Before And After Impact Study of Accidents on Elevated Roads - Case Study

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ABSTRACT

Road network provides the arterial network to facilitate trade, transport, social integration and economic development. It facilitates specialization, extension of markets and exploitation of economies of scale. It is used for the smooth conveyance of both people and goods. Now days, elevated roads are built to ease the traffic between two points to enhance accessibility and flexibility of operations. Case study represents before and after accidents impact on Panipat-flyover stretch. This study examines the impact of the construction of Panipat Expressway over the traffic scenario of the city. This study presents accident data analysis over a period of 11 years (2003-2013) which includes collection of 5.5 years (Jan 2003- June 2008) data before construction and 5.5 years (July 2008 – Dec 2013) data after construction. The results suggest that increased provision of elevated roads is likely to reduce accidents. Journey and running speed is also improved due to construction of elevated roads. Elevated roads also reduce traffic congestion and conflicts resulting in a safer and more efficient circulation of traffic in the city.

1. INTRODUCTION

The development of roads and highways related infrastructure has picked up significantly in the recent times along with a significant increase in the vehicle ownership and also the number of larger and heavier vehicles on the road network. With the proposed expressway system being gradually completed, a new requirement has risen. Since the roadside developments are high and the land acquisition for new roads would be difficult, one option is the use of elevated expressways constructed above the existing highways. Elevated roads have been proposed to ease congestion on busy roads of the city so that cities can get rid of the huge number of heavy vehicles that congest its roads. Traffic congestion has become synonymous with life in major cities with hundreds of cars being added to the city roads every day. Elevated roads involve "simple connectivity between two parallel stretches for better traffic management". In order to mitigate road traffic congestion, several urban authorities in India have taken up initiatives for construction of flyovers at major intersections. A flyover is meant to support traffic and is constructed to reduce congestion on city roads. They are essential feature of urban road development and they are resorted for 'grade separation' – avoidance of crossings on the same level.

Panipat Elevated Expressway was built to ease the traffic on NH-1 between Delhi and Amritsar The existing traffic on road was extremely heavy and almost reached the capacity of the road. Heavy traffic, mixed city

traffic and congested road crossings created serious congestion. The congested junctions and thick concentrations of industries around Panipat created hurdles in movement of heavy flow of vehicles. This study examines the impact of the construction of Panipat Expressway over the traffic scenario of the city. This study presents accident data analysis over a period of 11 years (2003-2013) which includes collection of 5.5 years (Jan 2003- June 2008) data before construction and 5.5 years (July 2008 – Dec 2013) data after construction.

2 GENERAL ROAD SAFETY SCENARIO IN INDIA

The movement of people and goods is essential to achieving economic growth in a country and improving the lifestyle of its citizens. Moreover, the mobility and safety of any transportation system must be well balanced to realize the maximum benefits from the investments made on building and maintaining a highway infrastructure. Expansion in the road network, surge in motorization and a rising population of a country contribute towards increasing numbers of road accidents, accident related injuries and fatalities and all these factors viz road network, the numbers of registered motor vehicles and the population of India.

With the expansion in road network, motorization and urbanization in the country, the number of road accidents have surged. Road traffic injuries and fatalities have emerged as a major public health concern, with Road traffic injuries having become one of the leading causes of deaths, disabilities and hospitalizations which impose severe socio-economic costs. Road safety is an issue of national concern, considering its magnitude and gravity and the consequent negative impacts on the economy, public health and the general welfare of the people. Today, Road traffic injuries are one of the leading causes of deaths, disabilities and hospitalizations, with severe socioeconomic costs. Expansion in road network, surge in motorization and a raise population of a country contribute towards increasing numbers of road accidents.

2.1 ROAD ACCIDENT STATISTICS OF INDIA

Between 1970 and 2012. Number of road accidents increased by 4.3 times accompanied with 9.5 times increase in road accidents fatalities and 7.3 times increase in the number of persons injured in road accidents in India. [3]

During 2012, a total of 4,90,383 road accidents were reported by all States/Union Territories. Of these, about 25.1 per cent (1,23,093) were fatal accidents. The number of persons killed in road accidents were 1,38,258, i.e. an average of one fatality per 3.5 accidents. The proportion of fatal accidents in total road accidents has consistently increased since 2003 from 18.1 per cent to 25.1 per cent in 2012

According to World Health Organization [4], India leads the world in Road accident deaths. There are 1, 42,485 Number of people killed in India in a year. There is one fatal accident every 3.7 minutes in which 16 people die every hour in India which equals to 390 deaths happening every day.

