Simple harmonic motion are Banking of Road

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Abstract

Simple harmonic motion can be defined as the type of periodic and oscillatory motion, where the restoring force acts in the direction opposite to the displacement of the particle and is directly proportional to the displacement of the particle. As we know, Newton's second law of motion related the force acting on a system and the corresponding acceleration produced by the force. Thus, if the acceleration with which the particle is moving is known, the force acting on the particle can be determined. For an object executing simple harmonic motion, the acceleration of the particle is given by, $a(t) = -\omega^2 x(t)$, as the acceleration of a particle is directly proportional to the displacement of the particle and is opposite to the displacement of the particle. Here, ω is the angular velocity of the particle.\Simple harmonic motion provides a basis for the characterization of more complicated motions through the techniques of Fourier analysis (the definition can be restated as

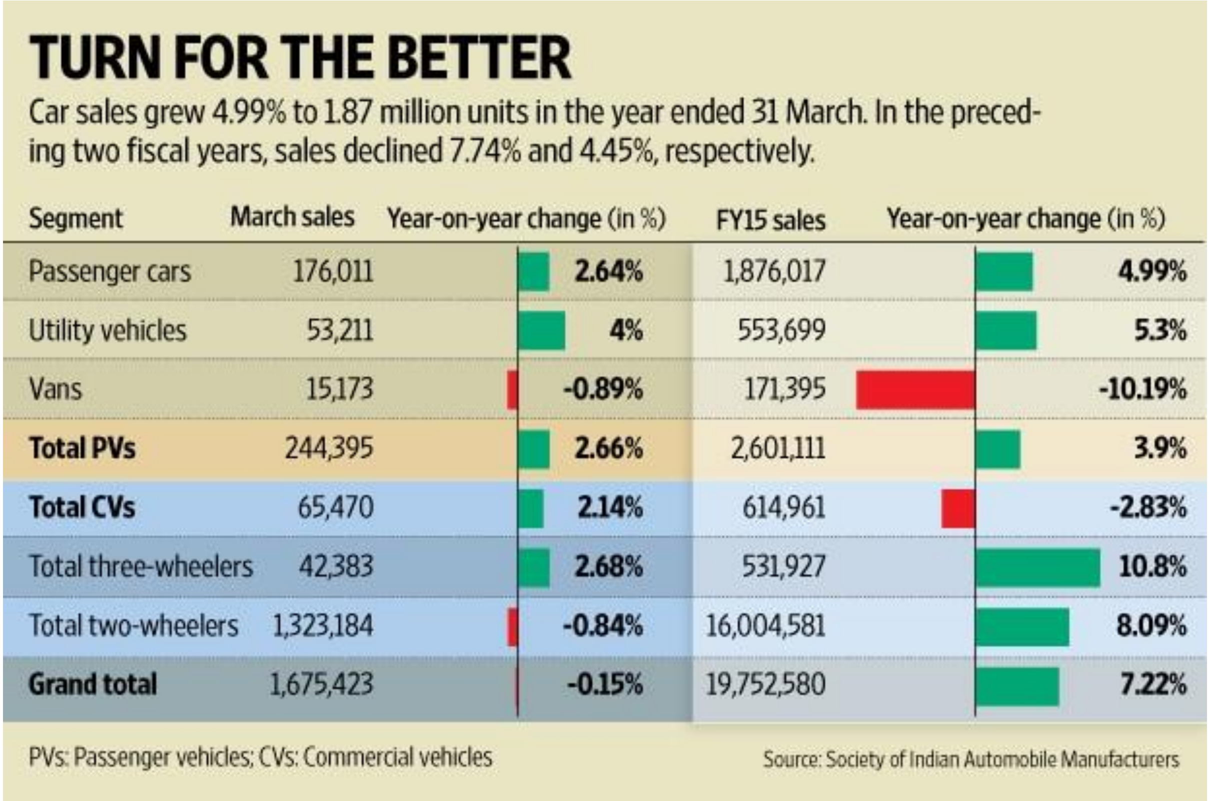
KEYWORDS:-SHM ,Velocity ,Angular displacement ,Coefficient of friction.

