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Analysis of Speed-Flow Relationship of Heterogeneous Traffic – A Case Study of Selected Stretch of Dakor Road

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Abstract - The developing cities have generated the high levels of travel demand by motor vehicles in the cities. This has resulted in changing in nature of traffic characteristics on road network and ultimately it affects the capacity of roadway, level of service on stream and congestion on roadway. Flow and speed are the critical parameters used to describe characteristics of traffic flow. In this paper, the relation between speed and flow has established. The R^2 value ranges 0.33 to0.40 which shows poor relationship between them. Hence it is require to consider several other parameters. Based on v/c ratio found out on selected stretches of Dakor - Maudha road and Dakor - Umreth road, the LOS-D
Is found on Dakor – Umreth road and LOS E on Dakor – Maudha road.
Keywords: Traffic flow, speed, capacity, level of service

I. INTRODUCTION

For the growing cities transportation system development is the basic needs for its growth and economy with the same goes with the automobile too because growing city also has a growth of automobile. This has resulted in changing in nature of traffic characteristics on road network and ultimately it affects the capacity of roadway, level of service on stream and congestion on roadway. The basic studies in traffic research is that pertaining to the relationship between speed and volume of traffic. Hence reduce in speed, road accidents, traffic jam, increase in travel time etc. are resulted. Therefore, the analysis of traffic stream parameter is needed to study for the effective planning, design, operation and maintenance of roadway system.

Flow, speed, and density are the critical parameters used to describe characteristics of traffic flow. To understand traffic flow, relationships have been established between the two main characteristics: flow and velocity. Three parameters plays an important role that is speed flow and density and to characterize the relationship between them diagram is used. In capacity analysis, speed-flow relation models are used to determine the level of service. Using this level of service existing situation on the road can be known.

II. AIM AND OBJECTIVES

The aim of study is to analyze the relation between speed and flow of heterogeneous traffic on selected stretch of Dakor. The objectives of study are as following,

To develop analytical relationship speed and flow.

To determine the congestion, capacity and level of service of selected road stretch under study.

To suggest the suitable solution for the observed problem of congestion.

III. NEED OF STUDY

Dakor is a pilgrimage area it is observed that a large amount of trip attraction takes place. The surrounding area comprise of large mining activities, as a result of this major traffic observed at the site are multi axle trucks, resulting into considerable congestion. Hence it is necessary to understand the traffic behavior at the chosen site.

IV. DATA COLLECTION AND ANALYSIS

The study consist of conducting various surveys on selected stretches of Dakor. Data collection is carried out carefully as it is the raw data for final analysis. Road inventory survey, classified volume count survey and spot speed study is carried out.

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A. Road inventory survey

The road inventory survey has been done using 30 m measure tape. The road inventory details such as carriageway width, shoulder width, no. of lane are as given in Figure.

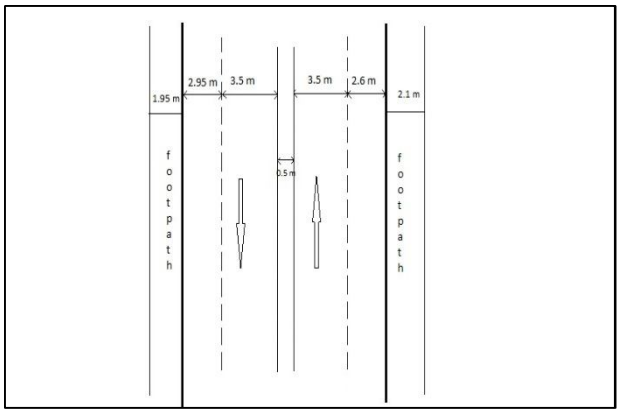

Fig. 1: Dakor to Umreth road stretch

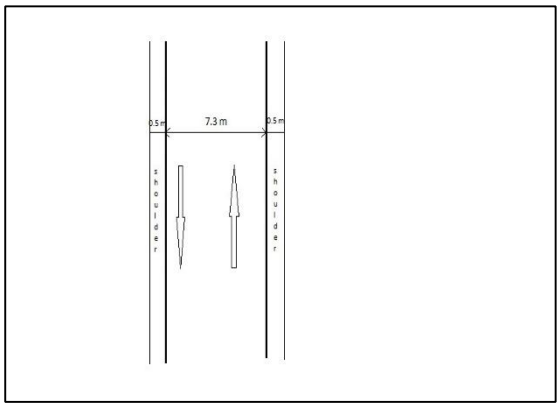

Fig. 2: Dakor to Umreth road stretch

B. Classified volume count survey

The classified volume count data was collected from two selected stretch of Dakor to Umreth road and Dakor to Maudha road by video recording technique for three days from 9:30 am to 6:30 pm for every 5 minutes time interval at mid-block section. The video camera was fixed in such a manner that each vehicle can identified on entire trap definitely at entry and exit point. The composition of different class of vehicle, traffic flow pattern, peak hour traffic volume is calculated from survey data. The following shows the result.