Common causes are: Speed, Drunken Driving, Low use of helmets, Seat belts, child restraints, lack of enforcement, bad roads. Trucks and

Two wheelers contribute for 40% of these fatal accidents.

Year	Number of Accidents		Number of Persons		Accident Severity*
	Total	Fatal	Killed	Injured	
2002	4,07,497	73,650 (18.1)	84,674	408,711	20.8
2003	4,06,726	73,589 (18.1)	85,998	435,122	21.1
2004	4,29,910	79,357 (18.5)	92,618	464,521	21.5
2005	4,39,255	83,491 (19.0)	94,968	465,282	21.6
2006	4,60,920	93,917 (20.4)	105,749	496,481	22.9
2007	4,79,216	1,01,161 (21.1)	114,444	513,340	23.9
2008	4,84,704	1,06,591 (22.0)	119,860	523,193	24.7
2009	4,86,384	1,10,993 (22.8)	125,660	515,458	25.8
2010	4,99,628	1,19,558 (23.9)	134,513	527,512	26.9
2011	4,97,686	1,21,618 (24.4)	1,42,485	5,11,394	28.6
2012	4,90,383	1,23,093 (25.1)	1,38,258	5,09,667	28.2

Table 1: Total Number of Accidents and Number of Persons Involved in India: 2002-2012

3. CONSTRUCTION OF FLYOVERS ON LARGE SCALE

The increase in urban traffic congestion has become a serious concern. In order to mitigate road traffic congestion, several urban authorities in India have taken up initiatives for construction of flyovers at major intersections. A flyover is meant to support traffic and is constructed to reduce congestion on city roads. They are essential feature of urban road development and they are resorted for 'grade separation' – avoidance of crossings on the same level. India being no stranger to congestion and traffic woes began constructing flyovers as early as '60s. They are built to increase the capacity of roads for accommodation of more traffic by providing additional road space overhead, minimizing the acquisition of built up lands.

In India too road flyovers have been built in large numbers over the past four decades, both on the major highways and in the cities. In order to ease transportation problems, many urban authorities in India have taken up initiative for construction of flyovers at major intersections. The locations for flyovers have been decided based on present day operating

conditions and the traffic impacts of such flyovers.

The scope of improvement of intersection at-grade or widening existing roads is very limited in urban areas. In order to minimize the surface level conflict and to provide a relief to mixed traffic, spatial separation in the form of flyovers is planned at major intersections in the congested cities of India. Flyovers at major urban intersections can be instrumental in reducing traffic congestion and delay. However, in most of the cases a comprehensive planning approach has not been adopted, either due to lack of fund or ignorance about the planning perspective of such proposals. Flyovers have changed the face of urban India and paved way to progress. They have enhanced the network of roads.

4. NEED OF THE STUDY OF IMPACT OF FLYOVERS

Flyover is a bridge constructed along an intersecting highway over an at-grade intersection. It allows two –direction traffic to flow at free flow speed on the bridge. The flyover is one of the methods for solving traffic problems at at-grade junctions on highways including capacity, congestion, long delay and queue length. But there is very less literature available on flyovers. So, there is a need of research work to be carried out on impact of flyovers

4.1 OBJECTIVES OF STUDY

The main aim of this before and after study is to evaluate the accident impacts of the construction of flyover over the traffic situation on NH-1 in Panipat city. Main objective is to

assess the impacts of Panipat expressway on traffic injuries and fatalities on project road in before and after period.

4.2 SCOPE OF THE STUDY

The scope of this study is limited to the study of accident before & after impacts of Panipat expressway but this could be extended to evaluate the impacts of any flyover or improvement in the road condition. In the present scenario of construction of a large number of flyovers and bypasses in the cities through NHDP or by other agencies this study may be beneficial to the working engineers and planners.

