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Conceptual Design of Special Purpose Machine for Cutting Chases in Wall during Concealed Electrical Fitting

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Abstract: ***The construction industry worldwide having solid growth due to industrialization, urbanization over the last decade. In survey of these construction sites we found that for concealed electrical fitting the chases cut in the wall is done with help of hand tools like hammer, chisel, grinders, demolition hammer which is very tedious work. Therefore we have designed the wall engraving machine which is based on engraving techniques. With the use of wall engraving machine it is possible to remove the material from wall with ease and giving appropriate straight and clean cut to the wall at specified height for conceal electrical fitting. Our aim of designing this machine is making chases in wall of 30mm deep and 36mm wide in single operation without use of any hand tools so that electrical wires can easily accommodate space. The various parts of this machine like motor, cutter, gears are designed and selected by considering the bricks and concrete strength.***

Keywords: Engraving; Conventional tools; brick strength; concrete strength

1. Introduction

The construction industry worldwide is having a total growth of 30% from 2010 to 2014. In survey of these construction sites we found that for concealed electrical fitting the chases cut in the wall is done with help of hand tools like hammer, chisel, grinders, demolition hammer which is very tedious work. We designed wall engraving machine which is based on engraving techniques. **Engraving** is the practice of incising a design onto a hard, usually flat surface, by cutting grooves into it. Engravers in ancient times used engraving for make or decorate things that were needed in everyday life.[1]It is one of the processes which may be used by an artist when creating a sculpture. It is an activity where pieces of rough natural stone are shaped by the controlled removal of stone.[2] Our aim to design wall engraving machine is to get rid of all hand tools used in present date and make process simple and accurate. The various parts used in wall engraving machine.

1) Motor
2) Cutter Blade
3) Gear Box
4) Dust Cover

We used motor of 2500 watt, 3 cutter blade of 110mm diameter cutter blades are zigzag type width of blade is 10 mm so that they can cut groove of 36 mm wide. Worm and worm gear is used to transmit the power from motor shaft to cutters.

2. Conventional Tools and Techniques

Cutting a chase is a simple job and most electricians will own a chasing tool. The chasing tool seen in the image below is basically an angle grinder. [1]

Figure 1: Conventional Tools

Chasing tools in the above image:

1. Angle grinder
2. Chisel
3. Lump hammer
4. Large bolster
5. Medium bolster
6. Demolition hammer

Figure 2: Demolition Hammer

2.1 Working Method

- Mark lines on the wall with a pencil so that you can follow them.
- Use grinder to cut chase lines.
- Finally hammer bolster used to chop out middle part.

2.2 Need of Evolution

The construction industry worldwide having solid growth due to industrialization, urbanization over the last decade. To cope up with this growth we need more faster, accurate and easy techniques to cut chases in wall for concealed electrical fittings. There are various drawbacks with conventional techniques like:

1) Time consuming
2) Less accurate
3) Three operation required to complete task

3. Proposed Solution

Special purpose machine can be a solution for all problems occur. Our aim is design a special purpose machine is to get rid of all hand tools used in present date and make process less time consuming.

3.1 Objective of Special Purpose Machine

- With the use of engraving techniques cut chases in walls.
- To design a machine this is portable and can handle with ease.
- To make the process faster and accurate.
- To get rid of hand tools.
- To make the operation simple.

4. Proposed Conceptual Design

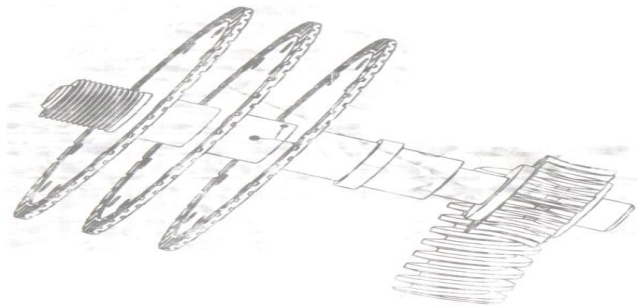


Figure 3: Conceptual Design

We are going to use 3 cutter blade of 110mm diameter. Cutter blades are zigzag type and width of blade is 10mm so that they can cut groove of 36 mm wide.

