International Journal of Engineering Science Invention Research & Development; Vol. III, Issue XI, May 2017
www.ijesird.com, e-ISSN: 2349-6185

ALUMINUM CASTING TOOL DESIGN FOR CONNECTING ROD USING 8 CAVITIES

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***Abstract*— The connecting rod is the intermediate member between the piston and the crankshaft. Its primary function is to transmit the push and pull from the piston pin to the crank pin and thus convert the reciprocating motion of the piston into rotary motion of the crank. The aim of this paper is to design a connecting rod for a 150cc engine motorbike using empirical formulas for the material Aluminum Alloy. A parametric model of connecting rod is done in 3D modeling software Pro/Engineer. The manufacturing of connecting rod can be done by using Forging, Casting, Direct Machining, and Powder Metallurgy. In this paper we have chosen manufacturing process is casting. The casting is done for 8 cavities since the bulk production reduces the cost of manufacture. For the manufacture of connecting rod Core and Cavity is to be extracted from the model using manufacturing module in Pro/Engineer. Total mould base is to be designed for the connecting rod which is ready to go for production. CNC Program is to be generated for both core and cavity using roughing and finishing processes. This is also done in manufacturing module in Pro/Engineer.**

***Key words:* CAD/CAM/CAE, ANSYS, CFD, CAMSHAFT, DIE CASTING**

I. INTRODUCTION TO CONNECTING ROD

In a reciprocating piston engine, the connecting rod connects the piston to the crank or crankshaft.
In modern automotiveinternal combustion engines, the connecting rods are most usually made of steel for production engines, but can be made of aluminum (for lightness and the ability to absorb high impact at the expense of durability) or titanium (for a combination of strength and lightness at the expense of affordability) for high performance engines, or of cast iron for applications such as motor scooters. They are not rigidly fixed at either end, so that the angle between the connecting rod and the piston can change as the rod moves up and down and rotates around the crankshaft. Conrods, especially in racing engines, may be called "billet" rods, if they are machined out of a solid billet of metal, rather than being cast.

The **small end** attaches to the piston pin, gudgeon pin (the usual British term) or wrist pin, which is currently most often press fit into the con rod but can swivel in the piston, a "floating wrist pin" design. The **big end** connects to the bearing journal on the crank throw, running on replaceable bearing shells accessible via **the *con rod bolts*** which hold the bearing "cap" onto the big end; typically there is a pinhole bored through the bearing and the big end of the con rod so that pressurized lubricatingmotor oil squirts out onto the thrust side of the cylinder wall to lubricate the travel of the pistons and piston rings.
Recent engines such as the Ford 4.6 liter engine and the Chrysler 2.0 liter engine, have connecting rods made using powder metallurgy, which allows more precise control of size and weight with less machining and less excess mass to be machined off for balancing.

A. FUNCTION OF CONNECTING ROD

The connecting rod is the intermediate member between the piston and the Connecting Rod. Its primary function the push and pull from the piston pin to the crank pin and thus converts the reciprocating motion of the piston into rotary motion of the crank. The connecting rod is under tremendous stress from the reciprocating load represented by the piston, actually stretching and being compressed with every rotation, and the load increases to the third power with increasing engine speed.

II. THEORETICAL CALCULATIONS OF CONNECTING ROD

A. PRESSURE CALCULATIONS FOR 150CC PETROL ENGINE

Suzuki GS 150 R specifications
Engine type: air cooled 4-stroke SOHC
Bore $\times\, stroke(mm) = 57 \times 58.6$
Displacement =149.5CC

Maximum power = 13.8bhp @8500rpm
Maximum torque = 13.4Nm @ 6000 rpm
Compression ratio =9.35/1
Density of petrol

$$C_8H_{18} = 737.22\frac{kg}{m^3}\ at\ 60F$$

= 0.00000073722 kg/mm^3
T = 60F =288.855K =15.55^{0}C
Mass = density × $volume$
m = 0.00000073722× 149500
m = 0.11kg
Molecularcut for petrol 144.2285 g/mole
PV = MRT

$$P=\frac{mRT}{V} = \frac{0.11\times 8.3143\times 288.555}{0.11422\times 0.0001495} = \frac{263.9}{0.00001707}$$