5. PROJECT ROAD

Panipat is an industrial city located on the busy NH-1. In recent years, there had been a big increase in the number of vehicles passing through the city. Keeping in view the magnitude of traffic, which was affecting the general life along the national highway; it was necessary to construct such a fly-over. Panipat Elevated Expressway is an Indian elevated expressway located in Panipat, Haryana. Expressway was built to ease the traffic on NH-1 between Delhi and Amritsar .NH-1 connecting Delhi-Panipat-Ambala-Amritsar and going upto Indo-Pak Border. It was opened to traffic on 16 July, 2008. Project road is a part of National Highway 86.000(Delhi side) & 96.000(Karnal side). It is 10 km long. The main 6 lane part of this elevated expressway is in between the Panipat city which lengths 3.6 km. For use by the locals, a separate 2-lane peripheral road with paved shoulders is provided on either side of the access-controlled 6-lane highway. Traffic intensity on this road is

very high. It brought relief to a large number of road users in Panipat and to the people proceeding to Punjab, Jammu & Kashmir and Himachal Pradesh who were earlier facing traffic jams on NH-1. The stretch falls in urban area of Panipat with central portion thickly built up and remaining is having industrial and residential structures on both sides. Land use all among the road is mostly industrial and commercial. The central portion is very intensely built up with several hotels, schools, colleges, police station, hospitals, bus stand etc. Lying on NH-1 between km 86 and km 96, the six-lane expressway was expected to decongest the busy Delhi-Amritsar route. It is India's first BOT (Build Operate & Transfer) project to be completed well ahead of schedule.

6. METHODOLOGY ADOPTED

Various factors are required to evaluate the safety effects of a specific improvement to compare its net benefit to other improvement options as well as to justify its implementation. The typical method of evaluating the safety improvements of a treatment is comparing the crash prevalence associated with the transportation facility before and after the treatment implementation (a before-and after study).

This before-and-after study determined the safety effect of an improvement by comparing the crash rate expected without implementing the improvement with the crash rate observed after the improvement. A hypothesis is set that road improvement reduces road accidents as assumed by road authorities. Appropriate statistical methods are used for testing. The scientific design of "before and after" framework provided basis for analysis data to ascertain the validity of assumption. With and without designs allows the measurement of impacts by comparing. Qualitative and quantitative data is required to test the hypothesis.

7. USE OF BEFORE AND AFTER IN HIGHWAY SAFETY

It is common practice that road sites are modified in order to achieve improvements. Few years after, engineers have to assess frequently whether the safety measures adopted at particular location of road have been really effective in reducing the number of accidents. Before and after evaluations are conducted to assess the safety effectiveness of a given type of improvement or an improvement program as a whole. These studies range from simple before and after comparisons of accident counts to the more complicated empirical approaches.

Before and after data on accidents can be evaluated

- To determine the effectiveness of the safety improvements
- To determine the effectiveness of specific countermeasures and combination of safety treatments in alleviating traffic crash and injury problems
- To perform an economic analysis of the implemented safety treatments.
- To study the effects of road change.

7.1 CHI SQUARED DISTRIBUTION METHOD [6]

It is adopted for comparing accident frequencies and to estimate the effectiveness of improvement made on NH-1 by constructing Panipat Expressway. To do the comparative analysis, Chi Square test is used to check whether the experimental data meet the

allowable deviation from the theoretical analysis.

Let b be the number of accidents before the improvement and a be the number of accidents after the improvement. And the factor C be the control ratio.

$$X^2 = \frac{(a-bC)^2}{(a+b)C} > X^2_{nom}$$

where, X2norm= minimum values of Chi Square at which probability of deviation of laws of accident occurrence after reconstruction P from the laws existing before reconstruction does not exceed permissible values (usually 5%).

If the value of X2 is greater than X2norm , it means change is effective . if the value of X2 is smaller than X2norm it means there is no real change due to improvements. Regression analysis is used for calculating control ratio C which is defined as mathematical measure of average relationship between two or more variables in terms of the original units of data.

