STRUCTURAL AND THERMAL ANALYSIS OF DISC BRAKE MADE UP OF NYLON 6,6 MATERIAL

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ABSTRACT

This paper aims towards developing a brake that will provide high efficiency, life and low heat generation. The Nylon 6,6 material brake is capable of having high life and elimination heat is fast than the current brake material. The brake must have strong enough to stop the vehicle; this should have more wear resistance. The brakes must be strong enough to stop the vehicle within a minimum distance in an emergency. The driver must have proper control over the vehicle during emergency braking and the vehicle must not skid. Their effectiveness should not decrease with prolonged application, thus it demands that the cooling of the brakes should be very efficient. This compact design is very useful in elimination of heat, have more life and it would replace the present disc brake.

Keywords*:* *Nylon 6,6 material, wear, life, heat elimination.*

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1. INTRODUCTION

We are pleasure to introduce our idea “Disc brake made up of Nylon 6,6 material”. Brake drums must have sufficient strength to resist the mechanical and thermal stresses developed during braking. To satisfy these requirements the drum material should possess a high thermal conductivity, thermal capacity, and low coefficient of thermal expansion, modulus of elasticity, high strength, sufficient hardness and a suitable metallurgical structure. The steady state thermal analysis calculates the effects of steady thermal loads on the brake drum. Transient thermal analysis determines temperatures that vary over time. A transient thermal analysis follows basically the same procedures as a steady-state thermal analysis. The main difference is that most applied loads in a transient analysis are functions of time. To specify time-dependent loads, it can use either a function tool to define an equation or a function describing the curve and then apply the function as a boundary condition, or it can divide the load versus time curve into load steps. Temperatures that a transient thermal analysis calculates can be used as input to structural analysis for thermal stress evaluations.

2. OBJECTIVE

- To increase the life of the brake.
- To increase the efficiency of the brake.
- To increasing the tighter.
- It helps to more resistant to heat.

- And also making it stronger.

3. PROBLEM IDENTIFICATION

- Low life of brake.
- Lower braking efficiency.
- Heat generation in the disc is more.
- Production cost is high
- Due to friction wear becomes high.

4. SOLUTION

- The life of the brake is increased as well as the efficiency.
- Heat generation is extremely low when compared to the current brake materials.
- Production cost is reduced.

5. NYLON 6,6

- Nylon6,6 is a type of polyamide chain are held together using hydrogen bonds, adding to the strength and dexterity of the fibers.
- It forming a more open structure with less internal hydrogen bonding, making it stronger and more resistant to heat.
- This material has high mechanical strength and organic chemicals.
- NYLON6/6 has more than double the strength and stiffness of unreinforced nylon and a heat deflection temperature which approaches its melting point.
- CHEMICAL FORMULA - (C12H22N2O2)n
- DENSITY - 1.15 g/ml
- MELTING POINT - 300' c
- THERMAL CONDUCTIVTY- 0.24 w/(m.k)

6. COMMON APPLICATIONS OF NYLON6,6

- Battery modules
- Bolts and fasteners
- Recreational equipment
- General purpose housings

7. STEEL VS NYLON 66

S.NO	Property	Steel	Nylon 66
1	Hardness (HRC)	106.8	118-120
2	Tensile Strength (MPa)	67-70	85
3	Flexural Yield Strength (MPa)	40	145-310
4	Elongation at Break (%)	13	5-640
5	Melting Point (Celsius)	1470	260
6	Thermal Conductivity (w/m-k)	46	0.53
7	Tensile Modulus (MPa)	240	5500

The above table reveals the important properties of the steel and Nylon66 + Glass fiber / molybdenum disulphide (MoS2) filled. Based on these properties the material is chosen. The properties of the Nylon66 is better than steel except for the thermal conductivity and melting point. Even though thermal conductivity and melting point is low for Nylon66, this does not affect the dimension and function of the disc brake.

8. MATHEMATICAL CALCULATION

Specifications:

B.H.P = 7.6

Bore = 49 mm

Stroke = 56 mm

Crank Radius = 56/2 = 28 mm

Piston Diameter = 48.5mm

Piston weight = 65g (0.065 kg)

RPM = 7500

Torque = 0.8 kg – m

Load calculation:

$$P_m = \frac{B.H.P x 60}{L x A x N'}$$

$$N' = \frac{N}{2} = \frac{7500}{2} = 3750 \text{ rpm}$$

$$= \frac{7.6x60}{56x\frac{\Pi}{4}x48.5^2x3750}$$

P_m = 1.175 x N / mm^2

F_L = P_m x Area

$$F_L = 1.175 \text{ x} \frac{\Pi}{4} \text{ x } (48.5)^2$$

F_L = 2170 N

$$F_I = M_R x \, W^2 \text{ x r} \left(Cos\theta + \frac{Cos2\theta}{n} \right)$$

$$n = \frac{l}{r} = \frac{100}{28} = 3.571$$

θ = 0^0

$$F_I = 0.065 \text{ x } \frac{2\pi x7500}{60} \text{ x } 0.028 \ \frac{1+0.028}{0.100}$$

F_I = 1437 N

Assumption: Engine is mounted Vertically

F_P = $F_2 \pm F_I + W_R$

Assumption piston moves from TDC to BDC

F_p = $F_L - F_I + W_R$

= 2170 – 1437 + (0.065 x 9.81)

= 2170 – 1437 + 0.6377

F_P = 733.64 N

Assumption: Moves from BDC to TDC

F_P = F_L + 1437 + 0.6377

$= 2170 + 1437 + 0.6377$

$= 3607.64$ N

For all practical purposes, the forces in the Connecting Rod (F_C) is taken equal to the maximum force on the piston due to pressure of gas (F_L) neglecting inertia effects.