P = 15454538.533 j/m^3 = n/m^2
P =15.454 N/mm^2

B. DESIGN CALCULATIONS OF CONNECTING ROD

- *Dimensions of cross section of connecting rod*

Thickness of flange & web of the section = t
Width of section B= 4t
Height of section H=5t
Area of section A= 2(4t×t) +3t×t = 11t²
MI of section about x axis
I_{xx}=1\12 (4t(5t)^3-3t(3t)^3)=419\12t^4
MI of section about y axis
I_{YY}= (2+1\12t (4t)^3+1\12(3t)t^3) = 131\12 t^4
I_{XX}\ I_{YY}= 3.2
Length of connecting rod = 2 times the stroke
L= 2×58.6 =117.2mm
Buckling load W_B = maximum gas force × F.O.S
W_B =6569.148×6 =39414.88611

$$W_B = \frac{\sigma_C \times A}{1+ a(L\backslash K_{XX})^2}$$

σ_C = compressive yield stress= 172 MPa

$$k_{xx} = I_{XX}\backslash A = \frac{419\backslash 12t^4}{11t^2}$$

= 3.17t^2
k_{xx} = 1.78t
f_c= maximum load
f_c= p= 39414.88611
a= f_c \π^{2}E

$$a = \frac{39414.88611}{\pi^2 \times 80000}$$

a = 0.05

$$39414.88611 = \frac{172 \times 11t^2}{1+0.05(117.2\backslash 1.78t)^2}$$

$$39414.88611 = \frac{1892t^2}{1+ (4334.9\backslash t)^2 0.05}$$

$$39414.88611 = \frac{1892t^2 * 3.168t^2}{3.168t^2+686.79}$$

5993.856t^4-124866.36t^2-27069749.63=0

$$t^2 = \frac{124866.36 \pm \sqrt{((124866.36)^2+4\times 5993.856\times 27069749.63)}}{2\times 5993.856}$$

$$t^2 = \frac{124866.36 \pm 815230.23}{11987.712}$$

$$t^2 = \frac{94009656}{11987.712}$$

t^2 = 78.42168
t= 8.85= 9mm Approx.)
Width of section B = 4t =36mm
Height of section H = 5t = 45mm
Area A = 11t^2 = 891mm^2
Height at the big end (crank end) = H_2 = 1.1H to 1.25H
H_2 =56.25 mm
Height at the small end (piston end) = 0.9H
H_1 =40.5mm

- *Dimensions of crank pin*

Load on the crank pin = projected area × bearing pressure
F_L =d_c × l_c ×p_{bc}
l_c = 1.25 d_c to 1.5d_c
F_L = 1.5 d_c^2× p_{bc}
p_{bc}= allowable bearing pressure at the crank pin bearing = 12.5N\mm^2
F_L = $(\pi D^2 \backslash 4) \times P = 39414.88611$
39414.88611 = 1.5 d_c^2× 12.5
39414.88611 = 18.75d_c^2
d_c^2 = 2102.12 = 45.84
l_c = 1.5d_c = 68.77mm

- *Piston pin (gudgeon pin (or) wrist pin)*

d_o=outside dia of the piston pin
l_1=length of the piston pin in the bush of the small endof the connecting rod in mm
l_1=0.45D=0.45×57=25.65mm
Load on the piston due to gas pressure

$$P_{max}=p\times\frac{\pi D^2}{4}=30090.38N$$

Load on the piston pin due to bearing pressure (or) Bearing load=bearing pressure×bearing area

Load = $P_{b1} \times d_o \times l_1$

P_{b1}=bearing pressure at the small end of the connecting rod bushing

P_{b1}=77.28N/mm^2

30090.38=77.28× d_o×25.65

$d_o = \frac{30090.38}{641.25}$ = 15.16mm

d_i=0.6 d_o=9.1mm

Length between the supports $l_2 = \frac{l_{1+D}}{2}$

l_2=41.325mm

III. DIE CASTING

Die casting is a versatile process for producing engineered metal parts by forcing molten metal under high pressure into reusable steel molds. These molds, called dies, can be designed to produce complex shapes with a high degree of accuracy and repeatability. Parts can be sharply defined, with smooth or textured surfaces, and are suitable for a wide variety of attractive and serviceable finishes.

Die castings are among the highest volume, mass-produced items manufactured by the metalworking industry, and they can be found in thousands of consumer, commercial and industrial products. Die cast parts are important components of products ranging from automobiles to toys. Parts can be as simple as a sink faucet or as complex as a connector housing.

A. MATERIAL AND PROPERTIES FOR DIE-CASTING

The materials used for die-casting are Aluminum alloys, Zinc alloys, Magnesium alloys, Copper alloys and Lead alloys.

