[Pawar* *et al.*, 6(6): June, 2017]
IC™ Value: 3.00
ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

IJESRT
INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

DESIGN OF HORIZONTAL INDEXING SIX CYLINDER BLOCK ROTARY HOLDING BRACKET AND ITS STRUCTURAL BEHAVIOUR

Komal Pawar[*1], Prof.Vikram Avhad[2] & Prof.Anantharma[3]
[*1]PG Student, Department of Mechanical Engineering, Dhole Patil College of Engg. Pune, Maharastra India
[2&3]Asst. Professor, Department of Mechanical Engineering, Dhole Patil College of Engg. Pune, Maharastra India

DOI: 10.5281/zenodo.809168

ABSTRACT
Heavy six cylinder block processing machine needs rotation of component with its horizontal axis. For indexing rotation at multiple angular turn a both side holding bracket need to design and to fulfeel this mechanism indexing bracket takes role with self driven arrangement ,On both sides of cylinder block face holding bracket is to be design which will be optimised and validated solution to make indexing feasible in horizontal position, while designing this indexing arrangement forces and othe boundry conditions to be considered to make feasible all the machining and other industrial processes.

KEYWORDS: SPM, Indexing, weldment.

I. INTRODUCTION
This work is in the field of SPM development and this bracket is made for cylinder block indexing application. In existing system manual rotation and locking without full proofing in side the SPM cabinet **.**

Fig: Machine inside cabinet view

Automated Rotary indexing concept For Cylinder Block is taken from the special purpose machine in which component Cylinder Block is to be machined for gasket

Fitting surface and drilling, and debarring, machining to be carried in SPM.

Fig: Machining needed for this gasket mounting surface.

After machining will be proceed towards assembly section in continuous production lineof Automobile company ,The arrangement of said project will be process wise well defined sequence and operation for the decided cycle time where the rotary indexing bracket along with component will be get stoppage at every angular position with the used sensors. Operation cycle will be run through PLC Programme.

II. PROBLEM IDENTIFICATION
Heavy component not easy to handle in machineries, material handling is very important in spm .transfer and processing this affect safety and other norms in industries, cycle time also increase due to material handling. Hence handling of six cylinder block for its face machining operatons is carried out by developing side indexing bracket to make it flexible in axial rotation inside the cabinet.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

III. OBJECTIVES

To design and structural formation of horizontal rotary fixturing assembly Side holding bracket for heavy cylinder block,
To Optimisation the weight along with required torque.

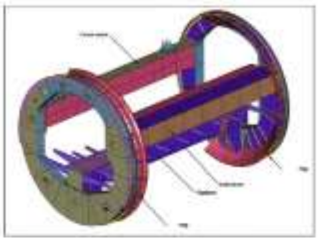
IV. LITERATURE REVIEW

Welding cage type machines

- VTA series cage welding machinery is designed for the manufacture of cylindrical cages with or without bells. Machines for the production of oval or rectangular cages are available on request.

Fig: Welding Setup in rotating cage type assembly

- Wagon loading cage in mining area .Structural analysis done by considering different angle position. Solid model constructed for cage assembly



The cylinder block is the largest part of the engine. Its upper section carries the cylinders and pistons. Normally, the lower section forms the crankcase, and supports the crankshaft. It can be cast in one piece from grey iron. Or it can be alloyed with other metals like nickel or chromium. The iron casting process begins by making up the shapes of what will become water jackets and cylinders as sand cores which are fitted into moulds. This stops these parts becoming solid iron during casting. Molten iron is poured into sand moulds that are formed by patterns in the shape of the block. After casting, core sand is removed through holes in the sides and ends, leaving spaces for the cooling and lubricant passages. These holes are sealed with core or welsh plugs. The casting is then machined. Cylinders are bored and finished, surfaces smoothed, holes drilled and threads cut. All cylinder blocks are made with ribs, webs and fillets to provide rigidity but also keep weight to a minimum.

V. SCOPE IN DESIGN

In existing system no drive unit found operations are with handle turning and precision not found in thecurrent operation . so spur gear idea to apply drive system is completely failed as this is bigger and heavy cylinder for installatrion of gear assembly will take too bulky motor mechanism and bushings .so surfaceholding assembly to carry cylinder block load and bracket holding this block assembly is to be analysed on CAE and engineering development validation processes. Spur gear installation will be of costly manbufacturing parameters.also drive motor required will be heavy to rotate the load .

