

# Standard method for making and curing cubes made from pre-bagged grouts and polymer modified mortars

## General

The method described below is based on practical experience of making and curing mortar and grout cubes in the laboratory and on site. BASF offers the methods stated in good faith and endeavours to ensure that any advice given is accurate, however, the method, although using ASTM C-109 and C-942 as a guideline, should not be construed as relating to any International standard.

The method statement relates to BASF products only. Other materials falling into the above categories may be mixed successfully using this method, but BASF cannot be held responsible for failures caused by not following manufacturer's recommendations or stated procedures.

## Philosophy

The basic philosophy behind testing should be to assess the material quality following a standard procedure. The results of these tests should, initially, be used to determine the suitability of the product for use, and later to check the consistency of the supply. Tests may also be carried out to check the quality of the product being used in a critical area. This type of testing, however, should be more a check on the mixing quality rather than the product itself.

The manufacture and testing of cubes made from grout or polymer modified cementitious mortars can pose many problems to the Engineer. The materials are based on cement, and yet there may be conflicting requirements as to how to do the 3 'C's (cast, cure and crush). Maybe, because the material is cementitious in nature, and all

technicians and Engineers know BS 1881, it is often easy to treat these types of product as "concrete". However, this does not take into account the type of products or the product's reaction to different curing regimes. With so many Standards, different cube sizes and various curing methods, it is possible for the Engineer to become confused.

This guideline hopes to cover some of these points and set out what is believed to be a reasonable method, easily reproduced on site or in the laboratory, and able to provide consistent results.

## Cube size

Detailed below are some of the various cube sizes found in grout and repair specifications used world-wide.

BS 1881	Methods for testing concrete	100mm
BS 4551	Methods for testing mortars	100 or 70.7mm
BS 4550	Methods for testing cement	100 or 70.7mm
BS 6319	Methods for testing resin compositions	40mm
ASTM C-109	Compressive strength of grouts	50mm

Cube size used is to an extent irrelevant. The main points to consider are:

- I. The correct type and quality of testing equipment must be specified and maintained at a fit for use level. (Planeness, levelness, quality of internal surfaces, cleanliness etc.)
- II. The testing should be comparative throughout. Cubes of 40, 50 and 70mm will give similar results however, there may be a big difference

# Standard method for making and curing cubes made from pre-bagged grouts and polymer modified mortars

between 50 and 100mm cubes, which could amount to 4 - 5 N/mm<sup>2</sup>.

- III. The testing should be carried out by trained personnel and procedures should be followed strictly and under supervision.

Curing regimes should be used to check the potential strength of the product. Regimes designed to simulate "site conditions", e.g. cubes stripped at 1 day and allowed to air dry until test, will result in lower strengths. These should not be compared to data sheet values, which have been determined using maximum curing regimes. Cube strengths are directly related to the manufacturing technique (given all other values equal) and to the curing regime employed. Full immersion curing may be suitable for some products and detrimental for others. The curing method specified allows for full curing without over-wetting or over-drying of the sample. Small cubes are more prone to rapid drying out due to their size /volume ratio. For high strength materials, e.g. grouts, once that water has escaped no amount of immersion in water will recover the lost strength. Full curing is particularly important over the first 3 days.

The one aspect not able to be covered by this method is temperature of cure. All standards specify a curing temperature. In a static laboratory this is usually available, but may be impossible to achieve in a site laboratory. Curing tanks stored outside and not temperature controlled may suffer from solar gain in the day and rapid cooling at night. Temperatures and standard temperatures vary from region to region.

The general rule which should be followed, where ever possible, is to maintain the temperature within the range of:

20 ± 1°C for temperate climates

27 ± 1°C for tropical and sub-tropical climates.

Normal weight grout and repair mortar cubes (Density > 1900 kg/m<sup>3</sup>)

Due to the density of the products, curing in the traditional way, (full immersion in water) does not pose any problems. However, often curing tanks on site are not maintained and the cubes need to be transported from site to a testing house. This is also an area where ill treatment of cubes can occur.

Light weight repair mortars (Density <1900 kg/m<sup>3</sup>)

The strengths of these types of product are greatly influenced by the curing regime. Insufficient curing will show low strengths due to rapid de-hydration of the specimen. Conversely, total immersion in water can also show a loss in strength. The full reasons for this are unclear at the present time but one theory has it that, because the porosity is slightly higher, the pores fill with water and the water exerts an internal hydrostatic force during the crushing process, which weakens the material.

