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Design and Analysis of Cylinder Head with Different Materials

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ABSTRACT

The main aim of this work is to predict the design performance based on the stress/strain and behavior of cylinder head under various operating conditions. The effects of engine operating conditions such as combustion gas maximum internal pressure, components on the stress and thermal stress behavior of the cylinder head have been analyzed. The analysis was carried out using a finite element analysis (FEA) software package, which is use to simulate and predict the Von- Misses stress and strain pattern and thermal distribution of the cylinder head structure during the combustion process in the engine and the geometry modeling was carried out using a popular computer-aided engineering tool, Catia v5..

In this investigation, structural analyses of the cylinder head highlight several areas of interest. The maximum stress is found not exceeding the material strength of cylinder head, and thus the basic design criteria, namely no yielding and no structural failure under firing load case, can be satisfied. which can be improved in the early stages of cylinder head with compared of two materials structural steel and aluminum . This steady-state finite element method (FEM) structural analysis can play a very effective role in the find the stress and deformation of the cylinder head with two materials.

Keywords: Cylinder Head, catia,ansys, stress, deformation.

INTRODUCTION

The first successfully working internal combustion engine used in an automobile was built by Siegfried Marcus in approximately 1864 [1]. It was an upright single-cylinder, two-stroke petroleum-fuelled engine that also utilized a carburettor to deliver fuel to the engine. The engine was placed on a cart with four wheels and successfully ran under its own power. Not only has Marcus produced the first engine that is the direct predecessor to today's engines, he had also built the first automobile in history, some 20 years before Gottlieb Daimler's automobile.

Today's engines are an integral component of an automobile that are built in a number of configurations and are considerably more complex than early automotive engines.

Technological innovations such as electronic fuel injection, drive-by-wire (i.e., computer-controlled) throttles, and cylinder-

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deactivation have made engines more efficient and powerful.

The use of lighter and stronger engineering materials to manufacture various components of the engine has also had an impact; it has allowed engineers to increase the power-to-weight of the engine, and thus the automobile.

Common components found in an engine include pistons, camshafts, timing chains, rocker arms, and other various parts. When fully stripped of all components, the core of the engine can be seen: the cylinder block. The cylinder block (popularly known as the engine block) is the strongest component of an engine that provides much of the housing for the hundreds of parts found in a modern engine. Since it is also a relatively large component, it constitutes 20-25% of the total weight of an engine [2]. Thus there is much interest in reducing the block's weight.

Cylinders integrated into one or several cylinder blocks

A **cylinder block** is a unit comprising several cylinders (including their cylinder walls, coolant passages, cylinder sleeves if any, and so forth). In the earliest decades of internal combustion engine development, monobloc cylinder construction was rare; cylinders were usually cast individually. Combining their castings into pairs or triples was an early win of monobloc design.

Each **cylinder bank** of a V engine (that is, each side of the V) typically comprised one or several cylinder blocks until the 1930s, when mass production methods were developed that allowed the modern form factor of having both banks plus the crankcase entirely integrated.

Cylinder blocks and crankcase integrated

Casting technology at the dawn of the internal combustion engine could reliably cast either large castings, or castings with complex internal cores to allow for water jackets, but not both simultaneously. Most early engines, particularly those with more than four cylinders, had their cylinders cast as pairs or triplets of cylinders, then bolted to a single crankcase.

Combined block, head, and crankcase

Light-duty consumer-grade Honda GC-family small engines use a monobloc design where the cylinder head, block, and half the crankcase share the same casting, termed 'uniblock' by Honda. One reason for this, apart from cost, is to produce an overall lower engine height. Being an air-cooled OHC design, this is possible thanks to current aluminum casting techniques and lack of complex hollow spaces for liquid cooling. The valves are vertical, so as to permit assembly in this confined space. On the other hand, performing basic repairs becomes so time-consuming that the engine can be considered disposable. Commercial-duty Honda GX-family engines (and their many popular knock-offs) have a more conventional design of a single crankcase and cylinder casting, with a separate cylinder head.

Cylinder Head

1 Function and structural characteristics

(1) Function: covered the cylinder, and forms the combustion chamber together with the piston and cylinder liner, it is one of the most complex parts in an engine.

