

BULETINUL INSTITUTULUI POLITEHNIC DIN IAȘI  
Publicat de  
Universitatea Tehnică „Gheorghe Asachi” din Iași  
Volumul 65 (69), Numărul 2, 2019  
Secția  
CONSTRUCȚII. ARHITECTURĂ

## **STUDIES ON PREDICTABILITY AND QUANTIFICATION OF QUALITY SPECIFIC ACTIVITIES IN BUILDING – CONCRETE**

BY

**NICOLAIE GABRIEL COSTOAEA\*, MARINELA BĂRBUȚĂ,  
EDUARD ANTOHIE and RADU LUPĂȘTEANU**

Technical University “Gh. Asachi” of Iasi,  
Faculty of Civil Engineering and Building Services

Received: April 10, 2019

Accepted for publication: May 17, 2019

**Abstract.** In Romania, according to Law no.10/1995 on the quality in construction, republished with the subsequent modifications and completions, the premises of the compulsory implementation of the quality system in constructions are created, in order to obtain and exploit corresponding quality constructions. The Construction Log Book includes the documents attesting the quality of the construction works executed. These documents are a vector of quality argumentation. This paper aims to analyse the existing situation in the construction site regarding the execution, verification of the reinforcement works and the content of the documents drawn up in order to prove the quality of the construction works as established by the project in accordance with the norms, rules and legislation. This paper proposes a new approach to establishing the content of the documents before starting the construction works, thus ensuring the predictability of the verification activities and establishing a score, at the time of the verification, thus ensuring the quantification. The quality of construction works executed for the investor (but not limited to) will be reflected by an indicator for the categories of works to which we refer.

---

\*Corresponding author: *e-mail*: gabi\_costoaea@yahoo.com

**Keywords:** score; quality; reinforcement; investor; The Construction Log Book; verification.

## 1. Introduction

Quality, seen as the ratio between product performance and investor expectations – as defined by Law 10/1995 on quality in construction constructions, republished with subsequent modifications and completions, as "the result of all the achievements of their performance in exploitation, in order to satisfy, on (1) requires the existence of a Quality System in Construction, with a differentiated application depending on the importance of the construction.

The essential requirements that must be met during the lifetime of the building, according to the legislation in force, are:

*"(A) mechanical strength and stability;*

*B) fire safety;*

*C) hygiene, health and the environment;*

*D) safety in operation;*

*E) protection against noise;*

*F) energy saving and thermal insulation "(1).*

On the construction site, following the verifications made by the stakeholders, the following types of completed documents, which attest the quality of the executed works, were identified:

- minutes for verifying the quality of the work that is hidden;
- qualitative reception report;
- infrastructure reception report;
- minutes of reception of the structure;

Documents contain information about:

- identification of the contractor;
- the date of the document;
- object/work;
- the phase of the work subject to verification;
- identifying elements (sector, portion, axis, quota, etc.);
- project provisions;
- conclusions.

The contractor, the investor and the designer, sign these documents. Proof of the fulfillment of the requirements of the project, of the norms, laws and legislation in force, is the existence in the Construction Log Book of the document signed by the actors involved, a document whose format is in Fig. 1.

**BENEFICIAR**  
**OBIECTIV**

**PROCES VERBAL**  
**PENTRU VERIFICAREA CALITĂȚII LUCRĂRILOR CE DEVIN ASCUNSE**

Nr. 8 Data. 09.03.2017

Faza din lucrare supusă verificării:

**ARMARE PEREȚI PS6, PS5, PS3, PS4, PS1 (cota -3.25) S2**

**CORP C1/T1**

Elementele de identificare:

PS 6 : AX ( 1 - 4 ) / AX ( 1 - A ) - AX (1-F)  
 PS 5 : AX ( 1 - 5 ) / AX ( 1 - A ) - AX (1-F)  
 PS 3 : AX ( 1-6 ) / AX ( 1 - A ) - AX (1-F)  
 PS 1 : AX (1-A) și (1-F) de la (1-3) +3m până la ( 1-6 )  
 PS 4 : AX (1-C) și (1-D) de la (1-3) +3m până la ( 1-6 )

Verificările s-au făcut pe baza prevederilor proiectului nr. 34/2016 planșa nr. C1/T1 - R02, R06, R07, R10, R11, R12, R13, R14, R15, R16

