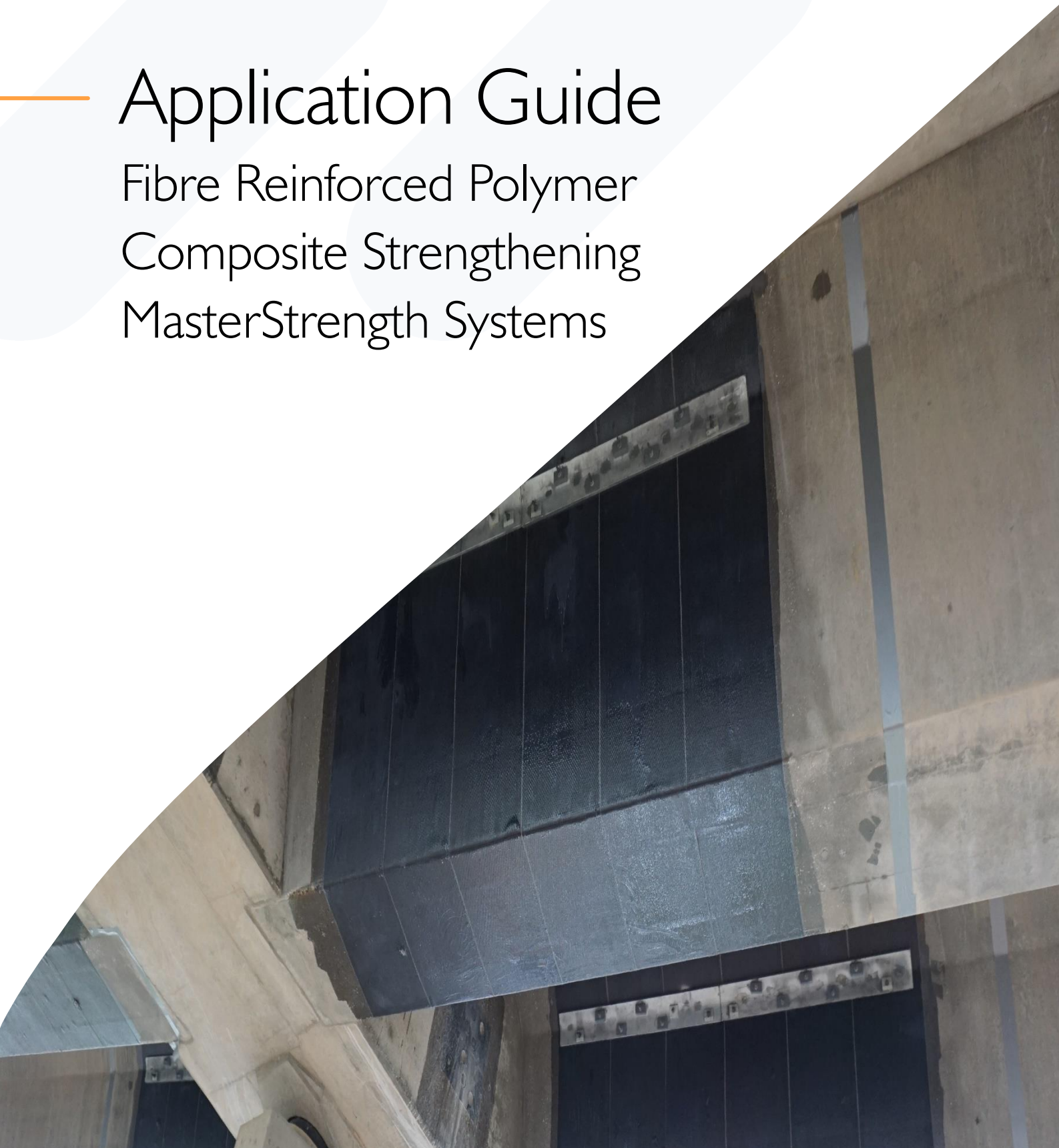
MASTER® BUILDERS SOLUTIONS

Application Guide

Fibre Reinforced Polymer Composite Strengthening MasterStrength Systems



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GENERAL

This application guide applies to the MB Solutions Australia Ltd FRP (Fibre Reinforced Polymer) Composite Strengthening systems, known as MasterStrength (Formerly MasterBrace). It specifically deals with the pre-formed (pultruded), MasterStrength Laminate Plate, Bar, Anchors as well as the MasterStrength Fabric type FRP systems. This application guide shall be read in conjunction with all project specifications (including drawings), by others, and the current material technical data sheets (TDS) and safety data sheets (SDS).

Products Info

Renamed Brand	Formerly as	Size	AS 5100.08 classification	Fibre material
MasterStrength FIB	MasterBrace FIB	Length: 25-100Lm Width: 500mm GSM: 200-900	CFS and CFM	Carbon Aramid Glass
MasterStrength LAM	MasterBrace LAM	Length: 100Lm Width: 50-150mm Thickness: 1.4-4mm	CLS and CLM	Carbon
MasterStrength ANC	MasterBrace Anchor	Pultruded part:150mm Dry part: 200mm Dia: 8 and 9.5mm	N/A	Carbon
MasterStrength BAR	MasterBrace MBar	Dia: 8, 19, 12,16mm	CR	Carbon
MasterStrength PRI 3500	MasterBrace P3500	4-5 m^2/lt	2 Comp. Epoxy primer	
MasterStrength 4000	MasterBrace 4000	3.33L/10 m of laminate @3 mm thick	Epoxy adhesive for MasterBrace laminates & bar/rod	
MasterStrength 4500	MasterBrace 4500	~0.7-1.0 L/m^2 (depending on fabric)	High strength epoxy saturant for Fabric	

*Note:

- Laminates can be supplied as double sided or one-sided peel ply.
- Other widths and thicknesses of Laminates as well as High Modulus laminates type CLM are available as made to order and subject to minimum order quantity.
- Specially designed fabric style, width and length to meet the specific project requirements as well as High Modulus fabrics type CLM are available as made to order and may be subject to minimum order quantities.
- Other fabrics such as Aramid (for Impact resistance) as well as Glass (for Seismic) fibres are available.

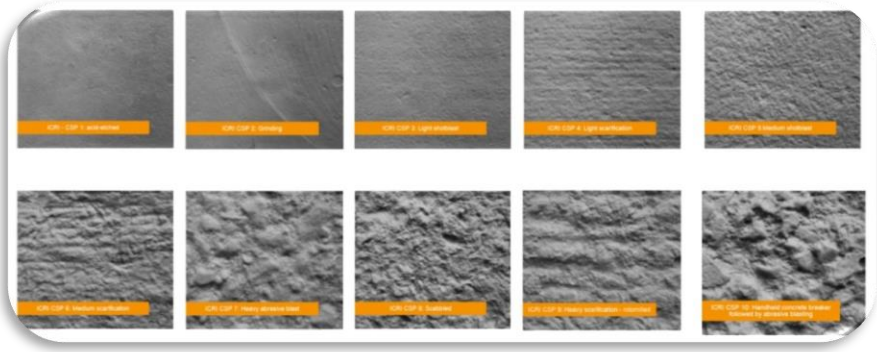
Application Requirements

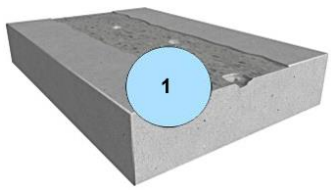
- Training: All work shall be carried out by adequately trained and skilled applicators/installers, under appropriate supervision.
- Safety: Always ensure the appropriate use of adequate PPE (gloves, goggles, long sleeves etc) and comply with all other safety related requirements when applying Master Builders Solutions materials.
- Quality Systems: The applicator shall operate under a fully compliant quality system, to ensure the on-site quality of applied material. The applicator shall keep fully documented work records for all works undertaken.
- Quality Control: If after application and/or testing, any applied material is deemed as unsatisfactory by the specifying consulting engineer and/or MB Solutions Australia Ltd, it may need to be rectified at the applicator's cost.
- Useful documents: MasterCrete Repair Products are used for a variety of concrete repair applications and share some common attributes and often some installation techniques.
- For detailed explanations of the mechanisms of concrete deterioration, inspection and interpretation of inspections and repair technologies, several documents should be referred to. Some of these include:
    - Standards Australia HB 84:2018 "Guide to concrete repair and protection"
    - BS EN 1504-10:2017 "Products and systems for the protection and repair of concrete structures"
    - International Concrete Repair Institute, ICRI 310.2R-2013 "Concrete Surface Profile Chips (CSP 1-10)"
    - AS 5100.8-2017 "the Bridge Design code Appendix A "FRP Strengthening"
        - Table A2.2.2: Min characteristic value for Carbon Fabrics (CFS: Tensile Strength is the dominant required property and CFM: Tensile Modulus is the dominant required property)
        - Table A2.2.1: Min characteristic value for Carbon Laminates (CLS: Tensile Strength is the dominant required property and CLM: Tensile Modulus is the dominant required property)
        - Table A2.2.1: Min characteristic value for Carbon Rods (CR)

