Numerical Investigation on Structural Analysis of Connecting Rod Bush

S. Dharani Kumar [1], Sureesh.G [2], NithishAravinth.M.B [3], Revanth.J [4], Raghul.P [5], Krishnamoorthy.V [6], Vinukarthikeyan.P [7]
[1]Assistant Professor, Department of Mechanical Engineering, Sri Eshwar College of Engineering, Coimbatore -641202, India,
[2,3,4,5] UG student, Department of Mechanical Engineering, Sri Eshwar College of Engineering, Coimbatore -641202, India,
[6] Manager R&D,Bimetal Bearings Limited, Race Course Road,Coimbatore-641018,India
[7] Engineer R&D,Bimetal Bearings Limited, Race Course Road,Coimbatore-641018,India

Abstract – This paper mainly aims to design and analyse the connecting rod bush which is to connect the reciprocating piston in IC engine. The bush is designed according to the data available for specific IC Engine. The static structural analysis of bush is carried out with ABAQUS 6.13 FEA software by considering material properties of cladded copper with backing layer as SAE1010 steel. It is found that the maximum vonmises stress acting on the bush is lesser than the yield strength of the material. From the results, the bush is suitable for particular operating conditions.

Index Terms – Small-end-bush, ABAQUS 6.13, static analysis, von mises stress

1. INTRODUCTION

Journal Bush is widely used in various reciprocating machines and it is a vital component for all reciprocating machinery. The circular shaft called journal, made to rotate around a fixed sleeve, which is the Bush. Even a good lubricant film is maintained during the process of the Bush, however, most of the bushes suffers from wear [1]. Wear is one of the factors for reducing the lifetime of the bush. Wear behaviour of journal bushes [2-4], but there are lack studies observed in the basic structural analysis of bush.

Over the years, iron, and some metals have been used as the material for the journal Bush. But, later on materials like brass, bronze and stainless steel are also used including with the recent addition is the aluminium and zinc-based materials also come with the composition in the journal Bush [5].The continuous lubrication is not possible with the improvements in technological, plastic materials and sintered Bush etc. So it is very important to choose the Bush material according to its application.

Where copper-based material has widely used the material for Bush in recent years, where it has high electrical and thermal conductivity and it has good corrosion, self-lubricating property and wear resistance [6].Copper-based tin bronze is used as the material for the bush to have a high wear resistance [7]. M Bhuptani et al (2013) describes modelling and analysis of small end bush using Pro-E Wildfire 4.0 software. Static structural analysis of small end bush of connecting rod is done by considering three different materials and they found the Vonmises stress for three materials. S. Dharani Kumar et al (2017) discussed with structural analysis of Connecting rod and crank shaft bearings using ANSYS APDL 15.0.

Their results conclude that maximum vonmises stress acting on the bearings is lesser that the yield strength of the selected material, which shows that the bearing material are suitable for particular operating conditions [8]. The main aim of this paper is to find the selected bush material is suitable for particular operating condition.

2. RELATED WORK

The selected key areas which are necessary to be taken into account and cognate to one another in order to analyse the connecting rod Bush. The steps involved in the methodology are shown in the Figure 1.

- Data collection
- Bush Design Calculations
- Geometric Modelling
- Structural Analysis

2.1 DATA COLLECTION

For structural analysis of connecting rod small end bush it is necessary to collect the data for the bush understudy. The data is collected from the functioning guide of the particular IC engine. Table 1 shows the technical specification of IC engine including bush dimensions

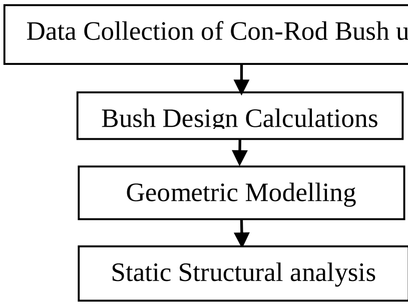

Fig.1. Methodology

Table 1 Technical Specifications of IC Engine [8]

