Global Scientific JOURNALS

GSJ: Volume 10, Issue 7, July 2022, Online: ISSN 2320-9186

www.globalscientificjournal.com

Design and Manufacture of block crusher Machine

[I]Sisay Abera Belayneh, [II] Prof Houjun Qi, [III] Prof Doing Xianhui

[I,II]Mechanical Manufacturing and Automation,

[I,II,III] Tianjin University of Technology and Education, 1310, Dagu south Rd, Hexi, Tianjin, China

Abstract- This work describes the design and manufacturing of block crusher Machine which helps to crush the used waste block, terrazzo, limestone, granite and other materials of medium hardness. This paper aims to design and manufacturing a crusher that could be installed anywhere and would aid crush of used construction material wastes. However, the problems are crushing of waste block, terrazzo, and minerals machine is not locally available. Thus, the objective of this project is to design and manufacture of electrical driven crusher machine to crush waste block and terrazzo for the purpose of recycling to make different items or products. The crushing process is achieved by the use of a multiple of hammers in a crushing chamber which beating the material fed into it. The machine size is 110mm X 63 mm X 40mm and is contained four main bodies hoper, crushing box, frame, and outlet. It is electrically driven machine and has a capacity to crush about 10 Kg block per hour. Finally designed crusher was then checked and the crusher effectively crushed all the waste material with ease and with reduced human effort.

Key words; Crusher Waste block, terrazzo, crusher, hammers

I. Introduction

Blocks had been modern construction materials, used in all building constructions, such as residential, commercial and industrial building constructions. The demand for this block was high, due to the growth of construction of residential apartments, commercial buildings and industrial buildings. Increase in population and rapid urbanization are the main culprits of solid waste generation. With more people moving towards urbanization, the amount of waste generated is increasing in construction.

The process of block recycling starts with the crushing of waste block material using crusher. Depending on the explanation in [2] the basic principle of Crushers is one of the major size reduction equipment that is used in metallurgical, mechanical, and other similar industries.

The hammer crusher machine was fabricated from locally available materials for crushing of waste block, wasted terrazzo, minerals such as calcite, dolomite, limestone, granite and other materials of medium hardness. The crushing process is achieved by the use of a set of hammers in a crushing chamber which beats the mineral feeds into smaller particles small enough to pass through the aperture of the replaceable sieve positioned beneath the crushing chamber. The size aimed depends on the aperture of the replaceable screen. Based on the theoretical design, it was found that the main shaft speed of 1440 rpm transmitted by a belt drive from a five horse power electric motor is suitable to crush effectively. The results however indicated that the new machine can perform better in terms of products with improved design. The machine is portable, design to be power operated.

