# Some procedures for concrete rehabilitation

# Some Procedures for Concrete Rehabilitation

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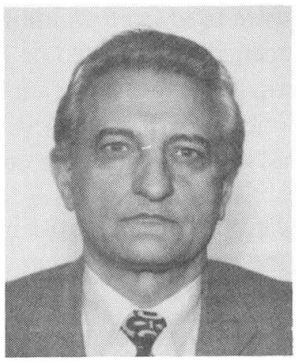

Corneliu Bob, born 1939, received his civil engineering degree from University "Politehnica" of Timisoara in 1962 and PhD in 1970. He is currently professor of Reinforced Concrete Structures and head of the National Research Institute INCERC- Timisoara branch. He published many papers and some books on various aspects of civil engineering.

## Summary

The paper presents the deterioration of the different reinforced and prestressed concrete elements, the causes of deterioration and the procedures for rehabilitation. The existing buildings with reinforced concrete structures analyzed in the paper are: inside of cloak rooms (reinforced beams, reinforced strips); industrial hall (columns and foundations); inside of a textile factory (prestressed beams, strip with hollows, open caissons); water tower (conical roof); ground beam for travelling crane; bridges, power-line towers.

## 1. Introduction

The necessity to maintain and preserve the existing reinforced concrete structures in Romania is recognized, mainly, as economic good sense. This reason is due to the great number of such structures and of the low quality of concrete in some of the existing reinforced concrete structures. The durability of concrete structures depends both on the resistance of the concrete against physical and chemical attack and on its ability to protect embed steel reinforcement against corrosion.

During the last years the author has examined a lot of reinforced concrete structures with different durations of service life and some deteriorations of component parts. The deterioration of the reinforced concrete elements, the causes of degradation and specific procedures are presented.

## 2. Procedures for concrete rehabilitation

The procedures for concrete rehabilitation have been chosen in function of the causes of deterioration, the position of the elements in the structure, the detailing of elements, the available technology, the cost of rehabilitation etc. The main used procedures for reinforced concrete elements are presented below.

**Cloak room elements**. The deterioration causes of the reinforced beams and strips are: the presence of the intermittent humidity (RH>75%) and low quality concrete (17.5 N/mm$^2$ for the reinforced beams and 15.3 N/mm$^2$ for the reinforced strips). After 23 years of using, the carbonation depth was over 40 mm, from both theoretical and experimental determinations; the corrosion of main reinforcement was observed on a large area of the cross section. The methods of rehabilitation used for the beams and strips are presented . The strengthening consists in using the new reinforcements placed on the bottom part: close and welded at the two ends to the old reinforcement for the reinforced strip; space lattice with new stirrups for the reinforced beams.

**Industrial hall** has presented serious deterioration at the inferior part of the reinforced concrete columns which have had the main reinforcement corroded due to the intermittent humidity. On the other hand the structure was not well designed to the seismic actions in the transversal direction. The rehabilitation consists in erection of new reinforced concrete frameworks with bigger side spans and in the repairing of the former columns placed between the new frameworks.

**Textile factory** was examined due to special conditions existing inside the hall: intermittent and high humidity, presence of chlor ions, high temperature. Three structural elements have been investigated: prestressed beams, strips with hollows and open caissons. From these elements only open caissons have presented a serious corrosion of main reinforcement caused by actions of both carbonation and chloride penetration. New types of open caissons with high quality of concrete and bigger concrete cover have been used instead of the damaged elements.

**Water tower** is of 500 m$^3$. The reinforcement in the radial direction of the conical roof has presented significant corrosion due to: insufficient concrete cover and high humidity. The final solution, chosen for rehabilitation, was the use of eight pairs of channel iron profiles U of 120 mm (the height of the cross section). These profiles have to prevent the development of the possible yield lines caused by the positive bending moment in the conical roof.

**Ground beams for travelling crane** have presented very dangerous soil settlement (0 to 400 mm) under the weight of coal storage and travelling crane. The strengthening has been performed by erection of two types of over concreting with variable height and reinforcement.

**Other elements** as bridges, water cooling towers, power-line towers have been examined and specific procedures of rehabilitation were proposed. The reinforced concrete beams of an 80 years old bridge in Timisoara were also tested. The corrosion of the reinforcing steel was very large so that the strength and rigidity of the bridge beams were much diminished; this bridge was demolished and rebuilt. Some prestressed concrete columns, used for open-air transmission line, were fractured after a few years of use because of reinforcement corrosion: low quality of concrete and insufficient concrete cover. New power-line towers have been used.

## 3. Conclusions

The procedures for the concrete rehabilitation have to follow two main steps:

- The first step is a theoretical and/or experimental analysis for obtaining the data concerning the nature and the magnitude of the damages existing into the elements of a structure.
- The choice of the rehabilitation design for the building structure in order to obtain a low cost, good safety and durability, available technology etc. is an engineers main duty.