Economic Feasibility and Efficient Project Scheduling of Fly-Over in Visakhapatnam (India)

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Abstract

Construction of flyover in major cities due to heavy traffic is very essential in the present day scenario in order to reduce fuel consumption, accidents and travel time. It is also important to schedule the construction duration efficiently. In the present paper an economic feasibility of a flyover in Visakhapatnam (India) between Maddilapalem and Satyam junction is carried out. Based upon the benefits acquired and construction cost of the flyover, feasibility study has been done. Then, the flyover construction scheduling is carried out through different stages of construction. The construction period and cost of construction is worked out for two different stages of construction. A database prepared for construction manager to decide between economy and duration of the project.

Key words: Flyover construction scheduling; Economic feasibility; cost-benefit analysis

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INTRODUCTION

In the present day, the transportation system is an important component of the infrastructure, which is essential in the development of any country. Construction management is a highly specialized task to achieve project with a minimum of elapsed time, capital investment without delay.

This involves three phases: Project planning, Project scheduling and Project controlling. The first two phases are accomplished before the actual project starts. This third phase is operative during the execution of the project. The aim is to recognize the difficulties during execution and to apply the measures to deal with those difficulties.

Project planning is the most important phase of construction management, which involves tasks, must be performed in the estimations of costs, durations for various jobs, direction and uniformity of the work. Project scheduling depends upon available resources and man power, and equipments. Project controlling is organizing, decision making and the skill to solve problems occurred during construction time. This is the normal or casual mechanism to determine deviations in planning.

ESTABLISHING THE STUDY METHODOLOGY

The realization of highway projects involves large capital. The features being permanent need a thorough analysis for technical and economical feasibility. Scarcity of resources and computing demands from various sectors are dominating features for an economy like India. In order to allocate the available resources in the most beneficial manner, a systematic economic analysis is outmost importance. Over the years, a scientific methodology has been evolved to evaluate highway projects, keeping in view the changing economic parameters. The methodology is explained in the Fig1.

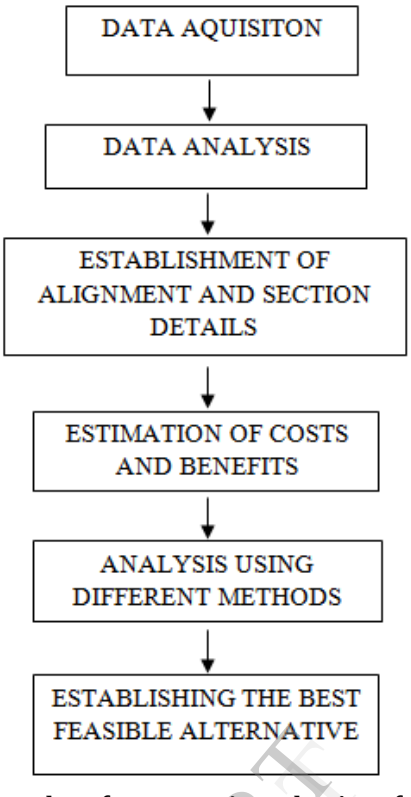

Fig1: flow chart for economic evaluation of the project.

DATA COLLECTION AND ANALYSIS

The traffic data is essential to know the magnitude of travelers who are going to use the fly-over once it is constructed [1]. The traffic data is also essential to determine both the technical and economic feasibility of the flyover. Maddilapallem junction and satyam junction, both are four road junctions where the proposed flyover will take off from NH-5 from satyam junction to maddilapalem junction by covering both the junctions (Fig 2). The details of the traffic data collection and preliminary analysis are presented in the subsequent articles. The flow of the traffic between these junctions is shown in the Fig 2 by passenger car units (PCU) per day.

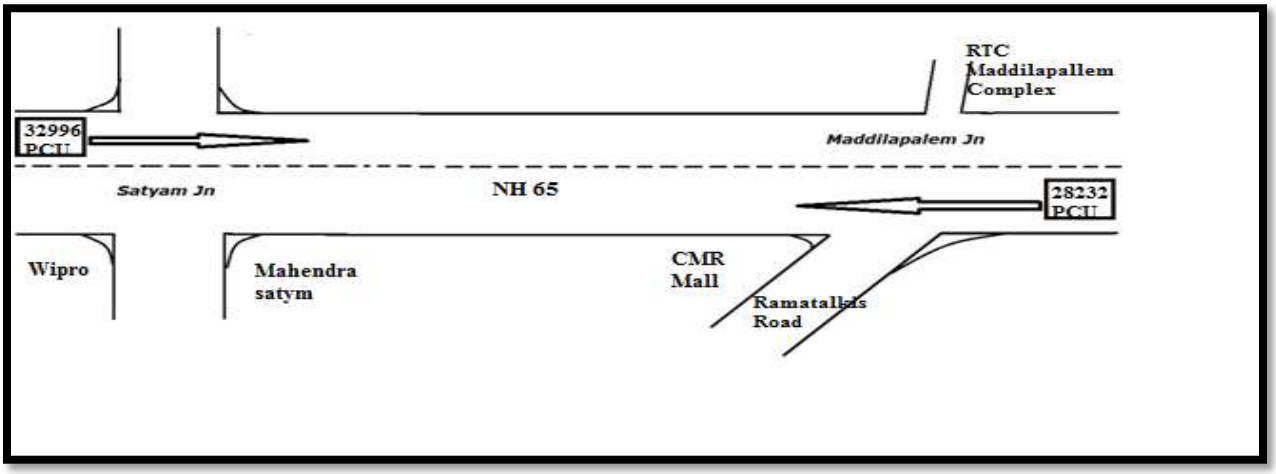

Fig2: Traffic flow at Maddilapallem Junction and Satyam junction.

