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Machining Performance Optimization For Minimizing Material Losses By Thickness Variation Method

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Abstract: ***In this project a problem is identified and analyzed, modified and resulted. The problem identified in this project was thickness gets varied in mass production of brake linings which leads to various material losses during grinding operation. The thickness variation is mainly obtained during preforming and curing operation. In this project a problem is identified by various strategies of man, material and mould. Various analyses were taken on the strategies and concluded with a problem. The solution to the problem was obtained on the detailed study of the strategies and arrived with different alternatives. On that the best alternative is the designing of a plate which gives a permanent solution to the problem. In this project a plate is introduced in mould of performing machine to reduce thickness avoiding material losses. This project mainly deals with increase in productivity, time consumption and fulfilling customer satisfaction.***

Keywords: **Machining;** ***optimization;*** **material;** ***designing; productivity; customer satisfaction.***

I. INTRODUCTION

Raising the quality of work pieces is one of the most important objectives in modern production systems, which supervise technological processes in real-time (on-line) is a must to ensure their continuous operation with high efficiency and quality.**[9]**Preforming is a process of producing the required shape by hydraulic press. The mixture of raw materials is put into the performing mould and leveling is provided to even distribution of raw materials into the performing mould. The performing operation is carried out and the desired raw materials are converted into desired shape with some amount of thickness required. Next process to be carried is the curing operation where final thickness is obtained **[9].** Curing is the process of obtaining a required shape by hydraulic press and workpiece subjected to heat treatment. The thickness produced during curing cannot be reduced to initial .The cured block is then subjected under oven and cooling is preformed and then subjected to finishing line where cutting, grinding, chamfering, wear marking are carried out and the final product with required thickness is inspected and packed. The objective of the project is to reduce the variation of thickness during preforming and curing by optimization [10] techniques. An improvement in machine output at required level of thickness. To reduce material losses and to improve productivity and to reduce cost for promoting improvement in process quality and employee morale.

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1.1 Importance of this project

The lead to this project helps to reduce rejection parts per million. The overview of this project is to maintain a constant range over the preformed and cured work pieces leading to avoid excess grinding operations. Due to excess grinding some mechanical properties of the material get affected, hence thickness variation must be constant to reduce excess grinding.

1.2 Problems in excess grinding

The most significant are abrasive grain and bond wear phenomena, which are responsible for most energy AE impulses generation. Symptoms of wear of the abrasive grains and the bond are primarily abrasion and cracking. Bond bridges are mainly prone to cracking, while the abrasive grains are subject to a more complex process of wear.

II LITERATURE REVIEW

2.1 Introduction

This review is about the study of preforming machine [2] used for brake lining manufacturing process [3] and study on effect of mechanical properties on grinding [4].

2.2 Study of preforming machine

2.2.1 Press

A machine has stationary bed and a ram which has constant reciprocating motion towards and away from the surface of the bed and at right angle to it. The slide instructed in the frame of the machine to produce a definite path of the motion.

2.2.2 Bottom drive

Any press with the drive mechanism located within or under the bed connection of the drive to slides or slides are within or along the upright.

2.2.3 Mechanical presses

Mechanical presses utilize flywheel energy which is transferred to the workpiece by gears, cranks, eccentric or levers. Mechanical presses can be non-geared or geared, with single or multiple reduction gear drive, depending upon the press size.

2.2.4 Single action press

A single action press has one reciprocating slide acting against a fixed bed. Process of this type, which is the mostly widely used, can be employed for many different metal stamping operation including blanking, embossing, coining, and drawing. Depending upon the depth of draw, single action press often require the use a die cushion for blank holding . In such application, a blank holder, ring is depressed by the slide against the die cushion, usually mounted in the bed of the press.

2.2.5 Knockout

A mechanism for taking out work pieces from a die, also called ejector, pull out or lift out. Crossbars, cams motion, springs or air cushions are commonly used to work slide knock outs.

2.2.6 Pneumatic toggle links

The main links of toggle press which are equipped with pneumatic cushions and a link to give air pressure controlled flexibility. These links compensate for thickness variation under the blank holder and also can be adjusted to exert different pressure at any corners of the blank holders.

