An Approach to Increase Motorcycle Safety by Analyzing Some Factors of Motorcycle and Road Surface

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Abstract: This is a study on motorbike safety by analyzing various factors of a motorbike such as road condition, braking, various weathers and many more. In this paper we have tried to develop the motorcycle safety system by analyzing the causes of accidents and motorcycle dynamics. For doing these we have explained some factors and relate the dynamics of a motorcycle with safety facts. Some Simple mathematical calculations and formulas can be used to reduce the risk of various kinds of motorcycle accident which are considered as major. By analyzing these by mathematics and physics, we have found some points which can be used to reduce the probability of a motorcycle crashes and for saving lives caused by motorcycle crashes.

Introduction

This attitude to risk consists of self-criticism, constant vigilance, perpetual training and practice, and continual upgrading of safety equipment. It is sometimes a reaction to an epiphany. There are many examples of riding advice which enumerate strategies for avoiding danger while riding, but they de-emphasize the rider accepting inherent risk as part of riding, instead emphasizing the rider's agency, based on his education and practice, in determining whether he will crash or not, and the utility of the correct safety gear in whether or not he will be injured in a crash. And this idea can be implemented broadly according to many factors and area. The risk of a motorcycle accident depends on various factors. It may vary region to region. The risk depends on road conditions and on the performance of various motorcycle parts too. These risks can be reduced by analyzing these properties and finding a very accurate value of parameters by using the formulas of physics and mathematics. The values of parameters simply differ from state to state of everything. But those changes of parameters are not our headache. We are developing formulas for controlling and reducing the probability of motorcycle crashes and its variable must differ from state to state and provide different results such as speed limits, tire condition, road slope, friction and many more.

Methodology

Here we have used very vast techniques and methods for our work. We analyzed vast amount of data related to motorcycle accident and each and every parts of motorcycles for getting more perfect results. The performance analysis of motorcycles plays a vital role in our work. There are many categories into motorcycles. Different kind of motorcycles is used for different purposes. And the performance of motorcycles is very uncertain, it depends on various factors. We took a very close view to how each parts of a motorcycle works, what is their capacity, capability, lacks at any certain points and performance. Then we calculated their performance and lacks at many points. The result includes where, when and how a part of a motorcycle can betray and how we can reduce the risks of accidents at every situation. We calculated the expected performance of a motorcycle at various situations like road condition, environment, and psychology of a rider, ages of a rider, weight and many more. We used many formulas for our calculation. The value of parameters of all formulas will be different at different places and situations.

How Brakes Work

Motorcycle Brakes works in such a mechanism that is a little bit harder to understand. For better braking response, one must has a tire with better grip and the road surface always play a vital role here. What is grip? It is the friction. But friction depends on weight. More weight means more friction. The motorcycle tires are made of rubbers. So, more weight means more pushing power. But, more weight means more momentum too. So, we can’t say that, a bike with more weight will stop soon. Because a motorcycle with more weight will take more time to decelerate and to accelerate simultaneously. So, the weight of a motorcycle is
simultaneously responsible for increasing and decreasing the stopping distance. So, for a better stopping distance, a motorcycle needs the more braking power. A motorcycle can be stopped soon if the motorcycle has the ability to use the more braking power means grip to stop with more weight instantly.

When a motorcycle is not running, the center of gravity can be at the midpoint of two wheels. But, it can be any other point for some other motorcycles. The amount of weight on each wheel depends on a number of factors. Using GPS longitudinal acceleration data, approximations can be found that show how the total weight is distributed when the motorcycle is accelerating or braking on level ground. Total weight is distributed between the front and rear wheels of a motorcycle. When the motorcycle accelerates, weight is transferred from the front wheel to the rear wheel. Under braking, weight transfers from the rear wheel to the front wheel.

Understanding the Torque, Power and Gear

Torque is the capacity of any vehicle which defines pulling capacity of the motorcycle. If a motorcycle has much torque at lower rpm (revolution per minute), then it can accelerate very faster. The horsepower indicates actually the top speed of any motorcycle. If a motorcycle has much torque, it means it can accelerate faster. The Power of any motorcycle indicates the capacity of the engine to take the motorcycle to its maximum speed.

Each gear has an effective operating range of speeds which depend on the revolution range of the engine. The faster the engine rotates, the quicker you can go up to the point when you need to change up a gear. Within the operational rotational speeds of the engine, there is a range of optimum efficiency known as the 'power band', and this is where the fastest acceleration can be obtained. Most gearboxes are designed so that when you change up a gear when accelerating, the next gear will be at the start of the engine's power band. This design provides maximum acceleration all the way up to the top speed of the motorcycle.

Braking

On a motorcycle, the major braking power comes from the front for the weight distribution. A very little amount of power the rear brake contributes to almost all regular types of bikes when the rear wheel can be in the air.

Other bikes like cruisers don’t pitch as much on the brakes and the rear wheel will not come off the ground. Thus the rear brake has some braking performance. However, the big share remains with the front brake. The majority riders will lock the rear brake in initial emergency braking drills. This can put the machine out of control and the rider will be required to regulate the rear brake to regain control.

Contribution of rear brake depends on bike. Good training and practice is the best way to understand any motorcycle’s breaking performance, rider’s own reaction times and improve your skill.

Obviously in an emergency time for avoiding crashes anyone must stop the motorcycle as quickly as possible. But, keep a look at your back. Because any vehicle can hurt your motorcycle from the back if they can’t stop the vehicle. Make sure when you have stopped that you are in first gear and ready to get out of the way of any four-wheeled chaos that might come your way. Because any motorcycle can accelerates faster at lower gear.