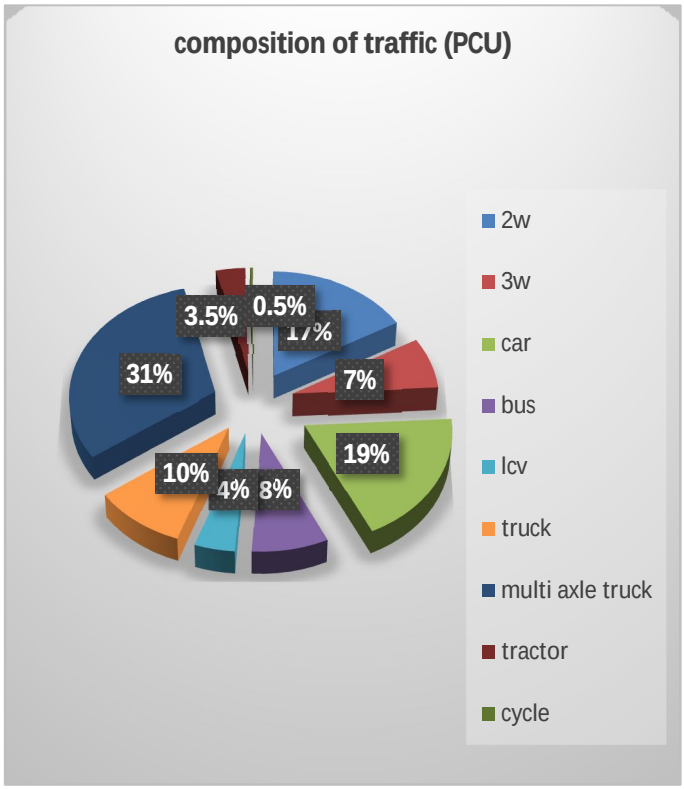

Fig 3: Traffic composition of Dakor to Umreth road stretch stretch

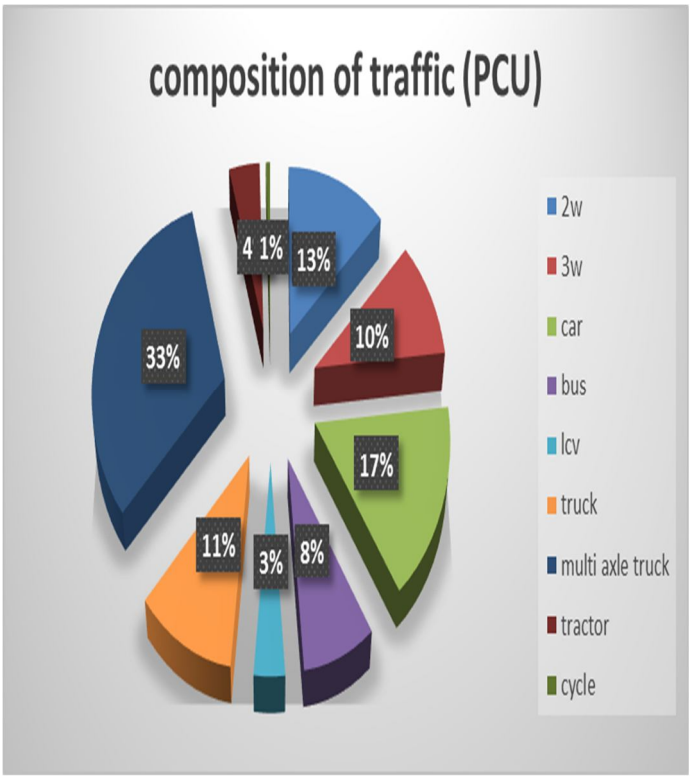

Fig. 4: Traffic composition of Umreth to Dakor road

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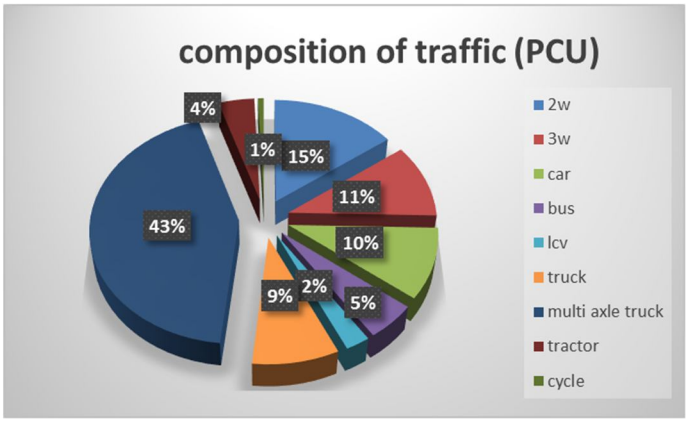

Fig 5: Traffic composition of Dakor to Maudha road stretch

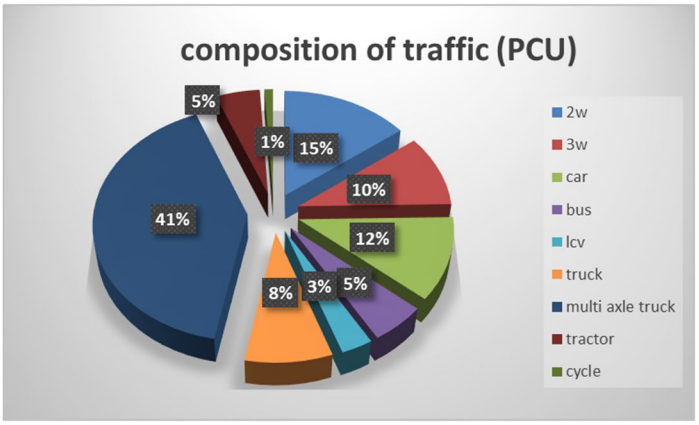

Fig 6: Traffic composition of Maudha to Dakor road stretch

The above traffic composition graph shows that the multi axle vehicle comprise of maximum percent is 31% and 33% on Dakor to Umreth and Umreth to Dakor road respectively. Similarly on Dakor to Maudha and Maudha to Dakor road the multi axle vehicle comprise of maximum percent is 43% and 41% respectively.