S.No	Details	Values
1	Piston Diameter	69.4 mm
2	Connecting Rod Length	82.0 mm
3	Connecting Rod Weight	0.467 kg
4	Piston Weight	0.507 kg
5	Crank Radius	25.2 mm
6	Speed	5200 rpm
7	Weight of Flywheel	9.2 kg
8	Peak Firing Pressure	13.69 MPa
9	Peak Firing Pressure Angle	10^o
10	Diameter of Connecting Rod Bush	44.100 mm
11	Length of Connecting Rod Bush	33.500 mm
12	Thickness of Connecting Rod Bush	1.700 mm
13	Diameter of Main Bush	54.23 mm
14	Length of Main Bush	18.925 mm

2.2 BUSH DESIGN CALCULATIONS

For structural analysis of connecting rod bush some important design calculation are necessary. Pressure acting on bush is calculated by considering the force acting on the piston. Table 2. Shows the evaluated values of connecting rod and peak firing pressure.

Table 2

S.No	Bush Design Calculation	Value
1	Mass of the Reciprocating Parts	M_R= 0.66466 kg
2	Area of the Piston	A_P= 3802.66 mm^2
3	Area of the Connecting Rod Bush	A_b= 1477.35 mm^2
4	Gas Force Acting on the Piston	F_l= 52058.49 N
5	Gas Pressure Acting on Connecting Rod Bush	GP_b= 34.21 Mpa

2.3 GEOMETRIC MODELLING

The bush of connecting rod is modelled using Creo 2.0. The generated 3D solid model is shown in the Figure 2 for analysis purpose

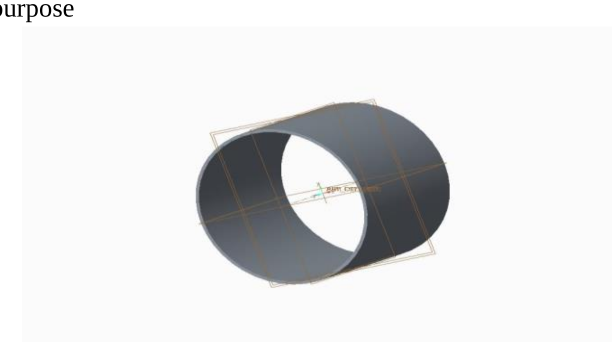

Fig.2. Geometrical model of connecting rod bush

2.4 STRUCTURAL ANALYSIS

Modelled file of the bush is converted to IGES format, and it is imported in the ABAQUS software for further analysis. As a second step of analysis the material property of the bush has been assigned from the Table 3. The material utilized for specific investigation of bush is copper for the covering layer and low carbon steel (SAE 1010) as support layer. The material is prepared by cladding process [4]. Boundary condition for analysis of the bush is shown in the Figure 3. The top surface and side face of the bush is fixed in all Degree of freedom. Calculated gas pressure is applied in the Y direction of the inner surface of the bush and pressure value is taken from the Table 2. Geometric model is converted in to finite element model by meshing. In this analysis 3D Hexagonal 8-Node Linear Brick element is used with the element size of 4 mm with the aspect ratio of 1. The size element is fixed by taking convergence study of various element size which is shown in the Figure 4

Table 3 Material Property of the Bush

S.No	Properties	Value	Unit
1	Young's modulus	21000	MPa
2	Yield Strength	170	MPa
3	Poisson ratio	0.3	No unit

