

ESTIMATION OF THE IN-SITU CONCRETE STRENGTH: PROVISIONS OF THE EUROPEAN AND ITALIAN SEISMIC CODES AND POSSIBLE IMPROVEMENTS

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ABSTRACT

Evaluation and possible retrofitting of existing RC buildings require specific procedures being set up. Many seismic codes have been developed with reference to this topic around the world. In Europe, Eurocode 8 – part 3 is specifically devoted to this subject. Investigations have a crucial role to adequately know the structures to be subjected to evaluation. For this reason, there is an increasing need to put at disposal sufficiently reliable as well as not very expensive methods to estimate in-situ material properties. The results presented in the paper confirm that a suitable combination of Non Destructive and core tests provides an effective solution from both the economical and technical point of view. Further, based on the experience deriving from widespread in-situ and laboratory experimental investigations, some possible improvements of the current code provisions are given. Finally, an outline of future research developments is provided.

KEYWORDS

RC structures, assessment, Eurocode 8, concrete strength, in-situ tests.

1 INTRODUCTION

A large quantity of Reinforced Concrete (RC) buildings both private and public, now placed in seismic zones, were originally designed taking into account only gravity loads and without explicitly provide ductile detailing. Evaluation and possible retrofitting of such buildings require specific procedures being set up, where investigations have a crucial role to get an adequate knowledge of the structure to be evaluated. Many seismic codes have been developed with reference to this topic around the world, e.g. FEMA 356, (2000) in the United States and the 2006 Recommendations NZSEE, (2006) in New Zealand. In Europe, Eurocode 8 – 3 (CEN, 2005) is specifically devoted to this subject, to pursue the following main objectives:

- to provide criteria for the evaluation of the seismic performance of existing individual building structures;
- to describe the approach in selecting necessary corrective measures;
- to set forth criteria for the design of the retrofitting measures (i.e. conception, structural analysis including intervention measures, final dimensioning of structural parts and their connections to existing structural elements).

Structural evaluation and possible structural intervention of existing structures are typically subjected to a different degree of uncertainty (level of knowledge) than the design of new structures. Different sets of material and structural safety factors are therefore required, as well as different analysis procedures, depending on the completeness and reliability of the information available. To this purpose, codes require that a knowledge level (KL) is defined in order to choose the admissible type of analysis and the appropriate confidence factor (CF) values in the evaluation. The design strength to be used in the safety verifications is computed on the basis of the mean value obtained from tests and other additional sources of information, divided by the achieved CF value. Among the factors determining the KL, there are the mechanical properties of the structural materials. In RC structures, the compressive strength of concrete has a crucial role on the seismic performance and is usually difficult and expensive to estimate. Reliable procedures to take into account the factors influencing the estimation of in-situ concrete strength, particularly in case of poor quality concrete, are not currently available. According to various codes (e.g. CEN EC8-3, 2005; ACI 228, 1998) estimation of the in-situ strength has to be mainly based on cores drilled from the structure. However, non-destructive tests (NDTs) can effectively supplement coring thus permitting more economical and representative evaluation of the concrete properties throughout the whole structure under examination. The critical step is to establish reliable relationships between NDT results and actual concrete strength. The approach suggested in most codes (e.g. in CEN EC8-3, 2005) is to correlate the results of in-situ NDTs carried out at selected locations with the strength of corresponding cores. Thus, NDTs can strongly reduce the total amount of coring needed to evaluate the concrete strength in an entire structure. In this paper the characteristics of the most usual methods (core testing, rebound number, ultrasonic pulse, ...) has been shortly examined. Particularly, the combined Sonreb method has been described, and a specific procedure to estimate concrete strength has been proposed. Further, the provisions reported in some seismic codes to achieve information on mechanical properties and conditions of concrete are described. Based on the results from experimental in-situ or laboratory programs carried out on existing building structures designed only for gravity loads, the variability of in-situ concrete strength for populations of RC structures and within single structures has been examined, thus providing some provisions (number and type of test, locations for sampling, etc.) to get the better knowledge of in-situ strength.

