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Rules of measurement in building construction

Proposed model for application in Portugal for secondary elements of stonework, carpentry and metalwork

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Extended Abstract

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1. Introduction

The development of this thesis, “Rules of measurement in building construction. Proposed model for application in Portugal. Secondary elements of stonework, carpentry and metalwork.” is part of the present Master’s degree course in Civil Engineering at Instituto Superior Técnico (IST).

This project was developed following the guidelines of investigations published by LNEC, namely: “Course on rules of measurement in construction” [1] 1997, and based on two Bologna thesis developed by fellow IST students, “Earthwork – Rules of measurement in construction. Model applicable in Portugal” [2] and “Cladding measurement rules for building works. Proposal for national standard method of measurement.”[3].

2. Justification

The lack of regulation for the establishment of rules for measurement in project design and construction, constitutes a major cause of conflict among its actors. Therefore, the need for measurement rules to be mandatory is understandable, for those to be used in the elaboration of the bill of quantities and to avoid misinterpretation of the work described there, as well as quantities. Thus, rules that have a structure that suits the needs of technicians at construction sites and simultaneously standardize the criteria used when making a connection with other applications in the construction area (ProNIC[1]), should be set.

3. Objectives

This work’s intention is the development of a proposal for measurement rules that fit the existing problems at a national level with regard to secondary elements in buildings, namely stonework, carpentry and metalwork. To carry out this proposal, current legislation will be taken into account, always bearing in mind the objective of filling the gaps of the technical environment. For this purpose, a survey of existing information at both national and international levels is needed, in order to adapt its effectiveness to national reality. With the development of the proposed model, the following objectives are to be achieved:

- Gather information through existing literature and legislation, at national and international levels, on rules of measurement applied to stonework, carpentry and metalwork;

[1] ProNIC - Project that aims to produce standard task lists of construction works, allow access to all users of the platform of work, materials and cost sheets, which are associated with the building contract documents generated, generate all the documentation required for the launching of a new construction, including Financial Estimate, Detailed Measurements and Bill of Quantities and Work [8]

- Classification and coding of the elements described in bills of measurement that fall into the categories under study;
- Definition of measurement units, general and specific rules applicable to different building elements, always accompanied by the type of work that is being analyzed;
- Characterization, whenever necessary, of more relevant technical aspects of the construction, thus ensuring the quality control specified in the description of work, safety measures and standard details;
- Presentation of descriptive examples and evidence relating to the objectives identified above.

4. Methodology

To accomplish this thesis and to achieve the goals outlined initially, a methodology is used, based on the following points:

- Literature research

The literature research was done through a documentary survey on the subject under study, being this research divided into national and international documents and applications. In the case of international documents, it was given special relevance to European countries in order to give response to the increasing standardization of used rules. It is intended, therefore, to collect the references commonly used in business rules of measurement, whether binding or merely consultative. It is considered that the exposure of the historical evolution of those documents assumes some relevance, because the evolution process of measurement rules and the impact they had in the countries where they were released can be observed. It will also serve as a good basis for learning to future results that emerge in our country.

- Consultation within the technical environment

At this stage, consultation to companies was conducted through interviews. These interviews were carried out to assess the knowledge of companies on the bibliography, seeking if the rules contained in these documents are appropriate to current needs. Information considered useful for the construction of the proposed model was also collected and analyzed.

- Comparison

After the literature review and selection of documents that were considered relevant to the topic of the thesis, a critical and comparative analysis of the information collected on each document is carried out, checking major aspects of complementarity, such as:

- Which should be the best way to structure the information;
- What should be the coding and numbering of the works;
- Which elements should be included in the model.

After this analysis, the most important aspects of each document were selected, crossing them with the information gathered in the technical environment. This process has, as its ultimate goal, the proposal of a model on rules of measurement to be used in Portugal.

- Proposed Rules of Measurement Model

The construction of the rules of measurement model begins after being performed all the research and analysis on the collected information. The proposed model was constructed to contain updates on existing information in Portugal, making several changes considered necessary, based on the opinions and needs of the technical environment.

- Conclusions and future developments

Finally, a retrospective and conclusive analysis was conducted, where some of the problems and justifications that arose during the development of this thesis are shown. Also, some suggestions were described towards the continuation of the study in the topic of this work, or in the chapter of rules of measurement.

5. Bibliography

After literature research, a characterization of the most relevant documents to this dissertation was carried out. Despite the large number of documents in several countries, the difficulty of consulting and taking into account the proposed objectives, it is considered that the most important literature to the theme is:

- CSRMC – "Curso Sobre Regras de Medição na Construção"[1] – Portugal;
- SMM7 – Standard Method of Measurement 7th edition [5] – United Kingdom;
- SMM7 – Explained an Illustrated [7] – United Kingdom;
- CESMM3 – Civil Engineering Standard Method of Measurement 3rd edition [6] – United Kingdom.

Other documents:

- DIN – Deutsches Institut für Normung [4] – Germany.