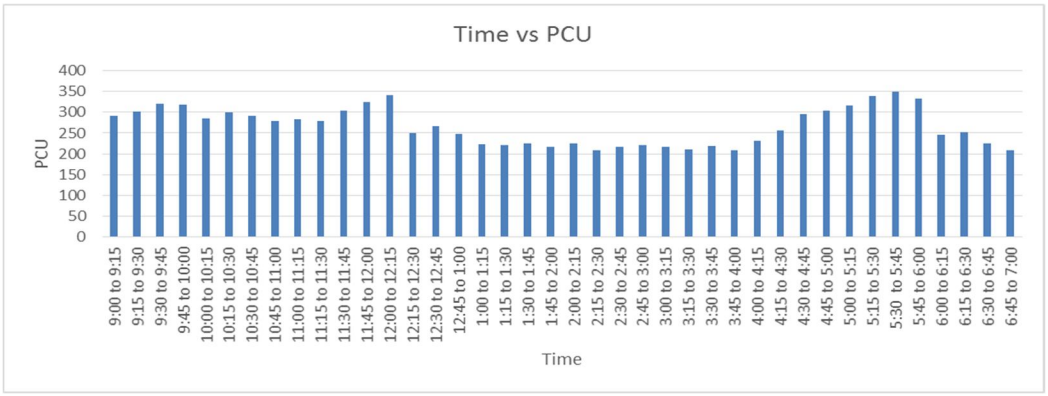

Fig 7: Time vs PCU graph at Dakor to Umreth road stretch

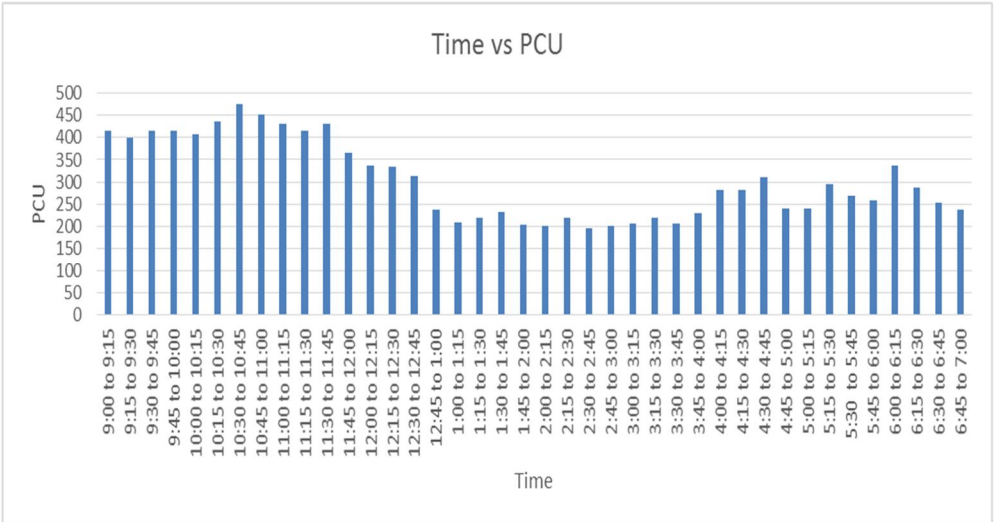

Fig 8: Time vs PCU graph at Umreth to Dakor road stretch

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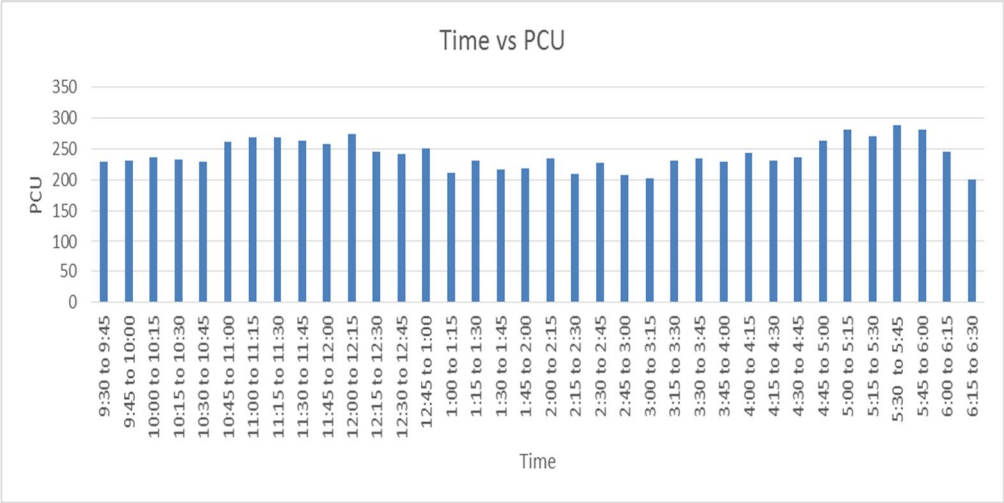

