Repair and Strengthening Systems for Historical Masonry Structures
Master Builders Solutions from BASF

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The Master Builders Solutions brand brings all of BASF’s expertise together to create chemical solutions for new construction, maintenance, repair and renovation of structures. Master Builders Solutions is built on the experience gained from more than a century in the construction industry.

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- Chemical solutions for underground construction
- Waterproofing solutions
- Sealants
- Tile fixing system
- Concrete repair and protection solutions
- Performance grouts
- Performance flooring solutions
Before making material selection, first the existing damages have to be analyzed. Materials to be used should be decided depending on analysis results. Scientific research methods used in damage analysis are summarized below:

- Defractometric analysis by X-ray
- Heat analysis
- Moisture Analysis
- Conductivity analysis
- Solubility by salts
- Ionic chromatography
1. INTRODUCTION

The following principles have to be considered during the selection of methods and materials that are to be used in repairing and reinforcing historical structures.

- Reducing moisture and its negative effects;
- Investigating the reasons of structural irregularities;
- Investigating the physical and chemical effects of damages and irregularities;
- Re-setting the load bearing capacity of the structure;
- Re-setting architectural aesthetics to the structure;
- Making the repair and/or strengthening reliable and permanent.

To make the restoration works scientific and multi-disciplinary, specialists in engineering, architecture, history of arts, chemistry, and material sciences have to be involved in the process.

EN 998 EN 1504 standard, describing products and systems for protection and repairing of reinforced concrete structures, has come into force in Europe. With this standard, materials and techniques to be used in repairs of reinforced concrete structures are classified and a sound guidebook for project holders and appliers is formed. Similarly, EN 998 standard, which classifies and standardizes materials to be used in repairs of historical structures, is being used throughout Europe. With this catalog,

BASF aims to guide project holders and appliers in applications of repair and strengthening of historical structures with the following steps.

- Re-identification of typical situations encountered during the building of walls;
- Through evaluation of the environment of the structures, investigation of negativities and changes that the existing materials will be exposed to over time;
- Selection of application techniques;
- Selection of proper material for application of the techniques;
- Preparation of method of statements that contain test methods and material specifications, which will meet the demands of the process.

In this scope, taking thousands of years of architectural experience of our world into consideration, structural materials that can be used in accordance with historical structures have been developed under the brand name MasterEmaco® and MasterInject® (ALBARIA®):

- Natural hydraulic lime based ready-packed plasters and joint materials;
- Natural hydraulic lime based fine graded, ready-packed plasters for surface repairs;
- Puzzolanic lime based, injection mortars;
- Lime putty for finishing top layer and cosmetic repairs.
2. Damage Types and Observations

Possible damages that may be encountered in masonry structures in general are summarized below:
- Falling of plasters;
- Erosion in the joints;
- Spallings formed in the walls;
- Rotations and settlements in foundations;
- Cracks, free joints and smashess on wall surfaces;
- Cracks and regional collapses on arches, and vaults;
- Effects of temperature changes;
- Strengthening need against earthquakes;
- Overloading (addition of floors, etc.);
- Falling, non-adhesion, and swelling of coatings and paints.

2.1 Falling of plasters

Ground water, rising from the soil in the masonry walls with capillary effect, causes the salts inside the walls to be dissolved. When the water, rising with capillary effect, evaporates from the surface of the wall, solubile salts in the water crystallize out below the surface and cause salt leaching by accumulating in the spallings of the material and on the surface of the plaster. Salts, becoming crystallized depending on the amount of water rising and evaporating inside the wall, cause an increase in the pressure inside the plaster, and ultimately blasting of bricks and plaster.

Observations

Examinations and observations to be made:
- Visual analysis;
- Investigation of sulfate salts: Defractometric analysis by X-ray and heat analysis;
- Moisture analysis: Moisture amount of the sample, and maximum amount of water it can absorb when sunk into water are identified;
- Existence of salts: By identifying electrical conductivity, effects of existence of chloride, sulfate, etc. salts;
- Type of salt: Types and amounts of salts can be identified sensitively by solubility and ionic chromatography methods.

2.2 Erosion in the joints

Joints on masonry walls are the weakest link of the walls, since they are unprotected against environmental effects. In time, joints on the surfaces of the walls start to wear out as they are exposed to friction, impact, wind, water, and various chemicals. After a while, joint mortars may be completely lost. When joints are damaged, more pollutants (water, acid, etc.) leak into the wall and weaken it from the inside. Joints may be also damaged by severe contraction of mortar during its application, overloading of the wall, etc.

The main reasons for deterioration of joint materials are:
- Freeze – thaw cycles;
- Chemical effects like acid rain, etc;
- Crystallization of salts on the joint surface as a result of moisture variability.

2.3 Spallings formed in the walls

Spallings are generally formed by physical deterioration and chemical decomposition or a combination of both. The problem may be understood by observations, but endoscopic, sonar, and coring techniques may also be used for this purpose.
Settlements in the foundation cause additional internal forces to be formed in the structural system. As a result of these additional internal forces, rotations on the superstructure, cracks and splits on different points are formed.

**Evaluation Of Damages**

Evaluation process should be started with investigation of the causes of settlement. Rotations, cracks, and settlements on the structure, additions and removals on the structural system over time have to be examined. Then, enough number of core samples should be taken for evaluating the strengths of existing material. By assessment of collected data, reasons of damages can be identified. Setting out from these reasons, main reasons of settlement can be put forward. Possible sewage leaks of the structure or its neighboring structures may cause a loss in the bearing capacity of the soil by softening it over time, and cause settlement in the building. Settlements are formed by liquefaction of the soil as a result of seismic activity, and vibrations caused by vehicle traffic may also damage foundations of the structure. Bearing capacity of the foundation may be exceeded because of additional floors or overloading, and this may cause settlements.

2.5 Cracks, free joints and smashes on wall surfaces

Vertical loads on the wall and seismic activities cause a rapid growth and propagation in microcracks that may be formed on the wall. Besides the damages that may be caused by type of structural system, additional loads, spallings and cavities, deteriorations of mortars may cause damages on the wall. Stone, brick, etc. materials, with poor mechanical properties, used in the wall may cause smashing on the wall over time. In general, damages that may be formed on walls because of the reasons summarized above may be categorized into three:

- Breaking of bricks and/or smashing, crumbling of joints as a result of an increase in vertical loads;
- Formation of cracks as a result of seismic loading in the plane and out of the plane;
- Formation of diagonal/shear cracks as a result of an increase in shear forces.

**Observations**

Existing loads on the wall, visual aspect of the wall, and damage types have to be examined. Then, core samples should be taken and mechanical tests should be run to identify compressive strength of the wall.
After examining the core samples, appropriate repair and strengthening techniques have to be determined. After evaluating the chemical and mechanical properties of the existing building materials, the compatible repair and strengthening materials should be selected.

2.6 Cracks and regional collapses on arches, domes, and vaults

Although masonry walls have compressive strength, they don’t have strength under tensile forces, since they don’t have reinforcements, and become damaged. For this reason, slab, roof, etc. elements that will be exposed to flexural effect are designed as curvatural elements like arches, domes, and vaults. This way, tensile stresses in the cross section of structural elements are limited and elements takes compressive stresses. However, asymmetric loadings, different settlements and seismic loadings increase tensile stresses in structural elements. In places where tensile stresses increased, cracks perpendicular to tensile stresses are formed. Thus, continuity of load transfer is lost and regional collapses/cracks and falls are observed. Especially settlements and rotations on structural elements are very dangerous. For this reason, damages are permanent and may cause the structure to totally collapse at that region.

Observations

Another important reason for the damages on arches, domes, and vaults is overloading and the weakness of mortars used as binders. After determining geometric properties of structural element and loads exerted on it, structure must be hanged up by temporary supports depending on needed safety conditions under service loads. Afterwards, repairs of damaged parts may be started. Following steps should be followed for damage analysis:

- Crack-shaped visible swellings and physicochemical crumbling should be determined;
- Material and cross-section of the structural elements should be examined by ultrasound methods;
- Existence of chemicals like sulfate, which may cause crumbling, should be examined by chemical methods.

2.7 Effects of temperature changes

Climate conditions may cause serious damages on structures. Especially in continental climates, where there is a significant difference between day and night temperatures, concrete, wooden or metal parts (plank, lock, etc.) that may be found inside the masonry structure may cause formation of cracks on masonry element due to thermal expansion differences.