2 STRENGTH ESTIMATION IN EUROPEAN AND ITALIAN SEISMIC CODE

Three knowledge levels are defined in both European (CEN EC8-3, 2005) and Italian Code IC (Ministero delle Infrastrutture, 2008, 2009), that is limited, normal and full knowledge, in order to choose the appropriate CF values in the evaluation. A certain knowledge level regarding material properties can be obtained complementing test results and information derived from standards at the time of construction or provided by original design specifications or test reports. When the test results do not confirm such information a higher level of testing is required (e.g. from limited to extended) and the available information has to be given up. This consideration is not clearly stated both in the EC8-3 and in the Italian Code. While in the EC8 it is specified when a limited knowledge is pursued, this does not happen for the KL2; the contrary happens in the IC. Particularly, EC8 specifies that:

- *“KL1 (Limited knowledge): ... default values should be assumed according to standards at the time of construction, accompanied by limited in-situ testing in the most critical elements. ... However, if values from tests are lower than default values according to standards of the time of construction, an extended in-situ testing is required.*

- *KL2 (Normal Knowledge): information on the mechanical properties of the construction materials is available either from extended in-situ testing or from original design specifications. In this latter case, limited in-situ testing should be performed.*
- *KL3 (Full Knowledge): information on the mechanical properties of the construction materials is available either from comprehensive in-situ testing or from original test reports. In this latter case, limited in-situ testing should be performed.”*

Experience shows that information from original design specifications or test reports have usually poor reliability when related to concrete properties, thus strength estimation shall be always based on, or at least complemented by, testing. For this reason, using the term “should” in these circumstances, seems inappropriate and substitution with the term “shall”, or at least “have to”, is suggested. An analogous consideration can be made as for the use of non destructive testing in estimating concrete properties. EC8 specifies that: “*Use of non-destructive test methods (e.g., Schmidt hammer test, etc.) should be considered; however such tests should not be used in isolation, but only in conjunction with destructive tests (i.e. tests on material samples extracted from the structure)*”. On the contrary, experience clearly shows the need that NDTs shall be always used in conjunction, as clearly stated in IC. The classification of the levels of testing is dependent on the number of material samples per floor that have to be taken for testing. For ordinary situations the recommended minimum values in EC8 are given in Table 1.

Table 1. Recommended minimum requirements for different levels of testing.

| Level of testing | For each type of primary element (beam, column, wall) |
|------------------|---|
| | Material samples per floor |
| Limited | 1 |
| Extended | 2 |
| Comprehensive | 3 |

In the IC the same requirements are recommended, but there is a specification relating the minimum number of samples to the dimensions of the structure, that is a floor area equal to 300 m², beyond which such minimum number needs to be increased. Further, to effectively apply the rigid provisions of Table 1, IC explains that recommended requirements have to be considered as reference values to be adapted to each single particular case, also providing some directions. These directions derive from a widespread experience in estimating concrete properties, thus their use could be suggested also in the EC8-3.

3 REVIEW OF TESTING METHODS

In-situ concrete strength can be estimated through non-destructive (NDT) and destructive methods. The most widespread methods for existing buildings include core testing, rebound number, ultrasonic pulse velocity, combined non destructive methods. Specifications to use core testing are given in several standards (e.g. in Italy UNI EN 12504, 2002). Although core testing is the most direct and reliable method to estimate concrete strength in a structure, it has to be taken into account that there are many differences between the strength measured on core specimens and the actual in-situ strength. The main factors are the size and geometry of the cores, the coring direction, the presence of reinforcing bars or other inclusions, the effect of drilling damage. To this purpose, a relationship to convert the strength of a core specimen f_{core} into the equivalent in-situ value f_c is given in (Dolce *et al.*, 2006):

$$f_c = (C_{H/D} \cdot C_{dia} \cdot C_a \cdot C_d) \cdot f_{core} \quad (1)$$

where:

- $C_{H/D}$ = correction for height/diameter ratio H/D, equal to $C_{H/D} = 2/(1.5 + D/H)$;
- C_{dia} = correction for diameter of core D, equal to 1.06, 1.00 and 0.98 for D, respectively, equal to 50, 100 and 150 mm;
- C_a = correction for the presence of reinforcing bars, equal to 1 for no bars, and varying between 1.03 for small diameter bars (ϕ 10) and 1.13 for large diameter bars (ϕ 20);
- C_d = correction for damage due to drilling.

