

REPAIR AND STRENGTHENING OF DOT COLUMNS AND PIERS WITH WATER ACTIVATED AQUAWRAP 22-77

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Abstract

Aquawrap 22-77 is a pre-impregnated, water activated, structural wrap that has been used successfully to repair and strengthen NYDOT and IDAHO DOT bridge columns and piers, and has also been tested extensively and utilized as a FRP Wrap for repairing damaged aluminum and steel freeway sign structures. The product has also been utilized in the repair of wooden telephone poles and for pipeline reinforcement. Aquawrap consists of either glass fiber (Woven and UD) or carbon fiber (Woven and UD) sheets pre-impregnated with a water cured polyurethane resin. The resin content is set at the factory. No impregnation equipment or effort is required at the job site. There is no field saturation required. The material comes in hermetically sealed pouches that are opened prior to use. The water activated polyurethane resin has a faster cure than most epoxy systems. It cures under ambient temperature, with a relatively high glass transition temperature. The wrap may be applied in cold temperatures (32 F.), and in wet conditions, even in the rain or under water.

Introduction

Aquawrap 22-77 consists of a water cured polyurethane resin system impregnated into a variety of reinforcing fibers such as glass and carbon. It has a known % resin content from the factory, and requires no impregnation equipment on site. Resin content is set at the factory. There are no VOC's, no hazardous waste, and no mess to clean up. There is a faster cure compared to epoxy systems. The cure does not require heat and is not exothermic. Ambient temperature has little effect on cure time. As a urethane based system, there is excellent creep performance. The system has been used with woven glass fabric, unidirectional glass fabric, woven carbon fabric and unidirectional carbon fabric. NYSDOT, IDAHO DOT and NSF have approved the system. An ICBO Evaluation is in process.

Project - NYSDOT – Painted Post, NY, RT 17

The New York State Department of Transportation, District #6 (NYSDOT), operating under an emergency repair contract, carried out repairs on Bridges No. 7012680 and 7012690 on Rt. 17 in Painted Post, New York. The bridge, built in 1952 was exhibiting serious spalling on the columns. This bridge supports the Norfolk Southern Railroad over Rt. 17 in Painted Post, NY. NYSDOT elected to use Aquawrap 22-77 Concrete Repair System to perform the repair to the four spalled columns, two per bridge.

The deteriorated condition of the columns was primarily due to weathering, freeze / thaw cycling, and the use of salt in winter conditions. Not all of the four columns exhibited the same amount of degradation.

System Components

Aquawrap 22-77 Concrete Repair System consisted of three components: 22-77 Structural Adhesive, 22-77 Structural Prepreg Cloth, and 22-77 Veil Prepreg Cloth. 22-77 Structural Adhesive is a two part bonding material designed to produce a bond between the 22-77 Structural Prepreg Cloth and the concrete substrate. 22-77 Structural Prepreg Cloth is the main structural component of the repair system. This is a woven roving material impregnated with the water cured resin system. The material comes packaged in moisture-tight packaging.



Unpacking Aquawrap 22-77

22-77 Veil Prepreg Cloth is a tight-woven glass cloth impregnated with the same water cured resin system used in the 22-77 Structural Prepreg Cloth. The material is also packaged in the same manner as the 22-77 Structural Prepreg Cloth.

Column Repair

The procedure for repairing the spalled columns consisted of the following:

- Remove spalled concrete from column.
- Clean column surface.
- Repair spalled areas with HD-25 Vertical and Overhead patch material.
- Apply the Aquawrap 22-77 Structural Prepreg Cloth.
- Apply the 22-77 Veil Prepreg Cloth.
- Allow the 22-77 System to cure.
- Paint the surface with a system compatible polyurethane paint.

Aquawrap 22-77 Structural Prepreg Cloth is applied by wrapping it around the column and onto itself for the second layer. This process is repeated for the entire length of the column. Since the system is a water-cured system, water is sprayed on each layer as the material is applied. This is a confinement application therefore does not require the use of Aquawrap 22-77 Structural Adhesive.



Aquawrap 22-77 Structural Prepreg Application

After the 22-77 Structural Prepreg Cloth has been applied the next step is the application of the 22-77 Veil Prepreg Cloth. Water is sprayed on the surface of the 22-77 Structural Prepreg Cloth. The Veil is then applied in a spiral manner around the column. The 22-77 Veil Prepreg Cloth is the finish layer.



Start of Veil Layer

Bull-Nose Repair

The procedure for repairing the spalled surfaces that are not confined (Bull Nose):

- Remove spalled concrete from column.
- Clean concrete surface.
- Repair spalled areas with HD-25 Vertical and Overhead patch material.
- Apply 22-77 Structural Adhesive
- Apply 22-77 Structural Prepreg Cloth.
- Apply 22-77 Veil Prepreg Cloth.
- Allow 22-77 System to cure.
- Paint the surface with a system compatible polyurethane paint.

The lower sections of the columns were attached to one another with a wall approximately three feet, three inches high by 14 inches thick. Because of the location of the wall and its attachment to the column, the confinement technique used on the upper portion of the column could not be used. Since one could not wrap the material onto itself one had to use an adhesive to assure a proper bond to the concrete substrate. The 22-77 Structural Adhesive is a two-part system mixed in a one to one ratio. The adhesive is applied to the substrate using a roller or trowel. For this application rollers were used to apply the adhesive.