2.8 Strengthening need against earthquakes

Tensile stresses formed due to seismic activities are very forcing for masonry structures. Main reason of damages in masonry structures during earthquakes is that they have very low tensile strength and ductility. Masonry structure elements tend to crack under earthquake loads. However, after formation of cracks, their energy absorption capacity increases due to hyperstatic properties of the structure. Existing safety level of the structure should be evaluated according to the current codes whether it should be strengthened. Then, the structure has to be remodeled by applying selected repair and strengthening techniques, and its earthquake behavior should be evaluated.
2.9 Overloading

Since changes in the structure like adding new floors, etc. will cause overloading, significant increases may be seen in compressive stresses. Exceeding compressive strengths of mortars used in building of the wall may cause smashing and regional collapsing of the wall. In some cases, settlements in foundations and cracks due to these settlements may be encountered.

Observations

Damages caused by overloading show themselves over time. Openings formed around doors and windows, smashing of wall mortar, microcracks formed on vertical surface all show intensification of compressive stress on the structure caused by overloading. Tests should be made on core samples to be taken from the structure and existing loads should be compared to determine safety of the structure under existing loads.

2.10 Erosion and contamination of natural stones

Due to freeze-thaw cycles; natural stones used in masonry structures are seriously damaged by erosion caused by environmental factors like acid rain, etc. over time. Also they are affected by the pollution in the atmosphere because of their absorbent properties and lose their aesthetic looks by darkening over time.
3. Identification Of Damage Types and Repair – Strengthening Methods

**DAMAGE TYPES**

- **Falling of plasters**
  - Low humidity
  - High humidity and salt
- **Joint loss**
- **Spallings on wall material**
- **Rotations and settlements on foundation**
- **Wall surface damages**
  - Local spallings and free joints, local smashes
  - Excessive free joints and smashes, horizontal and/or diagonal cracks, earthquake loads
- **Wall arches and vaults**
  - Cracks formed by asymmetric loads, collapsing risk on arches and vaults, settlements, earthquake effects
  - Change in usage purpose of the structure
- **Horizontal closing of the arches and vaults**
- **Temperature changes**
- **Strengthening against earthquakes**
- **Increase in vertical loads**
- **Swellings and falls on coatings and paints**
- **Erosion of natural stones**
- **Contamination of natural stones**

**STRENGTHENING TECHNIQUES**

- **Replastering**
  - Plastering by lime based plasters
  - Plastering by special dehumidifying and desalting plasters
- **Repair of joints**
- **Connections and separations, point interventions, and building of wall**
- **Strengthening the foundations and improving the soil conditions**
  - Strengthening by injection
  - Increasing the strength by using FRP bars and laminates
  - Increasing the strength and ductility by using FRP bars between joints
  - Increasing the strength and ductility with FRP confinement
- **Strengthening by FRP bars**
  - Increasing the strength and ductility with FRP confinement
  - Increasing the strength and ductility with FRP laminates and bars
  - Jacketing by reinforcement mesh

**Classification of plasters according to mechanical properties in EN 998/1 standard**

<table>
<thead>
<tr>
<th>Mortar type</th>
<th>CS I</th>
<th>CS II</th>
<th>CS III</th>
<th>CS IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive strength</td>
<td>0,4-2,5 MPa</td>
<td>1,5-5 MPa</td>
<td>3,5-7,5 MPa</td>
<td>6 MPa</td>
</tr>
</tbody>
</table>

Plastering techniques vary and in general, application is made in three consecutive stages:
- **Priming:** Milkmetric application to increase adhesion to the bottom layer.
- **Plaster:** Main plaster layer over 1 cm thickness.
- **Finishing:** Surface repair process to achieve a uniform/levelled finishing before milkmetric last layer application like paint.

**Surface Preparation**

Damaged, dumped plastered walls and repairs made at various times on the wall surface must be removed from the surface by using hammer and mulch or by using electric hand crusher precisely without damaging the existing wall. The walls must be completely removed both the inner and outer surfaces. After the walls are completely removed from the dust and loose particles with the help of the compressed air, they must be soaked in dry areas before the plaster application.

**Material Preparation**

The material to be used in the plastering of masonry walls (like cement) must not contain components that will damage existing wall materials. Plaster mortars must be natural hydraulic lime based. Water soluble salts should be limited. Mortar breathing ability must be developed. MastereEmaco® N 275 TIX is a natural hydraulic lime based, cement-free, thixotropic joint and mortar for historical structures. Depending on ambient conditions, 3.8-4 liters of water is poured into a clean mixing bucket with the help of a scale. MastereEmaco® N 275 TIX is slowly added and stirred for 4 minutes until a homogeneous and lump-free mixture is obtained with a 400-600 rpm mixer. After resting for about 4 minutes and stirring again for 30 seconds, material handling becomes ready. Concrete mixer can also be used for material preparation when large quantities of material are to be used. After adding water and material in the concrete mixer at the required amount, it is mixed for 4-5 minutes until a homogenous consistency is obtained.

**3.1 Replastering**

When the walls do not need to be increased in cross section and strengthened, it is sufficient to replace the existing plasters on the inner and outer surfaces without the steel wire jacketing. For plaster, first of all, it should be started from the inner surface of the walls. The outer surface plaster application should also be done after injection / consolidation application. In general terms, the plasters used for historic masonry structures can be classified under two main groups. When taken in a group of traditional Khorasan and natural hydraulic lime-based plasters, the macro-porous plasters used to remove moisture and salt will be investigated separately.

**3.1.1. Hydraulic lime based plasters:**

Hydraulic lime based plasters can be classified in two main groups as thick and fine plaster. Ready use natural hydraulic lime-based plaster and joint material, as well as Khorasan plaster prepared in the on-site by using natural hydraulic lime and slaked lime are classified as MastereEmaco® N 275 TIX scratch plaster, MastereEmaco® N 215 FC decorative plaster is classified as finish plaster.

**Requirements**

- Expected properties of the material is summarized as below:
  - Good adherence to the lower surface (EN 1015/12).
  - Air pockets UNI EN 1015/7 and total porosity (Normal 4-80).
  - Water vapor permeability coefficient, $\mu$, (UNI 1015/19).
  - Efflorescence resistance (WTA).
  - Heat permeability coefficient, (UNI 1745).
  - Mechanical properties (EN 998-1);

**3.1.1.1. Protection against freeze-thaw cycle:**

The protection against freeze-thaw cycle is necessary to protect the material from freezing and thawing. In case of freezing and thawing, the material should be protected from moisture and freezing conditions.

**3.1.1.2. Contamination of natural stones:**

The contamination of natural stones is necessary to protect the material from contamination by external sources. In case of contamination, the material should be protected from contamination sources.

**3.1.1.3. Settlements, earthquake effects:**

The settlements, earthquake effects are necessary to protect the material from settlements and earthquake effects. In case of settlements, the material should be protected from settlement sources. In case of earthquake effects, the material should be protected from earthquake sources.

**3.1.1.4. High humidity and salt:**

The high humidity and salt is necessary to protect the material from high humidity and salt. In case of high humidity, the material should be protected from humidity sources. In case of salt, the material should be protected from salt sources.

**3.1.1.5. Rotations and settlements on foundation:**

The rotations and settlements on foundation are necessary to protect the material from rotations and settlements on foundation. In case of rotations, the material should be protected from rotation sources. In case of settlements, the material should be protected from settlement sources.

**3.1.1.6. Spalling on wall material:**

The spalling on wall material is necessary to protect the material from spalling on wall material. In case of spalling, the material should be protected from spalling sources.

**3.1.1.7. Swellings and falls on coatings and paints:**

The swellings and falls on coatings and paints are necessary to protect the material from swellings and falls on coatings and paints. In case of swellings, the material should be protected from swelling sources. In case of falls, the material should be protected from fall sources.

**3.1.1.8. Crack formation by asymmetric loads, wall arches and vaults:**

The crack formation by asymmetric loads, wall arches and vaults is necessary to protect the material from crack formation by asymmetric loads, wall arches and vaults. In case of crack formation, the material should be protected from crack sources.
The surfaces must be thoroughly wetted and saturated with water before application. Make sure there is no dirt, loose parts or dry parts on the wall surface. Then an additional amount of water should be added and mixed up to 10% of the amount of water in the prepared mortar and a mortar having high consistency and is suitable for base coat should be obtained. This mortar prepared for base coat should be applied on a waterlogged surface by using a trowel as a thickness of 5-10 mm.