6. Technical environment

Several companies were contacted, but only two proved willing to share their knowledge in the measurement rules chapter:

- Grupo Mota-Engil - Engenharia e Construção, Ambiente e Serviços e Concessões de Transportes;

- Somague Concessões e Serviços S.A..

The results obtained in this analysis are not regarded as imperatives, but otherwise considered to be of chief importance in the model proposal, since it is in the technical environment that actual difficulties in rules application are observed.

With the purpose of validation of the measurement rules model, the information provided by the technical environment will be crossed and made compatible with researched information, having as final product the model proposal.

From the meetings with the companies, it was possible to determine the main barriers for using measurement rules and the usual conflicts between contractors and owners. Accordingly, the most frequent problems are:

- Inaccurate reading/misutilization of measurement criteria by contractors in the elaboration of the budget (not being mandatory);
- Usage and definition of inadequate criteria, when these are not defined by the owner;
- Lack of detailed specification of the used materials;
- Ignorance or nonexistence of rules to a certain heading;
- The suitability of certain rules for a practical level does not show results in several cases, those being therefore subjected to modifications, either in project or at the construction site.

After a detailed analysis of the collected information, it was considered that the most important issues to be taken into account in this thesis are:

- Improve the specification of the used materials;
- Conduct a review and update of the existing criteria;
- Creation of inexistent headings.

The close monitoring of the difficulties shown by the technical environment lead to the conclusion that the inexistence of an official mandatory base document that clarifies all doubts and conflicts that may exist is the main cause of the existing problems.

7. Proposal of the measurement rules model

The proposed measurement rules model had the researched and consulted elements as its basis, both in Portugal and internationally. The consultation of the technical environment also assumed a prevailing role in the construction and validation of the model, since it allowed both theoretical and practical analysis.

The proposal of the model adopts a table structure. The main reasons for this decision are:

- Easy reading and comprehension of the rules;

- Objectivity;
- Ease of interaction with the bill of quantities;
- Consistency with the investigations already undertaken.

The organization of the rules is closely linked with the consulted publications, namely the SMM7 [5] and the CESMM 3 [6], which have a table structure.

The adopted frame in the measurement rules proposal is the one described in Table 1:

Table 1 – Standard table of the measurement rules model proposal.

<table>
<tr><td colspan="10">($) Stonework elements</td></tr>
<tr><td colspan="5">Information</td><td>Measurement rules</td><td>Definitions</td><td>Included works</td><td>Additional information</td></tr>
<tr><td colspan="3">Included elements:</td><td colspan="2">Excluded elements:</td><td rowspan="2">R1</td><td rowspan="2">D1</td><td rowspan="2">T1</td><td rowspan="2">I1</td></tr>
<tr><td colspan="5">Classification table</td></tr>
<tr><td>1.</td><td rowspan="2">5.</td><td>9.</td><td>13.</td><td rowspan="2">17.</td><td>R2</td><td>D2</td><td rowspan="2">T2</td><td rowspan="3">I2</td></tr>
<tr><td>2.</td><td rowspan="2">10.</td><td rowspan="2">14.</td><td rowspan="2">R3</td><td rowspan="2">D3</td></tr>
<tr><td>3.</td><td>6.</td><td>11.</td><td>15.</td><td>18.</td><td>D4</td><td>T3</td></tr>
<tr><td>4.</td><td>7.
8.</td><td>12.</td><td>16.</td><td>19.</td><td>R4</td><td>D5</td><td>T4</td><td>I3</td></tr>
</table>

Observing Table 1, it follows that it is divided into four distinct sections, namely;

1. In **area 1**, in the upper part of the table, the designation “($) stonework elements” is shown. The purpose of these designation is to identify the work classes, being represented by a number, symbolized as ($), indicating chapter. The items on the table are referenced based on that header.

Table 2 – Works class area.

($) stonework elements	1

2. **Area 2** is located below the previous area, representing the information related to the included or excluded elements on the respective table. In this zone the elements contained in that table are defined, which will be subject to the rules that the table complies. The excluded elements will have a reference to the table in which they can be consulted.

Table 3 - Area of included/excluded elements

Information	
Included elements	Excluded elements

2

3. **Area 3** is designated as the classification table and embraces five columns, each corresponding to a subdivision of the works approached by the measurement rules. In the first column the most general works are presented, succeeding the second, where a subdivision of these works is presented, the same applying to the third column. The fourth column contains the unit definitions of the previous columns content, and details can be found in the fifth column, usually provided in specific documents.

Table 4 –Classification Table

Classification table				
1.	5.	9.	13.	17.
2.		10.	14.	
3.	6.	11.	15.	18.
4.	7. 8.	12.	16.	19.

3

4. In **area 4** the measurement criteria are presented. This area is located at the right hand of the included and excluded elements and the classification table. The structure of this area is connected to the classification table so it establishes a match between the works and the respective measurement rules. These criteria are subdivided into four columns:

- Measurement rules (**R**): gathers the criteria by which jobs are quantified and how they should be measured;
- Definition rules (**D**): contains the rules that establish the extension and the limits of the work represented by a word or expression used in the rules;
- Included works (**T**): gathers the criteria that define which particular works would be included in each heading of the Quantity Bill, so that the prices presented in the budget reflect the quantity and extension of the works to be done;
- Additional information (**I**): it contains criteria/specifications which should be additionally provided to the description of the included headings.