THE DESIRABLE PROPERTIES OF DIE-CASTING ALLOYS (A) ADAPTABILITY TO THE SYSTEM SHOULD HAVE GOOD FLUIDITY, GOOD CAST ABILITY, LESS SHRINKAGE, RANGE OF TEMPERATURE FOR SOLIDIFICATION, LOW MELTING POINT (B) MECHANICAL PROPERTIES SUCH HAS TENSILE STRENGTH, HARDNESS, DUCTILITY, FATIGUE STRENGTH, GOOD MACHINABILITY, RESISTANCE TO CORROSION, ABILITY TO BE PLATED

B. SHRINKAGE TABLE FOR DIE-CASTING ALLOYS

Casting alloy	Shrinkage (%)
Aluminum	0.5 – 0.7
Magnesium	0.8 – 1.2
Brass	0.7 – 1.2
Led	0.3 – 0.6
Zinc	0.4 – 0.6
Tin	0.2 – 0.5

C. DESIGN ASPECTS OF DIE CASTING

- Since the metallic mold of a die casting expands when it is filled with a molten metal and then both the casting and the mold shrinks during cooling the shrinkage allowances taken in the die mold design are smaller than those in the Sand casting.
- Parts of 0.05 lb. (20 g) to 75 lb. (34 kg) may be cast.
- The section thickness of permanent mold casting may vary in the range 0.02” - 0.5” (0.5-12 mm).
- The dimensional tolerances are 0.01-0.03” (0.25-0.75 mm) depending on the casting section thickness.
- Allowances of 0.004-0.01” (0.1-0.25 mm) are taken for the dimensions crossing the parting line of the mold.
- The draft angle is commonly about 1%.

IV. DIE DESIGN CALCULATIONS

A. TONNAGE CALCULATION (ALUMINUM)

Projected area of one component (a) = 7492.47 mm^2

Number of cavities(n) = 8

Projected area of Casting(A) = axn = 7492.47 x 8=59939.76 mm^2

Area of slide:

Projected Area of Slide 1 =7250.64 x 8 =58005.12 mm^2

Wedge Angle(α) =2 deg

Final Projected Area of slide1 (A_1) = 58005.12 x tan 2 = 2025.5834 mm^2

Projected Area of Slide 2=7725.5 x 8 = 61804mm^2
Wedge Angle(α) =2deg
Final Projected Area of slide 2 (A2) = 61804x tan 2 = 2158.2432 mm^2
Projected area including overflows and feed system (AF) =A x c/100 = =59939.76 x 40/100=23975.904 mm^2
Total Projected area= A +A1+A2+AF= 59939.76 +58005.12 +61804+23975.904
=203724.784mm^2
Specific Injection pressure =800 kgf/cm^2 =800x 10-2 kgf/ mm^2
Total force acting on the die plate (F) =Projected area x Injection Pressure =203724.784 x 8 kgf =1629798.272T
Considering machine efficiency of 80%,
Locking tonnage required =F x 1.2 =1629798.272x 1.2 =1250.866T
Hence according to locking tonnage we can select 1300T

B. SHOT WEIGHT CALCULATION
One component volume (v)= 9.10 x 10^{5}mm^3
Total component volume(V) = v x n mm^3=9.10 x 10^5 x 8 =72.8 x 10^{5}mm^3
Volume of component + Volume of overflow and feed system (V_t) = V x (1 + c/100)
=72.8 x 10^{5}x(1+ 40/100)
= 10192000 mm^3

C. PLUNGER DIAMETER CALCULATION
Actual shot volume = V_t + Πd^{2}h/4
Where h is biscuit thickness and d is the plunger diameter
Stroke length for 1300 T machine (l) = 750 mm
Effective stroke length (L) = l – biscuit thickness = 750 – (42-15) =723mm
Assume fill ratio =0.50
Volume delivered by machine = πd^2 x (L/4) x f
i.e. V_t + π d^2 x (h/4) = πd^2 x (L/4) x f = πd^2 x (723/4) x 0.50
V_t = π/4 x d^2 (l x f - 15) = π/4 x d^2 (723x 0.5 - 15)
V_t = π/4 x d^2 (l x f - 15) = π/4 x d^2 (346.5)
10192000 = 767.4975 d^2
d= 115.25mm

