

Traffic Flow Analysis and Highway

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ABSTRACT

Capacity Evaluation of the Road. This study focuses on the capacity evaluation of the 2-lane dual carriageway extending from the Humnabad Ring Road to the Kharge Bus Stop. The capacity of any location is defined based on the volume of vehicles traversing that point, which has been selected for this project.

The capacity of a road is influenced by several factors, including the number of lanes, lane width, road gradient, population density of the area, and the type of surrounding environment. For instance, if the area is industrial, the capacity tends to be higher due to the increased movement of both commercial and private vehicles. In India, road capacity is expressed using the Passenger Car Unit (PCU). However, due to heterogeneous traffic conditions and the lack of disciplined lane behavior, it is challenging to study and analyze traffic flow and capacity accurately.

Traffic flow principles are typically represented mathematically, as they describe the interaction between vehicles and drivers. In our thesis, "Traffic Flow Analysis and Highway Capacity of NH-50:" our aim to analyze traffic flow and highway capacity on the selected segment road of NH-50. Specifically, we are studying traffic conditions at the Humnabad Ring Road Bus Stop and designing a new type of carriageway that will facilitate smoother and safer traffic movement.

To evaluate the road's capacity, we employed a manual survey method. We conducted a week-long survey to determine the total traffic volume across seven days, including both peak and non-peak hours.

In our thesis, our aims to allow continuous vehicle movement without stoppage, thereby saving both time and fuel.

After analyzing the traffic flow and capacity of selected segment road NH-50 from Humnabad Ring Road to the Kharge Bus Stop, we identified several areas that require improvement. These proposed changes will help manage traffic volume more effectively and enhance the overall capacity of NH-50 (selected segment road of NH-50).

Keywords – Traffic, Flow Analysis, Highway

I. INTRODUCTION

1.1 General

Traffic flow studies are accompanied to determine the number, movement and type of vehicles at a given location. Traffic flow analysis helps to improve the capacity of flow. Traffic flow analysis also help to reduce the accident level. Traffic flow concepts to also describe in the mathematically way the interaction between vehicles and driver.

1.2 Traffic flow analysis

OVERVIEW

The concept of traffic flow is a relationship between vehicles, drivers and type of infrastructure like highways, expressways, signals and devices which is install to control the traffic flow. The main purpose of understanding the traffic network is to help to reduce the traffic congestion. Due to increasing of population and transportation day by day the traffic volume is increase.

Traffic volume is the most important part while we are studying the traffic flow and capacity. According to traffic volume the design and planning of the road system has to plan. Basically traffic is congested in developing countries or developing cities like India. The main reason of traffic in India is the nature of traffic. The nature of traffic in India is heterogeneous. In this the traffic, the vehicles do not follow the lane rules which are specified for every type of vehicles. Due to this, the traffic flow get slow and increase the traffic volume also. The main problem due to heterogeneous traffic to analysing the traffic volume and analysing the data for the further requirement or improvement in future.



Fig:1.1 heavy Traffic Volume

Traffic flow in India due to heterogeneous condition it is not possible that the vehicles movement in lane. Due to this India facing problem traffic due to heavy traffic volume. Measuring the traffic volume of a heterogeneous nature traffic is represented by transforming the types of vehicles corresponding to the conveying in terms of passenger car unit per hour.

1.2.1 MODEL OF HETEROGENEOUS TRAFFIC FLOW

In developing countries composition of traffic is mixed with different type of vehicles like fast moving and slow moving in same direction or using same right of way. The fast moving vehicles like taxi, buses, truck, bikes, auto rickshaws etc. and slow moving vehicles like bicycles, cycle rickshaws etc. this heterogeneous traffic flow increase the traffic. Huge study has been done to develop traffic flow models for the roadways and expressways, mostly for fast moving vehicles. And also heterogeneous traffic is representing in industrial countries like India. In India this is the factor which affect the whole traffic jam because all vehicles are moving without any specified lane.



Fig:1.2 Heterogeneous traffic flow in India

An evaluation of the literature has shown that limited revisions is already done of traffic flow for heterogeneous or mixed condition of the vehicles in developing countries. Some of the experiments are used to develop to convert the heterogeneous traffic into passenger car unit. It helps to reduce the traffic jam and improve the traffic flow.