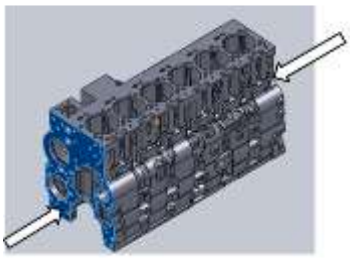


Fig: marked surface area of cylinder block

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Machine is holding processes like machining, drilling on end faces of cylinder block, also after these operation holes, galaries and cavities will get cleanned by air blow.

Input :-Process and instrumentation diagram where this is to be used in machine

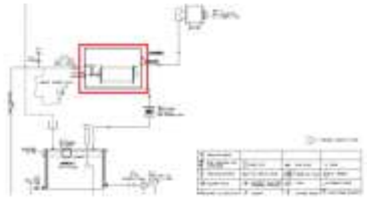


Fig: P&I Diagram

VI. DESIGN AND DEVELOPMENT

Proposed tentative Design

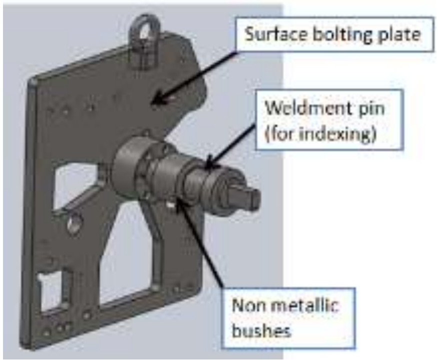


Fig: Mechanical components used

VII. MATERIAL PLANNING

AISI 304 stainless steel

It is having Better corrosion resistance than Type 302. High ductility, excellent drawing, forming, and spinning properties. Stainless steels can absorb considerable impact without fracturing due to their excellent ductility and their strain-hardening characteristics. Essentially non-magnetic, becomes slightly magnetic when cold worked. Low carbon content means less carbide precipitation in the heat-affected zone during welding and a lower susceptibility to inter granular corrosion.

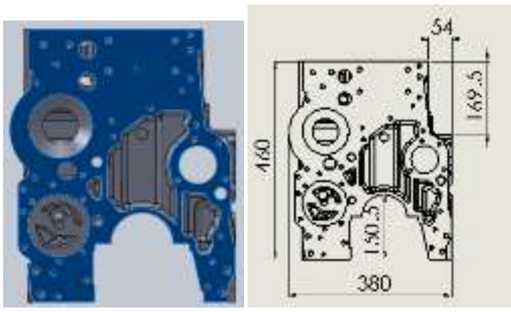


Fig: Block surface view and dimensions

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

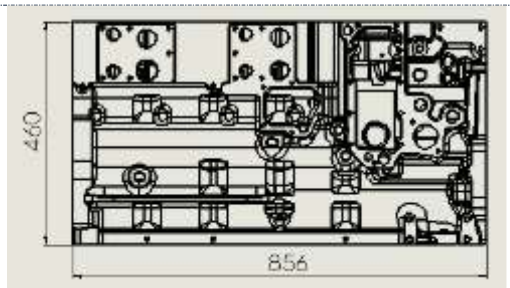


Fig: side view of object

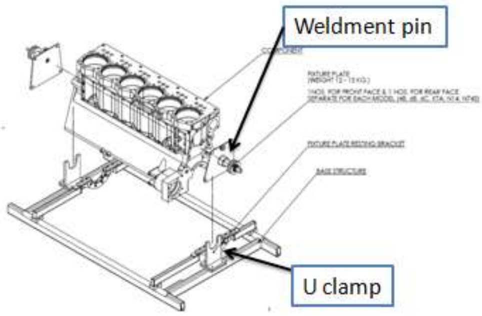


Fig: Major loaded components

Component 1- U Clamp For Mounting This Assembly

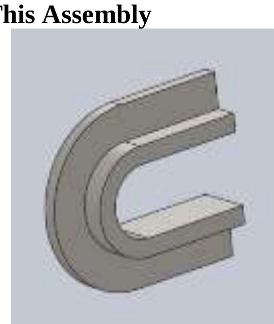
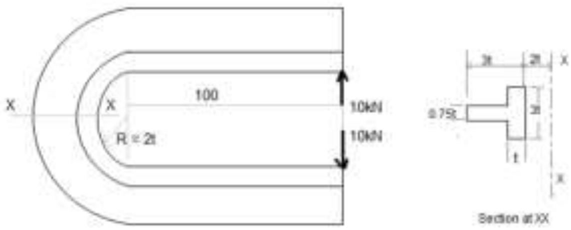