SUBSTRATE

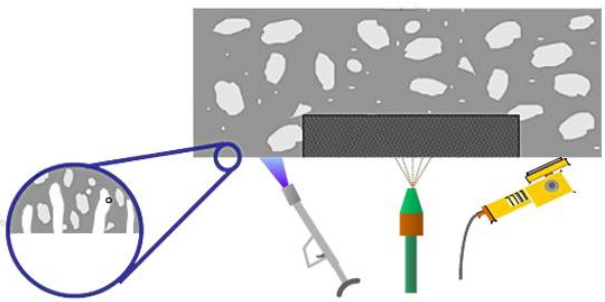
Concrete Surface Preparation

- A load-bearing substrate is a pre-requisite for the reinforcement with all FRP systems.
- All concrete substrates shall be at least 28 days old.
- A tensile bond strength of the substrate of > 1.5 MPa is required. The testing of the substrate shall be performed as required utilizing the testing procedure indicated in Quality Control section of this document as: "General Description of Tensile Pull-Off Test". This should be tested prior to work proceeding and to verify the contractor's chosen preparation procedures.
- All cement laitance must be removed prior to application. The surface layer of the concrete shall be removed to expose small particles of sound aggregate such that the minimum roughness or surface profile to be achieved is CSP 3, as per ICRI (International Concrete Repair Institute) Technical Guideline No. 310.2R-2013. The optimum mean surface roughness or profile is 0.5 – 1.0 mm and must expose soundly bonded aggregate with a surface presenting similar to 60-grit sandpaper.



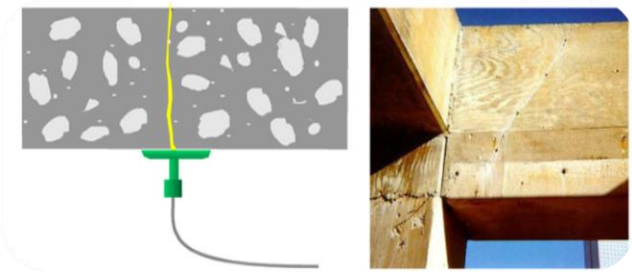


- The surface shall not be roughened excessively, or in a manner that will create unnecessary damage to the substrate concrete. Ideal surface preparation methods are grit blasting, shot peening or grinding.

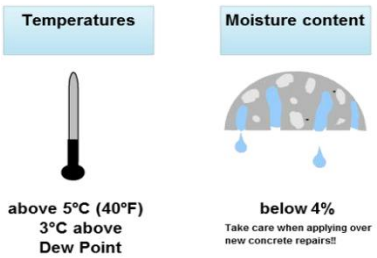


- Any additional water must be avoided. Dirt, oil, grease and other contaminants must be removed. Immediately prior to the application of the FRP strengthening system including epoxy primer, levelling mortar and/or adhesive, the surface must be cleaned with a brush or a vacuum cleaner to remove all loose particles and dust.

- Cracks in the substrate concrete need to be assessed and treated depending on their location and movement characteristics.
- Cracks parallel to the laminate, generally need no special treatment.
- All cracks crossing the laminate shall be epoxy injected (high pressure type, using the SCBP system and resins, such as MasterInject ER 1311).

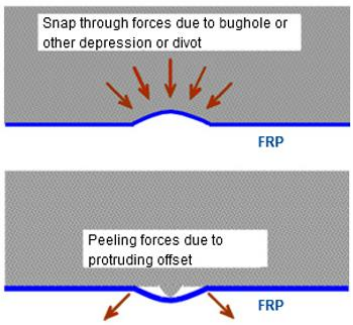


- Immediately prior to application, remove all loose dust particles and adopt a visual inspection of the concrete surface.
- Measure the moisture content of the concrete substrate. The moisture content of the concrete must be below 4% or its relative humidity less than 70% according to AS1884-1995.

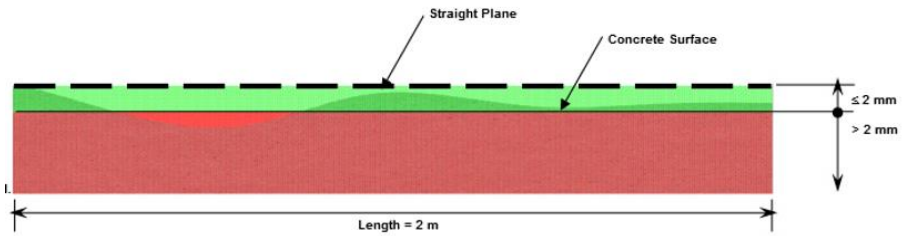


Concrete Flatness

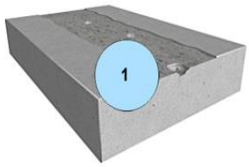
- Generally, the FRP shall not be positioned on surfaces that, under load, reverse the curvature that the FRP originally forms on application. That is, for a FRP on the underside of a typical slab or beam, an upward substrate curvature (or hog) is generally unacceptable. A flat or downward substrate curvature (or sag) is required.

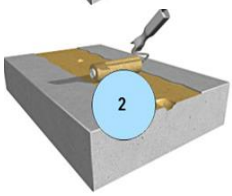


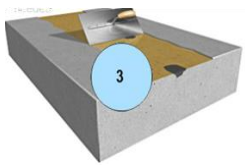
- The flatness of the concrete substrate surface must be checked by means of a metal straight edge. The surface flatness shall not exceed 2 mm within a substrate length of 2 metres. Furthermore, the general flatness shall not exceed 1 mm in 300 mm for any length of FRP.



Levelling of the Substrate

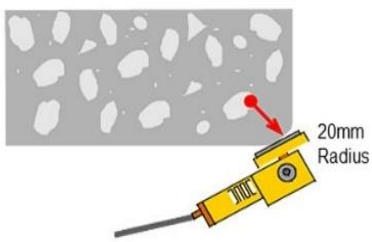






- Where required, any voids must be levelled, by either grinding the surface flat, or building it up, with a levelling mortar. Local grinding of high points and removal of formwork edges etc is mandatory to achieve the required profile.
- Generally, voids are levelled with an epoxy-based levelling mortar at least one day prior to the application of the laminate.
- Clean and then prime the surface with MasterStrength PRI 3500 prior to application of the levelling mortar.
- Apply the levelling mortar (such as MasterStrength 4000) while the primer is still tacky.
- If the primer is allowed to dry, the surface must be re-prepared and primed prior to any work proceeding.
- In extreme situations the levelling mortar (such as MasterStrength 4000) can be bulked out with MasterCoat FIL 5 or 30 1/1 by volume to aid in deep fills, greater than 20 mm.
- The levelling mortar shall generally be left with a smooth yet open textured, level surface.
- If the FRP is applied in excess of 24 hrs after levelling, prepare the levelling surface by grinding with a belt sander or similar and wiping the surface with a solvent soaked rag (MasterCoat THI 955).
- Alternatively, level voids by use of a cementitious based mortar (MasterCrete CI 5488). This must be placed at a minimum thickness of 10 mm and cured to a moisture content of <4% prior to application of the FRP material.
- When FRP fabric is running perpendicular to an external corner and is to be wrapped around it, the concrete must be rounded to a radius of at least 20 mm.
- Internal corners must be smoothed by forming a cove or chamfered detail.
- No special detailing is required if fabric material is running parallel to the corner.