Traffic volume count surveys

The traffic volume count surveys at 15-minutes intervals were conducted to estimate the traffic patterns at both the junctions. Traffic volume survey at MADDILAPALLEM JUNCTION towards NAD was conducted on 21st Dec 2012 from morning 8.00 Hrs to 11.00 Hrs and at evening 17.00 Hrs to 21.00 Hrs and the survey was conducted at SATHYAM JUNCTION towards PM Pallem on 24th Dec 2012 from morning 8.00 Hrs to 11.00 Hrs and at evening 17.00 Hrs to 21.00 Hrs.

Speed and Delay Survey

A survey is conducted by travelling between these two junctions by different modes of transport. The travel time and delays in travel time are shown in the table 1

Table.1 travelling time results between junctions

	Junction	Time	Duration		
			Trucks	Car	Bike
Morning Period	Maddilapallem Junction - Satyam Junction	Journey Time	00:05:42	00:05:32	00:04:18
		Stopped delay	00:03:50	00:03:34	00:03:08
		Running Time	00:01:52	00:01:58	00:01:10
	Satyam Junction - Maddilapallem Junction	Journey Time	00:05:54	00:05:26	00:05:47
		Stopped delay	00:03:58	00:03:42	00:02:52
		Running Time	00:01:56	00:01:44	00:02:55
Evening Period	Maddilapallem Junction - Satyam Junction	Journey Time	00:05:19	00:05:18	00:03:50
		Stopped delay	00:03:27	00:03:53	00:02:48
		Running Time	00:01:52	00:01:25	00:01:02
	Satyam Junction - Maddilapallem Junction	Journey Time	00:05:41	00:04:41	00:05:22
		Stopped delay	00:03:46	00:03:19	00:03:39
		Running Time	00:01:55	00:01:22	00:01:43

ANALYSIS OF TRAFFIC DATA

The time to time variation of the traffic at both the maddilapalem junction and at satyam junctions are represented in Fig3 and 4 represents the traffic flow at Maddilapallem junction morning and evening periods respectively and Fig 5 and 6 represents the traffic flow at Satyam junction morning and evening periods respectively.