The correction coefficient C_d asks for a particular attention: whereas constant value equal to 1.06 is suggested in ACI, 2003, in the technical literature also $C_d = 1.10$ is proposed provided that the extraction is carefully carried out by experienced operators. However, taking into account that the lower the original concrete quality the larger the drilling damage, it appears more suitable to put $C_d = 1.20$ for $f_{core} < 20$ MPa, and $C_d = 1.10$ for $f_{core} > 20$ MPa, as suggested in Dolce *et al.*, 2006. More recent results are provided in Masi, 2008, where the possible reduction amount of core specimen strength due to drilling damage has been examined on the basis of a wide experimental database, thus providing more accurate correction coefficients.

Rebound number and ultrasonic pulse velocity methods are quick and little expensive. Specifications to apply them in concrete structures are given in several standards (e.g. in Italy UNI EN 12504-2, 2001; UNI EN 12504-4, 2005). Rebound number test consists in measuring the rebound distance of a plunger pulled by a spring against the surface of the concrete specimen. Because the test investigates only the surface layer, the result may not represent the interior concrete. For example, the carbonation process typical of old concretes heavily affects the rebound numbers, providing high values, which do not correspond to actually high strengths. Ultrasonic test requires the determination of the velocity of propagation of ultrasonic longitudinal waves in concrete, using two transducers placed at a known distance, and then correlating this value to the concrete properties by using curves provided with the test device or in other references (e.g. Masi, 2008). Really, the correlation may be affected by a number of factors, such as the water/cement ratio, the moisture content, the presence of reinforcement, the age, etc. For this reason a general correlation cannot be proposed, but the specific characteristics and conditions of the concrete under test have to be taken into account, as recommended by several international standards (e.g. ACI standard 228.2R-98, 1998). On the contrary, ultrasonic method is particularly suitable for the detection of local defects (voids, cracks, etc.). Measurements can be made by placing the two transducers on opposite faces (direct transmission), on adjacent faces (semi-direct transmission), or on the same face (indirect or surface transmission) of a concrete structure or specimen.

Combined non destructive methods are treated in the RILEM NDT4, 1993, recommendation. They aim to increase the accuracy of the estimation, compared with that from any single method. SONREB method, based on the combination of ultrasonic pulse velocity V and rebound number S measurements, is the best known and widely used of combined methods. In RILEM NDT4, 1993, iso-strength curves for a reference concrete are suggested, where the compressive strength can be estimated by knowing the rebound number and pulse velocity values. When estimating the strength of a specific in-situ concrete, in order to improve the accuracy of prediction, a number of correction coefficients that allow for the differences in composition compared to the reference concrete, have to be evaluated and applied to the iso-strength values. These coefficients of influence take into account differences in cement type and content, aggregate types and size, presence of admixtures. In practice it is very rare to

know the composition of the concrete under test, thus a total coefficient of influence needs to be estimated by using the results of some core tests.

4 ASSIGNATION OF CONCRETE STRENGTH

NDTs are not satisfactory methods to estimate concrete strength, unless their results are correlated to core tests. On the contrary, they can be effectively used as a means to determine the uniformity of concrete properties in a structure. In estimating in-situ concrete strength some statements needs to be preliminarily made:

- a) core tests are as more reliable as more intrusive and expensive they are, but only a limited number of them can be carried out in practice; this results in estimates which can be not representative of the in-structure property variations;
- b) on the contrary, NDTs are very simple and little expensive, but they provide unreliable predictions of concrete strengths;
- c) a suitable combination of cores and non destructive tests is the best solution, providing as much reliable estimates as widespread tests are made all over the structure.

In the RILEM NDT4, 1993, standards a procedure based on the determination of a total coefficient of influence is proposed to correlate non destructive and destructive test results. An alternative procedure can be used to obtain a relationship between the in-situ strength f_c and the NDT measurements, based on the following equation:

$$f_c = a \cdot S^b \cdot V^c \quad (2)$$

where the coefficients a , b and c are experimentally derived for the specific concrete under test. The first step is the execution of a non destructive testing program in N_{NDT} points, aimed at verifying the homogeneity of the concrete under examination. In such a way the possible presence of portions of structure representing different concrete batches can be acknowledged. After, in a limited number of points $N_{\text{core}} \subset N_{\text{NDT}}$, randomly selected between each homogeneous portion, some cores are extracted and after tested in laboratory to evaluate their cylinder compression strength f_{core} . Core test values are then converted into the equivalent in-situ values f_c by using Eq. (1). Finally, a multivariable regression is performed to compute the values of coefficients a , b and c providing the best correlation between destructive and non destructive results, i.e. the Eq. (2) specifically applicable to the concrete under examination. By applying the obtained Eq. (2), the in-situ concrete strength f_c also in points where only non destructive measurements were made can be estimated, thus permitting to determine design strengths in a more representative and reliable way.