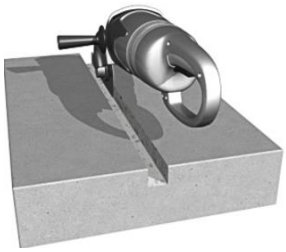
• Round edges to 20-mm radius

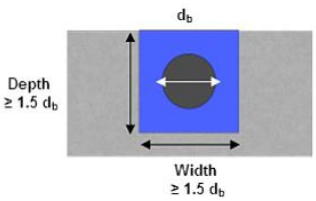


Environmental Conditions

- The presence of moisture may inhibit adhesion of primer and/or resin. Do not apply FRP materials when rainfall or condensation is anticipated.
- In general, for application of FRP systems, the ambient temperature must be at least 5°C and may not exceed 35°C.
- The temperature of the substrate concrete must be higher than 8°C.
- Determination of dew point, air and substrate temperatures and of relative humidity of air, immediately prior to the application is required, if the substrate is exposed to the weather or is in an external environment.
- If the dew-point temperature differs by less than 3°C from the substrate temperature, the substrate must be warmed up, or the relative humidity of the air must be reduced.
- Application may proceed if "concrete temperature > Dew point + 3°C".
- Under some circumstances, dependant on substrate porosity and environmental factors, out-gassing of air may occur, producing small air-voids under a freshly laid sheet of fabric. If this occurs, pre-priming to seal the surface may be required, as well as application of the fabric on a "falling-thermometer", to minimize the amount of out-gassing produced.
- Trialling of the appropriate procedures and tensile bond testing are recommended, prior to moving forward in this situation.

Near Surface Mounted Surface Preparation





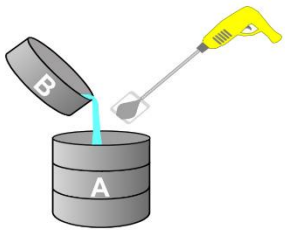
- Under normal conditions, preparation of surfaces for NSM Bars, Laminates and -sometimes- Anchors requires cutting groove/slot into the surface according to the depth and widths indicated on the table below.
- For laminates, the groove width shall be 6 mm wider and at least 6 mm deeper than the laminate. The laminate to be orientated in a vertical direction.
- Depth and width of groove should be greater than 1.5 x diameter or width of rod or bar.
- Check that no reinforcement or other structural elements will be cut or compromised.
- Thoroughly clean the slot prior to application.
- Ensure moisture content as per Environmental Conditions section.

FRP type (size)	Groove width	Groove Depth	MasterStrength 4000 yield (1x5kg kit/Lm of FRP)
Bar (8mm)	14mm	14 mm	20 m
Bar (10mm)	16 mm	16 mm	16 m
Bar (12mm)	18 mm	18 mm	13 m
Bar (16mm)	22 mm	22 mm	10 m
Anchor (8 or 9.5mm)	16 mm	16 mm	16 m
LAM 15/2.5	8.5 mm	21 mm	24 m

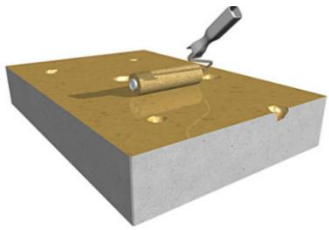
PRODUCTS

Epoxy Resins- General Notes

- All epoxy products used with the MasterStrength FRP systems are two component (Part A and Part B).
- Part A and B to be mixed in the proper proportions (preferably full pack size).
- Mechanically mix Part A before adding Part B.
- When component B has been added, mix for approximately 2 minutes until a homogenous mix has been obtained.
- Do not dilute any epoxy resins used with the MasterStrength FRP systems with solvent.
- After any resin has been mixed with hardener, the mixed resin batch must be used within its pot-life. This sometimes referred to as open-time or batch-life.
- The mixed batch of resin must not be used after expiration of its pot-life, as the adhesion may be affected.
- In the case of MasterStrength 4500 saturant, an increased resin viscosity will prevent proper impregnation of the FRP fabric materials.



MasterStrength PRI 3500- Epoxy Primer for Both Concrete and Composites



- Research has indicated that long term bond strengths to the substrate, especially in wet-dry cycles, will be improved by priming with MasterStrength PRI 3500.
- To comply with AS 5100.8 requirements; priming shall be applied in all FRP applications for laminate, bar and fabric systems, unless directed otherwise.

Application

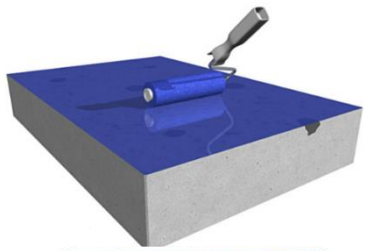
- Apply MasterStrength PRI 3500 by brush or roller to the prepared substrate at a coverage of 6m^2/L.
- Always apply the next layer of FRP resins onto the primer, whilst it is still tacky.
- If the primer is allowed to dry, the surface must be reprepared and primed prior to any work proceeding.
- When required, grind the hardened primer to give a roughened surface and solvent wipe using MasterCoat THI 955, allowing the solvent to completely flash off.

MasterStrength 4000- Epoxy Adhesive for Laminate, Bar and Anchor

- The homogeneously mixed epoxy adhesive (MasterStrength 4000) is applied to the tacky primed concrete surface by means of a notched steel trowel or similar.
- If necessary, apply a levelling coat of MasterStrength 4000 using a putty knife, to fill any bug holes or imperfections. Maximum layer thickness of MasterStrength 4000 for re-profiling is 20 mm. Refer to “Leveling of the Substrate” section of this document. Recheck surface tolerances.
- Apply a layer of MasterStrength PRI 3500 first and apply the MasterStrength 4000 while the primer is still tacky.
- DO not allow to become tack free before application of the MasterStrength 4000. Otherwise, sand seed the MasterStrength PRI 3500 whilst wet and apply MasterStrength 4000 within 48 hours.
- In the application area of the laminate, the concrete surface shall be completely covered with adhesive to a nominal thickness of between 1-3 mm.

- MasterStrength 4000 adhesive is generally applied onto both the concrete surface and the back of the laminate, to minimise the air voids in the final adhesive layer .
- For application of MasterStrength 4000 to the back of the cleaned and fully dried FRP laminate , refer to "Application of MasterStrength Laminate" section of this document.

MasterStrength 4500- Epoxy Saturant for MasterStrength FIB



- Apply first coat of fully mixed MasterStrength 4500 to primed concrete substrate using roller or brush.
- In case of protection with plaster or render, ensure oven dried fine aggregate is broadcast whilst the saturant is still wet to assist bond strength with the subsequent render.
- Apply a coat of MasterStrength 4500(saturant) to the primed surface using a medium nap roller (approx. 10 mm) to approximately 500 - 750 microns wet film thickness (1.3-2 m^2 per litre) or sufficient to achieve a wet-out of the FRP Fabric. This value will vary depending on the weight of the FRP Fabric used (in gm/m^2) as well as the ambient conditions and wastage. A trial on site prior to full application is advisable to establish actual usage rates and to ensure complete wet out of the FRP fabric.
- Place the MasterStrength Fibre sheet and roll in the longitudinal direction of the fibres two or three times using a deforming roller and rubber spatula in order to impregnate the resin into the fibres and to deform the resin coat. For joining strips of fibre sheet see the application guide for details.
- Apply the second coat of MasterStrength 4500 ensuring total saturation of the MasterBrace Fibre sheet. In cases where more than one layer of fibre sheet is to be applied see the application guide for details.
- For application of MasterStrength 4500 to MasterStrength Fibre sheet, refer to " Application of MasterStrength Fabrics" section of this document.

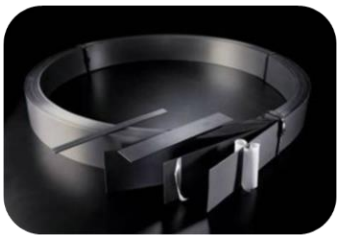
MasterStrength LAM- Carbon Fiber Laminates

Handling

- Handle with care: MasterStrength Laminate carbon plates can be fragile if improperly handled.
- Manual handling should always be with protective gloves to prevent harm from carbon splinters.

