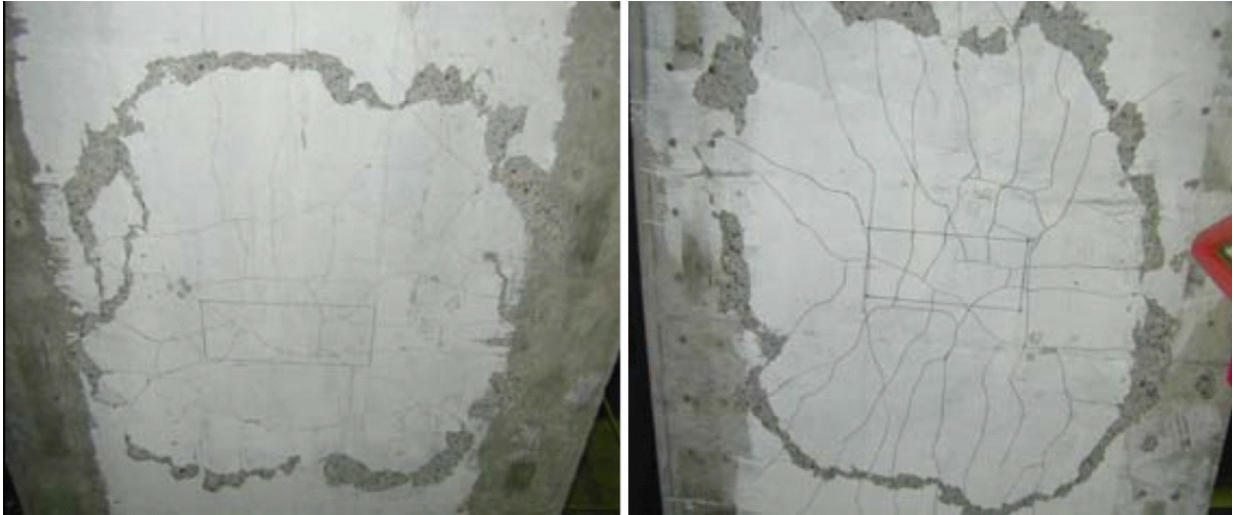


The corrosion cycle of steel begins with the rust expanding on the surface of the bar and causing cracking near the steel/concrete interface. As time marches on, the corrosion products build up and cause more extensive cracking until the concrete breaks away from the bar, eventually causing spalling.

The membrane cost can exceed the cost of the reinforcement. The structure will still be subject to fatigue cracking over time.

## Fatigue Effect

Bridge deck studies simulating heavy traffic over concrete slabs have concluded that properly reinforced GFRP rebar slabs experience:



- 1) Experience 2.5 times less cracking than steel reinforced slabs
- 2) Last 20 times longer than steel reinforced slabs when exposed to heavy fatigue loads

Researchers believe that this is due to the differences in the modulus of elasticity between GFRP and steel. GFRP has a modulus very similar to concrete. Steel's modulus is many times higher. Steel is less forgiving than GFRP. Damage occurs to concrete as steel bends within the pour.

### **Conclusion:**

Fiberglass rebar (GFRP) is a cost effective way to:

1. Eliminate fundamental and expensive repair problems created by black steel reinforcement.
2. Maintain cosmetically attractive structures over time (less cracking and ugly rust staining) resulting in higher property resale values.
3. Reduce concrete cover and corrosion protection measures taken to protect black steel rebar.
4. Ensure your structures will last up to 4 times longer eliminating expensive capital expenditures over time.
5. Make slabs exposed to cyclic loads last 20 times longer than steel reinforced slabs.

## Summary of features GFRP VS. black steel rebars

| Black Steel Rebar                       | Performance and Characteristics Comparison | GFRP rebar  |
|---|--|---|
| <b>Physical / Mechanical Properties</b> |  |   |
| 7.8                                     | Specific gravity                           | 2.0   |
| 400--600Mpa                             | Tensile strength                           | 800-1000Mpa   |
| 200Gpa                                  | Tensile modulus                            | 40 to 60 Gpa  |
| Brittle                                 | Tensile strength in cold                   | unchanged   |
| 4 to 5 Mpa                              | Bond strength to concrete                  | >10 Mpa   |
| Poor                                    | long term bond strength to concrete        | unchanged   |
| No                                      | Non-magnetic                               | Yes   |
| No                                      | Thermal insulation                         | Yes   |
| No                                      | Electrical insulation                      | Yes   |
| Difficult                               | Cutability                                 | easy  |
| Yes                                     | Bending in field                           | No  |
| <b>20 years or less</b>                 | <b>Corrosion Resistance</b>                | <b>50 to 100 years or more</b>                                    |
| High                                    | Need for membranes, crack control          | Low   |
| High                                    | Corrosion risk profile                     | Low   |
| Susceptible                             | Contact corrosion                          | Not susceptible   |
| Susceptible                             | Cathodic protection needed                 | Not susceptible   |
| Susceptible                             | Electro chemical                           | Not susceptible   |
| Susceptible                             | Acid rain                                  | Not susceptible   |
| Susceptible                             | Rust expansion/Rust staining               | Not susceptible   |
| Susceptible                             | Alkali in concrete                         | Not susceptible   |
| Susceptible                             | Chloride stress corrosion                  | Not susceptible   |
| Susceptible                             | Acid soils, marshes                        | Not susceptible   |
| Not susceptible                         | UV damage                                  | Not susceptible initial 6 months; Strength reduced after 6 months |
| Susceptible                             | Viral and H2O penetration in walls         | Not susceptible   |
| Susceptible                             | Corrosion at bends                         | Not susceptible   |
| <b>Not Good</b>                         | <b>Fatigue Performance</b>                 | <b>Much longer life</b>   |
| <b>Cost Comparison</b>                  |  |   |
| High                                    | Life cycle cost advantage                  | Low   |
| Low                                     | Initial cost of material in length         | High  |
| No                                      | Transport savings                          | Yes   |
| No                                      | Handling savings                           | Yes   |
| No                                      | Concrete cover savings                     | Possible  |
| No                                      | Labor savings during installation          | Yes   |
| No                                      | Patching savings                           | Yes   |
| No                                      | Unlimited custom lengths                   | Yes, any length available   |
| High                                    | Work related injuries                      | Low   |