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A Feasibility Study of Bypass Connecting SH-41 and NH 27-A Case Study of Palanpur City

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Abstract- Due to increase in population and attraction of human activity in urban areas, the demand for road space is becoming greater than the supply. The rate of provision of transport facilities is less than the rate of growth of vehicular ownership, which results into serious effect of traffic congestion. Similar condition is observed in Palanpur City of Banaskantha District. In this City, large part of through traffic and local traffic cause unnecessary slow movement at the intersection of SH 41 and NH 27, which ultimately leads to increase in vehicle operating cost and pollution too. The feasibility study of bypass is carried out and the route of bypass is proposed based on geometric standard and pavement design criteria by IRC: 37-2018. Economic evaluation of suggested bypass is carried out by Net present value method, Benefit/Cost ratio and Internal Rate of Return Method. It is observed form the study that the suggested bypass is feasible to construct for reducing delay, vehicle operating cost and pollution also.

Index Terms - Bypass road, Economic Evaluation, NPV method, B/C method, IRR method.

1. INTRODUCTION

Due to rapid urbanization in the country, the people are migrating towards the urban areas for the better employment and education, which result in the increase of population of the entire area, ultimately leading to rapid growth of surrounded area. Due to inadequate transportation facilities, people use private vehicles, which results in the severe ill-effect on the flow of traffic behavior. Demand for highway travel by people continues to grow as population increases, particularly in the city area. The problem of congestion occurs when traffic demand approaches or exceeds the available capacity of the road system. It does not remain constant because traffic demand may vary significantly depending on the season of the year, the day of the week and even time of the day **(1)**. The effect of traffic congestion of road of design capacity cannot be identified accurately for whole year but its significant effect can be seen on delay, congestion, pollution, discomfort, excessive fuel consumption, excessive vehicle maintenance factors etc. are accounted for economic loss. To solve the problem of traffic affecting the nearby localities, Highway bypass have been beneficial in providing a practical approach for improving levels of service by re-routing through traffic around small cities and towns, which not only increase the employment near the surrounded bypass road but also increase the economic growth of entire area **(2)**. It will provide indirectly benefit to the environment by lesser fuel consumption and less delay on intersection. The construction of bypass needs a very massive amount of investment and it also affects the economy of starting area. Before starting the construction activity, it is required to carry out the the feasibility of suggested bypass. In the present study, the economic evaluation of proposed bypass route is carried out for its viability.

2. LITERATURE REVIEW

Many past studies are referred and important researches are discussed**. [J.L Gaffney, 2017] (3)** Suggested a methodology with the objective to identify the relationships between bypasses and regional centers. Specific areas of investigation included; regional center economies, land development, road safety, social activities and network efficiency. This examination of published literature adds to the method to identify key arguments which explain the relations for and against the development of bypasses adjacent to regional centers **[Trojanoval, 2017] (4)**, evaluated the traffic congestion and selection of appropriate location for investigation analysis (CBA). CBA is a tool which purpose is to determine all impacts (financial, economic, social, environmental and others) of the project and quantify all costs and benefits of the project. For the evaluation of road infrastructure, paramount is the economic analysis, which is not evaluated only through financial flows, but in addition, identification and quantification of societal benefits. By performing the economic evalution the output in the form of IRR is 17 % and B/C ratio method is 1.54, which proves that the project is economically feasible**.[Nayan K. Rabadiya, 2015] (5)**, considered the Nemours parameter to perform the economical evaluation such as traffic volume count, delay, accidental analysis, traffic forecast till 2030, vehicle operating cost etc. The result obtained by performing the economic evaluation using the SP 30

