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Design and Construction of a Marble Slab Waste Cutting Machine Table Using Marble Cutting Tools in South Aceh.

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ABSTRACT

A grinding machine is a useful tool for processing metal and non-metal cutting as well as cutting various types such as wood, stone, ceramics and can be utilized as needed. Marble slab waste is the result of the process carried out in the marble cutting industry, this waste is in the form of a solid slab. Slab waste can be used to make natural stone wall products. In the processing there are obstacles in the cutting process so that a cutting tool with a grinding machine is needed as a cutting machine. The design process for the grinding machine table uses AutoCAD software and the manufacturing process is carried out manually which includes making, making the frame, machine stand, water box, and the painting process. The results of this study produced one unit of marble slab waste cutting machine.

I. Introduction

A grinding machine is a tool used for abrasive cutting of metals and non-metals through friction between the abrasive material and the metal workpiece. In addition to cutting metal, grinding machines can also cut various materials, such as wood, stone, ceramics, and others. [8]. Marble slab waste is a byproduct of the initial marble cutting process. This waste is in the form of solid slabs, which are usually piled up on the edge of the Marble and Granite Laboratory at the South Aceh Polytechnic and can pose an environmental problem. [4]. The Marble and Granite Laboratory at the South Aceh Polytechnic produces marble slab waste. This marble slab waste can be managed properly to prevent it from piling up and incurring costs. Recognizing the potential of this waste, the author transforms marble slab waste into economically valuable natural wall stone products. To process this natural wall stone, a cutting machine is required to simplify the processing process and reduce the workload of cutting marble slab waste into natural wall stone of specific sizes. In this study, the author designed a grinding machine table for the process of cutting marble slab waste into valuable products and saving energy and time.

II. Proposed Method/Algorithm

A. Marble

Marble is a type of metamorphic rock, formed by the metamorphosis of limestone. Marble is often found decorating homes, used for floors, walls, and even furniture such as tables, benches, and so on. Marble is a rock produced by the metamorphosis of limestone over a long period of time. [4]. Marble is a metamorphic rock resulting from the metamorphism of limestone. This metamorphism is influenced by temperature and pressure, which can cause changes in the structure, texture, and mineralogy of the limestone. The main minerals that make up marble are calcite ($CaCO_3$), dolomite, and other minerals, such as clay minerals, mica, quartz, pyrite, iron oxides, and graphite. Calcite, the constituent of limestone (marble protolith), undergoes recrystallization during the metamorphism process. [3]

B. Grinding Machine

A grinding machine is a machine widely used for smoothing workpieces and sharpening tools, such as drill bits, chisels, scrapers, and so on. In the process of making chopping knives, a grinding machine is used to sharpen the blade. [1]

C. Hand Grinding Machine

A hand grinder is a machine used to grind workpieces. Initially, grinding machines were only intended for workpieces made of hard metals such as iron and stainless steel. Grinding can be used to sharpen workpieces such as knives and chisels, or it can also be used to shape workpieces, such as smoothing cuts, smoothing welds, forming curves on angled workpieces, preparing workpiece surfaces for welding, and so on. [5]. Grinding machines are designed to produce speeds of around 11,000–15,000 rpm. At this speed, the grinding wheel, which is a composition of aluminum oxide with the appropriate roughness and hardness, can grind metal surfaces to achieve the desired shape. At this speed, the grinding wheel can also be used to cut metal objects using grinding wheels specifically designed for cutting. To find out the appropriate grinding wheel composition for the workpiece, see the grinding wheel specifications article. [1]

D. Working Principle of a Hand Grinder

The working principle of this grinding machine is that the grinding wheel rotates in contact with the workpiece, causing abrasion, sharpening, honing, or cutting. The grinding wheel is driven by an AC motor. [9]

E. Function of a Hand Grinder

This machine can be used to smooth or cut metal and non-metallic objects. Hand grinders are commonly used as cutting tools in small workshops or households. [9]

1. Type of grinding material
2. Grinding grit size
3. Hardness level
4. Grinding grit arrangement
5. Adhesive type
6. Grinding blade hardness

F. Functions and Types of Hand Grinding Wheels

The following are the types of cutting grinding wheels: [2]

1. Cutting Wheel: For cutting metal and non-metallic materials.
2. Flap Disc: For sanding. We can use this grinding wheel to remove paint from wood or metal because it doesn't damage the surface of the object.
3. Grinding Wheel: This is the grinding wheel we often see, usually used to grind metal.
4. Sanding Disc: Like regular sandpaper with varying degrees of fineness/coarseness.
5. Backing Pad: This grinding wheel is more or less used like a sanding disc, except that it has a flat surface and is equipped with a rubber backing pad.
6. Brush Wheel: This grinding wheel is a metal brush that we usually use to clean metal surfaces of rust and other debris.

