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Analysis of Master Cylinder of Hydraulic Braking System Using ANSYS

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Abstract: **Braking system is a means of converting momentum into heat energy by creating friction in the wheel brakes. The braking system that works with the assistance of hydraulic principles is thought as hydraulic braking systems. The braking system used most frequently operates hydraulically, by pressure applied through a liquid. In this present work, minimize the weight to increase mileage in case of general road cars and to increase the speed of the vehicle in case of sports cars. Polymers have good elastic properties and are strong enough to use for master cylinder. The use of polymers in the manufacturing of master cylinder reduces the weight of the master cylinder. The master cylinder is modelled in PRO-E and the analysis is carried using ANSYS work bench.**

Keywords: **Pro-E, polymers, ANSYS, cylinder, pressure**

1. INTRODUCTION

The master cylinder displaces hydraulic pressure to the rest of the brake system. It holds the foremost vital fluid in your automobile, the brake fluid [1]. It really controls 2 separate subsystems that ar together activated by the pedal. this is often done so just in case a serious leak happens in one system, the opposite can still perform [2]. The piston chamber displaces hydraulic pressure to the remainder of the brakes. It holds the foremost vital fluid in your automobile, the brake fluid. It actually controls two separate subsystems which are jointly activated by the brake pedal. This is done so that in case a major leak occurs in one system, the other will still function [3]. The two systems may be supplied by separate fluid reservoirs, or they may be supplied by a common reservoir. Some brake subsystems are divided front/rear and some are diagonally separated. When you press the treadle, a push rod connected to the pedal moves the "primary piston" forward within the piston chamber. the first piston activates one among the 2 subsystems. The hydraulic pressure created, and so the force of the primary piston spring, moves the secondary piston forward. Once the forward movement of the pistons causes their primary cups to cover the bypass holes, hydraulic pressure builds up and is transmitted to the wheel cylinders spring, moves the secondary piston forward. When the forward movement of the pistons causes their primary cups to cover the bypass holes, hydraulic pressure builds up and is transmitted to the wheel cylinders.

2. DESIGN CONSIDERATIONS OF MASTER CYLINDER

The basic information about brake system and its master cylinder, function, purpose, working principle, different shape and size of master cylinder, failure considerations has been taken from automotive brake system. The work done by brake system parts manufacturers tells that cost mold brake master cylinder made of cast iron was used universally in all the old car and light trucks and after that there has been increased research done on improving the mileage of the vehicle by reducing the weight. The research made a way to concentrate on reducing the weight of brake master cylinder by changing the materials. The manufacturers came up with new idea of composite master cylinder having integral body made of aluminium and reservoir made of plastic material and thus reducing the weight when compare to cost mold master cylinder made of cast iron .

Pro /ENGINEER (Pro/E) is a program that is used to create precision three dimensional computer models. The 3-D parts created on Pro /E use a technique known as solid modelling, (as opposed to wire frame or surface modelling). Other important descriptors used to classify Pro/E include: feature-based, associative, and constraint (or parametric)-based. Pro /E is a fully parametric CAD program This means that the geometry of features (e.g., holes, slots) on a part have to be fully specified in terms of size, shape, orientation, and location. This specification allows the user to write equations (i.e., relations) which describe how features on individual parts or multiple parts should relate to each other.

Name	Symbol	Units	Dimension
Reservoir outer diameter	D_0	mm	75
Reservoir inner diameter	D_i	mm	69
Thickness of reservoir	T	mm	3
Height of reservoirs	H	mm	88
Cylinder outer diameter	d_0	mm	33.4
Cylinder inner diameter	d_i	mm	25.4
Thickness of Cylinder	t	mm	4
Height of Cylinder	h	mm	148.5

Table 1: specifications for cylinder

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Figure 1: designed model in pro-E

Materials	Young's Modulus (N/mm^2)	Poisson's Ratio	Mass (Kg)	Density Kg/m^2
Aluminium Alloys	70000	0.3	0.355	2710
Polymer	2000	0.28	0.214	946

Table 2: Properties of different materials

The way finite element analysis obtains the temperatures, stresses, flows, or other desired unknown parameters in the finite element model are by minimizing energy functional. Energy functional consists of all the energies associated with the particular finite element model. Based on the law of conservation of energy, the finite element energy functional must equal zero. The finite element method obtains the correct solution for any finite element model by minimizing the energy functional. The minimum of the functional is found by setting the derivative of the functional with respect to the unknown grid point potential for zero. Thus, the basic equation for finite element analysis is:

$$\partial f / \partial p = 0$$

Where F is the energy functional and p is the unknown grid point potential (In mechanics, the potential is displacement) to be calculated. This is based on the principle of virtual work, which states that if a particle is under equilibrium, under a set of a system of forces, then for any displacement, the virtual work is zero. Each finite element will have its own unique energy functional.