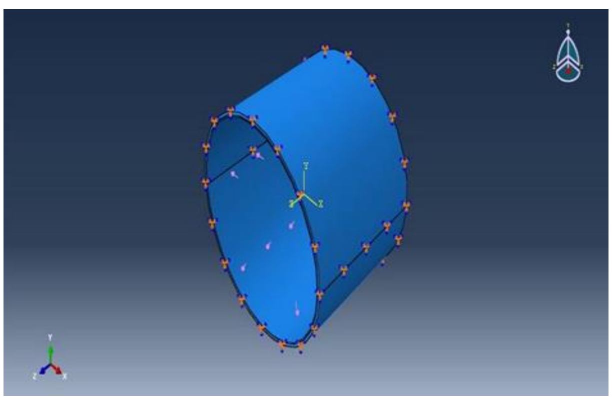

Fig.3. Boundary condition

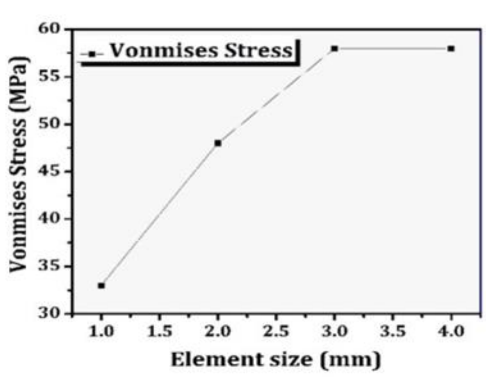

Fig. 4. Size of Element vs Von Mises Stress

3. RESULTS AND DISCUSSIONS

3.1 Vonmises Stress Distribution of Connecting Rod Bush

The Vonmises stress appropriation across the component boundaries for the chosen nodes and element of the mesh is depicted with the help of contour as shown in Figure 5. Red shade demonstrates most extreme stress and the blue shade indicates the least value of the stress. Different colour lies in the middle of red and blue indicating the road values of the vonmises stress between the greatest and minor values. In this case, maximum value of vonmises stress is 58 MPa and minimum value of vonmises stress is 5 MPa. From the basics of structural analysis of the connecting rod bush illustrates that maximum vonmises stress on the bush is lesser than yield strength of material. The intermediate values of vonmises stress on the connecting rod bearings are 10,14,19,24,29,34,38,43,48,53 from blue color to red color

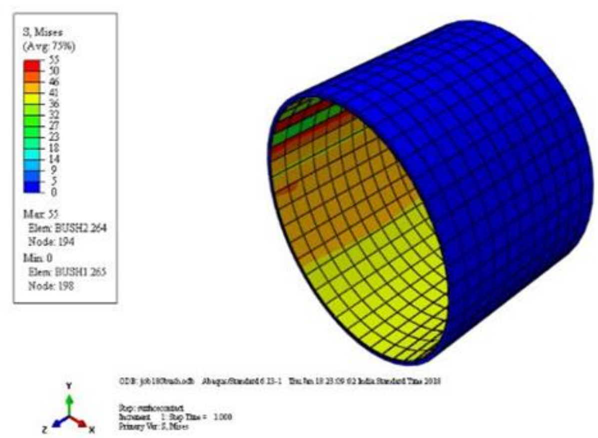

Fig.5. Von Mises stress distribution of bush

4. CONCLUSION

From the numerical investigation the maximum vonmises stress is of around 58MPa on the connecting rod bush for particular pressure. It is lesser than yield strength of the material 170 MPa. So that designed bush and selected material is suitable for particular operating condition of an IC engine.

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Authors

G.Sureesh is UG student, Department of Mechanical Engineering at Sri Eshwar College Of Engineering, Coimbatore, India. Project - Intern at Research and Development Center, Bi-Metal Bearing Ltd – Coimbatore, India.

M.B.Nithish Aravinth is UG student, Department of Mechanical Engineering at Sri Eshwar College Of Engineering, Coimbatore, India. Project - Intern at Research and Development Center, Bi-Metal Bearing Ltd – Coimbatore, India.

J.Revanth is UG student, Department of Mechanical Engineering at Sri Eshwar College Of Engineering, Coimbatore, India. Project - Intern at Research and Development Center, Bi-Metal Bearing Ltd – Coimbatore, India.

P.Raghul is UG student, Department of Mechanical Engineering at Sri Eshwar College Of Engineering, Coimbatore, India. He published one international journal at Malaysian University of Science and Technology, Malaysia. Project - Intern at Research and Development Center, Bi-Metal Bearing Ltd – Coimbatore, India.

V.Krishnamoorthy is a Manager at Research and Development Center, Bi-Metal Bearing Ltd – Coimbatore, India.

P.Vinukarthikeyan is an Engineer at Research and Development Center, Bi-Metal Bearing Ltd – Coimbatore, India.