Scientific Journal of Impact Factor(SJIF): 3.134
e-ISSN(O): 2348-4470
p-ISSN(P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 2,Issue 5, May -2015

Design and Development of Boring fixture for Connecting rod

S.A.Raijada[1], A.L.Dudhatra[2]

[1]P.G. Student, Mechanical Engineering Dept, A.I.T.S, Rajkot, India
[2]Asst. Professor, Mechanical Engineering Dept, A.I.T.S, Rajkot, India

Abstract-*Connecting rod is key piece of engine. It ought to be precisely machined with the obliged resilience. Additionally the varieties of measurements in work-piece to work piece ought to be low so it will be simpler to amass in engine. At the same time, it has been watched that in the majority of the cases the process duration needed for machining (boring) the connectingrod was an excess of furthermore with the lower resilience precision in exhausting operation because of traditional installation.The diameters required of the smaller end and the Bigger end of the said connecting rod are 35.6±0.010 mm and 55.6±0.02 mm respectively. The aim of this project is to design and development of a new fixture for machining (Boring) operation using designing softwares i.e. Pro E. Because of varieties in diameters of the end side the rejection rate is high so with this new outline the point is to reduce the rejection rate up to 5% which is 13% presently furthermore to expand the production rate up to 10% to 15%.*

Keyword-*Connecting rod ;clapmings;lcator ; Iscar online calcualtion;Creo 3.0(PRO E)*

I. INTRODUCTION

A fixture is a production tool that locates, holds, and supports the work securely so the required machining operations can be performed easily. Set blocks and feeler or thickness gauges are used with fixtures to guide the cutter to the work-piece. A fixture should be securely fixed to the table of the machine upon which the work is done. Though largely used on milling machines, fixtures are also designed to hold work for various operations on most of the well-known machine tools. Fixtures are production work-holding devices used to manufacture duplicate parts accurately. The correct relationship and alignment between the cutter, or other tool, and the work- piece must be maintained. To do this, a fixture is designed and built to hold, support, and locate every part to ensure that each is drilled or machined within the specified limits. The difference between the jig and fixture is in the way the tool is guided to the work-piece. Fixtures vary in design from relatively simple tools to expensive, complicated devices. Fixtures also help to simplify metalworking operations performed on special equipment.[1]

A. Classification of Fixture

Fixtures are typically grouped by the sort of machine on which they are utilized. Apparatuses can likewise be recognized by a sub characterization. Case in point, if a fixture is intended to be utilized on a milling machine, it is known as a milling Machine. On the off chance that the undertaking it is planned to perform will be straddle processing, it will be called a straddle-milling Fixture. The same rule applies to a machine installation that is intended to machine radii. It is known as a machine sweep Fixture.

The following is a partial list of production operations that use fixtures.

- **Assembling**
- **Boring**
- **Broaching**
- **Drilling**
- **Forming**
- **Gauging**
- **Grinding**

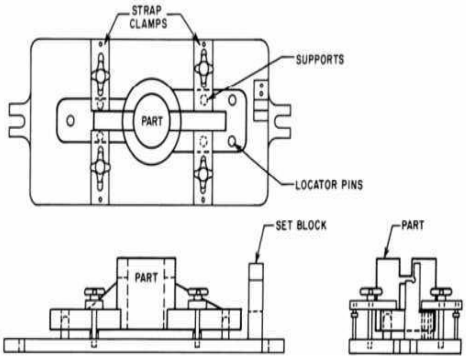

Figure 1.Plate Fixture [1]

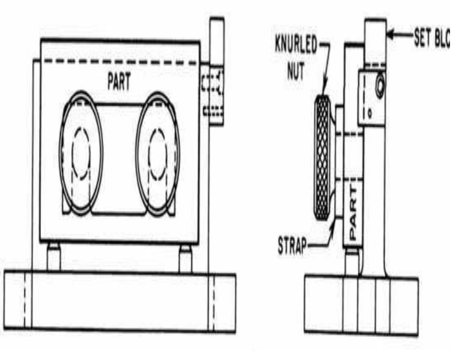

Figure 2.Angle plate Fixture [1]

Plate fixtures arethesimplestformoffixture(Figure1).Thebasicfixtureismade fromaflatplatethathasavariety ofclampsandlocatorstoholdandlocatethepart.The**angle-platefixture**isavariationoftheplatefixture(Figure1.2).Withthistool, thepartisnormallymachinedatarightangletoitslocator.Whilemostangle-platefixtures aremadeat90degrees, therearetimeswhenotheranglesareneeded.[2]

B. Elements of Fixtures

* **Locators:** A locator is usually a fixed component of a fixture. It is used to establish and maintain the position of a part in the fixture by constraining the movement of the part. For work-pieces of greater variability in shapes and surface conditions, a locator can also be adjustable.