After the application of the mortar, in order to prevent to dry it, the mortar surface should be moistened again and the application of the main jacketing layer should be started. However, no water should be added to the material to be used. Even if a certain amount of mortar is obtained after base coat application, this mortar should not be used for jacketing. After the thick plaster has been applied, the surface should be smoothened with wood or metal finisher.

Original Mortars
Mortar compositions are determined by chemical and physical analysis of the samples taken from the historical structure plasters. These mortars usually contain stone dust, slaked lime, tow, brick shavings and dust, marble dust, stream sand, etc. materials were used. In today’s conditions, natural hydraulic lime is also used to reconstitute the original mortars on site. These mortars usually contain stone dust, slaked lime, tow, brick shavings and dust, marble dust, stream sand, etc. materials were used. In today’s conditions, natural hydraulic lime is also used to reconstitute the original mortars on site.

Finish plaster application
It is very important that the surface is smooth and smooth before finishing coat if it is considered to be a top coat for a more decorative appearance. For this reason it is necessary to apply undercoat finish plaster on MastereEmaco® N 275 TIX. The coating must be at least 1 week old before application. All surfaces must be thoroughly wetted so that there are no dry areas.

Plaster material to be used under paint must not contain components that will damage existing wall materials, cement etc. Water soluble salts should be limited and the breathability must be improved. MastereEmaco® N 215 FC is a cement-free, natural hydraulic lime-based plaster material used to obtain a smooth surface prior to paintwork in masonry structures.

Depending on ambient conditions, 6.0-6.5 liters of water are poured into a clean mixing bucket with the help of a scale. MastereEmaco® N 215 FC is slowly added and stirred for 4 minutes until a homogeneous, lump-free mixture is obtained with a 400-600 rpm mixer. After resting for about 4 minutes and stirring again for 30 seconds, material handling becomes ready.

The prepared mortar is applied with a trowel in a thickness of 2-3 mm. It is expected that the plaster is absorbed the water and the water is sprinkled with the plastering brush and the surface is finished with steel or rubber trowel. In order to obtain a much smoother surface, it is necessary to apply two coats. One day should be expected between the layers. The previous layer must be dampened before the new layer is applied.
3.2 Repairing of joints and building of walls

To build a new wall or repair an old wall, different types of mortars may be used. New European standard describes different mortars.

### Classification of wall mortars according to mechanical properties in EN 998/2 standard

<table>
<thead>
<tr>
<th>Mortar type</th>
<th>M1</th>
<th>M2.5</th>
<th>M5</th>
<th>M10</th>
<th>M15</th>
<th>M20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive strength EN 1015/11</td>
<td>1MPa</td>
<td>2.5MPa</td>
<td>5MPa</td>
<td>10MPa</td>
<td>15MPa</td>
<td>20MPa</td>
</tr>
</tbody>
</table>

**Requirements**

- Wall mortars must have the following properties:
  - Good workability (UNI 7044);
  - Low chloride content (EN 1015/17);
  - Good adherence to the lower surface (EN 1015/12);
  - Having appropriate structural properties according to EN 998/2 standards;
  - High vapor permeability (UNI EN 1015/19);
  - Water soluble salts it contains must be limited (Normal 13-83);
  - High efflorescence resistance (WTA);
  - Water impermeability property (Capillary water absorption EN 1015/18).

3.3 Strengthening of foundations

To increase bearing capacities of foundations or to decrease soil stress, foundation cross sections may be enlarged by using special concrete.

This technique is easy to apply in shallow foundations. However, caution is needed during the application. In thick and big walls, foundation cross section has to be widened symmetrically from both sides depending on wall width cross section to transfer the loads homogenously. Thus loads exerted on structure are transferred to soil homogeneously. Considering the loads carried by the structure, project works have to be made under the safety level of the structure and additions to the foundation have to be sized. Also leakages from neighboring structures’ sewers may soften the soil in time and cause settlements. Liquidation effect in soil also causes excessive settlements. Thus, before any intervention on foundations, extensive soil investigation is necessary. Reducing underground water level controllably and draining excess water from foundations by an efficient drainage system will ease foundations. However, during these processes, different settlements of the building should be watched out for.

3.4 Repair of walls by injection

Repair by injection includes injection of appropriate physicochemical liquid material into the wall to give mechanical properties back to the structure. With injection application, the aim is to fill the spallings and cracks inside the wall, and regain monolithic structure by attaining continuity in wall cross section. Thus, loads on the wall are transferred to foundations without any interruption, and possible failings and collapses are prevented. Wall materials in our country may show regional differences in terms of physical and chemical properties. The injection material to be used must be in accordance with the existing materials composing the structure. For this reason, hydraulic lime based injection materials are the most appropriate products that can be recommended for repair of cracks. The fineness and fluidity properties of the material to be used for filling the spallings inside the wall must be highly advanced. Especially in porous walls built by using different building materials with high absorption, applying injection enables consolidation of the wall. This improves the strength of the wall. In walls built by more strong stones, when the spallings are filled by injection application, a lesser strength increase is achieved compared to weaker stones.

**Requirements**

- Çok yüksek aksı şanlı gösterilen su kusma görülmemelidir (Marsh konisi).
- No water leaching and very high fluidity (Marsh cone);
- Low hydration temperature;
- Water soluble salts must be limited (Normal 13-83);
- Resistance to sulfates;
- High vapor permeability (UNI EN 1015/19);
- Mechanic properties (According to EN 998/2);
- Good adherence to steel or FRP bars.

With injection application, compressive strengths of elements are increased by filling spallings and cracks in the masonry bearing elements. Injection application is also used in seams made with FRP material, besides crack repairs. Since FRP (fibrous polymer) materials are highly resistant to environmental conditions (corrosion, melting, etc.) they are ideal materials preferred in repairing applications. FRP bars are placed in holes opened in structure cross section, and then injection is applied on these. With this application, FRP bars act as reinforcements in structure cross section and resists to tensile forces on the cross section of structural element.
Using lowly permeable grout with salts that have good mechanical properties, but high solubility (sulfates, chlorides, nitrates, etc.) in high hydration temperatures or using epoxy resins is directly controversial to the principles explained above and must be avoided.

3.5 Strengthening by reinforcement mesh or FRP

Strengthening by reinforcement mesh includes jacketing application preferably by a highly resistant hydraulic lime based mortar together with steel mesh protected cathodically against corrosion on one surface or both surfaces of the masonry structure element. This method should be preferred in critical situations when structure element is so weak that it cannot be strengthened by other methods and cross section increase is needed. This method cannot be applied in historical structures with structural walls that have ornaments (fresco, mosaics, etc.) on it. FRP bars and laminates may be embedded in mortar and used instead of reinforcement mesh. Since FRP material is corrosion-proof, corrosion protection systems like cathodic protection, etc. is not required. Although this method may also be applied on outer shells of vaults, it is not widely preferred in other conditions. If damages like collapsing, cracking, etc. are occurred on mortar after the application, injection application may be used to intervene.

Requirements

Mortars to be used must have the following properties:

- High thixotropic property for trowel or spraying application;
- Limited chloride amount (EN 1015/17);
- High mechanical strengths (EN 998/2);
- Good adherence to the lower surface (EN 1015/12);
- High adherence property to FRP bars;
- Water soluble salts it contains must be limited (Normal 13-83);
- High abrasion (Crumbling) strength (Normal M 3387);
- Water impermeability property (Capillary water absorption EN 1015/18).

3.6 Improvement of ductility by using FRP bars

In this method, 2-3 cm deep spallings are opened in wall joints and FRP carbon bars are placed in these spallings by using special resin or lime based mortars. With FRP bars, tensile stresses on the wall surface are matched and ductility of the wall is improved. FRP bars have much higher mechanical strengths compared to steel reinforcements, and their life span is much greater because they are corrosion proof. These bars may be circular with 5-12 mm diameter or rectangular with 1.4 mm x 10 mm.

3.7 Strengthening by FRP sheets and laminates

Using FRP in strengthening of masonry structure elements is a very practical and efficient method. Retrofitting with FRP is used on outer surfaces of walls, arches, vaults, and domes to increase bearing capacity and ductility of them under existing loads. However, application details are very important in this strengthening technique. Especially preparation of low surfaces that will be adhered is very important.

Requirements

Mortars to be used must have the following properties:

- High thixotropic property for trowel or spraying application;
- Limited chloride amount (EN 1015/17);
- High mechanical strengths (EN 998/2);
- Good adherence to the lower surface (EN 1015/12);
- High adherence property to FRP bars;
- Water soluble salts it contains must be limited (Normal 13-83);
- High abrasion (Crumbling) strength (Normal M 3387);
- Water impermeability property (Capillary water absorption EN 1015/18).