*Concluzii: Armătura montată și recepționată în baza PVCC din 02.03.2017 + 09.03.2017, respecta prevederile proiectului și normativelor în vigoare. Repetitia crăciunilor, umiditate și dispoziția armăturilor în diferitele etaje în tranșeele sunt conform cu Normativul CSE/08, capitolul 4, pct. 2. Distanța dintre bare / etaje, dimensiunile acestora și nivelul de fierbere sunt conforme cu planșele de armătură prestabilite. S-au făcut distanțări între așchii a conformă cu beton de 2,5 cm.*

Numele	Prenumele	Functia	Semnătura
		ȘEF ȘANTIER	
		RCO	
		DIRIGINTE ȘANTIER	
	CONSTANTIN	RTE-CONSTRUCȚII	

Fig. 1 – Minutes to verify the quality of the work that is hidden.

Does the content of this document indicate that all possible verifications have been made, that dimensional or constructive deviations have been made to the project or to the normative or normative specifications? If the deviations have existed at the end of the works, could they be found in the documents so that the investor can form an objective point of view regarding the quality of the construction works executed? Could the investor, the designer, the performer set a "score", a "value"?

For the reinforcement works, this paper proposes the types of documents to be drafted, which, after carrying out the checks established by the project, lead to the achievement of quality construction works.

Moreover, when performing the checks, it is possible to set points from 1 to 10. The minimum score is 1, representing very bad, and the maximum score is 10, representing very good.

The score obtained for this category of works, along with the scores for the other categories of works executed at the end of the execution of the construction works, will form the basis of the overall score.

This quantification may reflect the quality of the construction work for the investor.

## **2. Argumentation of the Proposed Topics**

Classification of buildings, according to technical regulations and literature and according to various criteria:

- by destination: civil constructions, social-cultural buildings, industrial constructions, agrozootechnical constructions;
- by durability: permanent constructions, semi-permanent constructions, temporary constructions;
- according to the basic material of the structural structure: masonry, concrete and reinforced concrete constructions, wooden constructions, metal constructions, mixed constructions;
- by category of importance: category A – exceptional, category B – special, category C – normal, category D – reduced.

From the multitude of categories of work being done on the site for this work we chose the reinforcement.

We can define reinforcement as the total assembly and fixation operations of a reinforcement, a percentage of a piece of reinforced concrete, relative to the useful surface of the concrete section of the workpiece.

On site, the following activities/verifications and documents were identified:

- the contractor of the building works, upon receipt of the fittings in the building site, will receive qualitatively the materials;
- the fittings will be stored on site;
- the investor, the contractor and the designer will check the reinforcement. It must comply with the provisions of the project and the technical prescriptions. Qualitative reception report for hidden works will be prepared.

What is not recorded? No records are available to perform the following checks:

- existence of a steel-concrete certificate of conformity or technical agreement;
- existence of the declaration of conformity of concrete steel;
- existence of the inspection certificate given by the manufacturer or his authorized representative;
- the existence of the technical dossier of the product (where applicable);
- existence of test bulletins;
- product labeling;



14 Nicolaie Gabriel Costoaea, Marinela Bărbuță, Eduard Antohie and Radu Lupășteanu

0	1	2	3	4	5	6	7	8
1	The existence of the steel-concrete certificate of conformity issued by an accredited body or technical agreement	Required					Construction-site responsible Contractor	A score of 10 is awarded to meet the requirement, for lack of the document or lack of signatures 0
2	Existence of Conformity Declaration of Concrete Steel	Required					Construction-site responsible Contractor	A score of 10 is awarded to meet the requirement, for lack of the document or lack of signatures 0
3	Existence of the inspection certificate given by the manufacturer or his authorized representative	Required					Construction-site responsible Contractor	A score of 10 is awarded to meet the requirement, for lack of the document or lack of signatures 0
4	The existence of the technical file of the product (where applicable, certificate of conformity, test reports with initial results and/or quality documents)	Required					Construction-site responsible Contractor	A score of 10 is awarded to meet the requirement, for lack of the document or lack of signatures 0
5	The existence of test bulletins before the product has been put into service as well as traceability	Required					Construction-site responsible Contractor	A score of 10 is awarded to meet the requirement, for lack of the document or lack of signatures 0
6	Verification of product labeling	Required					Construction-site responsible Contractor	A score of 10 is awarded to meet the requirement, 0 is awarded for lack of labels