* **Clamps:** A clamp is a force-actuating mechanism of a fixture. The forces exerted by the clamps hold a part securely in the fixture against all other external forces.

* **Supports**: A support is a fixed or adjustable element of a fixture. When severe part displacement/deflection is expected under the action of imposed clamping and processing forces, supports are added and placed below the work-piece so as to prevent or constrain deformation. Supports in excess of what is required for the determination of the location of the part should be compatible with the locators and clamps.

* **Fixture Body:** Fixture body, or tool body, is the major structural element of a fixture. It maintains the spatial relationship between the fixturing elements mentioned above, viz., locators, clamps, supports, and the machine tool on which the part is to be processed.[2]

II. LITERATURE REVIEW

Previously all the work related to fixture design based on two factors first was to minimize some parameters which will ultimately increase the output i.e. The deflection , Vibrational effects ,Rejection rate , Cycle time etc.

Maximization parameters i.e. Productivity , Immobilization Capability of fixture etc.

All the above parameters are to be optimized are based on the type of the operation for which the fixture is used.

After reading various papers related to the stated fixture design many methodologies are available. In which three methodologies are used in this research which are (1) Computer Aided Fixture Design (2) Case Based Reasoning (3) Feature Based Fixture.

III. PROBLEM DEFINITION

The major problem in existing fixture is the diameter dimensions which are not achieved in tolerances continuously. The diameters of the bigger end and the smaller end of the said connecting rod are 55.6±0.020mm and 35.6±0.010 mm respectively according to customer's order. Which is quite difficult to achieve on a continuous basis.Due to which the rejection rate is high. Also the production rate with this existing fixture is low so with the new design the aim is to overcome the above stated problems. Figure below shows the existing fixture with its model.

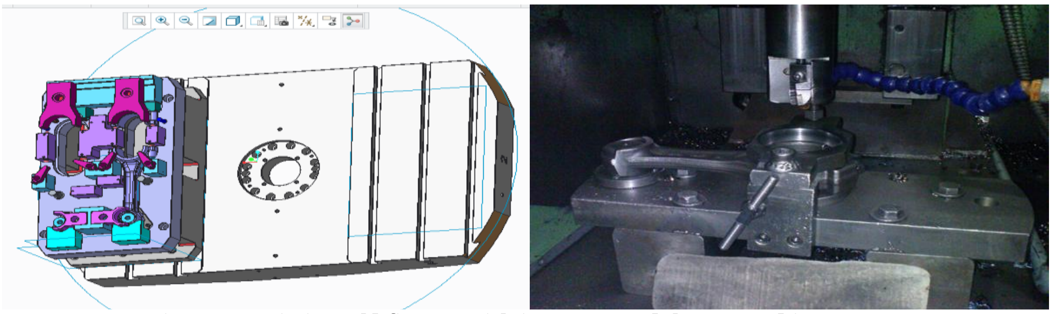

Figure 4.Existing old fixture with its CAD model prepared in creo 3.0

This is a existing mechanical fixture used in the company. Material use for connecting rod is:-S48c forged steel

IV. Design and Development of new fixture

First of all a base plate is designed for new fixture which is based on the dimensions of the said connecting rod. This base plate is designed using creo 3.0 Pro Engineering software. The figure below shows the CAD model of the Base plate and Connecting rod .

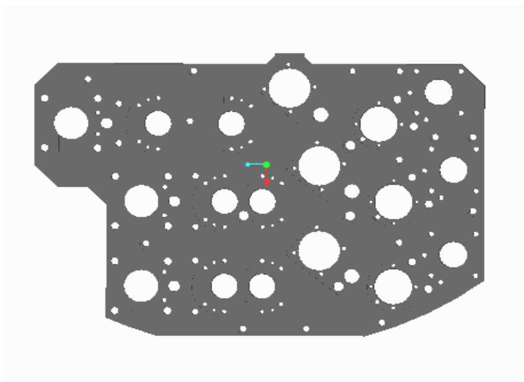

Figure 5.Base Plate

A.Thickness calculation of the base plate

The thickness of the Plate is determined by considering the plate as a simply supported beam as shown in fig below. The length and width of the plate is determined from the conrod dimensions and apex table of the SX 4 VMC on which the fixture is mounted.

