Design And Fabrication Of Plastic Brick-making Machine

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ABSTRACT

This works with the help of an electrical AC motor to drive the gear drive and actual experimental setups, in the generation of the de-plastic brick. The Gearbox assembly, hopper setup, screw conveyor, and stand were fabricated with a simple design and with easily available materials to serve and fulfill the purpose of the project. The drive system of the project starting from the motor to the conveyor system has reduced the speed to nearly 95:1 (i.e., 1440 to 15 RPM). Standard Trial tests have been carried out with the plastic molding materials to produce Plastic brick. Plastic brick is a product of industrial importance that is manufactured by burning plastic in the absence of air.

Plastic brick is used in domestic and industrial etc. for construction work. This project deals with the design and fabrication of contraptions for producing plastic bricks from plastic wastages and plastic powders etc., this project aims to produce plastic bricks from waste plastics with drastic elimination in cost.

This paper aims at the design and fabrication of a Plastic Reinforced Brick Manufacturing Machine which brings down the plastic waste in landfills which is primarily responsible for environmental pollution. The most common recyclable plastic products are beverage packaging widely used for water, soda, cool drinks, and juice, and plastic bags and plastic containers used for packing food products. These recyclable plastic products are reinforced with bricks. At this time of energy crisis and fast depleting resources, the availability of conventional building materials perennially in terms of quantity and quality poses a hectic task for builders.
Demand for building materials is going up tremendously day by day given the ever-increasing requirement of housing and habitat sectors. Such a crisis prompted the researchers to re-orient themselves to evolve a new technology to manufacture appropriate masonry products, using locally available low-cost materials. The concept of construction using green materials was aptly conceived in research realms to employ marginal materials and deploy unskilled laborers in massive production schemes.

At the same time, considering the earth as a sustainable material, there is a growing interest in the maximum use of its resources as modern ingredients in the construction sector. The major environmental challenge confronting our country in modern times is Solid Waste Management. Plastic is one of the materials mostly used in the modern world. Being lightweight and durable plastic is being widely used for various purposes and it has now become an integral part of our daily life. The plastic products that we mostly use are non-biodegradable and hence after use, these are ultimately used for filling our landfills.

1. INTRODUCTION

This work aims to reduce the plastic waste that is rising in the present world by using a system incorporating a plastic extruder to recycle waste plastic into useful products. The maximum compressive load sustained by the Polypropylene/Rubber composite brick is 17.05 tons, followed by the LDPE/Rubber composite brick with 16.55 tons. Waste is now a global problem and must be addressed to solve the world's resource and energy challenges. Plastics are non-biodegradable, synthetic polymers derived primarily from petro-fossil feedstock and made up of long-chain hydrocarbons with additives. The modeled P/C tie is 8% virgin HDPE plastic, 7% talc, and a mixture of post-consumer recycled milk bottles, grocery bags, and tires.

Electric energy is required to process the mixture and extrude the P/C product. The machine consists of a cutting unit, a recycling unit, and a mixing unit made of mild steel. The efficiency of the machine was established using plastic waste, cement, and other aggregates.

