**Dow Aksa CarbonWrap® Systems for Concrete and Masonry Structures**

**Description**
The DowAksa CarbonWrap® System for Concrete and Masonry Structures system provides a balance of properties most suitable for saturating carbon fiber fabrics predominantly applied to concrete structures as supplemental reinforcement or for the remediation of damaged structures. The low viscosity and thixotropic nature allow for fast and thorough wetting of the carbon fiber fabrics without drainage or sagging on vertical and overhead surfaces. The pot life and cure speed are balanced to allow for multiple applications or layers in a single day. Depending on temperature conditions, the system develops >95% of full properties in as little as 7 days. The system is designed with a colored hardener that makes it easy to identify and assess the thoroughness of the mixing process.

**General**
The integrity and quality of the DowAksa CarbonWrap® systems critically depend on a careful initial planning and evaluation of the project. All construction specifications, materials storage and handling, as well as installation steps, must be carefully reviewed by all those involved in the project and adhered to. The following sections describe various steps necessary for successful completion of the project.

**Initial Planning**
Because DowAksa CarbonWrap® materials can be affected by temperature and moisture during installation and curing, it is recommended that a careful plan for executing different stages of the project be put in place at the start of the project to assure a timely and efficient execution. Several important points to consider include, but are not limited to the following:
- **Schedule:** Plan installation dates and times
- **Equipment:** Provide all tools and equipment necessary for the particular project
- **Materials:** Provide sufficient lead time and order all materials from DowAksa to be ready at the site before the start of the work
- **Workforce:** Determine size, skill level and timeframe for the workforce
- **On-Site Assistance:** Work with DowAksa to determine if an on-site representative of DowAksa is required

**Typical Tools and Equipment**
The following are samples of tools required for installation:
- Heat gun, rags, measuring cups (1L)
- Scissors (4)
- Power generator
- Acetone (4 gallons)
- Silica-based dry sand
- Impregnating machine for automatically saturating the fabric
- Sand- or water-blasting equipment
- Grinder and wire wheel or wire brush
- Pressurized air and dust-removing tools
- Mixing and measuring containers (5 gallons and 2 gallons)
- Weight measuring scale
- Coveralls, chemical-resistant gloves and goggles
- Ventilation equipment
- Roller brush to apply resin, short-handled and long-handled
- Spiked wheel rollers to remove air pockets
- Industrial shears to cut the carbon fabric
- Jiffy or other rotary mixers and mixing paddles
- Rubber trowel or spatula to spread the putty
- Dropcloth and plastic sheets

Consult OSHA for appropriate safety equipment and measures for application of chemicals, resins and epoxies.
**Storage and Safe Handling**

DowAksa CarbonWrap® epoxy and resin compounds must be stored in their unopened containers and conditions described in the Technical Data Sheets (TDS).

As with all chemicals, DowAksa CarbonWrap® epoxy and resin materials have a limited shelf life. In order to preserve their properties and reactivity, these materials should be stored in their unopened containers for periods of two years or less. Materials that have exceeded their shelf life and materials that have been stored improperly, as specified by DowAksa CarbonWrap®, must be disposed of in accordance with the disposal instructions given in the Clean Up and Disposal Section.

DowAksa CarbonWrap® fabrics and laminates have indefinite shelf life. Therefore, they can be stored indefinitely. All materials including the fabrics must be kept away from dust, moisture, chemicals, direct sunlight, physical damage and fire.

All DowAksa CarbonWrap® materials must be handled with care to avoid any physical damage and to avoid potential safety hazards. Those who are involved with handling and application of the epoxy compounds must be thoroughly informed of the safety hazards and potential dangers of the particular chemical they are handling. This includes access to and familiarity with the Safety Data Sheets (SDS). The SDS must be consistently placed in a familiar location and at all times be accessible to the work crew.

The contractor is responsible for providing SDS to all personnel and informing them of the potential safety hazards and other important characteristics of epoxies and resins. Furthermore, the contractor is responsible for making sure that all stages of the project are executed in accordance with federal, state and local environmental laws and regulations in addition to the OSHA requirements and laws to protect the safety of all workers.