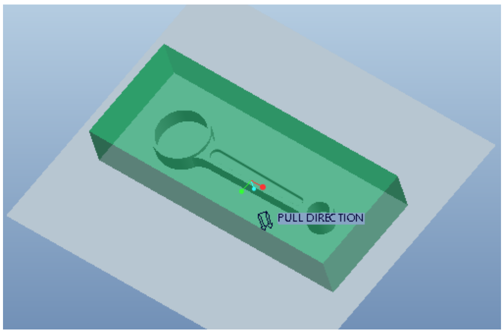
Available plunger sizes in 1300T machines are 125 mm (This value is taken from stranded value).
Hence we can select 125 mm plunger tip
Shot volume = V_t + πd^{2}h/4 = 10192000 +π (100) 2 x15/4 = 10194356.19 mm^3
Shot weight = Shot volume x density = 10194356.19x2.7x10^{-6}=27.524g=0.027524kg
From machine manual, for 250T machine, shot weight capacity is 9.2 kg. Hence according to shot capacity also 1300T machine is suitable.

D. FILL RATIO CALCULATION
Fill ratio (f) = Metal volume/Shot sleeve volume= (V_t + π d^{2}h/4)/π d^2 x (L/4)
=10194356.19 /π (100)^2 x (401/4) = 3.236
This value for fill ratio is acceptable for the process

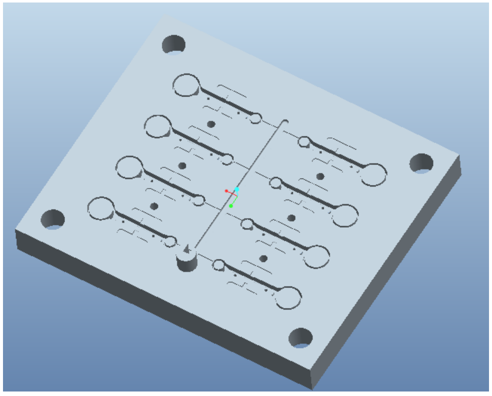
E. FILL TIME CALCULATION
Fill Time = k [T_i – T_f + sz] T/ [T_f – T_d]
Where k, empirically derived constant = 0.0346
T_i, Temperature of molten metal as it enters the die= 640^{0}c
T_f, Minimum flow temperature of metal =580^0 c
T_d, Temperature of die cavity surface just before the metal enters =200^{0}c
S, percent solid fraction allowable in the metal at the end of filling =30%
Z, Units conversion factor = 4.8
T, casting thickness = 9.78mm
Therefore t = 0.0346[640–580+30x4.8]x 9.78/[580 – 200] = 0.182 seconds = 182milli seconds
G_v = min is minimum gate velocity = 20 m/sec
Metal Pressure (Min)= Density x Gv^2/2 x Ag x Cd^2= 2.7 x (2000)^2/2 x 981 x (0.3)^2=61162.079gm/cm^2
= 61.16 Kgf/cm^2
Flow rate, Q= Volume of metal through gate/ Fill time
Volume of metal through gate = V x (1 + c/100) = 9.828 x 105 x (1 + 40/100)=1375920 mm^3
Fill time =0.182 sec
Flow rate, Q = 1375920/ 0.182 = 7560000 mm^3 /sec