By employing the method stated below, cubes manufactured on site can be assured full cure without the need to take from tanks and risk dehydration during transport or, over soaking.

- IV. The method of tamping the material into the moulds is also important. Grout cubes need only light tapping of the mould to release any

# Standard method for making and curing cubes made from pre-bagged grouts and polymer modified mortars

entrapped air. Lightweight repair mortars need careful handling to ensure full compaction.

## Summary

Normal site testing should only be carried out to check the consistency of supply using some or all of the tests employed to confirm initial acceptance, unless other testing regimes have been agreed.

Only trained technicians should be used for the preparation and testing of materials, as without doubt, the majority of product failures come from poor curing and testing technique.

Curing should be properly employed to ensure cementitious materials gain their full potential strength. Any other technique is open to variation unless fully controlled and monitored.

Making and curing cubes made from cementitious grouts and normal weight / light weight repair mortars

## General

The method described below, if carried out by trained staff, should ensure consistency of manufacture and hence consistency of results.

## Equipment

### Cube moulds

The size to be used should not exceed 70mm and certainly not be more than 100mm for grout products. Only one size of cube should be used. Combinations of mould sizes will give inconsistent cube strengths.

The cube moulds should be precision moulds, specifically designed as cube moulds, made from metal with matched parts marked with unique numbers or characters on the opposite sides of the top flange to facilitate correct assembly.

The internal faces of the moulds shall be machined. All angles will be at right angles (90°) to adjacent faces. The depth of the mould and the distance between either pair of opposite internal faces based on the average of four measurements should be the nominal size  $\pm$  0.15mm.

The joint between the mould sections and the bottom plate should be watertight. The mould's internal and external surfaces and joints should be kept clean from build up of cement and loose rust by wire brushing, or other suitable technique, and lightly oiled with a proprietary mould release agent.

Note: Mould oil should not be allowed to pool in the mould and any excess oil should be removed prior to use. The correct application can be checked by wiping a dry finger across the mould surface. If the mould oil is ridged either side of the finger mark an excess of oil is present. If the finger is still oil free then insufficient oil is on the surface. New moulds should have the travelling grease removed before use.

All fasteners should be tightened using the correct tools such that the mould sections are rigid and will not loosen under compaction or movement. Avoid over tightening that can distort the sections. Where the cubes are made from products that have partial or complete expansion or are to be

# Standard method for making and curing cubes made from pre-bagged grouts and polymer modified mortars

restrained in application, the moulds shall be provided with a covering plate which shall be firmly fixed ensure that the top of the grout is not allowed to expand freely.

## Cleaning equipment

- Wire brush
- Rags or similar cleaning materials
- 25mm paintbrush
- Mould release oil
- Dust pan and brush
- Spanners or hexagonal screw keys
- Scrapers
- Rubber hammer
- Screwdriver

## Tamping bar

A normal concrete tamping bar (25mm square) is too heavy and not suitable. A hard wood, or hard rubber or plastic rod of cross-section approximately  $\frac{1}{4}$  -  $\frac{1}{2}$  of the nominal dimensions of the mould should be used. The rod should be 150 - 200mm in length. (If wood is used the wood should be prepared by saturating in a light mineral oil. This prevents water from being absorbed during tamping. Note: remove all excess oil before use.)

## Steel float for levelling

Absorbent cloth or heavy duty tissue to wrap the cubes after stripping

Heavy gauge polythene bags and 50mm wide plastic packing tape

Permanent marker pens and self adhesive labels

## Small scoop for filling

## Procedure

Prepare an area to manufacture and store the cubes. The area should be dry and the cubes should be made on a flat, solid base free from vibration and the effects of weather. The area should be shaded and if possible inside an enclosed room.

Ensure that the moulds are clean and ready for use, and all equipment required to complete the task is at hand. (i.e. rags, plastic bags, heavy duty cloth etc.)

Follow the mixing method outlined in the appropriate technical datasheet to mix the material. Use only full bags of product.

On completion of mixing make the cubes immediately. Do not wait until the pour is complete and then cast the moulds.

It is recommended to make at least 2 cubes for each age of test and curing regime. Recommended standard ages for test are 1, 3, 7 and 28 days although other ages can be cast at the Engineer's discretion, provided sufficient moulds are available.

Scoop a quantity of the mortar or grout and half fill each of the moulds to be cast. Ensure that a representative sample is taken. This is particularly important for grout products.

