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Machining Procedure of Four Wheel Drive Double Cab Engine Head using CAD, CAM and Matlab Software

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Abstract: the machining process of engine head for four wheel drive double cab engine, especially machining of the contact surface of the engine head .This surface plays an important role in engine combustion system. Then this surface is connected with the engine block, so surface accuracy is very important. The cylinder head performs several functions. It provides the top seal for the cylinder bore or sleeve. It provides the structure holding of exhaust valves and inlet valves, the nozzles and the necessary linkages. For machining of this surface, milling operation and grinding or surface finishing are used. So determination of proper operation is required and spindle speed, cutting speed, feed rate, depth of cut and machining are calculated. Surface accuracy depends on usage of CNC machine. Gray cast iron is considered in engine head.

Keywords: Cutting Speed, Depth of Cut, Grinding Operation Machining Process, Milling Operation and Spindle Speed.

I. INTRODUCTION

The machining processes produce finished products with a high degree of accuracy and surface quality. Parts manufactured by casting, forming, and various shaping processes often require further operations before they are ready for use or assembly. Machining involves the removal of some material from the work piece (machining allowance) in order to produce a specific geometry at a definite degree of accuracy and surface quality. For machining the bottom surface of the cylinder head, face milling and grinding operations are mainly required. Milling is a machining operation in which metal is removed by applying power to a rotating cutter. Grinding is a machining operation in which material is removed by a powered abrasive wheel, stone, belt, paste, sheet, etc. Grinding is used to realize fine finish tolerances and surface finishes. During milling, the tool performs the cutting motion, whereas the workpiece (that is, the milling machine table on which the work piece is mounted) executes the feed motion. The milling techniques are defined according to the tool axis position relative to the workpiece and the tool denomination. Before machining the detail dimension of casting of cylinder head and machining allowance are required. CNC machines are used for these operations.

II. MATERIAL OF ENGINE HEAD

Material plays an important role in the construction and manufacturing of the components of the engine. Surface finishes depend on material or alloy being processed and the condition of operation. Cylinder head is usually made by cast iron or aluminum alloy. The engine head of the double cab engine is made by gray cast iron. The modulus of elasticity of gray cast iron is smaller than that of steel. Gray cast iron has high damping capacity. The mechanical properties of gray cast iron are shown in Table I.

Table I: Mechanical Properties of Gray Cast Iron

Mechanical properties	Symbols	Value
Density	ρ (kg/m^3)	7200
Modulus of Elasticity	E (GN/m^2)	91
Modulus of Rigidity	C (GN/m^2)	98.5
Ultimate tensile stress	f_{ut} (MN/m^2)	150(tensile) 750(compressive)
Brinell Hardness Number	HB	180
Melting temperature	t_m (˚C)	1178
Thermal conductivity	K^* (W/m˚C)	46.5

III. MEASURING AND MARCHING FOR ENGINE HEAD

To measure the engine head of double cab engine, various measuring devices can be used such as venire clipper, high gauges, etc. It is detail measured by CMM machine. A coordinate measuring machine (CMM) is also a device used in manufacturing and assembly processes to test a part or assembly against the design intent. Machining allowance must be considered in casting process to receive the surface accuracy after machining process which it is based on calculation from these data. The work piece or the casting of the engine head is shown in Figure 1.

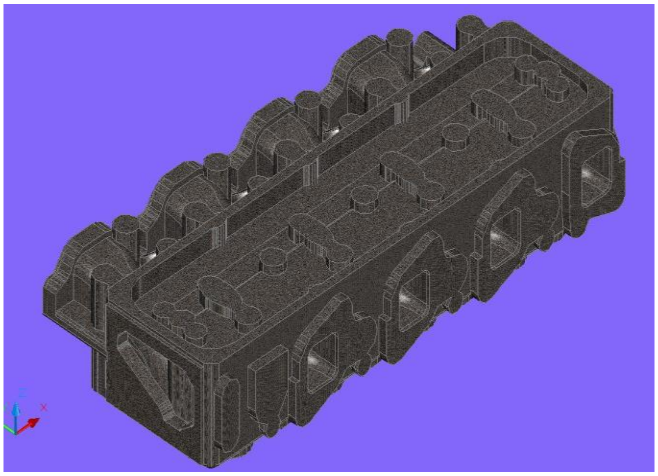

Figure 1. The casting of the engine head of double cab engine.