3.8 Confinement of columns

The aim is to increase load bearing capacities of columns. When the columns are very weak, the structure is hanged up regionally by special supporting techniques and the load on column is removed. After necessary surface preparations on the column are completed, confinement is made with FRP sheets. Surface preparation is a very important stage. Lower surface has to be clean, dry, and strong for an efficient application. When necessary, column can be repaired by plastering with cement based structural repair mortars. The material to be used in application and application details should be decided by existing status analysis and preparing appropriate strengthening projects. With this application, ductility of columns are improved against earthquake effects and shear strengths are increased.

3.9 Protection of plasters

Plaster layer constituting outer surfaces of the structures is both an important element completing the structure in architectural terms and protecting it from external factors like a shield. In short, it is an aesthetical protector.
Until 1800’s, lime putty, carbonated and quartz sands, colored clay based materials had been used in structures as the last layer.

Requirements

Expected properties of materials that will be used as the last layer:
- High water vapor permeability (water vapor permeability coefficient, UNI EN 1015/19);
- Good adherence to the lower surface;
- High UV resistance;
- High resistance to mold and fungus.

Starting from the early years of 1900’s, potassium silicate based materials had been used in building facades as the last layer.

These materials are considered as young materials and are highly resistant to aggressive environmental conditions. They give water repellent property to the surface they are applied to and act as a protective shield against aggressive environmental conditions like acid rain, salty wind clouds, etc. They can be applied to all kinds of surfaces easily, except chalk, etc.

3.10 Protection of natural stones

Protection against freeze-thaw cycles

Natural stones, especially open to atmospheric effects, experience erosion over time with the effect of acid rains and freeze–thaw cycles. To counteract these damages, entrance of water and harmful ions dissolved in water to natural stones must be prevented. By using new generation silane based water repellents, a water impermeable shield is formed on cross section of the stone. Thus, entrance of water and harmful ions dissolved in water to natural stones to the stone is prevented, and the stone is protected from freeze-thaw cycles.

Requirements

Expected properties of materials to be used as water repellent:
- It must not contain solvents;
- It must have very low viscosity, and be able to penetrate into stones;
- It must prevent entrance of water and harmful ions dissolved in water to stones;
- It must be transparent and it must not change the color of stones;
- It must not harm chemical structure of stones.

Surface preparation against contaminations

Especially intense atmospheric pollution in cities causes darkening of natural stone and marble surfaces over time. Natural stones absorb pollution in the atmosphere and become contaminated. Since cleaning of this contamination cause abrasion on stone surface, stone is seriously damaged over time. For this reason, protection of natural stones against contamination is needed to prevent damages caused by surface cleaning (sand blasting, etc.). The materials to be used for surface preparation should not change natural structure of the stone in any way and act for a long time. Protections made by inappropriate materials cause bigger problems in time.

Requirements

Yüzey koruyucu olarak kullanılacak malzemelerde aranan özellikler:
- It must be silane based;
- It must have high vapor permeability;
- It must not contain solvents;
- It must have UV resistance;
- It must have very low viscosity;
- It must be able to create easy cleaning effect on stone surface (adherence of materials like moss, mold, dirt, etc. has to be made difficult);
- It must be transparent and it must not change the color of stones;
- It must show water and oil repellent effects on stone surface;
- It must not harm chemical structure of stones.
## 4. Product Recommendation Table

### REPAIR – REINFORCEMENT TECHNIQUES and MATERIALS

<table>
<thead>
<tr>
<th>Damage Types</th>
<th>Wall surface damages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Falling of plaster</td>
<td>MasterEmaco® S 285 TIX</td>
</tr>
<tr>
<td>Joint loss</td>
<td>MasterEmaco® A 265</td>
</tr>
<tr>
<td>Spallings formed in the walls</td>
<td>MasterEmaco® N 275 TIX</td>
</tr>
<tr>
<td>Rotations and settlements in foundations</td>
<td>MasterFiber® 15 MF</td>
</tr>
<tr>
<td>Wall surface damages</td>
<td>MasterEmaco® N 275 TIX</td>
</tr>
<tr>
<td>MasterEmaco® A 265</td>
<td></td>
</tr>
</tbody>
</table>

### Renewal of joints

<table>
<thead>
<tr>
<th>Connections and separations, point interventions, and building of wall</th>
<th>MasterEmaco® S 285 TIX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interventions under the wall and foundation</td>
<td>MasterEmaco® S 285 TIX</td>
</tr>
<tr>
<td>Increasing strength by injection</td>
<td>MasterInject® 222</td>
</tr>
<tr>
<td>Increasing the strength by using FRP bars and laminates</td>
<td>MasterBrace® BAR</td>
</tr>
<tr>
<td>Increasing the strength and ductility by using FRP between joints</td>
<td>MasterBrace® LAM</td>
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<tr>
<td>Repairing with FRP bars</td>
<td>MasterBrace® BAR</td>
</tr>
<tr>
<td>Increasing the strength and ductility with FRP confinement</td>
<td>MasterBrace® FIB</td>
</tr>
<tr>
<td>Increasing the strength and ductility by using FRP bars and laminates</td>
<td>MasterBrace® BAR</td>
</tr>
<tr>
<td>Improvement of ductility by using FRP bars</td>
<td>MasterBrace® FIB</td>
</tr>
<tr>
<td>Confinement of columns</td>
<td>MasterEmaco® S 285 TIX</td>
</tr>
<tr>
<td>Jacketing by mesh reinforcement</td>
<td>MasterEmaco® S 488</td>
</tr>
<tr>
<td>Surface repair and painting</td>
<td>MasterProtect® H1100</td>
</tr>
<tr>
<td>• Lime plaster</td>
<td>MasterProtect® H1100</td>
</tr>
<tr>
<td>• Silicate plaster</td>
<td>MasterProtect® H1100</td>
</tr>
<tr>
<td>• Lime putty</td>
<td>MasterProtect® H1100</td>
</tr>
<tr>
<td>• Silicate</td>
<td>MasterProtect® H1100</td>
</tr>
<tr>
<td>Protection against freeze-thaw cycle</td>
<td>MasterProtect® H1100</td>
</tr>
<tr>
<td>Surface protection</td>
<td>MasterProtect® H1100</td>
</tr>
</tbody>
</table>
## Repair and Strengthening Systems Products

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>MasterInject® 222 (Formerly ALBARIO® INIEZIONE)</td>
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<td>MasterEmaco® A 265 (Formerly ALBARIO® CALCE ALBAZZANA)</td>
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<td>42</td>
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<td>MasterBrace® BAR (Formerly MBRACE MBAR®)</td>
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<td>47</td>
</tr>
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<td>MasterBrace® LAM (Formerly MBRACE LAMINATE)</td>
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<td>MasterEmaco® S 488 (Formerly EMACO® S88/S88 C)</td>
<td>49</td>
</tr>
<tr>
<td>MasterFlow® S 928 (Formerly EMACO® S55)</td>
<td>49</td>
</tr>
</tbody>
</table>
**MasterInject® 222**
(Formally ALBARIA® INIEZIONE)

**Puzolanic Lime Based Injection Mortar Designed For Historical Masonry Buildings**

**DESCRIPTION OF PRODUCT**

MasterInject® 222 is an injection mortar that is used for repair purposes in brick, stone or tufa containing historical buildings especially in places where cracks have been formed and supporting capacity has been lost.

MasterInject® 222 is used in:
- Consolidating the masonry walls under sulphate attacks.
- Consolidating the masonry domes and vaults.
- In the filling of small or large voids in the walls.
- Cracks repairs in masonry elements.
- Consolidating the masonry foundations.

**FEATURES AND BENEFITS**

- Cement free
- Can be used in environments under sulphate attacks.
- It doesn’t react with original building materials neither physically, nor chemically.
- The superior hydraulic nature of the binder enables the injection mortar to penetrate into the building deepley. With the assistance of the medium elasticity modulus, it is ideal in the filling of small and large voids even in bearing problems due to the high moisture content of the original building material.
- Does not affect the vapour and moisture permeability of the existing building.
- It shows limited expansion that does not cause to any additional internal stresses in the masonry elements
- Does not bleed
- Easy to inject even under low pressures
- Water-born salts (alkalis, sulphates, chlorides or nitrates), are limited

**APPLICATION PROCEDURE**

Preparation of Substrate

The surfaces should be free of frost, curing membranes, waterproofing treatments, oil stains, laitance, friable material and dust. The surfaces should be wetted before application. If there is a water leakage it must be drained or properly plugged.