(2) Structural characteristics:

(I) For mounting the injector, intake and exhaust valves and its' driving parts.

(II) Layout the intake and exhaust passages, cooling water cavity, and bolts channels.

(3) Working conditions:

(I) Working under the high temperature and high pressure.

(II) Under these that bolt preload, compression stress, bending stress, thermal stress.

(4) Production requirements:

(I) To ensure the strength and stiffness.

(II) To ensure a good seal interface.

(5) Materials:

(I) Cast aluminium:

a Good thermal conductivity, light weight, good cast process.

b The high thermal expansion coefficient, easy distorted, high price, and used in the small high-speed engine.

(II) Cast iron: high temperature resistance, good casting process, and cheaper.

(III) Cast steel: high tensile strength, high toughness, high-temperature strength, not prone to cause fatigue cracks, poor technology.

(1) The separate cylinder (animation): There is a cylinder head for each cylinder. Advantages:

(I) Easy manufacture, easy to maintain and repair.

(II) Easy to seal the cylinder.

(III)Large heat expansion room,small thermal stress.

Therefore, the separate cylinders are commonly used in the large and medium diesel engines.

Structure characteristics:

(I) There is a lobe on the bottom of the cylinder, matched with the annular grooves which is on the cylinder linear. These two parts are sealed with copper gasket.

(II) The water cavity are divided into two tiers, the flowing direction of the cooling water: the top plane of the engine

(2) Single-cylinder (animation): Linking several cylinder head as a whole is a single-cylinder.

Advantages: excellent rigidity, the short distance of the cylinder centres, convenient layout for exhaust passages. It is commonly used in the high-speed diesel engine.

Structural characteristics:

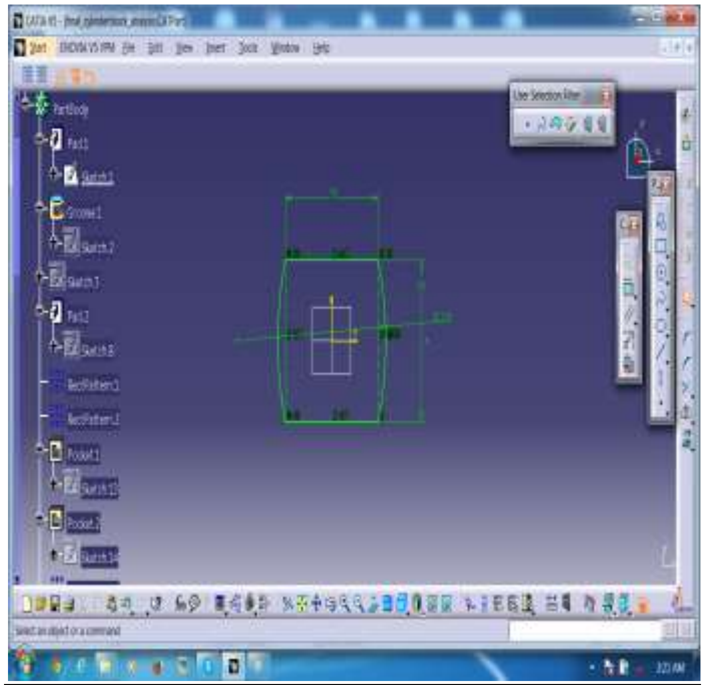
(I)4 valves per cylinder: two for intake and two for exhaust.

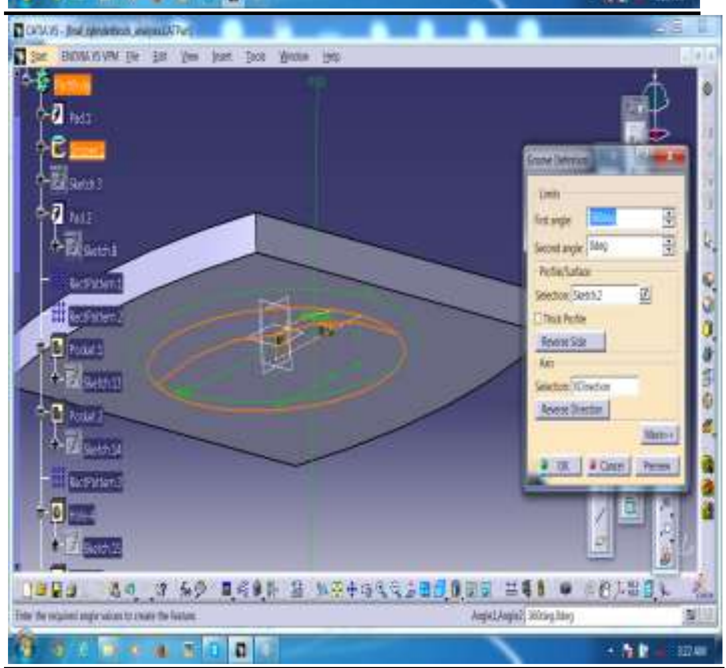
(II) There is intake manifold in the medial of the V-shaped cylinder, and exhaust manifold in the lateral.

