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STUDIES ON PREDICTIBILITY AND QUANTIFICATION OF SPECIFIC QUALITY ACTIVITIES IN THE CONSTRUCTION OF BUILDINGS - MASONRY

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Abstract: *Proper quality of construction works is a mandatory requirement as stipulated in Law no.10 / 1995 on quality in construction, republished with subsequent modifications and completions. Documents proving the quality of the works performed are enclosed in the Construction Log Book. The documents enclosed in the Log Book could be a solid proof for defining the quality level of a given construction work, for all the parties involved in the construction project and for various stake holders as well. This paper proposes to determine the types of documents to be drafted and their content in order to prove the carrying out of verifications leading to the obtaining of construction works that meet the quality requirements established by the project in accordance with the regulations and current legislation, and for which a score could be determined when performing the checks (if necessary by measurements). The investor, at the end of the execution of the construction works, will have the quality reflected by an indicator for the categories of works to which we refer.*

Key words**:** *score, quality, masonry, investor*

1. Introduction

Quality in construction is defined as "the result of all the performance of their behavior in exploitation, in order to satisfy the requirements of users and collectives throughout the lifetime" [1]. In other words, the ratio between product performance and investor expectations means quality.

The quality system in construction (established by the Law no.10 / 1995 on quality in constructions, republished with subsequent modifications and completions) is differently applied, according to the category of importance of the construction.

The current legislation obliges investors, designers, certified designers, contractors, manufacturers and suppliers of construction materials and products, certified technical experts, and all the actors involved in the construction of a building, to build

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constructions for which, for their entire life duration the essential requirements should be achieved [5,6]. According to the Romanian legislation, the essential requirements are as followes:
"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]

Documents existing in the Log Book resulting from the specific activities carried out by the involved actors, attest the quality of the works executed.

On site, the following types of completed documents have been identified in the construction of a building, respecting the current technical regulations (eg: C56 / 1985 [3], NE012 / 2-2010, [4] etc.):
- Minutes of handover - reception of site and landmarks;
- Minutes of work drafting;
- Minutes for verification of the foundation quota;
- Verification of the nature of the foundation ground;
- Minutes for verifying the quality of the work that is hidden;
- Verification report for the appearance of concrete after deformation and positioning of technological and installation holes;
- Qualitative reception report;
- Containment for the evidence of cast concrete;
- Single job report on the results of tests on concrete samples taken at the site;
- Infrastructure reception report;
- Minutes of reception of the structure;
- Minutes of reception at the end of the works;
- Minutes of final acceptance.

The contents of the documents listed above contain references to: identification of the contractor, date of the document, object / work, phase of the work to be verified, identification elements (sector, part, ax, quota, etc.), project provisions, conclusions. Documents shall be signed, as appropriate, by the representative of the contractor, the investor and the designer.

The existence of the Technical Paper of a construction of the document signed by the stakeholders implies that all the verifications have been made and the conditions established by the project are met, in compliance with the current norms, and legislation in force.

Any investor may ask some simple questions as: "Have all possible checks been made? What are those checks? To what are the values obtained when performing the checks compared? If dimensional or constructive deviations are within the permissible limit, can the construction be received? The construction where deviations almost do not exist can have the same value as another construction made after the same project at which

deviations are at the maximum limit? The factors involved in the construction, the Investor, the designer, the executor, the user, could set the "value"?

This paper proposes the types of documents to be drafted, the content of which proves the verifications established by the project in accordance with the norms, legislation in force, which lead to the obtaining of construction works that meet the quality requirements.

At the time of the checks, where appropriate by measurements, a score of 1 to 10 can be established. The score of 1 is minimal and very bad, and the score of 10 is the maximum and means very good.

The score obtained for each category of works at the end of construction works will be the basis for the overall score. For the investor, this score will reflect the quality of the executed work [7,8,9].

2. Argument of the Proposed Theme

Specialised literature and technical regulations set out various criteria to classify buildings:

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

To support ideas, according to the criteria listed above, we chose for this study buildings with concrete, reinforced concrete, reinforced concrete structures or mixed structure (masonry and reinforced concrete).

For buildings that meet the requirements listed above we identified the following categories of works:

- Earthworks
- Improve the foundation ground
- Foundations
- Concrete, reinforced concrete and prestressed concrete
- Boxing
- Masonry
- Lime
- Plywood
- Painting works
- Floors
- Insulation
- Joinery
- Windows

- Covers
- Boilers

The paper will treat masonry works.

Masonry can be defined as a non-homogeneous assembly of materials, consisting of rigid elements called blocks / strips / plates / bricks and materials or connecting elements. The resulting assembly is able to withstand the demands.