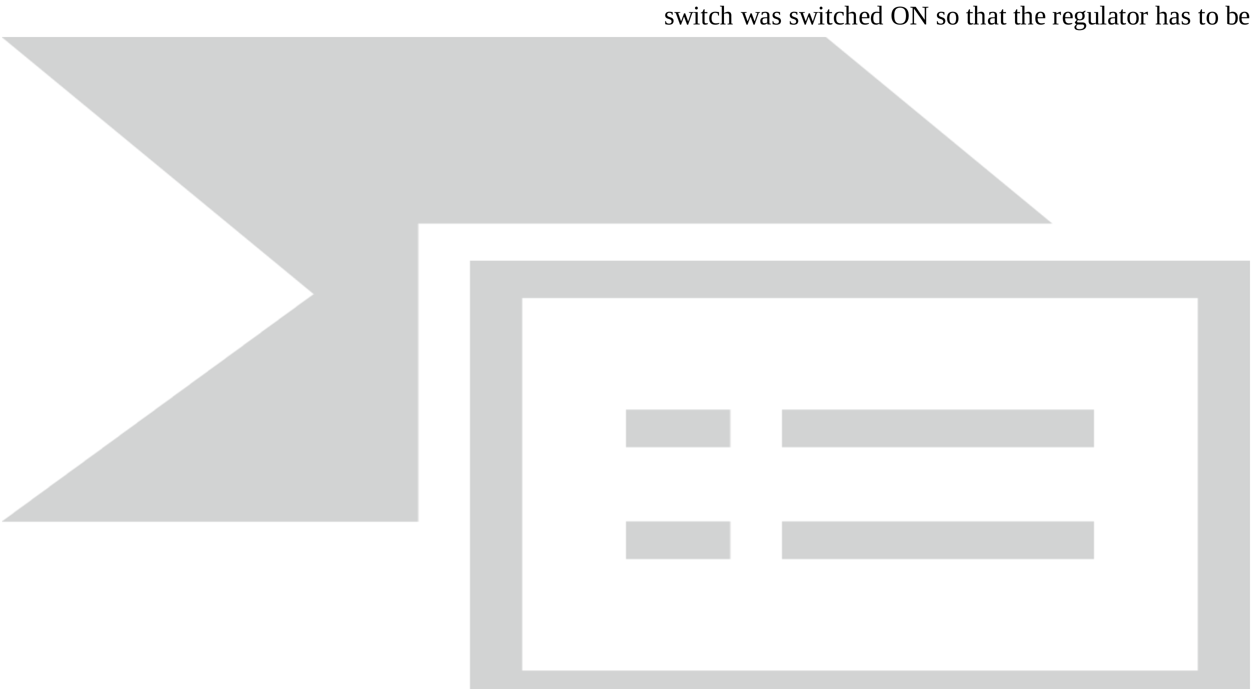
2. PHYSICAL PROPERTIES COMPARISON TABLE

Type	Roller Chain	Tooth Belt	V Belt	Spur Gear
Synchronization	◎	◎	×	◎
Transmission Efficiency	◎	◎	×	◎
Anti-Shock	△	○	◎	×
Noise/Vibration	△	○	◎	×
Surrounding Condition	Avoid Water, Dust	Avoid Heat, Oil, Water, Dust	Avoid Heat, Oil, Water, Dust	Avoid Water, Dust
Space Saving (High Speed/ Low Load)	×	◎	○	○
Space Saving (Low Speed/ High Load)	◎ Compact	△ Heavy Pulley	× Wider Pulley	○ Less Durability Due to Less Engagement
Lubrication	× Required	◎ No Lube	◎ No Lube	× Required
Layout Flexibility	◎	○	△	×
Excess Load onto Bearing	◎	△	×	◎

◎ Excellent ○ Good △ Fair × Poor

3 RESULTS AND DISCUSSION

3.1 DESIGN OF THE PROJECT



3.2 WORKING PROCESS

Waste products taken from waste plastic are dried for two to three days. The heating chamber switch was switched ON so that the regulator has to be adjusted gradually to reach the maximum temperature. Then it was allowed to heat for up to five minutes. Then the motor was switched ON. Thus, the screw conveyor rotates. The conveyor has taken it inside the hopper.

Inside the extruder, more heat is generated because the heat is transferred from the heating chamber to the extruder. Thus, the plastic waste burnt inside the extruder.

The operational principle of this machine is as follows:

(a) Switch on the heater and set the required temperature slightly above the melting point of different waste plastics.

(b) Mixing waste plastics, rubber composites, and calcium carbonate in the required quantity and is poured into the hopper when the required temperature in the control box has reached.

(c) Switch on the motor and the screw conveyor starts rotating at 80 rpm.

(d) The waste plastics from the hopper get melted and conveyed toward the nozzle.

(e) A brick mold is kept at the end of the nozzle tip and the molten plastic/rubber composite material starts filling the mold box. After the mold is filled the mold box is removed from the nozzle tip dipped in the water bath and kept inside the bath for an hour for proper cooling.

(f) The final product is removed from the mould box and is sent for compression testing using a Hydraulic Brick testing machine.