Line of the regression passes through the point

$$(\overline{x}, \overline{y})$$

$$Y - \overline{y} = b\,(X - \overline{x})$$

Where

$$b = \frac{\mu_{11}}{\sigma_x^2}$$

And

$$\mu_{11} = \frac{1}{n}\sum_{i=1}^{n} x_i y_i - \overline{x}\,\overline{y}$$,

$$\sigma_x^2 = \frac{1}{n}\sum_{i=1}^{n} x_i^2 - \overline{x}^2$$

8. ACCIDENT DATA COLLECTION

The problem of accident is a very acute in Panipat city due to complex flow pattern of vehicular traffic, presence of mixed traffic along with pedestrians. Information on accidents is received from the police station as FIR (First Information Report). These cover the period of 11 years (2003-2013) which includes collection of 5.5 years (Jan 2003- June 2008) data before construction and 5.5 years (July 2008 – Dec 2013) data after construction. It is found that no work has been carried out on this expressway.

9. ACCIDENT DATA ANALYSIS

Road accidents are a human tragedy, which involves high human suffering. They impose a huge socio-economic cost in terms of untimely deaths, injuries and loss of potential income. I found that no work has been carried out on this expressway. The records covered the period of 11 years (2003-2013) which includes collection of 5.5 years (Jan 2003- June 2008) data before construction and 5.5 years (July 2008 - Dec 2013) data after construction. A detailed study was made of road accidents and comparisons made with results of before and after period. Regression equations were derived which relates accidents to improvement features of the road.

9.1 ROAD ACCIDENT STATISTICS AND COMPARISON:-

There are 1689 total number of road accidents are registered in both police stations from 2003 to 2013 and 1036 accidents occurred on NH-1 stretch (85:00 to 97:00). This represents that

61% of the total accidents registered are occurred on project road. This fraction of 1036 road accidents which occurred on NH-1 stretch (85:00 to 97:00) from 2003 to 2013 includes 510 fatal accidents in which 533 people loss their life and 631 are injured. This shows that approximately 49% accidents are fatal accidents.Table-2 gives the numbers of accidents occurred from 2003 to 2013. There were 586 accidents occurred in the 5.5 years Before period (average 97 accidents per year) , and 450 accidents in the five years after period(average 75 accidents per year). There were 586 accidents in the 5.5 years Before, and 450 accidents in the 5.5 years, After. Thus there were 136 fewer accidents in the After period, an average saving of 22.6 per year, which represents a 23% reduction. In the 'Before' period, there were 283 casualties. In the 'After' period, there were 250 casualties. There has

been an 11% reduction in casualties since completion of the scheme.

	YEAR	TOTAL ACCIDENTS	FATAL ACCIDENTS	PERSON DIED	PERSON INJURED
BEFORE	2003	85	42	42	48
	2004	120	58	58	69
	2005	113	53	55	67
	2006	109	50	53	82
	2007	107	47	48	56
	Upto June 2008	52	25	27	36
	TOTAL	**586**	**275**	**283**	**358**
AFTER	From July 2008	47	21	21	33
	2009	88	40	43	57
	2010	77	45	51	44
	2011	86	46	50	53
	2012	64	34	35	42
	2013	88	49	50	44
	TOTAL	**450**	**235**	**250**	**273**

Table 2: Road Accident Statistics

9.2 COMPARISON OF TOTAL ACCIDENTS OCCURRED:

The following chart gives the comparative profile of total accidents in before and after period.
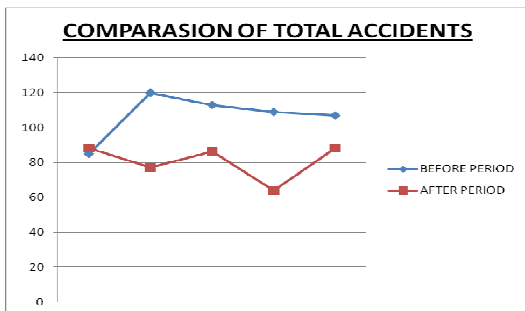

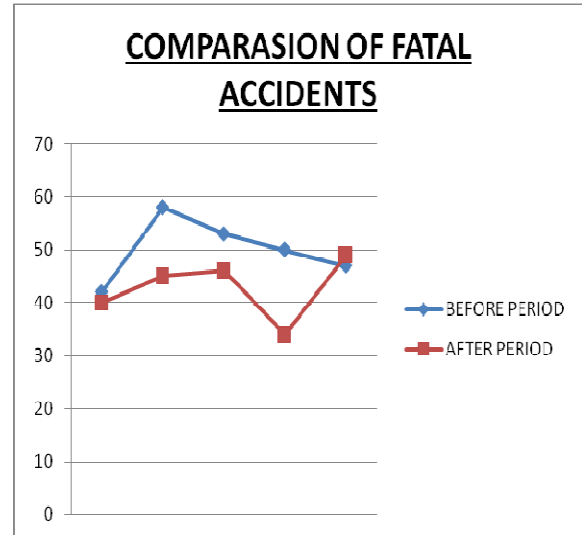**Figure 1**: Number of Total Accidents in Before and After Period