Masonry works can be made of:

- Full bricks
- Ceramic blocks with vertical and horizontal holes
- Concrete blocks with lightweight aggregates
- Autoclaved cellular concrete blocks and slabs
- Blocks of natural stone
- Pressed glass bricks
- Plasterboard and phosphogypsum full and void
- Autoclaved cellular concrete strips
- Plaster strips
- Asbestos plates
- Glass U-profile plates
- Plates of clay or stabilized earth

On the site, following the requirements of C56 / 1985, NE012 / 2-2010, P100-1 / 2013, CR 6-2013 ... etc, the following activities / verifications are carried out and the following documents are prepared:

- The contractor of the construction works will receive qualitatively the materials by taking into consideration the dimensions, brand, class and quality according to the technical conditions required for each material to be produced when the building blocks / strips / slabs / bricks are received on site put into the work;
- The investor and the contractor will proceed to verify the support over which the masonry is executed. It must comply with the provisions of the project and the technical prescriptions. A Minutes of Hidden Works will be drawn up;
- The investor, the contractor and the designer will check the layout prior to the execution of the masonry work. Minutes will be drawn up;
- The investor, the contractor and the designer will check the quality of the masonry work. A verbal reception of qualitative reception will be drawn up.

On site, all activities / verifications previously submitted to a contractor of construction works that have their own quality assurance system implemented / certified, are performed.

What is not recorded? On site, the head of the workplace performs the following checks:

- Checking how to store on site, and prohibiting the use of loose blocks / strips / slabs / bricks;
- Check the blocks / bricks / tiles / strips of the coating for dust, dirt or ice and the condition of the surfaces. Where non-compliance is found to be forbidden;

- Check if the bricks are wet before putting them into operation. Mandatory verification for work in warm weather;
- Checking whether brick / block fractions are used less than 15% of the bricks / blocks;
- Checking the mortar, plaster paste composition at each batch;
- Verification of the realization of the vertical joints and fulfillment of the overlapping requirement of 1/2 of the building block;
- Verification of mortar filling of vertical and horizontal joints;
- Verify the reach of each wall.

For all the above-mentioned checks, we do not find any records in the technical 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.

Which reference?

The designer should establish the level of quality to be achieved by defining the deviations in which each type of work must fit in the project, in compliance with the current legislation, rules and regulations.

What do we find on the site and what sets the legislation in the field?

In accordance with the provisions of Law no.50 / 1991 on the authorization of construction works, republished, as subsequently amended and supplemented, annex no. 1, The content of the project authorization of construction works - CAP, the documentation contains "the list and the signatures designers, memorandum describing the works subject to authorization, with reference to the site, topography, plotting of works, specific climatic and natural phenomena, geology and seismicity, objective importance category, data and urbanistic indicators characterizing the projected investment surface area, useful floor area, building heights, number of levels, building volume, POT, land use coefficient - CUT), general worksheet, geotechnical study, beam inspection reports level using "[2].

Execution projects, existing on site, refer to:

- The records refer to the location, neighborhoods, seismic area, climate zone, building structure on the whole and elements. The part of the masonry works contains from 1 to 2 pages, and speaks about the type of masonry blocks, wall thicknesses, materials to be used ...;
- In the workbooks there are references to the technology of execution, materials;
- In all the documents listed above, there are brief references or no deviations to the construction work to be executed.

3. Results and Discussions

Quantification of the actual performance / quality of the executed works for masonry, taking into account the above mentioned, will be done by a project that will contain the drawings, to be completed in execution as the execution of the works, with the content exemplified in Fig.1.

Building Permit No ..... from .....
Designation of construction works (according to AC): .....
Address of investment: ....
Investor / Beneficiary: ....
Investor Address: ....
Nr. investor phone: ....
Executor:..... ....
Execution Address: ....
Nr. contractor: ....

MASONRY

VERIFIED ELEMENT							
Verification / document to be drawn up	**Deviation established**	**Deviation found**	**Meets the requirement**		**Date of verification and document**	**Who participated in the verification (surname name)**	**Score obtained when the requirement was met**
			YES	NOT			
1	2	3	4	5	6	7	8
Proof of dimension, brand, class and quality verification is made according to the technical conditions required for each material to be put into operation	**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
Proof of the existence of the verbal records of hidden works proving that the support over which the masonry is executed corresponds to the provisions of the draft and the technical prescriptions	**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
There were presented the qualitative reception reports containing references to:	**Required**						Total score awarded = sum a) + b) + c) + d) + e) + f) + g) + h)
a) checking the condition of brick, block, gypsum board, glass bricks (it is forbidden to use dust, dirt or ice or cracks or broken corners)	**Required**					**Construction-site responsible Contractor**	In order to meet the requirement, a score of 1 is awarded, for the absence of the document or the absence of signatures is given a score of 0
*b) check, especially during warm weather, if the bricks are wet before putting t**hem** into operation*	**Required**					**Construction-site responsible Contractor**	In order to meet the requirement, a score of 1 is awarded, for the absence of the document or the absence of