When working with epoxy and resin compounds the work area must be very well ventilated. Safety goggles or glasses are necessary when working with epoxies. Coveralls and chemical-resistant gloves must be worn by all personnel in the work area. The gloves must have been tested for resistance to resins, epoxies and solvents.

Personal cleanliness is very important when working with chemical compounds. Involuntary habits such as eyeglass adjustment, face scratching and touching other objects, tools or equipment must be avoided. Eating, drinking or smoking must be avoided until the individual has washed up. Avoid unnecessary and prolonged handling of fabrics. Do not fold the fabrics as this may cause misalignment, pulling and/or breakage of the fibers.

**Clean Up and Disposal**

Any material that has exceeded its shelf life, is damaged or has not been stored according to the specified instructions, or is in excess or not used when opened must be disposed of in accordance with the SDS and all other federal, state and local laws.

The contractor must be thoroughly be familiar with the environmental laws and regulations governing the disposal of chemicals. He/she is responsible for the complete cleanup of the project site, including removal of excess and unused materials (waste), empty containers and other aesthetically unpleasing materials.

**Surface Preparation**

The effectiveness, integrity and performance of the DowAksa CarbonWrap® System critically depend on the preparation and soundness of the substrate. Therefore, preparing a clean and sound substrate is the most important part of the entire application process.

**Removal of Damaged and Unsound Concrete**: Environmental effects and corrosion of the reinforcing bars can cause damage to concrete or masonry. Any such concrete or masonry area that is determined by the engineer of record or other properly trained personnel to be damaged and unsound must be removed and repaired before DowAksa CarbonWrap® can be applied. Defects in concrete substrate can compromise the strength of the DowAksa CarbonWrap® System. Covering of carbonated or chloride-contaminated concrete with DowAksa CarbonWrap® without addressing the source of contamination will be detrimental to the effectiveness of the repair system. Special design consideration needs to be implemented by the engineer of record to address the possibilities of carbonation, alkali silica reactions or reactive aggregates. Careful attention must be paid when removing defective concrete to not damage the surrounding areas. The removal of defective concrete must be in accordance with the guidelines of ACI 546R-96 and ICRI No. 03730. Proper equipment such as chippers and electric jackhammers must be used to remove defective concrete at sufficient depth of at least 1/2 inch beyond the repair area to expose sound aggregates. If concrete removal exposes any pre-stressing or reinforcing steel that is corroded or de-bonded as a result of the removal of defective concrete, additional concrete shall be removed to a depth of 3/4 inch, or at least 1/4 inch larger than the largest aggregate size in the repair material, and repaired again before the application of DowAksa CarbonWrap®. Substrate must be cleaned and repaired before the application of DowAksa CarbonWrap®.

**Repair of Defective Reinforcement**: The corroded reinforcement must be cleaned and repaired in accordance with ICRI No. 03730, and to the satisfaction of the engineer of record. DowAksa CarbonWrap® should not be applied to concrete having unrepaird corroded reinforcement. The corroded reinforcement shall be cleaned to expose the white metal (SSPC SPS-5). Defective steel that is deemed unrepairable by the engineer of record and/or other properly trained persons shall be removed and new steel be spliced in according to the construction documents before the surface is rebuilt.

**Repair of Concrete Surface**: The DowAksa CarbonWrap® System must be bonded only to clean and sound substrate as verified by the engineer of record or a properly trained person. The concrete surface must be built up to its original conditions and all voids greater than 1/2 inch in diameter be filled with repair materials that conform to ICRI No. 03733. The repair materials must have compressive strength greater than that of the original concrete, but not less than 4,500 psi and 5,000 psi at 7 days and 28 days, respectively. Furthermore, the bond strength of the repair materials shall be a minimum of 200 psi according to ASTM D4541 pull-off test. The repair materials shall be cured for a minimum of 7 days before installing the FRP system, unless it’s curing and strength are verified by tests.
Surface Preparation: All sharp fins, protrusions, surface irregularities and unevenness shall be ground to a smooth surface with less than 1/32 inch in deviation. Surface preparation shall promote continuous intimate contact between the DowAksa CarbonWrap® material and concrete by providing a clean and smooth flat or convex surface. Disk grinders or similar equipment may be used to remove paint, stains and other surface substances that may affect the bond. All surface voids greater than 1/2 inch in diameter and 1/8 in depth must be filed before bonding DowAksa CarbonWrap®. Cracks in the concrete surface must be injected with epoxy as well. Any surface protrusions caused by crack injection must be removed before bonding DowAksa CarbonWrap®. Crack injection will prevent water from getting behind the DowAksa CarbonWrap® material. The surface must be completely cleaned of any dust, grease, oil, curing compounds, wax, stains, paint, surface lubricants, foreign particles, weathered layers or any other bond inhibiting materials. If water blast is used to clean the surface, the surface shall be allowed to dry completely before installing DowAksa CarbonWrap®.