B. calculation for thickness

Total load = wt. of component + wt. of other element on plate 134.5
\+ 63.78

= 198.28N

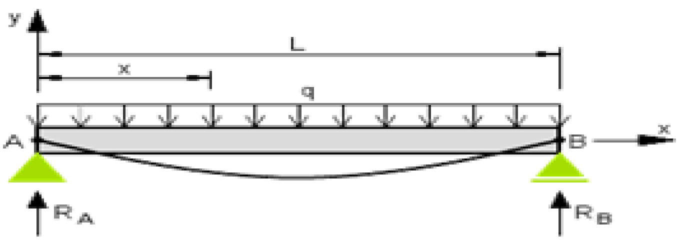

Figure 6.simply supported beam[3]

for MS plate…,

E = 21000 MPa = 21×10^9 N/m^2

Maximum permissible deflection

δmax = 0.01mm = 10^{-5} m

$$\delta max = \frac{(5 \times w \times l^4)}{384 \times E \times I}$$

$$I = \frac{5 \times 200 \times 0.582^4}{384 \times 21 \times 10^4}$$

$$= 1.422 \times 10^{-6} m$$

W= weight on plate (i.e. w=198.28 ≈ 200N)

l = Length of the plate (i.e. l= 582mm=0.582m)

I=Moment of inertia ,m^4

$$I = \frac{b \times d^3}{12}$$

(Considering rectangular section)

b =Width of the plate =351m=0.351mm

d = Thickness of the plat

$$d^3 = \frac{12 \times I}{b}$$

$$= \frac{12 \times 1.422 \times 10^{-6}}{0.351}$$

$$= 4.8615 \times 10^{-5}$$

$d = 0.036m$ =36 mm ,thickness of the plate

1. Clamping Device Calculation

Calculations forCutting Force

For cutting force calculation ,CMTI design data book is used which forms a standard base for the calculation .

Sr no.	Parameter	Meaning	Unit
1	vc	Cutting speed	m/min
2	D	Cutter diameter	mm
3	n	Spindle speed	rpm
4	Vf	Table feed or feed speed	mm/min
5	fz	Feed/tooth	mm
6	Zc	Number of effective teeth	no.
7	ap	Depth of cut	mm
8	Q	Metal removal rate	mm3/min
9	Ps	power at spindle	kW

10	***Pz***	Tangential cutting force	N
11	**Kc**	Specific cutting force	N

Table 1.Parameter table [4]

The above parameters are used for the calculation of the cutting force and the clamping force.

FOR SMALLER END

1 Cutting speed (n):

$$Vc = \pi \times \mathrm{Db} \times \mathrm{n}/1000$$

N=1637 rpm (Machine specification)

D=35 mm

$Vc = 3.14 \times 35 \times 1637/1000$

Vc= 180 m/min

2 Feed per revolution(fn)

$$fn = zc \times fz$$

fz = 0.08 (as per standard tooling)

$$fn = 1 \times 0.08$$

fn = 0.08mm/r

3 Power at the spindle (Ps)

$$Ps = \left((ap \times Kc \times fn \times Vc) \div 60000\right)\left(1 - \frac{ap}{dc}\right)$$

= ((1.5×2738×0.08×180)÷60000)(1-1.5/35

= 0.94KW

4 Metal Removal Rate

$$Q = (Db \times fn \times 180)/4$$

$Q = (35 \times 0.08 \times 180)/4$=19.62 mm3/min

5 Mean Torque

$$Tm = \frac{Ps \times 30000}{\pi \times n}$$

$$= (0.94 \times 30000) \div (\pi \times 1637) \quad = 5.45\ Nm$$

Machining ForceCalculation by ISCARTool SoftwareForSmaller endBoringOperation(For finding of tangential force)