Introduction

In mechanics and physics, simple harmonic motion is a type of periodic motion or oscillation motion. Where the restoring force is directly proportional to the displacement and acts in the direction opposite to that of displacement. Simple harmonic motion can serve as a mathematical model for a variety of motions, such as the oscillation of a spring. In addition, other phenomena can be approximated by simple harmonic motion, including the motion of a simple pendulum as well as molecular vibration. Simple harmonic motion is typified by the motion of a mass on a spring when it is subject to the linear elastic restoring force given by Hooke's Law. The motion is sinusoidal in time and demonstrates a single resonant frequency. For simple harmonic motion to be an accurate model for a pendulum, the net force on the object at the end of the pendulum must be proportional to the displacement. This will be a good approximation when the angle of swing is small. Simple harmonic motion

Provides a basis for the characterization of more complicated motions through the techniques of Fourier analysis. The motion of a particle moving along a straight line is called linear motion. The motion of a particle moving along a straight line with an acceleration which is always towards a fixed point on the line and whose magnitude is proportional to the distance from the fixed point is called simple harmonic motion.

Observation of banking of road in form of percentage :



TURN FOR THE BETTER

Car sales grew 4.99% to 1.87 million units in the year ended 31 March. In the preceding two fiscal years, sales declined 7.74% and 4.45%, respectively.

Segment	March sales	Year-on-year change (in %)	FY15 sales	Year-on-year change (in %)
Passenger cars	176,011	2.64%	1,876,017	4.99%
Utility vehicles	53,211	4%	553,699	5.3%
Vans	15,173	-0.89%	171,395	-10.19%
Total PVs	244,395	2.66%	2,601,111	3.9%
Total CVs	65,470	2.14%	614,961	-2.83%
Total three-wheelers	42,383	2.68%	531,927	10.8%
Total two-wheelers	1,323,184	-0.84%	16,004,581	8.09%
Grand total	1,675,423	-0.15%	19,752,580	7.22%

PVs: Passenger vehicles; CVs: Commercial vehicles

Source: Society of Indian Automobile Manufacturers

Literature Survey

Question	radius	angle	gravity	$F_{net} = F_{centripital}$	mg tanθ = mv^2/r	velocity	Answer
1)	r = 50 m	θ = 15º	g = 9.8 m/s^2	$F_{net} = F_{centripital}$	mg tanθ = mv^2/r	V=?	11 m/s
2)	r = 100 m	θ =33º	g = 9.8 m/s^2	$F_{net} = F_{centripital}$	mg tanθ = mv^2/r	V=?	25.22 m/s
3)	r = 125 m/s	θ =75º	g = 9.8 m/s^2	$F_{net} = F_{centripital}$	mg tanθ = mv^2/r	V=?	67.61 m/s
4)	r = 25 m/s	θ = 25º	g = 9.8 m/s^2	$F_{net} = F_{centripital}$	mg tanθ = mv^2/r	V=?	10.68 m/s
5)	r = 60 m/s	θ = 28º	g = 9.8 m/s^2	$F_{net} = F_{centripital}$	mg tanθ = mv^2/r	V=?	17.68 m/s
6)	r = 23	θ = 23º	g = 9.8 m/s^2	$F_{net} = F_{centripital}$	mg tanθ = mv^2/r	V=?	9.78 m/s

