Case Study on Tool Wears Reduction in CNC Machine

Manufacturing Technology

*R. Saiyuvaraj, M. Raja Pandian, G. Ramesh Babu, M. Revanth, M .Nagaraja
Department of Mechanical Engineering,
PSNA College of Engineering & Technology,
Dindigul – 624622.

***Abstract*:- The CNC boring bar used in boring operations is made of stainless steel. This material t ends to wear at certain conditions by losing its hardne ss. This paper tells about the manufacturing of bo ring bar with material harder than stainless steel to avoid unusual wear so that the tool life will be extend ed.**

Keywords: Tool Wear, Manufacturing Technology

I. INTRODUCTIONN:

The forces generated when the cutting tool comes in contact with work piece produce certa in deflections. These structural deflections modulate the chip thickness that, in turn, changes the ma chining forces. For certain cutting conditions, this cl osed loop, self exited system becomes unstable an d regenerative chatter occurs. Regenerative chatter may result in excessive machining forces and tool wear, tool failure and scrap parts due to unacce ptable surface finish, thus severely deceasing operatioon productivity and part quality [1]. Because of low rigidity of boring bar chatter is difficult to be avoided even if the depth is very small. So, chatter is one of the main obstacles to the improvement of the work piece surface finish and tool life boring [2]. In order to improve the stability against chatter vibrations, va rious types of boring bars have been devised by several researchers [3]. This paper describes the use o f an alternate material which is harder than stainless steel is used to manufacture the boring bar for extended tool life.

II. BORING BARS

A boring bar is a tool used for met al working. In metal boring the tool can be plunged a nd dragged on the X or Y axes to create a slot or asy mmetrical hole or channel, or it may be moved only in an up and down motion (on the Z axis) to create a perfect circular hole.

Fig : S 12 M SCLS L 06 Boring Tool 2d model

A. ISO DESIGNATION S YSTEM FOR TOOL HOLDER

S	:	Type of Shank
12	:	Shank Diameter
M	:	Lengt h
S	:	Clamp ing Method
C	:	Shape
L	:	Style
C	:	Clearance Angle
L	:	Holde r
06	:	Edge Length

B. SPECIFICATION OF BORING TOOL

Designation	d	H1	H2	L1	L2	f	Dmin
S 12 M SCLC L 06	12	5,5	1 1	150	10	9	16,0

TOOL DATA	
Shank Height (h)	11 mm
Functional length (L_f)	150 mm
Body diameter	12 mm
Functional height (H_f)	0 mm
Functional width (W_f)	9 mm
Torque (Tq)	0.9 Nm
Body material code	Steel
Weight of item	0.16 kg

Connection diameter	12 mm
Tool cutting edge angle	95 degree
Tool lead angle	5 degree
Maximum ramping angle	0 degree
Minimum bore diameter	16 mm
Workpiece side body angle	0 degree
Machine side body angle	0 degree
Minimum overhang	24.5 mm
Maximum overhang	48 mm
Hand	Left
Life cycle state	Obsolete
Damping property	False
CUTINMASTER	CCMT 06 02 04

C. *Components of boring bar:*

Modern boring tools have three primary components.

1. The body
2. Bar holder
3. Dial screw

D. *Boring operations*:

1. **Roughing** – Roughing is primarily focused on metal removal in order to enlarge existing holes made by methods such as drilling, casting, forging, flame cutting etc.
2. **Fine boring** – Intended to complete an existing hole to achieve a close hole tolerance, position and high quality surface finish.

III. EXPERIMENTAL TESTING

A. *Determination of Rockwell Hardness number:*

- The term hardness in general means the resistance of material to indentation.
- The hardness value obtained in a particular test serves only as a comparison between materials or treatments.
- Hardness tests are widely used for inspection and quality control.
- An indenter of fixed and known geometry makes an impression with the specimen under known static load applied (either directly or by means of a lever system).
- The hardness is then expressed as a number that is either inversely proportional to the depth of indentation or proportional to a mean load over the area of indentation.

❖ Intender scale and load for testing hardness of HSS, HCHC, NFCA.

Material	Indenter	Load	Scale
Hard material	Diamond cone	150 kg	C scale

Table 1 : Intender scale and load for testing hardness of SS, HCHCr ,AISI 040

Readings observed:

Sl no.	Material	Load (kg)	Indenter size	Scale	Hardness number			Mean value
1	Stainless Steel	150	120	C	54	55	59	56
2	HCHCr	150	120	C	85	88	87	86.6
3	AISI 1040	150	120	C	99	96	94	96.3