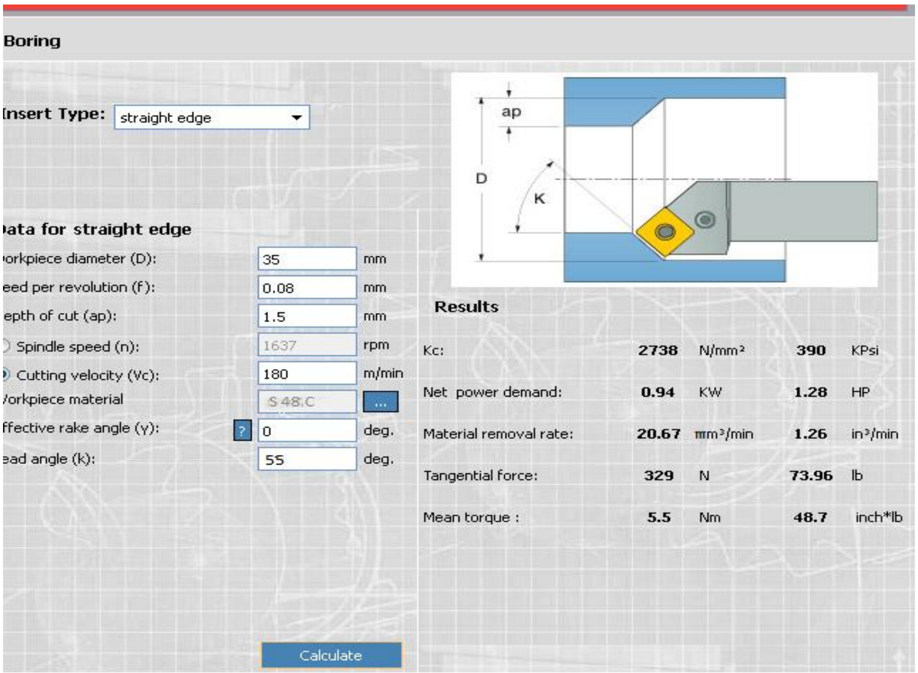

Figure 7.Online Machining using ISCAR Software[5]

An online software is used , called ISCAR tool ,for finding out the tangential force required for the connecting rod boring operation. In the above result ,the values which are in the white box is calculated using standard design data book .While putting these values in the stated software, it gives the tangential force required as shown in the figure. Based on that force , clamping force is calculated. Same calculation is done for bigger end of the said connecting rod.

PARAMETER	VALUE	UNIT
Cutting Speed	180	m/min
Feed per revolution	0.08	mm/r
Power at the spindle	0.96	KW
Mean Torque	8.8	N.m
Metal Removal Rate	21.01	m m3/min
Tangential force	329	N
Total Tangential Force	329	N

Table 2.Parameter table for bigger end dia.

Online Calculation for bigger end

As shown in above figure the same online calculation is made for the smaller end connecting rod. And in both the case the tangential force is same .which is 329 N given from the result.

2 Selection ofClamping Devices Boring operation

As per the above analytical and online calculation it is found that the tangential force for both ends are same which is 329 N .Now here the insert used for the operation is onle 1. So tagential for per insert is 329 * 1 = 329 N . the Clamping for must be more than the cutting force so we are taking the clamping force 5 times the tangential force .so the clamping force required for clamp the con rod is 329 *5 = 1=1645 N. so there are 3 clamps used , so this 1645 is equally distributed to these 3 clamps.

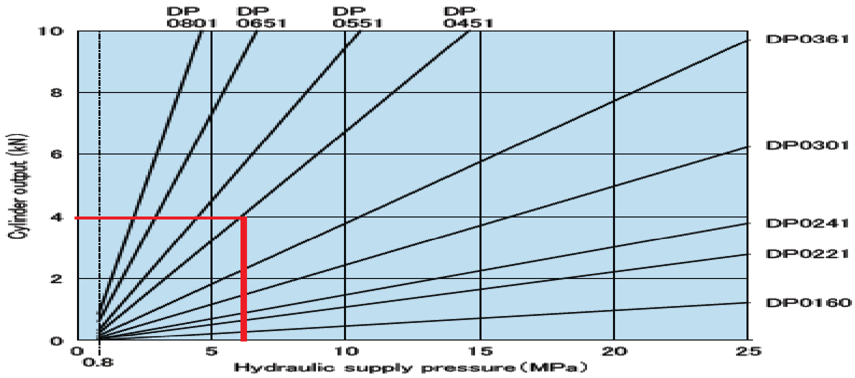

Figure 9.Hydraulic clamping device selection chart[6]

The required pressure is 7 MPa so based on requirement DP0451 clamping device selected from the above chart, which satisfies the requirement .Here the hydraulic clamping device is selected because it gives the best result which is required.

