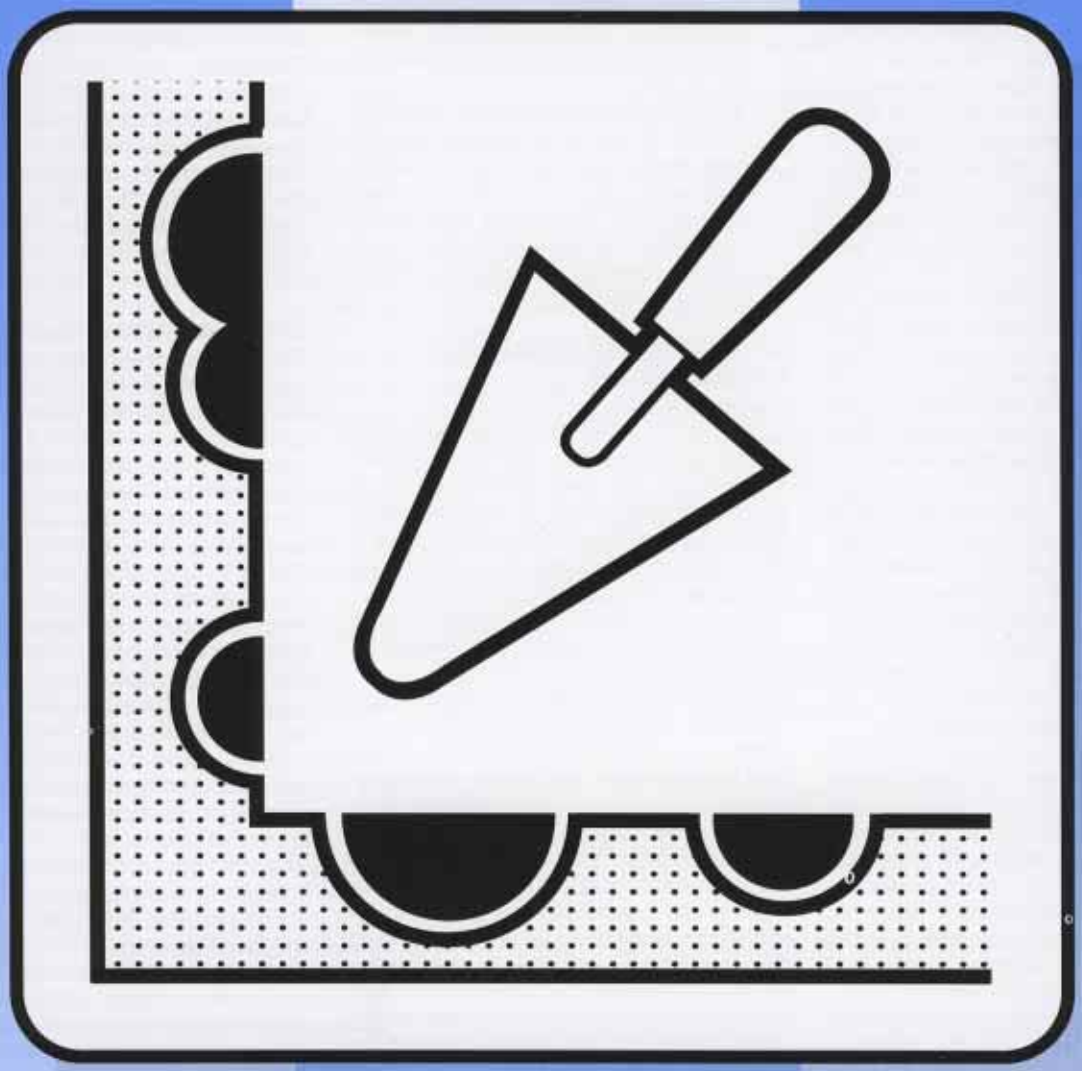
4° Division: damp-proofing plasters for refurbishment and restoration. Water-proofing cements. Shrink - resistant mortars, paints, protective, water-proofing and epoxy coating, water repellent treatments, additives for improved bonding, sealants for joints, adhesives for tiles.



CONCRETE REFURBISHMENT

TECHNICAL SPECIFICATION

index

Problems

CONCRETE DURABILITY

Concrete is without doubt the most widely used building material. This is due to its economy of use, the ease and speed with which it can be worked, its ability to be shaped and moulded which allows work of the most complex nature to be carried out, and the compatibility of concrete with reinforcing steelwork which increases it's mechanical resistance to bending and tensile strength. Concrete was always considered to be a durable material and this belief, combined with its ease of production, has led to poor quality control. Often the most elementary rules have been ignored with the result that concrete has failed to achieve the necessary quality to guarantee long life of the works.