The tool path is selected for machining by using Master Cam software. When the tool path is satisfied, the next step can be started. The detail drawing of contact surface is shown in Figure 2. The actual dimensions of the finished product must be known to calculate the number of depths tooling and to determine the machining layout.

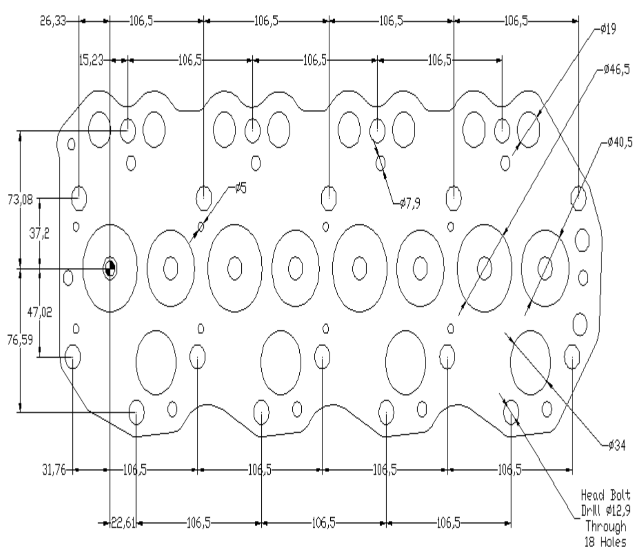

Figure 2: Auto CAD drawing of contact surface

In casting process, machining allowance is needed for the surfaces or holes intended machining operations. Numbers of allowances are usually considered during pattern design. On the drawing of the products, surfaces to be machined are usually indicated by standard symbols. This finishing mark indicates the pattern maker that some extra metal is added on the casting which can enable the desired machining to bring the product to the size. The amount of material added to be pattern also depends on machining method used and functional requirement of casting. In casting of the engine head of double cab engine, there is 3mm in machining allowance shown in Figure 3.

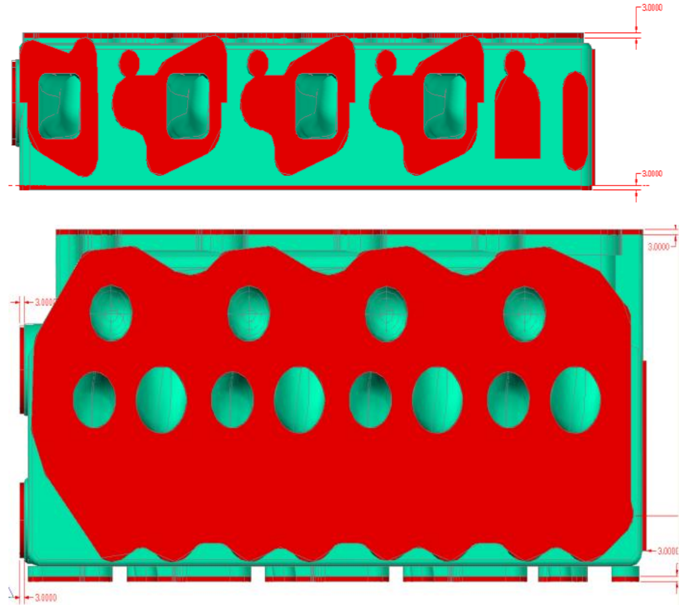

Figure3. Machining allowance for engine head.

IV. MILLING

Milling is a process of generating machined surfaces by progressively removing a predetermined amount of material from the work piece. There are many types of milling methods i.e. face milling, up milling or conventional milling, down milling or climb milling and grinding. In this project must be used for grinding machining the engine head of double cab engine.

V. GRINDING

Grinding is a metal cutting procedure in which a multi-edged tool, whose cutting edges are geometrically undefined, removes the chips. During grinding, the tool carries out the cutting motion. There are many grinding processes such as surface grinding, cylindrical grinding, centerless grinding and form grinding, etc. Surface grinding process is used for machining the contact surface of the engine head. This process is used for flat surface. In surface grinding, the grinding procedure is carried out with the front end of the grinding wheel (Figure 4). In contrast to circumferential grinding, the contact area between work piece and tool is much greater in surface grinding.