(III) Dealt the valve holes and valve guides with bronze, increase the wear resistance and thermal resistance of the valve seats and guides.

(IV) Single-cylinder head of the 12V180 light diesel engine

MODELLING OF CYLINDER HEAD





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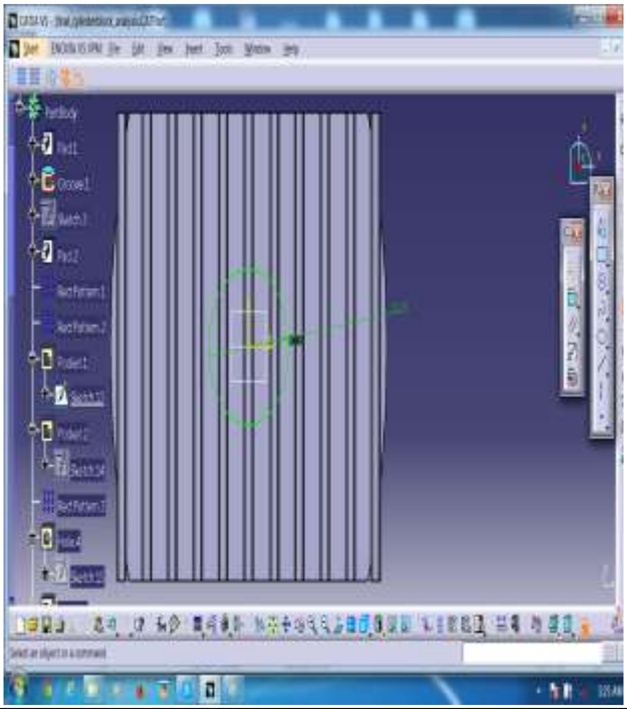
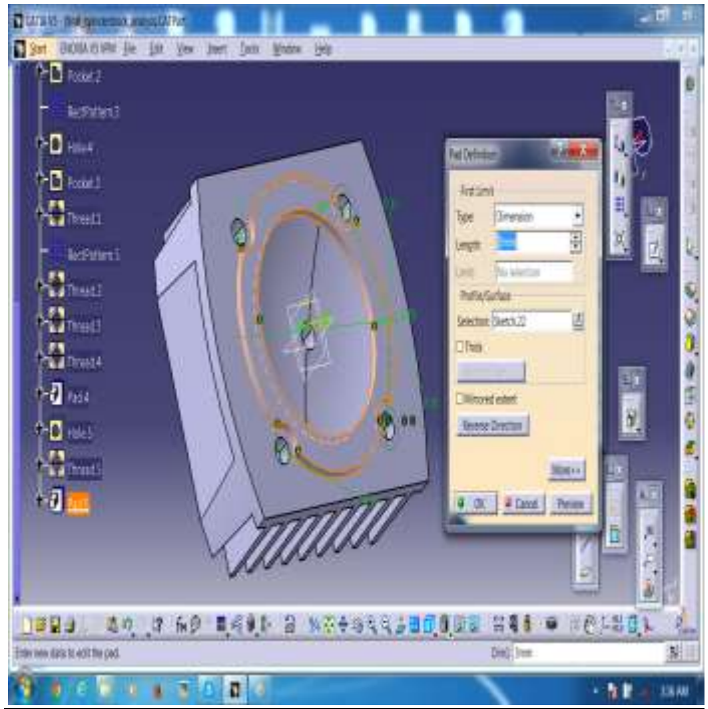
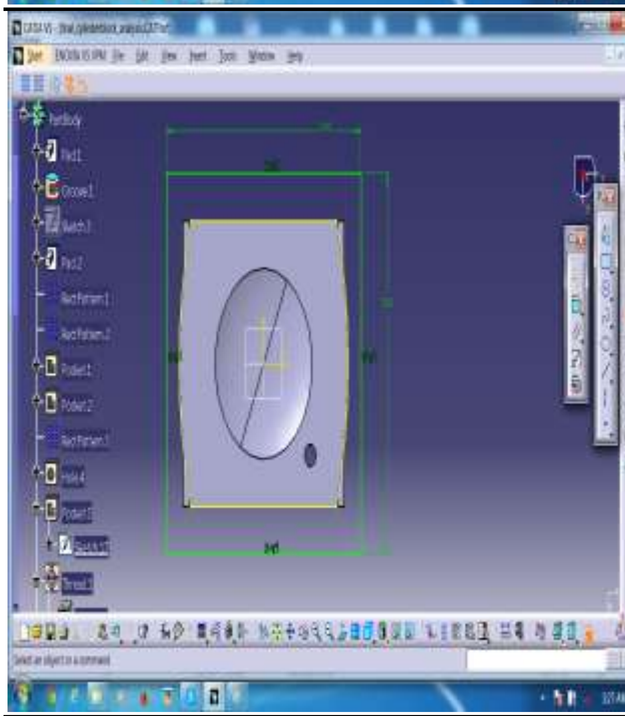
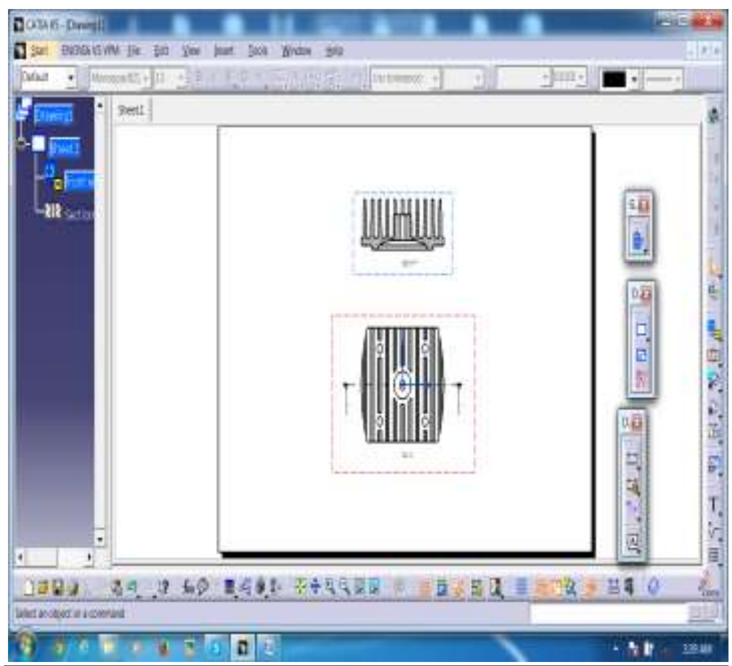






