MODELING AND ANALYSIS OF DISC BRAKE IN AUTOMOBILES

Hayder H. Khaleel1, Mohammed K. Khashan2, Ali sh. Baqir3

1Engineering Technical College/Najaf, Al-Furat Al-Awsat Technical University, 31001 Al-Najaf, Iraq.
2Najaf Technical Institute, Al-Furat Al-Awsat Technical University, 31001 Al-Najaf, Iraq.
*Corresponding Author Email: aviation_eng88@yahoo.com

Brake system is the one of the most significant components in modern automobiles. Its duty is reducing the speed of the vehicle and stops it. Disc brake changes the kinetic energy of rotating parts (wheels) to the heat and dissipated it to air. In this paper the disc brake is modeled and simulated with specific dimensions and analysis it with Finite Elements software (ANSYS R16.1). Two materials were chosen for the disc brake, the Grey Cast Iron and Carbon-Ceramic. Comparison can be done with temperature distribution, deformation and stress and choose the best material. The results showed the Carbon-Ceramic can withstand the thermal stress and approximately there is no deformation for it. Carbon-Ceramic is preferred for disc brake to achieve better performance.

KEYWORDS

Disc Brake, Grey Cast Iron, Carbon-Ceramic, ANSYS R16.1.
Table 1: Mechanical properties of materials

| Properties                  | Grey Cast Iron | Carbon Ceramic |
|-----------------------------|----------------|----------------|
| Density (Kg/m³)             | 7200           | 1800           |
| Young modulus (pa)          | 1.1e+11        | 9.5e+10        |
| Poisson’s ratio             | 0.28           | 0.31           |
| Thermal conductivity (w/m.c) | 52             | 40             |
| Specific Heat (J/Kg.C)      | 447            | 800            |

The mass of disc brake which is made of Grey Cast Iron is 7.5 Kg while the mass of disc brake with ceramic carbon is 1.8 kg because the carbon ceramic is lighter than grey cast iron. The atmosphere temperature is 22 oc and the disc brake subjected to 90oc caused by frictional force during hard braking.

2. MESH GENERATION

The main objective of the finite element analysis is to analyze the structure, which is a collection of separate pieces named elements, which are connected to each other at a finite number of points named Nodes. The boundary conditions are then applied to these elements and nodes [11]. The mesh process was carried for Grey cast iron as shown in figure 2 with number of nodes 1404836 and number of elements 934867.

Figure 2: The mesh generation for Grey Cast Iron disc brake.

The mesh process was carried for Carbon-Ceramic as shown in figure 3 with number of nodes 1404836 and number of elements 934867.

Figure 3: The mesh generation for Carbon-Ceramic disc brake.

3. RESULTS AND DISCUSSION

The temperature distribution, deformation and stress for two materials were obtained in order to compare between them to choose the better material. The results for two materials as below:

3.1 Grey Cast Iron

The temperature distribution as shown in figure 4, when the surrounding atmosphere temperature is 22o c and the disc subjected to 90oc because of the applied friction force.

Figure 4: Temperature distribution for Grey Cast Iron disc brake. The maximum deformation for Grey Cast Iron is 0.1173 mm as shown in figure 5 below

Figure 5: Total Deformation for Grey Cast Iron disc brake.

The maximum stress according to von-mises theory is 2.4758 (pa) as shown in figure 6 below

Figure 6: The total stress for Grey Cast Iron disc brake.

3.2 Carbon-Ceramic

The temperature distribution for carbon-ceramic as shown in figure 7, when the surrounding atmosphere temperature is 22 oc and the disc subjected to 90oc.

Figure 7: The Temperature distribution for Carbon-Ceramic disc brake.

The maximum deformation for Carbon- Ceramic is 0.0025 mm as shown in figure 8 which is very small value and this is because the carbon- ceramic can withstand high temperature and forces and therefore it is used for high speed and race cars.
The results can be summarized in table (2) below:

| Results                  | Grey Cast Iron | Carbon Ceramic |
|--------------------------|----------------|----------------|
| Total Deformation (mm)   | 0              | 0.117          |
| Stress (pa)              | 5452.9         | 2.4758e+008    |
| Temperature Distribution (°C) | 87.968     | 87.382         |

4. CONCLUSIONS AND RECOMMENDATIONS

The disc brake was simulated and analyzed by using finite elements analyzer (ANSYS R16.1). Grey Cast Iron and Carbon –Ceramic were selected as materials for disc brake. Temperature distribution, total deformation and stress were obtained for both materials. It can be observed from the results the minimum deformation and stress occurred in carbon-ceramic and it can well withstand the high temperature, so it is preferred for manufacturing disc brake to get better performance. For future works, it is recommended to simulate the disc brake with different materials and various temperatures and study the effect of presence holes or cracks on the performance of disc brake.