A.Unit Design of Fixture using Creo 3.0 with modifications

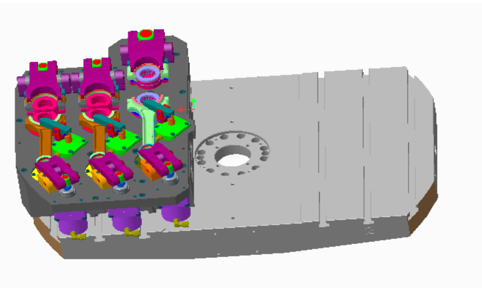

Figure 10.Unit Design with CAD model *Figure 11.Actual Fixture*

V. VALIDATION OF THE DESIGN

ProcessCapabilityAnalysisBasedOn MachiningTrial

Thecasestudy showstheimportanceofstatisticalprocesscontrolformonitoringand ensuringtheproductproducedisabletosatisfy customers'needsandrequirements.A detailedstudy ofmanufacturingprocesswascarriedoutfortheeliminationofthe quality characteristicproblemduring millingoperation.Thefocusofthestudy wasto investigatetheprocesscapability oftheongoingprocesssoastodecideuponthe suitabilityofthemachineto hold particulartolerance. In this study, in orderto demonstratetheapplicability oftheproposedmethodandtomakeacleardecision aboutthecapability ofthemachiningprocess,thesamplesizewasdeterminedanda sufficientnumberofsamplepartswere inspected.Asinglesamplingplanwas implementedby usingthelot-acceptancesamplingplan.Sampleswerechosen randomlyduringthemachiningprocess.

A table below gives the values for the smaller end diameters which are measured form older fixture. In first step the process capability is calculated for the smaller end with older fixture.

Readings taken from the old fixture (smaller end)

		Sample Size			
		1	**2**	**3**	**4**
	Drg. Limits	**35 .6±0.010**	**35.6 ±0.010**	**35.6±0.010**	**35.6±0.010**
	LSL	**35.59**	**35.59**	**35.59**	**35.59**
	USL	**35.61**	**35.61**	**35.61**	**35.61**

1	**AK1**	35.012	35.013	35.014	35.014
2	**AK2**	35.010	35.012	35.015	35.241
3	**AK3**	35.012	35.011	35.012	35.014
4	**AK4**	35.019	35.015	35.014	35.015
5	**AK5**	35.001	34.999	35.031	35.017
6	**AK6**	35.25	34.985	35.015	34.826
7	**AK7**	35.014	35.010	34.987	35.012
8	**AK8**	34.991	35.009	35.0.17	35.019
9	**AK9**	35.010	35.248	35.016	35.014
10	**AK10**	35.011	35.005	35.124	34.989
11	**AK11**	34.992	35.018	35.015	35.017
12	**AK12**	35.017	35.125	35.014	35.019
13	**AK13**	35.017	35.019	35.014	35.019
14	**AK14**	35.018	33.018	35.014	35.017
15	**AK15**	35.017	34.613	35.012	35.014
16	**AK16**	35.018	34.987	35.608	35.124
17	**AK17**	34.523	35.014	35.014	34.985
18	**AK18**	35.011	35.016	34.988	35.017
19	**AK19**	35.125	34.785	35.611	35.016
20	**AK20**	35.011	34.988	35.012	33.012
21	**AK21**	35.006	34.985	35.020	35.145
22	**AK22**	35.325	35.006	34.783	35.015
23	**AK23**	35.010	35.015	35.015	35.014
24	**AK24**	35.005	35.014	35.014	34.988
25	**AK25**	35.018	35.015	35.014	35.014
Mean of theprocess					
STDEV(σ)		0.130221	0.4099121	0.17832424	0.40828196
3*STDEV(σ)		0.390664	1.2297363	0.53497273	1.22484588
6*STDEV(σ)		0.781329	2.4594725	1.06994547	2.44969177
Cpu		0.00588	0.7548	0.0486	0.0628
Cpl		0.09650	0.00951	0.1445	0.0635
Cpk		0.00588	0.00951	0.0486	0.0628
Cp		**0.051**	**0.016**	**0.037`**	**0.016**
AcceptanceCriteria		**CpCpk 1.33**	**CpCpk 1.33**	**CpCpk 1.33**	**CpCpk 1.33**