Compact in the following manner for:

# Standard method for making and curing cubes made from pre-bagged grouts and polymer modified mortars

## Grouts

Using the rubber hammer, tap the four corner of each section of the mould until no air bubbles are seen to rise and the grout is level. The corners should be completely filled. The more fluid the product, the less taps are required.

Repeat the process, slightly overfilling the mould. Strike off level with the trowel using a sawing motion. When all sections of the mould are filled immediately attach the top plate and tighten it down. Cover the whole with a plastic sheet. Alternatively the moulds can be sealed inside a plastic bag.

## Repair mortars

Using the square section tamper, rod with firm even pressure over the entire surface of the mould 25 times. Do not strike through the mortar as this can have the effect of leaving holes behind after filling the second layer. At the end of the tamping, lift and drop the mould through 10mm 5 times. This will ensure that any bubbles are forced out.

Repeat the process, again slightly overfilling the mould. Strike off level with the top surface of the mould. Immediately fit the top restraining plate and cover the whole with a plastic sheet. Alternatively the moulds can be sealed inside a plastic bag.

Clearly mark the moulds with the identification assigned to that batch of cubes.

After 24 hours carefully strip the cubes from the moulds. Set the mould sections aside in groups for easy cleaning and re-assembly. Examine the cubes for any defects. Reject any that do not look

normal (e.g. have an excess of surface voids or are not complete) and inform the Laboratory Supervisor or Engineer. Mark on the surface of each cube with the permanent marker, its' full identification and the age for test. Do not scratch details onto the cube.

Immediately wrap each set of cubes in the heavy duty tissue or absorbent cloth pre - soaked in water and seal inside the polythene bag. Fold over the open end and seal it with packing tape, such that a water tight and air tight seal is formed. Repeat the identification marks on a self-adhesive label for sticking on the polythene bag. Store the bag containing the cubes carefully ,ensuring that it has no punctures and cannot be punctured, away from sunlight or other operations until ready for testing.

Grout and normal weight cubes may alternatively be stored directly in water until ready for test. Follow the identification procedures as above prior to immersion. Ensure the marking medium is water proof. It is recommended that if the cubes need to be transported to a testing house, they are wrapped as described above for the journey.

# Standard method for making and curing cubes made from pre-bagged grouts and polymer modified mortars

## Clean up

Carefully clean the mould sections with the wire brush and lightly oil the sections before re-assembly. Ensure all joints and internal faces are clean and there are no steps between pieces. Ensure all fasteners are tightened correctly and the corresponding matching sections are in their proper position.

Stack the moulds in a covered area away from the influence of weather, dirt and other operations. Periodically check the internal faces and joints dimensions for excessive wear. Do not join non-matched sections,

## Reporting

For each set of cubes made the following minimum information should be available.

- Name of product and manufacturer.
- Manufacturer's batch identification.
- Appearance of the powder (e.g. free flowing, lump free etc.)
- Quantity of mixing water per bag of product used for mixing. (and temperatures where required)
- Cube identification marks and number made for each age of test. (These must be unique to each set of cubes)
- Time of casting the cubes.
- Temperature at time of manufacture.
- Temperature and conditions under which the cubes were stored.
- Address of testing house.
- Comment on appearance of cubes at stripping.
- Position reference where product was used and quantity represented by the cube test.

- Name, signature and position of the person making the cubes.
- Name, signature and position of the Supervisor.

## Cube crushing

The cubes should be transported to the testing house if this is not at the site of the cube manufacture, at least 1 day prior to the crushing time. Grout cubes and normal weight mortar cubes should be stripped from the paper and plastic wrapping and stored in water until ready for crushing.

For reference cubes should be crushed within the following time limits after casting.

1 day	23.5 - 24.5 hours
3 days	71.0 - 73.0 hours
7 days	7 days $\pm$ 3 hours
28 days	28 days $\pm$ 4 hours

The cubes should be crushed in accordance with BS 1881, Part 116 ASTM C109 or DIN standards using a compression test machine with ranges suitable for the maximum strength and cube size of the material under test.

# Standard method for making and curing cubes made from pre-bagged grouts and polymer modified mortars

## Reporting

- Cube identification and age of test.
- Cube dimensions in three directions to the nearest 0.5mm.
- Cube weight.
- Density (either from cube weight or weight in air and water).
- Crushing load in kN.
- Compressive strength in N/mm<sup>2</sup>.
- Type of failure observed.
- Name, position and signature of technician carrying out the testing.
- Name, position and signature of Supervisor.

11/94 BASF\_CC-UAE revised 08/95

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