Why V-ROD Composite Rebar?

Reinforced Concrete is a common building material for construction of facilities and structures. While concrete has high compressive strength, it has limited tensile strength. To overcome these tensile limitations, reinforcing bars are used in the tension side of concrete structures. Steel rebar has historically been used as an effective and cost-efficient concrete reinforcement. Where not subjected to chloride ion attack, steel reinforcement can last for decades without exhibiting any visible signs of deterioration. However, it is susceptible to oxidation (rust) when exposed to chlorides. Examples of such exposure include coastal areas, sites where road salts are used for deicing, locations where salt contaminated aggregates are used in the concrete mixture, and sites where aggressive chemicals and ground conditions exist. Where corrosion of rebar occurs, the resulting products have a larger volume (2- 5 times) than the metal product from which they originally derived. The concrete cannot sustain the tensile load developed from this volume increase, and eventually cracks and spalls, leading to further deterioration of the steel. The combination of ongoing deterioration and loss of reinforcement properties ultimately requires potentially significant and expensive outlays for repair and maintenance, and possibly the endangerment of the structure itself.

History and research data has proven that epoxy coated steel rebar is not an adequate answer to these needs, although it is presently the most commonly used product for such applications. Stainless steel will address corrosion issues, but is too expensive. V-ROD™ (the registered trademark name for Pultrall's composite rebar product) with its superior tensile properties and built-in corrosion resistance offers a unique and economically feasible reinforcing rebar for such applications.

The V-ROD™ products offer the following features / benefits when compared to steel rebar:

- **CORROSION RESISTANCE** - will not rust, and are impervious to the action of salt ions, chemicals, and the alkalinity inherent in concrete.
- **LIGHTWEIGHT** - weigh approximately one-quarter the weight of an equivalent size steel bar, offering significant savings in both placement and use.
- **ELECTROMAGNETIC NEUTRALITY** - contain no metal, and will not interfere with the operation of sensitive electronic devices such as medical MRI units or electronic testing devices.
- **THERMAL INSULATOR** – highly efficient in resisting heat transfer, such as from building exteriors to interiors.

Market Applications

Utilizing inherent features / benefits, V-ROD™ has cost effective application as a concrete reinforcing bar in the following markets when analyzed on a life-cycle cost basis:

1. **Reinforced Concrete Exposed to Deicing Salts:** Parking structures; bridge decks; Jersey barriers; parapets; curbs; retaining walls and foundations; roads and slabs on grade.

2. **Structures Built in or Close to Sea water:** Quays; retaining wall; piers; jetties; caissons; decks; piles; bulkheads; floating structures; canals; roads and buildings; offshore platforms; swimming pools and aquariums.
3. **Applications Subjected to Other Corrosive Agents:** Wastewater treatment plants; petrochemical plants; pulp/paper mills; liquid gas plants; pipelines / tanks for fossil fuel; cooling towers; chimneys; mining operations of various types; nuclear power and dump plants.
4. **Applications Requiring Low Electric Conductivity or Electromagnetic Neutrality:** Aluminum and copper smelting plants; manholes for electrical and telephone communication equipment; bases for transmission / telecommunication towers; airport control towers; magnetic resonance imaging in hospitals; railroad crossing sites, and specialized military structures.
5. **Tunneling / Boring Applications Requiring Reinforcement of Temporary Concrete Structures:** Structures including mining walls; underground rapid transit structures and underground vertical shafts.
6. **Weight Sensitive Structures:** Concrete construction in areas of poor load bearing soil conditions, remote geographical locations, sensitive environmental areas, or active seismic sites posing special issues that the use of lightweight reinforcement will solve.
7. **Thermally Sensitive Applications:** Apartment patio decks; thermally insulated concrete housing and basements; thermally heated floors and conditioning rooms.

Designing with Composite Rebar

The mechanical properties of FRP reinforcing bars differ from those of conventional steel rebar in a number of areas. As a result, several issues arise in the development of a design methodology for concrete structures reinforced with such bars. The general design recommendations for flexural concrete elements reinforced with FRP reinforcing bars are presented in **CSA S806-02**, the world's first full standard for FRP and **ACI 440.1R-01, Guide for the Design and Construction of Concrete Reinforced with FRP Bars,** as reported by the American Concrete Institute (ACI) committee 440.

The CSA S806 and ACI 440 recommendations are based on principles of equilibrium and compatibility, and the constitutive laws of the materials. The new design philosophy adopted for FRP bars used as reinforcement for concrete allows consideration to be given to either FRP rupture or concrete crushing as the mechanism that controls failure. It is based on limit states design principles. An FRP reinforced concrete member is designed based on its required strength, and then checked for fatigue endurance, creep rupture endurance, and serviceability criteria. In most cases serviceability criteria or fatigue and creep rupture endurance limits will control the design.