Roller Application of Adhesive

The adhesive was applied and allowed to “tack-off” before the application of the 22-77 Structural Prepreg Cloth. By applying the 22-77 Structural Prepreg Cloth to the adhesive when it has “tacked-off” adhesion to the concrete sub-straight is assured.

The 22-77 Structural Prepreg Cloth is applied to the bull-nose in the same manner as applied to the columns. The first layer of 22-77 Structural Prepreg Cloth is allowed to “tack-off” before the application of the second layer. This again, allows for better bonding.



Structural Layer over Adhesive

The NAVLIGHT ER 22-77 Veil Prepreg Cloth is applied over the structural material. The NAVLIGHT ER 22-77 Veil Prepreg Cloth is not wrapped in this case. It is applied in the same manner as the structural material.



Completed Veil Over Bull-Nose

Once the veil has been applied and allowed to cure, the surface is painted with a system compatible polyurethane paint.

Field Durability Samples

In order to ascertain the long-term durability of the Aquawrap 22-77 system, durability samples were made on the structure. Enough material was put down on the structure to pull a sample each year and do mechanical tests.

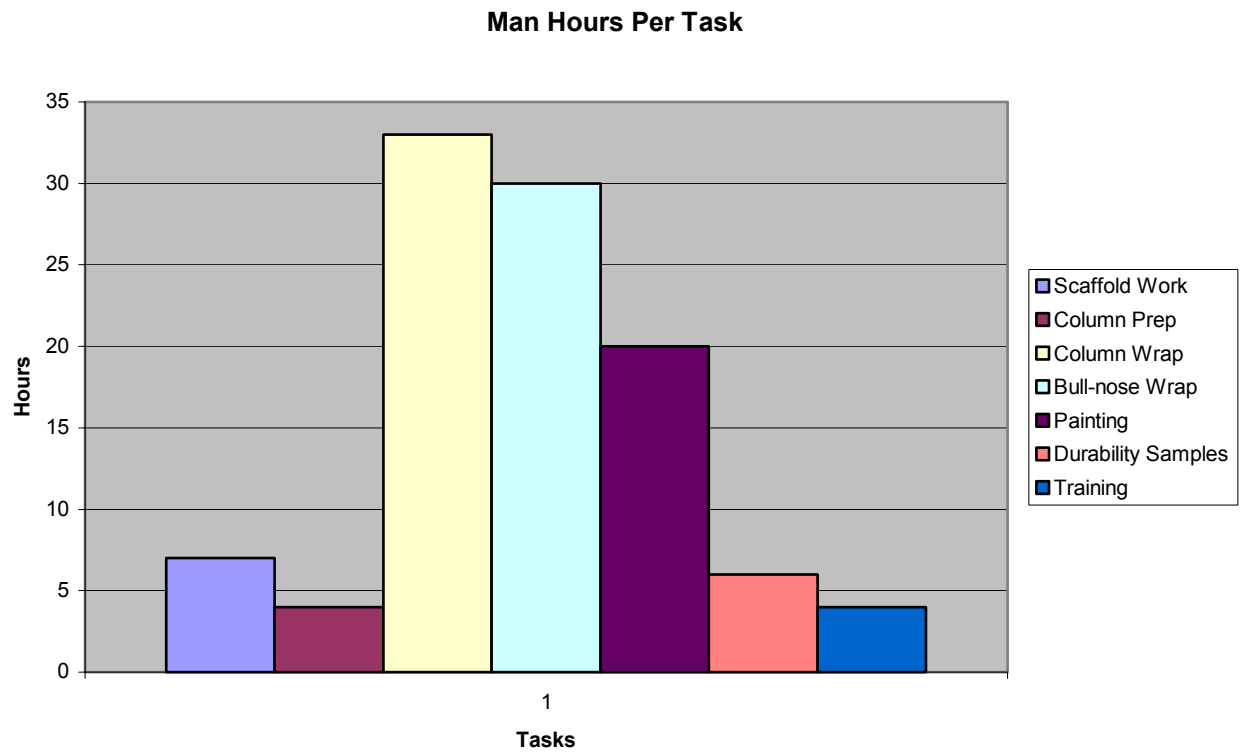


Laying-up Durability Samples

A detailed review of the installation was made by engineering staff from Air Logistics and the NYSDOT. This was done after one winter of freeze thaw cycles. The repair looked very good. There was no evidence of delamination, voids, aging, or other defects.

Labor and Labor Analysis

The man-hours used per task are given in the chart below.



Conclusion

The repair of the Painted Post Bridge was accomplished in a timely manner. There was little waste of material and time. The process of repair using composite materials has been demonstrated many times in NY, each time increasing the knowledge base for the introduction of this technology.

In this case, the viability of composites from a constructability standpoint has been successfully demonstrated. In this particular application, the use of the water cured prepreg material proved to be very valuable. The quality of the impregnation was improved from the typical wet lay-up method. The impregnation of the fabric was complete and there was no evidence of dry fibers, even at the low temperatures encountered during the installation.

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