- Delivery: MasterStrength Laminate are normally delivered to site in two ways. Both packaging methods, may be handled with a fork-lift on site:
- In rolls that are packaged into cardboard boxes, loaded on pallets.
- In pre-cut lengths, packaged in wooden crates.

Storage



- MasterStrength Laminate requires protection against heat, sun and weather.
- They must be stored on a solid, flat and dry surface, inside a ventilated shelter. If stored in the open, protect with opaque waterproof covers.
- Rolls must be stored only in the horizontal position.

- MasterStrength Laminate rolls are delivered with a specific roll diameter (800 mm in most cases). This specific diameter is the minimum diameter. In case of re-rolling, the minimum diameter must never be reduced.
- All MasterStrength Laminate that are delivered in rolls, are provided with plastic straps. Unrolling should be completed by at least 2 persons. While one maintains the roll in position, the second cuts the plastic straps one by one. The beginning and end on unrolling are the 2 critical phases of unpacking a roll. Alternatively, a simple roller frame may be used to help hold the MasterStrength Laminate in position.

Cutting

- MasterStrength Laminate plates should be cut with diamond coated tools. The cutting speed should be between 20 and 80m/s.
- Protection against dust is required.
- A guillotine saw of proper size as well as a metallic hand saw are acceptable alternative solutions.
- Drilling: Do not drill MasterStrength Laminate, otherwise the mechanical properties will be altered.
- Peel-ply: Most of the MasterStrength Laminate are delivered with 2 peel-plies, one on each side of the laminate, which must be removed before bonding. There are also one sided peel ply or none peel ply options available upon request.

MasterStrength FIB- Carbon Fiber Fabrics

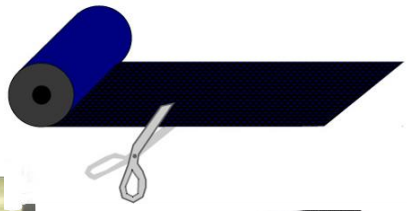
Handling

- Handle with care: MasterStrength Fabric can be fragile if improperly handled.
- Manual handling should always be with protective gloves.
- Delivery: MasterStrength Fabric is normally delivered to site in rolls, which are wrapped in plastic and contained within cardboard boxes, loaded onto pallets.

Storage

- MasterStrength Fabric requires protection against heat, sun and weather.
- It must be stored on a solid, flat and dry surface, inside a ventilated shelter. If stored in the open, protect with opaque waterproof covers.
- Rolls must be stored only in the horizontal position.
- MasterStrength Fabric rolls are delivered with a specific roll diameter (150 mm in most cases). This specific diameter is the minimum diameter. In case of re-rolling, the minimum diameter must never be reduced.
- All MasterStrength Fabrics rolls may be delivered with a layer of plastic between successive layers of fibre. This shall be removed prior to bonding.

Cutting



- MasterStrength Fabric should be cut with good quality shears (scissors or utility knife), designed to cut cleanly through the fibre.
- Fibres oriented in direction of roll therefore called Uni-Directional.
- Do not drill through MasterStrength Fabric, otherwise the mechanical properties will be altered.
- Aramid fibers require special cutting shears.

MasterStrength BAR- Carbon Fiber Rods

Handling

- Handle with care: MasterStrength BAR carbon rods can be fragile if improperly handled.
- Manual handling should always be with protective gloves to prevent harm from carbon splinters.
- Delivery: MasterStrength bars are normally delivered to site In pre-cut lengths, packaged in wooden crates.

Storage

- MasterStrength BAR requires protection against heat, sun and weather.
- They must be stored on a solid, flat and dry surface, inside a ventilated shelter. If stored in the open, protect with opaque waterproof covers.

Cutting

- MasterStrength BARs are delivered with a specific pre-cut length (typically 11.8). This specific Length is due to maximum size can be delivered in a container.
- Other customised length can be cut based on project specific details.
- MasterStrength BARs should be cut with diamond coated tools.
- Protection against dust is required.

- A guillotine saw of proper size as well as a metallic hand saw are acceptable alternative solutions.
- Drilling: Do not drill MasterStrength BAR, otherwise the mechanical properties will be altered.
- Peel-ply: Most of the MasterStrength BARs are delivered with a protective peel ply layer which ensures the optimum clean surface for the best bond with the epoxy adhesive which must be removed before bonding. There are also none peel ply option available upon request.

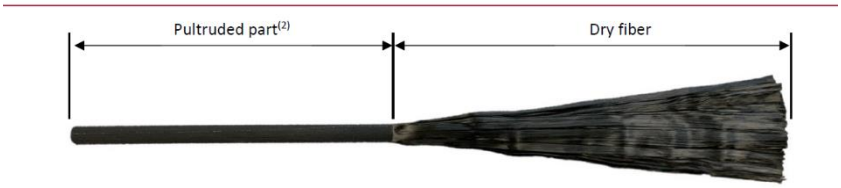
MasterStrength ANC- Carbon Fiber Anchors

Handling

- Handle with care: MasterStrength Anchor can be fragile if improperly handled. Manual handling should always be with protective gloves.
- Delivery: MasterStrength Anchor is normally delivered to site in cardboard Boxes including 200 pieces of anchors in each box.

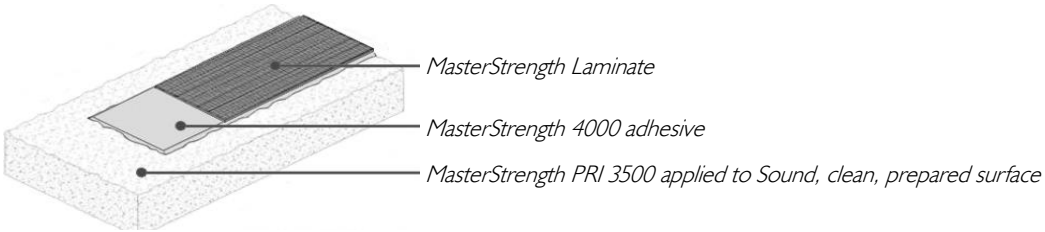
Storage

- MasterStrength Anchor requires protection against heat, sun and weather.
- It must be stored on a solid, flat and dry surface, inside a ventilated shelter.
- If stored in the open, protect with opaque waterproof covers.
- The length of both pultruded part (Standard size is 150mm) or the dry part (Standard size is 200mm) can be customised upon request.



CFRP COMPOSITES INSTALLATION

MasterStrength Laminates



- The range of MasterStrength Laminates come supplied with either protective plastic peel-ply layers (on both sides of the Laminate or one sided) or as a plain section (with a rougher, matt surface on the one side and smoother, glossy surface on the other).

Preparation of Laminates Supplied with Peel-Ply:

- Take a sharp cutting blade and scrape along the width of the laminate, until the peel ply starts to some loose.
- Working from one corner, lift the peel-ply with the help of the cutter.

- Using the cutter by running the blade under the peel-ply, lift a small section of the ply, across the whole width of the laminate.
- When you can grip the peel-ply, gently remove it, pulling at a 45° angle, along the full length of laminate to reveal the clean laminate ready for adhesion. There is no need to use solvent to clean the laminate, unless it gets contaminated.

- At this stage, it is not necessary to remove the peel-ply from the other side of the laminate. This peel-ply may be left in place, but must be removed prior to painting or subsequent layers of laminate going over.
- Once the peel-ply is removed, either side may be used to bond, as the surface has a slightly textured roughness on both sides. Decide which surface you intend to bond to the concrete (or previous Laminate) as this is the surface to which you will apply adhesive.

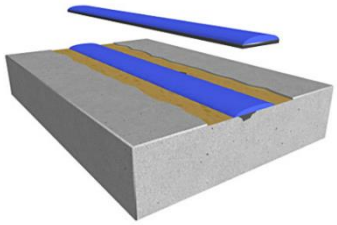
- For preparation of Laminates, prior to subsequent materials (eg protective coatings, other FRP fabric, toppings etc): Remove the peel-ply from the face of the first Laminate, exposing the rough surface. Apply the subsequent layer of material to the clean surface, according to the relevant instructions. Note that this may involve the use of a primer.

- When placing multiple plies (layers) of Laminate: Remove the peel-ply from the face of the first Laminate, exposing the rough surface and apply a layer of adhesive to the clean surface. Apply adhesive to the second layer of Laminate in accordance with the instructions above and bring the two together and squeeze out the excess adhesive.

