POLYTECHNIC OF TORINO
FACULTY OF ARCHITECTURE 2
Degree in Architecture
Honors theses

The degradation of concrete between diagnosis and therapy
by Paolo Bona
Tutor: Cesare Romeo

The latter part of the work develops with the experimentation made of two stages that I carried on at Torggler Chimica S.p.A. in Merano. The first stage (autumn 2000), concerns the knowledge of the chemical analyses of lab that are carried out on the building materials. The goal is to establish which elements could be considered the main causes of degradation and to intervene with a reconditioning to eliminate them, if it's possible, and, afterwards, to intervene on the structure with specific degradation-proof materials to protect the future arising of the same damage.
The principal analyses are:

1) *thermo–gravimetry*: the test tube is shattered in dust, is heated up to 900*°C*. Is calculated the quantity of H_2O present in the material;
2) *X–rays diffraction*: it reads the crystals of the test tube and provides with a qualitative response about the material;
3) *Ionic chromatography*: it determines the salts present in a sample. The tool with three standard liquids which contain a known amount of the elements we are looking for, is put at zero. These fluids are: a) 10 *ppm* of Cl^-, $SO_4^=$ e NO_3^-; b) 50 *ppm*; at the end of the setting we proceed to the analysis of the followig prepared samples:
   - grinding of the fragments, a few μm;
   - solubility in H_2O;
   - injection of the liquid in the tool and proceeds of the sought-after value.

The second stage (spring 2001) concerns the knowledge of the physycal and mechanical test carried out on the concrete. Proofs are carried out on different samples such as concrete and plastic mortar made up of three different recipes; normal concrete with H_2O (*w/c*= 0,5) to which are referred other mixtures made with the addition of a superfluidificant additive dosed in percentages of 1% and 2% compared with the weight of the cement, *SF1%* e *SF2%*. The addition of the additive reduces the H_2O present in the mixture, with higher resistances both mechanical and to the drgrading agents. Some interesting tests were also carried out: resistance to the penetration of H_2O under pressure; compression and flexion tests; natural and forced carbonation depht tests; right consistence research examinations and definition of beginning and end of the set. The conclusion of this experience is a didactic reality called *Cantiere–studio* carried out on a five level civil building situated in front of the sea, in Ventimiglia (IM).

The most degradated zones are the irons of the reinforcement that are uncovered for over the 50% of their extension; the corrosion is distributed in a unvaryng way, with light localized reductions of the diameter.

A sampling has been made to carry out chemical analysis (at Torggler Chimica) and single samples were drawn from three different elements; a former series of samples is made of two fragments of concrete lightened with expansible clay which was drawn from the parapet of the sea front balcony, the second series of samples is drawn from the parapet of the western lateral balcony; finally the last sample is a portion of the cover of the iron drawn from an intermediate zone between the two balconies.

Chemical analyses were required to verify carbonation depth, and a qualitative and quantitative research on the salts present into the material.

The analyses results have shown the complete carbonation of the cover of the iron and a negligible amount of Cl^-, $SO_4^=$ e NO_3^-, with the exception of the sea front parapet, invested by the marine air. The main cause of degradation is the presence of a very porous concrete, not the penetration of salts. According to the results, to have a correct restoration of the building, epox resin materials to protect the irons, reinforced mortar with resins in dispersion to integrate the missing portions and a transparent pictoric acrylic pellicle to create a protective barrier against the degrading agents are recommended.

For further information, e-mail: le.modulor@libero.it