5 REVIEW OF EXPERIMENTAL RESULTS

In this section the results of some experimental campaigns are reported and discussed. The main objective is to investigate the variability of the in situ concrete strength for populations of structures and within individual structures. Further, criteria for planning in-situ test programs and analysing their results are discussed.

Firstly, the main results from a wide experimental campaign carried out on the structures of school and hospital buildings in the framework of a seismic vulnerability evaluation program in Basilicata region, Italy, are reported. The buildings under examination were designed and constructed in the period '40s – '90s, taking into account only gravity loads, according to old Italian codes in effect in the period. Working on more than 200 RC buildings, about 3600

NDTs (rebound number, ultrasonic velocity) and more than 800 core tests have been globally carried out on both column and beam members of the structures. The work is currently in progress then in the next years more data will be available.

Analysis of test results on the entire population of buildings show mean values of $f_{c,core}$, as converted in the equivalent in-situ strength f_c through the Eq. (1), equal to 22.8 MPa and relatively high values for the rebound number S (mean value=36) and the ultrasonic velocity V (mean value=3519 m/s). High values of the coefficient of variation (CV) relevant to core strengths (equal to about 46%), while a lower variability of S and V values (CV=17% for both S and V) has been found (table 2 and figure 1).

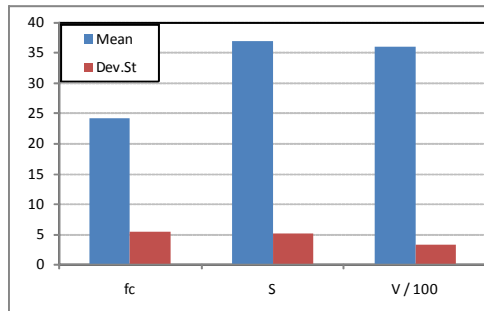


Figure 1.

| | f_c (MPa) | S | V (m/s) |
|-------------|----------------|------|--------------|
| N. of tests | 846 | 1647 | 2009 |
| Mean value | 22.8 | 36 | 3519 |
| Dev.St | 10.6 | 6 | 614 |
| CV | 46% | 17% | 17% |

Table 2.

Being available the period of design and construction of the buildings in the dataset, test results have been examined separately for 4 periods, whose interval has been identified on the basis of significant modifications in design or construction practice in Italy. The results show that in-situ concrete strength is remarkably dependent on the period of construction. Mean values of f_c are in good accordance with the expected values relevant to the standards of the time of construction (table 3). Dispersion of values is variable with the considered construction period, even though CV values are averagely high, being not lower than about 35% in the periods 1946-1960 and 1982-1991. In figure 2 the frequency distributions of the in-situ strength values have been compared with the mean default values $f_{cm,def}$ assumed for the various construction periods. Generally, the mean value of the measured in-situ strength is greater than the mean default strength.

Table 3. Main statistical values of f_c in various construction periods.

| Construction period | $f_{cm,def}$ (MPa) | f_c – Mean value | | | |
|---------------------|-----------------------|--------------------|-------|-------------------------|-------------------|
| | | N. of tests | (MPa) | f_c – Dev.St (MPa) | f_c – CV (%) |
| '46÷'60 | 12-16 | 93 | 16.74 | 5.67 | 33.8 |
| '61÷'71 | 16-20 | 361 | 21.47 | 9.65 | 44.9 |
| '72÷'81 | 20-24 | 261 | 25.54 | 12.05 | 47.2 |
| '82÷'91 | 24-28 | 109 | 25.37 | 9.08 | 35.8 |

As for the dependence of mean strength values from the type of structural element where cores have been extracted, significant differences were not found between columns and beams, as reported in table 4. It is worth noting the large difference in the number of tests available for either columns or beams, demonstrating that cores are typically extracted from columns. Both technical reasons, that is columns are considered more important in

determining the seismic resistance, and practical difficulties, particularly in case of embedded beams, give rise to that large difference.