Fig: C -frame holding for holding the cylinder block assembly

Conditions are applied as per the loads obtaining from cylinder block weight and machining conditions as 10000 N load is taken from machining forces and component load.

C- Frameload study and dimension outcomes design



Material of the frame – Steel 304
Ultimate tensile strength = 515 MPa
Considering factor of safety (f_s) = 3
Permissible tensile stress,
σ_t = 515 / 3 = 171.67 MPa
Let

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

R_o = Radius of outer fibre
R_i = Radius of inner fibre
R = Radius of centroidal axis
R_N = Radius of Neutral axis
h_i = distance of inner fibre from neutral axis
h_o = distance of outer fibre from neutral axis
M_b = Bending moment with respect to centroidal axis
A = Cross section area
b_i =3t, h = 3t R_i = 2t
R_o = 5t, t_i = t t = 0.75t

$$R_N = \frac{t_i(b_i - t)th}{(b_i - t)\log_e({}^{R_i + t}/_{R_i}) + t\log_e({}^{R_o}/_{R_i})}$$

R_N = 2.8134t

$$R = R_i + \frac{\frac{1}{2}th^2 + \frac{1}{2}t^2(b_i - t)}{th + t_i(b_i - t)}$$

R = 3t

Eccentricity,e
e = R - R_N
e = 3t – 2.8134t
e = 0.1866 t
Bending Stress
$h_i = R_N - R_i$ = 0.8134t
A = (3t) (t) + (0.75t) (2t) = $4.5t^2$ mm^2
$M_b = 10 \times 10^3$ (1000+ R)
$M_b = 10 \times 10^3$ (1000+ 3t)N mm
Bending stress at inner fibre is given by

$$\sigma_{bi} = \frac{M_b h_i}{AeR_i}$$

$$\sigma_{bi} = \frac{10 \text{ x } 10^3(100 + 3t)\ 0.8134t}{4.5t^2\ (0.1866t)(2t)}$$

$$\sigma_{bi} = \frac{10 \text{ x } 10^3(100 + 3t)\ 2.1795}{4.5t^3} \text{ N/mm}^2$$

Direct tensile stress,
$\sigma_t = \frac{P}{A} = \frac{10\,x10^3}{4.5t^2}$ N/mm^2
Adding two stresses and equating to permissible stress,
$\sigma_{bi} + \sigma_t = \sigma_{max}$
$\frac{10 \text{ x } 10^3(100+3t)\ 2.1795}{4.5t^3} + \frac{10\,x10^3}{4.5t^2} = 171.67$
Solving above we get,
t = 16 mm

Bending stress at inner fibre

$$\sigma_{bi} = \frac{10 \text{ x } 10^3(100 + 3t)\ 2.1795}{4.5t^3}$$

$$\sigma_{bi} = \frac{10 \text{ x } 10^3(100 + 3\text{x } 16)\ 2.1795}{4.5 \text{ x } 16^3}$$

$$\boldsymbol{\sigma_{bi} = 175.003 N/mm^2}$$

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Direct tensile stress,

$\sigma_t = \frac{P}{A} = \frac{10\,x10^3}{4.5t^2}$ N/mm^2

$$\sigma_t = \frac{P}{A} = \frac{10\,x10^3}{4.5\,x\,16^2}$$
$$\boldsymbol{\sigma_t = 8.68N/mm^2}$$

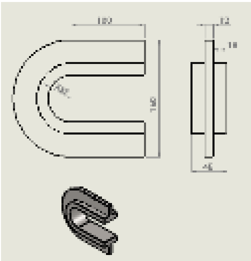
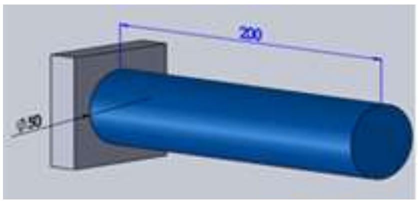


