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Sheila Belayutham ·
Che Khairil Izam Che Ibrahim ·
Anizahyati Alisibramulisi ·
Hazrina Mansor · Muntasir Billah *Editors*

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Editors
Sheila Belayutham
School of Civil Engineering, College of Engineering
Universiti Teknologi MARA
Shah Alam, Selangor, Malaysia

Che Khairil Izam Che Ibrahim
School of Civil Engineering, College of Engineering
Universiti Teknologi MARA
Shah Alam, Selangor, Malaysia

Anizahyati Alisibramulisi
School of Civil Engineering, College of Engineering
Universiti Teknologi MARA
Shah Alam, Selangor, Malaysia

Hazrina Mansor
School of Civil Engineering, College of Engineering
Universiti Teknologi MARA
Shah Alam, Selangor, Malaysia

Muntasir Billah
Department of Civil Engineering
Lakehead University
Thunder Bay, ON, Canada

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Contents

Experiment to Determine Worker Needs Index in Brick Work with Space Mold Tools

Albani Musyafa', Irsyad Hanif Ansori, and Muchammad Rizky Anugrah

Abstract Indonesian people are experiencing a huge backlog of decent housing. The data shows that almost a third of the houses in Indonesia are categorized as unfit for housing. This means the backlog can reach 22 million homes. This number continues to grow along with population growth and insufficient supply of livable homes. With these conditions, Indonesian people must increase the construction of livable homes. Brick wall houses are increasingly in demand by the community. Based on the government's program to increase the production of livable homes, the productivity of works in the construction of these houses must also be increased. One way to increase productivity is to use equipment that can speed up the process of installing spaces (mortar). For this reason, it is necessary to experiment with the use of these spacing molds in brick work. The purpose of this research was to determine the worker's need on the work of masonry wall with mortar spacing molds. The benefit that can be taken from this research is that the results can be used as a reference for construction services in estimating the productivity of laborers. With the increased productivity of this work, it is expected to help overcome the problem of the backlog. The experimental research object is the labor productivity of the couple's brick work. The research sample is a worker who works on residential development in Sleman, Yogyakarta. The data of this research are the results of the total time and effective time of the work of masonry performed by 18 masons. The calculation of work time is expressed in units of seconds. The production unit takes 70 bricks which is equivalent to 1 m^2. In conclusion, the index of need for workers on brick wall pair work is 0.7. The need was validated by t-test which showed that the use of this mortar spacing tool significantly increased productivity. Therefore, to

A. Musyafa' (✉) · I. H. Ansori · M. R. Anugrah
Civil Engineering, Universitas Islam Indonesia, JL. Kaliurang KM 14.5, Sleman Yogyakarta 55582, Indonesia
e-mail: 955110102@uii.ac.id

I. H. Ansori
e-mail: 17511078@students.uii.ac.id

M. R. Anugrah
e-mail: 17511213@students.uii.ac.id

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improve the productivity of masons in the work of masonry spaced molding tools should be used.

Keywords Productivity · Worker index · Masonry work · Space mold · Housing

1 Background

Shortage of appropriate housing in Indonesia today is still very large. Taking into account the rate of population growth and demolishing, the shortfall can be overcome if the production of livable homes in Indonesia reaches 2 million units per year over the next 25 years [1].

Because of the great need for the house, in 2015 the government launched a project of 1 million homes each year. However, to be able to meet the house production target that can be categorized as a high amount like that, we need a high amount of production. Therefore, it is necessary to increase production capacity. These efforts, one of which is the selection of work implementation methods that can produce material efficiency. These efficiency efforts must be developed in the process of building houses in Indonesia, from the beginning to the end of the process, as well as in small and large scope [2].