Table 5 – Measurement criteria area

<table>
<tr><th>Measurement rules</th><th>Definitions</th><th>Included works</th><th>Additional information</th></tr>
<tr><td>R1</td><td>D1</td><td>T1</td><td>I1</td></tr>
<tr><td>R2</td><td>D2</td><td rowspan="2">T2</td><td rowspan="3">I2
4</td></tr>
<tr><td>R3</td><td>D3</td></tr>
<tr><td rowspan="2"></td><td>D4</td><td>T3</td></tr>
<tr><td>R4</td><td>D5</td><td>T4</td><td>I3</td></tr>
</table>

In order to ease and standardize the numbering of the various articles in the bill of quantities, the measurement rules are also numbered. This numbering shall consist of a letter, which refers to the kind of rule, and by a number, which indicates the position in the column.

The rules shall be used and read according to the arrangement of the columns and rows, as described below:

- The rules/items R1, D1, T1 and I1 are found above the classification line and, therefore, are applied to all the items of the section;
- The works in cell 1 use the sub classifications of cells 5 and 9, the units specified in cell 13 and supplementary items indicated in cell 17. The specific rules associated with these items are defined in cells R2, D2, T2 and I2;
- The works in cell 2 use the sub classifications of cells 5 and 10, the units specified in cell 14 and supplementary items indicated in cell 17. The specific rules associated with these items are defined in cells R3, D3, T2 and I2;
- The works in cell 3 use the sub classifications of cells 6 and 11, the units specified in cell 15 and supplementary items indicated in cell 18. The specific rules associated with these items are defined in cells R3, D4, T3 and I2;
- The works in cell 4 can use the sub classifications both of cell 7 and cell 8. This fact is represented in the table with a dashed line.

In short, the rules included in the tables are read from left to right with the horizontal lines defining the relationship between items, sub classifications and specific rules.

8. Conclusions

In the execution of a project, budgeting and task management are a critical activities to prevent deviation on time and cost. Measurement assumes a leading role in the implementation of budgets, since it is through quantitative determination of the work that they are prepared. The lack of regulation and standardization of measurement rules often generates conflicts between owners and contractors. The creation of measurement rules in construction thus becomes essential so the following objectives can be achieved:

- Standardized criteria that support statements in the bill of quantities;
- Standardized measurement criteria used by contractors in preparing their tender proposals;
- Standardized classification systems used in the bill of quantities, budgets, and economic analysis;
- Standardized work criteria for measuring in construction works;
- Reduce conflicts between owners and contractors.

As thesis previously developed, this work has the objective of proposed a model of measurement rules for stonework, carpentry and metalwork on buildings. The lack of legislation and the needs on the national technical environment led to the development of this study, taking into account legislation and other applications (ProNIC) currently used. The study was developed based on the methodology set previously, emphasizing the following aspect:

1. Search for information on existing legislation and publications, both national and international, about rules of measurement applied to secondary elements of stonework, carpentry and metalwork;
2. Classification and coding of the elements described in the bills of quantities;
3. Definition of measurement units, general and specific rules applicable to different building elements.

Through literature research and consulted applications the most relevant documents have been defined. The establishment of contacts with companies allowed an assessment of the current application of measurement rules in Portugal. Subsequently, a comparative analysis between the selected documents and the information gathered in technical environment was made, defining a set of points that were taken into account during this work's development, particularly:

- Information structure: it is concluded that the table type structure is preferred because it allows easy reading and understanding of the rules, facilitating interaction with the task list of the bill of quantities;
- Coding and numbering of the work: it was considered preferable to maintain the type of coding and numbering shown in ProNIC because it allows a greater resemblance to the international bibliography and hence greater uniformity;

- Classification of work: it was considered appropriate to conduct a cross between tasks (stonework, carpentry and metalwork) and elements.

The developed work made possible to identify a number of requirements related to the theme of the rules of measurement. It is considered that the creation of a simple and objective model of measurement rules that fulfills the needs of the technical environment in Portugal, may solve many of the problems experienced in the execution phase.

The scope of measurement rules in Portugal is confined only to the construction of buildings. It is considered that measurement rules should be extended to general construction, in order to standardize its application to any type of work.

On the other hand, this study made possible to determine the need to refine a complete set of specifications and features of constructive elements, namely the classification AEV [2] for windows and doors, frequently unknown or merely not used by technical means.

The development of this work aims to be an integral part of work currently under development aimed at creating a set of measurement rules. The study includes the classification, identification and updating of the main secondary elements of stone, wood and metal, always relying on consulted elements and information acquired from the companies.

Finally, it is considered that the main objectives of this thesis were achieved, with the hope that it will contribute to change the rules of measurement in Portugal.

References

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