



Forton[®] Modified Gypsum

In 1990, the Forton[®] Modified Gypsum Casting System (Forton[®] MG) was introduced to the global market by Forton BV, Sittard, Holland and Ball Consulting Ltd., Ambridge, PA. Forton BV was a subsidiary of DSM Resins, who had extensive experience in polymer modified, glass fiber reinforced concrete (GFRC). Forton[®] MG was the first commercially viable and technically researched chemistry that when combined with certain alpha-hemihydrate gypsums resulted in a matrix suitable for interior or **exterior** applications. The Forton[®] MG system can be used in all production techniques - spray-up, hand lay-up and premix - to fabricate lightweight, high strength parts with a wide variety of surface finishes. These features, plus the quick demolding times normally associated with gypsum products, make this system ideal for the architectural ornamentation, casting or decorative arts markets. In addition, it is a non-toxic, water-based material with a neutral to acid pH. No hazardous materials are used in the manufacturing process and no hazardous waste products are generated.

Extensive research and testing in the United States, United Kingdom and Holland has proven the system to be durable in exterior use when **painted or sealed**. At its first introduction, projects were completed in the United Kingdom, Holland and Saudi Arabia. Since then, many projects, large and small, have been completed in Europe, Canada, the United States, Australia and the Far East. These projects utilized the high strength, light weight and quick mold turnover features of the system.

Features of Forton[®] MG

- **Forton[®] MG** is a lightweight composite with a density of 95 to 100 pcf.
 - Architectural parts typically have a composite thickness of 1/2", including the face mix, which equates to 4 pounds a square foot of surface area.
- **Forton[®] MG** is an inert material, and depending on the production method used, contains from 5 to 15% glass fiber reinforcement which gives the composite high flexural, tensile and impact strengths.
 - Parts can be produced with a smooth or textured surface in a natural white or a range of integrally pigmented colors.
- **Forton[®] MG** castings can also have integrally pigmented and aggregate filled face mixes which when sand blasted or wet polished, give the look and feel of natural stone. Castings produced with an as demolded surface provide an ideal substrate to receive a wide range of applied surface coatings.
 - Commercially available coating systems are suitable for spray, brush or roller application.
 - Metal powders can be added to the mix and brushed or slush cast into the mold. When the casting is demolded, the piece can have patinas applied and/or polished to achieve "metal like" looks.
- **Forton[®] MG**, when tested according to ASTM E 84, is classified as Class I by the UBC Building Code and has a low smoke rating.

Description of the System

Forton[®] MG allows the use of a wide range of integral or post demolding finishing processes via traditional casting, laminating or spraying techniques. The system is simple to use for either the beginner or the experienced user. Incorporating metal powders offers the look and feel of traditional foundry cast metal at a fraction of the time or expense. Cold applied patinas and polishing further enhance the beauty of parts cast with the addition of metal powders.

Packaging

For small users and R&D, the system is available in kit form. For commercial plants all ingredients are available in larger sizes.

Starter Kit

The Starter Kit contains FGR-95 (10 lbs), MF-415 (1 lb), ammonium chloride (22 gr), VF-812 (7 lbs) and chopped E fiber (1 lb). Metal powder (3.25 lbs) can also be added to this kit to experiment with metal face mixes.

Sculptor Kit

The Sculptor Kit consists of the Forton[®] VF-812 water-based polymer in a 5 gallon bucket (40 lbs.), 8 lbs (1 lbs packages) of MF415 and 176 grams (22 gram packages) of ammonium chloride. This provides enough material to make eight 16 lb mixes.

Materials

The alpha gypsum component is available from Ball Consulting Ltd., or distributors of FGR-95 (US Gypsum) or Densite HL (Georgia Pacific). Additional materials such as glass fiber reinforcements and various metal powders are also available.

Silica sands, calcium carbonate (marble dust) and natural or synthetic aggregates can be added to the Basic Mix design as fillers or to give surface texture and color when sand blasted or polished. These fillers are available from local sources.

Pigments can be either dry powder iron oxides or pre-dispersed liquid pigments. In either case it should be determined that the pigments are UV stable and suitable for exterior use. For consistency and ease of use, all dry materials can be pre-blended and stored in a sealed container prior to use.