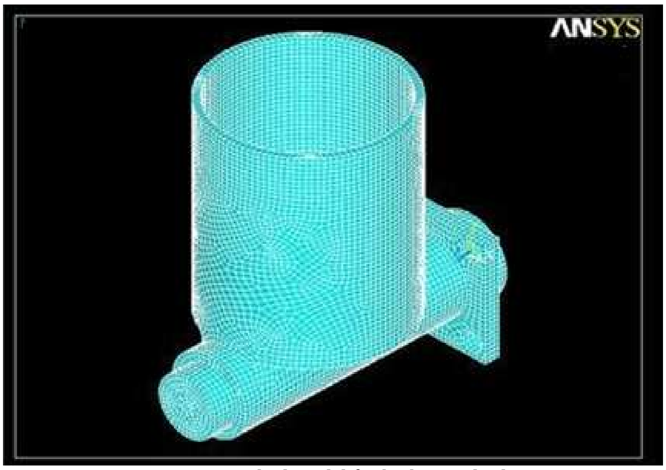

Figure 2: Meshed model for braking cylinder

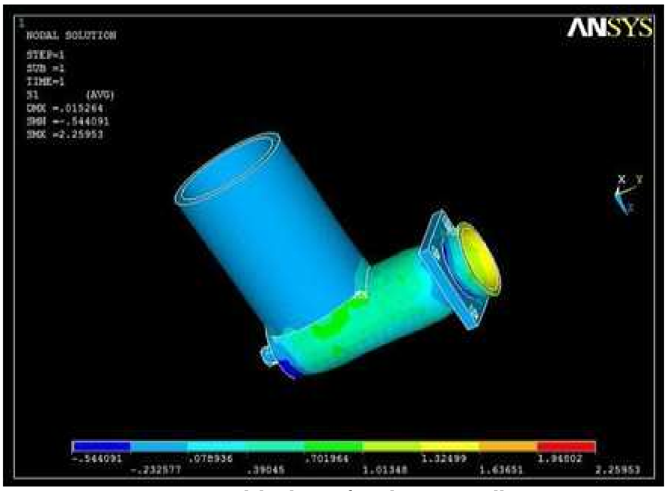

Figure 3: Nodal solution for Aluminium Alloys

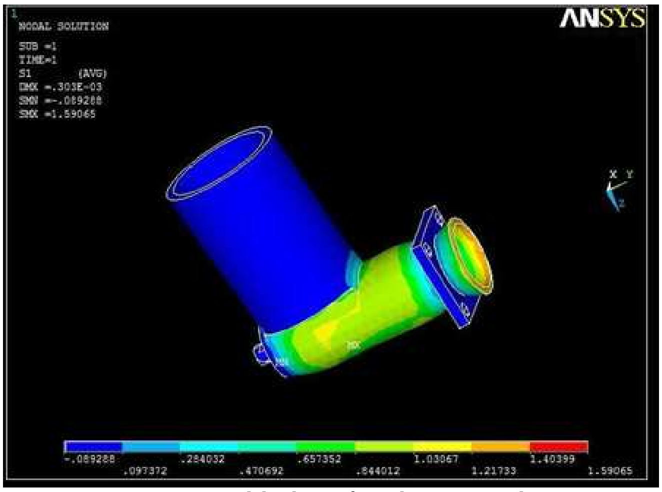

Figure 4: Nodal solution for Polymer material

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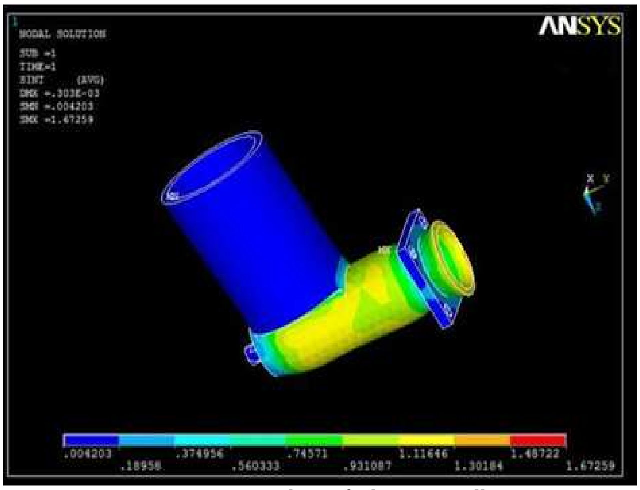

Figure 5: Stress analysis of Aluminium Alloys

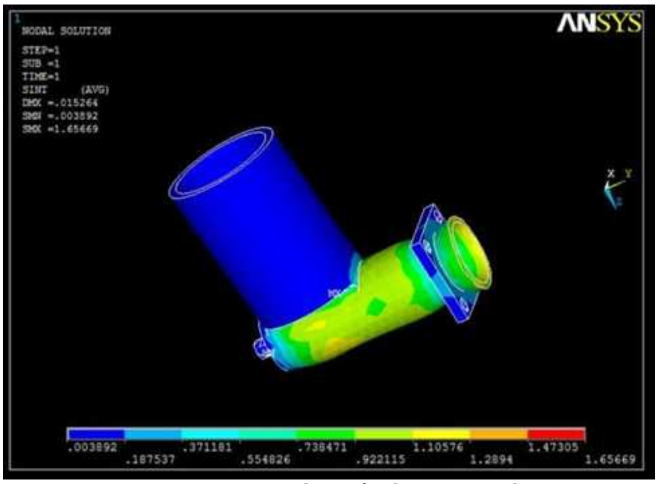

Figure 6: Stress analysis of Polymer material

For a pressure 4.85 N/mm^2, the maximum stress acting on the surface of polymer cylinder is 3.25953 N/mm^2, which is slightly higher than the maximum stress that acts on the surface of aluminium alloys cylinder, which is 2.67259 N/mm^2. Since the maximum stress acting the surface of cylinder is very less compare to the ultimate strength of that material, the polymer material can easily withstand the pressure.

3. CONCLUSION

The weight of cylinder made up of polymer i.e. 0.124 kg is less than cylinder made up of Aluminium Alloys i.e. 0.355 kg. The stress induced in cylinder made up of polymer material is more when compared with that of cylinder made up of Aluminium Alloys material but the stresses induced in polymer cylinder is very less compare to the ultimate strength of that material.

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