V. DESIGN AND MANUFACTURING WITH PRO/ENGINEER

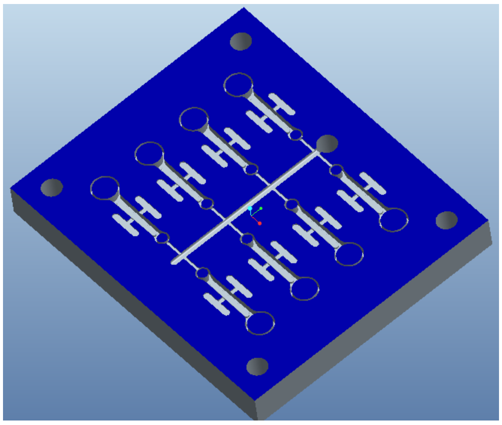
Create a Work piece



CAVITY1



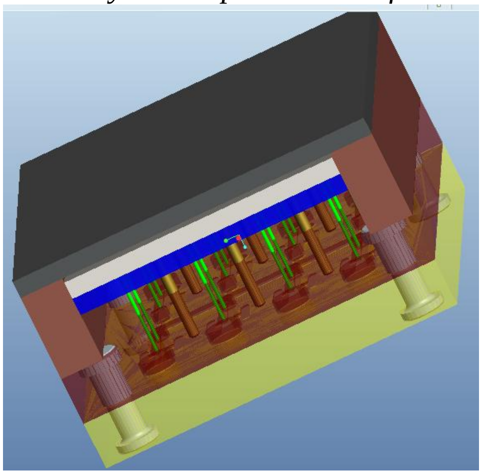
CAVITY2

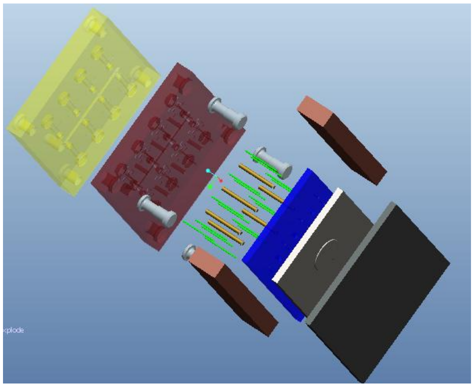


TOTAL DIE PARTS

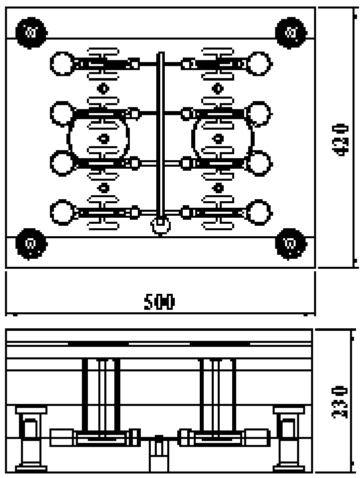
- Grid
- Retainer plate
- Backplate
- Ejector plate
- Retainer pin
- Ejector pin
- Guide sleeve
- Guide bush

Assembly and Explode View of Die





2D Drawings of Total Assembly



VI. COMPUTER AIDED MANUFACTURING IN PRO/ENGINEER

By using the fundamental abilities of the software with regards to the single data source principle, it provided a rich set of tools in the manufacturing environment in the form of tooling design and simulated CNC machining and output.Tooling options cover specialty tools for molding, die-casting and progressive tooling design.Manufacturing lets you set up and run NC machines, create assembly process sequences, create bills of material, and generate inspection programs for Coordinate Measuring Machines (CMMs).

A. PROCEDURE OF MANUFACTURING

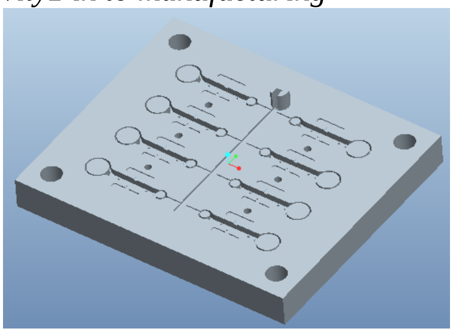
For Cavity1

Select New – Manufacturing – NC Assembly – Enter name – Select units – ok

Retrieving the cavity in to manufacturing

Creating Work piece

Cavity1 in to manufacturing



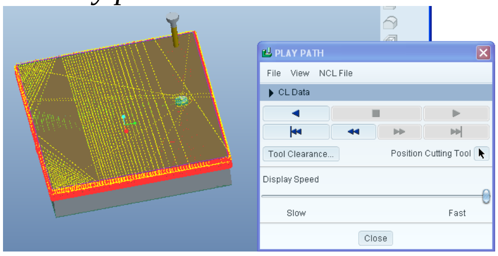
Set up the machine tool by selecting type of machine, cutting tool, Machine zero and retract.

For roughing,

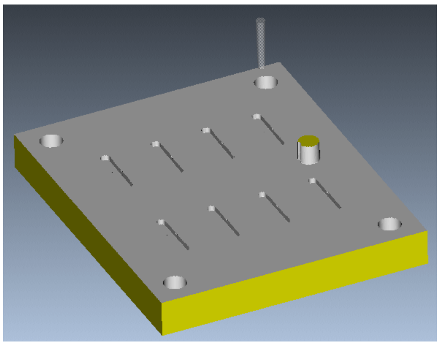
Select NC sequence – Machining – Volume – Done – Select tool and enter parameters like Cut feed, Step depth, Step over, Profile stock allow, rough stock allow, scan type and spindle speed.