Fillers, aggregates and pigments with high pH values (alkaline) must not be used in Forton[®] MG. They interfere with the cross-linking of the polymer and the dry resin, preventing a complete cure.

Molds

The type of mold is usually determined by the configuration of the part to be cast, the number of parts to be cast and any post finishing considerations that will impact the choice of material. The two most common materials for flexible molds is either urethane or silicone elastomers. The Shore hardness used is determined by the detail in the master, undercuts and demolding considerations.

Release Agents

When using a urethane mold material, a release agent is required. However, it does not need to be especially strong nor solvent based, which may cause swelling or other damage to the urethane mold. It has been determined the new water-based, low VOC release agents give a clean, crisp release.

Silicone molds do not require a release, but experience has shown that in some cases a very mild release breaks the surface tension on the mold surface and assists in releasing air bubbles when applying the face mix. In all cases, prior knowledge of the type of post-finishing to be done to the cast part is important. You do not want to use a release agent with strong silicone chemistry when the parts are going to be painted.

Mixing

Note: It is recommended to wear a NIOSH approved dust mask while weighing and mixing the Forton[®] MG. There are no hazardous materials in the system, but the powders are considered a nuisance dust.

Batch mixing of Forton[®] MG can be done in plastic buckets. The most important thing to remember is to correlate the diameter of the mixing blade to the diameter of the bucket. Roughly speaking, the diameter of the mix blade should be 1/3 the diameter of the bucket. It should also be the type that imparts a large amount of shear into the mix. The drill used should be the high rpm type. For full bag batches a 1/2" chuck drill capable of at least 1000 rpms will give a quick, thorough mixing action in a 30 gallon bucket.

It is strongly recommended to have a good scale to weigh components, especially if color uniformity is required.

For large scale, pigmented projects, the pigment can be dispersed into the VF-812 drum in the proper amount specified for that mix design. It is advisable to periodically agitate the drum to keep the pigment in suspension. In determining the amount of pigment required, a sample piece should be cast and allowed to dry for 3 days before viewing the color to decide if it is acceptable. Due to the strength of certain pigments and their high pH values, it is possible to over pigment and retard the set of the material. Over pigmentation also can have a negative effect on the exterior durability of Forton[®] MG.

1. In a clean plastic bucket, weigh the Forton[®] VF-812 liquid polymer. Typically, no additional water is required. If pigments or retarders are used, they are added to the VF-812 at this time.
2. In a second, **dry** plastic bucket, weigh the alpha gypsum, dry resin and hardener. If metal powders, sands, aggregates or fillers are used, they can be added to the same bucket. It is advisable to blend these materials with a dry mixer blade in a high rpm drill to reduce clumping. Large amounts of dry blend can be made ahead of use and stored in plastic bags of a set weight or in a clean container with a lid that can be sealed tightly when not in use. This technique can be important in high humidity areas due to the hygroscopic nature of the dry resin. This technique reduces the clumping that may result of the dry resin when added to the mix independently.
3. The dry materials are then mixed into the bucket containing the liquid. The dry materials can be added to the liquid as the mixer is turning. It is not required to add the powder and allow the gypsum to slake. Mix thoroughly with a high rpm drill using a shear type mixer. These mixers can be found at Home Depot and Lowes. The high rpm drill and high shear mixer are mandatory to get a smooth, well dispersed mix. Typical mixing time is 1 to 2 minutes. Over mixing introduces excessive air to the slurry.

4. If mixing metal powders, small amounts of clean water may be added during mixing if the slurry appears too thick or is setting too quickly. Prolonged mixing can accelerate the thickening rate of certain metal powders.
5. If accelerator is used, it may be added at this time.

Casting Techniques

In all casting or laminating methods, care should be taken to remove entrapped air from the mix. This can be accomplished by vacuuming the slurry after mixing (29 inches of mercury) or by pouring the slurry in the mold and slush casting, brushing, puddling or vibrating. Pressure casting is also possible, but the molds must also have been cured under pressure to equalize the density of the rubber to the slurry.

