

# PROCEEDINGS THE 3<sup>rd</sup> RESEARCH SYMPOSIUM 2018



UNIVERSITY OF VOCATIONAL TECHNOLOGY



N TEACHING LANGUAGES. MULTIMEDIA AND WEB TECHNOLOGY.  
MANAGEMENT TECHNOLOGY. BUILDING SERVICES TECHNOLOGY.  
OD PRODUCTION  
NOVATIVE CONSTRUCTION TECHNOLOGIES. SUSTAINABILITY AND

*Emerging Technologies for Industrial Sustenance*

# **PROCEEDINGS**

## **The 3<sup>rd</sup> Research Symposium 2018**

University of Vocational Technology

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*Emerging Technologies for Industrial Sustenance*

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# DEFINING THE EFFECTIVE SIZE AND PROPORTIONS OF A MUD-CONCRETE BLOCK

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## ABSTRACT

*This paper presents how to define the effective size and proportion for a novel, self-compacting masonry walling material named Mud-Concrete, which is developed to achieve the sustainable goals in the construction industry. Whilst thinking of sustainable approaches of introducing the product to market, the block sizes, proportions should be rationalized and socially acceptable. Thus, qualitative methods were adopted to analyze the social acceptance of selecting the effective sizes and proportions of Mud-Concrete block considering the golden proportions. Results defined that 225mm x 100mm x 200mm is the most preferable Mud-Concrete block type, because people are more familiar with the proportions which are already existing.*

**Keywords:** Block sizes, proportions, golden proportions, Sustainable, Mud-Concrete Block (MCB)

## 1. INTRODUCTION

Aesthetics treats the natures and conditions of occurrence of various human experiences such as the experiences of the beautiful, the garish, and the cute, while the philosophy of art in contrast treats the nature of works of art (Eldridge, 1985). Aesthetic concepts in design are always linked with the visual aspects, though it is structurally viable or not. Indeed, the appearance may be an essential part of purpose or use. 'Engineering' and 'Aesthetics' are not isolated disciplines, having as they do links with many other disciplines as well (Kulasuriya et al., 2002). Thus, the form making and maintaining the correct proportions with shapes are one of the main core concepts of aesthetics. While form often includes a sense of three-dimensional mass or volume; shape refers more specially to the essential aspects of form that governs its appearance. Size is the characteristic outline or surface configuration of particular forms and it is the key aspect of identifying and categorizing different forms. The Fibonacci numbers and golden proportions (length/width=1.6) gave a great lead to this research when analyzing the relationship between form, shape and size, (Han et al., 2012), (Vogel, 1979), (Fiorenza and Vincenzi, 2013). The Sequence has been described as the "magical intersection" between the fields of mathematics and beauty, and that is exactly what it is. Fibonacci proved that everything has a reason for its formation or the existence in nature and helped people understand why things are the way they are (Han et al., 2012), (Fiorenza and Vincenzi, 2013). With this thought, a literature survey was done to explore whether the conventional soil-based masonry blocks (fired and unfired) can be introduced to the market with these concepts.

Bricks and blocks are produced in many formats as solid, perforated and hollow. Bricks are typically 215mm x 102mm x 65 mm (length x width x height). Whilst conventional sized blocks are available in lengths 400mm x 600mm, heights 150mm x 300mm and a wide range of thicknesses between 60 mm to 250 mm (Hendry, 2001). According to the SLS standards, the minimum required wall thickness, handling considerations (weight) and method of compaction governed the block dimension of Compressed Stabilized Earth Blocks (CSEB) (Sri Lankan Standard Institute, 2009).

Table 1: Work Sizes of CSEB Blocks

Block Type	Length (mm)	Width (mm)	Height (mm)	Block Description
I	230	110	75	Plain block
II	240	115	90	Solid or hollow block
III	290	140	90	plain or interlocking block
IV	220	140	130	plain or interlocking block
V	220	220	130	plain or interlocking block

(Source: Sri Lankan Standard Institute, 2009)

Table 1 shows the different work sizes of CSEB blocks. According to the face dimensions and width of the block the purchaser can specify the work size of the required CSEB block during a construction.

This paper focuses on a novel walling material called Mud-Concrete which is produced using soil, cement and water (Arooz and Halwatura, 2017, Halwatura, 2016, Arooz et al., 2017). It is a self-compacting material which is capable of self-consolidating without any external efforts like vibration or poking. With this quality Mud-Concrete can be formed in any shape and size using an appropriate formwork. But achieving the sustainable demands while maintaining the public preference needs a lot more attention when introducing a block masonry to the market. As to initiate the whole composition visually attractive the golden ratio was integrated into each block type. Thus, the main objective of this study is to identify the effective block size and proportion of a proposed Mud-Concrete Block. As a result, the following methodology was adopted.