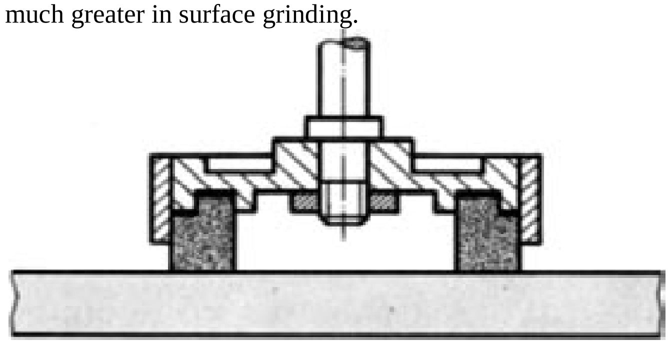

Figure 4. Surface grinding principle[3]

In surface grinding, the tool axis may be vertical or horizontal. Due to their compact design and great cutting capacity, machines with vertical wheel spindle axis are predominantly used for surface grinding. Special surface grinding machines are used for high accuracy of surfaces. Grinding wheel speed n arises from the permissible peripheral speed of the grinding wheel, which can be taken from reference tables

$$n = \frac{v_c \cdot 60\ s/min \cdot 10^3\ mm/m}{D \cdot \pi} \quad (1)$$

Where,

n - min–1 wheel speed
v_c - m/s cutting speed of the grinding wheel = peripheral speed
D- mm grinding wheel diameter

Workpiece speed v_w is much lower than the wheel's peripheral speed. It is also drawn from reference tables. For cylindrical grinding, the workpiece speed is:

$$n_w = \frac{v_w \cdot 60\ s/min \cdot 10^3\ mm/m}{d \cdot \pi} \quad (2)$$

Where,

n_w in min–1 workpiece speed
v_w - m/s peripheral speed of the workpiece
d- mm workpiece diameter
Both speeds v and v_w should be in a predefined mutual speed ratio q.

$$q = \frac{v_c}{v_w} \quad (3)$$

Where,

q- speed ratio
v_c - m/s cutting speed of the grinding wheel (peripheral speed)
v_w- m/s peripheral speed of the workpiece

For the corresponding q values of different materials are shown in Table II.

Table II. Speed Ratio Q For Different Materials

Material	Q
Steel	125
Grey cast iron	100
Ms and Al	60

The contact surface of engine head is very important for engine combustion system. So grinding process is needed for the required surface finish.

VI. SELECTION OF MACHINE AND MACHINE TOOL

In recent years, CNC machines are used for advanced machining operations. CNC Machine is short for computer numerically controlled machine. One of the main purposes in using CNC machine is to increase the production range. The major feature of the CNC machine is its ability to cut down drastically the lead time for similar components manufactured by a different plant. In CNC machines, NC system is the basic requirement which can perform machining on the parts as instruction or program. It is composed of a control program of coded manufacturing instructions, control unit and a machine tool. CNC machines can be used continuously 24 hours a day and only need to be switched off for occasional maintenance. CNC machines are programmed with a design which can then be manufactured hundreds or even thousands of times. Each manufactured product will be exactly the same. The selection of tool plays in an important role for machining operations. During the machining process, the tool is constantly in contact with the work piece and there is a relative motion between them. This situation develops serve cutting conditions which include friction, rise in temperature and pressure at the cutting zone. So the tool may fail or wear-out. The tool material must be harder than the material to be cut. The material of tool must possess the following properties:

Red hardness: the high hardness and strength can be retained at high temperatures and pressures;
Wear resistance: the geometry of a tool can be maintained at high temperatures for a long period of time while machining;
Toughness: the impact strength must be high;
High thermal conductivity: the generated heat at interface can be conducted in shorted possible time.

Universal milling machine, DMU340P, is used for machining of the engine head and CoroMill®200 face milling cutter is selected.

VII. MACHINING PARAMETERS AND RELATED QUANTITIES

The different machining parameters or variables are discussed below.

Spindle speed (n):

$$n = \frac{V_c \times 1000}{\pi \times D_e}, \quad (4)$$

Where,

n— spindle speed, rpm,
V_c— cutting speed, m/min, (185~200),
D_e— effective cutting diameter, mm.

$$D_e = D_c + \sqrt{ic^2 - (ic - 2a_p)^2}, \quad (5)$$

Where,

D_c— cutting diameter, mm,
ic— inscribed circle, mm,
a_p— depth of cut, mm.