Fig 9: Time vs PCU graph at Dakor to Maudha road stretch

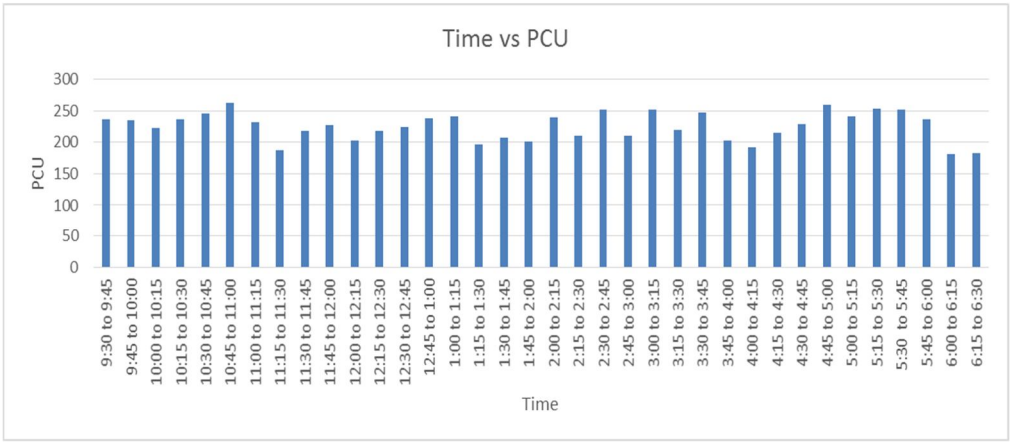

Fig 10: Time vs PCU graph at Maudha to Dakor road stretch

Above graph shows that the maximum traffic at Dakor to Umreth road stretch during 11:15 am to 12:15 pm with morning peak traffic volume 1249 PCU/hr and during 5:00 pm to 6:00 pm with evening peak traffic volume 1339 PCU/hr and the maximum traffic at Umreth to Dakor road stretch during 10:30 am to 11:30 am with morning peak traffic volume 1722 PCU/hr and during 5:15 pm to 6:15 pm with evening peak traffic volume 1395 PCU/hr. Same as on second location the maximum traffic at Dakor to Maudha road stretch during 11:15 am to 12:15 pm with morning peak traffic volume 1063 PCU/hr and during 4:45 pm to 5:45 pm with evening peak traffic volume 1101 PCU/hr and the maximum traffic at Maudha to Dakor road stretch during 10:15 am to 11:15 am with morning peak traffic volume 978 PCU/hr and during 4:45 pm to 5:45 pm with evening peak traffic volume 1007 PCU/hr.

C. Spot speed study

In a spot speed study, the video camera setup was kept on terrace of building in such a way that it covers a distance of stretch of 30 m. The time taken to cross the stretch by different class of vehicle is calculated using stop watch. Then from this time mean speed and space mean speed of different class of vehicles is calculated. Speed is one of the most important characteristic of traffic as measure of effectiveness of traffic system performance. Speed is highly sensitive to the interaction among vehicles in the stream. The spot speed study is carried out on both section of Dakor to Maudha road and Dakor to Umreth road. The time mean speed, space mean speed, standard deviation, minimum and maximum speed is calculated from spot speed data.

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Table 1: Spot speed study data on Dakor to Umreth road

Types of vehicles	standard deviation	Space mean speed (km/hr)	Time mean speed (km/hr)	median speed (km/hr)	minimum speed (km/hr)	maximum speed (km/hr)
2-w	4.77	34.35	34.98	34.19	26.34	45.19
3-w	3.79	27.50	28.02	27.64	20.69	40.91
4-w	5.90	28.57	29.57	26.67	22.27	44.08
Bus	2.66	30.38	30.64	30.17	24.60	37.24
Truck	3.07	26.59	26.98	27.27	21.95	32.14
Multi Axle Truck	4.38	26.33	27.01	25.81	20.69	36.61
LCV	5.84	34.68	35.68	37.89	22.41	43.90
Tractor	2.50	16.19	16.55	16.67	12.46	22.59

Table 2: Spot speed study data on Umreth to Dakor road

Types of vehicles	standard deviation	Space mean speed (km/hr)	Time mean speed (km/hr)	median speed (km/hr)	minimum speed (km/hr)	maximum speed (km/hr)
2-w	5.53	34.64	35.43	34.12	27.14	48.36
3-w	3.77	27.63	28.15	27.69	21.69	39.71
4-w	6.27	28.71	29.79	26.67	24.05	47.37
Bus	2.43	30.37	30.60	30.34	25.00	35.76
Truck	3.30	26.97	27.41	27.27	21.95	33.64
Multi Axle Truck	4.98	26.61	24.45	25.96	20.69	37.37
LCV	5.63	35.22	36.30	37.89	23.08	46.15
Tractor	2.86	16.63	17.04	16.67	14.06	23.53

Table 3: Spot speed study data on Dakor to Maudha road

Types of vehicles	standard deviation	Space mean speed (km/hr)	time mean speed (km/hr)	median speed (km/hr)	minimum speed (km/hr)	maximum speed (km/hr)
2-w	4.94	25.01	25.85	25.17	17014	47.79
3-w	3.18	20.98	21.47	21.09	14.40	32.14
4-w	5.08	24.59	25.55	24.94	16.0	49.54
Bus	3.83	24.06	24.66	24.27	17.76	35.06
Truck	3.70	22.03	22.68	22.86	14.98	35.76
Multi Axle Truck	3.89	19.12	19.84	19.50	14.59	28.88
LCV	3.79	22.28	22.88	22.46	15.47	35.29
Tractor	2.31	11.49	1.93	11.63	7.10	17.14

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Table 4: Spot speed study data on Maudha to Dakor road

