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MASTER WORKS™ Incorporation of Fillers into Master Works™ M1

1 Introduction

Master Works™ M1 can be readily filled with a wide variety of fillers. Fillers can be used with Master Works™ M1 for:
Decorative effect
Modification of physical and mechanical properties
Lower cost.

2 Decorative Fillers

These will generally take the form of:
Stone dusts such as sandstone, marble, slate etc
Sand
Crushed aggregate
Metal powders.

These can be incorporated into gelcoats or into mass castings.

If the filler is expensive, i.e. bronze, it is practical to incorporate the filler into the gelcoat only.

If inexpensive stone dust or fillers are used it is more cost effective to include these in the entire mass casting as this will involve only one process and the incorporation of the filler could lower the overall costt of material used.

Incorporation of decorative stone and sand fillers
These materials should be purchased washed, dried and graded.

Washing removes any chemical impurities such as residual salts that will have an adverse effect on set time.

Please note that some fillers although “clean” may have a latent pH which can affect set time.

Drying ensures that no additional water is added to the mix as this will impair the strength development.

Grading removes very fine particles that severely limit the amount of filler that can be added as smaller particle size fillers ‘absorb’ a higher proportion of the liquid components.

Ideally the filler target particle size distribution should be between 0.5mm - 3mm.

All fillers should be evaluated before use in production to assess their impact on set time and to determine the amount of filler that can be added to M1and maintain good working properties.

Fillers that have irregular, fissured or crystalline structures will absorb more of the base liquid material and therefore allow less filler to be incorporated. These fissured fillers tend to hold onto water and thus delay the final strength development of M1.

Method of assessing the filler loading capability and impact on set time of particular fillers in M1

Step 1: Mix a control sample of 100gm (Component A) and 45gm (Component B) and determine and record the initial set time.

Step 2: Weigh out a separate quantity of 100gm (Component A) and 45gm (Component B) into separate containers.

Step 3: Weigh out 200gm of the desired filler.

Step 4: Add the filler separately to both the A and B components continuously stirring it in. Addition should cease when the viscosity of the Components reaches a level where any further addition would render the product unworkable

At this stage water can be added up to a maximum of 2% of the combined weight of A+B and further filler added to a point where the product still remains workable.

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Step 5: Now weigh the remaining filler. This will enable calculation of the percentage of the filler that can be included i.e. say 120 gm of the initial 200gm of pre weighed filler has been used the filler incorporation percentage can be calculated as follows: 120gm divided by the 145gms of A an B weighed out in Step 2 will give an incorporation percentage of 82.7%.

Now the set time of product with the filler included must be evaluated.

Mix the filled A and B components together and determine the set time.

Set time influences and correction:

If the set time differs from standard this can be caused by contamination or 'latent' pH of the filler.

If the set time has **decreased** this is either due to traces of metal salts or a low 'latent' pH.
Provided the material sets and develops full strength this set time can be corrected by the use of Master Works™ Retarder.

If the set time has **increased** this could be due to sodium/salt contamination or a high 'latent' pH. This slower set time can be corrected by use of the Master Works™ Accelerator. Add the accelerator in 0.2% increments on total mix weight until the desired set time is reached.

However if the delayed set is more than four times that of the standard then select another filler to provide the end results desired.

Filled gelcoats:

If filled M1 is to be sprayed as a gelcoat then the use of Master Works™ Thixotrope will assist in adjusting the gelcoat to the correct rheology and preventing slumping on vertical surfaces.

When using stone dust fillers in order to achieve a realistic stone finish the surface should be abraded following demoulding.

This can be achieved by one of the following methods:
Washing with hot water and rubbing with abrasive cloth (Scotchbrite).
Dry sanding with sand paper if a flat surface is desired.
Grit blasting where a more aged and pitted surface is desired.

Incorporation of metal powders/fillers

Most types of metal fillers can be combined with Master Works™ M1 to create decorative finishes with the exception of aluminium which creates a gaseous reaction.

However if any other metal filler gives rise to gas generation this indicates incompatibility and the filler should not be used with M1.

Metal fillers fall into three main groups of particle shape: spherical, irregular and flake

The choice of metal filler will largely be determined by the surface appearance required and what is available from the local supplier industry.

Metal filler loadings are determined by the same method as outlined above.

In selecting metal fillers the following general observations regarding the influence of particle shape apply:

Spherical particles allow greater packing density and are easier to incorporate but give a slightly less metal-rich surface.

Irregular particles, around 350 mesh, give good results but the surface will require post mould treatment such as abrading back with metal wool or fine abrasive paper to expose the metal particles. The surface will then require patination and applications of wax to give lustre and the appearance of metal.

Flakes, although more expensive, are more economical in use as lower amounts can be used as the flakes tend to layer and overlap and give a good quality metal surface without post mould treatment and the labour this entails.

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3 Fillers to Alter Physical and Mechanical Properties

Fibre

The inclusion of chopped or unstructured fibre will enhance flexural, tensile and impact resistance properties. As there are many fibre types available it is only possible to discuss this topic in general.

The method described above should be used to determine the appropriate addition rate of any selected fibre.

It should also be noted that some glass strand is sized with a silane binder, this will prevent a full bond with the M1 and the maximum benefit from the fibre will not be achieved, there will however be some benefit.

Nylon fibre develops a good bond and enhances flexural, tensile and impact resistance.

Carbon, as prepared for today's industries have little benefit, the bond tends to be poor, so little is gained from the high tensile potential that is its highest yielding property.

Chopped e-glass strand, in either 6mm or 13mm lengths, is commonly incorporated and gives good benefits in terms of enhancing flexural, tensile and impact resistance properties.

We recommend in our laminating methodology the inclusion of 6mm or 13mm chopped e-glass in the spacer layer as this material is very easily workable.

Natural fibre such as sisal, coir and bamboo have many good characteristics, staining can be an issue and this can take place over time so careful examination is essential if colourfastness is important.

Generally fibre should be mixed in gently as high shear can disrupt the fibre and form clumps (agglomerations).

Lightweight fillers

The inclusion of lightweight fillers will reduce the density of the product; this can be of benefit in the back up mass castings behind decorative gelcoats.

This technique can also be used in the spacer layer between the 2 layers of multiaxial reinforcement fabric when making a laminate.

Use the same method as described above to determine percentage loading and any detrimental effect on set time, some glass hollow spheres have free sodium attached, this will slow set time.

Very fine and absorbent materials should be avoided, if hollow spheres are being considered care should be taken when mixing in as violent high shear will break up the spheres.

As a general rule the inclusion of lightweight filler will reduce the compressive strength of the product, this will have a relative effect on other physical and mechanical properties.

As a guide smooth spherical particles will greatly reduce flexural properties as the bond with the matrix will be poor. Irregular particles with a high degree of mechanical key will give much greater flexural performance.

4 Fillers to Reduce Cost

There is a wide range of bulking fillers available and these will vary from location to location.

Again percentage loading and any effect on set time should be assessed by the above method and the comments on purity and particle size noted.

Obviously in order to reduce cost the cheapest material will have the most impact but care should be taken that the supply quality and consistency of the filler can be maintained.

These fillers could be calcium carbonate, sand, crushed aggregate etc. Good particle size distribution will also allow greater packing density. Material with a high percentage of fines should be avoided.

Effect on properties will be directly linked to the properties of the filler eg softer fillers will reduce compressive strength and surface hardness, harder fillers will increase these properties.

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