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A Proposal of Foot Over Bridge at Congested Intersection

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ABSTRACT

The motto of this study is to suggest the best possible NMT infrastructure at the intersection having mixed traffic flow along with the heavy traffic leading towards the congestion, delay and accidents. Variety Square, Nagpur has been selected for study purpose, this square is having major landmarks contributing towards continuous increase in the traffic flow and the current infrastructure is up-to-date to meet the today's demand. It has been seen or observed that the non availability of proper NMT infrastructure leading towards the decrease in the contribution of NMT users, Which is indirectly forcing the user to use motorized transportation over NMT? This behaviour is adversely affecting the environment resulting into the increasing carbon footprint, sudden change in environment, pollution, increase in green house gases etc. It is high time now to consider the junction improvement plan as the short term improvement. So, traffic volume study is carried out at the variety square by manual count method.

So, the main objective of this study is to propose the foot over bridge at variety square, Nagpur to eliminate the traffic congestion delay conflict between pedestrian and the moving vehicle and to decrease the accident rate, which will eventually increase the contribution of the NMT users by providing promising safety.

Keywords: Foot Over Bridge, NMT Infrastructure, LOS, Pedestrian Safety.

I. INTRODUCTION

It is very important to provide proper infrastructure for NMT because in last few decades' percentage of NMT users are getting declined and overcome by the motorized transport. As per the pedestrian volume survey maximum numbers of pedestrians were observed at Variety Chowk with almost 31000 pedestrians in a day followed by Jhasi Rani Chowk with almost 26000 pedestrians. The maximum peak hour pedestrians were observed at Variety Chowk with 3200 pedestrians, as shown in Table 1 [1].

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The junction volume counts show that Variety Chowk carry more than 1 lakh pcu traffic in a day and with more than 10,000 pcu during peak hour. The peak hour span varies from case to case basis, however the morning common peak hour recognized as 10.00 to 11.00 while evening peak hour was observed as 18:30 to 19:30 [1].

The traffic level at these junctions has already reached the rage of 7000 to 9000 pcu during peak hour. The situation will become more considerable within a year or two. Based on this, the junction improvement plan can be considered as a part of short term improvement plan. Variety Square is having various landmarks such as Eternity Mall, Sita Bardi Street (Local Vendors, Shops etc.), Bardi Bus Terminal (having 23000 numbers of passenger movement daily, as shown in Table 2.), City Bus-Stop, Zero Mile Metro Station and ongoing construction of Glocal Square. [1]

Table 1 : Pedestrian Volume Count Summary-12 Hrs and Peak Hour [1]

Sl No	Locations	Pedestrian Volume (12 Hrs)	Peak Hour	Peak Hour Pedestrian Volume
1	Badkas chowk, Mangalwari	10938	18:00 to 19:00	1501
2.	Chatrapati Chowk	4404	19:00 to 20:00	512
3.	Cotton Market Chowk	12498	11:00 to 12:00	1345
4.	Dighori Chowk	8063	18:00 to 19:00	923
5.	Golibar Chowk	11309	18:00 to 19:00	1309
6.	Indora Chowk	6089	10:00 to 11:00	612
7.	Jagnade Chowk	6931	19:00 to 20:00	981
8.	Jhasi Rani Chowk	26234	17:00 to 18:00	3082
9.	Kadbi Chowk	2358	10:00 to 11:00	254
10.	LIC Chowk	5066	18:00 tp 19:00	487
11.	Lokmat Chowk	10469	17:00 to 18:00	1062
12.	Munje Chowk	12506	18:00 to 19:00	1434
13.	Nagpur Rly. Station	19530	9.00 to 10.00	2054
14.	Old Pardi Naka	4104	18:00 to 19:00	426
15.	Pancha Sheela Chowk	10922	10.00 to 11.00	1171
16.	S.T. Bus Stand Chowk	9420	17.00 to 18.00	937
17.	Telephone Exchange Chowk	5489	10.00 to 11.00	548
18.	Variety Chowk	31661	16.00 to 17.00	3201

Table 2. : Bus Passenger In and Out Count at Bardi Bus Terminal (12hrs) [1]

Time	Passengers In	Passengers Out	Total
8:00 to 9:00	845	595	1440
9:00 to 10:00	920	636	1556
10:00 to 11:00	1193	763	1956
11:00 to 12:00	1214	632	1846
12:00 to 13:00	1053	683	1736
13:00 to 14:00	1097	614	1711
14:00 to 15:00	792	676	1468
15:00 to 16:00	1185	578	1763
16:00 to 17:00	1433	690	2123
17:00 to 18:00	1269	722	1991
18:00 to 19:00	1800	915	2715
19:00 to 20:00	1475	1083	2558
Total	14276	8587	22863

The grade separated pedestrian crossing (Foot Over Bridge) is an efficient way of improving safety for pedestrians, particularly at a location with high traffic volume or on the corridors with larger width. Busy junctions like Variety Square with minimum 5 arms or more can be provided with well designed circular pathways to ensure safety for pedestrian movement.