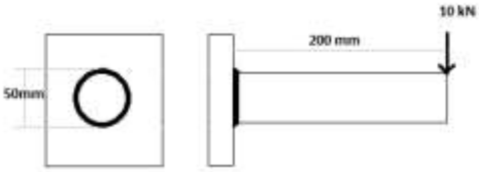
Fig: Finalised dimensions

Component 2- Weld Pin



Holder main support design (Weld pin)

The shaft is welded to a support by means of fillet weld as shown in the figure. Let the permissible shear stress in the weld is limited to 100 N/mm^2.



Primary shear stress

Primary shear stresses in the weld is given by,

$$\tau_1 = \frac{P}{A} = \frac{P}{\pi D t}$$

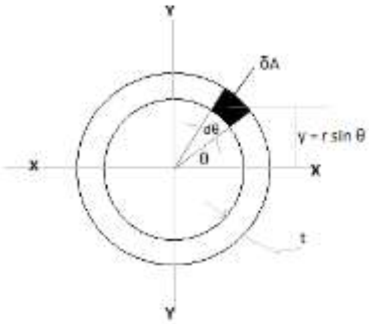
$$\tau_1 = \frac{10000}{\pi(50)t}$$

$\tau_1 = \frac{63.66}{t} N/mm^2$ .... (i)

Bending stress

Consider an elemental section of area δA as shown in figure. It is located at an angle θ with X Axis and subtends an angle dθ.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7



$\delta A = r\, d\theta\, t$
and
$\delta(I_{xx}) = (\delta A)(y^2) = (r\, d\theta\, t)\,(r \sin\theta)^2$
$= tr^3 \sin^2\theta\, d\theta$

The moment of inertia of an annular fillet weld is obtained by integrating the above equation.
Thus,

$$I_{xx} = 2\int_0^{\pi} tr^3 \sin^2\theta\, d\theta$$

$$I_{xx} = 2tr^3 \int_0^{\pi} \sin^2\theta\, d\theta$$

$$I_{xx} = 2tr^3 \int_0^{\pi} [\frac{1-\cos 2\theta}{2}] d\theta$$

$$I_{xx} = 2tr^3\, (\frac{\pi}{2})$$

Or

$$I_{xx} = \pi tr^3$$

For the given welded joint,
$I_{xx} = \pi(t)(25)^3$ mm^4
From bending equation,

$$\sigma_b = \frac{M_b y}{I}$$

$$\sigma_b = \frac{(10000\ x\ 200)\ (25)}{\pi(t)(25)^3}$$

$\sigma_b = \frac{1018.59}{t}$ N/mm^2........................... (ii)

Now, Maximum shear stress,
The maximum shear stress in the weld is given by,

$$\tau = \sqrt{(\frac{\sigma_b}{2})^2 + (\tau_1)^2}$$

$$\tau = \sqrt{(\frac{1018.59}{2t})^2 + \left(\frac{63.66}{t}\right)^2}$$

$\tau = \frac{513.26}{t}$ N/mm^2
Size of Weld

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Since the permissible shear stress in the weld is 100 N/mm^2