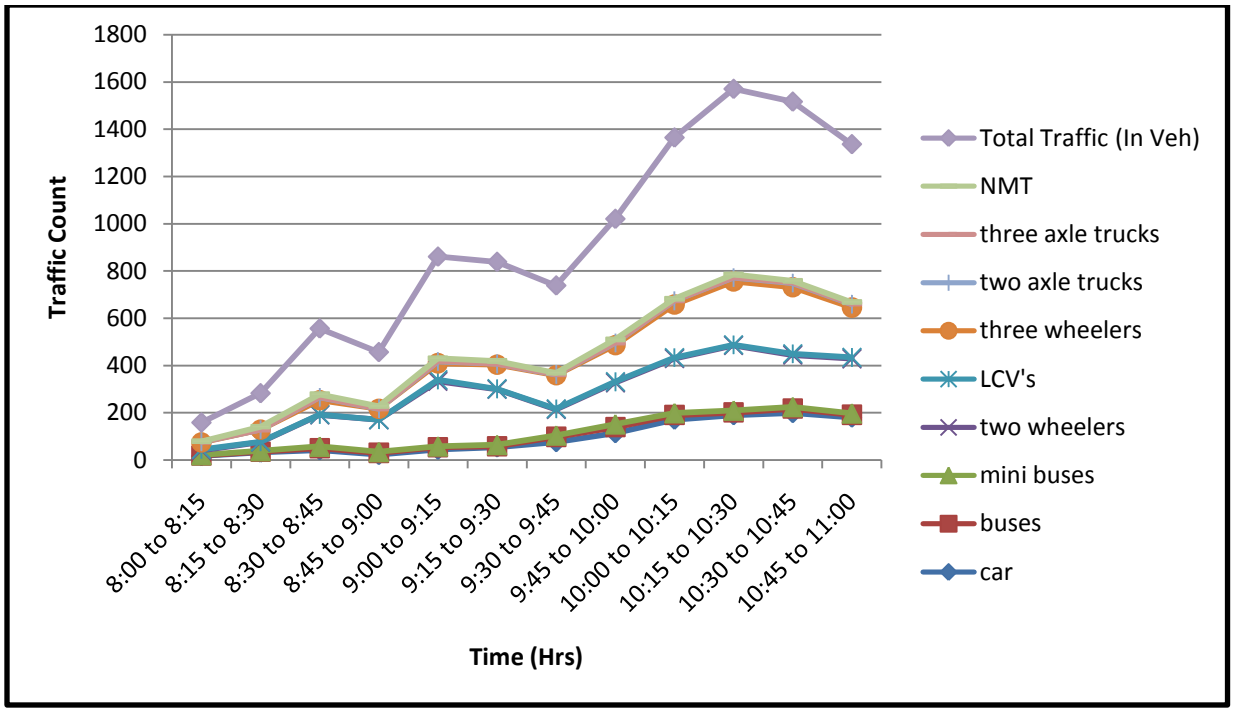

Fig 3: Morning Period Traffic at Maddilapallem junction towards NAD

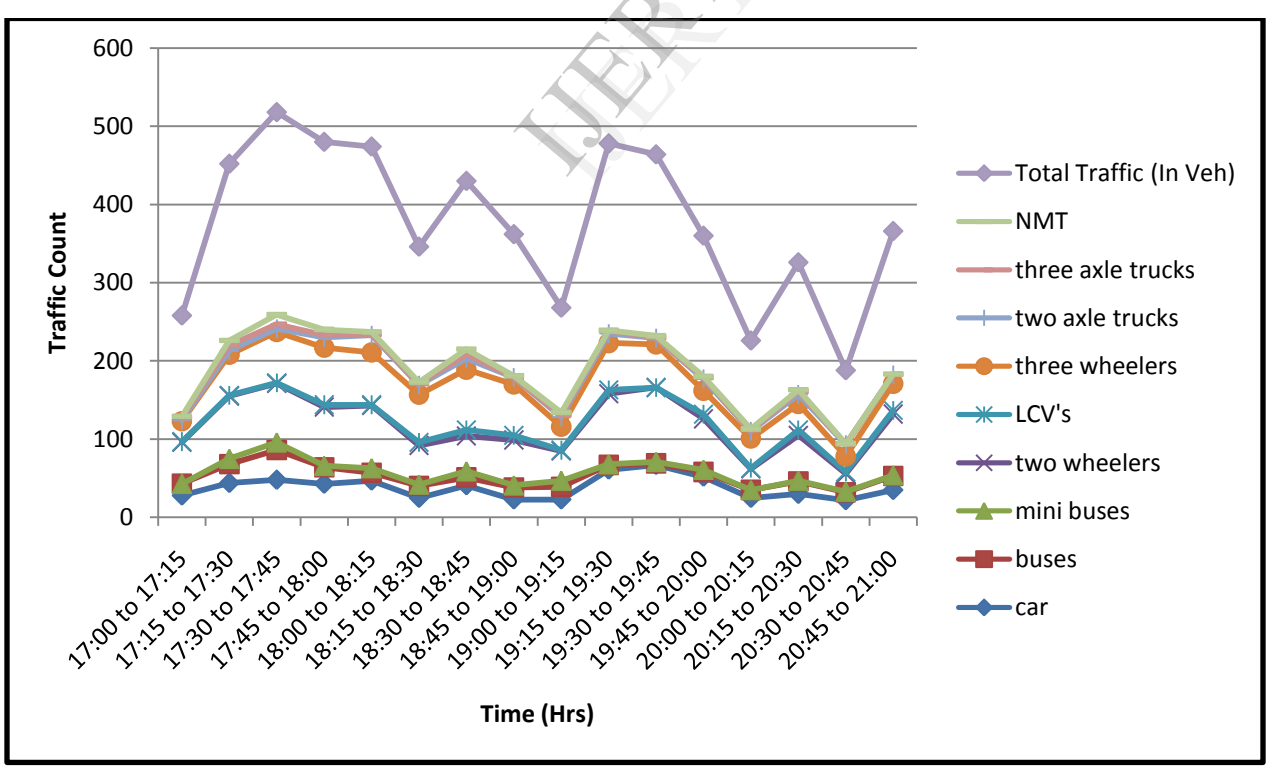

Fig 4: Evening period Traffic at Maddilapallem junction towards NAD

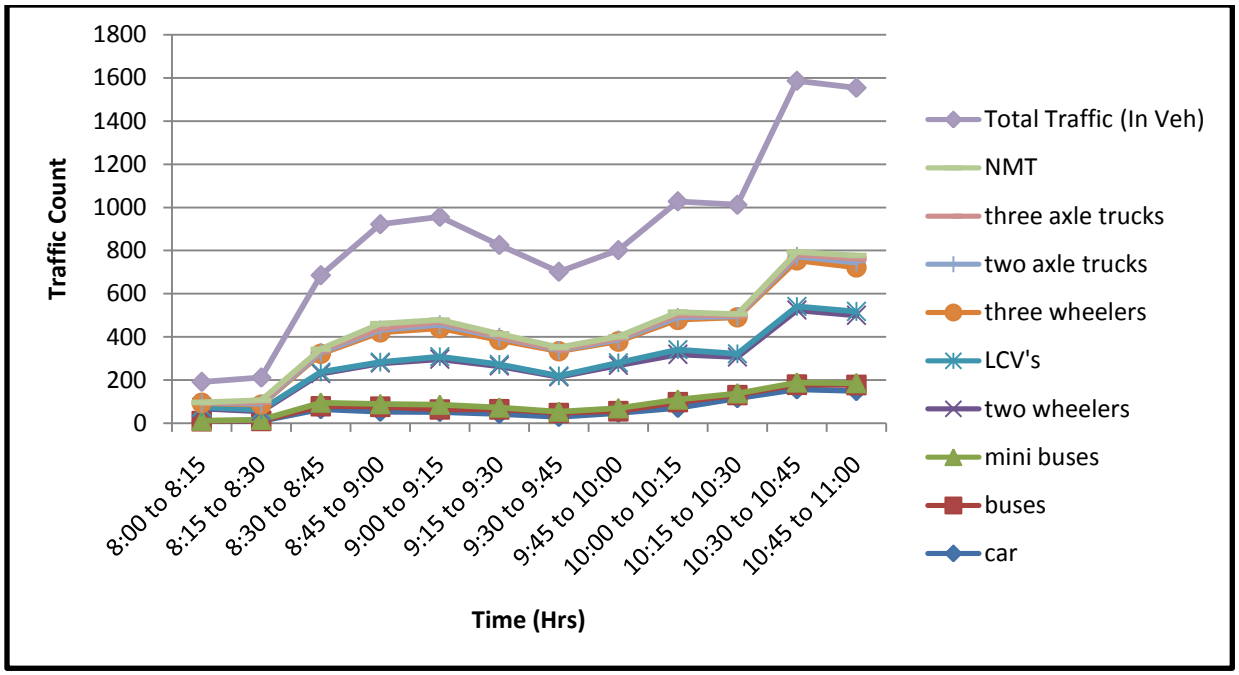