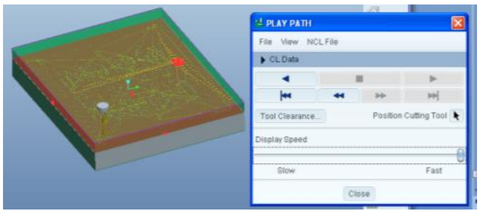
Create volume.

Select Play path



After completing Play path, Select NC check





Machining → CL data → NC sequence → sequence → file → MCD file.

Done. Enter name. Ok. Done.

B. NC PROGRAM FOR ROUGHING

```
%
G71
O0001
(D:\connect_rod\mfg_of_connectingrod\rough.ncl.1)
N0010T1M06
S5000M03
G00X419.167Y5.997
G43Z0.H01
G01Z-1.94F200.
X422.613Y1.227
X425.981Y-3.522
Z0.
G00X414.195Y5.997
G01Z-1.94
G02X425.981Y-10.62I-388.405J-287.986
G01Z0.
G00X409.197Y5.997
G01Z-1.94
G02X425.981Y-17.865I-359.249J-270.517
G01Z0.
```

```
G00X404.173Y5.997
G01Z-1.94
G02X425.981Y-25.273I-345.534J-264.221
G01Z0.
G00X399.12Y5.997
G01Z-1.94
G02X425.981Y-32.86I-336.37J-261.237
G01Z0.
G00X394.038Y5.997
G01Z-1.94
G02X425.981Y-40.645I-329.025J-259.59
G01Z0.
G00X388.926Y5.997
G01Z-1.94
G02X425.981Y-48.652I-322.538J-258.587
G01Z0.
G00X383.781Y5.997
G01Z-1.94
G02X425.981Y-56.908I-316.497J-257.933
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G01Z-1.94
G02X425.981Y-65.447I-310.704J-257.482
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G01Z-1.94
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G00X425.981Y-425.836
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G01Z-1.94
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G00X425.981Y-374.249
G01Z-1.94
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G01Z0.
G00X425.981Y-361.501
G01Z-1.94
X424.243Y-366.828
G02X341.298Y-505.997I-354.243J116.827
G01Z0.
G00X425.981Y-347.168
G01Z-1.94
G02X420.957Y-364.002I-399.471J110.057
G01X420.442Y-365.582
G02X335.771Y-505.997I-350.442J115.581
G01Z0.
G00X425.981Y-330.361
G01Z-1.94
G02X417.153Y-362.766I-355.721J79.509
G01X416.641Y-364.336
G02X330.189Y-505.997I-346.641J114.335

G03X50.372Y-462.298I-.343J3.423
X50.372Y-462.298I-10.376J2.293
G01X50.433Y-460.92Z-81.641
X50.022Y-459.604Z-81.485
X49.189Y-458.506Z-81.19
X48.032Y-457.756Z-80.633
X47.327Y-457.53Z-79.69
Z-68.69
G00X36.Y-460.
Z-76.69
G01Z-81.69
X36.238Y-461.358Z-82.943
X36.922Y-462.555Z-83.348
X37.972Y-463.448Z-83.572
X39.264Y-463.932Z-83.676
X40.Y-464.Z-83.69
G03X40.Y-464.I0.J4.
G02X42.728Y-465.344I0.J-3.44
G01X42.83Y-465.477
G03X45.651Y-465.662I1.492J1.146
X45.651Y-465.662I-5.651J5.662