1. **Face Mixes:** various effects can be achieved using face mix slurries incorporating metal powders, aggregate filler and/or pigments. These mixes can be applied to the mold surface by pouring (slushing), brushing or spraying. Regardless of the application technique, care must be taken to ensure all mold surfaces are covered, details filled and entrapped air is removed. Allow the Face Mix to firm to the touch before laminating or back filling. Depending on the size of the mold to cast, it is advisable to accelerate the Face Mix with a solution of aluminum sulfate dissolved in water. The amount of accelerator added is determined on a shop by shop basis. The thickness of the Face Mix is determined by the fillers used and the post finishing process. Typically between 1/16 to 1/8 inch coverage is advised. If the piece will be sand blasted, a generous 1/8 inch coverage is required.
2. **Solid casting:** a mold can be poured solid with Forton[®] MG slurry. If sands, aggregates or fillers are used, preliminary tests should be done to determine the percentage to be added. A thickening agent such as calcium carbonate or Cab-o-sil may be added to prevent segregation or settling of the sands during casting. Vibration, vacuuming or pressure casting techniques can be used to remove entrapped air. Glass fiber chopped strands can also be added to increase impact strength.
3. **Back-up Mix:** laminating is the term referred to when applying the Back-up Mix with the glass fiber reinforcement. After the Face Mix has been applied and is firm to the touch, laminating can begin. This can be done by the spray-up process where slurry and chopped glass fiber are sprayed into the mold and compacted or a premix of slurry and chopped glass fibers is sprayed or hand placed in the mold and compacted. Another option is to use the slurry and glass fiber mats or fabrics laminated to the back of the face mix. Other fibers can be used for interior applications or where they have been adequately tested and their properties in the composite are understood. With any fiber reinforcement used, make sure there is good wetout between the fiber and slurry and that the material is well compacted against the face mix. Be careful not to push too hard and crack the face mix. After the lamination is in place and stiff but still 'green' (like frozen butter), the overhang on the edges can be trimmed with a sharp knife. **Note: always remember to cut in the direction that pulls the material towards the side of the mold for a clean cut.** Be careful not to pull the material away from the side of the mold. Ribs, stiffeners or hangers can be laminated on the backside of pieces. Any metal in contact with Forton[®] MG must be protected; i.e... galvanized or painted to prevent corrosion of the metal and/or staining in the piece.

4. **Set Time:** this is the time when the slurry loses workability and begins to stiffen and set. Using a typical alpha product formulated for this process, that will be in the 20 to 30 minute range. Set time can be shortened by using an accelerator or extended by using a retarder. In all cases, make sure the accelerator or retarder chemistries are correct for gypsum and stable in exterior applications.
5. **Demolding:** without acceleration, pieces made with FGR-95 are normally demoldable after 1 to 1 ½ hours. Test the back of the piece with your fingernail. If it leaves an impression – **WAIT** until it does not leave an impression. Once the production people are comfortable with the system, the set time can be controlled with accelerators or retarders. After the piece is demolded, tooling or chasing of flashing while the material is still in this ‘green’ state is very easily accomplished.
6. **Cure:** a demolded piece will begin drying immediately after removal from the mold. The rate and degree of final curing will be dependent on ambient weather conditions. Hot/dry will cure faster than cold/wet. In high production environments, a drying room with temperature control and an exhaust fan is advisable. It is not advisable to blow hot air directly onto the piece. In typical conditions of temperature and relative humidity, full cure can take 5 to 7 days. For larger pieces such as architectural moldings, orientation or support of the piece while curing is very important. All gypsum based materials are subject to cold creep. If the pieces are not stored properly, warping or bowing might be cured into the piece. As the pieces dry out, they will lighten in color. This is true for all mix designs. Therefore, it is best to judge color when the pieces are dry. In addition, mold materials can influence the intensity of the color of the casting. It is recommended to test each case.

Finishing

There is a very wide range of architectural or artistic looks achievable when using Forton[®] MG. In most cases the only limitation is your imagination and access to materials. The choice of materials used in the Face Mix correlates to the finishing technique and the final look of the piece.