DRAFTING OF CYLINDER HEAD



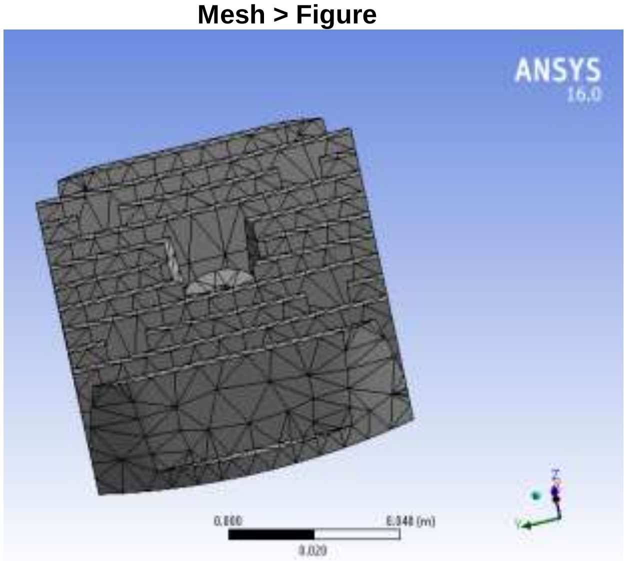
ANSYS RESULTS

STRUCTURAL ANALYSIS WITH STEEL MATERIAL

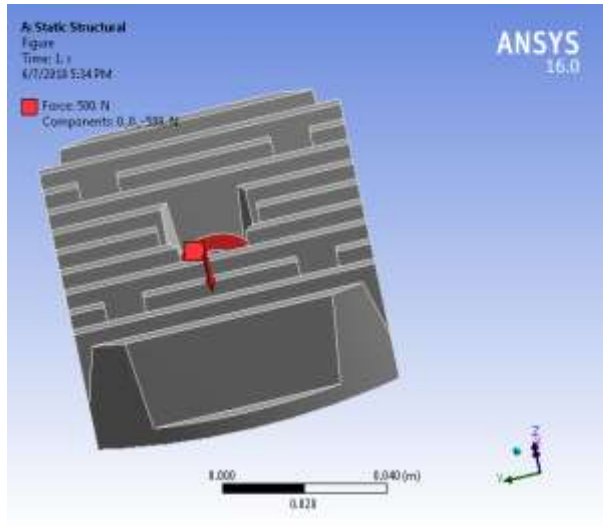
Material Data

- Structural Steel

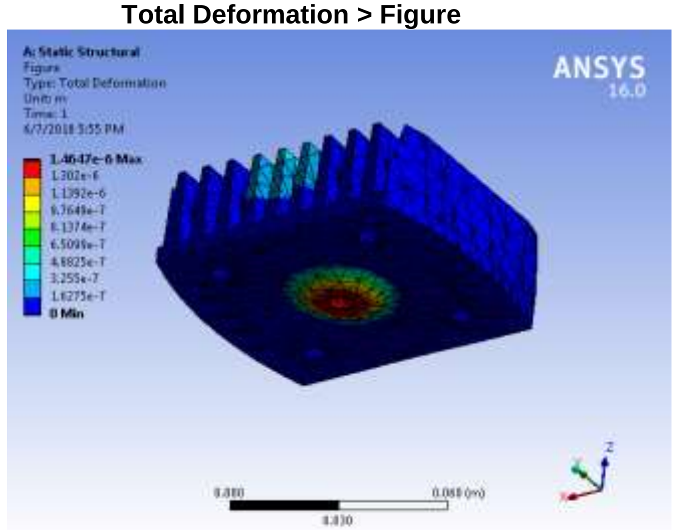
Mesh > Figure



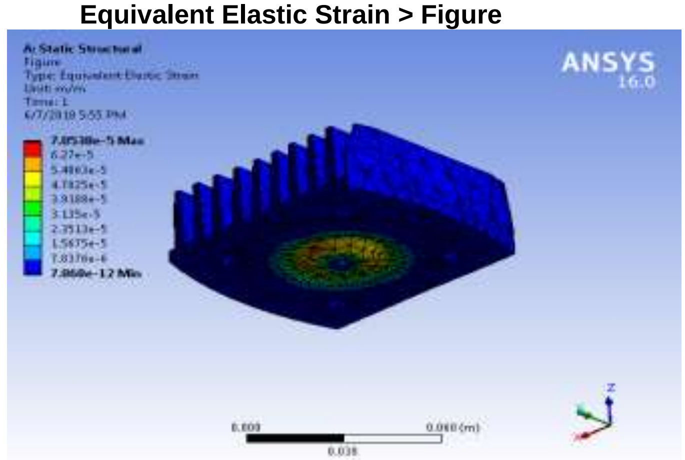
Model (A4) > Static Structural (A5) > Force > Figure