Stopping Distances

Each and every accident can be prevented if the rider can stop the motorcycle within the expected distance. This stopping distance depends on various facts. It includes road surface, Tire, braking, friction and many more. It also depends on the rider’s psychology too. Rider’s attention plays a vital role here. We just derived a simple formula by analyzing these facts. This formula includes some parameters that cannot work in all road and motorcycles.

The braking distance is the distance that a vehicle travels while slowing to a complete stop. The braking distance is a function of several variables. First, the slope (grade) of the roadway will affect the braking distance. If you are going uphill, gravity assists you in your attempts to stop and reduces the braking distance. Similarly, gravity works against you when you are descending and will increase your braking distance. Next, the frictional resistance between the roadway and your tires can influence your braking distance. If you have old tires on a wet road, chances are you'll require more distance to stop than if you have new tires on a dry road. The last parameter that we will consider is your initial velocity. Obviously, the higher your speed, the longer it will take you to stop, given a constant deceleration. The acceleration of a braking vehicle depends on the frictional resistance and the grade of the road. From our knowledge of the frictional force, we know that the acceleration due to friction can be calculated by multiplying the coefficient of friction by the acceleration due to gravity. Similarly, we know from inclined plane problems that a portion of the car's weight will act in a direction parallel to the surface of the road. The acceleration due to gravity multiplied by the grade of the road will give us an
estimate of the acceleration caused by the slope of the road.

The final formula for the braking distance is given below. Notice how the acceleration rate is calculated by multiplying the acceleration due to gravity by the sum of the coefficient of friction and grade of the road. Here, we can denote:

\[ d = \text{Braking Distance} \]
\[ g = \text{Acceleration due to gravity} \]
\[ r = \text{Roadway grade as a percentage} \]
\[ v = \text{Initial vehicle speed} \]
\[ f = \text{Coefficient of friction between the tires and the roadway} \]

Then the braking distance can be found from the equation:

\[ d = \frac{v^2}{2g(f + r)} \]

If any road has no roadway grade, then the value of \( G \) will be 0.

But, braking distance is not the stopping distance. Because, every human brain takes some time for making decisions. During this time the motorcycle already passes some distance. We must add this distance for calculating our total stopping distance. By using this formula, anyone can find the stopping distance for a motorcycle for individual regions. For getting better results, everyone should check the tire condition regularly. The road surface may be dry or wet. On a wet surface, the friction must be less and stopping distance will be longer.

**Changes in momentum**

Momentum plays a vital role when we think about injuries of a rider. Momentum can be calculated by multiplying the mass and velocity. If we denote the momentum as \( p \), and mass by \( m \) and velocity by \( v \), then we get,

\[ p = mv \]

The more mass and velocity, the more momentum your motorcycle has. And, if the momentum is high during the crashes, the chances of injury are more, low momentum causes less injury. If a rider can decrease the speed of the motorcycle as soon as possible before crashes, the probability of being injured becomes less. It is applicable for each and every crash. If someone will collide with a wall, if the motorcycle has very less momentum, the chances of being injured are less. But, no one can reduce the mass, for this reducing the velocity is the only one way for reducing the momentum. If the mass is less, the risk of injuries is less. Because less mass means less momentum. Though stopping distance depends on the mass indirectly for friction, but in the case of being injured, the act of mass is just opposite.

**8. Turning and cornering**

Cornering and turning is hard to learn, but it’s interesting. Expert riders can do it easily by leaning the motorcycle with body. Because, by doing this, fast cornering and turning is possible. The faster you are travelling, the harder it is to change your bike’s angle relative to the road. Rider can’t lean same on a dry road and on a wet road. If the road surface is wet enough then the friction may be less. A spinning wheel is stable. There is a proportional relationship the speed of the spinning wheel and the stability. A force which is generally called torque is needed for changing the direction, orientation lean or speed of a spinning wheel. Spinning wheels (and crankshafts, sprockets and gears) possess a quantity known as angular momentum which can be calculated by the formula where \( I \) is angular momentum, \( m \) is mass, \( v \) is velocity and \( r \) is the radius.

\[ I = mvr \]

The greater the mass, the radius or the speed of the spinning wheel the greater the angular momentum. The greater the angular momentum, the greater the amount of torque required to initiate a change in direction or lean angle in a spinning wheel. When a torque is applied to a rotating wheel along an axis perpendicular to the rotational axis of the spinning wheel it results in another rotation of the wheel about an axis perpendicular to both the original rotation and the applied torque which creates leaning.

**Calculating the Lean Angle**

The lean angle depends on gravitational constant, radius and velocity. It can be obtained by simple formula where the angle is the lean angle. Let

\[ \theta = \text{the angle} \]
\[ v = \text{the velocity} \]
\[ r = \text{radius} \]
\[ g = \text{gravitational constant} \]

\[ \tan \theta = \frac{v^2}{rg} \]

By this formula, we can say that, the faster you take a turn, you have to lean more. The leaning depends on your motorcycle speed. But, one thing is missing that is friction. If the friction is less, then the lean angle may vary. So, we must consider the maximum static frictional force for finding the
the more accuracy and preventing the motorcycle crashes. These values are normally different for various region and situations. We don’t claim that our analysis is 100% accurate. But we tried our best for making it as perfect as possible. An individual research can be done on each point of this paper. Anyone can extend this work by their new ideas and methods. It can be considered as a short overview on this topic.

9. References