QUANTITATIVE ANALYSIS OF CLAY BRICK WASTE GENERATED DURING MASONRY EXECUTION IN RESIDENTIAL BUILDINGS IN THE CITY OF SÃO CARLOS, SÃO PAULO, BRAZIL.

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For many years, there wasn’t an estimate of losses and waste materials during construction processes. In addition, there was no information about the nature of constructive activities, the participation of several agents in the construction of buildings, and origin of waste. Nowadays, the information obtained point out rates of losses in the construction and the waste generated, which have high incidence in the composition of solid waste. The waste can’t be considered only as materials not used in the building site, but as any real loss during the construction process. So, currently in the construction process, planning is needed, from design to material control. This study aimed to quantify the waste of clay bricks generated during the masonry execution of three residential buildings in the Residential Damha 1, city of São Carlos, São Paulo, Brazil. The present research employed the method of follow up of the three works with clay bricks used to seal, the organization and analysis of information, in order to solidify the theoretical base of the study. To survey the generation of the amount of clay bricks waste: the initial and final inventory of material (bricks) for construction of the buildings were specified, the receipt of material (bricks) during the work implementation phase was quantified, and the area of masonry performed was measured. For the data analysis it was needed to calculate the amount of bricks used and required for the masonry execution. From these results the amount of waste generated was estimated. After the masonry was done, it was concluded that the generation of clay brick waste was due to several factors such as: an inefficient schedule of the site layout construction, lack of details in design, transportation losses due to management of large piles of bricks, unskilled workers, among others. Regarding the three buildings construction, there was a waste of 4,016 units of clay bricks. The higher percentage of waste was 7.5%. However, this percentage was considered low, for the masonry execution, because the study took in account only the first story, if the second was included, probably the generated waste would be greater.

Keywords: waste, loss, clay bricks, masonry, fencing

Theme: Construction and practice

INTRODUCTION

The great volume of residues produced each day has become one of the main problems for public administrations. Cities hall need to properly manage these wastes in order to avoid environmental, health, social, and economic problems that may impact the population (Xavier and Rocha, 2001). The waste or losses generated in civil construction are due to lack of design planning and building execution. The crescent and continuous increasing quantity of
waste from construction and demolition and the impacts they caused to the cities show the importance of management to reduce, reuse and recycle them. Thus, this study will analyze the loss rate of clay bricks masonry in the construction of residential buildings.

OBJECTIVES

The objectives of this study were:

- Quantify the clay brick masonry waste in the construction of three residential buildings.
- Compare the amount of waste generated by the bricks used in three residential buildings.
- Identify the causes that generated waste in the construction of the three buildings studied.

METHODOLOGY

Object

The object of this study was three constructions of two-stories residences located in the Residential Damha 1, in São Carlos, São Paulo (SP), Brazil.

Construction 1 (Figure 1)

![Construction 1 on lot 428 located in the Residential Damha 1, São Carlos, SP, Brazil.](image-url)
Localization: lot 428.
Hand-to-work: 3 bricklayers and 2 servants.
Material used for the masonry execution: clay brick ASF 10x4, 5x21.

*Construction 2 (Figure 2)*

![Construction 2](image)

*Figure 2* – Construction 2 on lot 86 located in the Residential Damha 1, São Carlos, SP, Brazil.

Localization: lot 86.
Hand-to-work: 3 bricklayers and 2 servants.
Material used for the masonry execution: clay brick JRS 10x4,5x21.

*Construction 3 (Figure 3)*

![Construction 3](image)

*Figure 3* – Construction 3 on lot 279 located in the Residential Damha 1, São Carlos, SP, Brazil.
Localization: lot 279.
Hand-to-work: 1 bricklayer and 1 servant.
Material used for the masonry execution: clay brick OV 10x5x21.

Method

Follow up of the components used to seal, information organization and analysis, in order to solidify the theoretical base of the study.

The works were followed twice a week for a period of three months, depending on the course of the work and receipt of materials.