Readings taken from the modified fixture (Smaller end)

		Sample Size			
		1	**2**	**3**	**4**
	Drg. Limits	**35 ±0.020**	**35 ±0.020**	**35 ±0.020**	**35 ±0.020**
	LSL	**35.02**	**35.02**	**35.02**	**35.02**
	USL	**34.98**	**34.98**	**34.98**	**34.98**
1	**AK1**	35.607	35.599	35.604	35.606
2	**AK2**	35.607	35.599	35.604	35.604
3	**AK3**	35.597	35.597	35.601	35.607
4	**AK4**	35.601	35.604	35.6	35.603
5	**AK5**	35.598	35.598	35.603	35.603
6	**AK6**	35.597	35.6	35.603	35.607
7	**AK7**	35.6	35.604	35.6	35.607
8	**AK8**	35.598	35.6	35.6	35.603
9	**AK9**	35.605	35.605	35.597	35.604
10	**AK10**	35.598	35.603	35.606	35.604
11	**AK11**	35.597	35.597	35.6	35.603
12	**AK12**	35.6	35.604	35.6	35.603
13	**AK13**	35.605	35.6	35.603	35.603
14	**AK14**	35.603	35.605	35.603	35.603
15	**AK15**	35.597	35.603	35.6	35.603
16	**AK16**	35.601	35.597	35.6	35.603
17	**AK17**	35.6	35.604	35.603	35.603
18	**AK18**	35.604	35.6	35.605	35.605
19	**AK19**	35.598	35.605	35.604	35.604
20	**AK20**	35.6	35.598	35.604	35.604
21	**AK21**	35.598	35.597	35.602	35.602
22	**AK22**	35.6	35.598	35.602	35.603
23	**AK23**	35.601	35.598	35.6	35.6
24	**AK24**	35.605	35.598	35.6	35.6
25	**AK25**	35.598	35.6	35.599	35.602
Mean of theprocess		35.60044	35.60028	35.60172	35.60356
STDEV(σ)		0.003110	0.002879	0.002189	0.001804
3*STDEV(σ)		0.009330	0.008639	0.006568	0.0054138
6*STDEV(σ)		0.018661	0.017278	0.013136	0.0108277
Cpu		1.024	1.1250	1.26063	1.189
Cpl		1.1188	1.189	1.78438	2.5046
Cpk		1.024	1.1250	1.2606	1.189

Cp	1.0717	1.15	**1.5225**	**1.84**
Acceptance Criteria	**CpCpk 1.00**	**CpCpk 1.00**	**CpCpk 1.00**	**CpCpk 1.00**

From the above table it can be seen that the Cp and Cpk values for the old fixture does not satisfies the criteria where as in new fixture Cp and Cpk values are within the given criteria.Same procedure is applied to bigger end dia of the connecting rod .

VII. CONCLUSION

In every cycle , work pieces are clamped with same clamping force which is 1645 N.Compared to existing old fixture this new proposed fixture is stable and capable. By this new fixture design work pieces are clamped in same direction every time so a correct location is achieved and eliminating the variability in work piece deflection from clamping force. The results from the machining trial and process capability is stated below**.**

- Achieved connecting rod dimensions in given tolerance continuously which is 35.6±0.010mm and 55.6±0.020mm for smaller end and for bigger end respectively.
- Achieved process capability (Cp and Cpk) more than 1.00

REFERENCES

[1] EdwardG.Hoffman, Jig andFixturedesign; 3rd Edition;Delmar PublishersInc., Clifton Park, NY pp no. 8 to 20
[2] P.C.Sharma,ATextbookofProductionEngineering,S.Chand&CompanyLtd., New Delhi2006, pp no. 2 to 3,
[3] Bela I. Sandor,Ryan Roloff,Stephen M. Birn, Mechanics of solid pp no 223
[4] Design data book, CMTI
[5] http://mpwr.iscar.com/machiningpwr/machiningpower.wgx
[6] http://www.kosmek.co.jp/data/eng/pdf/new/DP001_04_02.pdf
[7] ParveshKumarRajvanshiAnd Dr. R.M.Belokar, "Improving the process capabilityofaboringoperation by the ` applicationofstatisticaltechniques", International Journal of Scientific&Engineering,2012
[8] www.jyoti.co.in/company_profile.aspx

