Information for Structural Assessment

The main goals of inspections on RC existing buildings is the knowledge of:

- **overall dimensions and cross- sectional properties of the building elements;**
- **steel reinforcement diameter and details;**
- **mechanical properties of costituent materials: concrete and steel;**
- **presence identifiable materials defects and inadequate detailing mechanical;**

Information for Structural Assessment

Codes and Guidelines:

- NTC08 (D.M. Infrastrutture 14 gennaio 2008)
  Paragrafo 11.2.6. Controllo della resistenza del calcestruzzo in opera (NUOVE COSTRUZIONI)
  Paragrafo 8.5.3 Caratterizzazione meccanica dei materiali (COSTRUZIONI ESISTENTI)
- Circolare 02 febbraio 2009 n°617/ C.S.LL.PP.
  C8A.1.B Costruzioni in calcestruzzo armato: dati necessari per la valutazione; Tabella C8A.1.3°
- Linee Guida per la messa in opera del calcestruzzo strutturale e per la valutazione delle caratteristiche meccaniche del calcestruzzo indurito mediante prove non distruttive (Servizio Tecnico Centrale);
- Linee Guida: modalità di indagine sulle strutture e sui terreni per i progetti di riparazione/miglioramento/ricostruzione di edifici inagibili. Bozza Marzo 2010 (DPC, STM, ReLUIS, ALIG, ALGI).

❑ EUROCODE 8 PART 3

Information for Structural Assessment

Codes and Guidelines:

Concrete mechanical properties

- NTC 08 (D.M. Infrastrutture 14 gennaio 2008)

• **Section 11.2.6 reports some provisions related to concrete mechanical properties checks with reference to new structures;**

Other guidelines are recalled:

UNI EN 12504-1 : 2002 (Estrazione e schiacciamento di carote)
UNI EN 12504-2 : 2001 (Determinazione dell'indice sclerometrico)
UNI EN 12504-3 : 2005 (Estrazione d'inserti- *pull-out*)
UNI EN 12504-4 : 2005 (Determinaz. velocità di impulsi ultrasuonici)
UNI EN 13791: Determinazione della resistenza in situ

Information for Structural Assessment

Codes and Guidelines:

Material properties

- NTC 08 (D.M. Infrastrutture 14 gennaio 2008)

- **Section 8.5.3 reports some synthetic provisions related to material mechanical properties with reference to existing structures;**

More information are reported in:

- **Circolare 02 febbraio 209 n° 617 del C.S.LL.PP**

- C8A.1.B	Costruzioni in calcestruzzo armato: dati necessari per la valutazione;
- Tabella C8A.1.3a	Definizione orientativa dei livelli di rilievo e prove per edifici in c.a.

Information for Structural Assessment

Knowledge Levels:

Circolare 02 febbraio 209 n° 617 del C.S.LL.PP

- **C8A.1.B.3…. KNOWLEDGE LEVEL;**

For the purpose of choosing the admissible type of analysis and the appropriate partial safety factors values, the following three knolowledge levels are identified:

- **LC1: Limited knowledge**
- **LC2: Normal Knowledge**
- **LC3: Full Knowledge**

Information for Structural Assessment

Knowledge Levels:

Circolare 02 febbraio 209 n° 617 del C.S.LL.PP

- **C8A.1.B.3…. KNOWLEDGE LEVEL;**
  - **LC1: Limited knowledge**
  - **LC2: Normal Knowledge**
  - **LC3: Full Knowledge**

(2) The aspects entering in the definition of the above-listed knowledge levels are:

i) *geometry*: the geometrical properties of the structural system,

ii) *details*: the amount and detailing of reinforcement (for r.c., both longitudinal and transverse), connections (for steel, either welded or bolted),

iii) *materials*: the mechanical properties of the constituent materials.

Information for Structural Assessment

Knowledge Levels:

KNOWLEDGE LEVEL	GEOMETRY	DETAILS	MATERIALS	ANALYSIS	FC
LC1	From original architectural drawings with sample **visual** survey ***or*** from **full** survey	Simulated design according to relevant practice ***and*** from **limited** *in-situ* inspection	Default values according to standards of the time of construction ***and*** from **limited** *in-situ* testing	LS-LD	1.35
LC2		From incomplete original executive construction drawings with **limited** *in-situ* inspection ***or*** from **extended** *in-situ* inspection	From original design specifications with **limited** *in-situ* testing ***or*** from **extended** *in-situ* testing	All	1.20
LC3		From original executive construction drawings with **limited** *in-situ* inspection ***or*** from **comprehensive** *in-situ* inspection	From original test reports with **limited** *in-situ* testing ***or*** from **comprehensive** *in-situ* testing	All	1.00

FC: Confidence Factors

Information for Structural Assessment

Knowledge Levels:

KNOWLEDGE LEVEL	GEOMETRY	DETAILS	MATERIALS	ANALYSIS	FC
LC1	From original architectural drawings with sample **visual** survey ***or*** from **full** survey	Simulated design according to relevant practice ***and*** from **limited** *in-situ* inspection	Default values according to standards of the time of construction ***and*** from **limited** *in-situ* testing	LS-LD	1.35
LC2		From incomplete original executive construction drawings with **limited** *in-situ* inspection ***or*** from **extended** *in-situ* inspection	From original design specifications with **limited** *in-situ* testing ***or*** from **extended** *in-situ* testing	All	1.20
LC3		From original executive construction drawings with **limited** *in-situ* inspection ***or*** from **comprehensive** *in-situ* inspection	From original test reports with **limited** *in-situ* testing ***or*** from **comprehensive** *in-situ* testing	All	1.00

FC: Confidence Factors

Information for Structural Assessment

Knowledge Levels:

KNOWLEDGE LEVEL	GEOMETRY	DETAILS	MATERIALS	ANALYSIS	FC
LC1		Simulated design according to relevant practice ***and*** from **limited** *in-situ* inspection	Default values according to standards of the time of construction ***and*** from **limited** *in-situ* testing	LS-LD	1.35

FC: Confidence Factors

i) *geometry*: the structure's geometry is known either from survey or from original architectural drawings. In this latter case, a sample visual survey should be performed in order to check that the actual situation of the structure corresponds to the information contained in the drawings and has not changed from the time of construction. The information collected regards elements dimensions, beams spans and columns heights and is sufficient to build a structural model for linear analysis.

ii) *details*: the structural details are not known from original construction drawings and should be assumed based on simulated design according to usual practice of the time of construction. Limited *in-situ* inspections in the most critical elements should be performed to check that the assumptions correspond to the actual situation. The information collected should be sufficient to perform local verifications.

iii) *materials*: no direct information on the mechanical properties of the construction materials is available, neither from original design specifications nor from original test reports. In this case, default values should be assumed according to standards of the time of construction, accompanied by limited *in-situ* testing in the most critical elements.

(2) Structural evaluation based on a state of limited knowledge shall be performed through linear analysis methods, either static or dynamic (see 4.4). The relevant partial safety factors for the material properties shall be appropriately increased (see 3.5).

- EUROCODE 8 PART 3

Information for Structural Assessment

Knowledge Levels:

KNOWLEDGE LEVEL	GEOMETRY	DETAILS	MATERIALS	ANALYSIS	FC
LC1	From original architectural drawings with sample **visual** survey ***or*** from **full** survey	Simulated design according to relevant practice ***and*** from **limited** *in-situ* inspection	Default values according to standards of the time of construction ***and*** from **limited** *in-situ* testing	LS-LD	1.35
LC2		From incomplete original executive construction drawings with **limited** *in-situ* inspection ***or*** from **extended** *in-situ* inspection	From original design specifications with **limited** *in-situ* testing ***or*** from **extended** *in-situ* testing	All	1.20
LC3		From original executive construction drawings with **limited** *in-situ* inspection ***or*** from **comprehensive** *in-situ* inspection	From original test reports with **limited** *in-situ* testing ***or*** from **comprehensive** *in-situ* testing	All	1.00

FC: Confidence Factors

Information for Structural Assessment

Knowledge Levels:

LC2	From original architectural drawings with sample **visual** survey ***or*** from **full** survey	From incomplete original executive construction drawings with **limited** *in-situ* inspection ***or*** from **extended** *in-situ* inspection	From original design specifications with **limited** *in-situ* testing ***or*** from **extended** *in-situ* testing	All	1.20

i) *geometry*: the structure's geometry is known either from survey or from original architectural drawings. In this latter case, a sample visual survey should be performed in order to check that the actual situation of the structure corresponds to the information contained in the drawings and has not changed from the time of construction. The information collected regards elements dimensions, beams spans and columns heights and is sufficient, together with those regarding the details, to build a structural model for either linear or nonlinear analysis.

ii) *details*: the structural details are known either from extended *in-situ* inspection or from incomplete original executive construction drawings. In the latter case, limited *in-situ* inspections in the most critical elements should be performed to check that the available information correspond to the actual situation. The information collected should be sufficient for either performing local verifications or setting up a nonlinear structural model.

iii) *materials*: 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. The information collected should be sufficient for either performing local verifications or setting up a nonlinear structural model.

(2) Structural evaluation based on a state of normal knowledge shall be performed through either linear or nonlinear analysis methods, either static or dynamic (see 4.4). The relevant partial safety factors for the material properties shall be taken equal to those given in EN 1998-1 (see 3.5).