2.2.7 Bolster plate

A Plate fixed on the top of the press bed for location and supports the die assembly. It usually has 7slots for attaching the lower die or die shoe .Motion to bolster plates on self energized for transferring dies in and out of the press for die fixing .Also called rolling bolsters, they may be integral with or placed to a carriage . They are not to be collapsed with reciprocating bolster, the purpose of which is moving the lower die in and out of the press for feeding work pieces.

2.2.8 Cushion

An accessory for a press which provides a resistive force with motion required for some operation such as blank placing part, drawing or redrawing, maintaining uniform pressure on a work pieces and knocking or stripping also called pads or jacks. Although usually mounted in or under the press bed. They are also on the slide.

2.2.9 Slides

The pertinent reciprocating member of press, instructed on the press frame to which the punch or upper die is fastening, also called the ram. The inner slide of a double action press is called the plunger or punch holder slide. The outer slide of a double action press is called the blank holder slide.

2.3 Study of mould

Mould is a hollow form of rectangular bracket in which the work pieces are performed. The mould consist of two dies one is male die in which is connected to the ram and other female die is placed inside the mould.

2.3.1 Tool plate of female die

Tool plate is a plate which carries the mixture and when pressured by top force of ram produces the work pieces.

2.3.2 Vent gap

Vent gap is provided in the mould for free air to pass through.

2.3.4Clearance

The distance between the tool and the mould surface is known as clearance. The clearance is provided for free movement of the tool to move vertically. The clearance value should be within 0.25 +/- 0.1

2.3.5 Bottom portion of mould

The bottom portion of the mould has a hole in which ejection pin are provided.

2.4 Study on effect of mechanical properties of excess grinding

Generally, the grinding processes[4],[11]are diagnosed through multi parametric measurements: the force components (normal and tangent), grinding power, vibration, surface temperature, acoustic emission, etc.The most significant are abrasive grain and bond wear phenomena, which are responsible for most energy AE impulses generation. Symptoms of wear of the abrasive grains and the bond are primarily abrasion and cracking. Bond bridges are mainly prone to cracking, while the abrasive grains are subject to a more complex process of wear. The figure 1 shows the effect of mechanical properties.

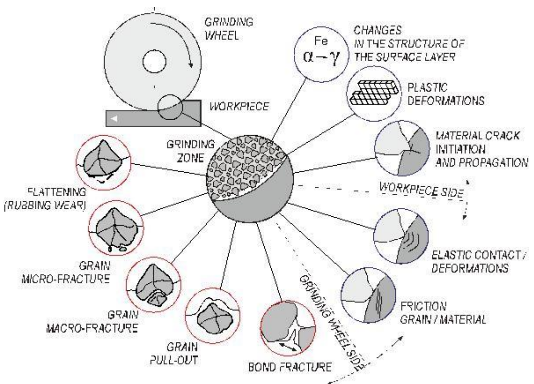

Figure 1: Effect of mechanical properties

The feed [14] is responsible for deflections in the work piece of the abrasive tool (in the machine-workpiece-tool system), as well as depends on the bluntness of the grains on the surface of the abrasive tool.

III PROBLEM IDENTIFICATION

The problem arises from the clearance value. Hence clearance value must be reduced to the required limit. Since clearance value is allowed to 0.25+/-0.1 limit and thickness allowed to 40±2 mm.

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The powdered raw material mixture travels along the clearance gap during vertical movement of tool (i.e) radius plate. Due to such problem the raw materials gets deposited on the bottom of the mould .hence staging of mixture on the bottom of the mould the radius plate gets a little tilted when resting on the spilled mixture on the bottom portion of the mould resulting thickness variation. The thickness after performing should be around 40±1 and curing thickness should be around 21±1.The figure 2 shows the cut section of the perform mould and figure 3 shows the powdered mixture deposited on the bottom portion of the mould.