II. LITERATURE REVIEW

Arunabha Banerjee, Akhilesh Kumar Maurya [2]: Pedestrians in India are particularly vulnerable to vehicular traffic due to a lack of or poorly managed pedestrian infrastructure and are forced to walk at-grade illegally or use the carriageway, resulting in pedestrian-motorized traffic interactions. Pedestrians account for 22% of vulnerable road user deaths, according to the World Health Organization (2015). Similarly, the majority of pedestrian deaths occurred in Kolkata, followed by Faridabad, according to the N.C.R.B. Report (2015). According to Mohan et al. (2015), Bengaluru, Kolkata, and Delhi accounted for more than 40% of pedestrian fatalities. Grade separation in the form of an overpass or underpass is critical to preventing such disasters and allowing pedestrians free and easy access. Foot over bridges (FOBs) are grade separated pedestrian facilities that enable pedestrians to easily cross from one side of the road to the other without risking their safety. Previous research by Räsänen (2007), Rizati et al. (2013), and Hasan &Napiah (2017) demonstrated that foot over bridges are structures with enormous potential for ensuring high pedestrian protection. Even though the facilities were highly competent to ensure pedestrian safety, Sabet (2013) and Sinclair &Zuidgeest (2016) discovered that encouraging pedestrians to use such facilities was extremely difficult. Räsänen (2007) discovered that familiarity with the region and the ability to save time were significant factors affecting pedestrians' decision to use the bridges in Ankara (Turkey). However, in India, these foot over bridges are built without any consideration of the need for such facilities. The bridges are constructed in areas that are inaccessible to pedestrians, lack proper lifts/escalators, and lack adequate protection. Researchers proposed that security improvements such as CCTVs, the construction of lifts/ escalators, and the elimination of

obstructions would enable pedestrians to use the bridges in order to cope with the current conditions and encourage them to use such facilities. The small number of studies that have been done in India to understand pedestrian movement behaviour over elevated facilities encourages further research in this field. Furthermore, it is critical to research such facilities and develop better design standards in order to enable better designing and planning of future FOBs. The current study looked at pedestrian movement activity across different FOBs and evaluated various parameters such as speed, flow rate, and density for different locations in order to capture the differences between cities.

The study compares pedestrian movement patterns on foot over bridges in four Indian cities with the same land use category (commercial area). The data was collected using videography technique at commercial locations in Kolkata, Bengaluru, Guwahati, and New Delhi on weekdays. The mean and median speed of pedestrians were predicted using the radar charts and box plots based on gender, age, and luggage. The speed variance among the different categories of pedestrians was also studied using probability density functions. Furthermore, a t-test and an ANOVA test were used to see whether there was a noticeable difference between the various pedestrian categories. Macroscopic relationships between speed, flow rate, and density were also plotted. The analysis revealed that pedestrians' average mean speed was higher at Ultadanga (site 1) and ITO (site 4) than at Marathahalli (site 2) and Maligaon (site 3). In addition, for all four locations, male pedestrians were found to have faster median walking speeds than female pedestrians. At all four places, pedestrians with luggage walked at 5-6 m/min faster than pedestrians without luggage, which was anticipated given the land use type of the pedestrian facilities. Furthermore, pedestrians between the ages of 23 and 45 had the fastest walking rates in all of the locations as compared to the other age groups.In contrast to the other sites, the maximum flow rate and density were also found to be highest at site

