

1.14.16. A STATISTICAL STUDY FOR THE CORRELATION OF NON-DESTRUCTIVE TESTING AND DESTRUCTIVE TESTING ON STRUCTURES IN CONCRETE

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Introduction. There is often a need to evaluate the in place strength of concrete in existing structures for an accurate assessment of their structural capacities.

A study was carried out on a building in concrete (Punta Perotti in Bari, Italy) before its demolition. Punta Perotti, exposed for more than ten years to aggressive environmental conditions (near the sea and in a windy area), was selected to study the life cycle of the materials. About 180 cores (10 cm diameter) were taken from the pillars at six different floors after a previous non destructive testing campaign (mainly ultrasonic and rebound hammer tests) made on the same stations. European (EN 13791) standard and USA (ACI 228) guide lines were followed for in situ measurements and data analysis. The possible correlations between non destructive testing (NDT) and compressive strength (DT) of cores are analysed with an exhaustive statistical approach and a new method to improve correlation results is proposed.

Basic results. A preliminary study involving the analysis of the NDT-DT measurements has shown that:

- there are not meaningful differences between the values of velocity and strength of the same pillar of the same floor taken at different height whereas there are significant variations of the compressive strength and of the ultrasonic velocity in the concrete versus the analysed floors;
- it was verified that there is not a meaningful difference between the measurements of ultrasound velocity carried out in situ on the pillars and the ultrasound measurements carried out in laboratory on the cores with same ultrasound instrument;
- the application of the correlation methods to evaluate the compressive strength in function of the ultrasonic pulse velocity or both ultrasonic pulse velocity and rebound number has suggested, for this situation, to use the correlation in function solely of the ultrasonic pulse velocity.

Using these data for each floor of the building, a statistical analysis was performed by considering all the possible combinations of 10 test stations measurements (decuples) selected on 10 different pillars.

This study was carried out to understand the possible implications in the measurements of concrete strength of the structure due to the arbitrary choice of the test station from the technician. The number of the possible combinations for each floor is reported in table 1.

Discussion of results. The correlation curves obtained following the standards EN 13791:2007 and ACI 228.1R-03 for the floors –1 and 2 are reported in fig. 1 and fig. 2.

An exhaustive analysis of all the possible decuples of cores (table 1) was carried out in order to verify the hypotheses of pre-selected zones on which to carry out the cores. In this way it was evaluated the behaviour of the regression curves – compressive strength versus ultrasonic pulse velocity – on all the available decuples of cores with respect to the regression curve on all the data of the floor.

Table 1. Data distribution on different floors

Floor	Number of cores	Number of cored pillars	Number of decuples
-1	47	18	269.034.631
0	14	10	16
1	18	10	256
2	56	20	3.348.291.335
3	19	11	1.792

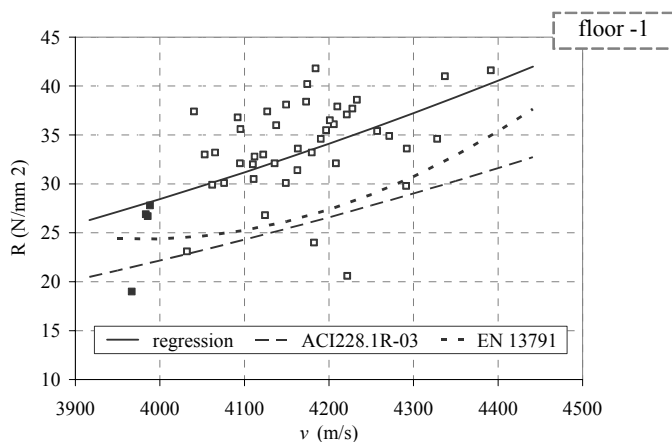


Fig. 1. Comparison between ad hoc regression curve, EN 13791:2007 and ACI 228.1R-03, for the floor -1

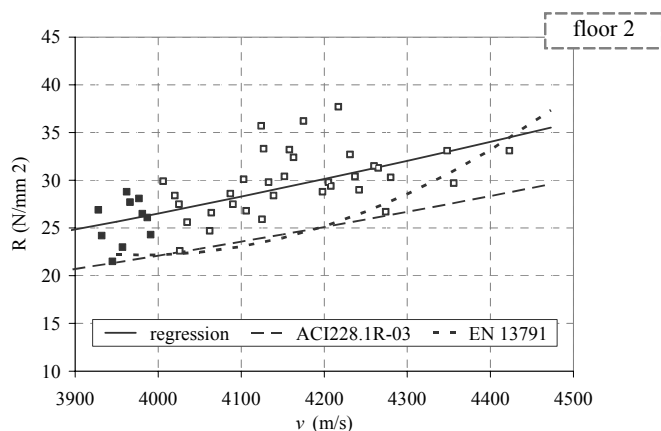


Fig. 2. Comparison between ad hoc regression curve, EN 13791:2007 and ACI 228.1R-03, for the floor 2

The results of the analysis demonstrate that, with a previous campaign of non destructive testing and an accurate statistical analysis of the results, it is possible to improve of 3% the probability to obtain correlation curves representative with the selected decuples.

Moreover following this new method and analysing the data using the technique of the statistical similarity of the ultrasonic velocity distribution, the risk to have cases of regression curves not representative of the state of the concrete structure under consideration can be reduced.

Summary. A wide campaign of non destructive and destructive tests on the same structure (Punta Perotti, Italy) was carried out in order to study a methodology to built up a better correlation curve to define the mechanical strength of the concrete.

The main goal of this research work is to support the designer to assess the reliability of an existing structure, without having a complete knowledge of its condition, in the choice of the best position in which to extract the cores. To reach this goal a statistical approach was used.