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Effect of Load on Coefficient of Friction between TYRE and Road Surface

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***Abstract:* -- The current situation of world is very cautious about energy sources. So we need to develop technology for saving or reducing the use of these sources. In this experiment, we have studied the importance of coefficient of friction between TYRE of vehicle and road for fuel economy. By experimentation, it is found that increase in weight of vehicle, increases coefficient of friction, which affects on fuel economy. So, for fulfilling these requirements, we have to reduce the load on vehicle TYRE, resulting in decrease in coefficient of friction, increasing performance of vehicle which will reduce use of fuel.**

***Index Terms*—coefficient of friction, fuel economy, static force, weight of vehicle**

I. INTRODUCTION

Now a day, the world is facing energy crisis. Therefore the world is tending towards the use of modified machines with the less fuel consumption or renewable energy sources. Renewable energy sources have very low output/efficiency and a lot much of disadvantages. So we have to turn towards the modification of the conventional systems. For fulfilling this requirement we have studied the relation between load and coefficient of the friction between road surface and tyre surface. So, saving the fuel could be achieved by friction between road and tyre surface.[1]

The friction coefficient plays an important role in achieving the proper performance of the vehicle. This paper illustrates the relation between load and coefficient of the friction between road surface and tyre surface.

In this paper we observed that as load increases the friction between the tyre and road surface increases due to this fuel economy gets decreased and as we decrease the load the friction between the tyre and road surface decreases due to this fuel economy increases.

II. OBJECTIVES

1. To increase the fuel economy
2. To reduce the friction between tyre and road surface by reducing load on the vehicle.

III. WORKING SETUP

The purpose of this experiment is to examine coefficient of friction between road and tyre surface. The two factors that are examined within this experiment are the surface area of the tyre surface and the road of surfaces in contact with one another. Both of these will be tested and compared to see which affects the value of coefficient of friction.

Friction is a force that always opposes the motion of the vehicle. Friction can be divided into two different types. One is called static, and one is called kinetic. Static friction is a force between two vehicles that are not moving relative to one another. For example, the vehicle resting on a slope, but not sliding down the slope, is kept in its position by static friction. Static friction must be overcome to cause the vehicle to move across a surface. Once enough force has been applied to the vehicle, it will begin to slide across a surface and kinetic friction will then act on the vehicle. Kinetic friction occurs when vehicle is moving on the road surface, at that time force will oppose the motion of the vehicle. Both types of friction are described by different coefficient of friction. These values are known as the coefficients of static and kinetic friction respectively. The coefficient of static friction is usually higher than that of kinetic friction. [2]

A small vehicle model was used, this vehicle was attached to a string. This string was threaded over a pulley, which was then connected to a mass hanger. Paperclips were used to add mass to the hanger, increasing the weight of the

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mass hanging on the string, until the vehicle began to slide across the surface of the road.

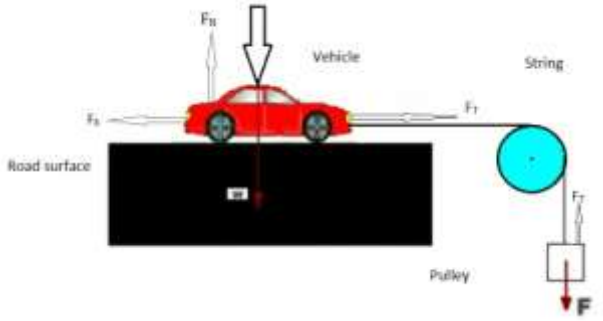

Figure 1Experimental Set Up

In order to calculate the coefficient of static friction, we observe set up and begin by examining the forces acting on the hanging mass. Using Newton's Second Law on the hanging mass, we find,

$$\sum F = F_T - m_h g = -m_h a \qquad (1)$$

F_T is the force of tension in the string, m_h is the mass of the hanger and paperclips, g is the acceleration due to gravity, and 'a' is the acceleration of the hanger. If we assume that the hanging mass is not accelerating, we can solve the above equation for F_T and find the following.

$$F_T = m_h g \qquad (2)$$

Next, we can look at the forces acting on the block resting on the table. Since the forces act in two different directions, we must sum the forces separately. To begin, we can look at the forces acting in the vertical direction.

$$\sum F_y = F_N - (M + m)g = (M + m)a_y \qquad (3)$$

In the above equation, F_N is the normal force acting on the block, M is the mass of the block, m is the mass added to the block, and a_y is the acceleration in the vertical direction. Since the block isn't accelerating in the vertical direction, we can set $a_y=0$ and solve the equation for F_N.

$$F_N = (M + m)\, g \qquad (4)$$

Now, we need to examine the forces acting in the horizontal direction by taking the sum of the forces.