Building regulations and standards specify quality controls guide the designer or planner who, in his turn, must take account of the mechanical characteristics of the structure and the degree to which the work will be exposed to aggressive surroundings. Placing of the concrete must be carried out with some precision in relation to compactness, cover too steelwork, curing, cast concrete, etc.

To this end, the European draft code ENV 206 and Italian UNI 9858, british BS: code of practise 8110 make recommendations on how to achieve long lasting durable concrete. In essence, concrete must be correctly prepared, mixed, placed and cured in order to ensure durability and provide a finish which will be impermeable to water and be resistant to aggressive agents.

It is therefore necessary to reduce to the minimum the porosity of the mixture, reducing the water/cement ratio, this can be achieved by adding super fluidising additives (see FLUXAN technical sheet) which at the same time improve workability and aid correct application. It is also necessary to pay particular attention to the curing of the concrete to increase the degree of hydration of the cement by protecting it from rapid drying with curing agents, anti-evaporants, or by simply constantly dampening using sprayed water or covering with a damp cloth.

CAUSES OF DEGRADATION

Most of the problems that occur with concrete are easily explained and may be summed up in three main factors:

Technological Factor:
Since the 50's the thickness of reinforced concrete sections has been continuously reduced whilst at the same time a fall in site quality control quality has resulted in some very porous and permeable concrete being produced.

Human Factor:
Mistakes in planning, design, detailing, mixing and application often has sever effects.

Atmospheric-Chemical Factor:
Chemical and atmospheric aggression combined, due to carbonisation, sulphates, chloride reaction, frost/thaw cycles, increasing mechanical stress have all resulted in the degradation of porous, permeable and less resistant concretes.

ATMOSPHERIC-CHEMICAL DEGRADATION

Carbonisation

Carbonisation is the most common cause of degradation. The more porous the concrete, the more permeable it is to carbon dioxide (CO_2), to oxygen and to the humidity present in the atmosphere.

This condition does not affect the durability of the concrete matrix but is extremely dangerous for the reinforcing steelwork which is then surrounded by an acid environment.

Due to the lime which is formed by the hydration of the cement, the PH in concrete is normally quite high (PH 12-14) and the steel bars are thereby made chemically passive and are protected from the alkaline surroundings by way of a non-reactive film (passivated layer) of iron oxide which is very adherent and impermeable and prevents further oxidisation.

When the passivated layer which covers the steelwork in concrete is penetrated by carbon dioxide the lime is neutralised by the formation of calcium carbonate which lowers the PH, thereby starting the corrosion of the steel.

$CO_2 + CA(OH_2 \longrightarrow Ca\ CO_3 + H_2O$

The rust which forms due to the oxidisation of the reinforcement produces an increase in volume which creates pressure causing the breakdown of the concrete which covers the steelwork. This results in concrete breaking away and exposing the steelwork (spalling).

The reinforcing rods are exposed to increased corrosion which causes rapid deterioration of the concrete which will, if left untreated, ultimately affect structural stability.

SULPHATE ATTACK

This cause of degradation also occurs frequently in concrete structures which are in contact with sulphates.

The sulphates react with the other chemical compounds present forming chalk, ettringite and thaumasite in accordance with the following chemical reactions:

$Ca\ (OH)_2 + SO_4 = + 2H_2O \longrightarrow Ca\ SO_4 \cdot 2H_2O + 2OH$-(Gesso bi-idrato) .

$CaO \cdot Al_2O_3 \cdot 6H_2O + 3\ (CaSO_4 \cdot 2H_2O) + 26\ H_2O \longrightarrow 3\ CaO \cdot Al_2O_3 \cdot CaSO_4 \cdot 32\ H_20$ (Ettringite)

$CaO \cdot SiO_2 \cdot H_2O + Ca\ (OH)_2 + CO_2 + 11H_2O + CaSO_4 \cdot 2H_2O \longrightarrow CaCO_3 \cdot CaSO_4 \cdot CaSiO_3 \cdot 15\ H_2O$ (Thaumasite)

Because of the formation of these products, expansion takes place which causes fissures in the concrete leading to the eventual breakdown of the concrete mass which becomes unstable because of the formation of thaumasite.

ATTACK FROM CHLORIDES

Chloride ions, in addition to being naturally present in sea water, are also present in the salts used to defrost roads and therefore this can be another important cause of degradation. Chloride ions may also be present in the concrete as a result of contaminated materials having been used during the original construction.

The chlorides bring about a corrosive action on the reinforcing rods by removing the passivated layer of iron oxide which causes further oxidisation.