Cracks with a width of 1 - 5 mm

Depending on the crack width the holes should be drilled in both sides of the crack line with an angle of 45º to the surface. The holes should be 5-10 cm away from the crack line and deep enough for passing across the crack plane and reach opposite side. Through the crack line, the holes should have a distance of 30-50 cm from each other. The holes have to be cleaned by air compressors to remove all dust and loose particles. Injection packers should be installed in to the holes, then screwed and fixed to the holes. All the cracks and packer sides should be sealed with MasterEmaco® N 275 TIX by using a steel spatula or trowel to prevent the leakage of injection mortar from the crack openings. Allow 24 hour (at 20ºC) for curing the cap.

**Mixing**

Add enough water into a clean mixing bucket (300-600 rpm) for 4 minutes until having a homogenous consistency. Let the mortar have rest for 4 minutes and re-mix for 30 seconds.

**Mixing Ratio**

<table>
<thead>
<tr>
<th>MasterInject® 222</th>
<th>Powder</th>
<th>Bag</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 kg Powder</td>
<td>± 0,20 kg</td>
<td>± 0,50 kg</td>
</tr>
<tr>
<td>12 kg Bag</td>
<td>± 1,50 kg</td>
<td>± 3,00 kg</td>
</tr>
</tbody>
</table>

**APPLICATION METHOD**

Tie the pneumatic pipe of the pump to the lowest hose/packer fixed to the cracked surface. Start pumping the mortar into the crack until it comes out from upper hose/packer. Remove the pipe from the current hose/packer and close/lock its opening by screwing or by steel wires. Follow the same instruction to the hose/packer fixed at the top of the surface. When the mortar leaks out from the upper hose/packer it is understood that the whole crack plane has been fully filled with MasterInject® 222 and finishes the application.

At least 24 hours after the application all the hoses/packers could be cut or pull out and surface could be finished with proper mortar in MasterEmaco® range.

**CLEANING OF TOOLS**

After the application all tools should be cleaned with water. MasterInject® 222 can be cleaned with only mechanical abrasion after hardening.

**PACKAGING**

15 kg bag

**STORAGE**

Store in original container in cool (+5ºC–+25ºC) and dry indoor conditions.

**SHELF LIFE**

12 months under proper storage conditions after production date.

**HEALTH AND SAFETY PRECAUTIONS**

It is dangerous to approach the application sites. During the application, a protective apparel, protective gloves, goggles and masks which comply with the Occupational Health and Safety Rules should be used. Due to the irritation effect of the uncured materials, the mixture should not come into contact with skin and eyes; in case of a contact, the affected area should be washed with plenty of water and soap; in case of swallowing, a physician should be consulted immediately. No food or beverages should be brought to the application area. The product should be stored and kept out of reach of children. For detailed information please consult the Material Safety Data Sheet.

**DISCLAIMER**

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**Technical Data**

<table>
<thead>
<tr>
<th>Product Chemistry</th>
<th>Includes Puzolanic Lime and Micronized Carbonates</th>
<th>KR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>Off white - light brown</td>
<td></td>
</tr>
<tr>
<td>COMP. Strength (20ºC) TS EN 196 7 days</td>
<td>&gt;7 N/mm²</td>
<td>&gt;13 N/mm²</td>
</tr>
<tr>
<td>Flow (DN Cup, No.8)</td>
<td>At the Beginning 20 Minutes Later</td>
<td>&lt; 30 s</td>
</tr>
<tr>
<td>Application Temp.</td>
<td>45ºC – 45ºC</td>
<td></td>
</tr>
<tr>
<td>Pot Life (20ºC)</td>
<td>30 minutes</td>
<td></td>
</tr>
</tbody>
</table>

**WATCH POINTS**

- During the application the substrate and environment temperature should be between 5ºC–30ºC.
- Injection works should be run by expert applicators.
- Injection pressure is defined due to crack width, crack depth and material properties of the existing structure. It should be defined according to the project.
**MasterEmaco® N 275 TIX**
(Fomerly ALBARI® INTONACO)

Natural Hydraulic Lime Based Mortar Designed For Historical Masonry Buildings

**DESCRIPTION OF PRODUCT**
MasterEmaco® N 275 TIX, is natural hydraulic lime based, cement-free, ready-pack mortar for restoration of historic buildings.

**FIELDS OF APPLICATION**
- Plastering the masonry walls in indoor and outdoor,
- Repair of lime based plasters,
- Repair of masonry and natural stone joints,
- Reprofiling of masonry walls.

**FEATURES AND BENEFITS**
- Cement free
- Shrinkage compensated
- Ready-pack
- It doesn’t react with original building materials neither physically, nor chemically
- Does not affect the vapour and moisture permeability of the existing building
- Water-born salts (alkalis, sulphates, chlorides or nitrates), are limited

**APPLICATION PROCEDURE**

**Preparation of Substrate**
The surfaces should be free of frost, curing membranes, waterproofing treatments, oil stains, laitance, friable material and dust. The surfaces should be wetted before application. If there is a water leakage it must be drained or properly plugged.

**Mixing**
Add enough water into a clean mixing bucket by using a proper water gauge. Add the powder into the bucket slowly and continuously. Mix the fresh mortar with a proper electrical mixer (300-600 rpm) for 4 minutes until having a homogenous consistency. Let the mortar have rest for 4 minutes and re-mix for 30 seconds.

**Mixing Ratio**

<table>
<thead>
<tr>
<th>MasterEmaco® N 275 TIX</th>
<th>1 kg Powder</th>
<th>20 kg Bag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Quantity</td>
<td>&lt; 0.10 l/kg</td>
<td>&lt; 0.20 l/kg</td>
</tr>
<tr>
<td>Viscosity</td>
<td>~200 cp</td>
<td></td>
</tr>
</tbody>
</table>

**APPLICATION METHOD**
MasterEmaco® N 275 TIX should be applied to the prepared surface by using a steel trowel. Application thickness should be between 1-2 cm. After the mortar finishes its first setting, some water should be sprayed onto the mortar and the surface should be finished with using steel or wooden trowel. Open areas should be protected from the rain, wind, etc. aggressive whether conditions during the first 24-48 hours after finishing repair by using wet clothes, curing membranes etc.

**COVERAGE**
17 kg/m² for obtaining 10 mm thick layer.

**WATCH POINTS**
- During the application the substrate and environment temperature should be between 5ºC-35ºC.
- For full curing of material, both the substrate and environment temperature shouldn’t be under allowed application temperature.
- Open areas should be protected from the rain, wind, etc. aggressive whether conditions during the first 24-48 hours after finishing application.

**Technical Data**

<table>
<thead>
<tr>
<th>Product Chemistry</th>
<th>Includes Natural Hydraulic Lime and Natural Fillers,</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive Strength (20°C) T5 EN 196 7 days</td>
<td>&gt;15 kg/cm²</td>
</tr>
<tr>
<td>Application Temperature</td>
<td>0ºC ± 5ºC ± 35ºC</td>
</tr>
<tr>
<td>Pot Life (20°C)</td>
<td>30 minutes</td>
</tr>
</tbody>
</table>

Typical values are obtained from the last layer of 40x40 mm master piece in 25ºC and 50% relative humidity conditions. High temperatures shortens the curing and working time, lower temperatures extends the durations.
CLEANING OF TOOLS
After the application all tools should be cleaned with water. MasterEmaco® N 275 TIX can be cleaned with only mechanical abrasion after hardening.

PACKAGING
20 kg bag

STORAGE
Store in original container in cool (+5°C to +25°C) and dry indoor conditions.

SHELF LIFE
12 months under proper storage conditions after production date.

HEALTH AND SAFETY PRECAUTIONS
It is dangerous to approach the application sites. During the application, a protective apparel, protective gloves, goggles and masks which comply with the Occupational Health and Safety Rules should be used. Due to the irritation effect of the uncured materials, the mixture should not come into contact with skin and eyes; in case of a contact, the affected area should be washed with plenty of water and soap; in case of swallowing, a physician should be consulted immediately. No food or beverages should be brought to the application area. The product should be stored and kept out of reach of children. For detailed information please consult the Material Safety Data Sheet.