1.2.2 TRAFFIC DUE TO ROAD CONDITION

Traffic is also increase due to the conditions of road. If we are talking about Indian roads in the autumn season all the drainage will get jam due to heavy rain. Due to heavy rain water gathering on the road, whole road get damage. Due to this damage traffic jam is increase and also increase the number of accident. Sometime due to this there is huge accident on that road. Due to low or poorly maintenance of road accident causes. Half of the fatal auto accident will happen due to low maintenance. It is happen at the national highways and expressways because of high speed. A driver must be avoid that situation which may cause accident like pothole or pooling water on the road. Many factors that affect the traffic flow.



Fig:1.3 due to construction of service road

1.2.4 Types of traffic jam due to bad road condition :

2. **Potholes:** In this types of road asphalt are missing in a large amount from the road. Due to potholes a huge traffic jam. Potholes is occurring due to failure of asphalt in huge amount at the time of heavy rain or blockage of drainage.



Fig:1.4 Potholes on roads

3. **ICE PATCHES ROAD:** Due to heavy snow fall on the roads the traffic jam or to decrease the traffic flow. Due heavy snow fall the asphalt failure is occurring because after melting the snow the water get gathered on road and it will damage the whole road, accident is also occurring due to this failure.

1.2.5 TYPES OF TRAFFIC CONGESTION

1. MATHEMATICAL THEORIES:

Some of dynamic rules are apply to control the traffic flow. Dynamic rule is just like to flow of a fluid in a pipe. Heavy traffic can raise naturally such as an unexpected routing by a single motorist. Because of poor results of theoretical model traffic flow to actual experimental traffic flow, we are using traffic forecasting for empirical models



Fig: 1.5 Heterogeneous Traffic

II. LITERATURE REVIEW

The study of traffic flow analysis is an interface between driver, vehicles and infrastructure of the roadway. The main purpose of traffic flow analysis is analyse a new idea to control the traffic flow and able to understand the road network by a common person. In also help to reduce the traffic jam and save the precious time of everyone.

Review on Traffic flow analysis and Highway Capacity Prof. Aarti chougule et al. (2024) Based on the results of traffic characteristics and traffic performance of shirol bypass road which have discussed, it can be concluded that: Shirol bypass road peak traffic hours at 09:00 am with capacity 260 light vehicle 450 vehicle unit so that the value of v/c ratio the relation between traffic flow and traffic density Find out the relation between speed and traffic density is that if density increases, speed will decrease The relationship between v/c ratio and traffic density is that as the traffic density increases, the v/c ratio for the road get worse. The relation between traffic flow and traffic density Find out the relation between speed and traffic density is that if density increases, speed will decrease. The relationship between v/c ratio and traffic density is that as the traffic density increases, the v/c ratio for the road get worse.

Kandukuru Jagan Mohan Reddy et al. (2020)

The study had implemented the concepts of mixed methods for framing the contents of the study. One major aspect of this study had been the data validity therefore both primary and secondary analysis has been implemented within the study accordingly. Survey is one of the means of data collection methods that have been used in the study. Loads of Obstructions within Roads have resulted in decrease in speed of traffic, apart from this; the issues related to frequent braking has reduced the quality of Roads in India.

F.M Salam et al.(2020)

According to different versions of HCM.measuring capacity and LOS for the purpose of studying and evaluating multi-lane roads have changed year after year based on research, although the changes are not dominant. The following points have been concluded: ID Multi-lane highway segments can be characterized by several performance measures: density in passenger cars per mile per lane. Space mean speed in miles per hour, and the ratio of demand flow rate to capacity (v/c). 2 4) With an increase in the proportion of heavy vehicle in traffic streams. The traffic operations. And hence the LOS, will be adversely affected.

Balaji Ponnu et al (2012) in this research the author discuss the vastly condition of the Indian roads for different type of vehicles on expressways. The author aim to design a new technology for the traffic flow or new model diagram which help to control the Indian road traffic flow by calculating the passenger car unit(PCU). It also help to evaluate the capacity of highways and expressways. In this research author want to decrease the PCU and increase the capacity ratio of the traffic flow.

SK Mahajan et al (2013) in this author discuss about a rotary. Traffic rotary is a special grade change of lane at any intersection. Rotary is basically design where the traffic meet three or more intersection and the traffic volume of that intersection is maximum 3000 per hour or more than 500 per hour. With the help of this rotary crossing or intersection of traffic problems will eliminate and traffic movement is very easy.