The sodium chloride may cause alkaline aggregate reaction in the presence of amorphous silica with the formation of an alkaline silicate which swells in humid surroundings, causing damaging fissures from which the typical whitish liquid leaks are noted.

Salt, sodium chloride, is therefore in a position to damage both the reinforcing steelwork and the concrete containing reactive aggregates such as amorphous silica. A similar degrading action is caused by the calcium chloride accelerating agent which in addition to provoking corrosion of the reinforcing steelwork, may react with the calcium hydrate present in the concrete producing calcium hydrate oxychloride with the consequent damaging effect due to increase in volume.

$CaCl_2 + Ca(OH)_2 + H_2O \rightarrow CaO \cdot CaCl_2 \cdot 2H_2O$

FROST-THAW CYCLES

Water acts as a carrier for all the aggressive agents and chemical reactions described. Therefore it is easy to understand the importance of concrete waterproofing. Water can cause serious damage by infiltration through the pores of poor quality concrete. The changes due to frost-thaw cycles, with the formation of ice and consequent increase in volume (approx. 9%) cause repeated pressures which provoke fissures and breakdown in the concrete. An effective way to assist in controlling some of these expansion phenomena (ice formation or calcium oxychloride) can be obtained by introducing into the concrete a controlled quantity of micro air bubbles by using suitable aerating agents.

Technical Specification

RESTORATION AND PROTECTION OF REINFORCED CONCRETE

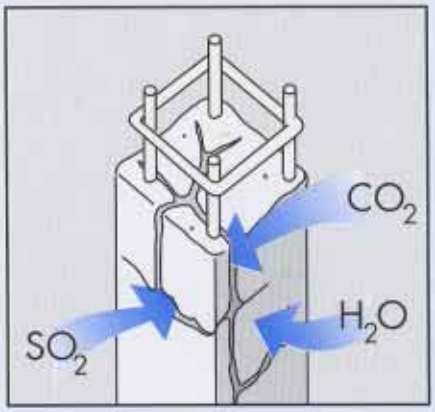
TECHNICAL SPECIFICATION

- Remove old plaster until the concrete surface is found.
- Remove any parts which have become detached, loose and friable by mechanical abrasion; mortar, release oils, dust and dirt in general are removed by sand blasting.
- Any reinforcement present must be cleaned down to bright metal, removing every trace of rust.
- Immediately after cleaning down to bright metal, the reinforcing bars should be treated and protected from further oxidisation with the application of two coats of brush applied fluid mortar made from one part STRATO 4900 and one part cement.
- Restoring the correct concrete cover will be carried out by applying RESISTO TIXO, a shrink-resistant cement mortar which is thixotropic and fibre reinforced. Before application, the surface to be treated should be thoroughly saturated with water.
- Where it is necessary to re-establish thick layers of concrete, a mould or shuttering should be prepared and a RESISTO FLUID treatment used. RESISTO FLUID mortar may be poured and is shrink-resistant and fibre reinforced.
- Any surface irregularities may be smoothed using RESISTO UNIFIX which is an easy to work for cement mortar for improved adhesion.
- The repaired surfaces will then be smoothed by the application of a two-part mortar containing selected inert hydraulic bonding agents and additives with synthetic polymers dispersed in water. This guarantees excellent surface adhesion, impermeability to water and to the aggressive gases in the atmoshpere.
- Finally, the structure must be protected against carbonisation with a suitable protective and decorative paint containing solvent based acrilic resins - INDECOLOR.

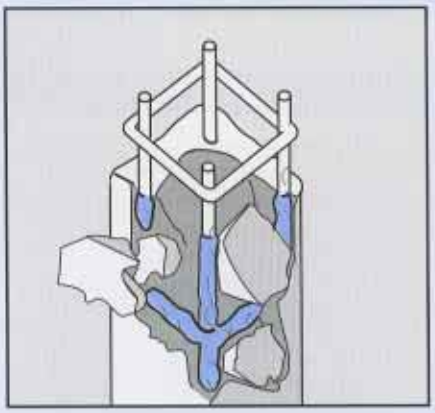
INDECOLOR is impermeable to water and to carbon dioxide but allows water vapour through.

Application may be carried out by brush, roller or spray in at least two coats.

PROBLEM:

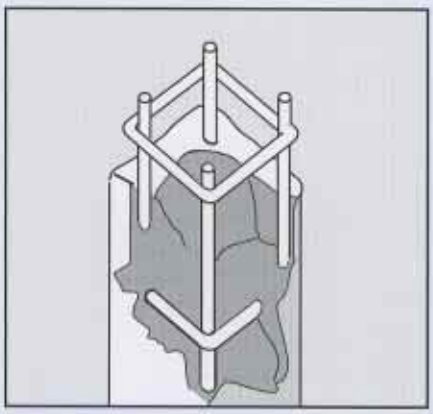


ATTACK BY CHEMICAL AGENTS.