G02X46.969Y-465.026I1.575J-1.578
G01X47.371Y-464.979
G03X50.333Y-462.309I-.395J3.417
X50.333Y-462.309I-10.336J2.305
G01X50.396Y-460.932Z-83.641
X49.988Y-459.615Z-83.485
X49.157Y-458.515Z-83.19
X48.002Y-457.763Z-82.633
X47.298Y-457.536Z-81.69
Z-70.69
G00X36.Y-460.
Z-78.69
G01Z-83.69
X36.238Y-461.358Z-84.943
X36.922Y-462.555Z-85.348
X37.972Y-463.448Z-85.572
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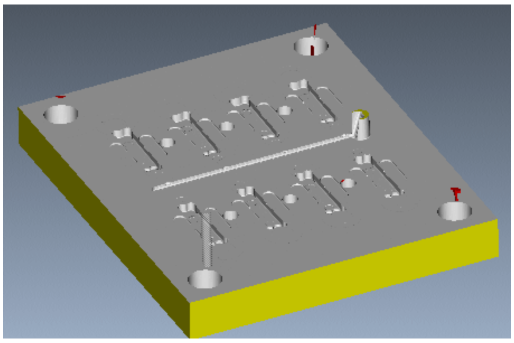
X39.264Y-463.932Z-85.676
X40.Y-464.Z-85.69
G03X40.Y-464.I0.J4.
G02X42.728Y-465.344I0.J-3.44
G01X42.83Y-465.477
G03X45.651Y-465.662I1.492J1.146
X45.651Y-465.662I-5.651J5.662
G02X46.917Y-465.039I1.554J-1.557
G01X47.389Y-464.977
G03X50.296Y-462.319I-.45J3.411
X50.296Y-462.319I-10.299J2.315
G01X50.361Y-460.942Z-85.641
X49.955Y-459.624Z-85.485
X49.125Y-458.523Z-85.19
X47.971Y-457.768Z-84.633
X47.268Y-457.54Z-83.69
Z-72.69
G00X35.999Y-459.999
Z-80.69
G01Z-85.69
X36.237Y-461.357Z-85.847
X36.922Y-462.554Z-85.897
X37.972Y-463.447Z-85.925
X39.263Y-463.931Z-85.938
X39.999Y-463.999Z-85.94
G03X39.999Y-463.999I0.J4.
G02X42.727Y-465.343I0.J-3.44
G01X42.829Y-465.476
G03X45.651Y-465.662I1.492J1.146
X45.651Y-465.662I-5.652J5.663
G02X46.906Y-465.04I1.549J-1.552
G01X47.397Y-464.974
G03X50.292Y-462.323I-.461J3.409
X50.292Y-462.323I-10.293J2.325
G01X50.359Y-460.946Z-85.934
X49.955Y-459.628Z-85.914
X49.127Y-458.525Z-85.878
X47.975Y-457.769Z-85.808
X47.271Y-457.54Z-85.69
Z0.
M30
%

For finishing

Select NC sequence – Machining – Finishing – Done – Select tool and enter parameters like Cut feed, Step depth, Step over, Profile stock allow, scan type and spindle speed.

Create volume.

Select Playpath



After completing Playpath, Select NC check

Machining → CL data → NC sequence → sequence → file → MCD file.

Done. Enter name . ok . Done.

C. NC PROGRAM FOR FINISHING

%
G71
O0001
(D:\connect_rod\mfg_of_connectingrod\finishing.ncl.1)
N0010T1M06
S5000M03
G00X419.167Y5.997
G43Z0.H01
G01Z-1.94F200.
X422.613Y1.227
X425.981Y-3.522
Z0.
G00X414.195Y5.997
G01Z-1.94
G02X425.981Y-10.62I-388.405J-287.986
G01Z0.
G00X409.197Y5.997
G01Z-1.94
G02X425.981Y-17.865I-359.249J-270.517
G01Z0.
G00X404.173Y5.997
G01Z-1.94
G02X425.981Y-25.273I-345.534J-264.221