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MasterEmaco® A 265
(Formerly ALBARIA® CALCE ALBAZZANA)
Natural Hydraulic Lime

DESCRIPTION OF PRODUCT
MasterEmaco® A 265 is cement-free, natural hydraulic lime burnt at low temperatures (900°C) for lime mortar production.

FIELDS OF APPLICATION
MasterEmaco® A 265 is used in following cases as binder of lime mortar:
- Plastering production
- Building of masonry walls
- Building of masonry and natural stone joints

FEATURES AND BENEFITS
- Cement free
- Burnt with traditional methods at low temperatures
- Can be used in production of different lime mortars compatible with existing building materials
- Does not affect the vapour and moisture permeability of the existing building

APPLICATION PROCEDURE
Preparation of Substrate
The surfaces should be free of frost, curing membranes, waterproofing treatments, oil stains, laitance, friable material and dust. The surfaces should be wetted before application. If there is a water leakage it must be drained or properly plugged.

Mixing
The work instructions of the restoration project should be followed.

APPLICATION METHOD
Fresh mortar should be applied to the prepared surface by using a trowel as mentioned application thickness in instructions. After the mortar finishes its first setting, some water should be sprayed onto the mortar and the surface should be finished with using steel or wooden trowel. For thicker applications first layer should be wetted after it hardens. Then the new layer application can be done. Open areas should be protected from the rain, wind, etc. aggressive whether conditions during the first 24-48 hours after finishing repair by using wet clothes, curing membranes etc.

COVERING
Depends on the mix design of lime mortar.

WATCH POINTS
- During the application the substrate and environment temperature should be between 5°C to 40°C.
- For full curing of material, both the substrate and environment temperature shouldn’t be under allowed application temperature.
- Open areas should be protected from the rain, wind, etc. aggressive whether conditions during the first 24-48 hours after finishing application.

CLEANING OF TOOLS
After the application all tools should be cleaned with water. MasterEmaco® A 265 can be cleaned with only mechanical abrasion after hardening.

PACKAGING
25 kg bag

STORAGE
Store in original container in cool (+5°C to +35°C) and dry indoor conditions.

SHELF LIFE
12 months under proper storage conditions after production date.

HEALTH AND SAFETY PRECAUTIONS
It is dangerous to approach the application sites. During the application, a protective apparel, protective gloves, goggles and masks which

<table>
<thead>
<tr>
<th>Technical Data</th>
<th>Natural Hydraulic Lime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Chemistry</td>
<td>Natural Hydraulic Lime</td>
</tr>
<tr>
<td>Color</td>
<td>Light Brown</td>
</tr>
<tr>
<td>Application Temperature</td>
<td>+5°C to +40°C</td>
</tr>
</tbody>
</table>
comply with the Occupational Health and Safety Rules should be used. Due to the irritation effect of the uncured materials, the mixture should not come into contact with skin and eyes; in case of a contact, the affected area should be washed with plenty of water and soap; in case of swallowing, a physician should be consulted immediately. No food or beverages should be brought to the application area. The product should be stored and kept out of reach of children. For detailed information please consult the Material Safety Data Sheet.

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DESCRIPTION OF PRODUCT
MasterEmaco® S 285 TIX, is puzolanic lime based, cement-free, high strength, thixotropic repair mortar for restoration of historical buildings. Complies with EN 998/2 M15

FIELDS OF APPLICATION
MasterEmaco® S 285 TIX is used in;
- Repair and strengthening of masonry walls
- Repair and strengthening of arches and vaults
- Repair of lime based plasters
- Strengthening of the masonry walls by using FRP bars in joints of masonry walls
- Repair and strengthening of foundations of masonry structures
- Used as a cement-free concrete by adding aggregates in repair of masonry slabs, domes and walls

FEATURES AND BENEFITS
- Cement free
- High mechanical strength
- High bonding strength
- Water-born salts (alkalis, sulphates, chlorides or nitrates), are limited
- Ready-pack
- Does not affect the vapour and moisture permeability of the existing building
- Low capillary water absorption
- Efflorescence resistant

APPLICATION PROCEDURE
Preparation of Substrate
The surfaces should be free of frost, curing membranes, waterproofing treatments, oil stains, laitance, friable material and dust. The surfaces should be wetted before application. If there is a water leakage it must be drained or properly plugged.

Mixing
Add enough water into a clean mixing bucket by using a proper water gauge. Add the powder into the bucket slowly and continuously. Mix the fresh mortar with a proper electrical mixer (400-600 rpm) for 4 minutes until having a homogenous consistency. Let the mortar have rest for 4 minutes and re-mix for 30 seconds.

Mixing Ratio

<table>
<thead>
<tr>
<th>MasterEmaco® S 285 TIX</th>
<th>1 kg Powder</th>
<th>20 kg Bag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Quantity</td>
<td>0.25-0.24 l</td>
<td>4.4-4.3 l</td>
</tr>
<tr>
<td>Mix water density</td>
<td>0.27-0.15 kg/l</td>
<td></td>
</tr>
</tbody>
</table>

APPLICATION METHOD
MasterEmaco® S 285 TIX should be applied to the prepared surface by using trowel. Application thickness should be between 1-5 cm. After the mortar finishes its first setting, some water should be sprayed onto the mortar and the surface should be finished by using steel or wooden trowel. For thicker applications new layer of the mortar should be applied.
be applied after first layer hardens. In multiple layer applications each layer should be wetted before the new layer. Cement-free concrete can be prepared by adding aggregates sized 5-20 mm and in a weight ratio of 30-35% of the mortar in screed application. The water ratio can be increased up to 10-15% more.

Open areas should be protected from the rain, wind, etc. aggressive whether conditions during the first 24-48 hours after finishing repair by using wet clothes, curing membranes etc. windy conditions should be avoided. Due to the irritation effect of the uncured materials, the mixture should not come into contact with skin and eyes; in case of a contact, the affected area should be washed with plenty of water and soap, in case of swallowing, a physician should be consulted immediately. No food or beverages should be brought to the application area. The product should be stored and kept out of reach of children. For detailed information please consult the Material Safety Data Sheet.

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**COVERED**
17 kg/m² for obtaining 10 mm thick layer

**WATCH POINTS**
- During the application the substrate and environment temperature should be between 5-40°C.
- For full curing of material, both the substrate and environment temperature shouldn’t be under allowed application temperature.
- Open areas should be protected from the rain, wind, etc. aggressive whether conditions during the first 24-48 hours after finishing application.

**CLEANING OF TOOLS**
After the application all tools should be cleaned with water. MasterEmaco® S 285 TIX can be cleaned with only mechanical abrasion after hardening.

**PACKAGING**
20 kg bag

**STORAGE**
Store in original container in cool (+5°C–+35°C) and dry indoor conditions.

**SHELF LIFE**
12 months under proper storage conditions after production date.

**HEALTH AND SAFETY PRECAUTIONS**
It is dangerous to approach the application sites. During the application, a protective apparel, protective gloves, goggies and masks which comply with the Occupational Health and Safety Rules should be used. Due to the irritation effect of the uncured materials, the mixture should not come into contact with skin and eyes; in case of a contact, the affected area should be washed with plenty of water and soap; in case of swallowing, a physician should be consulted immediately. No food or beverages should be brought to the application area. The product should be stored and kept out of reach of children. For detailed information please consult the Material Safety Data Sheet.

**DESCRIPTION OF PRODUCT**
MasterEmaco® N 215 FC is a natural hydraulic lime based, cement-free, ready-pack mortar for smooth surfaces under paintings in restoration of historical buildings.

**FIELDS OF APPLICATION**
- MasterEmaco® N 215 FC is used in:
  - Providing with smooth surfaces before painting
  - Surface leveling on lime mortars
  - Repair of lime based plasters

**FEATURES AND BENEFITS**
- Cement free.
- Water-born salts (alkalis, sulphates, chlorides or nitrates), are limited
- Ready-pack
- High bonding on plaster
- Does not affect the vapour and moisture permeability of the existing building
- Low capillary water absorption
- Elloforesence resistant

**APPLICATION PROCEDURE**
Preparation of Substrate
The surfaces should be free of frost, curing membranes, waterproofing treatments, oil stains, lattance, friable material and dust. The surfaces should be wetted before application. If there is a water leakage it must be drained or properly plugged.

**Mixing**
Add enough water into a clean mixing bucket by using a proper water gauge. Add the powder into the bucket slowly and continuously. Mix the fresh mortar with a proper electrical mixer (400-600 rpm) for 4 minutes until having a homogenous consistency. Let the mortar have rest for 4 minutes and re-mix for 30 seconds.