Fig 5: Morning period Traffic at Satyam junction towards PM Pallem

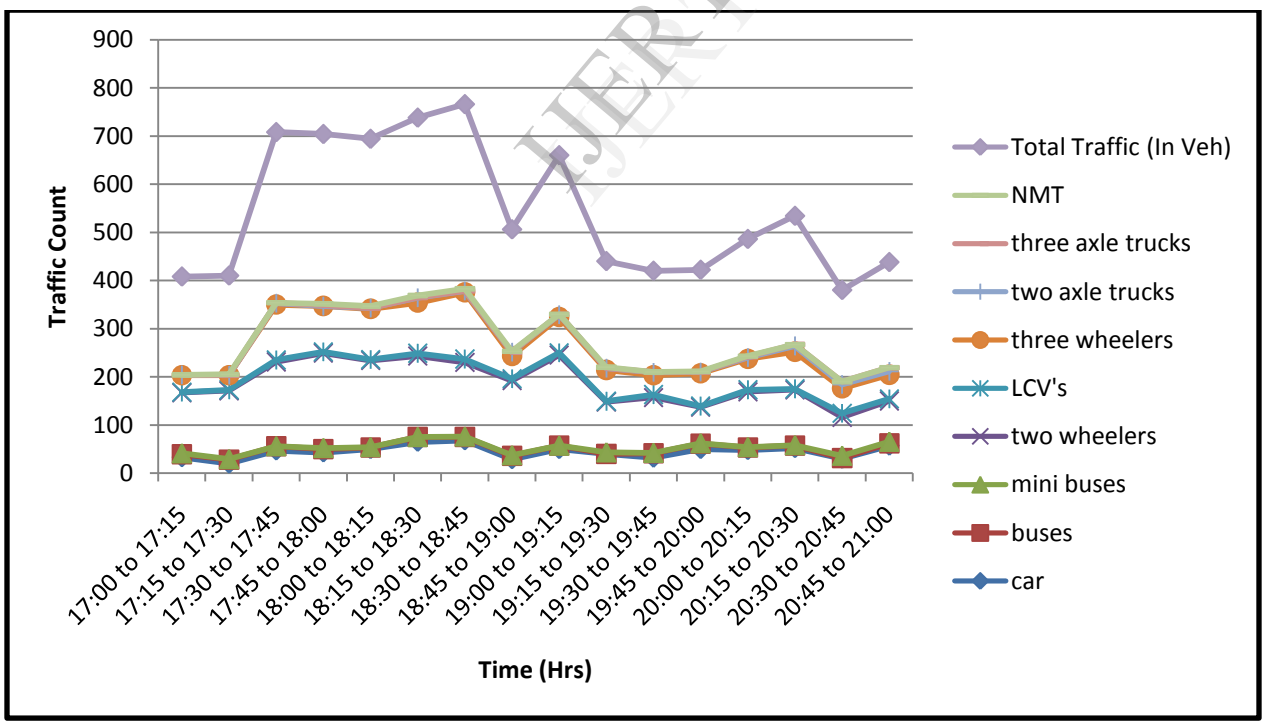

Fig 6: Evening period Traffic at Satyam junction towards PM Pallem

Traffic composition

The traffic composition at Maddilapalem junction in the morning and evening times are shown in Fig 7 and Fig 8.