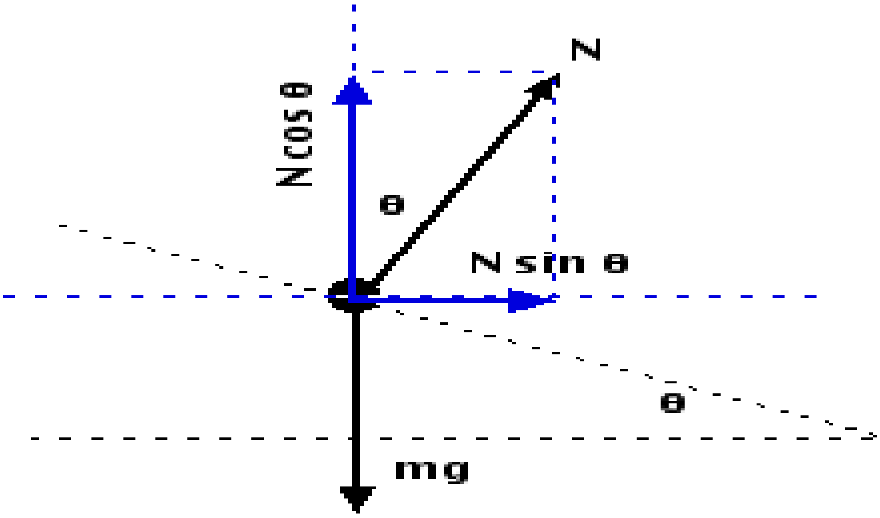


Fig 1: Banking of Road

BANKING OF ROAD IS NACCESSARY

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Skidding

Let us consider the situation in the figure. You are cycling fast on road I. You then want to take a turn to go to road II. However, due to big leak of mobile oil from some truck, the portions of the roads within the area ACBD have become slippery. You do not know about it. You are cycling fast. When you reach the line AC, you turn the handle mounted on the front wheel towards road II. What will happen? Will you be able to take the turn? No, you won't be. Although your front wheel is aligned to go towards road II, you still continue to go straight to road III. This is called skidding. You will skid.

How to avoid skidding

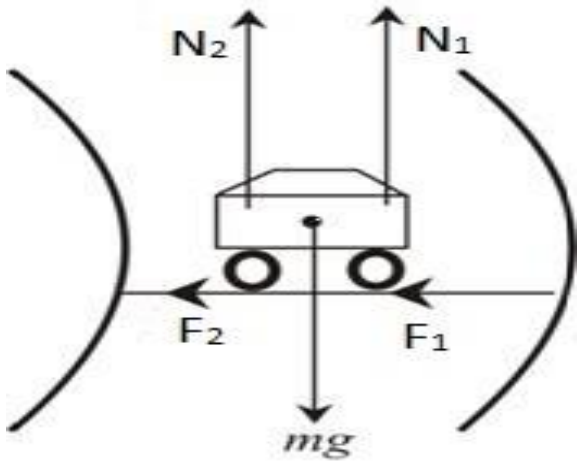

Fig 2:-How to avoid skidding.

Overturning

You may have seen overturned trucks lying on the road. Such heavily loaded trucks! Who could have overturned them!! Overturning occurs on the roads when the trucks try to change directions, take sharp turns. Overturning occurs, more after, in case of vehicles which have greater height or whose centre of gravity are much high up from the surface of road.

APPLICATION OF BANKING OF ROAD

Let's define Banking of Road first. The outer edge of road is raised at suitable angle with respect to inner edge of the road. This kind of arrangement is known as Banking of Road. Radically directed innered force which provides centripetal acceleration along the circumference of the circle is called as centripetal force. This force produces uniform circular motion. So after knowing what the Banking of Road is, we should know the basic concepts regarding it. The basic concepts or the forces which are involved for Banking of Road such as centripetal and centrifugal force.

1) If $\mu = 0$ then find the angle of θ…?

2) If $\mu \neq 0$ then find the angle of θ…?

Case I: If coefficient of friction, $\mu = 0$:-

What we really wish is that even if there is no friction between the tyres and the road, yet we should be able to take a round turn. In the given figure Vertical N cos θ component of the normal reaction N will be equal to mg and the horizontal N sin θ component will provide for the necessary centripetal force. [Please note that as we are assuming μ to be zero here, the total reaction of the road will be the normal reaction.] Frictional forces will not act in such a case.