Chamfering Corners: All corners and sharp edges shall be rounded or chamfered to a minimum radius of 3/4 inch or greater. Ridges and form lines larger than 1/4 inch shall be ground down or filed with epoxy before installation of DowAksa CarbonWrap®.

Installation of the DowAksa CarbonWrap® System

This section discusses the mixing of the resin systems and the saturation and placement of the fabric or laminate.

Temperature and Moisture: The temperature and moisture recommendations provided in the DowAksa literature and on the product labels must be adhered to during the installation and curing of the DowAksa CarbonWrap® System. Do not apply any of the resin or epoxy compounds on damp or moist surfaces. At no time should the resin or epoxy compounds be applied on frozen surfaces. The application temperature must be between 10 ºC and 38 ºC (50 ºF and 100 ºF). A minimum temperature of 24 ºC (75 ºF) must be maintained for at least one week to allow full cure of the system. Higher temperatures promote faster cure (less than one week); colder temperatures extend the full cure time beyond one week. Auxiliary heat sources may be used to elevate temperature and cure the system faster. Concrete dryness is essential when using elevated temperature cure to prevent moisture vapor transmission. At temperatures of above 38 ºC (100 ºF), the system will cure in less than 24 hours. It is recommended that the application temperature should be at least 3 ºC (37 ºF) above the dew point temperature.

Mixing of Epoxy Components: All resin and epoxy compounds manufactured by DowAksa CarbonWrap® are two-part systems, containing a Part A (resin) and a Part B (hardener). The mix ratios of Part A and Part B for different DowAksa CarbonWrap® epoxies are specified on the container label and the product data sheets. In all cases, it is crucial that the two parts are thoroughly mixed for proper development of the adhesives properties. All epoxy systems must be mixed at the specified temperature range using a Jiffy blade, or other power rotary tools and blades, for a minimum of 3 minutes, until a uniform color and consistency is achieved. No organic solvents or thinners should be used to thin the epoxies. Do not mix more resin than can be used during the pot life of the specific resin system. Any mixed resin that begins to generate heat or display increased viscosity should not be used and should be disposed of properly, according to the instructions (see the Clean-Up and Disposal section). Epoxy components are exothermic (heat up) when mixed and, if left alone, can catch on fire. Mix only small quantities in containers with a large surface area to volume ratio to allow heat dissipation and to prevent potential fire hazards. As an example, do not mix more than three gallons total of Parts A and B in a 5 gallon pail and use immediately following the mixing. The longer they are epoxy components are left in the pail, the more heat they generate, resulting in hardening and wasting of the epoxy.

Application of the Primer: If CarbonBond™ 200P Adhesive Putty Resin (putty used as a filler for spalled concrete areas) is specified, the concrete surface must first be primed with CarbonBond™ 300 Saturating Resin prior to the application of the putty. CarbonBond™ 300 Saturating Resin must be applied at ambient and surface temperatures between 10 ºC and 38 ºC (50 ºF and 100 ºF). The putty should be applied as soon as the primer becomes tacky. If the primer is cured, the surface must be slightly scuffed and cleaned before the putty is applied. The cleaned and prepared surfaces must be protected against recontamination until the DowAksa CarbonWrap® System is applied.

Alignment of Fibers: The fabrics and laminates provide the necessary strength in the primary direction of their fibers. Therefore, it is paramount that the plies and fibers in the fabric be oriented in the directions that are shown on the construction documents and drawings. Any deviation in the alignment of more than 5 degrees (1 inch/foot) is not acceptable and must be corrected. The installed fibers must be free of kinks, folds, waviness and misalignments.