Because of the delay in the three constructions, for calculations reason, it was considered only the execution of the first story.

The masonry type studied was the clay bricks, and their dimensions were in accord to the project.

The amount of bricks waste surveied was calculated in the following steps:

- quantification of the initial and final stock of material (bricks) for construction of the buildings;
- quantification of the receipt of material (bricks) during the execution of the work;
- measure of the masonry area performed.

Data Analysis

Equation 1 - \( A = B - C \), for calculation of the amount of bricks used, where:
- \( A \) = number of bricks used;
- \( B \) = bricks stock at the beginning + bricks received;
- \( C \) = bricks stock at the end.

Equation 2 - \( D = E / F \), for calculation of the amount of bricks required to perform the masonry, where:
- \( D \) = number of bricks required;
- \( E \) = total area of masonry executed;
- \( F \) = brick area.

Equation 3 - \( R = A - D \), for calculation of the amount of waste generated, where:
- \( R \) = waste generated;
- \( A \) = number of bricks used;
- \( D \) = number of bricks required.
The data analysis considered:

- Comparison of the amount of waste generated from the bricks used in the three buildings.
- Analysis of the amount of waste generated by the bricks and the volume they would occupy in a landfill.
- Analysis of the environmental impacts caused by these materials (bricks) improperly disposed.

In this way it was possible to analyze and quantify the clay bricks waste in the masonry execution of a building.

RESULTS AND DISCUSSION

Number of Bricks used and Amount of Waste Generated

The number of bricks used in construction 1 is presented at Table 1.

<table>
<thead>
<tr>
<th>Situation</th>
<th>Amount (units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial stock</td>
<td>12,000</td>
</tr>
<tr>
<td>Receipt</td>
<td>22,000</td>
</tr>
<tr>
<td>Final stock</td>
<td>1,665</td>
</tr>
<tr>
<td>TOTAL</td>
<td>33,335</td>
</tr>
</tbody>
</table>

The total masonry area executed was 302.52 m².

The amount of bricks required for the masonry execution was 32,013 units, considering the brick area equal to 0.00945 m² (302.52 m²/0.00945 m²).

The amount of waste bricks generated for this work was 1,322 units (33,335 – 32,013), which corresponds to 4% (33,335/32,013 =1.04).

The number of bricks used in construction 2 is presented at Table 2.

<table>
<thead>
<tr>
<th>Situation</th>
<th>Amount (units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial stock</td>
<td>10,000</td>
</tr>
<tr>
<td>Receipt</td>
<td>17,500</td>
</tr>
<tr>
<td>Final stock</td>
<td>19,77</td>
</tr>
<tr>
<td>TOTAL</td>
<td>25,523</td>
</tr>
</tbody>
</table>
The total masonry area executed was 227.40 m².

The amount of bricks required for the masonry execution was 24,063 units, considering the brick area equal to 0.00945 m² (227.40 m²/0.00945 m²).

The amount of waste bricks generated for this work was 1,460 units (25,523 – 24,063), which corresponds to 6% (25,523/24,063 = 1.06).

The number of bricks used in construction 3 is presented at Table 3.

**Table 3 - Number of bricks used in construction 3.**

<table>
<thead>
<tr>
<th>Situation</th>
<th>Amount (units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial stock</td>
<td>10,000</td>
</tr>
<tr>
<td>Receipt</td>
<td>11,000</td>
</tr>
<tr>
<td>Final stock</td>
<td>3,418</td>
</tr>
<tr>
<td>TOTAL</td>
<td>17,582</td>
</tr>
</tbody>
</table>

The total masonry area executed was 154.48 m².

The amount of bricks required for the masonry execution was 16,348 units, considering the brick area equal to 0.00945 m² (154.48 m²/0.00945 m²).

The amount of waste bricks generated for this work was 1,234 units (17,582 – 16,348), which corresponds to 7.5% (17,582/16,348 = 1.075).