K P Tiwari et at (2013) in this we have learnt that how to calculate the wastage of fuel. Emission of fuel increases the pollution. Author wants to decrease the pollution level. Basically wastage of fuel is more at crossing of train, signals. Author was suggest a construction of over bridge at crossing. According to author total wastage of fuel at signals or crossing point is 5.6×10^6 Petrol and 3.4×10^6 of Diesel, 1.6×10^6 kg per year. Total increasing of fuel in Indore 10.6×10^6 creating the CO₂.

III. OBJECTIVES

The main objective of this research is to analysis the traffic volume at Humnabad ring road and Kharge bus stop and suggests further improvement which is required to flow the traffic smoothly and easily. Some objectives are to be study which is given below:

To analysis the traffic volume from Humnabad ring road to Kharge bus stop and evaluate the total PCU at both site.

Study the intersection of Humnabad Ring road.

To investigate the level of service of the selected road segment.

Study Area

Total area of Kalaburagi city is 706043 and the coordinates of Kalaburagi is 17.3297° N, 76.8343° E total area of Kalaburagi city is 16224 km² and elevation 228 m. The total number of register vehicles in Kalaburagi is aprox.6.69 lakhs till 2024



Fig: 3.1.1 Kalaburagi city map



Fig: 3.1.2 Humnabad ring road to Kharge bus stop map

At Humnabad ring road there is a rotary which is made to control the traffic volume but now a day traffic volume is increase in a huge amount.

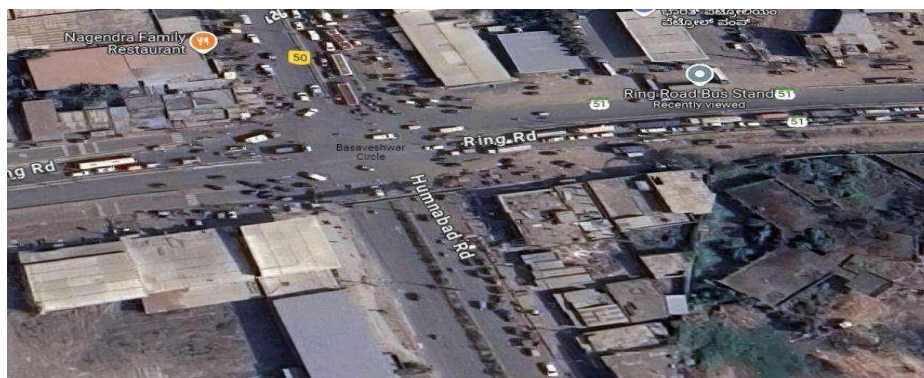
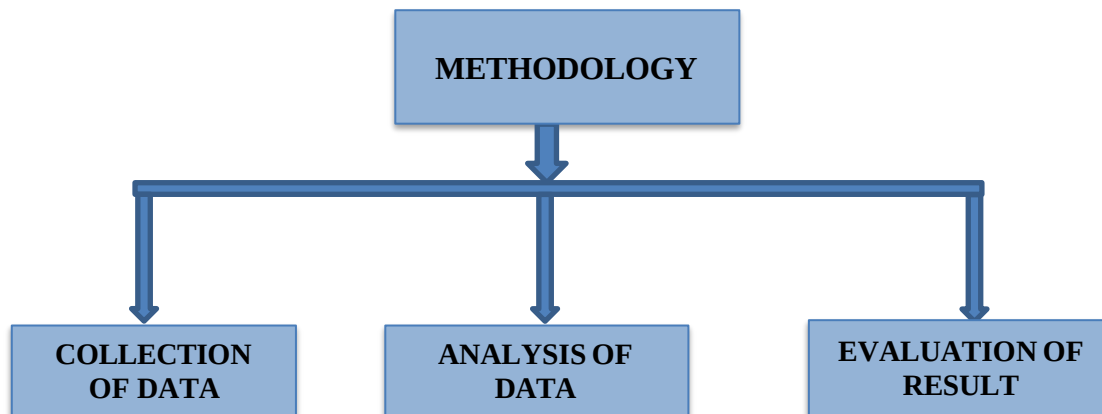