As the construction process in general, in the construction of houses, there is also material left over because it is wasted. In the work of masonry for walls, a lot of wasted material is mortar. This is due to the installation of mortar on the brick freely or does not have a mortar retaining system that allows the mortar not to fall. In reality, many of the fallen mortars were not taken any more so they were wasted. Mortar is composed of PC cement and tidal sand so that it has a significant value. In fact, the weight of this wall work is about 20% of the total construction cost [3].

Moreover, many workers do the work without using tools other than petting, resulting in widespread inefficiency of the mortar material. The volume of falling mortar can be reduced if the mortar installation is assisted by a mold that can withstand the fall of the mortar. This mortar mold has the function to form a species with a thickness and width as needed. In addition, this mold must be light enough so that it can be operated by a handyman. The significance of the use of these molds to reduce the volume of wasted mortar needs to be examined.

2 Purpose and Objective

The purpose of this study was to determine the efficiency of mortar requirements in the work of masonry walls using special molds.

3 Benefit

The results of this study can be used by implementers as information in determining the index of mortar needs in brickwork. In addition, the results of this study can also be used by related parties to persuade the public to do efficiency in the work of masonry pairs.

4 Literature Review

4.1 House Backlog

House backlog is one of the indicators used by the Government as stated in Rencana Strategis (Renstra) or strategic plan as well as Rencana Pembangunan Jangka Menengah (RPJMN) or Medium-term Development Plan related to the housing sector to measure the number of housing needs in Indonesia. House backlog can be measured from two perspectives, from the residential and ownership aspects.

House backlog from the perspective of occupancy is calculated by referring to the ideal calculation concept: 1 family occupies 1 house. The formula used to calculate a house backlog from an occupancy perspective is:

$$\text{Backlog} = \sum \text{Family} - \sum \text{House}$$

In the attachment of Book 1 of the Republic of Indonesia's Presidential Regulation Number 2 of 2015 concerning the 2015–2019 National Mid-Term Development Plan (RPJMN), the baseline backlog of residential homes in Indonesia in 2014 was 7.6 million.

The concept of inhabiting in the calculation of the backlog represents that each family is not required to have a house, but the Government facilitates/encourages every family, especially those who belong to Low Income Communities (MBR) can inhabit a decent home, either by leasing/contracting, buying/inhabiting their own home, or living in a house owned by relatives/family as long as the certainty of living (secure tenure).

Ownership backlog is calculated based on the home ownership rate/percentage of households (households) occupying their own home. The basic data source used in this calculation is sourced from BPS data.

In the context of utilizing data and information to support the implementation of the task of channeling and managing funds the FLPP (Fasilitas Likuiditas Pembiayaan Perumahan) or Housing Financing Liquidity Facility, PPDPP (Pusat Pengelolaan Dana Pembiayaan Perumahan) or Center for Housing Financing Management continue to utilize various strategic housing data. Please note that the first paragraph

of a section or subsection is not indented. The first paragraphs that follows a table, figure, equation etc. does not have an indent, either.

4.2 Brick Work

Basically, there are two building blocks for bricks, namely bricks and mortar. Brick is a building material in the form of blocks, generally measuring about 5 × 11 × 22 cm, which is made from soil that is burned in high temperatures so that it has a certain strength and is not easily destroyed.

Mortar is a mixture of cement, sand and water with a certain composition with the function as a binding agent between bricks. When still wet, the mortar is soft, but after the binding process by the PC, the mortar will harden so that it has a certain compressive strength. Therefore, the mortar must have a certain thickness, dry time, and strength so that it is expected that the mortar holding the compressive force due to the load acting on it is not destroyed. There are 3 main constituents of mortar, namely cement, fine aggregate (sand) and water.

In accordance with practice in the field, there are several types of brick wall installation, one of which is a pair of ½ stone, namely lengthwise brick installation with red brick width as the wall thickness. This type of couple is often found in residential construction.

Efforts for cost efficiency in the construction of residential houses can be done on brickwork. The work of brick masons has a significant weight on the construction of these houses.