by NPV, B/C ratio and IRR method. B/C Ratio for bypass road 1.34, which is greater than one. Hence, the project is economically justified. The NPV for Bypass road is 186.84 Lac, which are positive and IRR value for Bypass road is 15.00%**. [Mohapatra, 2015] (6)** carried out an economic analysis of the highway projects. A factor of 0.85 had been adopted to convert financial costs into economic costs. The IRR for flyover was estimated to be 15.57%, bridge to be 21.05%, underpass between sector 9 &17 to be 15.05%, underpass between sector 34 & 35 to be 14.14% and underpass between sector 22 & 35 to be 14.16%. The sensitivity analysis also proved the economic viability all the projects. **[Domingos, 2014] (7),** accounted for the true value that the infrastructure asset generates over time through its residual value will allow for a more accurate CBA and NPV. By calculating the residual value through its asset components and using more thorough methods to determine discount rates and project lifetimes, a more accurate RV can be included in CBA. The outcome in of CBA was 1.035 and NPV was 1.76 million $ based on economic viability**. [Pieneer, 2008] (8),** presented cost-benefit analysis for reconstructing the existing road section between Gobabis and Otjinene in Namibia. A cost-benefit analysis was carried out for constructing a new direct road link between Otjinene and Grootfontein, coupled with the road upgrading between Gobabis and Otjinene. The projects expected IRR of 42.3%, which was more than four times the economic cost of capital. The project's B/C Ratio of 5.3 and NPV of N$3.5 billion in economic terms also confirm its desirability**. [M N Murty, 2006] (9),** carried out benefit / cost analysis of Delhi metro train project. Delhi metro provide multiple benefit such as reduction in air pollution, saving in passenger time, reduction in accident, reduction in traffic congestion and fuel saving etc. The financial internal rate of return on investments in the Metro was estimated as 17 percent, while the economic rate of return is 24 percent. Accounting for benefits from the reduction of urban air pollution due to the Metro had increased the economic rate of return by 1.4 percent.

3. STUDY AREA

In the present work, the Aroma circle is selected as a study area, which is provided at the intersection of SH 41 sand NH 27 of Palanpur city. Location of study area and Aroma circle is shown in the figure 1respectively.

The main problem of congestion occurs at aroma intersection due to through traffic movement of heavy vehicles between SH 41, which connect Ahmedabad to Palanpur city and NH 27, which connect Palanpur to various important cities of Rajasthan state. The intersection carries heavy traffic from three different lane as shown in the figure 1 by red and yellow line.

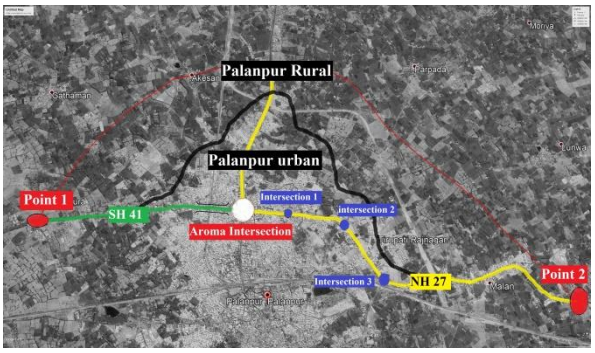

Figure 1 -: Map of study area

Various surveys are carried out at selected route shown by green line and yellow line in the figure 1 for checking feasibility of bypass.

4. DATA COLLECTION AND ANALYSIS

For the study, Videography and manual method is adopted to collect the data for various survey such as classified volume count study, Delay study, Spot speed Study etc. Videography is performed for 24 hours on the intersection of SH 41 and NH 27 to idealize the turning movement of vehicles in different direction for the purpose of knowing the existing traffic condition on stretches in terms of PCU. The procedure and technique adopted for collection of data are followed as per recommendation of IRC. Procedure for genuine data collection is very important to achieve accuracy in results for decision making.

4.1. *Classified Volume Count*

Road classified volume count survey is carried out at study area and at the intersection for 24 hours. It is observed from the extraction of data that the proportion of LCV, HCV and MAV in terms of PCU are very high. The composition of traffic in terms of PCU/day is shown in the Table 1.

Table 1: Total vehicle in terms of PCU/day

Vehicle type	Ahmedabad approach	Abu road approach	Deesa approach	Palanpur approach
2 W	3825	4187	2435	4343
3 W	3850	3246	4331	3014
Car	6290	7448	1863	4034
Bus	1638	2124	1083	1576
LCV	1104	5041	5442	552
HCV	17811	8973	2299	423
MAV	3506	3528	1485	303
Tractor	1082	963	1298	1152
Total	**39106**	**35510**	**20236**	**15397**

Traffic flow is observed for whole day for duration of 15 min interval of time and flow is converted into the veh/hr by multiplying the obtained value with the peak hour factor. The flow data (veh/hr) is converted in PCU/hr. Turning movement of vehicle in different direction at the intersection of SH41 and NH 27 are shown in the Figure 2. The values for converting the vehicles into PCU are adopted from IRC: SP: 30-2009