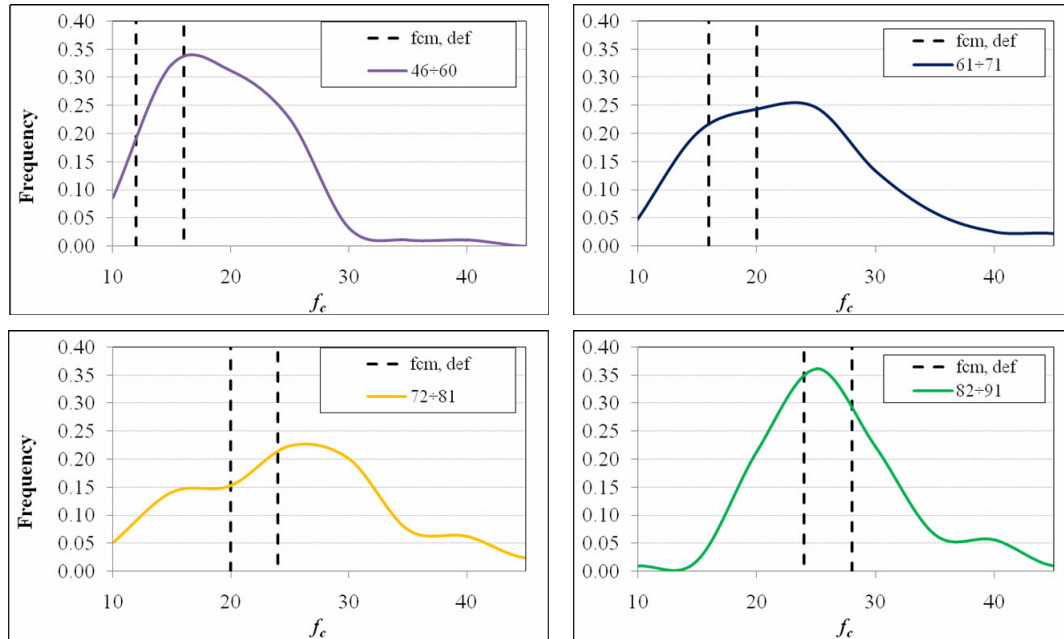


Figure 2. Distribution of in-situ strength values f_c vs mean default values $f_{cm,def}$ [MPa] in various construction periods.

Table 4. Main statistical values of f_c in beam and column elements.

| Type of structural element | N. of tests | f_c – Mean value (MPa) | f_c – Dev.St (MPa) | f_c – CV |
|----------------------------|-------------|--------------------------|----------------------|------------|
| Beams | 78 | 22.87 | 10.64 | 47% |
| Columns | 767 | 22.21 | 9.76 | 44% |

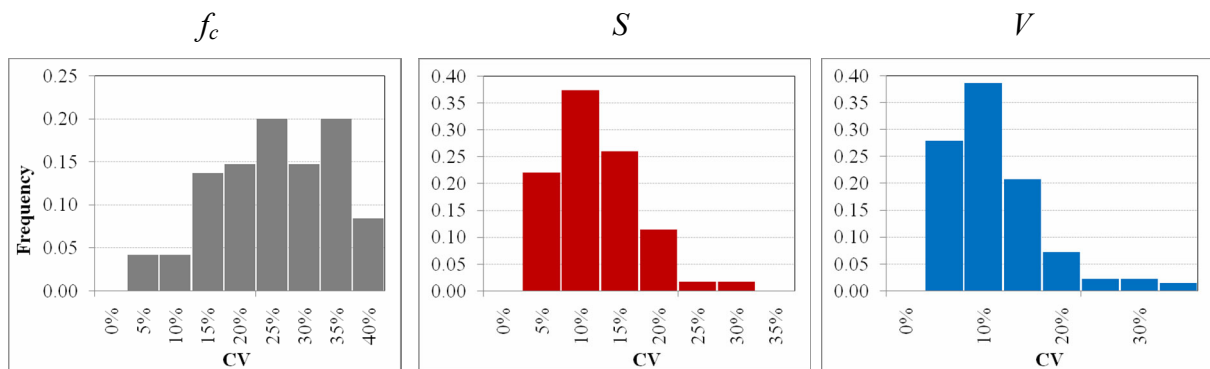


Figure 3. Distribution of CV values for core test and NDT results computed within individual buildings.