Theoretically, the need for mortar is the specific volume between bricks in a masonry wall. The volume of this space can be calculated by the surface area of the space on the wall multiplied by the thickness of the wall or brick. Basically, the surface area of the wall consists of brick side and spaced surfaces. Thus, if in 1 square meter the walls are 70 pieces of brick size 5 × 11 × 22 [4], then the volume of spacing is: 23,0001 cm^3. This means that the thickness of the space is approximately 1 cm in both horizontal and vertical spaces. Proportionally, if the spacing is 1.5 cm thick, the volume of spacing is 34,500 cm^3 or 0.0345 m^3. However, this volume is a theoretical requirement. This need will be noted in experiments.

To achieve these research objectives, first look for the value of mortar needs in brick masonry work with methods that use spacing molds and methods that do not use spacing molds. From these two values, the efficiency of mortar requirements is determined.

4.3 Space Mold

In the field of construction, many tools are created or developed to make work more efficient. Efficiency can be obtained in terms of time, cost and quality [5]. In

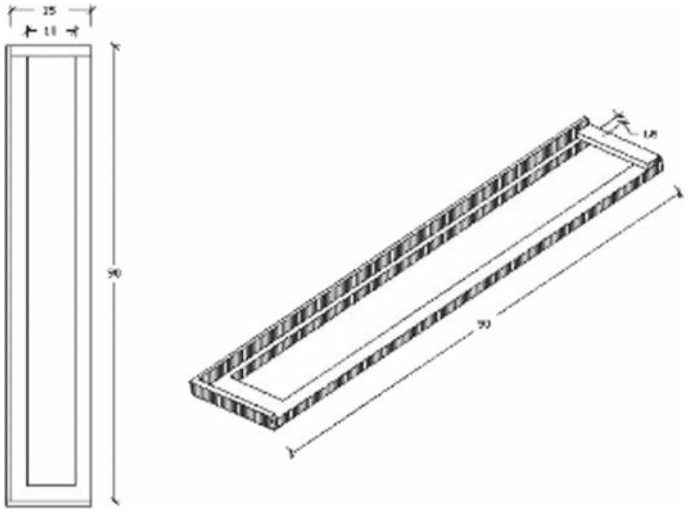

Fig. 1 Spacing mold

brickwork, a tool that can be used is a space mold. Besides making it tidier and easier to install mortar on bricks with mold aids can save the use of mortar because there's not that many mortars falling and is wasted.

Savings or efficiency in the use of mortar materials are the focus of this study. This efficiency means that by using this tool, the same volume of work can be achieved with less mortar [6]. In other words, with a smaller amount of mortar, will produce a product with the same volume.

The spacing tool used in this study is shown in Fig. 1. The way this tool works is: put the mold under the row of bricks to be installed; fill the mold with mortar; The mortar is lifted or moved; then the brick is placed on the printed mortar. This tool is made of wood with a size as shown in the picture.

4.4 Construction Worker

Explicitly, there is no definition of construction worker in the Law on Construction Services or PP on Business and the Role of the Construction Services Community. However, there is a requirement for Construction Workers as stipulated in Article 70 paragraph 1 of the UUJK: "Every construction worker working in the Construction Services field must have a Work Competency Certificate."

In the 2017 UUJK it is not explicitly mentioned who is included in the construction workforce. In fact, in the 1999 UUJK there is information about who must have a work competency certificate (article 9).

Construction workers have certain classifications and qualifications. Construction workers are classified based on scientific fields related to construction services, namely:

- Architecture
- Civil
- Mechanical
- Environmental governance
- Implementation management

Construction workers are qualified in positions:

- Operator
- Technician or analyst
- Expert

Each qualification position is still divided into levels/levels according to their abilities and experience.

4.5 Productivity

Productivity is the ratio between the results of activities (outputs) and all the sacrifices (costs) to realize these results (inputs) [7]. Inputs can include production costs and equipment costs. While output can consist of sales, earnings (income), market share, and damage (defects) [8].