Preparation of Plain Laminates, without Peel-Ply:

- The adhesive must be placed on the rougher, matt side of the laminate (sometimes this surface has no marking on it).
- Thoroughly clean this side first using a white rag soaked in a solvent-based cleaner (MasterCoat THI 955), in order to remove carbon dust and other contaminants.
- Cleaning must be repeated until the white rag remains free of black carbon dust and the surface is clean of all contaminants.
- When cutting the plain type FRP laminate to length, wrap the laminate with masking tape prior to cutting with an angle grinder or similar. Mount laminate securely during this operation to prevent longitudinal splitting.
- When placing multiple plies (layers) of Laminate: The smooth glossy surface must be carefully sanded to remove the gloss, taking care to not damage the carbon fibres contained within the first Laminate. Once sanded, completely clean the surface with a solvent soaked rag and allow to dry. Apply a layer of adhesive to the clean surface. Apply the second layer of Laminate, depending upon the type of Laminate used for the second layer.
- For preparation of Laminates, prior to subsequent materials (eg protective coatings, other FRP fabric, toppings etc): The smooth glossy surface must be carefully sanded to remove the gloss, taking care to not damage the carbon fibres contained within the first Laminate. Once sanded, completely clean the surface with a solvent soaked rag and allow to dry. Apply the subsequent layer of material to the clean surface, according to the relevant instructions. Note that this may involve the use of a primer.

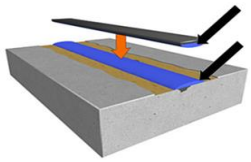
Application of MasterStrength 4000



- Refer to the "MasterStrength 4000" section for the instruction to be followed. In particular, mixing of full kits, correctly proportioned and by a mixing drill with an appropriate paddle, for at least 3 minutes, is required.
- MasterStrength 4000 adhesive is generally applied onto both the concrete surface and the back of the laminate, to minimise the air voids in the final adhesive layer.

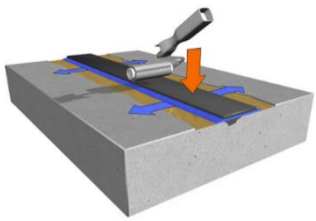
- The homogeneously mixed epoxy adhesive (MasterStrength 4000) is applied to the tacky primed concrete surface by means of a notched steel trowel or similar.
- In the application area of the laminate, the concrete surface shall be completely covered with adhesive to a nominal thickness of between 1-2 mm.

Application of MasterStrength LAM

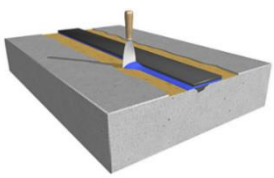


- Lightly press the FRP Laminate with the fingers onto the prepared application area.
- The FRP Laminate is then pressed on with a hard rubber roller until the fresh adhesive exudes from both sides of the laminate.

- Roll the laminate first in the centre of the strip and then roll each edge.
- This guarantees that no significant voids exist between the laminate and the substrate surface.

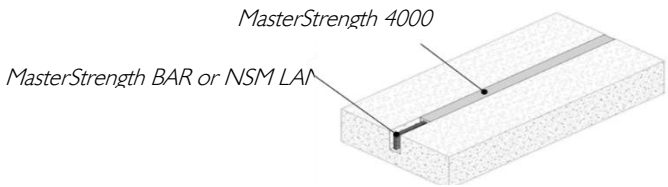


- The excess adhesive can be removed by means of a spatula. The mean layer thickness of the final adhesive should be 2mm (min. 1mm – max. 3mm).



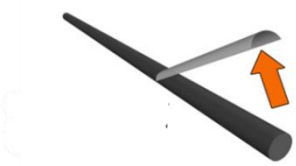
- If desired, adhesive residues on the laminate surface can be removed with MasterCoat THI 955 solvent before hardening.
- Additional FRP Laminates can be applied in parallel a t a minimum distance of 5mm.
- Due to the very high thixotropy of the MasterStrength 4000, no support devices are normally required. In certain cases, however, some form of temporary fixing may be required.
- Examples of this include situations where the weight is excessive (eg wide and thick laminates >1.4 mm) or where the laminate wants to straighten (eg where the substrate changes direction and the laminate has a slight bend in it).
- During the application and until hardening of the adhesive (normally after 1-2 days), any vibration that could affect the application area must be avoided.

MasterStrength BAR



Preparation of MasterStrength Bar

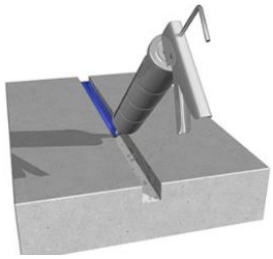
- The range of MasterStrength Bar come supplied with either protective plastic peel-ply layers wrapped completely around the bar or as a plain section.
- Take a sharp cutting blade and scrape along the diameter of the bar, until the peel ply starts to some loose.
- Working from one corner, lift the peel-ply with the help of the cutter.
- Using the cutter by running the blade under the peel-ply, lift a small section of the ply, across the half of diameter of bar.
- When you can grip the peel-ply, gently remove it, pulling at a 45°angle, along the full length of bar to reveal the clean bar ready for adhesion.
- There is no need to use solvent to clean the bar, unless it gets contaminated.



- For plain Bar, without peel-ply: If the surface of the bar is smooth and glossy surface then it must be carefully sanded to remove the gloss, taking care to not damage the carbon fibres. Once sanded, completely clean the surface with a solvent soaked rag and allow to dry. Apply a layer of adhesive to the clean surface.

- For plain Bar, without peel-ply: If the surface of the bar is matt and with roughness then thoroughly clean this side first using a white rag soaked in a solvent-based cleaner (MasterCoat THI 955), in order to remove carbon dust and other contaminants. Cleaning must be repeated until the white rag remains free of black carbon dust and the surface is clean of all contaminants.

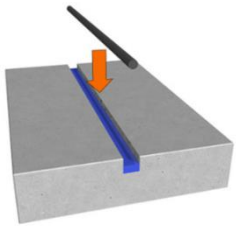
Application of MasterStrength 4000



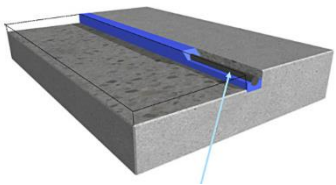
- Prepare the slots as per "Near Surface Mounted Surface preparation" section.
- Prime the slots with MasterStrength PRI 3500 and whilst still tacky.
- Apply MasterStrength 4000 to half fill the slot, via a caulking gun or similar, ensuring no air voids.

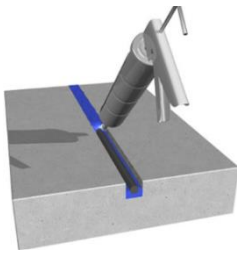
Application of MasterStrength BAR

- Remove the peel ply.
- Press the MasterStrength BAR or NSM Laminate into the wet adhesive.
- If required, immediately apply more adhesive to ensure no air gap exists.



- Tool over the surface flush with the surrounding substrate. Broadcast clean kiln-dried sand onto the wet adhesive surface (if required) to assist bonding of subsequent coatings or layers.

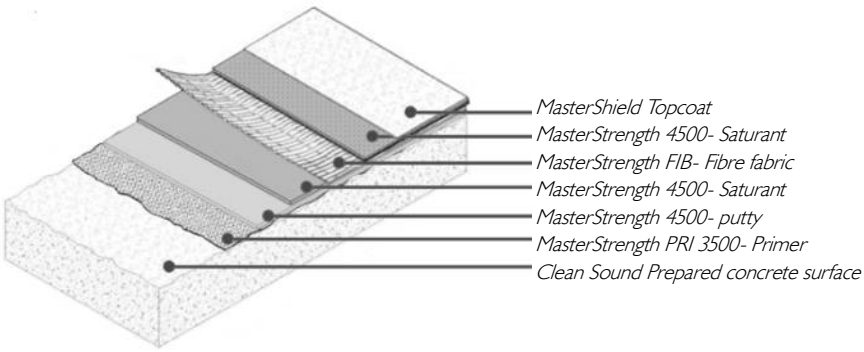




MasterStrength BAR or NSW LAM mounted in shallow groove cut in substrate surface.