Fig: 3.1.3 Google earth map

IV. METHODOLOGY



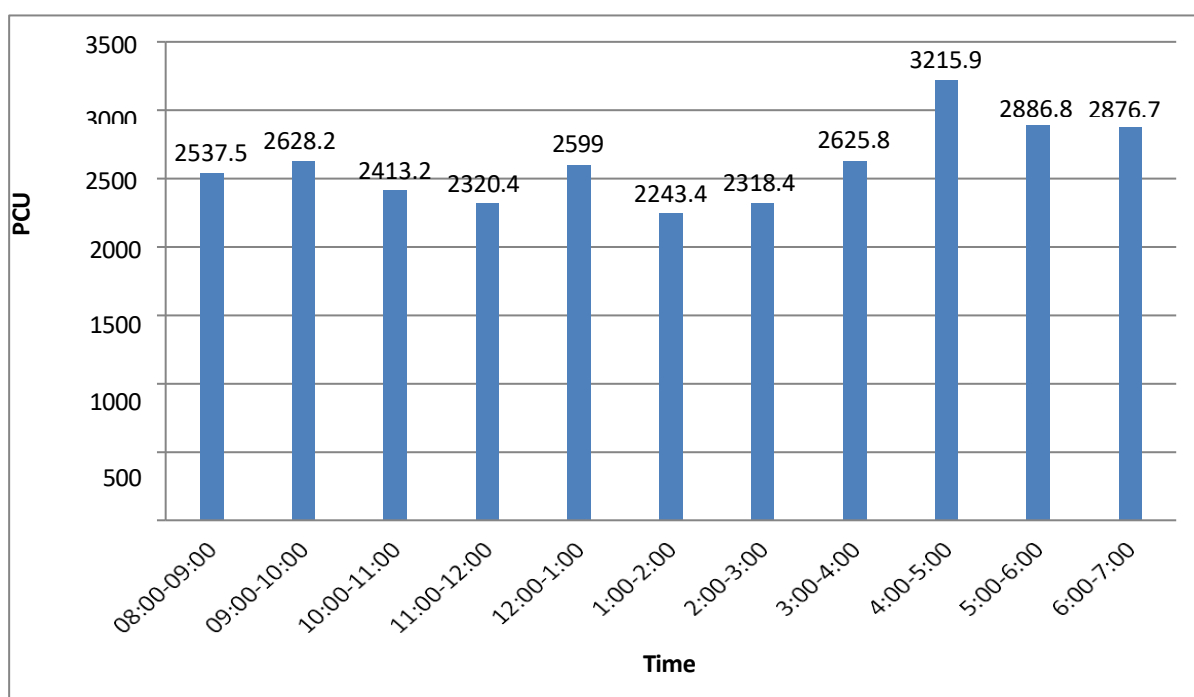
Collection of data (by Manual method)



Fig 4.1: Collection of Data

Collection of Data

Vehicles / Time	Two wheelers	Autos	Cars	LCM	HV	Total PCU
08:00-09:00	844	623	571	143	209	2537.5
09:00-10:00	960	348	347	67	88	2628.2
10:00-11:00	879	625	602	121	173	2413.2
11:00-12:00	802	570	506	152	178	2320.4
12:00-1:00	851	624	582	137	226	2599
1:00-2:00	759	517	530	159	163	2243.4
2:00-3:00	770	617	510	176	174	2318.4
3:00-4:00	820	681	597	151	212	2625.8
4:00-5:00	940	779	659	196	295	3215.9
5:00-6:00	898	683	758	157	220	2886.8
6:00-7:00	830	599	595	200	285	2876.7



2. Study the intersection of Humnabad ring road

Study was carried out in three stages

1. Collection of data
2. Analysis of data
3. Design

1. Collection of Data: collection of data done by manual method for 3 days (each day 2 peak hour data was collected).

Day 1

Vehicles / Time	Two wheelers	Autos	Cars	LCM	HV	Total PCU
05:00-06:00	470	255	248	79	111	1258.7
06:00-07:00	424	289	330	84	127	1402.5

Day 2

05:00-06:00	384	270	274	93	107	1261.1
06:00-07:00	229	230	268	104	98	1138.3

Day 3

05:00-06:00	484	238	375	98	94	1352
06:00-07:00	377	214	293	73	105	1180.8

During the peak hour total PCU per hour at a signalized four arm intersection should typically fall between the 3000 to 6000 PCU per hour depending on the road type and traffic mix.

If the volume to capacity ratio (v/c) exceeds 1.0 or the LOS falls below c intersection redesign optimization is needed as per the IRC 93-1985 & IRC SP 41-1994. (two lane divided dual carriageway of urban road).