0	1	2	3	4	5	6	7	8
7	Verify storage by types	Required					Construction-site responsible Contractor	A score of 10 is awarded to meet the requirement, if 0 is not deposited by type
8	Verify storage by diameter	Required					Construction-site responsible Contractor	A score of 10 is awarded to meet the requirement, if not deposited on diameters, a score of 0
9	Verify storage so as to avoid conditions that favor the corrosion of the reinforcement	Required					Construction-site responsible Contractor	A score of 10 is awarded to meet the requirement, if 0 is not assured
10	Verify storage so as to avoid dirt or other substances	Required					Construction-site responsible Contractor	A score of 10 is awarded to meet the requirement, if 0 is not assured
11	Verify storage so as to ensure easy access and identification of each assortment	Required					Construction-site responsible Contractor	A score of 10 is awarded to meet the requirement, if 0 is not assured
12	There are documents that prove the fittings characteristics and their traceability	Required					Construction-site responsible Contractor Designer	A score of 10 is awarded to meet the requirement, for lack of the document or lack of signatures 0
13	Are quality determinations made by the performer / processor: traction, simple bending, bending	There must be fittings (Laboratory Tests): 3 specimens / batch / diameter					Construction-site responsible Contractor Designer	A score of 10 is awarded to meet the requirement, for lack of the document or lack of signatures 0

16 Nicolaie Gabriel Costoaea, Marinela Bărbuță, Eduard Antohie and Radu Lupășteanu

0	1	2	3	4	5	6	7	8
14	Reinforced PV reception refers to procedures, records, traceability, staff qualification, nonconformity treatment	Required					Construction-site responsible Contractor Designer	A score of 10 is awarded to meet the requirement, for lack of the document or lack of signatures 0
15	Upon completion of fitting the fittings,							Total score awarded = (sum a) + b) + c) + d) + e) + f) + g) + h) + i)
16	a)the findings resulting from the checks made on:	Required					Construction-site responsible Contractor Designer	A score of 1 is awarded to meet the requirement, 0 is awarded for non-compliance
17	b) the distance between the stirrups, their diameter and their attachment;	Required					Construction-site responsible Contractor Designer	A score of 1 is awarded to meet the requirement, 0 is awarded for non-compliance
18	c) The length of the bar portions that exceed the supports ...;	Required					Construction-site responsible Contractor Designer	A score of 1 is awarded to meet the requirement, 0 is awarded for non-compliance
19	d) quality of welds;	Required					Construction-site responsible Contractor Designer	A score of 1 is awarded to meet the requirement, 0 is awarded for non-compliance
20	f) the number and quality of the links between the bars	Required					Construction-site responsible Contractor Designer	A score of 1 is awarded to meet the requirement, 0 is awarded for non-compliance

0	1	2	3	4	5	6	7	8
21	<i>g) devices for maintaining the position of the fittings during the concreting;</i>	Required					Construction-site responsible Contractor Designer	A score of 1 is awarded to meet the requirement, 0 is awarded for non-compliance
22	<i>h) how to ensure the thickness of the concrete coating layer and its dimensions</i>	<i>Positioning of the reinforcement, as a difference of effective concrete cover, relative to the nominal concrete coating), depending on the height of the pipe, h (between the values predicted to be interpolated linearly). For h (mm) ≤ 150, Δ = ± 10mm, h (mm) = 400, Δ = -10mm ... + 15mm, h (mm) &gt; 2500, Δ = -10mm + 15mm</i>					Construction-site responsible Contractor Designer	In order to meet the requirement, a score of 3 shall be awarded, which shall be reduced by the deviation established by measurements, a score of 0

0	1	2	3	4	5	6	7	8
23	<i>i) position, fastening and dimensions of the embedded parts.</i>	Required					Construction-site responsible Contractor	A score of 1 is awarded to meet the requirement, 0 is awarded for non-compliance
<b>POINT (weighted arithmetic mean of the number 1 to 15):</b>								
<b>Conclusions based on the score obtained: reinforcement work on this element corresponds to / does not meet the requirements, it can / can not proceed to the next step.</b>								

Fig. 2 – Check sheet for reinforcement works.