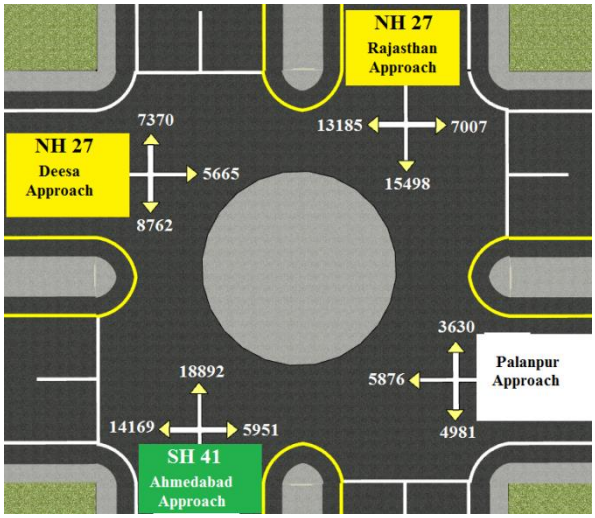

Figure 2 -: Turning movement Count

The vehicle composition is obtained by data extraction from the videography and manual count. The traffic obtained on the intersection of SH 41 and NH 27 is very high and as per the observation. It is seen from the extraction of data that the traffic on the SH 41, which is connecting Ahmedabad to Palanpur is seen to carry the traffic of heavy vehicle due to which, the congestion at intersection is observed. Traffic composition observed at the selected intersection is shown in the Figure 3.

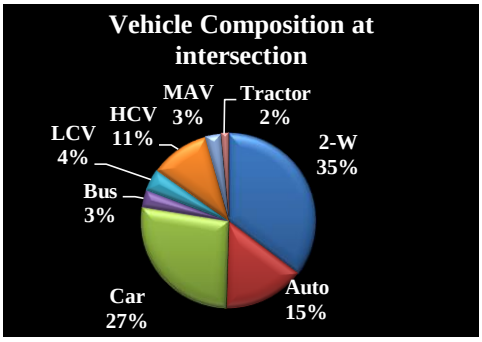

Figure 3: Vehicle composition at intersection

4.2. *Origin Destination survey*

Origin and destination study determines the pattern of a journey that people make. It is the basic study, which provides information for a planning of transportation facility or system for particular location. There are several methods to determine the origin and destination study but according to field condition, road side interview method is used. The drivers are stopped and interviewed at roadside and data are recorded on prepared forms. Data about type of vehicle, Number of person in vehicle, origin and destination of trip, purpose of trip, available routes are collected.

Table 2: Percentage of bypass traffic

No	Vehicle type	City traffic	Bypassable traffic	% of Bypassable traffic
1	MAV	260	192	73.85
2	Trucks	1885	1398	74.16
3	Bus	184	94	51.09
4	LCV	60	34	56.67
5	Car	1279	812	63.49
6	Auto	300	22	7.33
7	2 W	500	78	15.60

By performing the origin and destination survey, it is also found that if the bypass facility is provided, all HCV, MAV users will adopt suggested bypass or not. The samples are collected for Origin Destination survey is equal to 10 % of Average Daily Traffic according to IRC 102:1988 **(10).**

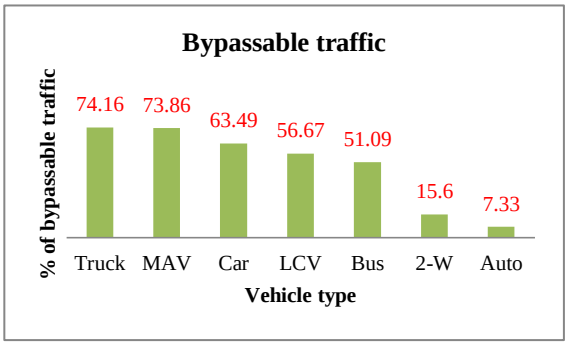

Figure 4: Percentage of bypassable traffic

It is observed from Figure 4 that road users of Truck, MAV, Car, and LCV have given consent for using proposed bypass, which will decrease delay at the intersection.

4.3. *Soil investigation and CBR*

The location of final alignment is finalized based on the terrain condition and levels of Government land available in the vicinity. Considering the proposed alignment, subgrade soil samples are taken to find the value of CBR for flexible design of pavement, which is shown in the Figure 5. After fixing the proposed alignment of bypass, soil samples are collected at 2 km interval to get the value of CBR. .