$$\sum F_x = F_T - F_s = (M + m)a_x \qquad (5)$$

Fs is the force due to static friction in the above expression. If we assume that the block only just starts to move and is not accelerating, we can set a_x to 0. Also, since the string attached to the block is the same string that the hanging mass is attached to, we can also assume that F_T is the same for both the block and the hanging mass. Solving the above equation for F_T, we find the following.

$$F_T = F_s \qquad (6)$$

From previous work, we know the equation force due to kinetic friction. It can be seen below.

$$F_s = \mu_s F_N \qquad (7)$$

The value μ_s is known as the coefficient of static friction. We can solve equation 7 for this value and substitute equation 6 into equation 7 to solve for the coefficient of static friction.

$$\mu_s = \frac{F_T}{F_N} = \frac{m_h g}{(M+m)g} = \frac{m_h}{M+m} \qquad (8)$$

This final equation is what we can use to calculate the coefficient of kinetic friction for this experiment.[3]

Where,

Fs = the force due to static friction
μ_s = the coefficient of static friction.
FN = the normal force
g = the acceleration due to gravity

Results and Discussion

Table 1

Sr. No.	Weight of the vehicle (N)	Static force (N)	Coefficient of friction
1	1962	147.15	0.075
2	2943	225.63	0.076
3	3924	304.11	0.077
4	4905	392.4	0.080
5	5886	490.5	0.083
6	6867	578.79	0.085
7	7848	676.89	0.086
8	8829	814.23	0.094

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As we can see in the table, the static force and coefficient of the friction increases with the increase in weight of vehicle. While testing the arrangement we have gradually increased the weight of the vehicle from 1962 N to 8829 N. Then we have observed that initial drag force is increased from 147.15 N to 814.23 N and the coefficient of friction increases from 0.075 to 0.094.

Table 2

Sr. No.	Wt. Of Vehicle (N)	Image	Coefficient of friction
1	200		0.075
2	300		0.076
3	400		0.077
4	500		0.080
5	600		0.083
6	700		0.085
7	800		0.086
8	900		0.092

The graphs are shown bellow. The figure 2 illustrates the relation between weight of the vehicle on X-axis and static force on Y-axis. As we can see in the figure 2, the initial drag force increase with increase in weight of the vehicle.

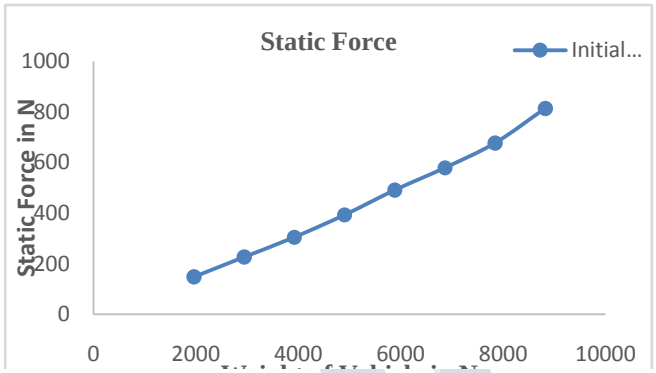

Figure 2 Static Force Vs Weight of Vehicle

The figure 3 indicates relation between weight of the vehicle on X-axis and coefficient of the friction on Y-axis. As we can see in the graph, the coefficient of the friction increases with the increase in weight of vehicle.

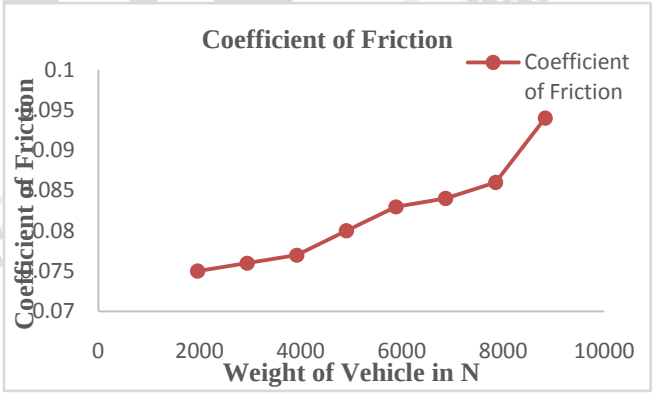

Figure 3 Coefficient of friction Vs Weight of Vehicle

IV. CONCLUSION

We have studied the relations between the weight of vehicle, static force and coefficient of friction. According to results we concluded that as we decrease the weight of the vehicle, the static force required, will be reduced. Therefore we can increase the efficiency of the vehicle and its fuel economy by reducing the weight of vehicle. This will help to increase the life of the tyres because of decrement in the friction between the road surface and tyre surface.

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