```
G01Z0.
G00X399.12Y5.997
G01Z-1.94
G02X425.981Y-32.86I-336.37J-261.237
G01Z0.
G00X394.038Y5.997
G01Z-1.94
G02X425.981Y-40.645I-329.025J-259.59
G01Z0.
G00X388.926Y5.997
G01Z-1.94
G02X425.981Y-48.652I-322.538J-258.587
G01Z0.
G00X383.781Y5.997
G01Z-1.94
G02X425.981Y-56.908I-316.497J-257.933
G01Z0.
G00X378.602Y5.997
G01Z-1.94
G02X425.981Y-65.447I-310.704J-257.482
G01Z0.
G00X373.387Y5.997
G01Z-1.94
G02X425.981Y-74.309I-305.051J-257.16
G01Z0.
G00X368.135Y5.997
G01Z-1.94
G02X425.981Y-83.546I-299.475J-256.921
G01Z0.
G00X362.843Y5.997
G01Z-1.94
G02X425.981Y-93.225I-293.938J-256.74
G01Z0.
G00X357.51Y5.997
G01Z-1.94
G02X425.981Y-103.434I-288.415J-256.599
G01Z0.
G00X352.132Y5.997
G01Z-1.94
G02X425.981Y-114.291I-282.887J-256.487
G01Z0.
G00X346.708Y5.997
G01Z-1.94
G02X425.981Y-125.967I-277.341J-256.396
G01Z0.
G00X341.234Y5.997
G01Z-1.94
G02X425.981Y-138.72I-271.768J-256.321
G01Z0.
G00X335.708Y5.997
G01Z-1.94
G02X425.981Y-152.973I-266.159J-256.258
G01Z0.
G00X330.126Y5.997
G01Z-1.94
G02X424.92Y-165.096I-260.165J-255.95
G01X425.981Y-169.748
Z0.
G00X324.484Y5.997
G01Z-1.94
G02X421.021Y-165.993I-254.523J-255.95
G01X422.805Y-174.059
G02X425.981Y-191.202I-397.583J-82.533
G01Z0.
G00X318.779Y5.997
G01Z-1.94
G02X417.123Y-166.89I-248.818J-255.95
G01X418.894Y-174.901
G02X425.981Y-233.029I-339.179J-70.848
G01Z0.
G00Y-496.575
G01Z-1.94
X422.646Y-501.275
X419.234Y-505.997
X379.32Y-25.213
X378.411Y-25.281
X378.019Y-25.326
X377.194Y-25.466
X376.5Y-25.616
X375.958Y-25.757
X375.539Y-25.884
X374.921Y-26.096
X374.121Y-26.41
X373.452Y-26.724
X372.915Y-27.003
X372.295Y-27.355
X371.859Y-27.636
X371.417Y-27.94
X370.818Y-28.385
X370.491Y-28.651
X369.887Y-29.191
X369.473Y-29.59
X369.195Y-29.876
X368.666Y-30.479
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X368.202Y-31.058
X367.876Y-31.503
X367.503Y-32.065
X367.2Y-32.564
X366.941Y-33.024
X366.638Y-33.627
X366.338Y-34.301
X366.088Y-34.937
X365.914Y-35.444
X365.745Y-36.01
X365.609Y-36.529
X365.464Y-37.184
X365.346Y-37.907
X365.254Y-38.674
X365.218Y-39.164
X365.2Y-39.71
X365.199Y-40.256
X365.229Y-41.02
X365.289Y-41.648
X365.394Y-42.408
X365.517Y-43.075
X365.644Y-43.613
X365.883Y-44.457
X366.014Y-44.856
X366.17Y-45.284
X366.462Y-45.988
X366.803Y-46.714
X367.006Y-47.096
X367.456Y-47.86
X367.738Y-48.296
X367.971Y-48.632
X368.393Y-49.187
X368.904Y-49.8
X369.197Y-50.127
X369.834Y-50.759
X370.215Y-51.108
X370.634Y-51.466
X371.063Y-51.802
X371.709Y-52.263
X372.217Y-52.596
X372.863Y-52.969
X373.316Y-53.208
X374.089Y-53.575
X374.736Y-53.835
X375.381Y-54.064
X375.945Y-54.239
X376.463Y-54.375
X377.063Y-54.508
X377.706Y-54.626
X378.082Y-54.681
X378.704Y-54.746
X379.174Y-54.78
X380.019Y-54.806
X380.68Y-54.787
X381.589Y-54.719
X381.981Y-54.674
X382.806Y-54.534
X383.5Y-54.384
X384.042Y-54.243
X384.461Y-54.116
X385.079Y-53.904
X385.879Y-53.59
X386.548Y-53.276
X387.085Y-52.997
X387.705Y-52.645
X388.141Y-52.364
X388.583Y-52.06
X389.182Y-51.615
X394.356Y-36.387
X394.117Y-35.543
X393.986Y-35.144
X393.83Y-34.716
X393.538Y-34.012
X393.197Y-33.286
X392.994Y-32.904
X392.544Y-32.14
X392.262Y-31.704
X392.029Y-31.368
X391.607Y-30.813
X391.096Y-30.2
X390.803Y-29.873
X390.166Y-29.241
X389.785Y-28.892
X389.366Y-28.534
X388.937Y-28.198
X388.291Y-27.737
X387.783Y-27.404
X387.137Y-27.031
X386.684Y-26.792
X385.911Y-26.425
X385.264Y-26.165
X384.619Y-25.936
X384.055Y-25.761
X383.537Y-25.625

X382.937Y-25.492 %
Z0.
M30

VII. CONCLUSION

In this paperfirst we designed a connecting rod used in a 150CC engine and modeled in 3D modeling software Pro/Engineer. After that designed 8 cavity die for the connecting rod. From the calculations, we haveto select 1300T machine.

We have extracted core, cavity, and prepared total die for the connecting rod. We have done CNC programming for both core and cavity. We have concluded that the total casting tool die of connecting rod is ready for manufacturing.

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