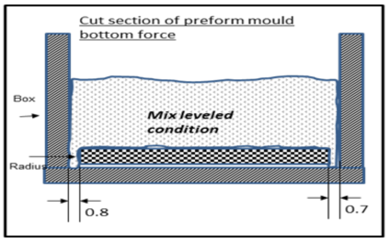

Figure 2: cut section of preform mould

Figure 3: mix deposition

3.1 Solution to the problem:

The problem is solved by implementing a I shaped rectangular plate screwed to the bottom portion of the mould. By this implementation the spilled mixture gets deposited on the slides of the I-plate. The plate I is provided with 20mm clearance on all sides of the plate with respect to the mould. Hence is reducing the thickness variation. The spilled mixture is cleaned every month once. Hence thickness variation is reduced in preforming machine.

IV DESIGN AND ANALYSIS

The figure 4 gives the design [5] of the I shaped plate and figure 5 shows the analysis of I plate and figure 6 shows the analysis of I shaped plate with radius plate.

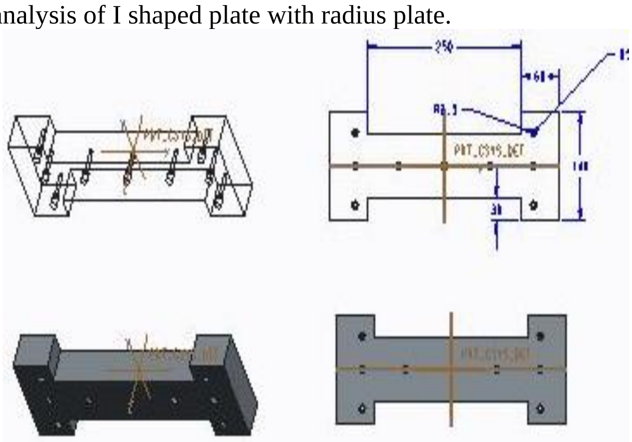

Figure 4: Design of I plate

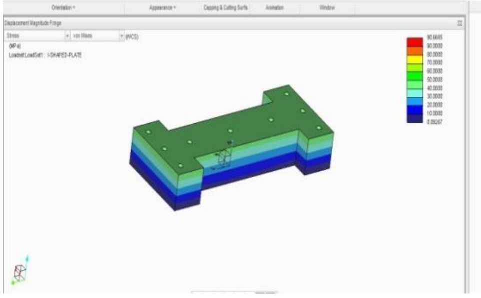

Figure 5: Analysis of I shaped plate

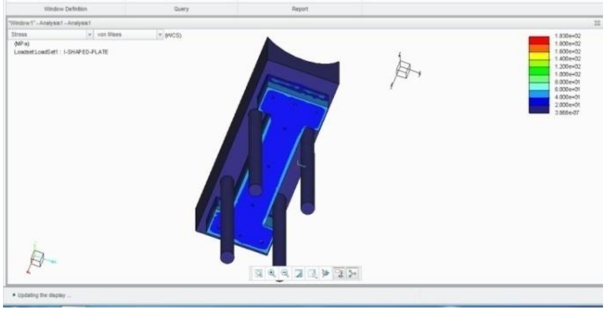

Figure 6: Analysis of I shaped plate with radius plate

V DESIGN CALCULATION

D=370 mm,d=250 mm, B=140mm,b=80 mm
Poisson ratio μ=1/m =0.27
Young's modulus E =199.95*10^3 N/mm^2
P=F=200 Tonnes =200*1000*9.81
=1.962*10^6 N

L=PL/AE

=1.962*10^6*370/AE
A1=L*B=140*60= 8400mm^2
A2=250*80=20000mm^2
A1=A3

Total area=36800mm^2

L =1.962*10^6*370/(36800*199.95*10^3)
L =0.09865mm

Strain e=δL/L

=0.09865/370
=2.66*10^-4

Stress σ = P/A

=1.962*10^6/36800
=53.3152 N/mm^2
E = 2G(1+μ)
199.95*10^3 = 2G(1+0.27)

Modulus of rigidity G=78.720*10^3 N/mm^2

E = 3k(1-2μ)
199.95*10^3 = 3k(0.46)

Bulk modulus K=144.891*10^3 N/mm^2

Calculation of maximum shear stress
Assume shear force F=1 KN

To find centre of gravity

Since the section is symmetric about its x-x axis the center of gravity is half the depth of the section.