5. Design Procedure

5.1 Wall Strength

Walls are normally constructed of brick, mortar, and concrete column so we focus on strength of bricks and concrete columns to design our machine.[4]

Bricks compressive strength

Speciation of Common Clay Building Bricks

Table 1

Size of bricks (mm)	compressive load (T)	Compressive strength N/mm^2
220.5×100.5	27	11.430
230.00×110	26	10.4

Calculations:

$$\text{Compressive strength} = \frac{\text{Maximum load at failure (N)}}{\text{Average area of bed face (mm}^2\text{)}}$$

5.2 Concrete Strength

Concrete specimens are tested using the ASTM39 Test Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens by using two samples made from the same test at the same age, usually at strength of 28 days old. Design engineers use the specified strength $f'c$ to design structural elements. This specified strength is incorporated in the job contract documents. The concrete mixture is designed to produce an average strength ($f'cr$) higher than the specified strength, such that the risk of not complying with the strength specification is minimized. Cylindrical specimens for acceptance testing should be 6 x 12 inch (150 x 300 mm) size or 4 x 8 inch (100 x 200 mm) when specified. The Concrete strength is calculated by dividing the maximum load at failure by the average cross sectional area. Concrete compressive strength requirements can vary from 2500 psi (17 MPa) for residential concrete to 4000 psi (28 MPa) and higher in commercial structures. Higher strengths up to and exceeding 10,000 psi (70 MPa) are specified for certain applications. The strength of concrete increases with age. Table shows the strength of concrete at different ages in comparison with the strength at 28 days after casting. [5]

Table 2: Concrete strength per day

Age	Strength percent
1 day	16%
3 days	40%
7 days	65%
14 days	90%
28 days	99%

5.3 MOTOR SELECTION

The more HP will give more efficient cut. Selection of motor is done on the basis of following points:[8]

a. concrete strength
b. speed
c. depth of cut (30 mm)
d. constant torque

a) RPM Calculations

$$\text{RPM} = \frac{\text{SFPM x 12}}{\text{Diameter x } \pi}$$

$$\pi = 3.14$$

Blade diameter should be in inches

Surface feet per minute (SFPM) is the speed at which a diamond particle on the perimeter of the blade is traveling. For a given blade diameter, surface feet per minute can be converted to revolutions per minute

b) Torque Calculations

HP = Torque x RPM ÷ 5252

5.4 Cutter Selection

6. Factors Involving Concrete Cutting

When cutting concrete, several factors influence your choice of blades. These include:

- Compressive strength
- Hardness of the aggregate
- Size of the a aggregate
- Type of sand
- Steel reinforcing (rebar)
- Green or cured concrete

Concrete slabs may vary greatly in compressive strength, measured in pounds per square inch (PSI). Compressive strength in concrete is a measurement of the load carrying capability of concrete.

Aggregate hardness is one important factor when cutting concrete. Because hard aggregate dulls diamond more quickly, segment bonds on diamond saw blades generally need to be softer when cutting hard aggregate. This allows the segment to wear normally and bring new, sharp diamond grit to the surface. Softer aggregate will not dull diamond grit as quickly, so harder segment bonds are needed to hold the diamonds in place on the saw blade long enough to use their full potential. Diamond saw blades are widely used in cutting concrete materials in civil engineering industry. Concrete is a kind of difficult-to-cut composite material. By taking all these factor under consideration we select three types of blade for cutting concrete.[4,5]

1. Diamond tipped blades
2. Tungsten carbides blades
3. Gemeni concrete blades

We made our cutter blades zigzag so that it can cut chases of 36 mm wide in the wall.

Figure 4: Cutters

5.5 Dust Cover

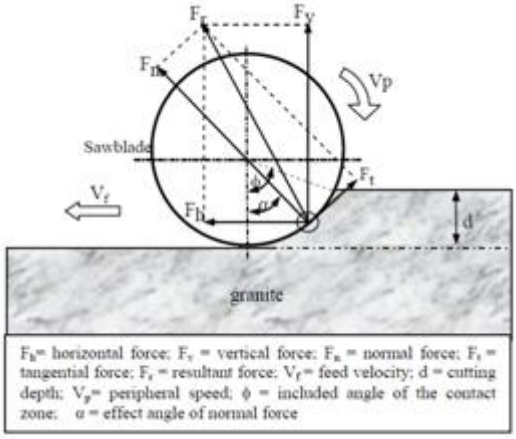
Dust cover is made of mild steel material. Which act as safeguard for user from dust while using machine.

Figure 5: Dust Cover

Figure 6: Dust Cover

7. Force Analysis

To do force analysis we have following method.[3,4]



F_h= horizontal force; F_v = vertical force; F_n = normal force; F_t = tangential force; F_r = resultant force; V_f = feed velocity; d = cutting depth; V_p= peripheral speed; ϕ = included angle of the contact zone; α = effect angle of normal force

Calculations:

Ft = P/Vc

Fn = [(Fh)2 + (Fv)2 - (Ft)2]1/2

Qw = d × Vf

8. Advantages

- Great time saving for engraving.
- Simple and faster operation.
- Get rid of hand tools.

9. Acknowledgements

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