3.3 CALCULATIONS

3.4 OBSERVED DETAILS:

Motor (AC):

Speed (N) =1440rpm

Power = 0.376 KW = 0.5 hp

Gear Box:

Input Speed = 1440 rpm

No of stages in reduction = >2.

3.5 Worm Gear & Worm Wheel:

WORM GEAR:

1. Reference diameter, d1 = q*mx

=11*4=16mm.

2. Tip diameter da1= d1 + 2*f0*mx

= 16+2*7*1.4

= 36mm

where f0 is the height factor here it is taken as

3. Tip relief radius r1= 0.1*mx

= 0.1*1.4 = 0.14mm

4. Root relief radius r2 = 0.2*mx

= 0.2*1.4 = 0.28mm

5. Nominal tooth thickness reference to dia. in axial section(s):

S =Π x mx/2

=Π x 1.4/2

=2.199 mm

6. Nominal tooth thickness reference to diameter in normal section:

s_n = Π/2 x mx x Cos ɣ

ɣ = $\tan^{-1}$ [z/q]

= $\tan^{-1}$ [1/11]

= 5.19

s_n = Π/2 x 1.4 cos (5.19)

= 2.190 mm

WORM WHEEL:

1.Reference diameter d2, = Z x mx

= 28 x 1.4

= 39.2 mm

2.Tip diameter da2, = (Z + 2x7+2x)x1.4

=58 mm

3. Pitch diameter d2 = d2

= 39.2 mm

whereas,

ɣ = tan⁻ [1/q]

= tan⁻ [1/11]

= 5.1944

Sn = (Π/2) x 1.4 x Cos (5.1944)

= 2.1901 mm

Length of warm gear teeth:

L ≥ (11 + 0.06 x Z) x Mx

≥ (11 + 0.06 x 41) x 1.4

≥ 18.844 mm

Total length L = 18.844 + 25

= 43.844 mm

For (Z=1) no of Starts.

No. of thread on Worm = L/3 (Π – Mx = 18.

The efficiency of a system:

η = (0.95 x tan ɣ) / {tan (ɣ + ρ)}

ρ = tan⁻ (μ)

μ = Ratio according to slicing velocity (Vs),

Vs = V1 / Cos(ɣ)

Here,

V1 = (Π x d1 x N1) / 60000

=1.206 m/sec.

∴Vs = 1.206 / Cos (5.1944)

= 1.210 m/sec.

According to Vs = 2 m/sec (approx.)

Value of μ = 0.03

η = {(0.95 x tan 5.1944) / [tan (5.1944+1.718)}

ρ = tan⁻ (μ)

= 1.718

η = 81.10 % ≤ 90 %

(Hence it is possible).

Area required:

(1 – η) x power input= Kt x (to-ta) x A

Were,

To = Max operating Temperature is 60º C

ta = Room Temperature = 30º C

A = (1- 0.8110) x 0.3756

=12 x (60-30)

= 0.197 m²

3.6 SPEEDS IN GEARBOX:

Measured Specifications:

=N1/N2

= D2/D1

= Z2/Z1

Were,

N1 = Input speed to the gearbox

= 436 rpm

N2 = Output speed from the gearbox

D2 = Diameter of the worm wheel = 50mm

D1= Diameter of the worm gear

= 36 mm

Z_1 = Number of starts in the worm gear
=1

Z_2 = Number of teeth on the worm wheel
=28 Nos.

$\therefore N_2 = (Z_2/Z_1) \times N_1$
$= (28 / 1) \times 436 = 15$ rpm

4. COMPLETED UNIT

The completed unit is shown in the below figure

5. CONCLUSION.

This work effectively converts waste plastic into useful building materials like building bricks and floor interlocks which can effectively reduce environmental pollution and further decreases the problem of waste plastics in society.

Rather than the waste plastics going into the landfill or incinerators, they can be used as construction materials at a much lower cost after undergoing certain specific processing.

It also reduces construction costs by eliminating the use of mortar during construction by using recyclable plastic/composite bricks and floor interlocks. From the compression testing results, we come to know that waste plastic material when effectively mixed with Rubber powder and Calcium Carbonate gives the highest compressive strength and sustains a high compressive load.

6. REFERENCES

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