Design and Development of Metal Chip Block Making Machine

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Abstract— there are several industrial production processes that involve mechanical machining of cast parts by various operations such as turning, milling and drilling. It is the process of finishing which transform work pieces into the required dimensions and surface finish by quietly removing the excess of material from the blank in the form of chips with the help of cutting tool. The large space required to store the chips as loose chips have a large surface area. The scope of the project is limited to the design and analysis of metal chips compacting machine for Precision Turncomp Pvt. Ltd. Hingna, Nagpur. This company has a 3000kg/month chip formation from machining through CNC Lathe machines. It is the second part of the research paper. In this paper we demonstrate the Calculation based on the data provided by the company, CAD Model, FE Model, and FE Results of the chip compacting machine.

Key words: Metal Chip, CNC Lathe

I. INTRODUCTION

Many industrial production processes include mechanical machining of cast parts by means of turning, milling and drilling. Machining companies sell their chips as scrap material, while foundries use it as a bulk material in their own melting units or sell it to scrap dealers. Loose chips have, however, many disadvantages. Hence compared with large-part scrap (sheet metal, casting scrap etc.), chips get considerably lower market prices. The bulk weight of chips is four times lower than (i.e. 25%) that of solid scrap. Large-scale containers are thus required to collect and transport chips inside and outside the foundry. These containers must be frequently emptied and require considerable space in the workshop. Road transport with container vehicles is the most expensive method of transport. As cast iron chips are contaminated with cooling lubricants, certain measures must be taken in connection with the storage of the chips. To prevent contamination of the groundwater, the chips must be collected in sealed containers placed on sealed surfaces.

Fig. 1: Chip storage in Precision Turn comp Pvt. Ltd.

These factors result in higher costs in connection with logistics and storage. As loose chips have a large surface area, the corrosion rate is relatively high, which results in lower valuation of the material. Additional price reductions must be accepted for moist/wet chips, as such batches contain considerable amounts of water. Due to these reasons it is important to process the chips by compacting it before recycling.

II. PROBLEM FORMULATION

Precision Turncomp Pvt. Ltd. Hingna, Nagpur has a 3000kg/month chip formation from machining through CNC Lathe machines. These loose chips are kept in the store area for one month. Subsequently it is sold to the scrap dealer for approximately 14 Rs/kg. The quality of chip get deteriorate during this period. If this chip can be compacted in the forms of solid lumps of metals, the price increases to Rs – 18/kg. This is the primary reason for company to perform compacting operation of loose chips.

III. RESEARCH METHODOLOGY

In present study, we develop the CAD model of metal chip compacting machine. Then perform FEA analysis of chip compacting machine for validation and perform hand calculation for loads and structure design of chip compacting machine after that results will be discussed and design will be finalized.

IV. DATA ACCUMULATION

A. Chip Formation

- By a single CNC machine – 10kg of chip produced per day
- Number of CNC Machine – 11
- Total weight of chip – 10X11 = 110kg/day by CNC machine
- Chip collected by other machines 50kg/day
- Chip collected in a bin, each bin carry 10kg chip
- Total chips collected in a day = 160kg

1) Volume of chip collecting Bin

- Diameter – 0.5m
- Height – 0.5m
- Volume = $\pi r^2 Xh = \pi 0.25^2 X0.5 = 0.098m^3$
- Total volume = $0.098X16 = 1.568m^3$ of chip/day
- $26X1.568 = 40.76m^3$/ month
- Total mass of chips in a month = 160X26 = 4160kg

Density of chips: mass of chips in a drum / volume of a drum

$$\text{Density} = \frac{10}{0.098} = 102.04 kg/m^3$$

According to the technical papers the 300mPa of pressure required to increase the density of chip about $5200kg/m^3$ (Briquetting of cast iron chips Dipl-Ing Andreas Jessberger, RUF Gmbh& Co KG, Germany. This paper was originally published in 'Giesserei' magazine)

$$\text{Now, compaction ratio} = \frac{5200}{102.04} = 51$$

Let, the surface area of briquette = $\pi r^2 = \pi X25^2 = 1963.5mm^2$

Force required for compaction of chip =

- Surface area of briquette in mm^2 X Pressure in mPa = 1963.5 x 300
- Force = 589050N
- Mass = 589050/9.81
- Mass = 60045.87kg