II. Concept design

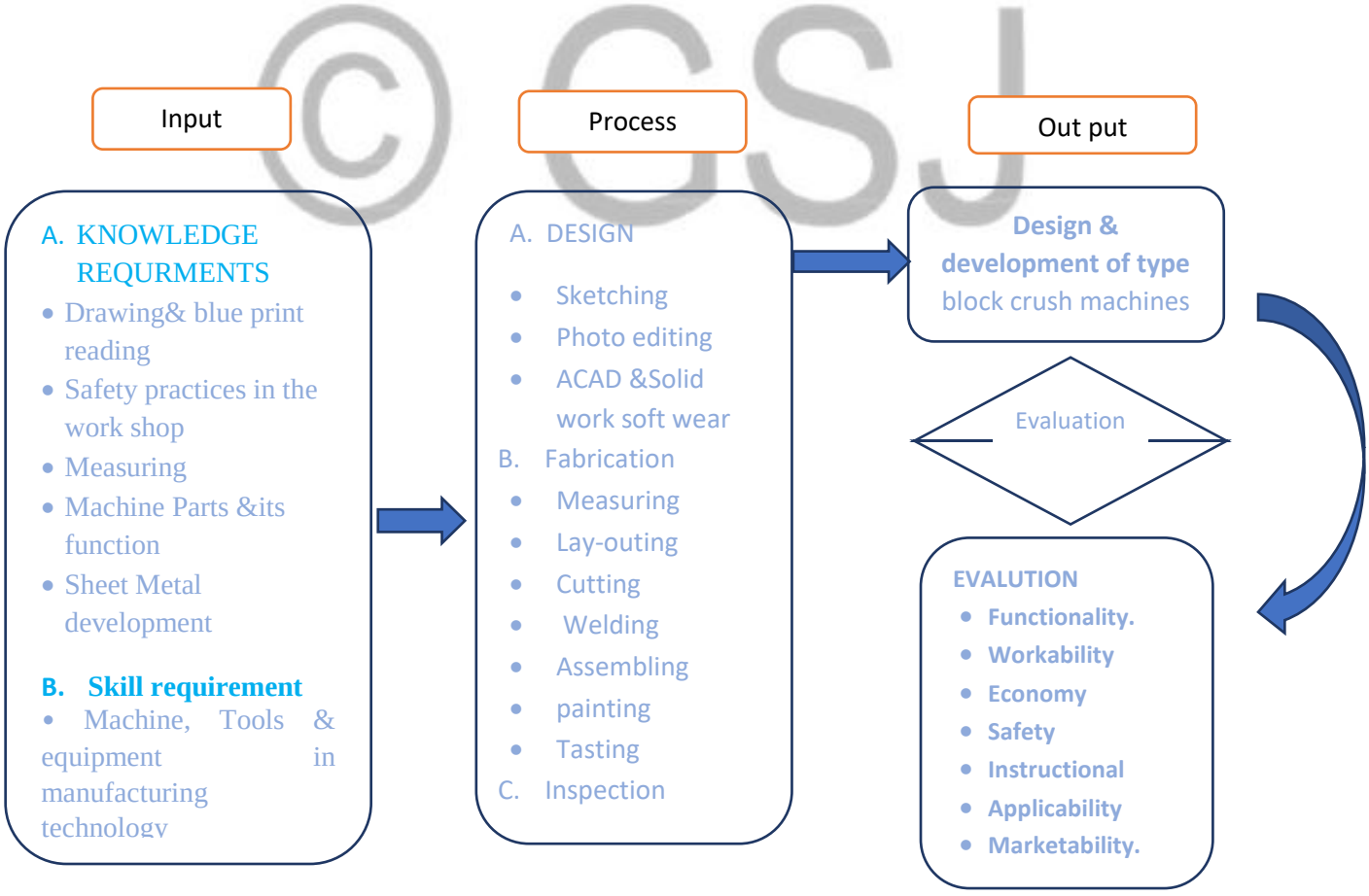

Figure 1: Concept Design

Concept product design also serves as a way to explore different manufacturing methods early on in the product development process; providing a range of different value designs for all budgets and requirements, from low cost and mid-range to premium manufacturing. The Design of this project is designed by using solid work and Catia drawing software for easily understanding and making it easily readable

III. Design Consideration

This section attempts to show the basic equations used in the design of the block crusher machine and the principles adopted. The major components of the machine include the shaft, bearing, Internal hammering parts pully, cover and electric motor.

Design analysis of shaft

A shaft is the rotating machine element which transmits power from one place to another. The shaft of the hammer mill which is rotating the hammers will be subjected to twisting moment only.

Materials selected are carbon and alloy steel with

- Ultimate tensile strength 560 to 760 Mpa and
- Yield strength between 320 to 390 Mpa.

Working stress for power transmission shafts: -

According to ASME code for the design of power transmission shafts.

- Maximum tensile stress: -84 Mpa for shafts with allowance for key ways.
- The maximum shear stress: - 42Mpa with allowance for key ways.

The shaft is design on the basis of strength.

The following are the stresses the shaft is subjected to: -

- Twisting moment due to the key and wheel.
- Bending moment due to the belt on the wheel.
- Axial load due to the mill stone

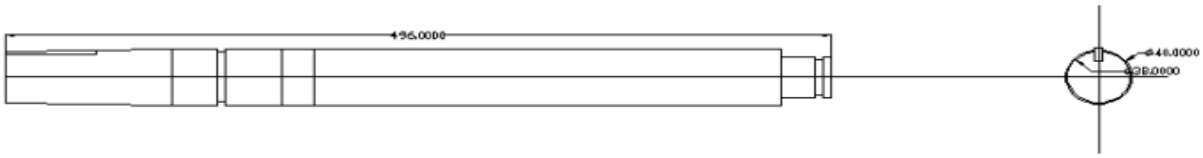

Figure 2: Shaft drawing

Power from the motor 3.7 KW (p1)

Speed of the motor shaft 1450 rpm (n1)

Speed ratio from table = 1.5

Power transmitted by output shaft in rpm (p2)

Speed of the output shaft in rpm (n2)

p2/p1 = 0.95 ≧ p2 = 17.1KW

$n1/n2$ = 1.5 ≧ n2 = 1000 rpm

Twisting moment (T)

$$T= 60p^2/2\Pi n^2$$

T=163.3 N-m

Bending moment (M)

(Drawing of forces on the shaft)

Tensions T1 + T2 = 2786.2N

Because the two reaction forces are symmetrical

R1 + R2 = 1393.1N

Maximum moment on the shaft is k_m

1393.1 * 0.07 = 97.517N-m

Equivalent twisting moment on the shaft subjected to fluctuating load.