1. **Sanding:** Forton[®] MG can be wet sanded (in a circular motion) after it hardens with 400, 600 or 1,500 grit paper to get a very smooth surface. It is advisable to let the pieces cure for a day or two before sanding. If the surface is too soft, it will gum up the paper and abrade the surface of the piece too much. After sanding, the pieces can be waxed to achieve a marble-like look and feel. Colored waxes can also be used to give different looks.
2. **Painting:** parts in basic white Forton[®] MG mix can be primed and painted with a high quality acrylic paint after it has completely cured. In the case of architectural pieces, it is strongly recommended to properly vent the installed parts so that moisture does not build up behind the piece and cause blistering.
3. **Sandblasting:** sand or aggregate filled face mixes can be sandblasted to expose the aggregate and impart texture to the surface. This should be done after the piece has cured and hardened to minimize the potential for any soft spots which would sandblast unevenly. Typically after the third day, the piece has achieved sufficient hardness. Good results are achieved with 40 psi at the sandblast nozzle while moving the nozzle in a tight circular motion across the surface of the piece being sandblasted. After blasting, the piece must be sealed. Another technique to expose

aggregate is to rub the piece in a circular motion with a wet Scotchbrite™ pad immediately after demolding. Wash the surface with clean water to remove residue.

4. **Sealing:** sandblasted pieces must be sealed to prevent moisture migration into the roughened surface. A sealer such as Behr Low Luster 986 is recommended. It is a water based, low VOC compliant, acrylic based sealer. It is also suggested to spray apply the sealer in two fog coats to maintain the matte finish. If a gloss finish is required, additional fog coats may be applied to build up the desired gloss.
5. **Cleaning and Polishing Cold-Cast Metal:** there are two distinct processes for finishing Forton® MG with metal powder. The first option is to clean and polish the cast piece for a natural metal look. The surface of an as cast piece containing metal powder in the Face Mix must be cleaned to expose the metal particles prior to polishing. Otherwise, the rich look of the metal powder will not come through the matrix. This can be accomplished in one of two ways: manually burnishing with fine steel wool (0000) or mechanically cleaning with floppy buffing wheels and cleaning compounds to abrade the surface. It is recommended to use water based cleaning and polishing compounds to prevent dark wax buildup on the pieces when using mechanical equipment to clean or polish. For best results, the pieces should dry for at least one to two days, depending on the ambient humidity, before attempting to clean and polish with air or electric polishing tools (This holds true for all the mixes: plain white, pigmented sand filled and metal powder filled). Once the piece has been cleaned, it can be polished using soft fabrics, floppy buffing wheels and fine steel wool (0000), either with or without the use of polishing compounds, to give very interesting effects. The use of colored waxes applied to the surface after polishing will also enhance and protect the finish.
6. **Patination:** pieces filled with metal powders can be patinized with the same cold applied patina formulas used on traditional foundry cast metals. The pieces will also patina naturally in the environment, as the specific metal would. Patinas can be applied in one of two methods, each of which will provide different results and looks. Patinas can be applied soon after demolding (30-45 minutes) and before burnishing or they can be applied after burnishing, but before polishing. Patinas can be spray or brush applied or the piece can be fully submerged in the patina chemical for a set time to achieve the desired effect. After the patina has dried, an acrylic sealer or lacquer should be applied to protect the patina. If the finished piece is intended for outdoors, a proper wax should be applied and buffed once the sealer has fully cured. We have also achieved great results using clear or colored wax on pieces intended for indoors. We recommend and have had good results using Sculpt Nouveau products. **Note: the application of wax will change the look of the dried patina.**

Patching and Joining

Forton® MG can be patched or pieces joined together by using the same slurry mix, surface applied to the problem area or the area to be joined. The areas to be joined should be roughed up with sand paper and be dust free prior to the patching or joining process. In patching, the mix will go through several viscosity stages – fluid to paste like. When the mix is in the paste-like stage, it can be worked and shaped with damp fingers or tools. When it has hardened, it can be sanded, filed or ground to match the original. **Note: when patching or joining metal powder filled pieces, do not sand the patch or**

joint. Always overbuild the area and work it down with files or a Dremel tool. When joining pieces, the joints must be bandaged with glass fiber and slurry mixture from the back. Then the face of the joint can be patched as above.

Cleanup

Forton[®] MG is a waterbased system. Tools and hands can be washed with water before the Forton[®] MG has set. Note: the material will harden under water, so do not leave dirty tools in buckets of water. The materials are environmentally safe and do not create a disposal problem. Forton[®] MG will not dissolve in acid.