TO INVESTIGATE THE LEVEL OF SERVICE OF SELECTED ROAD SEGMENT

- **LEVEL OF SERVICE (LOS) CONCEPT-**
- The LOS has been added through the means of Highway capability Manual, which reveals the level of facilities that a user can experience from the road under various conditions of the operation and traffic volumes. The Highway Manual is a booklet National Academics of Science which includes concepts, recommendations and approaches for understanding capability and high-satisfactory of provider of motorway facility. It justifies the quantitative measure of traffic, On the other hand Level of service (LOS) justifies a Qualitative measure. The road capacity could be constant while the actual flow rate would be different for different time and days. Depending upon volume to capacity ratio and journey speed, HCM has described 6 Level of Services i.e., from A to F. A represents the fine working situations and F represents worst condition.

INTERPRETATION of V/CRATIO (as per IRC:106-1990)

V/C Ratio	Level of Service (LOS)	Traffic Condition
0.0 – 0.2	A	Free flow
0.2 – 0.4	B	Stable flow
0.4 – 0.6	C	Stable, but speeds affected
0.6 – 0.8	D	Approaching unstable
0.8 – 1.0	E	Unstable flow (at capacity)
> 1.0	F	Breakdown / congested

Table No 4.6 : Volume to capacity ratio of LOS

$$LOS = \frac{VOLUME\ TO\ CAPACITY\ RATIO}{CAPACITY}$$

$$LOS = \frac{3215.9}{4000} = 0.80 \text{ (Approaching unstable)}$$

Standard PCU Values (Passenger Car unit)

Values of PUC	
Car	1.0
Motorcycle	0.5
Non-motorised Vehicles	0.2
LCV	2.2
HMV	3.5
3-Wheeler	0.8

(Source : As per IRC)

V. DESIGN OF ROTARY

• Design Of Rotary

The rotary is located in urban section and hence a design speed of 30 K.P.H is appropriate. Since the intersection legs carry almost equal traffic, a round shaped central island will be adopted. A radius of 20 m at entry, 40 m at exit and 27 m for the central island will be adopted according to Current Indian Standards as discuss above. The traffic in terms of PCUs from each leg is depicted in fig below:

$$\text{Area} = L \times B$$

$$= 31.5 \times 9$$

$$= 598.5 \text{ m}^2$$

$$\frac{\pi d^2}{4} = 598.5$$

$$d = \frac{\sqrt{598.5 \times 4}}{\pi}$$

$$d = 27.60m$$

Center at island dia = 1.33 times $\times$ entry width

$$= 1.33 \times 13 = 17.29m$$

Design of rotary

$$\varepsilon_1 = \text{entry width} = 4.5 + 1.5 + 7 = 13m$$

$$\varepsilon_2 = \text{exit width} = 7m$$

$$w = \frac{\varepsilon_1 + \varepsilon_2 + 3.5}{2}$$

$$w = 13 + 7 + 3.5$$

$$\frac{e}{w} = \frac{10}{13.5} = 0.74 \text{ to safe}$$

e/w is with in the range of

0.4 to 1.00

$$P = \frac{\text{sum of crossing streams}}{\text{total number of weaving section}}$$