Groove filled with MasterStrength 4000 (2 component 100% solids epoxy adhesive)

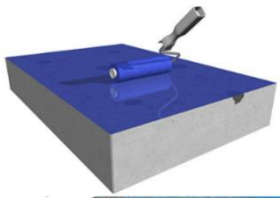
MasterStrength FIB



Preparation of MasterStrength Fabrics

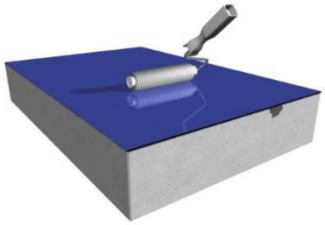
- FRP Fabric must be cut beforehand into prescribed sizes using appropriate scissors and/or cutters. The maximum size of sheet to be cut is preferably less than 3 m in length but may be longer if access allows.
- When multiple lengths of fabric materials are adhered to a concrete surface, a minimum of 150 mm overlapping length must be applied in the longitudinal fibre direction, unless otherwise noted.
- No overlapping is required in the lateral direction.

Application of MasterStrength 4500



- Apply a coat of MasterStrength 4500 (saturant) to the primed surface using a medium nap roller (approx. 10 mm) to approximately 500 - 750 microns wet film thickness (1.3-2 m^2 per litre) or sufficient to achieve a wet-out of the FRP Fabric.

- This value will vary depending on the weight of the FRP Fabric used (in gm/m^2) as well as the ambient conditions and wastage. A trial on site prior to full application is advisable to establish actual usage rates and to ensure complete wet out of the FRP fabric.



- After smoothing down by hand, a squeegee or hard roller may be used, over the outside surface (or backing plastic/paper if supplied), to enhance the impregnation of the fabric material.

- If supplied, the backing plastic/paper is then peeled away. The surface of adhered fabric must be squeezed in the fibre longitudinal direction using a ribbed roller in order to impregnate resin into the fabric material and remove any air bubbles. Then go over the surface with a rubber squeegee/spatula to smooth out any remaining imperfections. Finally use a de-foaming roller to de-foam the resin coat if required.

- Minimise the elapsed time between mixing and application of the MasterStrength 4500 saturant to ensure the material is applied to the fabric at least 15 minutes prior to any thickening or gelling.

- Allow sufficient time between the application of FRP Fabric on the first coat of wet saturant and the application of the second coat of saturant.
- This is to allow for epoxy impregnation and is suggested at around ten minutes (depending on ambient conditions). Any lifting or delamination that may occur during this period, must be corrected by pressing down the FRP using a de-foaming roller or spatula.
- The second coat of MasterStrength 4500 saturant must then be applied onto the surface of the FRP Fabric.

- Apply the next coat of saturant whilst the first coat is still wet to touch.
- The surface onto which resin has been applied must be applied in the FRP Fibre longitudinal direction.
- In order to impregnate and replenish resin into the FRP Fabric, use a medium nap roller and squeegee/spatula, with the same amount of saturant applied to achieve a wet film thickness as per the first coat above.

- In the case where more than one layer of FRP Fabric must be applied, the processes as detailed above must be repeated in a “wet-on-wet”, continuous process.

- In the case of outdoor applications, the work must be protected from rain, sand, dust, etc. by using protective sheeting and other barriers until fully cured. The curing rate of the adhered FRP is temperature dependent.
- If there is to be a top-coat application of a UV-stable acrylic paint (MasterShield AC 150/160), provide a sand-seeding, broadcast onto the still-wet, last layer of saturant applied to the MasterStrength Fabric.

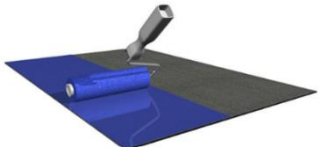
Cementitious coating being applied over an FRP system

Sand broadcast to refusal into final layer of saturant

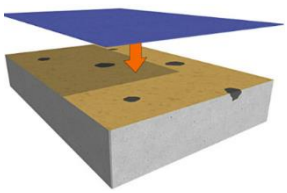
- Prior to applying the acrylic topcoat, remove any loose sand from the surface.
- The acrylic topcoat may be applied after a minimum of 48 hours curing of the last coat of saturant.

Wet Lay-up Method

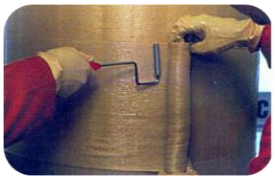
- The "wet layup" technique involves first applying MasterStrength 4500 saturant to both sides of the fabric to completely saturate the fabric and encapsulate fibres.
- MasterStrength 4500 is applied by roller or using special apparatus consisting of baths and rollers.

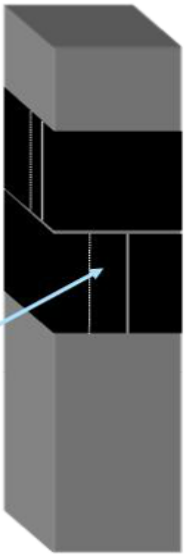


- The wet fabric is then applied to the primed and levelled surface by hand.
- Use a plastic putty knife, rubber squeegee or ribbed rollers to expel air and ensure full load bearing contact is achieved.
- Ensure fibres are correctly aligned, undamaged and pulled as lightly as possible in their longitudinal direction during application.



Standard Details





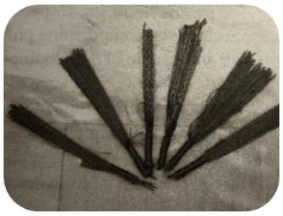
- When confining columns, ends of wrap should overlap by 50mm.
- For joining strips of FRP Fabric Sheets in the fibre longitudinal direction, a 150 mm overlapping length is required. At the overlapping location, additional resin is applied to the outer surface of the fabric layer to be overlapped.
- It's a good practice to offset the overlaps of successive confinements fabrics as shown in the diagram.

- It's NOT considered to be necessary, or good practice, to overlap successive sheets in the longitudinal direction (i.e. parallel to direction of fibers).

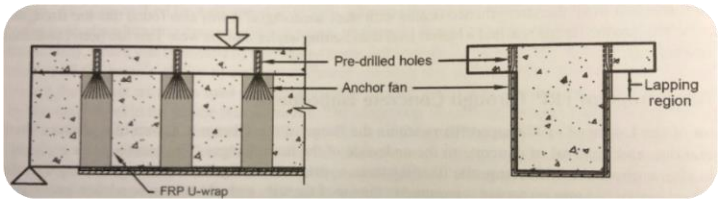
- No lapping is required in the fibre lateral direction-Successive horizontal wraps do not need overlapping.
- Similarly in vertical or Axial direction successive sheets do not need overlap.

MasterStrength ANC

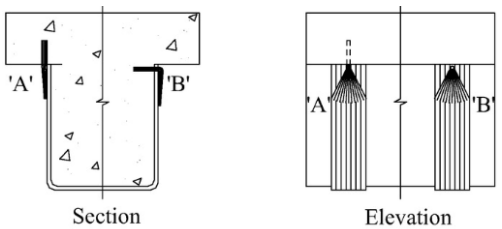
Preparation and Installation of MasterStrength Anchors



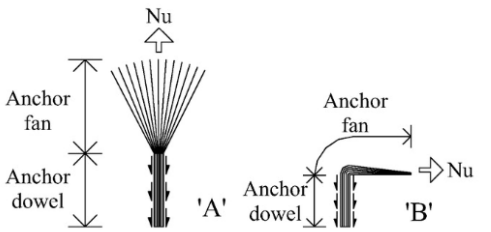
- MasterStrength Anchor can be installed either into a hole drilled into the substrate, or into a NSM slots cut into the surface of the substrate. Refer to Near Surface Mounted application section".
- To install the MasterStrength Anchor, it's necessary to create a hole with a min. 16 mm diameter and a length of the pultruded part (normally min 150mm), unless otherwise specified by the engineer.