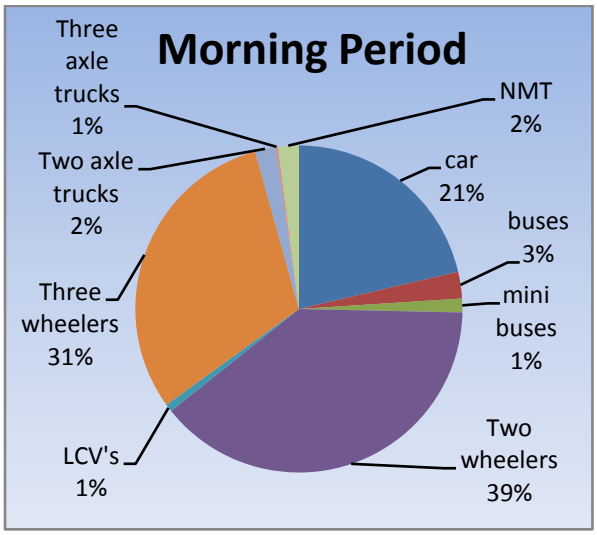

Fig 7: Morning Period Traffic at Maddilapallem junction

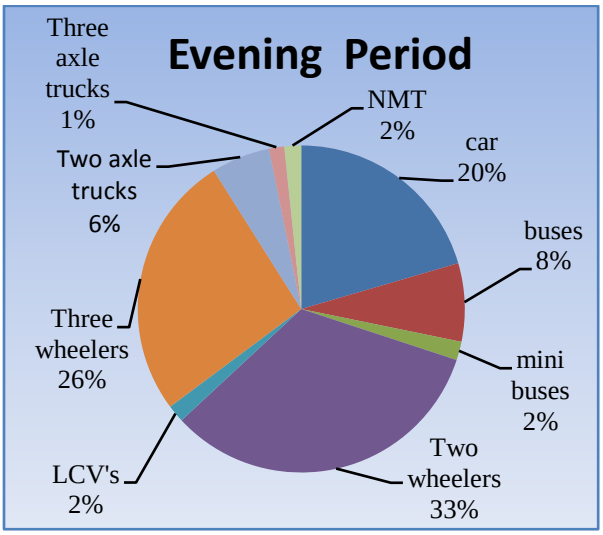

Fig 8: Evening period traffic composition at compositions maddilapalem junction

The traffic composition at Satyam junction in the morning and evening times are shown in the Fig 9 and Fig 10

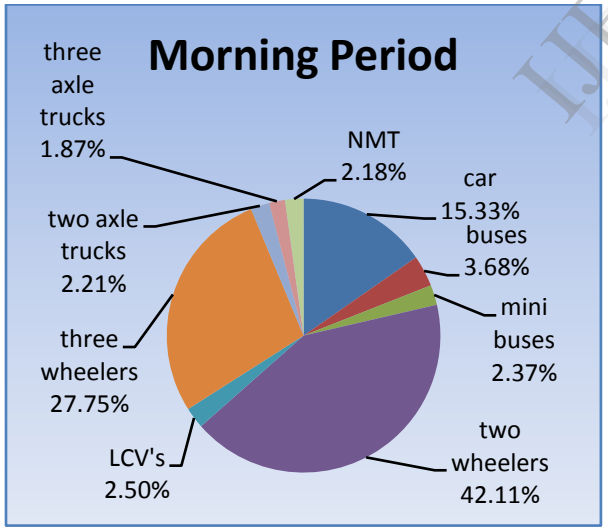

Fig 9: Morning Period Traffic compositions at Satyam junction

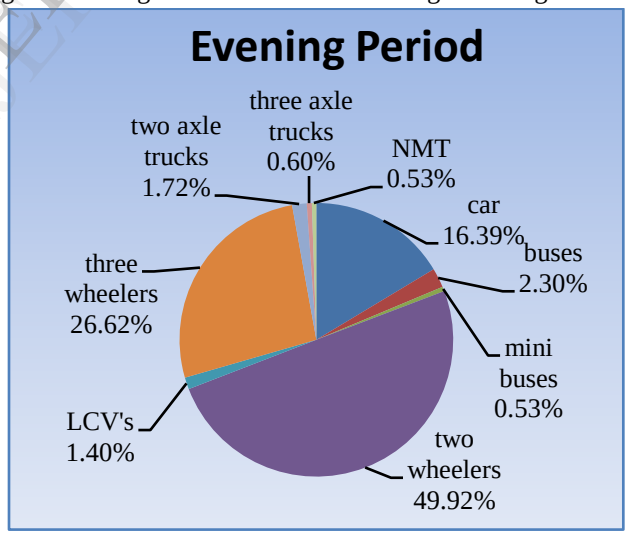

Fig 10: Evening period traffic composition at Satyam junction

Peak hour traffic

The peak hour traffic is calculated at both junctions in morning and evening periods and tabulated in table 2.