$$P = \left(\frac{b + c}{a + b + c + d} \right)$$

$$P = \left(\frac{1172 + 609}{391 + 1172 + 609 + 435} \right)$$

$$P = 0.6$$

$$L = W \times 4 = 13.5 \times 4 = 54$$

$$Qp = \frac{280 w (1 + \frac{e}{w}) (1 - \frac{p}{3})}{1 + \frac{L}{54}}$$

$$= \frac{280(13.5)(1 + 0.74)(1 - 0.6)}{1 + \frac{13.5}{54}}$$

$$= 4209.408 \text{ Pcu/hr}$$

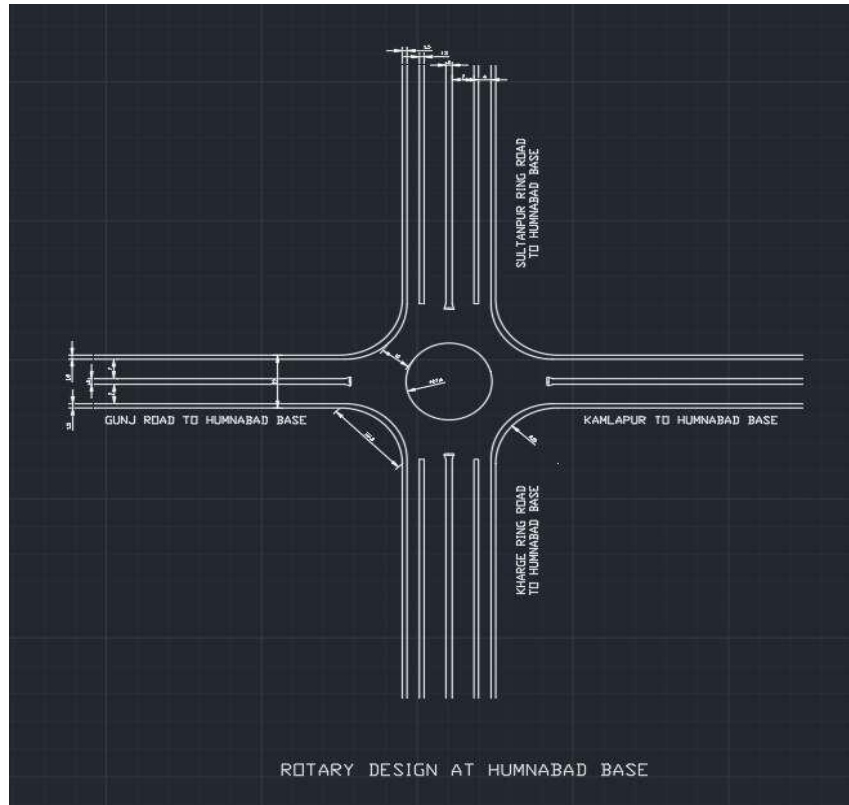


Figure 5.7: Rotary design at Humnabad base intersection

Table No 5.1 : Collection of data

VEHICLES	DAY 1 Date :- 12/09/2025	DAY 2 Date :- 13/09/2025
Two Wheelers	446	442
Auto	178	155
Car	467	448
HV	208	147
LCM	198	163
TOTAL	1497	1355

Average =
1497+1355

$$\frac{2}{2} = 1426 \text{ CVPD}$$

$$N = \frac{A \cdot D \cdot F(1+r)^{n-1}}{r} \cdot 365$$

N:- Cumulative number of standard axles to be catered in the design in terms of msa. r:- Commercial Vehicles Annual growth rate in decimal(5% as per IRC 37-2012)

n:- Design life in years.(10 years)

D:- Lane Distribution Factor (0.75 as per IRC 37-2012)F:- Vehicle Damage Factor (4.5 as per IRC 37-2012)

A:- Initial trafficin the year of completion of construction of interms of CVPD.

$$N = \frac{A \cdot D \cdot F(1+r)^{n-1}}{r} \cdot 365$$

$$N = \frac{1426 \cdot 0.75 \cdot 4.5(1+0.05)^{15-1}}{0.05} \cdot 365$$

N = 37.90 msa $\approx$ 38 msa Assume CBR 4%

Table No 5.1 : IRC 37-2001

CBR 4%					
PAVEMENT DESIGN CATALOGUE PLATE 2 – RECOMMENDED DESIGNS FOR TRAFFIC RANGE 10-150 msa (CBR 4%)					
Cumulative Traffic (msa)	Total Pavement Thickness (mm)	BC (mm)	DBM (mm)	Base (mm)	Sub-base (mm)
10	700	40	80	250	330
20	730	40	110	250	330
30	750	40	130	250	330
50	780	40	160	250	330
100	800	50	170	250	330
150	820	50	190	250	330