Khaled Mahmud Rana, Ahmed Sajid Hasan [3] : During the technological revolution, Dhaka, Bangladesh's most densely populated city, experiences rapid economic development, necessitating the use of the city's road network for a variety of purposes. The number of accidents involving pedestrians crossing busy highways to escape foot overpasses and underpasses is steadily rising. As a result, the effectiveness of Dhaka city's overpasses and underpasses in providing adequate pedestrian service is now being questioned. According to the Bangladesh Health and Injury Survey, there were approximately 13,200 confirmed road traffic deaths and 403,000 injuries in the country, with pedestrians accounting for 54 % of the dead. The proportion of pedestrians killed on the road in Dhaka is even higher, at 86 %. Pedestrian deaths account for about half of all traffic accidents, which happen when people are waiting for a bus or walking down the street. Crossing the road without using the foot over bridge or walking on the roads instead of using the foot path are the most common causes of accidents. This research aims to determine the current efficiency of foot overpasses and underpasses in Dhaka, the percentage of male, female, and child users, the reasons for not using overpasses and underpasses, and provide a long-term solution to improve efficiency.The pedestrian traffic at ten major overpasses and underpasses in Dhaka has been studied. Following study, it was discovered that the current efficiency of foot overpasses and underpasses in Dhaka city is about 60%, implying that more than half of all pedestrians use overpasses and underpasses while crossing roads. According to the findings, males account for 66.5 %, women for 25.4 %, and children for 8.1 % of all users. Farmgate overpass has been found to be the most effective, with a pedestrian passing rate of 94 %, while Gulistan underpass has the lowest rate of pedestrian passing at 17%. The majority of pedestrians who avoid and use overpasses believe that the current serviceability of overpasses and underpasses is inadequate. According to this report, 88.45 %, 87.8 %, and 74.9 % of pedestrians stop using an overpass or underpass for a long walk because it takes longer and has a higher step slope. In addition to these issues, 71.8 %, 66.9%, and 58.5 % of pedestrians who use foot overpasses and underpasses, respectively, believe that the current overpass is congested, populated by hawkers, and has low entry excess. Following an analysis of the situation, a proposal for a long-term solution to

improve the performance of the foot overpass and underpass was made.

Md. Sanaullah Shamim, Md. Mahadi Hasan, Md. Alamgir Hossain Mridha [4] : Walking is an ancient method of transportation that is still widely used today for short trips. The majority of road users in developing countries like Bangladesh are pedestrians. The more people on the highways of today's world, the more disputes there will be. Accident threats are rising in Dhaka on a daily basis. The aim of this study is to determine what percentage of people cross the road on foot over bridges or at zebra crossings on Progoti Sarani Road in Dhaka. A questionnaire survey of over 300 pedestrians was conducted for this purpose at various times of the day. To summarise the findings of this study, approximately 85 % of pedestrians agreed that walking over a bridge is healthy. At the same time, it was mentioned that crossing the bridge on foot takes time. When deciding between a foot over bridge and a zebra crossing, about 70% of pedestrians prefer the foot over bridge due to its dependability. To summarise, two-thirds of people decided that both the foot over bridge and the zebra crossing needed to be fixed in order to improve current crossing facilities.

Dhiraj P. Lad, R. D. Patil [5] : A bridge is a structure that allows people to cross a gap or obstacle such as a lane, tunnel, or river. Bridge construction is still a challenge for civil engineers. According to their types and materials, various types of bridges serve different purposes. The pedestrian bridge is one of the most widely used bridges for reducing traffic delays and congestion on highways. Similarly, the foot over bridge is used to avoid collisions with cars or trains. Any mixture of materials, such as concrete, steel, or composites, may be used to build the foot over the bridge. Steel foot over bridges is being used more frequently these days because they provide clean, reliable, and cost-effective results with quick construction. The aim of this paper is to present the detailed definition and working theory of various foot over bridge configurations, as well as current trends in foot over bridge implementation for pedestrians and cyclists. Aside from these issues, numerous issues related to walking across the bridge are also addressed.

Syedah Tabish, Er. Munish Kumar [6] : Walking isn't typically thought of as a means of transportation. This is due to the fact that it does not use cars and is a primary mode of transportation. For short trips, however, walking is the most convenient and reliable form of transportation. People walk for a variety of reasons, including work, shopping, and leisure. Furthermore, every journey must begin and end with a walk. Any trip in a city, whether by bus, car, or train, starts and ends with a pedestrian movement. In India, the percentage of people who walk is very high. Pedestrians are the most vulnerable road users, and they are the ones that are most affected by traffic accidents in cities. The problem of pedestrian fatalities in road traffic accidents, especially at crosswalks, can be solved by complete separation from vehicles through space. These can be accomplished by using stairways, pedestrian bridges, and subways, i.e. foot over bridges and foot under bridges, which are described as vertical or gradient pedestrian movement.