Table 2 Peak Traffic Volume

Junction Name	Direction	Peak Hour	Peak Traffic (PCU)
Morning Period			
Maddilapallem Junction	Towards NAD	10.00 – 11.00	2443
Satyam Junction	Towards PM Pallem	10.00 – 11.00	2366
Evening Period			
Maddilapallem Junction	Towards NAD	17.15 – 18.15	1078
Satyam Junction	Towards PM Pallem	17.45 – 18.45	1092

Projected Traffic on flyover

The traffic which is going to travel between these two junctions may not use the proposed flyover. So, the traffic which is using the flyover can be calculated from the origin and destination survey [1]. The Fig 11 shows the total projected traffic on the flyover is 15058 PCU per day at Maddilapallem junction and 11475 PCU per day at Satyam junction.

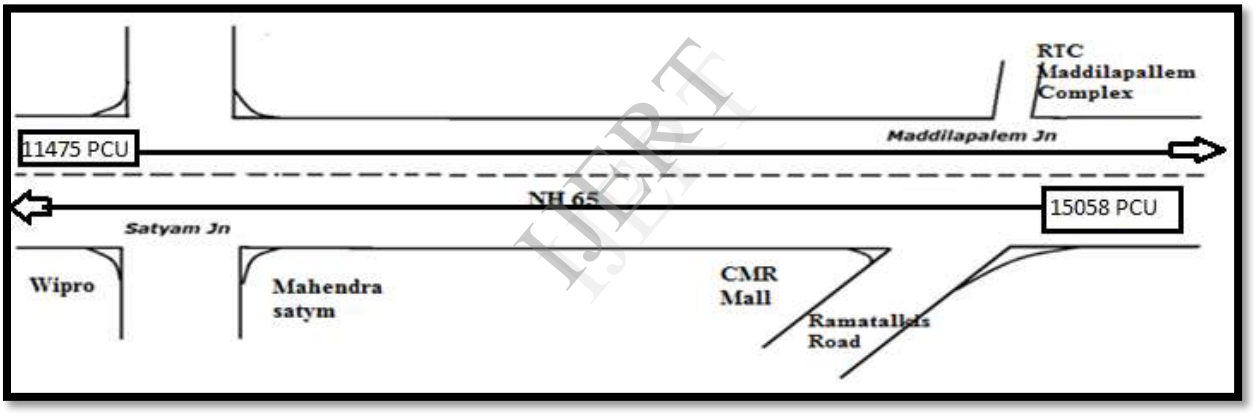

Fig11: Projected Traffic on flyover per day.

PROPOSED ALIGNMENT

The alignment details are essential in the geometric design of the flyover taking into consideration the design speeds and maximum horizontal curvature allowed to provide proper sight distance [5].

Alignment Details: The alignment details for the proposed flyover were assumed and the design aspect of the flyover is

- The design speed is 100Kmph.
- Gradient maintained 1:20 to 1:25
- Length of Bridge portion = 720 m
- Total length of flyover = 1250m
- Carriage way width of flyover = 4 lanes (2*7.5m)
- Length of Retaining wall approach towards NAD = 250m
- Length of Retaining wall approach towards PM Pallem = 250m
- Total Number of piers = 23_(P1,P2,Pn)
- Total Number of spans= 24 spans

- Span length = 30m

ECONOMIC ANALYSIS

The feasibility study of the fly-over must be done taking into consideration the various alternatives proposed [2]. The cost of construction is taken as per the present industry standards. The details of accident costs, travel time savings, vehicle idling costs and vehicle operating cost are estimated and tabulated in table 3.

Table 3: Total Annual Benefits (Costs in Rs. lakhs)

Year	Accident costs	Travel Time Savings	Vehicle Idling Cost	Vehicle Operating Cost	TOTAL BENEFITS
2012	15.19	1001.82	119.32	308.15	1444.46
2017	48.14	1457.13	174.39	562.59	2242.24
2022	152.64	2133.3	256.58	801.75	3344.25
2027	484	3136.27	379.62	1150.87	5150.74
2032	1534.68	4627.77	564.42	1662.68	8389.53
2037	4866.26	6852.98	842.65	2415.64	14977.51

Accident costs: The past accident data is collected and by using IRC SP-30 [4], the cost of accidents are calculated. The forecasting of the accidents are calculated according to the past 2years growth rate of accidents.

The annual costs of travel time Savings, vehicle idling costs and vehicle operating costs are calculated from the delay studies of table1 [4]. Based upon the growth rate of traffic [3], the individual costs are calculated forecasting up to 2037.

ECONOMIC ANALYSIS OF THE FLYOVER

For the purpose of economic analysis, the discount rate which are adopted for the present feasibility study are 8%, 9%, 10%, 11% and 12%.

Generally the economic life of highway projects is expected to be 20-30 years. In this particular case, the design life is taken as 25years.

Routine Cost: The routine maintenance cost is taken equal to 1% of construction cost.