Considering the preset minimum score 5, after the completion of the reinforcement work, the work can be declared appropriate or inappropriate on the basis of the score obtained. This sheet, together with all the documents proving the quality of the works performed, can be found in the Construction Log Book.

The designer should establish through the project the level of quality to be achieved, defining the deviations in which each type of work must fit.

The quantification of the actual performance/quality of the works executed for reinforcement, taking into account the above, is to be achieved by completing the works with the fine exemplary contents as they are executed.

For all the above-mentioned checks, we do not find any records in the Construction Log Book and the reports drawn up on the site do not record the deviations found and do not establish a score that shows the investor the quality of the work performed as a reference function.

Determining the scores for each category of works can be done using the calculation formula:

$$P = \left( \sum_{i=1}^n Ki \times Pi \right) / i,$$

where:  $P$  is the total score for each category of works;  $Ki$  – the weight of verification/work within each category of works;  $Pi$  – the score set for each verification/work within a category of works;  $i$  – the number of criteria taken as representative for each category of works.

#### 4. Conclusions

The checks to be made, the documents to be drawn up and the quality level requirements are known at the time of the execution of the reinforcement work, so predictability is ensured.

By setting the score, the quality of the reinforcement works can be measured, so quantification is ensured.

In the Construction Log Book, there will be the scores obtained, which may be the basis of the Investor's decision regarding the reception, purchase or assignment of some construction works of a certain performer.

### REFERENCES

- Antohie E., Iacob V., *The Determination of the Costs Associated with Constructions/ Demolition and Their Place in the Global Cost in Constructions*, Bul. Inst. Politehnic, Iași, **LIX(LXII)**, 2, s. Construcții, Arhitectură, 9-18 (2013).
- Bărbuță M., *Elemente structurale din betoane performante*, Editura Performantica, Iași, 2014.
- Bărbuță M., Haja M., Ciobanu G., *Mechanical Properties of Polymer Concrete Containing Tire Waste Power*, Journal of Food, Agriculture and Environment, **12**, 1185-1190.
- Lupășteanu R., *Calitatea investițiilor*, Technical Expert Publishing House, Iași, 2006.
- Lupășteanu R., *Construction Management – Introduction*, Gama Publishing House, Iași, 1997.
- Velicu C., *Buildings*, Technical Expert Publishing House, 2007.
- \* \* *Normative for Quality Verification and Reception of Construction Works and Installations Than are Concerned*, C56 / 1985, ICCPDC, 1986.
- \* \* *Design Code for Masonry Structures*, CR 6-2013.
- \* \* *Law no. 50/1991 on the authorization of construction works, republished, as subsequently amended and supplemented.*
- \* \* *Law no.10/1995 on quality in constructions, republished, as subsequently amended and supplemented.*
- \* \* *Normative for the manufacture of concret and construction of concret – execution of concrete*, NE012 / 2-2010, MO, 2010.
- \* \* *Seismic Design Code P 100-1/2013.*

### STUDII PRIVIND PREDICTIBILITATEA ȘI CUANTIFICAREA ACTIVITĂȚILOR SPECIFICE CALITĂȚII LA CONSTRUCȚIA CLĂDIRILOR – ARMARE

(Rezumat)

În România, prin Legea nr.10/1995 privind calitatea în construcții, republicată, cu modificările și completările ulterioare, se creează premisele implementării obligatorii a sistemului calității în construcții, în vederea obținerii și exploatarei construcțiilor de calitate corespunzătoare. Cartea tehnică a construcției include documentele care atestă calitatea lucrărilor executate. Aceste documente reprezintă un vector de argumentare a calității. Lucrarea propune analiza situației existente pe șantier în ceea ce privește

execuția, verificarea lucrărilor de armare și conținutul documentelor întocmite pentru a dovedi calitatea lucrărilor de construcție stabilite de proiect în conformitate cu normele, regulile și legislația. Prin această lucrare se propune o nouă abordare stabilind conținutul documentelor înainte de începerea lucrărilor de construire, realizându-se astfel asigurarea predictibilității activităților de verificare și stabilirea, la momentul verificării, a unui punctaj, realizându-se astfel asigurarea cuantificării. Calitatea lucrărilor de construire executate pentru investitor (și nu numai) va fi reflectată de un indicator pentru categoriile de lucrări la care ne referim.