- Depending on the installation type, the hole can also be extended through the substrate.
- When the Anchor is installed through the substrate rather than inserted from one side, the hole must be drilled from both sides. Ensuring the hole's straightness is of utmost importance in this case.
- The drilled hole should be thoroughly cleaned to eliminate all traces of dust and loose particles. To achieve this, make use of the blow-out tool and the round brush, alternating between the two tools at least three times.
- On the substrate's surface, cut some grooves. These cuts should be at least 8-10 mm wide and 5-10 mm deep. Once the cuts are made, it's crucial to remove any dust or residue using pressurised air or a vacuum cleaner.



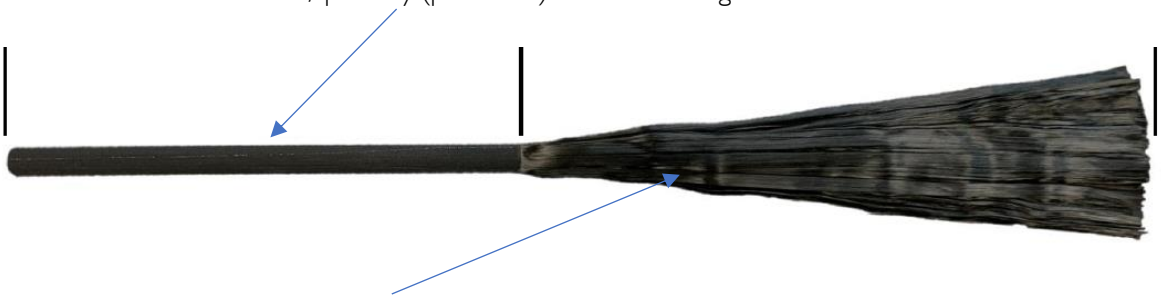
(a) FRP anchor types and applications



(b) FRP Anchor types and dowel stress distribution

- Apply MasterStrength PRI 3500 primer to the prepared cuts and inside the hole and once still tacky:
- Apply a coat of MasterStrength 4000 adhesive to the primed surface and then fill the hole drilled in the substrate with adhesive from the bottom up, using an adhesive gun.
- If the hole goes through the substrate and to avoid excessive waste of the resin adhesive, the hole can be only partially filled, leaving the "back end", where the Anchors exits, empty, as resin will be pushed into this area when the Anchor is inserted from the other side, and the hole will still be filled completely. Air enclosures must be avoided.

- Insert the Anchor dowel/ part dry (pultruded) of MasterStrength Anchor into the hole.



- Split the Anchor fan (fibre part) into the cuts and impregnate them with MasterStrength 4000 until completely saturated and push them into the cuts.
- Fills the cuts with MasterStrength 4000 to level the surface.
- Install other MasterStrength composite (Fabric or Laminate) on top of the Anchor as described in the relevant parts.

WEATHER CONDITIONS

Cold Weather Application

- For applications in cold weather or where accelerated curing is required due to time constraints, a number of methods are recommended.
    a) Pre-heat the adhesive at 25°C for 30 mins prior to mixing.
    b) After one hour of placement, maintain an ambient air temperature in the vicinity of the laminate not exceeding 5°C, for an additional hour (minimum). This is usually done by enclosing the structure and heating as required.
    c) Maintain heat in the laminate and adhesive directly, by covering with heating blankets or similar.

Hot Weather Application

- For applications in warm weather or where retarded curing is desirable, a number of methods are recommended.
    a) Pre-cool the adhesive in an air-conditioned (or chilled water) environment at 15-20°C for at least 8 hrs prior to mixing.
    b) Work during the cooler parts of the day and shade materials and application surfaces wherever possible.
    c) Minimize heat build-up in the epoxy materials by mixing smaller portions and/or spreading mixed material out into smaller volumes prior to use. Discard any material that has changed consistency since first mixing.
- This guideline will not cover every project requirement. Therefore, a project specific method statement may be required for heat curing, application method, surface preparation, timing of application and hand over periods to mention a few.

Application of Hot Mix Asphalt

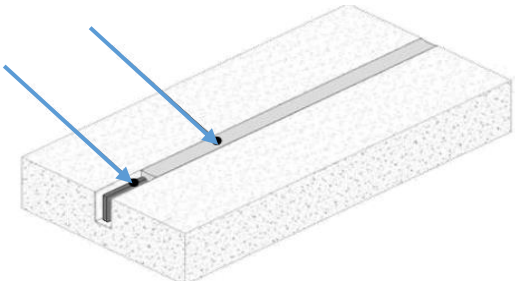
- When applying FRP materials and the intention is to overlay with hot-mix asphalt, the following general guidelines need to be addressed. Specific details need to be considered for each particular application, with reference to MB Solutions Australia Ltd once all parameters are known.

- For FRP composite of the MasterStrength fabric systems is produced in situ: MasterStrength 4500 saturant has moderate Tg of 55-75° C and it's not also recommended that MasterStrength fabric systems be overcoated with hot applied systems.

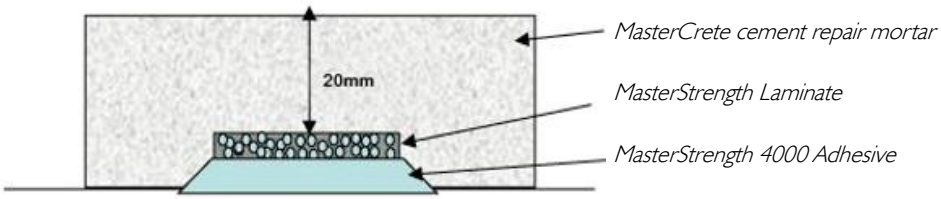
- The temperature of the hot mix shall be limited whenever possible, to the lowest practical temperature. Generally, temperatures shall not exceed 150° C, at the point of discharge.

Hot applied (often >200°C) roofing membranes, such as this in the photo should never be applied directly over an FRP system.

- The FRP materials shall be protected from this temporary temperature rise by one of two methods:
- Method 1- Near-Surface Mounted (NSM) FRP: As per "Near Surface Mounted Preparation" section of this document, either turn the laminate strip on edge and insert vertically into saw-cuts, pre-cut into the concrete substrate or use FRP Bar installed in pre-cut grooves. Allow for an additional 5 mm depth of cut/groove and place the FRP material within 3 mm of the base concrete. Fill the remainder of the cut/groove with epoxy adhesive and broadcast F5 sand onto the surface of the wet epoxy adhesive.



- Method 2- Surface mounted (SM) FRP: Provide a protective mortar layer of minimum thickness 20 mm on top of the laminate, extending no less than 50 mm beyond the laminate edge. Apply the FRP Laminate as per normal practices. Apply a thin layer of MasterStrength 2525 as a primer for the protective mortar layer. Apply a protective mortar layer of MasterCrete CI 5488 or MasterCrete FC 545 (to the wet primer, to a minimum thickness of 20 mm.

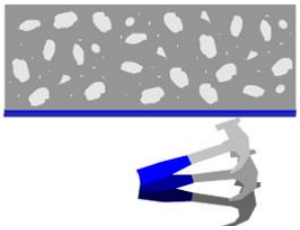


- Apply hot mix asphalt over entire surface no sooner than 7 days after application of mortar layer.

QUALITY CONTROL

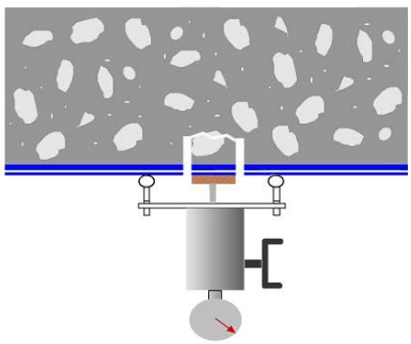
On-Site QC

Tap Test



- After allowing at least 24 hours for initial resin cure to occur, perform a visual and acoustic tap test inspection of the layered surface.
- Test all the areas where FRP is applied to check for voids, bubbles and delaminations. Repair all voids, bubbles and delaminations by approved methods as per the requirements of the specification and to MB Solutions Australia Ltd's satisfaction.
- In addition, the evenness of the FRP surface shall be checked. Deviations within a test length of 300mm may not exceed 1mm. If the test length measures over 2m, the maximum deviation is 5mm.