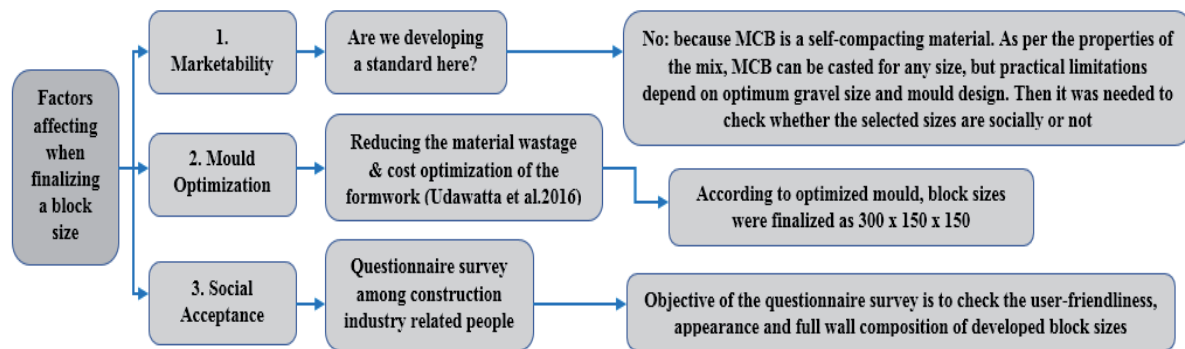


Figure 1: Factors Affecting the Finalizing of a Size of a Masonry Block

## 2. METHODOLOGY

In this methodology, the first section was analyzed through a literature survey. Thus, a question was raised as “what the exact factors are affecting the defining of the size of a masonry block when introducing it to the general public?” Figure 1 shows that three (03) factors mainly affect the finalizing of a block size such as, marketability, mould optimization and social acceptance on defining the effective sizes and proportions of the block. Developing a standard block size mainly affects the factor of marketability. However, Mud-Concrete being a self-compacting material, theoretically it can be formed in any size while catering to the optimum gravel size of the mix design. Because gravel governs the strength of Mud-Concrete mix. According to mix design of the Mud-Concrete the optimum gravel size is 4.75mm -20mm in 35% of the total weight of the dry mix (Arooz and Halwatura, 2017). Therefore, the selected block size should be capable to keep enough gravel, sand and fine with its porous structure while achieving its minimum 2.8 N/mm<sup>2</sup> (dry strength) with 4% cement from the dry mix. Subsequently, there was a need to check whether the selected block sizes are socially acceptable or not. Thus, a questionnaire

survey was conducted among a selected sample of 260 people who were related to the construction industry (Ex: Architects, Engineers, Quantity surveyors and construction workers). The two (02) attributes were considered in developing the physical proportions of a Mud-Concrete block as follows: 1] Appearance (Bonded block pattern of a wall) and 2] Size (Length, width, height and the weight of an individual block).

These two attributes were directly used to prepare the questionnaire and analyze the findings of the study.

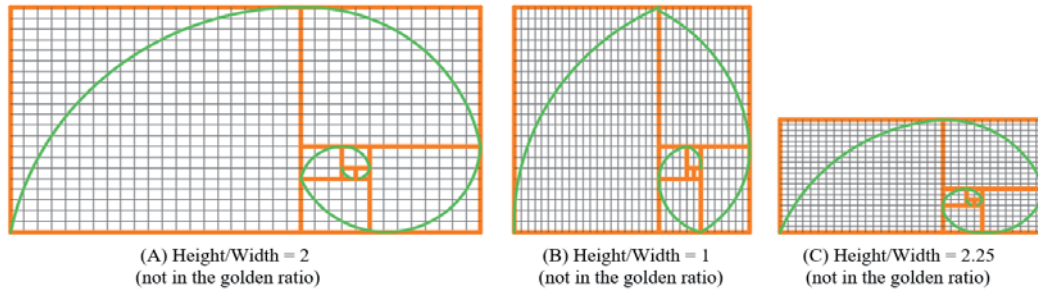


Figure 2: Height to Width Ratio of Block Type "A", "B" and "C" (source: author)

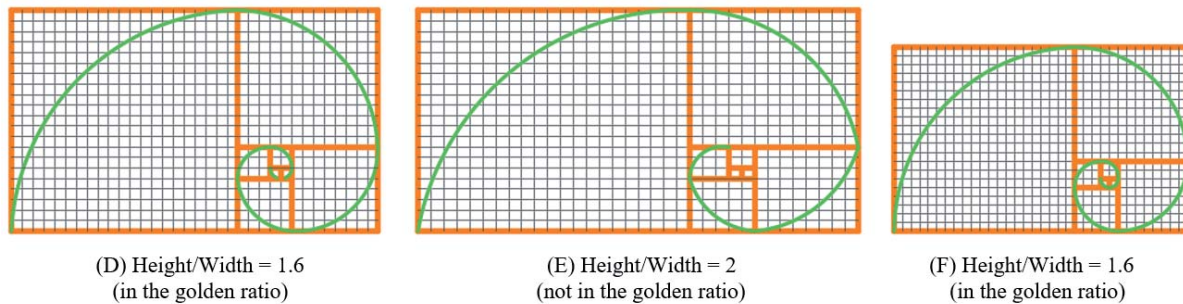


Figure 3: Height to Width Ratio of Block Type "D", "E" and "F" (source: author)