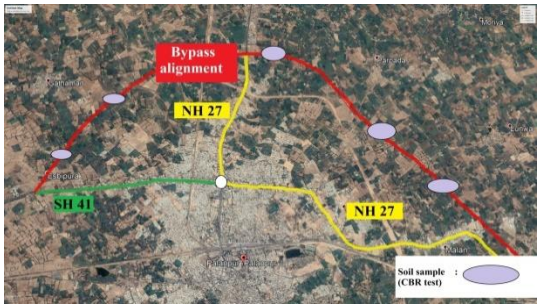

Figure 5: soil sample collection for CBR test on proposed bypass alignment

From the laboratory results, the soil category is of CH type. The value of CBR of subgrade for proposed bypass is 9.15 % **(11)**.

4.4. *Design of flexible pavement*

Based on the performance of existing designs and using analytical approach, the pavement designs have been carried out for subgrade CBR values for 9.15 % and design traffic for 5865 CVPD as per the guidelines of IRC 37: 2012. The important criteria for flexible pavement are discussed **(12)**.

Four lane carriageways is selected based on traffic forecasting.
Initial traffic: 5856 CVPD
Traffic growth rate: 8% (IRC 102:1988)
Design life: 15 years (after construction)
VDF: 4.5 (IRC 37:2012)
Effective CBR of Soil: 9.15 %
Period of Construction: 4 years

$$N = 365 * \frac{(1+r)^n - 1}{r} * A*D*F$$
$$= 79.27 \text{ msa}$$

Based on the result obtained from the calculation, the thickness of each layer is found out according to IRC 37: 2012 **(12) .**

Table 3: Thickness of different layers of road

No	Item	Thickness (mm)
1	BC	50
2	DBM	110
3	Granular Base	250
4	Granular sub base	200
5	Subgrade	500

Four lane divided highway without service road and raised medium is selected based on the future forecasting of traffic for 15 years of duration **(13).**

The cross section for the proposed bypass as shown in the figure 6 is selected based on the geometric design standard criteria obtained from IRC: SP: 84-2010 **(14).**

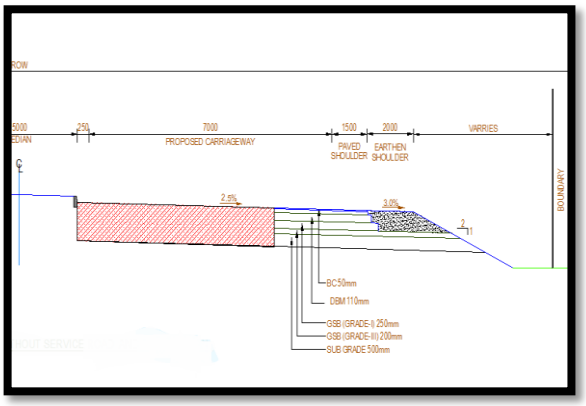

Figure 6: Cross section of proposed bypass road

5. ECONOMIC ANALYSIS

5.1. *Construction cost*

The cost of construction for bypass is shown in the Table 4, which includes the cost of estimation of quantity of materials required in different layers of roads are converted into cost by multiplying the quantity with their respective cost.

Table 4: Item wise cost of construction

No	Item	Unit	Rate	Quantity	Amount
Cost of item A					
1	Land	Sqm	122	459000	**5,59,98,000**
Cost of item B					
1	SDBC	Cum	9500	425	**5,45,06,250**
2	BM	Cum	8580	1190	**10,83,01,050**
3	Base	Sqm	981	2125	**2,81,42,438**
4	Subbase	Sqm	674	3465	**1,91,07,900**
5	Earthwork	Sqm	275	5250	**1,77,18,750**
6	Teak coat	Cum	14	8500	**16,06,500**
7	Prime coat	Cum	33	8500	**3,7,86,750**
8	Labors				**24,56,036**
Total					**23,44,31,888**
Cost of item C					
1	Furnishing cost				**2,92,88,592**
Cost of item D					
1	Physical injury			5%	**1,61,08,726**
2	supervision Charges			4%	**1,28,86,981**
3	Additional charges			3%	**96,65,235**
Total					**3,86,60,942**
Total cost of construction					**72.17 Cr.**

5.2. *Economic Evaluation using SP 30: 2009*

Construction of bypass of four lane road of 13.567 Km road length, being a capital intensive project, requires

economic viability to ensure that the investment made would yield adequate return to the economy of a country in general and public / private investor in particular. The Economic Evaluation for the road under Study area has been undertaken on the stretch connecting SH41 and NH 27 using IRC: SP: 30-2009. Analysis is carried out over duration of year 15 year after the period of construction until 2037.