CG=370/2=185 mm

To find moment of inertia

I=I1+I2+I3

I1=IG1+A1H1^2

=bd^3/12+A1H1^2

H1=185-(60/2)=155

=140*60^3/12 +8400*155^2

I1=204.330*10^6 mm^4

I2=IG2+A2H2^2

H2=60+(250/2)-185 =0

I2=104.16*10^6 mm^4

I1=I3 since symmetry about x-x axis

I = I1+I2+I3

I=(204.330*10^6)+(104.16*10^6)+(204.330*10^6)

I= 5.12*10^8 mm^4

Shear stress in the upper flange with web[7]

$$q = \frac{F A_1 \vec{y}}{IB}$$

$\vec{y}$ = 185-(60/2) =155

q = 1000*8400*155/((5.12*10^8)*140)

q =0.01816 N/mm^2

Shear stress in the web with upper flange[7]

$$q = \frac{F A_1 \vec{y}}{Ib}$$

= 1000*8400*155/((5.12*10^8)*80)

q = 0.03178N/mm^2

Table 1: Thickness before and after implementing

S.NO	(BEFORE)		(AFTER)	
	LH	RH	LH	RH
1	39.00	44.00	40.00	40.00
2	40.00	45.00	41.00	40.00
3	40.00	44.00	40.00	40.00
4	41.00	46.00	41.00	40.00
5	40.00	41.00	40.00	40.00
6	39.00	43.00	41.00	40.00
7	41.00	43.00	41.00	40.00
8	42.00	43.00	40.00	40.00
9	40.00	44.00	41.00	41.00
10	41.00	44.00	40.00	40.00
Min	**39.00**	**41.00**	**40.00**	**40.00**
Max	**42.00**	**46.00**	**41.00**	**41.00**
Avg	**40.36**	**43.7**	**40.50**	**40.30**
Range	**3.00**	**5.00**	**1**	**1**

The maximum shear stress lies in neutral axis since beam is symmetric about x-x axis therefore maximum shear stress of the beam[7]

$$q_{max} = \frac{F}{8I}\left[\frac{B}{b}(D^2 - d^2) + d^2\right]$$

=1000/(8*5.12*10^80[140/80(370^2-250^2)+250^2]

q_{max} **= 0.047 N/mm^2**

VI FABRICATION

The material chosen for I shaped plate is EN 31 which is a good wear resistant material. A rectangular bar of area 370*140 is taken and exact dimensions of I plate are marked and fabricated to the desired shape. Next stage of process is drilling a counter bored shaped hole with specified dimensions over the I shaped plate. The figure 7&8 shows the finished I shaped plate inserted into the perform mould and assembled view of perform mould. The table 1 shows the preform thickness before and after implementation of I plate.

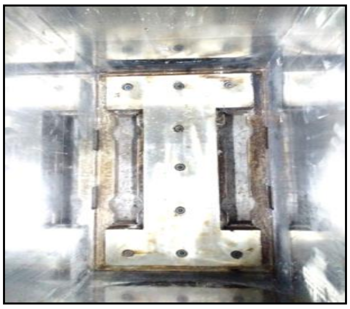

Figure 7: Inserted I plate

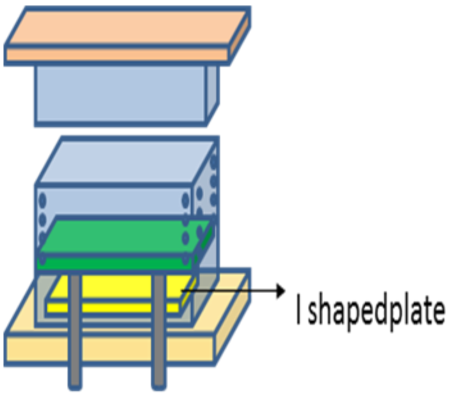

Figure 8: After fixation of I plate

VII. RESULT AND DISCUSSION

This project is concerned with the production and manufacturing .The objective of this project is to reduce material losses during production of brake lining in our concerned project esteem .The results have concluded that the project accomplished on the perform mould have led to reduction of material losses. The cornered vision over the project is to increase the customer satisfaction and to increase productivity. The lead to this project helps to reduce rejection parts per million. The overview of this project is to maintain a constant range over the preformed and cured work pieces leading to avoid excess grinding operations. The result avoids the chances of excess grinding preventing mechanical properties losses. The Figure 9&10 shows the no of rejected parts per weak and the amount of material losses reduced after implementation.