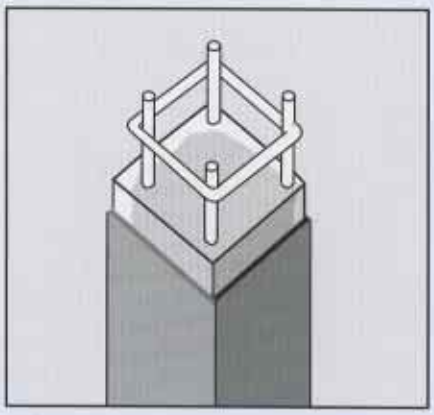


FORMATION OF RUST ON REINFORCING RODS RESULTING IN DETACHMENT OF THE CONCRETE COVERING.

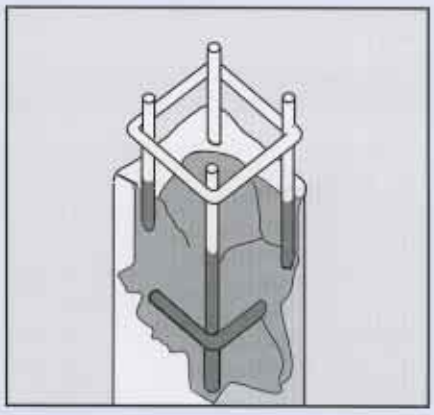
INTERVENTION STAGES:



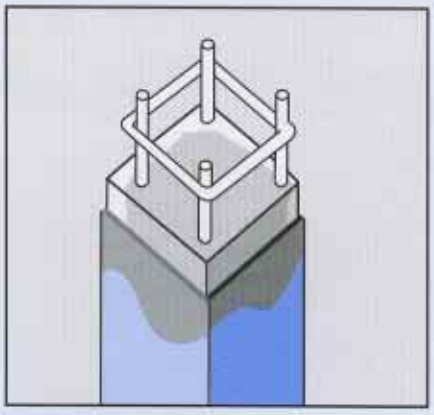
ELIMINATION OF LOOSE PARTS AND CLEANING OF REINFORCING RODS



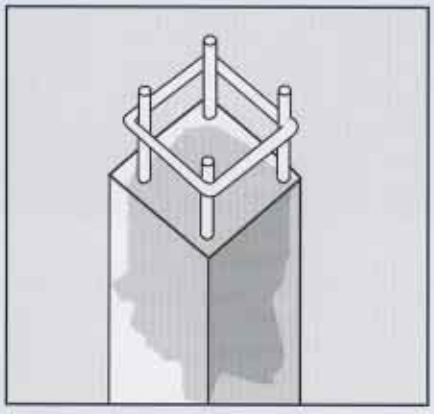
REGULARISATION OF SURFACES USING **RESISTO BIFINISHING**



PROTECTION AND PASSIVATION OF REINFORCING RODS WITH THE USE OF **STRATO 4900**



ANTI-CARBONISATION PROTECTIVE PAINT WITH **INDECOLOR BETON**



RESTORATION OF DAMAGED AREAS WITH **RESISTO TIXO** SHRINK-RESISTANT MORTAR

Grafiche Lauretti - 1000 - 8/96 I

Preliminary work and warning

DEGRADATION ANALYSIS AND PREPARATION OF THE SUBSTRUCTURE

Most attention is usually directed towards the surface layer of concrete structures and to their aesthetic appearance, without thinking too deeply about rebuilding the physical-chemical efficiency of the concrete mass underneath.
Each refurbishment application on concrete structures depends on the correct treatment and preparation of the damaged area. However, before proceeding with any restoration it is necessary to thoroughly investigate the causes of degradation by making an accurate in depth analysis of the degree of degradation in addition to superficial visual inspection.
Localised refurbishment of a limited and superficial nature on degraded concrete structures may not stop the process of degradation. It may result in some cases in stimulating the problem.
The objective of a refurbishment is above all:
- to impede corrosion advancement
- to restore the basic chemically passive condition for the steel reinforcing bars
- to eliminate holes and surface porosity
- to impede the penetration of water into the concrete, so providing a barrier to carbonisation and finally restore the aesthetic appearance of the surface.