Direct Pull up Test



- Direct pull-off tests shall be conducted to verify the tensile bond between the FRP material and the concrete substrate.
- Unless otherwise directed by the project specification, perform a minimum of one pull-off test per 100 m of laminate length or one test per 10 m^2 of fabric (or a minimum of two per project), to surfaces strengthened with the FRP materials. The test is to be completed prior to the application of finishes on the FRP materials.
- An average of 1.5 MPa minimum shall be obtained from these adhesion tests. Inspect the failure surface of the core specimen to ensure that failure is in the concrete substrate. Failure at the bond line at tensile stress below 1.35 MPa is not acceptable.

General Description of Tensile Adhesion Test

- The following is a description of a field test for concrete surface soundness and overlay bond in accordance with AS 1012.24 using 50 mm diameter aluminium dollies only, which have been modified to serve as the in-situ QA/QC test of the MasterStrength Composite Strengthening System.
- The tests are carried out on actual structural members strengthened with the composite FRP system. Although there are variations in the equipment for carrying out pull-off tests, the general procedure can be summarised as follows:

- After the composite strengthening system has hardened, core drill through the composite material and down 3 – 6 mm into the concrete substrate by means of an electric drill fitted with a carbide-tipped or diamond core bit. The core bit should be of such size as to produce a core the same diameter as the testing dolly, and which will have the appearance of a small island of composite material. The normal size of the dolly is 50 mm diameter. Ensure that the drilling operation does not cause any detrimental effects on the system by using wet drill techniques to minimise heat exposure, and ensure it is perpendicular to the surface.
- Prepare the top of the core surface to be tested. Preparation includes cleaning of the composite material surface, roughening it with sandpaper, and final cleaning of any dust.
- Place an aluminium dolly onto the surface of the core with epoxy adhesive (MasterStrength 1444). The bottom surface of the dolly has to be sandblasted or sufficiently roughened with sandpaper and be cleaned and free from any grease or dust. Mix the epoxy components according to the recommendations just prior to use. Apply a small amount of the mixed adhesive to the core surface and to the bonding (properly prepared) face of the dolly by spatula. Place the dolly on the core. In some cases, a disk is bonded to the composite surface prior to core drilling.
- Allow epoxy adhesive to cure sufficiently (usually 24 hours or as required).
- Attach a loading frame (Proseq or similar) to the dolly such that a load can be applied at right angles to the surface. A frame around the test area provides the reaction force to the load. Ensure that the attachment of the loading frame does not induce any lateral sideways force onto the dolly, either prior or during testing.

- Zero the machine and increase the load until a specified level is reached or the specimen fails.
- At failure, the maximum pull-force is registered and the pull-off tensile strength is calculated by dividing the force by the cross-sectional area of the core. The mode of failure shall be recorded i.e., within the concrete substrate, within the composite material, between substrate and composite material, between composite material and dolly, or any combination of the above.

- Pull-off tests shall be carried out on each selected area. The average of the values shall be taken as a pull-off strength result.
- Unless otherwise indicated by project specification requirements, most composite strengthening applications require minimum tensile strengths of the substrate of:
- 1.0 MPa for fibre fabric sheet material systems and 1.5 MPa for laminate material systems.

Repair Techniques

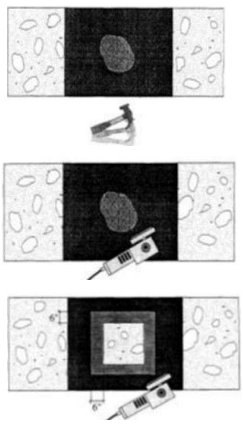
- When required, repair of defective works within MasterStrength FRP systems may be done by a number of means. The choice will depend on the size and location of defect and the FRP system being used. Repair systems may include:
- Small delaminations, less than 25 mm x 25 mm and which are isolated (maximum two defects in a 300 mm x 300 mm area), do not normally require any corrective action.
- If the size or number of defects is greater than this, corrective action will need to be taken as per below or as otherwise directed. Corrective Action may consist of two general methods:

Injection of Resin into Voids.

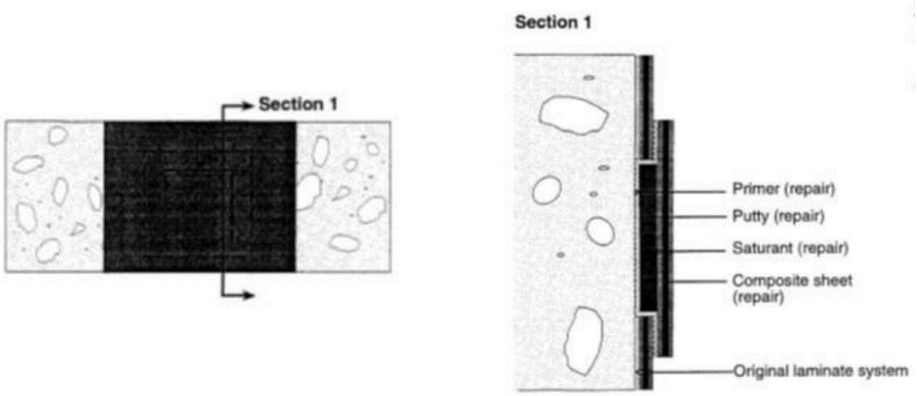
- This process involves the careful filling, by injection of MasterStrength PRI 3500, into the voids, without causing more damage than exists in the void. The techniques will vary but may include the use of a large needle arrangement, with an inlet and outlet hole, to ensure that any air can escape. Always aim to minimize any damage to the FRP.

Cut-out and Replacement of Defective Area

- This method is the preferred method for all repairs.
- For extreme cases where injection to the voids is not deemed appropriate, areas of large defects may be cut-out and replaced with new material.
- This repair technique shall be used to repair large areas of damage to MasterStrength Fabric systems.
- In this document, the material referred to as “putty” could be MasterStrength 1444 or MasterStrength 4000.
- Step 1: identify all delaminated/ unimpregnated or damaged areas by Tap/tensile testing.
- Step 2: Sawcut/grind perimeter of damaged area and remove composite material.
- Step 3: Lightly sand-grind composite repair lap area; Min repair lap is 150mm (around 6 inches)



- Step 4: Apply MasterStrength PRI 3500 and as required apply putty. Apply MasterStrength 4500 saturant and MasterStrength cmposite sheet per application instructions.



- Repair of all the defective work after the minimum cure time for the FRP. Comply with material and procedural requirements defined in this document and any related specifications. Repair all defects in a manner that will restore the system to the designed level of quality. Repair procedures for conditions that are not specifically addressed in this document or the specification, shall be approved by the Owner's representative. All repairs and touch ups shall be made to the satisfaction of the Owner's representative.

OVERVIEW

Master Builders Solutions provides comprehensive construction solutions designed to enhance the performance, durability, and longevity of infrastructure projects. Our innovative range of products ensures that projects meet the highest standards of quality and reliability.

Along with innovative products, customers also receive on-site and technical support from the Master Builders Solutions team of experts. By diagnosing the underlying cause of deterioration, our specialists develop the most suitable repair strategy to prevent further damage and deliver lasting protection. Our civil infrastructure solutions are tailored to meet the specific needs of the construction industry in ANZ, delivering consistent results for a wide range of applications.

Other products application guide

- **MasterCrete: "Cementitious Concrete Repair systems"** Application Guide
- **MasterStrength MasterFill ER: "Epoxy crack repair systems"** Application Guide
- **MasterFill PR: "PU injection resin"** Application Guide
- **MasterJoint CHR**: **"Joint sealants"** Application Guide
- **MasterJoint 910: "Hydro-swelling waterbars for construction joints"** Application Guide
- **MasterJoint 930: "FPO tape for joint waterproofing"** Application Guide
- **MasterFlux**: **"Cementitious grouts"** Application Guide
- **MasterFlux ER**: **"Epoxy grouts"** Application Guide
- **MasterShield AKS**: **"Chemical resistant HDPE liner"** Application Guide
- **MasterShield AC: "Anti-carbonation coatings"** Application Guide
- **MasterShield CI**: **"Impregnants and corrosion inhibitors"** Application Guide
- **MasterShield CP**: **"Galvanic cathodic protection systems"** Application Guide
- **MasterGeo**: **"Geotechnical Soil nails and anchors"** Application Guide

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