Periodic Cost: The periodic maintenance cost is taken equal to 5% of the construction cost and it is considered for every five years.

Economic analysis of the flyover is done by the following

- The first column indicates the different years within the design life of the fly-over.
- The second column gives the construction cost of the flyover for a length of 1.25km in the year 2012 is 5142Lakhs (approx).
- The third column gives the routine maintenance costs with respect to each year considering the wholesale price index.
- The fourth column indicates the periodic maintenance cost once in 5 years taking into considering the wholesale price index.
- The fifth column gives the construction cost computed with respect to each year taking into consideration the discount rate.
- The sixth column gives the total cost including the maintenance costs with respect to each year.
- The seventh column indicates the benefits obtained from table 3.
- The eighth column gives the benefits accrued with respect to each year.
- The ninth column gives the difference between columns eight and six that provides the benefits and costs for up to that year.
- The tenth column gives the difference of benefits and costs for each year. This is used to find the Internal Rate of Return IRR
- The eleventh column gives the break-even year

Table 4 Economic Analysis of the Flyover Discount rate 10% **(Cost in Rs.lakhs)**

Year (1)	Construction cost (2)	Maintenance Cost		const amount (5)	Total Cost up to that year (6)	Total benefits (7)	benefits up to that year (8)	benefits - cost(1) (9)	benefits - cost(2) (10)	benefits/ cost Ratio (11)
		Routine (3)	Periodic (4)							
2012	5142			5142	5142	1444.46	1444.46	3697.54	3697.54	0.28
2013		54.15		5656.2	5710.36	1652.85	3097.31	2613.05	1598.69	0.54
2014		57.036		6221.82	6278.86	1782.57	4879.88	1398.98	1725.53	0.77
2015		60.070		6844.01	6904.09	1922.72	6802.6	-101.49	1862.64	0.98
2016		63.266		7528.42	7591.69	2076.28	8878.88	1287.19	2013.01	1.16
2017			333.16	8281.27	8614.44	2242.24	11121.12	2506.68	2242.24	1.29
2018		70.177		9109.4	9179.58	2424.21	13545.33	4365.75	2354.03	1.47
2019		73.910		10020.3	10094.26	2623.88	16169.21	6074.95	2549.99	1.60
2020		77.842		11022.3	11100.23	2841.48	19010.69	7910.46	2763.63	1.71
2021		81.984		12124.6	12206.61	3080.37	22091.06	9884.45	2998.38	1.80
2022			431.72	13337.0	13768.82	3344.25	25435.31	11666.4	3344.25	1.84
2023		90.939		14670.8	14761.74	3633.92	29069.23	14307.4	3542.98	1.96
2024		95.777		16137.8	16233.66	3954.72	33023.95	16790.2	3858.94	2.03
2025		100.87		17751.6	17852.55	4310.65	37334.6	19482.0	4209.77	2.09
2026		106.23		19526.8	19633.08	4707.57	42042.17	22409.0	4601.33	2.14
2027			559.45	21479.5	22038.99	5150.74	47192.91	25153.9	4591.28	2.14
2028		117.84		23627.4	23745.34	5647.43	52840.34	29095	5529.52	2.22
2029		124.11		25990.2	26114.36	6207.21	59047.55	32933.1	6083.09	2.26
2030		130.71		28589.2	28719.99	6841.51	65889.06	37169.0	6710.79	2.29
2031		137.66		31448.2	31585.87	7564.09	73453.15	41867.2	7426.42	2.30
2032			724.96	34593.0	35317.99	8389.53	81842.68	46524.6	7664.56	2.31
2033		152.70		38052.3	38205.04	9339.7	91182.38	52977.3	9186.99	2.38
2034		160.83		41857.5	42018.41	10439.6	101622.0	59603.6	10278.8	2.41
2035		169.38		46043.3	46212.72	11717.9	113339.9	67127.2	11548.5	2.45
2036		178.39		50647.7	50826.07	13216.4	126556.4	75730.3	13038.0	2.48
2037			939.44	55712.4	56651.89	14977.5	141533.9	84882.0	14038.0	2.49

SENSITIVITY ANALYSIS

Future values are difficult to predict and there is some uncertainty about the project results. Hence it is necessary to assess the possible changes on the different project variables that are quantified. In the present study, sensitivity analysis has been carried out taking into consideration the following possibilities:

- When the costs increased by 15%.
- When the benefits decreased by 15%.
- When both the above cases occur simultaneously.

