PRODUCT DESIGN AND DEVELOPMENT OF WASTE PAPER PLASTERING MORTARS MACHINE

M.H.A Rahman¹, N.A. Maidin¹, M.K. Wahid¹, M.S.F Hussin¹, M.N. Ahmad¹, U.H. Ahmad¹, M.H. Osman¹, and A.V. Subramaniam¹

¹Faculty of Engineering Technology, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia.

mohdhidayat@utem.edu.my

Abstract. This paper present product design and development of waste paper plastering mortars machine. This waste paper plastering mortar is manual machine system. The main element to make mortar is cement, sand, water and waste paper. These machines have two separate tanks, which is the first tank is to produce a pulp and second tank is to mix up the entire ingredient. The objectives of this research are to design a Waste paper plastering machine, to develop a functional prototype of Waste Paper Plastering Machine and also to test the machine by compare the best method by with machine and without machine to make plastering mortar. The testing has been done between preparation and procedure how to make plastering mortar with machine and without machine. This machine can be used in every household. This can save environment and reduce pollution.

Keywords: Plastering Mortar, Pulp, Design And Development.

1.0 INTRODUCTION

Paper is the most frequent type of waste found in almost all types of area and represents an important source of cellulose fibres. In various forms (quality paper, mixed paper, newspaper and journals, undulated cardboard), the paper represents an estimated 40% of all household waste produced today [1]. The recycling technologies of paper waste in construction consists of the manufacture of products such as, plasterboard, cellulose fiber insulation and bricks made of paper fibres agglomerated with cement. A recycling of waste paper is mainly targeted in the composition of plastering mortars. Paper fibres are agglomerated with cement are an inexpensive material, with good thermal insulating properties [2]-[4].

2.0 RESEARCH METHODOLOGY

Plan or flow of the research is very important in order to plan and arrange the sequence of the process involved. It will explain the process, material, equipment and procedure for every stage of the research, the method of study shown in figure 1.
2.1 Fundamental of plaster mortar making process, method and ingredients

In this study, paper been re-used in the form of pulp as the plastering mortars agent together with cement. Combustion of paper mill sludge influences lightweight ash comes from the combustion of paper mill sludge [6]–[7].

The recycling of paper waste in the building material industry is an efficient solution with beneficial consequences for the construction industry as well as for environmental protection and improvement, contributing at the same time to the conservation of natural resources. In this context, the study on the use of paper waste in order to obtain ecological plastering mortar is presented. Portland cement 32.5mm, sifted sand with 0.4mm granularity, water, newsprint paper or copy paper was used. The study was performed in four mortar recipes whose composition is shown in Table 1 [2].

Table 1. Mortar Recipes

| Item                | Recipe |   |   |   |
|---------------------|--------|---|---|---|
|                     | I      | II | III| IV |
| Cement (kg)         | 200    | 400| 400| 500|
| Sand (kg)           | 300    | 300| 400| 400|
| Water (L)           | 320    | 320| 440| 440|
| Copy Paper (kg)     | 810    | 810| -  | -  |
| Newsprint Paper (kg)| -      | -  | 810| 810|
| Used Paper (%)      | 50     | 40 | 40 | 38 |

2.2 Customer Survey

To obtain customer need, a survey is distributed to the paper recycling industries. Through the survey, customer needs for the product can be obtain. Need statement and technical specification of the product can be listed. The target market and where the product can be located can be identified.

Data about customer needs are obtained by manual and online. This survey, it is done by 50
respondents for those who know that papers can be used to replace A1 plaster for mixing a mortar and 50 respondents of industries. Those 100 respondents are consists of male and female customers. The aim of the survey is for randomly paper recycling industries. Based on the pie chart shows in Figure 2 the percentage of respondents know that paper can be used for plastering mortar is 94% does not know and 6% know paper can be used for plastering mortar.

![Figure 2. Respondent know that paper can be used for plastering mortar](image)

Figure 2. Respondent know that paper can be used for plastering mortar

Figure 3 below show that paper can be reused is almost half of the respondents don’t know that paper can be reused, which is only 54% know that paper can be reused.

![Figure 3. Respondent know that paper can be reused](image)

Figure 3. Respondent know that paper can be reused

Figure 4 above show the percentage of respondents know the way of mixing plastering mortar. There are 90% of them who knows the way the rest 10% of them doesn’t know the way of mixing a plastering mortar. This shows that many of them are being ignorance.

![Figure 4. Respondent know the way of mixing plastering mortar](image)

Figure 4. Respondent know the way of mixing plastering mortar

2.3 Concept Selection
Based on the survey conducted, most of the respondents are supporting this plastering mortar mixing machine because the respondents are aware about the effect of throwing away used papers. The
respondents are also aware about the effect of used papers to environment. Table 2 below show that customer requirement for developing plastering mortar machine.

**Table 2.** Customer requirements consideration

| Item       | Specification                  |
|------------|--------------------------------|
| User Friendly | Safe design                   |
|            | Manual                         |
|            | Compact design                 |
| Functionality | Easy to mix                   |
|            | Easy to operate                |
|            | Easy to maintenance            |
| Strength   | Have good quality              |
|            | Can stand in high maintenance  |
| Time       | Save time                      |

The customers feedback is gained from the project need statement which was done based on the research that has been made. House of Quality in figure 5 shows the customer requirements gained from survey results being transformed to engineering characteristic which is more specific and detail.