Such a degradation analysis is carried out by determining the depth of the carbonisation, the degree of sulphur attack, the thickness of the steel covering, location of hidden fissures and air pockets.
The thickness of the covering over the steelwork can be determined by removing a small area of sound concrete, where it is not already evident because of spalling.
By using a solution of 1% phenolphthalein in ethane (base-acid indicator) we can find out the depth of the carbonisation by observing the colour change from colourless to violet; this is brought about by the change from PH values of 8,5 - 9 (carbonised concrete) to higher values.
Any cavities and associated porosity can be exposed by hammering and sandblasting which completely removes the surface layer of cement paste which hides them.
It is necessary to remove all loose parts by mechanical abrasion.
Traces of oil, release agents, rust and dirt in general must be removed either by strong brushing or high pressure water cleansing.
The carbonised concrete layer must be completely removed in the areas where reinforcing bars are present.
Oxidised bars are cleaned down to bright metal by sanding, eliminating every trace of rust. The following treatment to make them chemically non-reactive should be carried out immediately after the bars have been cleaned down to bright metal to avoid new oxidisation caused by humidity or moisture.
To protect and make rods chemically passive a coating of STRATO 4900 is used with a thin/fluid cement mortar applied by brush.
After the STRATO 4900 protection has dried, the surface should be thoroughly bathed with water, taking care not to create a surface film of water, in preparation for the next phase.
At this point the reconstruction of the concrete covering may be carried out using the shrink-resistant mortars from the RESISTO product range. These materials are user friendly and adhere well which facilitates application; they also possess an elastic modulus and thermal expansion coefficients similar to concrete.
The repaired, regularised surface can then be protected from carbonisation with a decorative paint containing acrylic resins - INDECOLOR.

The Products

STRATO 4900

Styrene butadiene co-polymer dispersed in water, resistant to alkaline and to the action of water. Reinforcing rods are passivated and made chemically nonreactive using STRATO 4900 thin mortar and cement immediately after cleaning down to bright metal.

RESISTO TIXO

A ready-mixed product in powder form, ready to use, containing high resistant cement, selected inert material, synthetic fibres and additives which give excellent handling and adhesion to surfaces. When mixed with water it becomes a thixotropic mortar which is easy to work with. It may be applied vertically achieving quite a thick layer without the need to use a mould.

RESISTO FLUID ANCHOR

A ready-mixed product in powder form, ready to use and contains high resistance damp-proofing bonding agents, selected fillers, expansive agents and various additives. The mortar obtained by adding a small quantity of water is of a fluid consistency and free from inert segregation. It has excellent bonding adhesion both on iron/steel and on concrete. The presence of suitable expansive agents creates shrink-resistance both at the uncured stage and when hardened with the development of high resistance to bending and compression even after a short period. RESISTO FLUID ANCHOR does not contain metal aggregates, chlorides or aluminium dust and it is free from aluminium cement. The excellent flow capacity and controlled expansion guarantee perfect adhesion and the complete filling up of all cavities.

RESISTO UNIFIX

A ready-mixed product in powder form, containing high resistance cement, selected inert material with maximum granulation of 0,5 mm and additives which guarantee excellent handling and surface adhesion. RESISTO UNIFIX is highly thixotropic for thick vertical applications without the need for moulds. RESISTO UNIFIX has an average setting time, high mechanical resistance and elastic modulus which is ideal for repairs. Because of its excellent handling it may also be used for very fine smoothing.

RESISTO BIFINISHING

It is a two-part mortar, the first part is ready mixed in powder form and contains damp-proof bonding agents, selected inert material and additives which improve handling. The second part is in liquid form and contains synthetic polymers dispersed in water. By mixing together the two parts, a ready to use mortar is obtained without the need to add more water to the mix. Because of the high synthetic resin content, excellent adhesion is achieved on concrete surfaces which become impermeable to water and aggressive gas such as C02-S02.

INDECOLOR BETON

A single part paint containing methacrylic solvent based resins. The paint, once dried, forms a film which is impermeable to water but permeable to vapour. It has good resistance to pulverisation, to yellowing, to occasional contact with mineral oils and petroliferous oils. INDECOLOR BETON is used to protect and decorate: concrete façades against carbonisation and atmospheric aggression, concrete flooring (tennis courts), cement fibre slabs (asbestos cement), concrete structures such as bridges, viaducts, tunnels, etc.

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TOTAL QUALITY

For other types of intervention we refer you to Index Technical Specifications

WATERPROOFING WITH LIQUID PRODUCTS

RESTORATION OF DAMP MASONRY BRICKWORK USING DAMP-PROOFING RENDERS

WATERPROOFING UNDERGROUND AREAS USING VAPOUR PERMEABLE CEMENTS

index
Construction Products

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