**TECHNICAL DATA**

<table>
<thead>
<tr>
<th>Product Chemistry</th>
<th>Includes Natural Hydraulic Lime, Microcrystalline Carbohydrates and Viscous Aggregates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Off-White</td>
</tr>
<tr>
<td>Aggregate Size</td>
<td>0-0.6 mm</td>
</tr>
<tr>
<td>Compressive Strength EN 196</td>
<td>11 kg/cm² (90 days)</td>
</tr>
<tr>
<td>Water Vapour Permeability</td>
<td>μg/m²</td>
</tr>
</tbody>
</table>

**Mixing Ratio**

<table>
<thead>
<tr>
<th>MasterEmaco® N 215 FC</th>
<th>kg Powder</th>
<th>25 kg Bag</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.24-0.26</td>
<td>0.62-0.65</td>
</tr>
<tr>
<td>Mixed Density</td>
<td>1.70-1.80</td>
<td>kg/liter</td>
</tr>
</tbody>
</table>

**APPLICATION METHOD**
MasterEmaco® N 215 FC should be applied to the prepared surface by using a trowel. Application thickness should be between 2-3 mm. After the mortar finishes its first setting, some water should be sprayed onto the mortar and the surface should be finished with using steel or wooden trowel. For obtaining smoother layer, second layer application should be done after 24 hours. First layer should be wetted before second layer applied. Open areas should be protected from the rain, wind, etc. aggressive whether conditions during the first 24-48 hours after finishing repair by using wet clothes, curing membranes etc.

**COVERAGE**
1.4 kg/m² for obtaining 1 mm thick layer.

**WATCH POINTS**
- During the application the substrate and environment temperature should be between 5-30°C.
- For full curing of material, both the substrate and environment temperature shouldn’t be under allowed application temperature.
- Open areas should be protected from the rain, wind, etc. aggressive whether conditions during the first 24-48 hours after finishing application.

**CLEANING OF TOOLS**
After the application all tools should be cleaned with water. MasterEmaco® N 215 FC can be cleaned with only mechanical abrasion after hardening.

**System for Historical Structures**
Repeair and Strengthening
Systems for Historical Structures
Repeair and Strengthening
Systems for Historical Structures
PACKAGING
25 kg bag

STORAGE
Store in original container in cool (+5°C–+30°C) and dry indoor conditions.

SHELF LIFE
12 months under proper storage conditions after production date.

HEALTH AND SAFETY PRECAUTIONS
It is dangerous to approach the application sites. During the application, a protective apparel, protective gloves, goggles and masks which comply with the Occupational Health and Safety Rules should be used. Due to the irritation effect of the uncured materials, the mixture should not come into contact with skin and eyes; in case of a contact, the affected area should be washed with plenty of water and soap; in case of swallowing, a physician should be consulted immediately. No food or beverages should be brought to the application area. The product should be stored and kept out of reach of children. For detailed information please consult the Material Safety Data Sheet.

DISCLAIMER
The technical information given in this publication is based on the present state of our best scientific and practical knowledge. BASF Türk Kimya Sanayi ve Tic. Ltd. Şti. is only responsible for the quality of the product. BASF Türk Kimya Sanayi ve Tic. Ltd. Şti. is not responsible for results that may occur because the product is used other than advised and/or out of instructions regarding the place and the method of use. This technical form is valid only till a new version is implemented and nullifies the old ones.
MasterProtect® H 1100  
(Formerly PROTECTOSIL® BHN)  
Water Repellent Material for Absorbent Surfaces

**DESCRIPTION OF PRODUCT**  
MasterProtect® H 1100, is a monomeric alkylclosilane based, single part, non-solvent, low viscosity, transparent, ready to use water repellent material.

**FIELDS OF APPLICATION**  
- On concrete surfaces (beams and tiles of bridge columns, sea structures, exterior surfaces of reinforced concrete buildings, etc.)
- On brick and roof tile surfaces (exterior surfaces of masonry structures)
- On tile surfaces
- On exteriors as water repellent against dusting and efflorescence

**FEATURES AND BENEFITS**  
- **Single part, easy to apply**  
- **Since it is transparent, it does not change the look and color of applied surfaces**  
- **Breathing, water vapor permeable**  
- **Prevents penetration of water to surfaces and acts as a shield against harmful effects of water soluble salts like chlorides**  
- **Superior penetration**  
- **High alkali resistance**  
- **Stops alkali-silicate reactions in the concrete.**  
- **Covers micro cracks up to 0.3 mm width**  
- **High freezing-thawing resistance**  
- **Ministry of Communication**  
- **High freezing-thawing resistance**  
- **Does not contain solvents**

**APPLICATION METHOD**  
MasterProtect® H 1100 is a single part and ready to use material. It must be applied by spraying after making necessary surface preparations. Pressure of the spraying equipment has to be low and a suitable nozzle must be used. MasterProtect® H 1100 must not be atomized during spraying and no brush should be used during the application. Enough material should be sprayed on the surface during the application and wet layers should be observed on surfaces.

**COVERAGE**  
150-300 g/m² depending on surface absorption.

**PACKAGING**  
200 liter barrel

**STORAGE**  
Must be stored in unopened original packing, and in cool and dry environment protected from freezing. In short-term storing, maximum 3 palettes can be stowed on top of each other and delivery has to be according to first in first out system. In long-term storing, the palettes must not be stowed on top of each other.

**SHELF LIFE**  
18 months after the production date under appropriate storing conditions. Opened packages have to be stored by tightly sealing the cover, and must be used in shelf life.

**HEALTH AND SAFETY PRECAUTIONS**  
It is dangerous to apply the product on the following surfaces. During the application, a protective apparel, protective gloves, goggles and masks which comply with the Occupational Health and Safety Rules should be used. Due to the irritation effect of the uncured materials, the mixture should not come into contact with skin and eyes; in case of a contact, the affected area should be washed with plenty of water and soap; in case of swallowing, a physician should be consulted immediately. No food or beverages should be brought to the application area. The product should be stored and kept out of reach of children. For detailed information please consult the Material Safety Data Sheet.

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**APPLICATION PROCEDURE**

**Preparation of Substrate**  
Application surface has to be dry and surface must be cleaned off all kinds of damaged, loose concrete particles, oil, paint, lime, fungus, moss, curing materials, efflorescence, asphalt, etc. traces that can prevent penetration of the material to the concrete. Pressurized water jet or mechanic abrasion methods (sand blasting, shot blasting) may be used for surface preparation. If the application will be made on newly poured concrete, then 26 days must be waited for curing to be completed. Damaged concrete surfaces have to be repaired by MasterEmaco® series repair mortars before MasterProtect® H 1100 application. If there is no sufficient information about pre applied chemicals on the surface, then material should be tested on a small area before application. Plants near application surface should be protected from contacting MasterProtect® H 1100.

**CLEANING OF TOOLS**  
All the tools and equipments must be cleaned by thinner after the application.

**WATCH POINTS**  
- **MasterProtect® H 1100 must not be atomized during spraying and suitable spraying equipment should be used. No brush should be used during the application.**
- **Environment and surface temperature should not be below +5ºC and over +45ºC during the application.**
- **Before the application, 24 to 72 hours must be waited for surfaces to dry after heavy rain or water jet application.**
- **If rain is forecasted in 4 hours, application should not be made.**
- **MasterProtect® H 1100 is delivered in ready to use packages. Solvents or water should not be added to the mixture during the application.**
- **MasterProtect® H 1100 must not be used on non-absorbing surfaces like glass, wood, plastic and metal.**

**Technical Data**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure of the Material</td>
<td>Monomeric Alkylclosilane</td>
</tr>
<tr>
<td>Color</td>
<td>Transparent</td>
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<tr>
<td>Density (KN 517/1)</td>
<td>0.61 kg/liter</td>
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<tr>
<td>Viscosity</td>
<td>0.05 mPas</td>
</tr>
<tr>
<td>Breaking Index</td>
<td>1.4000</td>
</tr>
<tr>
<td>Expansion Point (KN 817R5)</td>
<td>+63ºC</td>
</tr>
<tr>
<td>Boiling Point (KN 517/35)</td>
<td>+188ºC</td>
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<tr>
<td>Application Ground Temperature</td>
<td>-5ºC +45ºC</td>
</tr>
</tbody>
</table>
**MasterBrace® ADH 1406**