![Figure 5. House of Quality](image)

After acquired customer needs, the process continues to concept generation and concept selection. In the concept generation, the problems involved must be clarified and some of the concepts will be generated. Some initial concept sketches will be produced before the selection process was conducted.

The concept has been described based on consideration with the sketches. Although each concept nominally satisfied the key customer need, the best concept still need to be choose for further design and refinement has been show in figure 6 below. Concept sketch number four is selected after do a concept screening.
2.4 Development Process

Development of the prototype is based on the concept selection that has been made on concept screening. Table 3 below show the bill of material that will be used to develop the prototype.

**Table 3. Bill of Material for Waste paper plastering mortar**

| No | Part Name       | Quantity |
|----|-----------------|----------|
| 1  | Circular Container | 2        |
| 2  | Ball Valve      | 2        |
| 3  | Long Beam       | 1        |
| 4  | Short Beam      | 1        |
| 5  | Steel Body      | 1        |
| 6  | Mixing Steel    | 2        |

Figure 7 below show final product of waste paper plastering mortar and Table 4 below show product specification for waste paper plastering mortar.
Table 4. Specification of Waste paper plastering mortar

| No | Item                      | Specifications                                      |
|----|---------------------------|-----------------------------------------------------|
| 1  | Dimension (L x W x H)     | 700mm x 440mm x 430mm                               |
| 2  | Weight (kg)               | 10.5kg                                              |
| 3  | Materials                 | Mild Steel, Aluminum, Mild Steel Plate               |
| 4  | Colour                    | Grey                                                |
| 5  | Performance               | Manual mixer as a prototype                         |
| 6  | Product Life Span         | -                                                   |
| 7  | Maintenance               | Wash it with water after use                        |

2.5 Testing

Testing of making plastering mortar will only cover a manual process in this case. The purpose of testing this manually operated machine is to study about the efficiency of the output of plastering mortar. It is also to study the time taken to mix the waste paper, cement and sifted sand using manual method. The expected result is to show that the idea can be used in the future with a manual and large quantity.

3.0 RESULT AND DISCUSSION

Table 5 below shows the data of manual method mixing of plastering mortar. The testing is done twice with manual process to identify it with strong analysis. In both the test, equal amount of waste paper, cement, sifted sand and water is used. This is to differentiate the quality of the plastering mortar output. What can be concluded in this test is manual mixing method isn’t so efficient since the mortar breaks after it has been dried for 2 days. Figure 8 below show quality of mixing with manual method testing 1 and testing 2.
Table 5. Manual method

| Criteria                      | Number of Test |
|-------------------------------|----------------|
|                               | 1              | 2              |
| Paper Mixing                  | 20 minutes     | 22 minutes     |
| Cement & Sand Mix             | 20 minutes     | 24 minutes     |
| Pulp, Cement & Sand Mix       | 20 minutes     | 23 minutes     |
| Under Sunlight                | 2 days         | 2 days         |
| Waste Paper                   | 1000g          | 1000g          |
| Water                         | 1000ml         | 1000ml         |
| Cement                        | 500g           | 500g           |
| Sand                          | 500g           | 500g           |

Figure 8. Quality of mixing with manual method testing 1 and testing 2

Table 6 below shows data of machine mixing method of plastering mortar. The testing is done twice with machine process to identify it with strong analysis. In both the test, equal amount of waste paper, cement, sifted sand and water is used. This is to differentiate the quality of the plastering mortar output. What can be concluded in this test is machine mixing method is efficient since after drying for 2 days the mortar is strong and good in condition it show in figure 9 below. It is proven that machine method is much faster to be mixed using same amount of materials.

Table 6. Machine method

| Criteria                      | Number of Test |
|-------------------------------|----------------|
|                               | 1              | 2              |
| Time taken                    |                |                |
| Paper Mixing                  | 10 minutes     | 9 minutes      |
| Cement & Sand Mix             | 7 minutes      | 10 minutes     |
| Pulp, Cement & Sand Mix       | 11 minutes     | 13 minutes     |
| Drying Time                   |                |                |
| Under Sunlight                | 2 days         | 2 days         |
| Quantity                      |                |                |
| Waste Paper                   | 1000g          | 1000g          |
| Water                         | 1000ml         | 1000ml         |
| Cement                        | 500g           | 500g           |
| Sand                          | 500g           | 500g           |
4.0 CONCLUSION

It can be concluded that apart from the study of this project, a paper can only be recycled and used back. Waste papers being used in this project as the main ingredient because of fiber quantity which is in the paper. A small amount of fiber is enough to be in the paper so that the paper can be crushed into pulp and mixed with cement and sifted sand.

The survey is conducted to obtained customer need. Based on the customer need, four design concepts is sketch. From the four designs only the best one is chosen to be made as prototype. The design went through the process of concept screening, concept scoring and lastly the selected design.

Based on the criteria obtained, the manufacturing process begin by designing the machine using SolidWork software. The process that are involved are cutting, welding, machining, drilling and welding. The testing between manual and machine method is conducted to make comparison, on which one is the best method to produce a plastering mortar.

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