$$100 = \frac{513.26}{t}$$

Hence, $\mathbf{t = 5.13\ mm}$

$$h = \frac{t}{0.707}$$

Hence, $\mathbf{h = 7.26\ mm = 8\ mm}$

Bending Stress

$$\sigma_b = \frac{1018.59}{t}$$

$$\sigma_b = \frac{1018.59}{5.13}$$

$$\boldsymbol{\sigma_b = 198.55\ N/mm^2}$$

Primary shear stress

$$\tau_1 = \frac{63.66}{t}\frac{N}{mm^2}$$

$$\tau_1 = \frac{63.66}{5.13} N/mm^2$$

$$\tau_1 = 12.41\ N/mm^2$$

Maximum Shear stress

$$\tau = \sqrt{(\frac{\sigma_b}{2})^2 + (\tau_1)^2}$$

$$\tau = \sqrt{(\frac{198.55}{2})^2 + (12.41)^2}$$

$$\boldsymbol{\tau_{max} = 100.05\ N/mm^2}$$

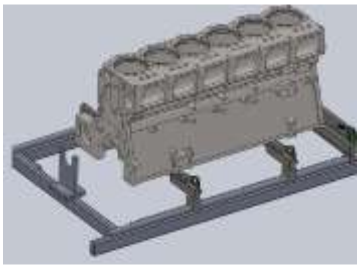
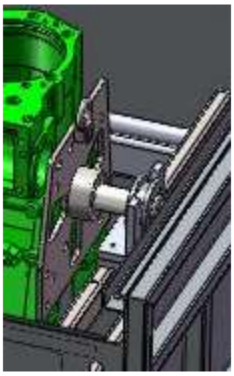


Fig: Blank cylinder block fixture before processing in SPM.

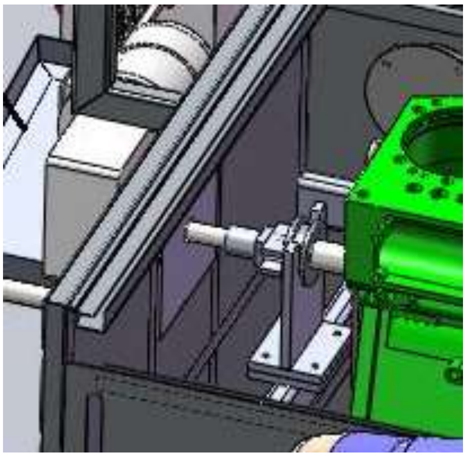
Design of side holder



ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

It's designed to make feasible holding bracket for indexing direct use for enabling the stoppages for cylinder block.

Other side rotary drive and holder



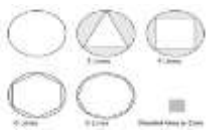
VIII. CAE VALIDATION

Meshing

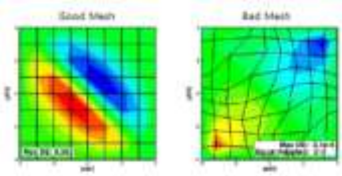
The model is made in ANSYS workbench used for the Stress analysis. The Finite Element Method (FEM) has developed into a key, indispensable technology in the modelling and simulation of advanced engineering systems in various fields like housing, transportation, manufacturing, and communications and so on the fine meshing is carried out. The meshed model created is shown in following figure.

Finite element analysis is the process of dividing or discretizing our geometry into finite nodes and elements and solving it for stress and strains and the particular process of discretization is known as meshing. Meshing is the way of communicating our geometry to the FEA solver. In meshing we will divide our geometry into any one of the following shapes of elements like triangles, quadrilaterals, tetrahedron, quadrilateral pyramid, triangular prism, and hexahedron. and the selection of particular shape of the element depends on the type of analysis and the shape of the geometry.

Elements on the mesh of the geometry will only capture the structural response of the system so it is mandatory to understand the impact of element type and mesh quality before solving a problem. Even the density of the mesh can affect the output so it is best to have a more elements. If we want to analyse a circle, then the geometry of the circle have to be captured as much as possible the image below shows that how the mesh have to be done for circular geometry



Also it is important to have fine structural mesh than coarse unstructured mesh, only at some critical points it is good to have coarse mesh to get accurate result. The image below shows the result variation for good structured mesh and unstructured mesh and also notes that the experimental results correlates more with the structural mesh.



Processing with Component

IX. VALIDATION ON U FRAME

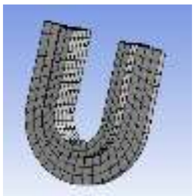


Fig: Meshed model

Details of "Mesh"

Defaults	
Physics Preference	Mechanical
Relevance	0
Sizing	
Use Advanced Si...	Off
Relevance Center	Coarse
Element Size	Default
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Fast
Span Angle Center	Coarse
Minimum Edge L...	12.0 mm
Inflation	
Use Automatic Te...	None
Inflation Option	Smooth Transition
Transition Ratio	0.272
Maximum Layers	5
Growth Rate	1.2
Inflation Algorit...	Pre
View Advanced ...	No
Advanced	
Shape Checking	Standard Mechanical
Element Midside ...	Program Controlled
Straight Sided El...	No

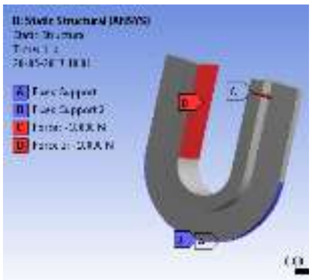


Fig: Boundary conditions applied

Conditions are applied as per the loads obtaining from cylinder block weight and machining conditions as 10000 N loads is taken from machining forces and component load.