Many studies have shown that productivity is strongly influenced by factors: knowledge, skills, abilities, attitudes, and behaviors of workers in the organization so that many productivity improvement programs put these as basic assumptions [8].

Increasing productivity can be achieved by minimizing all kinds of costs including in utilizing human resources (do the right thing) and increasing output as much as possible (do the thing right) [9]. In other words that productivity is a reflection of the level of efficiency and total work effectiveness [10].

In general productivity is defined as the relationship between real and physical results (goods or services) with the actual entry [11]. Productivity is also defined as the level of efficiency in producing goods or services. Productivity is also interpreted as:

(a) Comparison of price measures for inputs and results
(b) The difference between a collection of total expenditure and inputs expressed in general units.

The best-known measure of productivity is related to labor which can be calculated by dividing expenditure by the amount used or the hours worked by people.

5 Method

This type of research is an experiment, namely by testing the two methods, namely using and not using a space print. Of the two types of methods tested, the volume of mortar data is used.

The steps in the research are as follows. Determine the size of the brick used is 5 × 11 × 22 [4]. Determine the space between the bricks that is 1.5 cm both for vertical and horizontal. Determine the size of the wall area as an experimental cycle of 1 m^2, half a stone thick, consisting of 70 bricks [4] with 4 layers of brick or horizontal spaces. Determine the composition of the ingredients making up mortar 1PC:8PP. Prepare sufficient mortar, determine the craftsman who will do the experiment, which consists of 7 workers who each do 3 times of experiment so that there are 21 times of experiment in each method. So that in total in this study there were 42 experiments. Then, record the need for mortar material for each experiment.

Data processing is done by comparing the average value of mortar use for each method. Validation is done by t test two related samples [12]. Experiments carried out in the area of Caturharjo, Sleman, Yogyakarta.

6 Result and Analysis

The results of 42 experiments, carried out in each method of implementation, can be seen in Table 1. The experiment was carried out by 7 workers, so each worker conducted 6 experiments with details of 3experiments with mold equipment and 3 experiments without mold equipment.

Table 1 shows the volume of mortar needed in each experiment, whether or not using a spacebar. The volume of the mortar is calculated by reducing the volume of the mortar before installation with the volume of the remaining mortar. In this experiment mortar that fell in the installation process was not taken.

In general, the experiments carried out in this study went according to plan. Workers as an important part of the research instrument seems to be doing their job well. The experiment was considered to be going well because the standard deviations of the duration of the 2 methods were not too different i.e. 203,719 and 207,703. In addition, the duration of the implementation of the two experimental methods by workers has a correlation of 0.951 which can be interpreted that the workers perform two ways of carrying out experiments with the same conditions.

Theoretically, Table 2 shows that the amount of wasted mortar will be lowered if the brickwork is done with mold equipment. If using a spacing mold, the wasted mortar is 0.004 m^3, whereas if without the mold, the wasted mortar is 0.0156 m^3. The use of this mold can reduce wasted mortar by 0.152 per m^2 masonry. The table also shows that the use of molding tools in brick wall installation can save about 23% of the volume of mortar. These savings are proven to be consistent from the results of the t-test of two related samples [13].