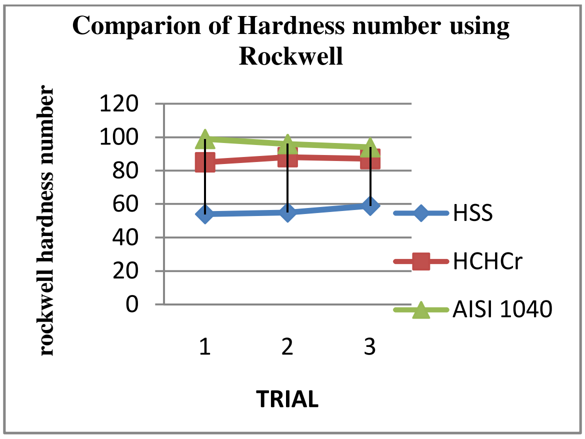
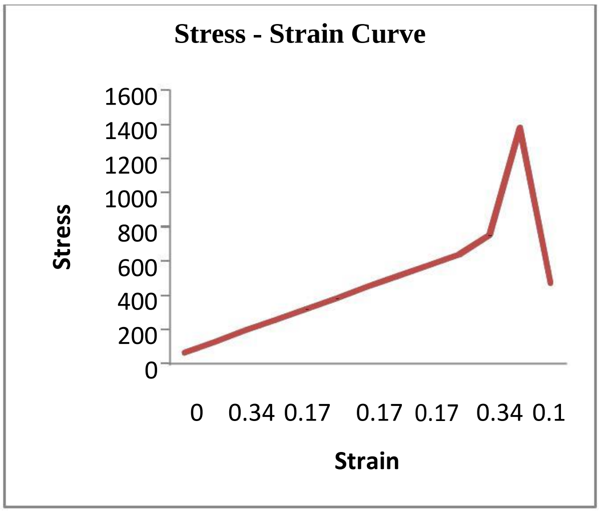


Fig 1. Comparison of hardness of different materials

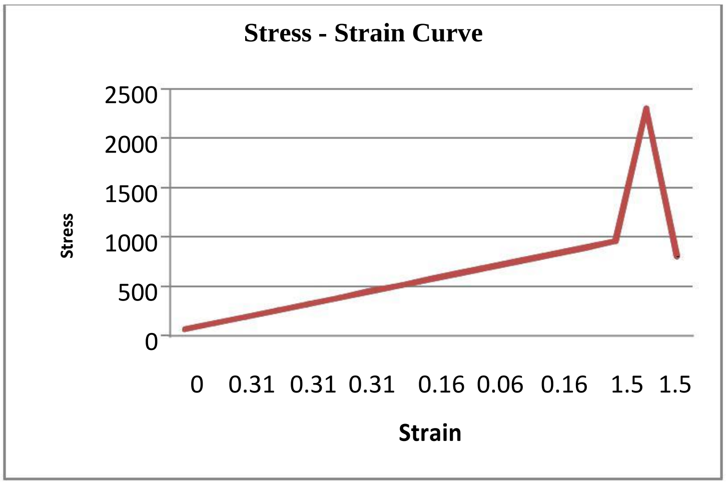
B. Tensile testing in Universal Testing Machine:
Stainless Steel

Sl.No	Load in kN	Stainless Steel		Stress	strain
		Scale reading in mm	Change in length in mm		
1	5	5	0	63.69	0
2	10	6	1	127.39	0.34
3	15	7	1	191.08	0.34
4	20	7.5	0.5	254.78	0.17
5	25	8	0.5	318.47	0.17
6	30	9	1	382.17	0.34
7	35	9.5	0.5	445.85	0.17
8	40	10	0.5	509.55	0.17
9	45	10.5	0.5	573.24	0.17
10	50	10.1	0.5	636.94	0.17
11	59	20	9.9	751.59	0.34
12	39	22	2	1380	0.06
13	37	25	3	471.34	0.1



AISI 1040

Sl.No	Load in KN	AISI 1040		Stress	strain
		Scale reading in cm	Change in length in cm		
1	5	1.4	0	63.69	0
2	10	1.5	0.1	127.39	0.31
3	15	1.6	0.1	191.08	0.31
4	20	1.7	0.1	254.78	0.31
5	25	1.8	0.1	318.47	0.31
6	30	1.9	0.1	382.17	0.31
7	35	2	0.1	445.85	0.31
8	40	2.05	0.05	509.55	0.16
9	45	2.1	0.05	573.24	0.16
10	50	2.15	0.05	636.94	0.16
11	55	2.17	0.02	700.63	0.06
12	60	2.2	0.03	764.33	0.09
13	65	2.25	0.05	828.02	0.16
14	70	2.4	0.15	891.72	0.4
15	75	2.9	0.5	955.41	1.5
16	65	3	0.1	2300	0.31
17	63	3.5	0.5	802.55	1.5



IV. STAINLESS STEEL

A. COMPOSITIONS OF STAINLESS STEEL:

COMPONENT	PERCENTAGE
Carbon	0.08%
Chromium	18% to 20%
Iron	66.3% to 74%
Manganese	2%
Nickel	8% to 10.5%
Phosphorous	0.045%
Sulphur	0.03%
Silicon	1%