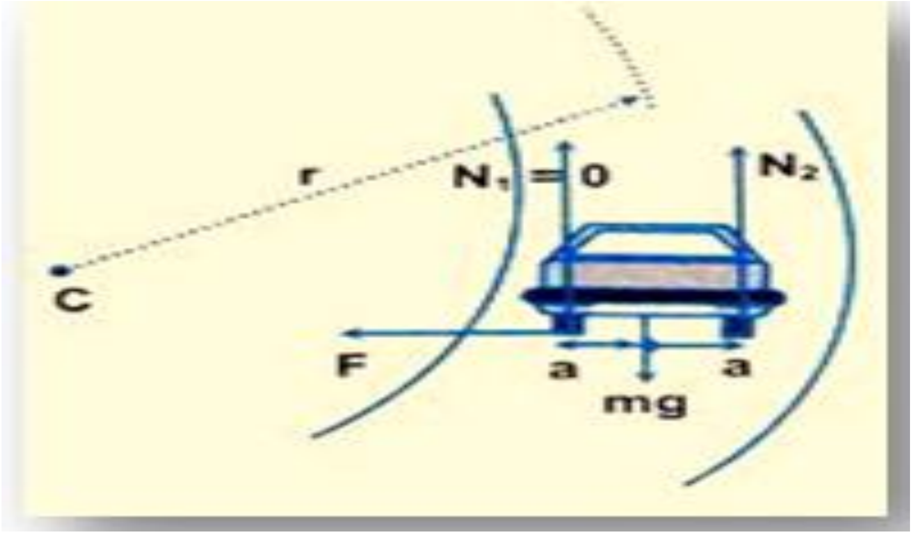

Fig 3:- coefficient of friction, μ = 0

$N \sin\theta = mv^2/r$ .... (ii)

Dividing equation (ii) by (i), we get

$\tan\theta = v^2/rg$

Thus, $N \cos\theta = mg$ .... (i)

$\tan\theta = v^2/rg$

where θ is the angle of banking.

Case - II : If coefficient of friction, μ ≠ 0

In the above figure shows a section of the banked road and the view of the vehicle form the rear end.

vehicle-form-the-rear-end

The total forces acting are,

N_1 and N_2 = normal reactions

f_1 and f_2 = frictional forces

mg = weight

r = radius

θ = angle of banking

Let N = Resultant of N_1 and N_2.

f = Resultant of f_1 and f_2.

Let us resolve all the forces horizontally and vertically. As the vehicle has Equilibrium in vertical direction.

so, $N \cos\theta + f \sin\theta = mg$ .... (i)

The resultant of horizontal components i.e., $(f \cos\theta + N \sin\theta)$, however, this becomes the net external force acting on the vehicle in the radially inward direction of the round-turn. This thus provides for the necessary centripetal force (mv^2/r).

Therefore, $f \cos\theta + N \sin\theta = mv^2/r$ .... (ii)

Further, if μ is the coefficient of friction, we have

$f = \mu N$ .... (iii)

These are the three basic equations from which, we can find out whatever we want to find out.

Putting (iii) in (i) gives

$N \cos \theta = \mu N \sin \theta + mg$

$N(\cos \theta - \mu \sin \theta) = mg$

$N = mg/\cos \theta - \mu \sin \theta$ ....(iv)

Putting (iii) and (iv) in (ii) gives

$\mu \times mg\cos \theta/(\cos \theta - \mu \sin \theta) + mg\sin\theta/(\cos \theta - \mu \sin \theta) = mv^2/r$

$\mu\ mgr \cos \theta + mgr \sin \theta = mv^2 \cos \theta - \mu mv^2 \sin \theta$

Thus, $\tan \theta = (v^2 - \mu rg)/(rg + \mu v^2)$ .... (A)

ADVANTAGES

1. When a vehicle moves along horizontal curved road, necessary centripetal force is supplied by the force of friction between the wheels of vehicle and surface of road.

2. Frictional force is not enough and unreliable every time as it changes when road becomes oily or wet in rainy season.

3. To increase the centripetal force the road should be made rough. But it will cause wear and tear of the tyres of the wheel.

4. Thus, due to lack of centripetal force vehicle tends to skid.

5. When the road is banked, the horizontal component of the normal reaction provides the necessary centripetal force required for circular motion of vehicle.

6. Thus, to provide the necessary centripetal force at the curved road, banking of road is necessary.

CONCLUSION

In this case study simple harmonic motion and its applications. Different applications problems are solved analytically with exact equation of simple harmonic motion. We can calculate the periodic time value of oscillating an object from origin by this method.
And in this case of simple harmonic motion is compulsory for banking of road because
Most of the vehicle are turn to turning point that time how to turn this vehicle that time
Use for banking of road. Banking of road some specific value are provide to curved road and Banking of road.

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