Table 1 Mortar needs data for 1 m^3 bricks

Sample	Production time with mold (s)	With mold (m^3)	Production time without mold (s)	Without mold (m^3)
1	1697	0.0416	1458	0.0523
2	1633	0.0403	1532	0.0502
3	1553	0.0396	1547	0.0530
4	1451	0.0396	1275	0.0502
5	1388	0.0406	1264	0.0495
6	1402	0.0396	1304	0.0516
7	1501	0.0374	1306	0.0516
8	1433	0.0385	1324	0.0502
9	1368	0.0388	1295	0.0502
10	1262	0.0353	986	0.0487
11	1187	0.0364	954	0.0195
12	1205	0.0346	1012	0.0480
13	1843	0.0360	1613	0.0495
14	1869	0.0364	1642	0.0484
15	1835	0.0360	1623	0.0487
16	1562	0.0410	1380	0.0480
17	1527	0.0381	1361	030,484
18	1495	0.0392	1327	0.0491
19	1314	0.0385	1154	0.0509
20	1291	0.0410	1097	0.0519
21	1298	0.0374	1126	0.0516
Total	31,114	0.8059	27,580	1.0515
Average	1482	0.0384	1313	0.0501

Table 2 Primary data description

Data	Minimum	Maximum	Mean	Standard deviation
Work duration with mold	1187	1869	1481.62	203.719
M^3 mortar with mold	0.0346	0.0416	0.038376	0.0020371
Work duration without mold	954	1642	1313.33	207.703
M^3 mortar without mold	0.0480	0.0530	0.050071	0.0014917

As is known that the composition of the mortar is cement and sand with a ratio of 1:8. To find out the efficiency of the ingredients of mortar, which is cement and sand, the volume of each ingredient needs to be calculated. The calculation is based on the index of material needs.

Table 3 Table of material needs index

Material needs	Unit	Index
Red brick	Piece	70
PC	Kg	6.5
PP	M3	0.05

Table 4 Material requirements in brickwork work according to experiments

Material	With mold		Without mold	
	Cement	Sand	Cement	Sand
Volume	4.992 kg	0.0384 m^3	6.5 kg	0.05 m^3
Price (IDR)	1275	115,000	1275	115,000
Cost (IDR)	6364.8	4416	8287.5	5750
Total (IDR)	10,780.8		14,037.5	

Material requirements for installing 1 m^2 of red brick walls measuring 5 × 11 × 22 cm ½ brick thick, mixed species 1 PC:8 PP is as shown in Table 3 [4]. Please note that, the composition of 6.5 kg PC and 0.05 m^3 of sand will form 1PC: 8 PS mortar of 0.05 m^3 as well. This is because the grains of cement only fill cavities between the grains of sand. Therefore, the material requirements for brickwork in accordance with the specifications in this experiment can be determined according to Table 4.

The table shows the average value of the required volume of cement and sand material in each method of carrying out the work in the experiment. The cost for these ingredients can be determined by multiplying the volume of the material and the unit price of the material. Although, the price of the work unit consists of 3 (three) components, i.e.: unit price of material/material, unit price of labor wages, unit price of equipment [4], in this discussion only alludes to the cost component that comes from the material.

The cost of the couple's work can be seen in Table 4. Cost savings derived from materials obtained by using these spaced molding tools alone reach more than 23%. If the cost of the masonry work can be saved 23% and the cost of wall installation is 11% of the whole building [3], then the use of this tool alone can save costs about 2.5% of the total cost of home construction. By using this tool, the brickwork process is expected to be able to save more material needs. This is because the species mold tool is able to minimize wasting mortar. Even if it is carried out by skilled workers, this special molding tool is able to reduce the duration of the brickwork.

7 Conclusion and Suggestion

Based on the analysis and discussion that has been done, it can be concluded that the influence of the use of spaced molding tools on brickwork can save mortar by 23%,

or can save costs by 23.2% if using a mixture of 1PC: 8 PP. Besides saving material, the spacing molding tool also results in a tidier job. Therefore, to the construction implementer to be able to use the spacing molding tool in brickwork.

On a national scale, these savings will definitely be very meaningful. Moreover, the Indonesian people now still need the construction of millions of housing units each year [1]. The success of this development program is influenced by effective and efficient implementation methods. Therefore, the results of this study are expected to contribute to the success of the development program. Besides that, with the spaces mold, the results of the work should be tidier. This tidiness adds to the quality of construction results. Besides that, the tidiness also had a positive impact on the plastering work [6].

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