Table 2: Details of Used Mud-Concrete Block Types for Questionnaire Survey

Block Type	(Length x Height x Depth)	Reasons for size selection
A	400 x 200 x 200	Similar proportions to standard concrete blocks
B	200 x 200 x 200	Square shape block
C	225 x 100 x 200	Similar proportions to standard engineering bricks
		(Though the standard brick size is 215 x 65 x 102.5 mm
		225 x 100 x 200 mm was used depending on the
		Maximum aggregate size of the MCB mixture
D	250 x 150 x 200	1.6 - Follows the golden ratio (large size)
E	300 x 150 x 200	Sizes according to the optimized mould (Udawatta et al., 2016)
F	200 x 125 x 200	1.6 – Follows the golden ratio (Small size)

Though there was a size (300x150x150) mm finalized through the study based on mould optimization, it was interesting to know whether these sizes are acceptable in the public eye who were willing to use these



technologies. Therefore, the first step of the research was commenced through casting different types of MCB as shown in Table 2. A few blocks from each type were kept presenting the size (Length, width, height and the weight of an individual block) of the block to the selected respondents. After that 3'-0" x 4'-0" walls were constructed from each block type. Stretcher bond was used in every single wall construction. The selected respondents (sample) were asked to answer the given questionnaire and rate their preferences. The rating system was graded as 0 (rejected)= 1, 1(very poor) =2, 3(poor)= 3, 3(satisfactory)=4, 4(good)=5, 5(very good) =6.

### 3. RESULTS & DISCUSSION

In the investigation on defining the appearance, it was found that a considerable number of respondents preferred block type "C" and "E" (Figure 4). In addition, block type "A" also received a reasonable number of preferences where the results reached for satisfactory level. The second investigation was carried out to define the size of the Mud-Concrete block (Figure 5). Here it was found that the most preferred block types were "C". Further, the block type "E" also reached to the satisfactory level. Despite the fact that the Fibonacci code and golden ratio has given the great explanation in nature forms, respondents preferred the type "C" more, (225mm x 100mm x 200mm) which was similar to the proportions of the standard brick size. Then an argument could be made that people don't want something truly new, they want the familiar things done differently. But the block type "E", the size derived from formwork optimization was also acceptable and it also reached to the satisfactory level of the respondents. The block types "D" and "F", which follows the 1:6 golden ratio have given the similar responses. The block type "B", the square one is the least preferable form of MCB.

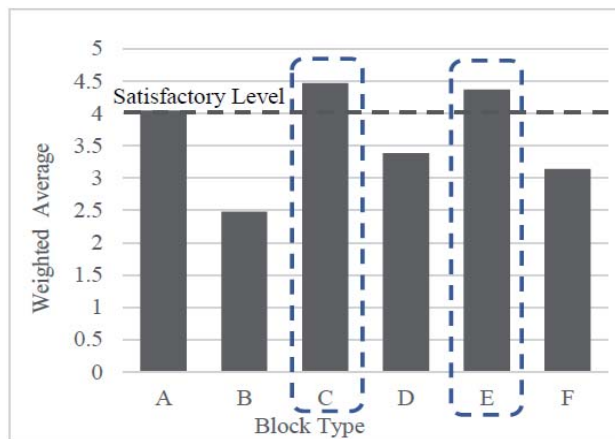


Figure 4: Average responses on different sizes of Mud-Concrete Blocks

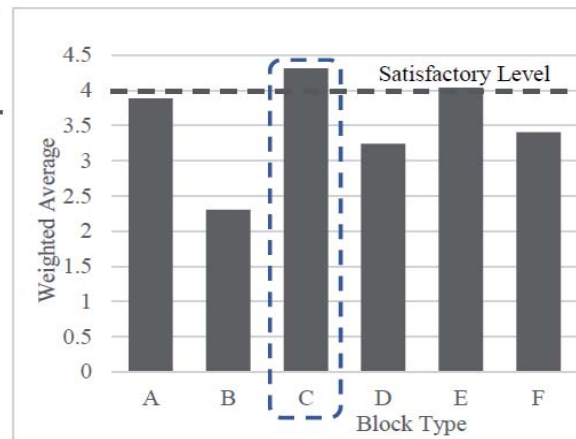


Figure 5: Average responses on different sizes of Mud-Concrete Blocks

### 4. CONCLUSIONS

Proper research needs to be conducted prior to introducing a novel material to the market in terms of thinking of the social acceptance towards the technology. Generally, people do love to select what is exactly familiar to their eyes when judging on the proportions. In addition, the choices could be varied according their very own personal experiences. As a final point, the study defines the 225mm x 100mm x 200mm (Block type "C") as the most preferable Mud-Concrete block type. Further, 300mm x 150mm x 200mm (Block type "E") is also acceptable and that can recommend to be utilized when thinking about the aspects of reducing the material wastage and cost optimization of the formwork.

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