**Comparison of the Three Constructions**

The construction 1 had the lowest loss rate (4%) (Table 4), probably due to the layout of the building site better planned. The pile of bricks was in a clean area and isolated from other materials, what made easy the access and mobility to carry them. The manpower employed had experience and was effective in the masonry execution. The building site was always clean, there weren't material scattered and broken bricks at the site.

**Table 4 - Number of bricks required and used for sealing, amount of brick and percentage of waste generated.**

<table>
<thead>
<tr>
<th>Construction</th>
<th>Number of bricks required (units)</th>
<th>Number of bricks used (units)</th>
<th>Brick waste generated (units)</th>
<th>Waste generated (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32,013</td>
<td>33,335</td>
<td>1,322</td>
<td>4.0</td>
</tr>
<tr>
<td>2</td>
<td>24,063</td>
<td>25,523</td>
<td>1,460</td>
<td>6.0</td>
</tr>
<tr>
<td>3</td>
<td>16,348</td>
<td>17,582</td>
<td>1,234</td>
<td>7.5</td>
</tr>
</tbody>
</table>
The construction 2 had 6% of loss rate (Table 4). It was observed that its building site was always full of materials and there were a lot of broken bricks next to big piles. Because of lack of space the workers couldn’t move and access the materials, they always beat themselves on the piles.

The construction 3 had the highest loss rate (7.5%) (Table 4). This loss can be associated to a reduced number of workers, they had to do a lot of effort to carry the bricks. The building site was well planned, had an easy access and was located on a clean space. However, it was noted that there were a lot of broken bricks next to big piles.

According to Pinto (1989) the percentage of actual loss of sealing components is 12.73%, while for Soibelman (1993) who studied the waste of five upper-middle class in Porto Alegre, the value found was 26.94% for solid bricks. The values obtained in the present study differ from those in the literature, this fact can be explained, mainly, because of a better qualification of manpower, the building site organization, and quality of the executive project.

In this study, the percentage found of real losses of sealing components was lower than that reported by Pinto (1989), because it was evaluated only the first-story losses, if the second-story masonry execution would be included, the total losses would be greater.

The measurement of the masonry total area executed didn’t consider the thickness of the mortar used. If it was estimated, the amount of bricks would be lesser and the waste greater.

The manpower was considered unskilled when it had lack of training for waste management, turnover of workers in the works, and reduced number of workers on site. It is important to point out that never it was seen the presence of a responsible engineer.

From the aspects observed, at works follow up, such as building site ocupation, projects without specific details, it is possible to establish the causes of the clay bricks waste, which are:

- Transport losses due to excessive or improper handling of bricks, as double handling and carelessness with the use of transport equipment.
- Unskilled and not trained manpower to manage the waste generated.
- Losses during the procedure because of inadequate execution process, for example, to break bricks manually due to lack of half-bricks.
- Inefficient layout of the building site generated excessive time spent in transportation because of the distance between the stock and the area of execution.
- The worker needed to do excessive effort because of unfavorable ergonomic conditions.
- Losses due to the existence of excessive stocks and very high piles because of an inadequate programm for material delivery or mistakes in the budget.
FINAL CONSIDERATIONS

From the quantitative analysis of clay brick waste generated during the masonry execution in the three buildings, it is possible to conclude that:

- the three constructions all together generated 4,016 units of clay brick waste;
- the construction 3 generated the highest percentage of waste (7.5%), while the constructions 1 and 2, 4% and 6%, respectively;
- during the constructions follow up, was observed that there are several causes for the generation of clay bricks waste: inefficient layout of the building site, project without detailment, bad handling during transportation of material. However, in the present study, the main causes of waste were: great piles of bricks and unskilled manpower.

The percentage of clay brick waste generated was considered low because the study was made only in one stage of the masonry execution (first story), if it would be included the losses execution of the second story, probably the waste generation would be greater.

This work provided information to confirm the theory data about the amount of waste generated in civil construction during the sealing stage. Besides, the data obtained may contribute to decrease those waste generation.

REFERENCES RECOMMENDED