Interpolation for finding the total pavement thickness

30 750

50 780 , 38

By interpolation we get = 762 mm

30 40

50 40 , 38

By interpolation we get = 40 mm

30 130

50 160 , 38

By interpolation we get = 142 mm

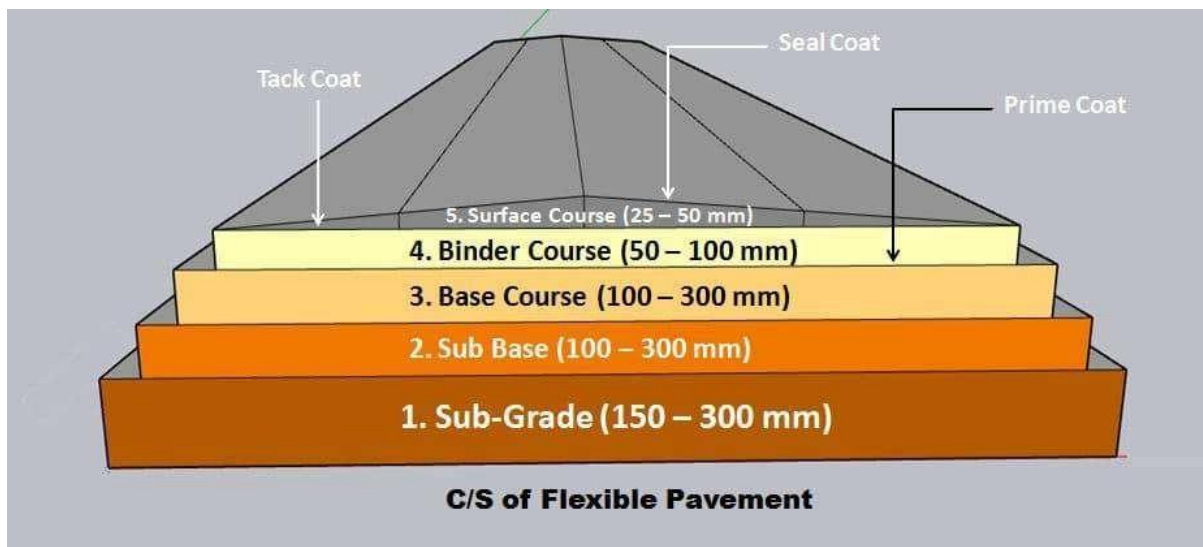


Figure 5.8: C/S of Flexible pavement

Design catalog using IRC 37-2012

For 38 msa design traffic and for CBR of 4% , following are the pavement structure thickness obtained from the code and given below in table 4.4(e) and quantity of material required Is calculated in table no 4.4(0Table no 4.4(e)pavement structure thickness

Table No 5.2 : THICKNESS OF EACH LAYERS

Layer	Thickness (mm)
Subgrade	300
Granular subbase	330
Granular Base (WMM)	250
DBM	142
BC (VG40)	40

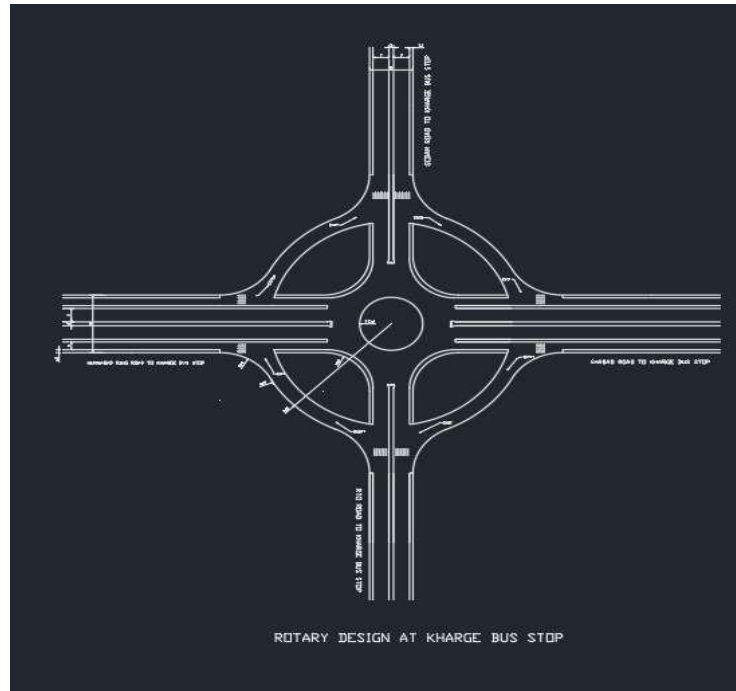


Figure 5.9: Rotary design at kharge intersection

VI. CONCLUSION

The outcome of this project is to design a rotary at intersection with IRC standards thus by providing safety and comfort to road users. Also there is a reduction of conflict among vehicles, reduce accidents during crossing, merging diverging and also avoid delays by provide proper and efficient design.

After conducting traffic volume survey, then find average daily traffic we have design circular type rotary of capacity 4209.8 PCU/hr with entry radius of 20 m, exit radius of 40 m central island of radius 27.6 m for proper functioning of traffic.

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