9.3 COMPARISON OF FATAL ACCIDENTS OCCURRED

The following chart gives the comparative profile of fatal accidents in before and after period.

Figure 2: Number of Fatal Accidents in Before and After Period

9.4 COMPARATIVE ANALYSIS OF ACCIDENTS AND PERSONS AFFECTED

The following chart shows the comparative analysis number of accidents and persons affected in before and after period.
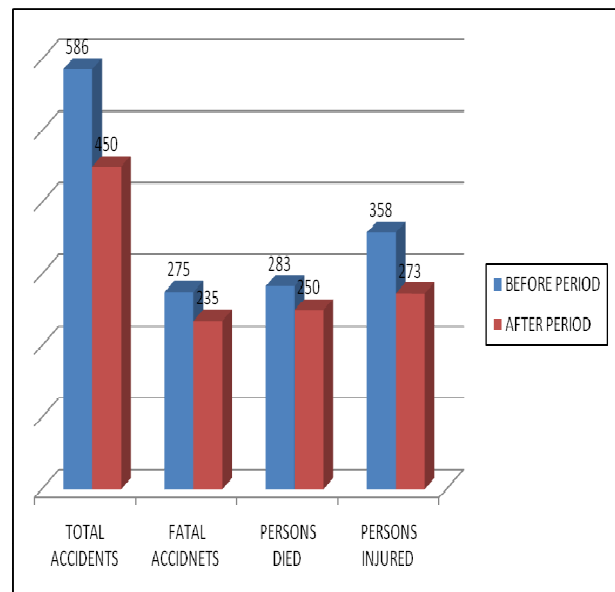
Figure 3: Accidents profile in Before and After Period

9.5 SIGNIFICANCE OF IMPROVEMENT ON TOTAL ACCIDENTS

$$Y - \bar{y} = \frac{\mu_{11}}{\sigma_x{}^2}(X - \bar{x})$$

Solving this, control point C = 1.464

$$X^2 = \frac{(a-bC)^2}{(a+b)C} > X^2_{nom}$$

$\chi 2 = \dfrac{[450 - 586 \times 1.46]2}{(450 + 586)1.46}$

= 10.93

For $\chi 2$ 5% significance level and one degree of freedom = 3.841

As $\chi 2$ (observed) > 3.841, it provides a strong evidence that the improvement was effective and reduction in number of total accidents is not merely due to chance alone.

9.6 SIGNIFICANCE OF IMPROVEMENT ON FATAL ACCIDENTS

$$Y - \bar{y} = \frac{\mu_{11}}{\sigma_x{}^2}(X - \bar{x})$$

Solving this, control point C = 1.02

$$X^2 = \frac{(a-bC)^2}{(a+b)C} > X^2_{nom}$$

$\chi 2 = \dfrac{[235 - 275 \times 1.02]2}{(235 + 275)1.02}$

=3.9

For 5% significance level and one degree of freedom = 3.841

$\chi 2$ (observed) > 3.841

Concluded that difference in fatal accident have reduced due to improvement.

10. CONCLUSION

The following results show that increased provision of elevated roads is likely to reduce accidents. Chi square method provides strong evidence that the improvement was effective and reduction in number of total accidents is not merely due to chance alone.

The number of accidents in the study area fell from 98 per year 'Before', to 75 per years 'After' the scheme, representing a drop of 23%. The change is statistically significant.

The proportion of fatal accidents to the total has increased from 0.469 'Before' to 0.522'After'.

Number of fatalities has been decreased from 45.8 accidents per year to 39.17 accidents per year.

Casualties has been decreased from 283 (47 persons per year) to 250 (41 persons per year),

Persons injuries also reduced   358(60 persons per year) to 273 (45 persons per year)

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