Khatoon, Tiwari and Chatterjee (2013) [7] : Pedestrians on Delhi's streets are often put in danger. This is because pedestrians' basic needs are not taken into account in Delhi's urban transportation infrastructure development projects. Instead, an ever-increasing number of cars and motorised two-wheelers promote the construction of a large number of flyovers/grade separators to allow for signal-free movement for motorised vehicles, putting pedestrians at risk. The statistical analysis of pedestrian risk-taking actions while crossing the road before and after the construction of a grade separator at a Delhi intersection is described in this paper. In both before and after cases, a large number of pedestrians are able to take chances. The findings suggest that in the absence of signals, pedestrians act independently, resulting in greater variability in their risk-taking behaviour. Since the installation of grade separators, the speed variability of all types of vehicles has increased. The waiting time of pedestrians at the starting point of crossing has increased since the grade separator was built, and the connection between waiting times and gaps accepted by pedestrians shows that after a certain amount of time waiting, pedestrians become frustrated and accept smaller gaps

to cross the path. The likelihood of pedestrians crossing the road depends on the gap size between pedestrian and conflicting vehicles, sex, age, number of pedestrians (single or in a group), and type of conflicting vehicles, according to a logistic regression model. The results of the Logistic regression showed that before the grade separator was built, the likelihood of a pedestrian crossing the road was solely determined by the gap size parameter; however, after the grade separator was built, other parameters became more important in deciding pedestrian risk-taking actions.

Limje Mayur, Solanki Dharmendra, Patel Darshan, Patel Neel, Patel Hiren, Chauhan Dixit [8] : A foot over bridge is a pedestrian-only bridge. It can be used decoratively to visually connect two distinct areas or to signify a transaction. Green bridges, which accommodate both pedestrians and cyclists, are an important part of the sustainable transportation trend toward greater sustainability. This project is about evaluating and designing a foot over bridge. Wherever there is traffic, there is a risk of confrontation between pedestrians and moving vehicles. Crossing by foot in our study area, which includes a stretch between Surat Railway Station and Surat Central Bus Station with a high average hourly traffic volume, is not only difficult but also dangerous. Because of these major issues, the aim of this project is to analyse and build a Foot Over Bridge between these two points. As a result, traffic congestion, delays, clashes between pedestrians and moving cars, and accidents will be eliminated.STAAD was used to study the different components of the Foot Over Bridge, including the Main Truss, Columns, and Footings. Manual design yields professional software as well as the most cost-effective and secure parts.As opposed to Reinforced Concrete Structures, the use of steel as a building material has resulted in overall construction cost savings. The components have been engineered for optimum protection, and the structure's adaptability to future changes has also been taken into account.

Hari Nukta Ramadani, HudanRahmani, and AkhmadGazali [9] : Pedestrians are one of the most common causes of traffic accidents.Accidents can be reduced in a variety of ways, including providing road crossing services such as zebra crossings and pedestrian bridge crossings. Unfortunately, such facilities, especially pedestrian bridge crossings, are still underutilised. This situation necessitates determining how to make the most efficient use of the pedestrian bridge crossing. The research site is a pedestrian bridge crossing on PangeranAntasari Road in Banjarmasin City. In general, pedestrian bridge crossings in Banjarmasin are underutilised, despite the fact that this bridge is located in the heart of the city's shopping district, which is clogged with both vehicular and pedestrian traffic. Many variables were supposed to indicate a relationship with bridge use, but none did. One example is the lack of a connection between traffic (speed and flow) and pedestrians crossing pedestrian bridges. This is due to the fact that the traffic platoon and time gap are wide enough for pedestrians to safely cross the lane. When it comes to time, crossing a bridge takes much longer than crossing under a bridge. For pedestrians in Banjarmasin, it appears that saving a little time is more necessary than personal protection. Another reason for the user's apprehension is that pedestrian bridge crossings require less maintenance (are dirty), are often used by beggars, and are less safe due to shielding by sponsoring boards, making pickpockets and other criminals simple to operate. The survey and study methods were used in the research.
According to the findings, a large number of pedestrians do not use pedestrian bridge crossings, with 87% doing so during peak hours and 88% doing so during off-peak hours. Installing a curb railing barrier on both sides of the road is one option for increasing the use of pedestrian bridge crossings (about 200 m).It is important to maintain the condition of the crossing bridge while it is in operation. As a result, regular protection and repair, as well as cleaning, are recommended. Design problems should be prioritised when constructing crossing bridges.Road safety education programmes are required in schools with a fixed studies norm (especially primary schools).For the next pedestrian bridge crossing project, a comparison analysis of pedestrian bridge crossing and other crossing facilities (zebra cross, pelican) in terms of pedestrian performance, expense, traffic impact, and so on is needed.There is also a need for further research into the effectiveness of the crossing bridge after the

implementation of UULLAJR (Traffic Rules on the Highway) Num. 14 / 1992 to see if there is a disparity between before and after UULLAJR.