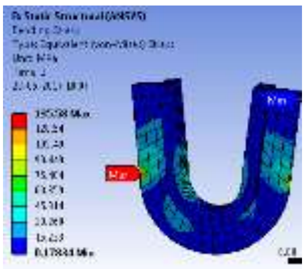


Fig: behaviour found Bending 135.6 mpa

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

X. SHAPE OPTIMISATION

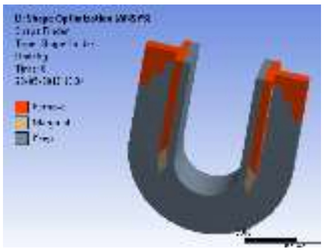


Fig: scoped Optimised zones found (Red highlighted)

Details of "Shape Finder"	
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Target Reduction	20. %
Results	
Original Mass	3.1723 kg
Marginal Mass	6.7477e-002 kg
Optimized Mass	2.6396 kg

Shape output table from Ansys
20% targeted reduction we done and can be execute to overcome on mass and cost reduction.

XI. SUPPORT PIN VALIDATION

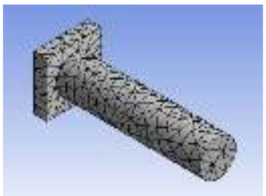
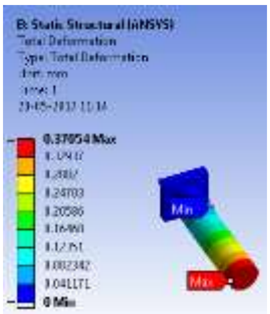


Fig: Boundary condition



Max stress 154.97 mpa
Deformation 0.37 mm
SPM Cabinet where this system is to be installed.

Fig: Machine view

XII. ADVANTAGES AND LIMITATIONS

Advantages

1. More strength and flexible
2. Easy component manufacturability
3. Cylinder block holding/indexing feasible
4. Easy replacement of component
5. JIB separation from super structure is possible.

Limitations

1. More cycle time operations may affect on smoothness.
2. Weld pin rod attachment is weldment so welding preparation may vary as per the manufacturing supplier..

XIII. RESULT AND CONCLUSION

Parameter	Engineering	CAE Testing
U frame holder Thickness derived t= 16 mm		
Bending Stress mpa	175	135.6
Tensile	8.68	20.26
Deformation	0.029 mm	
Weld Pin behavior output		
Bending mpa	198.5	154.8
Shear mpa	100 mpa	80.5

XIV. CONCLUSION

Cylinder block holder bracket is found satisfactory in working behaviour also depending on the manufacturing and weldment techniques used to form bracket strength will be counted. So for component tilting loads and load boundary condition design is found feasible. This is the best solution compare to conventional method of spur gear pair rotation. Six cylinder block and holding assembly can be standardized as these are commonly used application in many applications

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

XV. REFERENCES

[1] American Journal of Engineering Research (AJER) e-ISSN : 2320-0847 p-ISSN : 2320-0936 Volume-03, Issue-10, pp-145-150
[2] http://www.brother.com/as_oc/machine/cnc/sample/index.htm
[3] Paper machine drying cylinder block
US 3756093 A
[4] Cylinder block and method of fabrication thereof
US 6886522 B1
[5] Cylinder block mounting fixture
EP 0885080 B1
[6] Siamese-type cylinder block blank and apparatus for casting the same
US 4905642 A

CITE AN ARTICLE

Pawar, K., Avhad, V., Prof, & Anantharma, Prof. (2017). DESIGN OF HORIZONTAL INDEXING SIX CYLINDER BLOCK ROTARY HOLDING BRACKET AND ITS STRUCTURAL BEHAVIOUR. *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY*, *6*(6), 269-281. doi:10.5281/zenodo.809168