A Review on Possible Causes of Road Accidents and a Solution to Avoid Head on Collision

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I. Abstract:

India has highest frequency of road accidents in world, a report made by National Crime Records Bureau (NCRB) shows that every year more than 130000 traffic collision related deaths occurred in India. During year 2010 there are 5 lakh accidents in India which resulted in 1.3 lakh deaths, unfortunately more than half of victims are economically active age group of 25-65 years. National highway no.6 through Jalgaon city in India is proving to be one of very dangerous highway for traffic conditions. More than 100 accidents occur each year on this highway especially near Jalgaon region causing more than 200 deaths. Majority of these accidents occur between two wheeler and truck. The reason behind this is insufficient width and bad road conditions. To overcome this problem government has approved plan to increase the lanes of highway, but there is problem with land acquisition. This paper presents a design of tunnel system that will divide traffic between two streams, thus avoiding accidents and deaths caused by them, also it will not need widening of highway thereby saving in space required.

II. Introduction

Road traffic fatalities are forecast to increase over the next ten years from a current level of 1.3 million to more than 1.9 million by 2020. The Commission for Global Road Safety believes that the urgent priority is to halt this appalling and avoidable rise in road injury and then begin to achieve year on year reductions. The world could prevent 5 million deaths and 50 million serious injuries by 2020 by dramatically scaling up investment in road safety, at global, regional and national levels [3].

National highway no.6 through Jalgaon city is hotspot of accidents occurring in the region. Majority of accidents on this highway occur between Nashirabad village to Paldhi village. The major victims of accidents are bike riders hit by a truck. The major reason for accidents is bad road condition. The edges of highway are not smooth and are above the base surface this contributes in losing balance of bike riders. Also the road is full of damages and cracks and craters, another contributer to accidents. Again the width of the highway is also not sufficient and is two way, so while overtaking, majority of accidents happen. One possible solution could be to make the highway four lane. Government has approved the plan but there are problems with land acquisition i.e. people are opposing to give their land for the project. As the highway passes through urban Jalgaon city, if this project of widening is implemented, many of important properties nearby the highway would have to be removed and which would draw people’s anger. Another possible solution is to use tunneling system, in which a large rectangular block is used with partition in it, so that a partition is maintained between incoming and outgoing traffic.

III. Review of Literature:

Many articles have been published on road accidents in India and their causes. World Health Organization (WHO) has estimated that traffic crashes will be the third leading cause of loss of life and disability worldwide by the year 2020 [1]. During year 2010 there were 5 lakh accidents in India which resulted 1.3 lakh people, unfortunately more than half of victims are economically active age group of 25-65 years. The “Global Status Report on Road Safety” published by the World Health Organization (WHO) identified the major causes of traffic collisions as driving over the speed limit, driving under the influence, and not using helmets and seat belts. Failure to maintain lane or yield to oncoming traffic when turning are prime causes of accidents on four lane, non-access controlled National Highways. The report noted users of motorcycles and motor-powered three-wheelers constitute the second largest group of traffic collision deaths. Also those accidents cause large loss of property. The Planning Commission in its 2001–2003 research estimated that traffic collision resulted in an annual monetary loss of $10 billion (INR 550 billion) during the years 1999–2000. In 2012, the International Road Federation (IRF) estimated that traffic collision results in an annual monetary loss of $20 billion (INR 1 trillion (short scale) in India.
In India mobile phones and vehicles are increasing at same rate. But with such rapid rate of increase in vehicles, road safety is becoming negligible factor. Following factors are major contributors or causes of road accidents in India and abroad -

- Bad road conditions
- Disobeying of traffic rules by people
- Absence of sufficient amount of roads in order to accommodate large amount of traffic

Thus safety is becoming a negligible concern; unless proper safety precautions are taken we will continue losing precious manpower. So we need to implement some plan to reduce road accidents, some of plans are already been implemented in some parts of world like Montana’s comprehensive safety plan (CHSP) which is implemented in Montana city of USA. The program involves various practices to enforce traffic rules [4]. Also the field of safety improvement should move toward a scientific basis, with knowledge based on sound research studies rather than on conventional wisdom and observation of practice. Recent high-caliber research continues to demonstrate that, in some cases, conventional safety wisdom is incorrect. For example, efforts to provide the driver with a better view of the road in bad weather by providing permanent raised pavement markers were intuitively expected to reduce crash rates, whereas research has shown that this is not necessarily the case for all roadway types [5].

So we need to implement some preventive measures in order to stop the loss of life and property. Some of preventive measures have already been implemented in some parts of world, like traffic highway safety plan that is been implemented in Montana city of USA. They are implementing various methods to enforce traffic rules in order to avoid road accidents [4]. Also American Association of State Highway and Transportation Officials is carrying out various research work in order to know various factors contributing road accidents and their remedies [5]. Thus we need to implement such programs in order to avoid accidents in India.

PROBABLE CAUSES OF ROAD ACCIDENTS:
Following are the probable causes of road accidents observed from various sources like news channels, newspapers and internet source-

- Failure of vehicle components, like tyre bursting, Improper vehicle operation that is brake and steering system
- Vehicle Driver related problems, less visibility, drunk and drive, unskilled driver, over speeding and medical reasons etc.
- Traffic conditions like in india most of metro cities in beginning and end period of working hours heavy traffic jam occurs.
- Bad road conditions, like slippery road, improper material for road, leakage of oil from vehicles, Undeveloped muddy roads etc.