Maximum force on Connecting Rod

$F_C = F_L = 2170$ N (Neglecting Forces)

$$W_B = \frac{\sigma_C . A}{1 + a\left(\frac{l}{Kxx}\right)^2} N \quad \text{(or)}$$

$W_B = F_C$ x Factor of safety

Factor of safety = 6

$W_B = F_C$ x 6

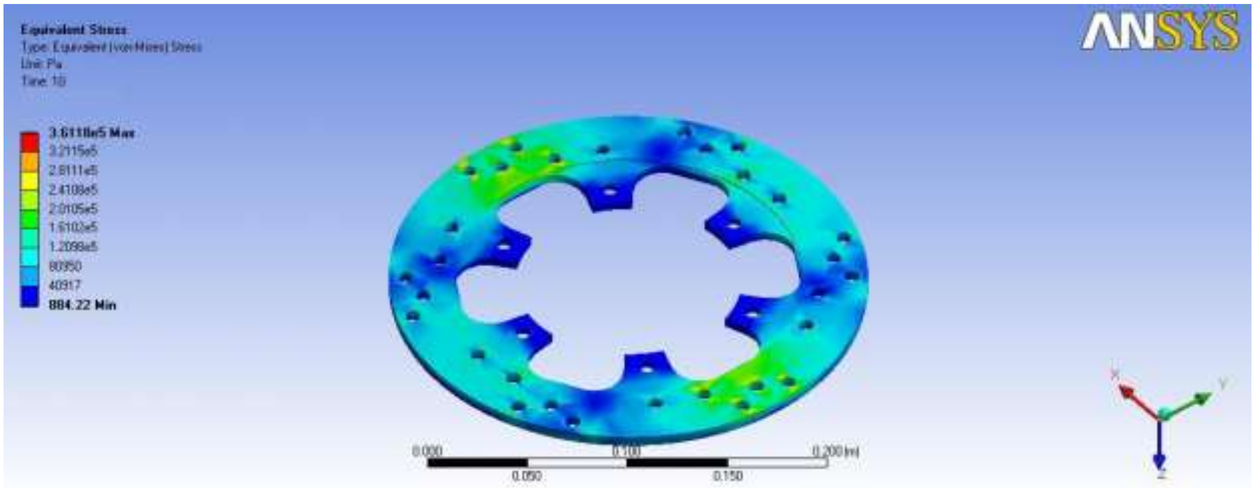
$= 2170$ x 6

$W_B = 13020$ N

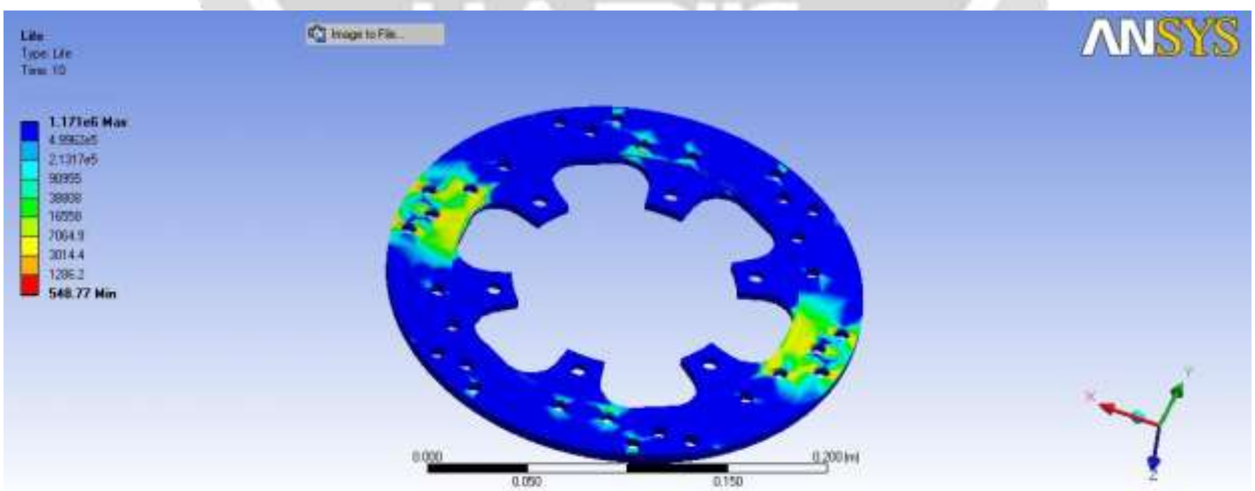
9. DESIGN OF DISC BRAKE

10. ANALYSIS FOR 6mm DISC BRAKE

Equivalent Stress



11. LIFE



12. CONCLUSION

The Structural and thermal analysis of disc brake made up of Nylon 6,6 material is much more efficient than the current brakes. In this analysis particular attention was given to the residual stress simulation for the various thicknesses and for different material brake-disk where problems may arise due to its design. Three-dimensional modeling and meshing using the simulation PRO-E and ANSYS were successfully implemented, allowing for greater flexibility and accuracy in the results achieved. So we suggest disc brakes made of nylon 66 with 6mm thickness has long life.

13. REFRENCE

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