III. DATA COLLECTION

Survey has been carried out with the manual count method.

This method is used to count the pedestrian flow through a junction, across road or along a road section/ footway manually using tally marking sheet or manual clicker. The survey is conducted from 8 am to 9 pm which includes peak hours and on working days avoiding weekends. Selected area for Study is - Variety Square (Table 3.)

Table 3. Pedestrian Count at Variety Square

Time	Variety Square		
	PH (Pedestrian/Hr)	Effective Width (m)	Average Speed (m/s)
8:00-9:00	1348	2	1.3
9:00-10:00	942	2	1.55
10:00-11:00	831	2	1.7
11:00-12:00	797	2	1.72
12:00-13:00	888	2	1.8
13:00-14:00	641	2	1.83
14:00-15:00	683	2	1.53
15:00-16:00	518	2	1.71
16:00-17:00	585	2	1.76
17:00-18:00	991	2	1.38
18:00-19:00	849	2	1.48
19:00-20:00	653	2	1.67

Calculation

Analysis for determination of Pedestrian Level of Service (Table 4)

Table 4. Calculation of Volume/Capacity Ratio for Variety Square

Time	PH (Pedestrian/Hr)	Effective Width (m)	Average Speed (m/s)	P15 (Pedestrian/15 Min)	Capacity (ped/hr) IRC-103	Flow Rate (ped/sec/m)	Average Space (sq.m/ped)	Vol/ Cap Ratio
8:00-9:00	1348	2	1.3	337	1800	0.187	6.946	0.749
9:00-10:00	942	2	1.55	236	1800	0.131	11.844	0.523
10:00-11:00	831	2	1.7	208	1800	0.115	14.729	0.462
11:00-12:00	797	2	1.72	199	1800	0.111	15.534	0.443
12:00-13:00	888	2	1.8	222	1800	0.123	14.595	0.493
13:00-14:00	641	2	1.83	160	1800	0.089	20.539	0.356
14:00-15:00	683	2	1.53	171	1800	0.095	16.121	0.380
15:00-16:00	518	2	1.71	129	1800	0.072	23.776	0.288
16:00-17:00	585	2	1.76	146	1800	0.081	21.645	0.325
17:00-18:00	991	2	1.38	248	1800	0.138	10.025	0.551
18:00-19:00	849	2	1.48	212	1800	0.118	12.554	0.472
19:00-20:00	653	2	1.67	163	1800	0.091	18.412	0.363

IV. RESULTS AND DISCUSSION

Table 9. Pedestrian Level of Service

Location	PH (Pedestrian/ Hr)	Effective Width (m)	Average Speed (m/s)	P15 (Pedestrian/ 15 Min)	Capacity (ped/hr) IRC-103	Flow Rate (ped/sec/m)	Average Space (sq.m/ped)	Vol/ Cap Ratio	PLOS
Variety Square (Average)	811	2.0	1.619	203	1800	0.113	15.560	0.450	D
Variety Square (Peak Hours)	992	2.0	1.482	248	1800	0.138	11.220	0.551	E

Level of Service for Variety Square has been calculated and found out to be "D" for average pedestrian count and "E" at Peak hours. It indicates that it is already having heavy pedestrian movement and need proper attention to improve the actual conditions.

V. CONCLUSION

To boost the contribution of Non Motorize Transportation it is very important to make sure that user feel safe and comfortable while travelling and that can be achieved by providing proper and developed infrastructure. While studying it has been found out that Level of Service for Variety Square is 'E" at peak hours and it is drastically increasing with the time. Various major landmarks has been constructed around the area such as Eternity Mall, Sita Bardi Street (Local Vendors, Shops etc.), Bardi Bus Terminal (having 23000 numbers of passenger movement daily), City Bus-Stop, Zero Mile Metro Station and ongoing construction of Glocal Square. When Zero Mile Metro Station and Glocal Square will work with 100 % efficiency then it will increase pedestrian count rapidly which will lead towards congestion and delay and may increase the accident rate. It is very important to plan the proper NMT infrastructure because that square is having major station of public transportation having maximum number of start and end trips. As Nagpur Police has already introduced 1 minute only pedestrian crossing signal which is sufficient now but can't meet the future demand. Variety Square is not only having high NMT traffic but also Motorized traffic. So, proper grade separated pedestrian crossing is an efficient way of improving safety for pedestrians, particularly at a location with high traffic volume, Variety Square having 5 arms can be provided with well designed circular pathways (Foot Over Bridge). This will encourage users to use NMT as well as public transport.

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