G. Diamond Grinding Wheels

A grinding wheel is a solid material used to cut or sharpen other solid objects. They come in various shapes and types and are coated with specific materials to enhance their grinding or cutting capabilities. Mountain marble cutting machines use diamond grinding wheels. Diamond grinding wheels are made of diamond grains on the edge of the grinding wheel and are used to grind hard materials such as concrete, stone, gemstones, and others. [7] In the creation of this machine for cutting marble slab waste into natural wall stone, the experimental method will be used. Experimentation is a method aimed at enabling students to find and discover their own answers to problems arising from each process by conducting their own experiments to produce a product.

A. Location and Time

The research on the design and construction of this marble slab tile cutting machine was conducted at the Materials Testing Laboratory of the Industrial Engineering Study Program, South Aceh Polytechnic. The study was conducted over a six-month period, from February to July 2021.

B. Tools and Materials

a. The tools used in this research are as follows:[6]

1. Tape measure, used to measure the material before cutting.
2. Carpenter's pencil, used to draw lines or mark/measure the measured material.
3. Axe, used to cut the part to be removed. Angle grinder, used to form 90º or right angles. The angle grinder is used to form angles in the construction of the cutting table.Tape measure, used to measure
4. An electric welding machine is used to join the metal components in the cutting table manufacturing process.
5. A ring spanner, for tightening and loosening bolts and nuts.
6. A cutting grinder, this machine is used to cut sheet metal and angle iron to be made into a table.
7. A drilling machine, used to drill holes in the machine stand and table.

The materials used in this study are as follows:

1. Sheet metal, used to form the base of the cutting table.
2. Hollow steel, used to form the legs of the table for cutting marble slab waste into natural wall stone.
3. Bolts, used to attach the bearings to the table stand for a strong bond. The bolts are also used to lock the grinder to the bearings on the table stand.
4. The grinder is used as the main tool on the slab cutting tool, which will be positioned on the table stand.

C. Design of the Grinding Machine Stand

The design process focused on utilizing marble slab waste. This product, in addition to producing a machine for cutting marble slab waste into natural wall stone, also provides a solution to environmental problems.[10]

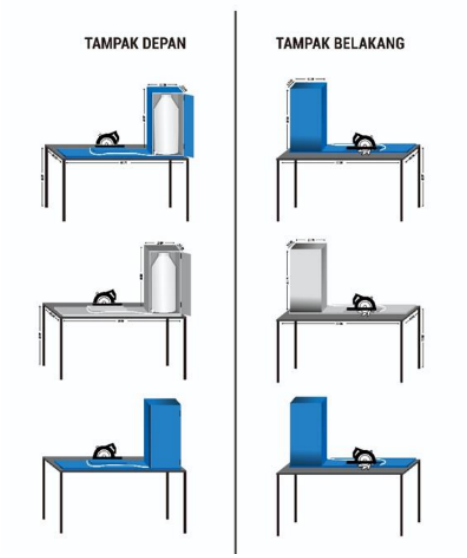

Fig. 1: Design

D. Process Flow Diagram

The process flow diagram for making this marble waste cutting tool into tiles is as follows:

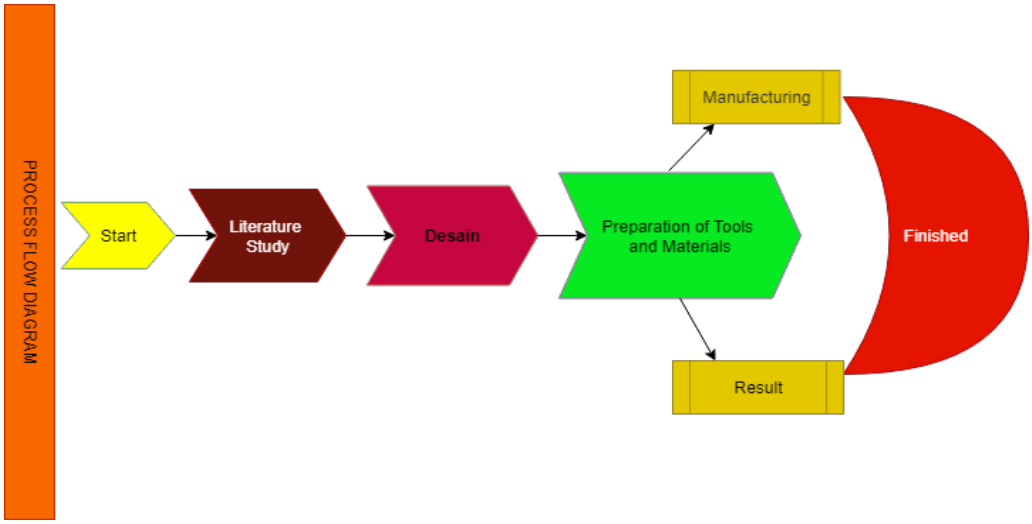

Fig. 2. Tool Design Flowchart

III. Results and Discussion

A. The process for making marble slabs is as follows:

a. Material Measurement

Measure the materials to be used in making the marble slab cutting tool. Materials such as hollow steel, iron plates, and boards are measured according to the specified dimensions. Temperature in the Smoking Room, While recording the temperature sensor data, leave it alone without any special handling,

Fig.3. Material Measurement

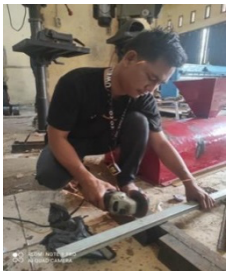

Fig. 4. Cutting

b. Material Cutting

Cutting: In this process, the metal and other materials used in the marble slab cutting machine are cut to predetermined dimensions.

c. Assembly
Assemble the marble slab cutting machine table by welding the hollow sections and the previously cut metal plates. The table legs consist of four hollow sections, each 40 cm high, and the metal plate serves as the table top, 80 cm long and 60 cm wide.

d. Water Tank Construction
Construct the water tank. This tank will be used to hold the water reservoir, which will then be channeled to the grinding machine during marble cutting to prevent cracking during cutting.

e. Grinding Machine and Water Tank Installation
Install the grinding machine and water tank on the assembled cutting table. The grinding machine used is the SH59 grinder.

Fig. 5. Installation of the Grinding Machine and Water Box

B. Design Results for a Marble Slab Tile Cutting Machine for Natural Wall Stone.

This marble slab cutting machine consists of several main parts: a cutting table, a water tank, and a grinder as a cutting tool.

1. Cutting table height: 40 cm
2. Cutting table width: 60 cm
3. Cutting table length: 80 cm
4. Water tank height: 40 kg
5. Water tank width: 13 cm
6. Water tank length: 20 cm
7. Pipe length: 100 cm
8. Grinder: SH59

Fig. 6. Product Design Results

The working mechanism of this marble slab cutting machine is to place the marble slab on the cutting table. Then, the grinding machine, acting as the cutting tool, moves it forward in a cutting motion to cut or split the marble slab. The cutting machine is continuously supplied with water from a water tank to prevent the marble slab being cut from cracking or breaking during the cutting process.

B. Functional and Structural Design

1. Cutting Table
   The cutting table is the container or area where the cutting takes place. The main components, such as the cutting machine and water tank, are placed on top of the cutting table. The cutting table is made of 2 mm steel plate to support the weight of the marble slab.

2. Cutting/Grinding Machine
   The grinder is the cutting tool used in this marble slab cutting machine. The grinder used is an SH59 grinder. The grinder is placed on a stand above the cutting table so it can be moved during the cutting process.

3. Water Box
   The water box is a container containing water, which is then channeled through a pipe to moisten the grinding wheel during the cutting process, preventing the cutting material from cracking or breaking during cutting.

C. Tool Test Results

This test was conducted to determine the machine's performance, including cutting performance with a grinder, water tank function, and cutting capacity. After testing, it was determined that the marble slab tile cutter cut effectively. The water flow from the water tank to the machine's blade functioned normally. The machine can cut marble slabs with a minimum width of 30 mm, a maximum of 90 mm, and a thickness of 4 cm.

This marble slab cutting machine was successfully built with a table height of 40 cm, a width of 60 cm, and a length of 80 cm. The water tank measures 13 cm wide, 20 cm long, and a height of 40 cm. This machine operates by cutting marble slabs using a grinder. This machine can be used to cut marble slabs with a minimum width of 60 mm, a maximum of 90 mm, and a thickness of 4 cm. This machine supports the grinder on the table so that it can be easily controlled during cutting, so that the cut results of the marble slab are neater and more precise.

IV. Conclusion

Based on the design and testing results, the following conclusions are drawn:

This marble tile cutting machine consists of three main parts: a cutting table, a water tank, and a grinder. The design specifications are a table height of 40 cm, a width of 60 cm, and a length of 80 cm. The water tank is 13 cm wide, 20 cm long, and 40 cm high. The materials used to manufacture this marble tile cutting machine are sheet metal, hollow steel, a grinder, and plywood. Consideration should be given to larger-scale machine construction. Further development of this research is expected to improve its effectiveness. Prioritizing safety during the cutting process using this machine is recommended.

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