Total Deformation > Figure



Equivalent Elastic Strain > Figure



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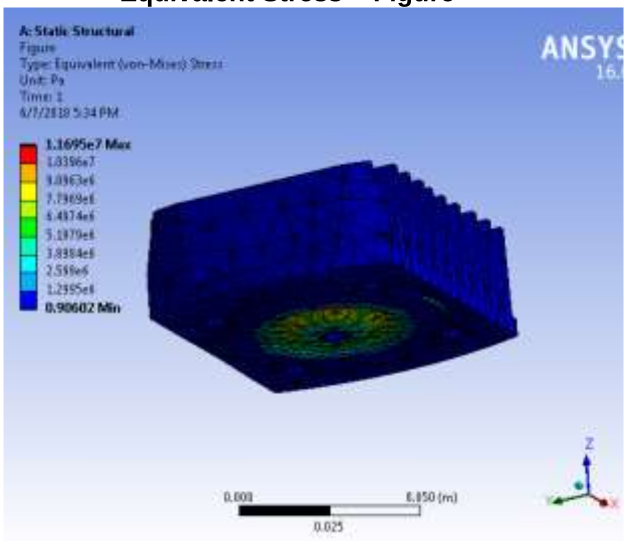
Equivalent Stress > Figure

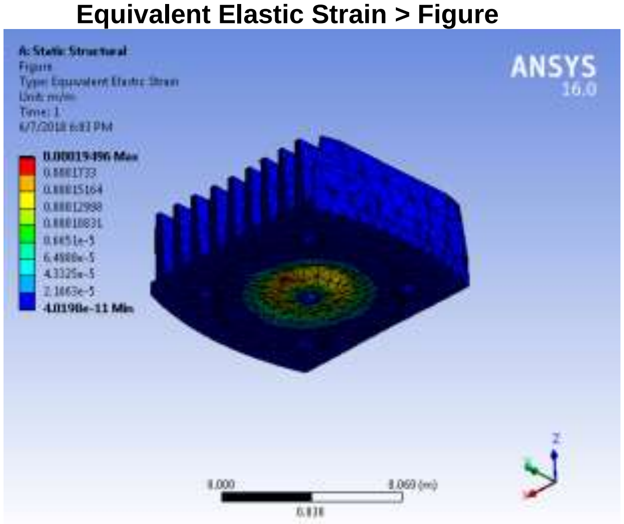


STRUCTURAL ANALYSIS ON 2ND MATERIAL OF CYLINDER HEAD

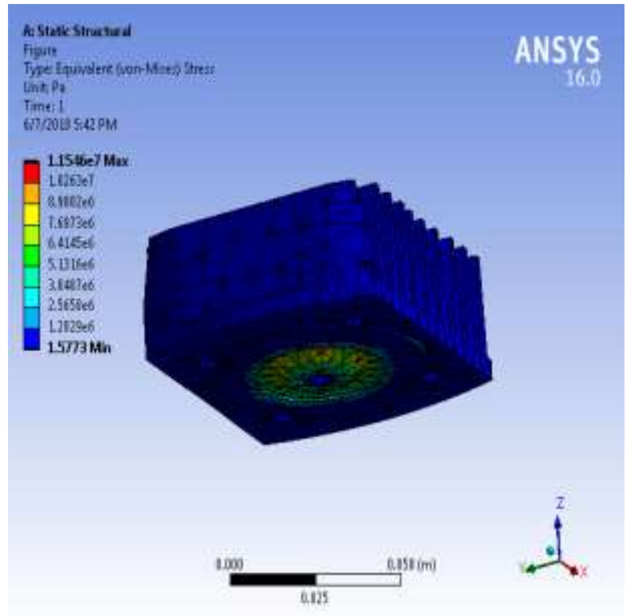
Aluminum Alloy

Total Deformation > Figure

Equivalent Elastic Strain > Figure



Equivalent Stress > Figure



Results table

	STEEL	ALUMINUM
STRESS (PASCALS)	1.169	1.154
STRAIN	7.053	1.949

CONCULSION

In this investigation, structural analyses of the cylinder head highlight several areas of interest. The maximum stress is found not exceeding the material strength of cylinder head, and thus the basic design criteria, namely no yielding and no structural failure under firing load case, can be satisfied. which can be improved in the early stages of

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cylinder head with compared of two materials structural steel and aluminum .

According to this project we do the structural analysis with two materials steel and aluminum. Compared to the both are good in strength to the cylinder head, but steel remaining strength in it and aluminum alloy is some more effected to the force acting on it. So aluminum alloy is the better material to the cylinder head to make it.

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