The sensitivity analysis is carried for the three cases and the Internal Rate of Return (IRR) is carried out and the results are shown in table 5

Table 5 Sensitivity Analysis

		8%	9%	10%	11%	12%	IRR (%)
Actual cost and benefits	benefit/cost	3.91	3.12	2.49	1.99	1.60	14.805%
	break-even year	2015	2015	2016	2016	2016	
Increase in cost by 15%	benefit/cost	3.40	2.71	2.17	1.73	1.39	13.955%
	break-even year	2016	2016	2016	2017	2017	
Decrease in benefits by 15%	benefit/cost	3.32	2.65	2.12	1.69	1.36	13.832%
	break-even year	2016	2016	2017	2017	2017	
Both Increase in cost and Decrease in Benefits by 15%	benefit/cost	2.89	2.31	1.84	1.47	0.82	12.955%
	break-even year	2017	2018	2018	2018	-----	

CONSTRUCTION SCHEDULING

Planning, scheduling and cost estimation are important activities in the project delivery process, linking the design of a facility to its construction. It takes many years to become an experienced scheduler and estimator and even experienced professionals. It is often challenge to develop realistic and cost estimates a challenge. Among other things, a realistic construction schedule must be in equilibrium with the estimate [7]. The estimate must reflect the cost of the resources required carrying out the proposed schedule, and it must be developed at the level of detail appropriate for its purpose [6].

Hence the flyover is feasible at this zone. The flyover having a length of 1.25km has been planned with 23piers and 24 spans with span length of 30m each and each span is having 12 spine segments and 24 cantilever segments, two approaches of each length 250m on either side [8].

So by using the MS Projects software [9] the secluding of the project is carried out. The major activities of the flyover are

- Preliminaries
- Mobilization
- Design and drawings
- Foundations & sub-structure
- Yard development & precasting

- Erection of segments - preliminary works
- Segment erection
- Miscellaneous works
- Handing over of viaduct

Considering, the critical path of the project depends upon the number of beds available for casting of spine segments and cantilever segments and the crash barriers. In this paper work there are two alternatives of construction has been planned i.e., single stage of construction and the second one is two stage construction. In single stage of construction all the pilling, pile caps, piers, and erection of segments is done one after the other from abutments A to another abutment B. Therefore the total project duration for single stage construction is 576 days and by two stage constructions the project duration is 557days, where the flyover is divided in to two parts of construction activities are carried in parallel.

The study has been conducted to vary the number of spine segment beds and cantilever segment beds in the precasting yard. The effect of variation of these beds on the duration of the project is carried out and listed in the following table 6

Table 6 Effect of casting beds on project duration

Type of construction	No. of Spine segments beds	No. of Cantilever segment beds	Duration (days)
Single Stage	4	4	576
	4	3	576
	3	3	617
	3	4	617
Two Stage	4	4	536
	4	3	557
	3	3	640
	3	4	640

SUMMARY AND CONCLUSION

In the present paper, economic feasibility of a flyover between Maddilapalem and Satyam junction is carried out. Then the construction scheduling is done for the proposed flyover using MSP. The duration verses economy for the construction is worked. The conclusions from the present study are as follows:

- From traffic survey study it is concluded that the peak hour traffic at Maddilapallem junction towards NAD at 10.00 Hrs –11.00 Hrs is 2443 PCU per day and at 17.15 Hrs – 18.15 Hrs is 1078 PCU per day and the peak hour traffic at Satyam junction towards PM Pallem at 10.00 Hrs 11.00 Hrs is 2366 PCU per day and at 17.15 Hrs – 18.15 Hrs is 1092 PCU per day.
- From the benefit cost study it is concluded that the construction of a 4-lane fly-over is thoroughly feasible between Maddilapalem and Satyam junction.
- Based on sensitivity analysis, considering 25 years of life span of the flyover, the construction of a 4-lane is feasible only if the discount rate is equal to or less than 11%.
- From the sensitivity analysis, the IRR for the actual benefits and cost is 14.8%. When the cost is increased by 15% then the IRR is 13.9%. When the benefits are decreased by 15% then the IRR is 13.8%. When the cost is increased and benefits are decreased simultaneously then the IRR is 12.9%.
- The duration of single stage of construction of a flyover is 576 days where as two stage construction the project duration is 557 days keeping duration of each activity is same both types of construction. Hence single stage of construction is preferred.
- By decrease or increase in number of casting beds for spine and cantilever segments, the duration of the construction is varied. So, the optimum number of casting beds for spine segments are four and for cantilever segments are three, then the duration for that construction is 576 days i.e., 82Weeks.

REFERENCES:

[1] Kadiyali. L.R. "Traffic Engineering and Transportation Planning", Khanna Publishers, Delhi-1983.
[2] Winfary, "Economic Analysis for Highways" International Textbook Company, 1969.
[3] "Whole Sale Price Index", Office of Economic Advisor, Ministry of Finance-India, from internet www.eaindustry.com.
[4] IRC SP-30, "Manual on Economic Evaluation of Highway Projects in India", Indian Road Congress, 1993.
[5] IRC64-1990, "Guidelines for Capacity of Urban Roads in Plain Areas.
[6] Seetharaman.S, "Construction Engineering & Management", Nai Sarak, New Delhi, 2006.
[7] Project management for engineering and construction : Garold D.Oberlender 1993
[8] Sengupta.B, and Guha.H, Construction Management and Planning, Tata Mc.Graw Hill publishing company Ltd., New Delhi, 2004.
[9] Microsoft Office Enterprise Project Management (EPM) Solution 2007.