$T_e = \sqrt{(km\ M)^2 + (kt\ T)^2}$

K_m = Combined shock and fatigue for Bending

K_t = Combined shock and fatigue for Torsion

From table of recommended values for K_m and K_t selecting suddenly applied load with minor shock only.

$K_m = 2$ $K_t = 2$

T_e = 380.40N-m

Now, diameter of the shaft (d)

$d = \sqrt[3]{16Te/\tau\pi}$

d=35.9m.m ≅ 40m.m is taken

Fatigue on the Shaf

The shaft is subjected to completely reversed bending stress

σ_e Endurance limit

σ_e =0.5x σ_u for steel

σ_e =0.5 600=300

k_b - load correlation factor for reversed or rotating bending load. Usually taken unity.

k_{sur} - Effect of surface finish, for machined surface k_{sur} =0. 85

k_{sz} - effect of size

$k_{sz} = 1.189d^{-0.097}$ $k_{sz} = 0.83$

k_t - effect of temperature taken unity

k_r – Reliability factor, from table $k_r = 0.5$

$\sigma_e' = \sigma_{eb} k_{sur} k_{sz} k_r k_t k_i$

$\sigma_e' = 105.82Mpa$

The Shaft is subjected to

$\sigma = \frac{MY}{I}$, for d = 40m.m

$\sigma = 105.82Mpa$

since $\sigma < \sigma_e'$, the shaft is safe for fatigue.

Design for belt:

Selection of belt type: Based on the power transmitted 3.7kw power v- belt B59 section black rubber material top width 17mm and total length is 1499mm

Determination of belt length

The belt length can be obtained as follow

$$L = 2C + \frac{\pi}{2}(D1 + D2) + \frac{(D1+D2)\,2}{4C}$$

where, L = Length of belt (mm), D1= Smaller pulley diameter (mm), D2= Larger pulley diameter (mm), C = Centre distance of pulleys (mm)

L=1499MM

Distance between driver and driven pulley

The center to center distance between driver and driven pulley is given as

$$\boldsymbol{C}=\mathbf{2}D_{\mathbf{1}} + \boldsymbol{D_2} \quad (10)$$

Where;

D1 = Diameter of the driver =100mm = 0.10m
D2 = Diameter of the driven = 70mm = 0.70m
C= Centre to center distance between driver pulley and driven pulley
Therefore;
C=270mm or 0.27m

Selection of bearing: Ball rolling contact bearing of standard designation UCP 206 pillow block bearing is consisted by insert bearing UC206 ,housing P206 and inside diameter of 35 mm was selected for the machine. It is heavy loading and long using time, Pillow block bearings are designed to support shafts. Features include mounting surfaces parallel to shaft axes & elongated bolt holes in bases or feet of units for adjustment & mounting of pillow block bearing.

IV. Consideration of raw materials

This block crusher machine reduces the time and utility cost and used for increasing productivity and quality product capacity

1. Availability of raw material
2. The shaft is exposed torque, bending moment, tensional memory
3. Durability
4. Productivity
5. Low cost
6. Easy to handle by manufacturing process (weldability, machinability, formability etc)

Manufacturing process plan

V. OPERATING MECHANISM

This crusher works in electrical on the simple mechanism called crank and slotted lever mechanism. The drive unit consists of an electrical motor of 5hp ,1440rpm. The motor is fitted with a pulley of 100mm diameter. The shaft starts to rotate which in turn rotates the pulley which is connected to the motor by means of a belt drive. This pulley gives rotary motion to the transmission shaft which in turn rotates the Internal hammering parts that is attached to the main shaft. The bearings in between the shaft and pulley ensures smooth power transmission. The shaft transmits the rotary motion for hammer parts that attached on shaft. The hammering parts rotates break rock by impacting the rock with hammers/blow bars that are fixed upon the outer edge of a spinning rotor. Here the rotor shaft is aligned along the horizontal axis. The input feed material hits the rotating hammers of the rotor and due to this sudden impact, it breaks the material and further breaks the material by throwing it on to the breaking bar. This crushed

material can now be removed from the bottom part of the machine body and can be transported just as it is to the recycling plants.

VI. MACHINE TESTING AND RESULT

The block crushing machine was successfully fabricated and the machine was tested. The machine crushed waste block, terrazzo simultaneously by electrical driven motor operated operation. The experimental material was waste hallow block of 3kg, were evaluated by computing the recorded test parameters such as the block quality (output), product capacity, and product efficiency of the machine. The recorded test parameters were computed in order to obtain the test results of the machine. The block crusher machine average mass of block machine 3kg and machined 1kg in 20sec Which means the machine can crushed 3kg crush in 1min. Therefor the machine can crash 120 kg/3=40 block crushed with in 1hr. The power source of the hammer mill is a three-phase electric motor with a power capacity of 3750 W and a rotational speed of 1440 rpm.