In the following, the test results within individual buildings are examined. Analysis of results shows a large scatter of the strength values from cores extracted by the same building, while lower scatters have been detected for the NDT results, as already found in previous investigations (Masi *et al.*, 2008). In fig. 3 the frequency distributions of the CVs calculated with regard to each building are displayed. CV relevant to core strengths is strongly variable

and its more probable values range between 15-35%. As for NDTs, more probable CV values are in the range 5-15% for both rebound and ultrasonic velocity measurements.

Some scatter in the test results is unavoidable, given the inherent randomness of in-place concrete properties and the additional uncertainty attributable to the preparation and testing of the specimens. Scatter of the in-situ concrete properties, and specifically of strength, within a single structure can be caused by some factors, among which: (i) random variation of concrete properties, both within one batch and among batches; (ii) systematic variation of in-situ properties along a member or throughout the structure.

To better understand such issue, the results of an experimental program (carried out at the Laboratory of Testing Materials and Structures of the University of Basilicata) on RC members extracted by existing old structures designed only for gravity loads, are shortly described. More details on the experimental program and obtained results are reported in (Dolce *et al.*, 2006; Masi *et al.*, 2008). Experimental data show a low variability of rebound number and direct velocity values. On the contrary, as a consequence of the microcracking condition due to past applied loads, a high variability was detected for drilled core strengths. Really, cracking due to flexure (perpendicular to the member axis) can affect core strength, provided that cores are usually extracted perpendicularly to the member axis. On the other hand, transverse cracking does not affect the velocity measured by direct transmission (wave direction parallel to the crack plane). Further, the procedure to estimate the in-situ concrete strength based on the Sonreb method (see section 3) has been applied to the experimental data and has been compared with other procedures given in the literature showing its higher efficiency (Masi *et al.*, 2008).

6 POSSIBLE IMPROVEMENTS OF CODE PROVISIONS

Analysis of the experimental results on the in situ concrete strength reported in this paper enables to make some remarks and to suggest some possible improvements of the current code provisions.

Investigation programs have to be planned taking into account a “milestone”: core tests are unavoidable but their amount should be limited as much as possible. In fact, core tests are generally more expensive than NDTs and, chiefly, cause damage on structural elements. In some cases such a damage can determine a remarkable reduction of the load bearing capacity of the structures under investigation, immediately after the extraction and also after restoration interventions if badly performed (Masi and Vona, 2009b). For this reason, underlying again that core tests are necessary to directly estimate in-situ concrete strength, the number and location of cores needs to be accurately defined. Keeping in mind such objective, some suggestions can be given in planning and performing investigations relevant to the following steps:

- definition of concrete portions to be separately investigated (concrete areas having homogeneous properties);
- amount of testing (minimum number of samples and measurements);
- location of sampling;
- assignation of concrete strength value for safety evaluations.

Definition of concrete areas having homogeneous properties

Recommended requirements regarding testing of concrete provide minimum sample numbers per floor and per primary element (see table 1). Experimental evidence shows that the variability of the in situ concrete strength cannot be dependent on the specific floor and type

of element. In real buildings one or more concrete areas showing homogeneous properties, that is having sufficiently low values of the CV relevant to strength values, can be defined. These areas can be effectively identified through non destructive measurements carried out along the building floors and elements and, after, core tests can be referred to there areas, as shown in Masi and Vona (2009a). Specifically, homogeneous areas can be identified on the basis of the mean values of NDT results achieved in the various building floors. Tentative values of the number of NDTs to be performed in identifying the homogeneous areas are suggested in Table 5. NDTs need to be adequately distributed among all the primary elements. It is advisable to performing at least 30-40% of total measurements per floor in each different type of structural element.

Table 5. Minimum number of NDTs tentatively suggested in identifying homogeneous concrete areas.

| Level of testing | Per each floor | |
|------------------|------------------------|--|
| | Minimum Number of NDTs | Percentage of NDTs (on the total N. of primary elements) |
| Limited | 6 | 8% |
| Extended | 8 | 12% |
| Comprehensive | 10 | 15% |

Amount of testing (minimum number of samples and measurements)

Within the homogeneous areas defined on the basis of the NDT results, the amount of cores to be extracted is dependent on the knowledge level to be achieved, as well as on the number and reliability of other additional sources of information. In order to have a minimum number of values to calculate a mean strength value and to make possible the application of the combined Sonreb procedure as explained in section 3, it appears necessary that the at least 3 cores are extracted from each homogeneous area (also for the limited KL). When higher KLs have to be achieved, such minimum number needs to be suitably increased in absolute values as well as in percentages of the total amount of structural elements within each homogeneous area being investigated. Such procedure has been already adopted in several applications, such as that one described in Masi and Vona (2009a), displaying its ability to provide a sufficiently reliable estimation of the concrete strength even though keeping as low as possible the required number of cores.