B. PROPERTIES OF STAINLESS STEEL:

PROPERTY	VALUES
Density	7.85 g/m^3
Bulk Modulus	134 GPa
Compressive Strength	205 MPa
Elastic limit	206 MPa
Rockwell Hardness	56 (HRC)
Tensile Strength	510 MPa
Young's Modulus	190 GPa

V. AISI 1040

5.1 COMPOSITION OF AISI 1040:

COMPONENTS	PERCENTAGE
Carbon	0.37% to 0.44%
Sulphur	0.05%
Manganese	0.60% to 0.90%
Iron	96% to 98%

5.2 PROPERTIES OF AISI 1040:

PROPERTY	VALUES
Density	7.84 g/cc
Bulk Modulus	140 GPa
Compressive Strength	210 GPa
Elastic Limit	190 MPa
Rockwell Hardness	96
Tensile Strength	620 MPa
Young's Modulus	210 GPa

VI. MANUFACTURING OF THE BORING BAR

This process includes the following machining processes.

1. Facing
2. Turning
3. Forging
4. End Milling
5. Heat treatment

VII. CUTTING FLUID:

GRODAL CUTSOL D is the cutting fluid used in boring operation. This fluid is used to reduce heat produced during machining and avoid unusual wear.

DESCRIPTION

Grodal Cutsol D is a water soluble cutting fluid with excellent corrosion resistant property which is designed for cutting and grinding operations. When it is mixed with the water it forms milky white emulsion. Grodal Cutsol D is formulated with the high quality mineral oil and high levels of lubricity additives to provide excellent performance in arduous operations.

BENEFITS OF GRODAL CUTSOL D

Excellent performance in high speed processing.
Outstanding machining performance on Aluminium, non-ferrous metals and ferrous metals.
Excellent anti rust property and protects machine and work pieces from rusting.
Contributes for effective operation and protection of the earth environment.
Safe to use and disposal is easier.
Excellent cooling performance.

RECOMMENDATIONS

Grodal Cutsol D is designed for machining and boring of ferrous and non ferrous metals, specially cast iron and its alloys.

Boring: from 2% to 5%Machining: from 3% to 10%

Working concentration depends on Severity of the operation harder materials or heavy-duty operations will require a higher concentration in order to improve the lubricity. Concentration must be kept lower than 10%. Be careful of controlling the concentration of Grodal Cutsol D. Rust preventive ability decrease according to the concentration of Grodal Cutsol D.

APPLICATION

Grodal Cutsol D is suitable for processing steel, cast iron, gray cast iron, Aluminium and non ferrous heavy metals. Grodal Cutsol D is recommended for most metal cutting and grinding operations where high quality coolant is required.

TECHNICAL DATA

Color and Appearance	: brown liquid
Sp. Gravity @ 30 °C	: 0.91
Appearance of 5 % emulsion	: Milky white emulsion
PH of 5 % emulsion	: 9 – 10
Foaming test	: passes
Corrosion Test	: Passes

VIII. CONCLUSION

From the above done case study the wear of tool is studied. It is noted that the hardness, tensile strength, elastic limit of the stainless steel tool is lesser than AISI 1040. This material can withstand the load given while machining, than stainless steel. So, AISI 1040 is the material chosen to manufacture the boring tool.

ACKNOWLEDGMENTS

The authors acknowledge the guidance rendered by faculty Mr.M.Nagaraja BE MS (Research) of PSNACET and Dr.D.Vasudevan HOD Mechanical PSNACET and Project advisor Prof.K.Harikannan for their continuous support and guidance.

Also we acknowledge Mr.R.Ranganathan technicians Mechanical and other technicians of electrical department for providing adequate facilities for smooth running of the project.

The author would like to thank Thiru.R.S.K.Sukumaran Vice-Chairman Establishment, of PSNACET for giving the wonderful environment of academics par excellence in research in PSNACET campus.

REFERENCES

[1] Robert G. Landers “Regenerative chatter in machine tools” by university of Missouri at Rolla.

[2] Yussefian, N.Z., B. Moetakef-iman and H. El-Mounayri, 2008. “The prediction of cutting force for boring process” International J. Machine tools and Manufacture.

[3] Lee, D.G., 1998. “Manufacturing and Testing of chatter free boring bars” Korea institute of technology-sponsored by N.P. Suh (1), MIT.

[4] Cakir, M.C., Ensarioglu, C. and Demirayak, I., Mathematical modeling of surface roughness for evaluating the effects of cutting parameters and coating material, Journal of Mechanical Proceeding technology, 2009, (209), pp.102-109.

[5] Ozel, T. and Karpat, Y., “Predictive modeling of surface roughness and tool wear in hard turning using regression and neural networks,” International Journal of Machine Tools & Manufacturing, 2005, (45), pp. 467– 479.