5.2.1 Traffic forecasting

Traffic forecast is carried out considering growth rate of 8% according to IRC 102:1988 **(10)** for induced traffic from 2019 to 2037. Volume capacity ratio is calculated for different cases **[13].**

- Case 1: Existing Pavement
- Case 2: Exiting Pavement After opening of bypass
- Case 3: Bypass road

5.2.2. Vehicle Operating Cost

Distance-related congestion factor and Time-Related congestion factor equation are used to calculate vehicle Operating Cost for different modes is given in IRC: SP: 30-2009 **(13)**.

Distance-Related congestion factor for car is;
CFD = 1.048 + 0.140 *(V/C)
Time-Related congestion factor for car is;
Vc = 85.140- 0.0091 *Q
Where Q is PCU/hour
Computation of vehicle operating cost for three alternatives is given in below in Table 5, Table 6, and Table 7.

Table 5: Vehicle operating cost for Case 1(in lakh)

Year	Car	Bus	HCV	MAV	LCV	2w	Total
2019	484	151	928	423	157	306	2451
2020	528	167	1049	478	174	334	2732
2021	578	185	1191	582	194	365	3058
2022	637	205	1361	619	216	401	3438
2023	679	228	1570	711	242	440	3891
2024	768	254	1735	790	273	486	4307
2025	849	283	1918	876	308	538	4774
2026	942	317	2122	973	349	600	5305
2027	1051	347	2304	1057	394	673	5828
2028	1180	378	2488	1141	447	750	6387
2029	1328	414	2687	1233	512	810	6986
2030	1435	454	2902	1331	553	875	7552
2031	1550	493	3134	1438	597	945	8159
2032	1674	533	3385	1553	645	1020	8812
2033	1807	575	3656	1677	697	1102	9517
2034	1952	621	3948	1811	753	1190	10278
2035	2108	671	4264	1956	813	1285	11100
2036	2277	725	4605	2113	878	1388	11988
2037	2459	783	4974	2282	948	1499	12948

Similarly, for Case 2 and Case 3, the roughness value are found out by assuming the rise and fall of 0 mm and roughness value of 2000 mm/km, which are provided by the state R&B Palanpur department.

Table 6: Vehicle Operating cost for Case 2(in lakh)

Year	Car	Bus	HCV	MAV	LCV	2w	Total
2019	484	151	928	423	157	306	2451
2020	528	167	1049	478	174	334	2732
2021	578	185	1191	542	194	365	3058
2022	634	205	1361	619	216	401	3438
2023	168	61	171	84	59	251	797
2024	181	67	188	92	64	271	866
2025	196	73	207	101	70	293	943
2026	212	80	228	112	76	317	1028
2027	231	88	252	124	83	342	1122
2028	250	96	279	137	90	369	1225
2029	272	106	310	152	99	399	1340
2030	296	116	344	169	108	431	1467
2031	322	128	384	189	119	469	1613
2032	351	141	429	211	131	510	1775
2033	382	156	480	237	145	556	1958
2034	417	172	540	266	161	606	2163
2035	456	190	610	300	178	662	2400
2036	499	211	693	341	199	724	2669
2037	547	234	792	389	222	798	2980

Table 7: Vehicle Operating Cost for Case 3(in lakh)

Year	Car	Bus	HCV	MAV	LCV	2w	Total
2019	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0
2023	331	83	745	302	103	44	1612
2024	360	91	811	335	112	47	1758
2025	391	99	885	371	121	51	1920
2026	425	109	967	412	130	55	2100
2027	462	120	1057	459	141	60	2301
2028	503	132	1159	512	154	65	2527
2029	548	146	1276	572	169	71	2784
2030	597	161	1432	642	187	78	3099
2031	652	178	1612	722	207	85	3459
2032	713	187	1823	816	230	93	3875
2033	781	218	2074	927	259	102	4361
2034	857	242	2375	1060	286	113	4935
2035	942	269	2718	1212	321	125	5589
2036	1040	300	3000	1342	361	138	6184
2037	1151	335	3317	1489	408	154	6856