- EUROCODE 8 PART 3

Information for Structural Assessment

Knowledge Levels:

KNOWLEDGE LEVEL	GEOMETRY	DETAILS	MATERIALS	ANALYSIS	FC
LC1	From original architectural drawings with sample **visual** survey ***or*** from **full** survey	Simulated design according to relevant practice ***and*** from **limited** *in-situ* inspection	Default values according to standards of the time of construction ***and*** from **limited** *in-situ* testing	LS-LD	1.35
LC2		From incomplete original executive construction drawings with **limited** *in-situ* inspection ***or*** from **extended** *in-situ* inspection	From original design specifications with **limited** *in-situ* testing ***or*** from **extended** *in-situ* testing	All	1.20
LC3		From original executive construction drawings with **limited** *in-situ* inspection ***or*** from **comprehensive** *in-situ* inspection	From original test reports with **extended** *in-situ* testing ***or*** from **comprehensive** *in-situ* testing	All	1.00

FC: Confidence Factors

Information for Structural Assessment

Knowledge Levels:

LC3		From original executive construction drawings with **limited** *in-situ* inspection *or* from **comprehensive** *in-situ* inspection	From original test reports with **extended** *in-situ* testing *or* from **comprehensive** *in-situ* testing	All	1.00

i) *geometry*: the structure's geometry is known either from survey or from original architectural drawings. In this latter case, a sample visual survey should be performed in order to check that the actual situation of the structure corresponds to the information contained in the drawings and has not changed from the time of construction. The information collected regards elements dimensions, beams spans and columns heights and is sufficient, together with those regarding the details, to build a structural model for both linear and nonlinear analysis.

ii) *details*: the structural details are known either from comprehensive *in-situ* inspection or from original executive construction drawings. In the latter case, limited *in-situ* inspections in the most critical elements should be performed to check that the available information correspond to the actual situation. The information collected should be sufficient for either performing local verifications or setting up a nonlinear structural model.

iii) *materials*: 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. The information collected should be sufficient for either performing local verifications or setting up a nonlinear structural model.

(2) Structural evaluation based on a state of full knowledge shall be performed through either linear or nonlinear analysis methods, either static or dynamic (see 4.4). The relevant partial safety factors for the material properties shall be appropriately decreased (see 3.5).

- EUROCODE 8 PART 3

Information for Structural Assessment

Material properties:

Circolare 02 febbraio 209 n° 617 del C.S.LL.PP

- **C8A.1.B.3…. MATERIAL PROPERTIES;**

➢ **Steel: Mechanical Characteristics are obtained by tests on samples extracted from the structure unless original tests reports are available (in a sufficient number according to the code enforced in the construction time); tensile tests should provide tensile yield and ultimate strength as well as ultimate axial strain.**

➢ **Concrete: Mechanical properties can be obtained by compression tests on samples extracted from the structure**

Non-destructive test:

-Only if their reliability has been validated

-<u>they cannot be used in place of tests methods on materials samples extracted from the structure</u>

-Their results should integrate results provided by destructive tests

Information for Structural Assessment

Material properties:

Circolare 02 febbraio 209 n° 617 del C.S.LL.PP

- **C8A.1.B.3…. MATERIAL PROPERTIES;**

➢ **Limited in-situ inspection:**

(1) A limited *in-situ* inspection is a procedure for checking correspondence between the actual details of the structure with either the available original executive construction drawings or the results of the simulated design in 3.4.2.1. This involves performing inspections as indicated in Table 3.2.

➢ **Extended in-situ inspection:**

(1) An extended *in-situ* inspection is a procedure used when the original executive construction drawings are not available. This involves performing inspections as indicated in Table 3.2.

➢ **Comprehensive in-situ inspection:**

(1) A comprehensive *in-situ* inspection is a procedure used when the original executive construction drawings are not available and when a higher knowledge level is sought. This involves performing inspections as indicated in Table 3.2.

Information for Structural Assessment

Table 3.2: Definition of levels of inspection and testing.

	Inspection (of Details)	Testing (of Materials)
	For each type of primary member (beam, column, wall):	
Limited	15% of the members are checked for details	1 concrete sample per each 300 m^2 of floor; 1 steel sample per floor
Extended	35% of the members are checked for details	2 concrete sample per each 300 m^2 of floor; 2 steel sample per floor
Comprehensive	50% of the members are checked for details	3 concrete sample per each 300 m^2 of floor; 3 steel sample per floor

- NTC 08 (D.M. Infrastrutture 14 gennaio 2008)

Information for Structural Assessment

Table 3.2: Definition of levels of inspection and testing.

	Inspection (of Details)	Testing (of Materials)
	For each type of primary member (beam, column, wall):	
Limited	20% of the members are checked for details	1 material sample per floor
Extended	50% of the members are checked for details	2 material samples per floor
Comprehensive	80% of the members are checked for details	3 material samples per floor

- EUROCODE 8 PART 3

Information for Structural Assessment

Material properties

- **It is allowed to replace some destructive tests (no more than 50%) with a wider number (at least three times) of non-destructive tests (single or double) calibrated on destructive tests.**
- **Number of tests (more or less) based on material homogeneity. In case of very non homogeneous results it is reccomended to perform other tests.**