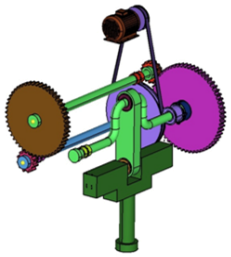
The 60tonne press machine required for the compression of chips

The volume required to store the compressed chip (briquettes) produced in a month = 40.76 X 0.02 = $0.81m^3$

CALCULATIONS:

Force required = 589050 N

Torque = 589050 x 0.385 = 226784.25 N.m



Motor RPM = 950

pulley mounted on the motor,

diameter (D1) = 110mm and N1 = 950

connected with pulley two along belt

diameter(D2) = 300mm and N2

N1 x D1 = N2 x D2

$$N2 = \frac{N1 \times D1}{D2} = \frac{950 \times 110}{300} = 348$$

gear1 mounted on same shaft,

t1 = 12 and N1 = 348

connected with gear2

t2 = 50 and N2

$$\frac{t1}{t2} = \frac{N2}{N1}$$

$$N2 = \frac{12 \times 348}{50} = 84$$

Gear 3 mounted on the same shaft

t3 = 15 and N3 = 84

connected with gear4

t4 = 60 and N4

$$\frac{t3}{t4} = \frac{N4}{N3}$$

$$N4 = \frac{15 \times 84}{60} = 21$$

$$P = \frac{2\pi NT}{60}$$

$$P = \frac{2\pi \times 21 \times 226784.25}{60}$$

Power = 498724watt

V. CAD MODELLING OF CHIP COMPACTING MACHINE

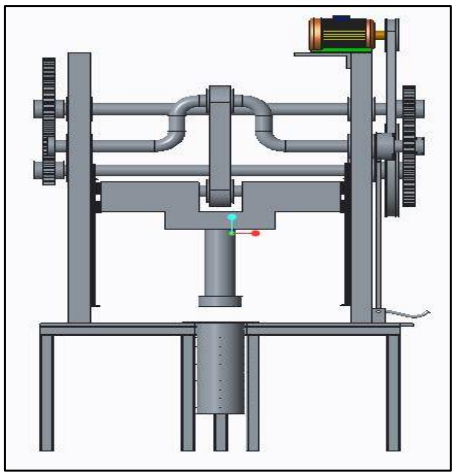


Fig. 2: CAD Modelling of Chip Compacting Machine