Table 5. Suggested tentative minimum requirements for different levels of testing.

| Level of testing | For each homogeneous area | |
|------------------|---------------------------|---|
| | Number of cores | Percentage of cores (on the total N. of primary elements) |
| Limited | 3 | 5% |
| Extended | 5 | 8% |
| Comprehensive | 8 | 12% |

Tentative values are suggested in Table 5, however a more reliable definition of number and percentages of samples to be taken requires further experimental studies aimed at achieving more general results. Also cores need to be adequately distributed among all the primary elements, drawing at least 25% of samples per homogeneous area from each different type of structural element.

Location of sampling

Experimental experience (e.g. Dolce *et al.*, 2006) shows that measurement points, need to be carefully located within the structural members. They have to be placed in zones without apparent damage and/or cracking, where stresses due to applied loads are absent or the lowest ones, and representative of the average conditions of the concrete taking into account casting-in-place and ageing effects. In the beams that were subjected only to gravity loads during their service life, the best points are located in the lower part of the member ends, provided that in the central upper part the presence of the adjacent slab usually does not permit drilling. In the columns, taking into account that the static pressure due to consolidation after placement makes strength variable along the member height, the technical literature suggests that the best points are placed at member mid-height.

Assignment of concrete strength value for safety evaluations

Firstly, results from core tests need to be adequately corrected taking into account the main differences between the strength measured on core specimens and the actual in-situ strength. To this purpose, Eq. (1) reported at section 3 can be used. Further, the procedure based on both destructive and non-destructive measurements, also reported at section 3, can be applied. It requires that the relationship between the in-situ concrete strength and the NDT measurements is experimentally derived for the specific concrete under test. By applying this relationship, the in-situ concrete strength also in points where only non destructive measurements were made can be estimated, thus permitting to estimate the design values of concrete strength in a more reliable way.

7 FINAL REMARKS AND FUTURE DEVELOPMENTS

Investigations have a crucial role to adequately know the structures to be subjected to evaluation and possible retrofitting. For this reason, there is an increasing need to set up and put at disposal of technicians and other involved stakeholders sufficiently reliable as well as not very expensive methods to estimate in-situ material properties. Number of tests required to suitably apply these methods have to be as low as possible, thus making the total required budget sustainable to building owners and, consequently, further encouraging their use. To this regard, the results presented in the paper confirm that a suitable combination of NDTs and core tests provides an effective solution from both the economical and technical point of view.

Based on the experience deriving from widespread in-situ and laboratory experimental investigations, some directions are drawn able to suggest some possible improvements of the current code provisions. Particularly, a procedure to develop the investigation plan and, subsequently, estimate in-situ concrete strength, alternative to that one in current codes, is provided. It is made up of the following main steps: (i) definition of concrete portions to be separately investigated (concrete areas having homogeneous properties), (ii) amount of testing (minimum number of samples and measurements), (iii) location of sampling, and (iv) assignment of concrete strength value for safety evaluations. Tentative values of number and percentages of tests (NDTs and cores) to be performed are suggested, however further studies are required to achieve a more general and reliable definition.

To this purpose, future research work has to be devoted to provide methods more and more able to achieve effective results in terms of prediction capability of concrete properties taking into account both aleatory and epistemic uncertainty. Further, NDTs currently available on concrete do not provoke damage on structural members but on some other building

components (e.g. partitions, infills, plaster, etc.) thus determining remarkable repair costs: new methods are necessary to make them really not very expensive.

Greater attention needs to be devoted also to the estimation of the properties of reinforcing bars. Mechanical properties of reinforcement, being it an industrial product, have a very small variability compared to those ones of concrete. Therefore, a different number of tests should be required to attain a certain knowledge level, conversely to the current EC8-3 and IC provisions, that also appear excessively onerous as far as reinforcement is concerned. In the same way, revisiting the significance of the confidence factor, different values for concrete and reinforcement steel could be suggested. Finally, taking into account the heavy damage caused by the extraction of steel bars, non destructive methods to estimate its mechanical properties need to be set up.

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