Table speed or feed speed (V_f):

$$V_f = n \times f_z \times z, \quad (6)$$

Where,

f_z— feed per tooth, mm(0.1~0.2),
z— total number of edges in the tool.

$$f_z = \frac{ic \times h_{ex}}{D_e - D_c}, \quad (7)$$

Where, h_{ex}— maximum chip thickness, mm.

Power requirement (P):

$$P = \frac{a_p \times a_e \times V_f \times k}{100,000} \quad (8)$$

Where,

a_e ─ working engagement, mm,

k ─ constant factor for power requirement.

Metal removal rate (Q):

$$Q = \frac{a_p \times a_e \times V_f}{1000} \tag{9}$$

Machining time (t_m):

$$t_m = \frac{l_m}{V_f} \tag{10}$$

Where,

t_m ─ machining time, min,

l_m ─ total tool path length, mm.

$$l_m = l + 3 + \sqrt{D_e . a_p - a_p^2} \tag{11}$$

Where, l ─ length of work piece.

VIII. RESULT DATA

The gray cast iron is selected for engine head of four wheel drive double cab engine. It is the cheapness and the easiest of machining, low melting temperature, ability to take good casting impression, good wear resistance and high damping capacity, but weakness in brittle. However, the properties of gray cast iron are used for the metal cutting data from the catalogue, the selection of tool and consideration of depth of cut. The following results for machining operations are mainly depended on the machining allowance, material of work piece and machining process used. These results are shown in Table III.

TABLE III: Calculated Results For Machining Process

The required data and Equation no.	Known Data	Results
Effective cutting diameter (2)	D_c= 88 mm ic= 12 mm a_p= 1mm	D_e= 95 mm
Spindle speed (1)	V_c= 185 m/min D_e= 95 mm	n= 620 rpm
Feed per tooth (4)	ic= 12 mm h_{ex}= 0.17mm D_c= 88mm D_e= 95mm	f_z= 0.3 mm
Table speed or feed speed (3)	n= 620 rpm f_z= 0.3 mm z= 6	V_f= 1116 mm/min
Power requirement (5)	a_p= 1mm V_f=1116mm/min a_e=50 mm k= 3.7	P= 2.06 KW
Metal removal rate (6)	a_p= 1mm V_f=1116mm/min a_e=50 mm	Q= 55.8 cm^3/min
Total tooth path length (8)	l= 484 mm a_p= 1mm	l_m= 835 mm
Machining time (7)	l_m= 835 mm V_f=1116mm/min	t_m= 3 min

IX. CONCLUSION

In this paper, the required parameters for machining operation of contact surface of the engine head of four wheel drive double cab engine are calculated from the related data of the tool and other dimensions. Firstly, the contact surface is roughly machining with milling process and depth of cut (1mm) is selected. However, the surface accuracy of the head is not ready for use. The accuracy of the contact surface is very important as it is connected with the block and the combustion process takes place in this surface area. Therefore the grinding operation is needed for surface finishing.

X. REFERENCES

[1] Kyaw Kyaw Myint, Maung: Design and Fabrication of Vertical Machining Center (saddle), Ph.D Thesis, Mandalay, Myanmar, July, 2008.

[2] Halverson, M. CNC Machine Selection and Test in Accordance to ASME B5.54 Specification, 1999.

[3] Jain, P.L: Principle of Foundary Technology, Tata McGraw-Hill Publishing Company, 1999.

[4] Zagorskii, F.N, An outline of History of Metal Cutting machines, Amerind publishing Co., New Delhi,1982.

[5] Boothrovd, G. Fundamental of Metal Machining and Machine Tools, Kogakusha, Tokyo, 1975.

[6] Juneja, B.L, Machining process─ Theory and Practice , Phell publishion, Ohio,1974.

[7] Richard Stone "Introduction to Internal Combustion Engines", 2nd Edition, Macmillon,1972.

[8] Habicht, F.H,. Modern Machine Tools ,D.Van Nostrand Co.,Toronto, 1963.

[9] Woodbury.S, History of Milling Machine, MIT Press, Massachusetts,1960.

[10] Mehta, N.K; Machine Tool Design and Numerical Control, Tata McGraw-Hill Publishing Company. http:// engineering.ucdavis.edu/eft/MILLING/MACHINES.pdf