(Formerly CONCRESIVE® 1406)

Epoxy Based, Repair and Anchorage Mortar

**FIELDS OF APPLICATION**
- Chemical anchoring in concrete and brick walls
- Repair and insulating of wide cracks
- Bonding of various types of construction materials such as steel, concrete, brick to each other
- Cap seal and entry ports installation in epoxy/polyurethane injection works
- Fixing the guard bars and seismic isolators to the bridges and viaducts
- Anchoring the rods and deformed bars to the concrete, stone or brick

**COVERAGE**
1.7 kg/m² for obtaining 1 mm thick layer.

**PACKAGING**
5 kg set
Part A: 3.75 kg pail
Part B: 1.25 kg pail

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**MasterBrace® ADH 1420**

(Formerly CONCRESIVE® 1420)

Epoxy Based, Flowable Adhesive

**FIELDS OF APPLICATION**
- Bonding freshly mixed concrete and hardened concrete
- Corrosion protection of reinforcement in structural repairs
- Priming the concrete substrates under repair mortars

**COVERAGE**
1.6 kg/m² for obtaining 1 mm thick layer.

**PACKAGING**
5 kg set
Part A: 3.33 kg pail
Part B: 1.67 kg pail

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**MasterFiber® 15 MF**

High Performance Polypropylene Fiber for Plaster and Repair Mortar

**Field of Application**
- Increase the abrasion strength of repair mortar
- Increase the fatigue strength of repair mortar and plaster
- Increase the life cycle of repair mortar
- Increase the toughness (energy consumption capacity) of repair mortar and plaster
- Increase the flexibility of repair mortar and plaster
- Decrease the risk of cracking repair mortar and plaster by using as additive

**Consumption**
For plaster: 900 gr/m²
For repair mortar: 1800 gr/m²

**Packaging**
900 gr pack
**MasterBrace® BAR**

(Formerly MBAR®)

High Strength and High Modulus Carbon Fiber Bars

**FIELDS OF APPLICATION**

MasterBrace® BAR is used in:
- Increasing the flexural strength of the concrete elements
- Increasing the flexural strength of the masonry walls
- Repair of the cracks as tie bars

**PACKAGING**

Pre-cut 6, 12 m bars

**Technical Data**

<table>
<thead>
<tr>
<th>MasterBrace® BAR</th>
<th>MasterBrace® BAR</th>
<th>MasterBrace® BAR</th>
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</thead>
<tbody>
<tr>
<td>800 CFS</td>
<td>1650,00</td>
<td>165,000</td>
</tr>
<tr>
<td>1000 CFS</td>
<td>1850,00</td>
<td>185,000</td>
</tr>
<tr>
<td>1200 CFS</td>
<td>1650,00</td>
<td>165,000</td>
</tr>
</tbody>
</table>

- Elasticity Modulus (N/mm²)
- Tensile Strength (N/mm²)
- Ultimate Tension Load (kN)
- Linear Weight (g/m)

**MasterBrace® FIB**

(Formerly® FIBRE)

High Strength and High Modulus Unidirectional FRP Sheets.

**FIELDS OF APPLICATION**

MasterBrace® FIB 230/50 CFS and MasterBrace® FIB 300/50 CFS (High strength carbon fibre sheets) are used in:
- Increasing the flexural strength of the wooden beams
- Increasing the mechanical strengths of the masonry elements
- Increasing the flexural and shear strength of the concrete beams
- Increasing the flexural strength of the concrete slabs
- Increasing the compressive strength of concrete columns
- Enhancement of the ductility of concrete columns

**Technical Data**

<table>
<thead>
<tr>
<th>MasterBrace® FIB</th>
<th>MasterBrace® FIB</th>
<th>MasterBrace® FIB</th>
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</thead>
<tbody>
<tr>
<td>230 g/m²</td>
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<td>230/50 CFS</td>
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<td>300/50 CFS</td>
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<tr>
<td>Material Type</td>
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<tr>
<td>Elasticity Modulus (N/mm²)</td>
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<tr>
<td>Tensile Strength (N/mm²)</td>
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<tr>
<td>Design Cross Section Thickness (mm)</td>
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<td>0.111</td>
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<tr>
<td>Fiber Weight (g/m²)</td>
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<td>300</td>
</tr>
<tr>
<td>Ultimate Tension Load (kN)</td>
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<td>1.10</td>
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<tr>
<td>Width (mm)</td>
<td>500</td>
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</table>
**MasterBrace® LAM**
(Formerly MBRACE® LAMINATE)

High Strength and High Modulus Unidirectional Pultruded Carbon Fiber Laminates

**FIELDS OF APPLICATION**
- Increasing the flexural strength of the concrete beams
- Increasing the flexural strength of the concrete slabs under heavy machine loads
- Increasing the rigidity of the beams and slabs against bending deformations
- Increasing the flexural strength of the concrete slabs damaged with ventilating channel openings, stairs and elevator holes etc.
- Increasing the flexural strength of the concrete beams and slabs under increased service loads (change of usage etc.)
- Decreasing disturbing effect of the vibrations on the slabs caused by machines

**Technical Data**

<table>
<thead>
<tr>
<th></th>
<th>MasterBrace® LAM 50/1.2 CFS</th>
<th>MasterBrace® LAM 100/1.2 CFS</th>
<th>MasterBrace® LAM 100/1.4 CPH</th>
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</thead>
<tbody>
<tr>
<td>Elasticity Modulus (N/mm²)</td>
<td>165,000</td>
<td>165,000</td>
<td>210,000</td>
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<tr>
<td>Tensile Strength (N/mm²)</td>
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<td>3,000</td>
<td>2,900</td>
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<tr>
<td>Elongation at Break (%)</td>
<td>1.2</td>
<td>1.2</td>
<td>1.4</td>
</tr>
<tr>
<td>Thickness (mm)</td>
<td>50</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Width (mm)</td>
<td>60</td>
<td>120</td>
<td>140</td>
</tr>
<tr>
<td>Cross Section Area (mm²)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MasterEmaco® S 488**
(Formerly EMACO® S88C)

Structural Repair Mortar

**FIELDS OF APPLICATION**
- Structural repairs of deep segregations on reinforced concrete members
- Protection of the concrete against sulphate and chloride attacks
- Repair of the marine structures
- Repair of the underground structures
- Structural and non-structural repairs of high strength concrete elements
- Surface repair of the RC elements before polymer coating applications
- Repair of the tie-rod, test and cone holes

**Consumption**
19.20 kg/m² for obtaining 1 cm thick layer.

**Packaging**
25 kg bag

**MasterFlow® 928**
(Formerly EMACO® S55)

Cement Based Grout Mortar

**FIELDS OF APPLICATION**
- Construction of shear wall caps and column caps
- Fixing of pre-cast concrete elements
- Fixing of the turbines on the foundations
- Fixing of the generators, compressors and pumps on the foundations
- Fixing of the industrial machines on the foundations
- Fixing of the steel columns on the RC foundations
- Filling of the voids in the jacketing applications

**Consumption**
18 kg/m³ for obtaining 10 mm thick layer

**Packaging**
25 kg bag
Note:
Master Builders Solutions by BASF

MasterAir®
Complete solutions for air entrained concrete

MasterBrace®
Solutions for concrete strengthening

MasterCast®
Solutions for the manufactured concrete product industry

MasterCem®
Solutions for cement manufacture

MasterEmaco®
Solutions for concrete repair

MasterFinish®
Solutions for formwork treatment

MasterFlow®
Solutions for precision grouting

MasterFiber®
Comprehensive solutions for fiber reinforced concrete

MasterGlenium®
Solution for hyperplasticized concrete

MasterInject®
Solutions for concrete injection

MasterKure®
Solutions for concrete curing

MasterLife®
Solutions for enhanced durability

MasterMatrix®
Advanced rheology control solutions for self-consolidating

MasterPel®
Solutions for water tight concrete

MasterPolyheed®
Solutions for high performance concrete

MasterPozzolith®
Solutions for water-reduced concrete

MasterProtect®
Solutions for concrete protection

MasterRheobuild®
Solutions for superplasticized concrete

MasterRoc®
Solutions for underground construction

MasterSeal®
Solutions for waterproofing and sealing

MasterSet®
Solutions for set control

MasterTile®
Solutions for tile fixing system

MasterTop®
Solutions for industrial and commercial floors

Master X-Seed®
Advanced accelerator solutions for pre-cast concrete

Ucrete®
Flooring solutions for harsh environments

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