							signatures is given a score of 0
c) verification of the execution of works if the percentage of bricks compared to the whole fractions exceeds the maximum limit of 15%	**Required**					**Construction-site responsible Contractor**	In order to meet the requirement, a score of 1 is awarded, for the absence of the document or the absence of signatures is given a score of 0
d) verifying the preservation mode, forbidding the use of those bricks that have become loose by improper storage	**Required**					**Construction-site responsible Contractor**	In order to meet the requirement, a score of 1 is awarded, for the absence of the document or the absence of signatures is given a score of 0
e) Checking, with the standard cone, at each working point, and at each mortar batch the mortar consistency	*• 8-13cm in full brick masonry and concrete blocks with light or heavy aggregates, • 7-8cm for brickwork and blocks with vertical and horizontal holes, • 10-11cm for small blocks of masonry and autoclaved cellular concrete slabs, • 4-5cm in brick masonry, • 11-13cm for plaster paste for gypsum boards and strips),*					**Construction-site responsible Contractor**	In order to meet the requirement, a score of 2 is awarded, for lack of the document or the absence of signatures 0
f) checking, by measurements on each wall, whether the vertical joints are woven on each row, with overlapping 1/2 of the masonry block	**Required**					**Construction-site responsible Contractor**	In order to meet the requirement, a score of 2 is awarded, for lack of the document or the absence of signatures 0
g) verifying that all vertical and horizontal joints are completely filled with mortar, except for a depth of 1 - 1.5 cm from the visible faces of the masonry	*no loose joints are allowed*					**Construction-site responsible Contractor**	In order to meet the requirement, a score of 1 is awarded, for the absence of the document or the absence of signatures is given a score of 0
h) verifying the brickwork of masonry on each wall.	*Verifying the thickness of the masonry will be done by accurately measuring 1 mm of the horizontal distance between*					**Construction-site responsible Contractor**	In order to meet the requirement, a score of 1 is awarded, for the absence of the document or the absence of signatures is given a score of 0

	two straight lines applied to both sides of the wall. Thickness measurement is done at three different heights or different points of the wall, and the arithmetic mean of the results compares with the thickness specified in the project						
Receiving minutes containing references to:							Total score awarded = sum a) + b) + c) + d) + e) + f) + g + h + + i k +l)
a) if the materials and parts used meet the requirements prescribed in the project and the standards	**Required**					**Construction-site responsible Contractor**	In order to meet the requirement, a score of 1 is awarded, for the absence of the document or the absence of signatures is given a score of 0
b) if the dimensions of the building elements executed correspond to those in the project	**Required**					**Construction-site responsible Contractor**	In order to meet the requirement, a score of 1 is awarded, for the absence of the document or the absence of signatures is given a score of 0
c) if the dilatation and compression joints are well executed at the locations specified in the project	**Required**					**Construction-site responsible Contractor**	In order to meet the requirement, a score of 1 is awarded, for the absence of the document or the absence of signatures is given a score of 0
d) if no defects have occurred due to compressions	**Required**					**Construction-site responsible Contractor**	A score of 0.5 is awarded in order to meet the requirement, for the lack of the document or the absence of signatures is given a score of 0
e) if the voids and grooves for the water pipes, sewage, heating provided in the project	**Required**					**Construction-site responsible Contractor**	A score of 0.5 is awarded in order to meet the requirement, for the lack of the document or the absence of signatures is given a score of 0
f) verticality of walls, pillars, doors and windows	**Required**					**Construction-site responsible Contractor**	In order to meet the requirement, a score of 1 is awarded, for the absence of the document or the absence of signatures is given a score of 0
g) horizontal glazing	**Required**					**Construction-site responsible**	A score of 0.5 is awarded in order to meet the requirement, for the lack

						Contractor	of the document or the absence of signatures is given a score of 0
h) if the lintels are well positioned above the door and window openings	**Required**					**Construction-site responsible Contractor**	In order to meet the requirement, a score of 1 is awarded, for the absence of the document or the absence of signatures is given a score of 0
i) Centering of the pillars as well as the main and secondary beams on the pillars and walls	**Required**					**Construction-site responsible Contractor**	In order to meet the requirement, a score of 1 is awarded, for the absence of the document or the absence of signatures is given a score of 0
j) execution according to the plans of the cornice inlet	**Required**					**Construction-site responsible Contractor**	In order to meet the requirement, a score of 1 is awarded, for the absence of the document or the absence of signatures is given a score of 0
k) surface quality of unstretched facade walls	**Required**					**Construction-site responsible Contractor**	A score of 0.5 is awarded in order to meet the requirement, for the lack of the document or the absence of signatures is given a score of 0
l) the connection between the filling masonry and the elements of the structure	**Required**					**Construction-site responsible Contractor**	In order to meet the requirement, a score of 1 is awarded, for the absence of the document or the absence of signatures is given a score of 0
POINT (the mean value for numbers 1, 2, 3 through 12):							
Conclusions based on the score obtained: Masonry for this element corresponds to / does not meet the requirements, it can pass / can not proceed to the next stage of execution.							

Fig. 1. *Scorecard*

After completion of this type of work, the work can be declared appropriate or inappropriate on the basis of the score obtained. The minimum reference score is considered to be the default.

4. Conclusions

By using the same method as those presented up to now, it is possible to draw up fiches for the other categories of works. At the end of the execution of the construction works, the quality of the construction works can be measured, by generating a general score as a weighted average of all the scores obtained on each category of works. The points obtained, which are contained in the Construction Log Book, can be based on the

Investor's decision regarding the reception, purchase or assignment of works for the construction of a certain contractor.

Other information may be obtained from the address: gabi_costoaea@yahoo.com

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