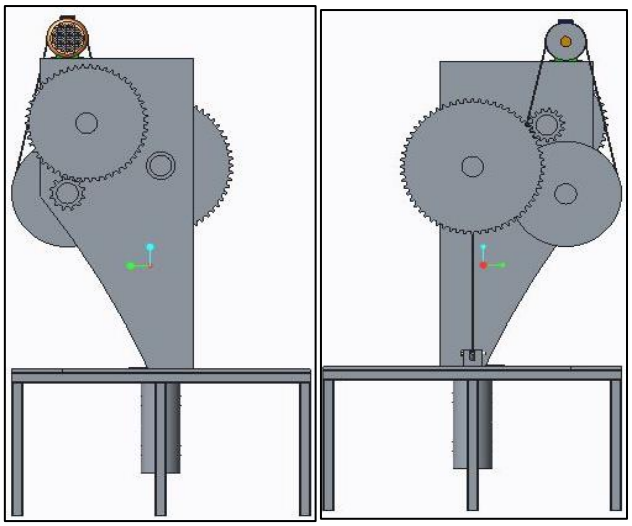


Fig. 3: CAD Modelling of Chip Compacting Machine

VI. ISOMETRIC VIEW OF CHIP COMPACTING MACHINE

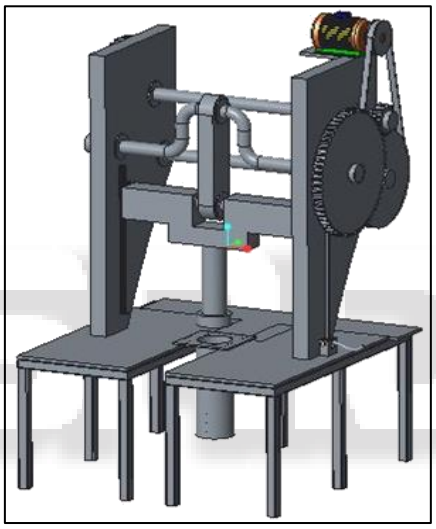


Fig. 4: Isometric view of chip compacting machine

VII. FE MODEL OF CHIP COMPACTING MACHINE

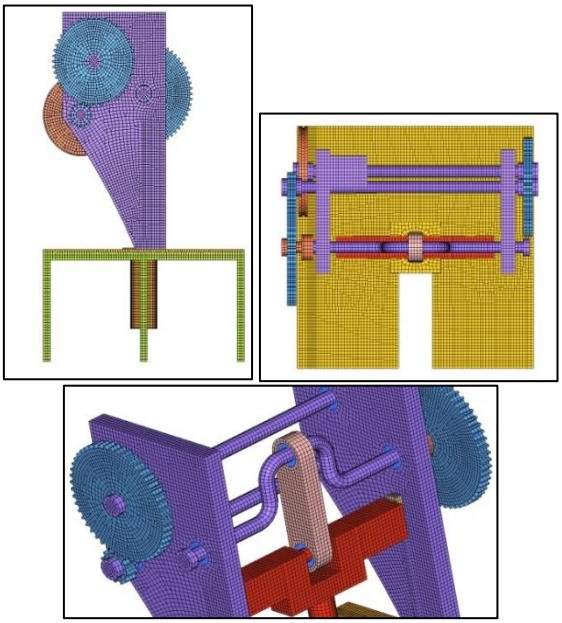


Fig. 5: FE Model of Chip Compacting Machine

VIII. BOUNDARY CONDITIONS: CONSTRAINTS

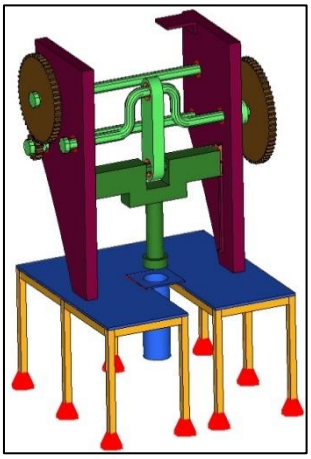


Fig. 6: Boundary conditions: Constraints

A. Forces

- Force of 589050 applied
- Torque = 13685 N.m

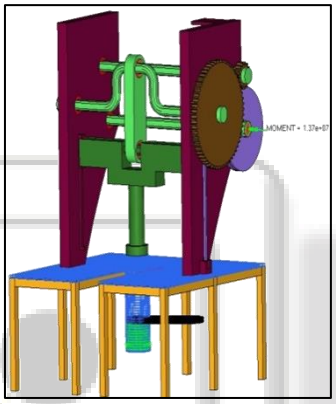


Fig. 7: Forces

IX. FEA RESULTS (STATIC)

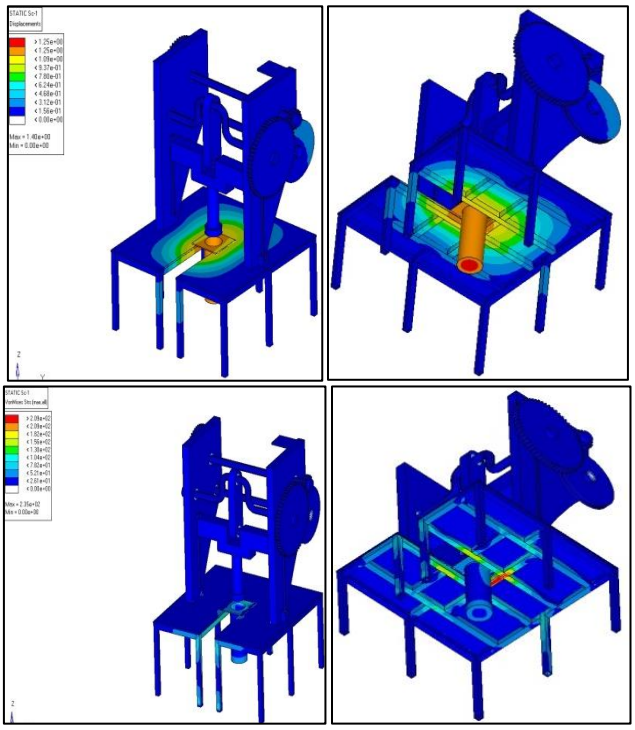


Fig. 8: FEA Results (Static)

X. RESULT TABLE

1.	Displacements = 1.4mm
2.	Stresses = 235Mpa

Table 1: Result Table

XI. CONCLUSIONS

We calculate the stresses after that we developed the CAD model of metal chip compacting machine. After the FE modeling, FE analysis of chip compacting machine was performed. The results was discussed and design get finalized.

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