IV. Proposed Roadway Tunnel Design:
The design is as shown in fig. no 1. This system will be used between two points viz. Nashirabad village to Paldhi village. The design consists of large rectangular tunnel block divided in two parts, part 1 and part 2. Anyone of the parts could be used to move away from the city and another part could be used to move towards the city. The tunnel sections are manufactured off the sight and will be assembled on the sight. The base material for the tunnel will be concrete reinforced with steel. The design will maintain partition between incoming and outgoing vehicles, thus avoiding head on collision of vehicles. As complete width of road will be used for one way traffic there will be less number of accidents.

The main challenge to implement this method is that there are two bridges in the path of this tunneling system, one is near shiv colony area and other is on girna river near bambhori village. If such large weight of tunnel is placed on those bridges, they might not be able to sustain it and may get fail. Hence in order to avoid that, cable stays can be applied to the tunnel at place of bridges to carry extra load or also extra supporting members could be used.

![Figure no.1. Main tunnel section](image)

Air ventilations will be provided for proper circulation of air. Also there will be accesses to remove an accident suffered vehicle from the tunnel.

V. Calculations
Considering the central beam of the main section of tunnel from which traffic on upper section will travel. This section will fail due to bending or shear. So to make design safe we must make this section strong enough to carry the load of traffic. The central beam is as shown on figure no. 2
Figure no. 2: Cross section showing the central beam

Considering the central portion of section as fixed beam with uniformly distributed load on it as shown in figure no. 3

Figure no.3 Forces acting on central beam

Considering the load on beam as 18 tonnes which is generally equal to two loaded trucks
18 tonnes = 18000 kg
= 176580 N

Considering the moments acting at both the supports as equal and opposite so they will get nullified and the modified figure will look as follows.

Now resolving forces vertically
\[ \sum f_y = 0 \]
\[ A_y - 1059480 + B_y = 0 \]
\[ A_y + B_y = 1059480 \].................(1)

Now taking moments at point A
\[ 1059480 \times 3 - B_y \times 6 = 0 \]
\[ B_y = 529740 N \]......................(2)

From equations (1) and (2) we get,
\[ A_y = 529740 N \]

Now considering shear force acting on central beam,

Figure no.4. Shear force acting on beam

SF at A = 0
SF at section x-x = 529740 N
SF at section z-z = 529740 - 1059480 = 429740 N
SF at section m-m = -529740 N
SF at B = 0

So maximum shear force will be at joints A and B.

And the shear force diagram is as follows

Figure no.5 Shear force diagram of central portion of beam

Now to find distance X where shear force becomes zero,
\[ \frac{529740}{X} = \frac{529740}{6 - X} \]
\[ X = 3 m \]

Now finding bending moment,
BM at A = 0
BM at C = 529740 \times 3 - 529740 \times 1.5 = 794610 N-m
BM at B = 0

Figure no.6. Bending moment diagram of central beam
As shown in the figure bending moment will be maximum at point C i.e. at the centre of beam, it will be maximum where shear force becomes zero. There is also possibility of failure of structure due to resonance, i.e. when frequency of loading matches with natural frequency of structure. To find natural frequency of structure we need to take following forces into account:

1. Inertia force (m\(\ddot{x}\)) of structure.
2. Restoring force \(K(x+\delta)\)
3. Gravitational force, mg

By D’alemberts principle
\[
\sum (\text{Inertia force} + \text{External force}) = 0
\]
\[
m\ddot{x} + K(x+\delta) - mg = 0
\]
\[
x = 0
\]

Natural frequency of vibrations-
\[
f_n = \frac{1}{2\pi} \sqrt{\frac{K}{m}}
\]

The above equation shows equation of natural frequency, but due to traffic there will be forced vibrations and it is necessary to find amplitude of them. The amplitude of forced vibrations can be found out using following equation-
\[
X = \frac{F_0}{K \sqrt{\left[1 - \left(\frac{\omega}{\omega_n}\right)^2\right]^2 + \left[2 \left(\frac{\omega}{\omega_n}\right)\right]^2}}
\]

We need to design such a structure that can resist the amplitude.

VI. Nomenclature

\(A_y\) = Vertical reaction at point A in Newtons
\(A_x\) = Horizontal reaction at point A in Newtons
\(M_A\) = Moment at point A in N-m
\(B_x\) = Horizontal reaction at point B in Newtons
\(B_y\) = Vertical reaction at B in Newtons
\(M_B\) = Moment at point B in N-m
\(F_o\) = external force acting on structure in Newtons
\(m\) = mass of structure in kg
\(\delta\) = deflection of structure in meter
\(X\) = Amplitude of vibrations in meter

VII. Conclusion:
In this paper review of causes for road accidents and a solution is provided by designing tunnel system to avoid accidents due to head on collision. This would further not require widening of highway. Also this solution does not require removal of agricultural land / properties thereby cost, which is not economical otherwise.

VIII. Acknowledgement
Authors are thankful to the SSBT’s, College of Engineering and Technology, Bambhori, Jalgaon for providing library facility. Authors also would like to thank the staff and colleagues for useful discussions

References


[5] Safety research on highway infrastructure and operations (report- 2008), Transportation research board, Washington DC.