5.2.2 Computation of Net present value (NPV), Benefit-cost ratio (B/C) and Internal Rate of Return (IRR)

The Internal Rate of Return is calculated using the standard procedures like trial and error method. Both cost and benefit are discounted at different rates till both are balance in trial and error method. For the calculation of NPV and B/C, the value for discount

rate is considered as 12 % as recommended by Planning commission **(13).**
All the obtained results as shown in the table 8 are forecasted for the total duration of 19 years including 4 years for the period of construction **(13).**

Table 8: Result of Economic Evalution

	Existing road Case 1 (Lakh)	**Existing road after bypass road Case 2 (Lakh)**	**Bypass road Case 3 (Lakh)**
Construction cost	2383.5	2383.5	**7217**
Maintenance cost	23.67	23.67	**30.60**
VOC	129529.46	36035.52	**53369.04**
NPV			**5978.06**
B/C			**1.82**
IRR			**22**

6.0. CONCLUSIONS

Followings are the conclusions made from the present study.

1. Excess delay and fuel consumptions is found at the Aroma intersection of Palanpur city. It results into queue length of 1 km from the intersection.
2. It is required to proposed bypass for connecting SH-41 and NH-27A to minimize the excess delay and fuel consumption.
3. It is also observed that maximum commercial vehicles originated from U.P., Rajasthan and moving towards Mumbai. It consists of maximum share of all vehicles.
4. The B/C Ratio for bypass road is 1.82, which is greater than one, hence, the proposed bypass is economically justified.
5. The NPV for bypass road is 5978 Lac, which is positive; hence, the proposed bypass is feasible in terms of economic viability.
6. The calculated IRR of proposed bypass road is 22.00%, which also indicates that the proposed bypass is justifiable.

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6. REFRENCES

[1] Ajay B. Mankadi, Nimmy Lancelot and Thomas Jacob **2015**," Elucidation of traffic congestion at Seematti Roundabout Kottayam", Research Gate, B tech Thesis.
[2] Amudapuram Mohan Rao and Kalaga Ramachandra. **2012,** " Measuring urban Traffic Congestion-A Review", International Journal for Traffic and Transport Engineering, Vol. 2. 286 – 305.
[3] Jack Logan Gaffney, Jonathan Michael Bunker and Les Anthony Dawes. **2012,"** An Investigation into the Need for highway Bypass Development", Auckland, Australasian Transport Research.
[4] Trojanova, Martina Margorinova and Maria. **2017,"**Cost Benefit Analysis: Bypass of Presov City", MATEC Web of Conferences. 00116.
[5] Nayan K. Rabadiya and Prof. Dr. L.B. Zala. **2015,**" Economic Evaluation of Town Bypass: A Case Study of Nakhatrana", International Journal for Scientific Research & Development.
[6] Mohapatra, Dr.Dipti Rajan. **2015,"** An Economic analysis of Improvement of Road infrastructure: A Case Study", European Academic Research, Vol. 2. 2286-4822.
[7] Heather jones, Filipe Moura and Tiago Domingos. **2014,"**Transport Infrastructure Project Using Cost Benefit Analysis", Elesevier,400-409.
[8] Pieneer, WJ. **2008,"**Economic Evalution of the Proposed Road Between Gobabis and Grootfontien,Namibia", South Aferican Journal of Economics, Vol. 76, OX4-2DQ.
[9] MN Murty, Dhavala, Kishore Kumar,Ghosh, Meenakshi and Singh, Rashmi. **2006,"** Social Cost-Benefit Analysis of Delhi Metro", Research Gate.
[10] Traffic Studies for planning Bypass around Towns. IRC 102:1988, Indian Road Congress, New Delhi, 1988.
[11] Manual for Survey, Investigation and prepairation of Road Survey, IRC:SP:19-2001, Indian Road Congress, New Delhi, 2001.
[12] Guideline for the Design of Flexible Pavement . IRC 37:2012, Indian Road Congress, New Delhi, 2012.
[13] Manual of Economic Evalution of Highway Projects in India, IRC:SP:30-2009 , Indian Road Congress, New Delhi, 2009.
[14] Four Laning of Highway through Public Private Partnership Maual of Standard and Specification, IRC:SP:84-2010, Indian Road Congress, New Delhi, 2010.