Anchoring of Fabrics or Laminates: Anchoring of the fabrics or laminates shall follow the specific directions provided on the construction documents and drawings. Care should be taken to not damage the fabric or the laminate when installing clamps, fasteners or other mechanical anchoring systems.

Lap Joints: The fibers must be fully continuous or lapped in their primary direction to be effective. Whenever there is an interruption in the primary direction of the fibers, a lap joint must be designed and fibers need to be overlapped. This must be done as part of the design and be shown on the construction documents and drawings; in no case should such overlap be less than 6 inches. For greater structural reliability, the lap joints on multiple layers should be staggered. No lap joint is necessary for unidirectional fabrics or laminates in a direction perpendicular to the direction of the primary fibers, unless specified on the construction drawings.

Multiple Fabrics Piles: When multiple plies are installed, the sequence and stacking shall follow the special instructions in the construction documents. Each ply shall be installed before the onset of complete gelation of the previous layer. Multiple plies can also be applied on different days and after the previously applied ply is cured, provided that the surface is roughened by sanding and is cleaned from dust and residue.
**Step-by-Step Installation Procedures**

**Step 1:** If the use of CarbonBond™ 200P Adhesive Putty (filling putty) is specified, first prime the surface using a brush or roller with CarbonBond™ 300 Saturating Resin. If CarbonBond™ 200P is not specified, go directly to Step 3.

**Step 2:** Use CarbonBond™ 200P to smooth and level uneven surfaces and to fill holes. CarbonBond™ 200P also can be applied between layers of fabric that are saturated with CarbonBond™ 300 Saturating Resin to help prevent sagging. CarbonBond™ 200P Adhesive Putty is best applied with a trowel or putty knife.

**Step 3:** Apply CarbonBond™ 300 Saturating Resin to the cleaned surface, leaving at least 10ml thick resin on the surface before the dry fabric is applied. Pre-cut the fabric to specified lengths as shown on the drawings and apply the fabric to the epoxy-coated concrete surface. NOTE: DowAksa CarbonWrap® CFU10T and CFB10T can be applied dry onto the epoxy-coated surface, but DowAksa CarbonWrap® CFU20T, CFU40T and CFB20T must first be fully saturated with CarbonBond™ 300 Saturating Resin, either manually or by using an impregnating machine, before being applied to the epoxy-coated concrete surface. When either DowAksa CarbonWrap® CFU10T or CFB10T is applied (dry), it must be top coated with CarbonBond™ 300 Saturating Resin and fully saturated before the next layer is applied. Following full saturation of the fabric, at least 10ml thick resin should be applied on top of the fabric before the next fabric layer is applied. Pre-saturated DowAksa CarbonWrap® CFU20T, CFU40T or CFB20T can be applied in multiple layers without the application of additional coats of epoxy in between the layers. Using a spiked roller, apply sufficient pressure to the fabric to remove any trapped air and to ensure an intimate bond throughout the entire length of the fabric. For DowAksa CarbonWrap® CFB10T or CFB20T (bi-directional fabrics), press and smooth the fabric from the center to the edge, along the fiber directions in both directions. For DowAksa CarbonWrap® CFU10T, CFU20T and CFU40T (unidirectional fabrics), press and smooth the fabric only along the direction of the fibers. Pressing and smoothing the fabric in directions other than the primary fibers results in misalignment and wrinkling of the fabric. For multiple layer fabric applications, the subsequent layers must be applied while the previous layer is still tacky; otherwise the surface must be scuffed and cleaned again before the next ply of fabric is applied.
Step 4: Apply paint or protective top coating onto the fabric as soon as it is tack-free. Cured, dry resin must be scuffed and the surface be cleaned for optimal bonding of the top coat or the paint. The paint or top coat must be extended at least 6 inches beyond the termination point of the fabric in all directions, if applicable.

Application of Pre-cured Laminates: The application of pre-cured laminate, DowAksa CarbonWrap® CFL-4-50, follows the basic principles of single-ply fabric installation. The pre-cured laminate should be cut to the desired length according to the construction documents and gently pressed onto the CarbonBond™ 200P Adhesive Putty coated surface. Rubber rollers may be used to slightly press the laminate and remove any entrapped air. The laminate should not be disturbed or moved while the resin is being cured.

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