

Q How does the bond strength of galvanized rebar compare with black and epoxy-coated rebar in concrete?

A I presume that when you say "Bond Strength" you are not referring to the next 007 movie.

The use of reinforced concrete relies on a good bond between the reinforcing bars and the concrete. Early tests on the bond strength of various rebar configurations reported confusing results. Galvanized rebar showed good bond strength in some tests and poor bond strength in others. More recent studies have all shown that galvanized rebar bond strength is equal or higher than black steel bond strength. It cannot be denied that the bright, uniform and smooth appearance of a well galvanized surface gives one the impression of much poorer adhesion than that of bare steel, mill scaled or rust on the surface. In this instance, however, as in many others, this impression does not agree with the recent experimental data.

The zinc coating on the galvanized rebar reacts with the calcium hydroxide solution, present in wet concrete. Excessive reactions can create hydrogen gas bubbles in the finished concrete, therefore, chromates are used to prevent these excessive reactives.

Processing of galvanized rebar should include passivation in 0.2 percent sodium dichromate solution applied by galvanizer, or the addition of chromium trioxide to concrete mix in a ratio of 300 ppm (0.3 grams per liter) by weight of mixing water, or 70 to 100 ppm by weight of concrete. Most Portland cements contain some residual, naturally occurring chromates, and exceed the 300 ppm level. Sufficient chromate levels are necessary to prevent hydrogen evolution at the zinc/concrete interface, ensuring high bond strength with no voids created by hydrogen gas evolution.

The bond strength of rebar has been studied in tests conducted by the University of California in accordance with American Concrete Institute (ACI). Both corroded and un-corroded rebar were used. Tests were conducted on concrete beams with plain or deformed bars. The figures, shown here, are compiled from the works of five investigators. Galvanized rebar demonstrated equal or better bond strength than un-galvanized rebar in all conditions.

But how does galvanized rebar stand up to the epoxy-coated reinforcing bar? While the epoxy protects the steel from corrosion, when comparing the bond strength to that of galvanized rebar, it comes up very short.

Based on the results of 21 splice tests with epoxy-coated and un-coated bars evaluated in a research study along with data from previous studies, epoxy coating significantly reduced the bond strength of reinforcing bars. The amount of the reduction was dependent on the mode of failure: pullout or splitting.

If a splitting failure occurred, the bond strength of epoxy-coated bars was approximately 65 percent of the bond strength of un-coated bars. If a pullout failure occurred, the bond strength was approximately 85 percent of that for un-coated bars.

When someone asks if you can use galvanized steel in concrete, just tell them that the bond between the galvanized steel and the concrete will be as good or better than black steel in concrete.