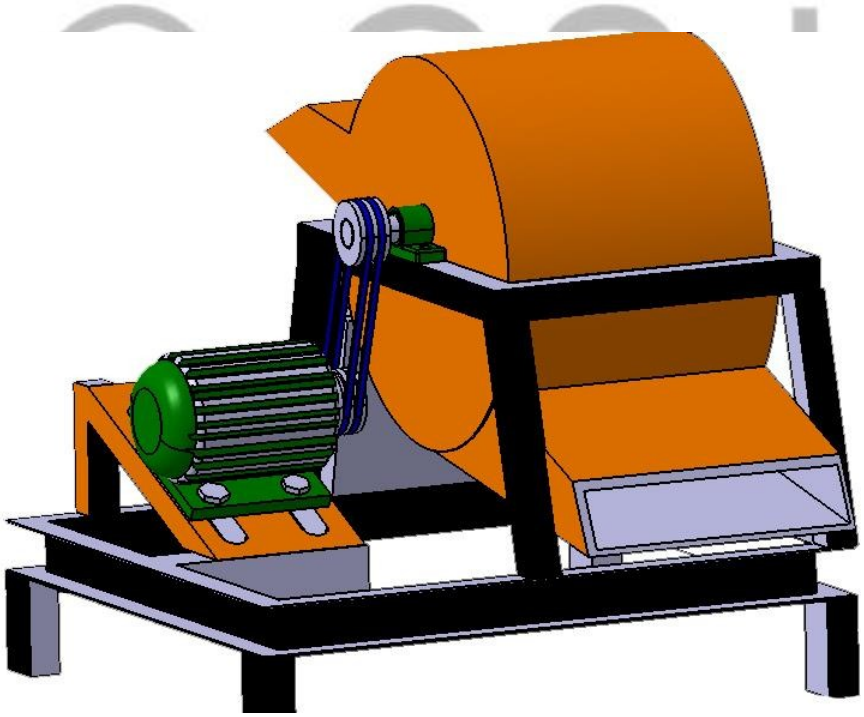

Figure 3: Crushing Machine Drawing

VII. Conclusion

The block crusher machine can be designed with high efficiency. The crusher has been designed by considering minimum power requirements and minimum effort to the operator. This machine

will reduce manual work and is suitable for mass production for block making enterprise. Compact structure and easy disassembling will be another advantage. this crushing machine will be help in the reduction of landfill and recycle need waste block, terrazzo and other materials of medium hardness, sewerage pollution caused by this waste blockage in relation to the environmental protection. It will also bring economic benefit to society as a source of business especially to SME's which are involving in metalwork. Hence the application of this electrical mechanism of block crusher is time to be saved. Therefore, the machine is very help full in the recycling of raw materials to be used the production of hallow block.

Reference

1. Kosse V., Mathew J. 2001 Design of hammer mills for optimum performance. Proceeding of the Institution of Mechanical Engineers,215(Part C): pp 87-94.
2. Fengnian Shi, Toni Kojovic, Joan S. Esterle, 2003 An energy-based model for swing hammer mills.
3. International Journal of Mineral Processing ; 71:147-166. Spolt, M.F. 1988. Design of Machines Element, 6th ed. Prentice Hall, New Delhi, India.
4. Vigneault, C.; T.M. Rothwell, and G. Bourgeois. 1992. Hammer mill grinding
5. rate and energy requirements for thin and conventional hammer. Canadian
6. Agricultural Engineering 34(2):203-205
7. A TextBook of Machine Design (S.I. Units) R.S. Khurmi - J.K. Gupta (2005)
8. Chawdhury (2007)
9. B. Nisbett. "shigley"s Mechanical Motorering Design", 8th Ed., McGraw-Hill Budynas − Nisbett, 2008, pp 1059
10. Rajender Singh, "Introduction to basic Manufacturing processes and workshop Technology", New delhi, 2006.
11. Hall A.S; A.R Holowenko, and H.G Laughlin.1980. Theory and Problems of Machine Design, Schaum's Series. McGraw. Hill Book Co; New York, U.S.A.
12. Hauhouot, M.; J.B. Solie; G.H. Brusewitz, and T.F. Peeper. 1997. Roller and hammer milling cheat (brooms secalinus) to reduce germination as an alternative to herbicides. Paper No. 971002, ASAE, St. Joseph, MI
13. Nasir A. 2005, Development and Testing of a Hammer Mill, AU J.T. 8(3), Jan. 2005: pp124-130.