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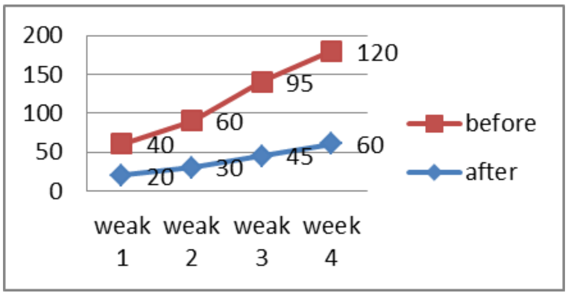

Figure 9: Rejected parts per week

The chart clearly describes the no of rejected parts in a week. The parts are rejected due to many major defects, but some defects regarding thickness variation have been reduced and the no of rejected parts have been reduced from 60 to 40 and so on.

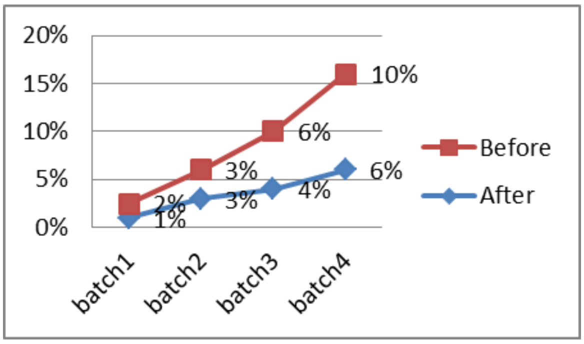

Figure 10 : Material losses per batches

The above chart clearly describes the material losses deduced in batches.Normally material losses are due to rejected parts which is also again used, but the material losses due to excess grinding cannot be reused,this project reduces the chances of excess grinding preventing material losses from 16-10%.

VIII CONCLUSION

The results have concluded that major rejection of parts is due to thickness variation which is obtained from the accumulation of mix on the bottom portion of the perform mould. The mix accumulation is due to clearance between the tool and the side portion of the perform mould which must be limited to 0.25±0.1, but the problem obtained in clearance is around 0.8 which is too much to detect. Required level thickness is attained, Material loss is deducted, Improvement in process quality, Reduction in process rejection rate, Improvement in customer satisfaction, to avoid continuous monitoring of inspecting the work piece. These projects are overview to increase in benefit of management and to the increase in customer satisfaction. Due to excess thickness in preforming and curing operation it is necessary to do excess grinding on the cured work pieces and by the way the mechanical properties of the material of the material gets affected ,in introducing the project the required thickness is obtained increasing in customer satisfaction.

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Palani S was born in Madurai, Tamilnadu, India, in 1967. He received the B.E., degree in Mechanical Engineering from M.K. University, Madurai, Tamilnadu, India in 2003, and the M.E., and Ph.D. degrees in Manufacturing Engineering from the Anna University, Chennai, Tamilnadu, India in 2005 and 2013, respectively. He has 13 years of experience in teaching and research and working as an Associate Professor in the Department of Mechanical Engineering, Vel Tech Multitech Dr. Rangarajan Dr. Sakunthala Engineering College, Avadi, Chennai-600 062. His research area include Advanced Manufacturing Technology, Artificial Intelligent Techniques, Machine Vision, On-line Monitoring, Material Science, Bio-Fuel, Heat Exchanger etc., He published more than 100 research papers through National and International Journals and Conferences. He is an authorized Research Supervisor for Anna University and Guiding more than 7 Ph.D., research scholars. He was awarded as a "Distinguished Scientist" by Venus International Foundation -Research Awards-VIRA 2016. He is a Life member of MISTE [LM91981} in professional bodies.