Types of vehicles	standard deviation	Space mean speed (km/hr)	time mean speed (km/hr)	median speed (km/hr)	minimum speed (km/hr)	maximum speed (km/hr)
2-w	4.86	25.00	25.83	25.06	17.01	44.08
3-w	3.17	20.97	21.46	21.09	14.44	31.86
4-w	4.95	24.58	25.53	24.94	15.47	43.37
Bus	3.86	23.98	24.60	24.27	17.28	34.29
Truck	3.92	22.08	22.80	22.86	14.40	32.83
Multi Axle Truck	3.87	19.03	19.74	19.12	13.76	29.67
LCV	3.82	22.27	22.89	22.46	15.38	33.96
Tractor	2.47	11.50	11.98	11.63	7.27	17.09

From the above tables, the standard deviation of 2-w and 4-w are greater than other class of vehicles and so their speed is most affected by mixed traffic. The results of 15th percentile, 50th percentile, 85th percentile and 98th percentile for different class of vehicle are shown below.

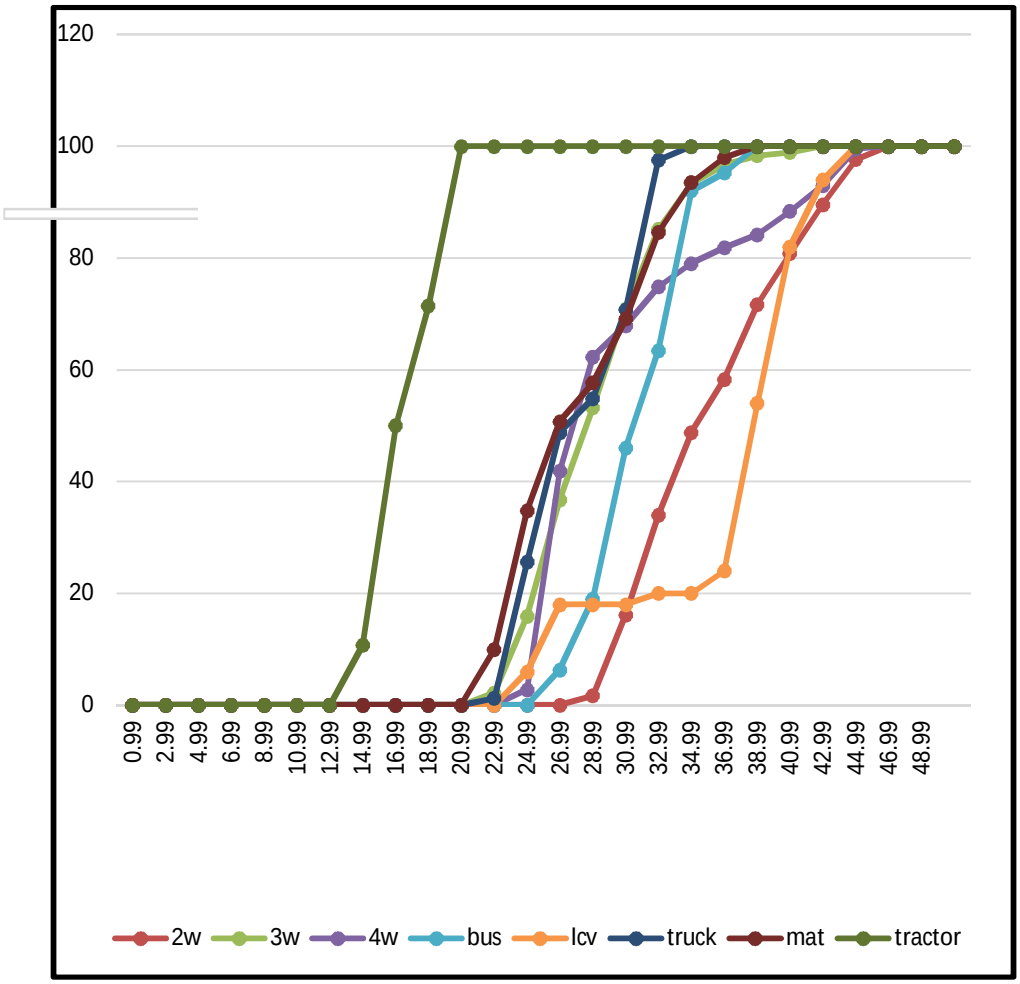

Fig 11: cumulative frequency distribution curve for Umreth to Dakor road

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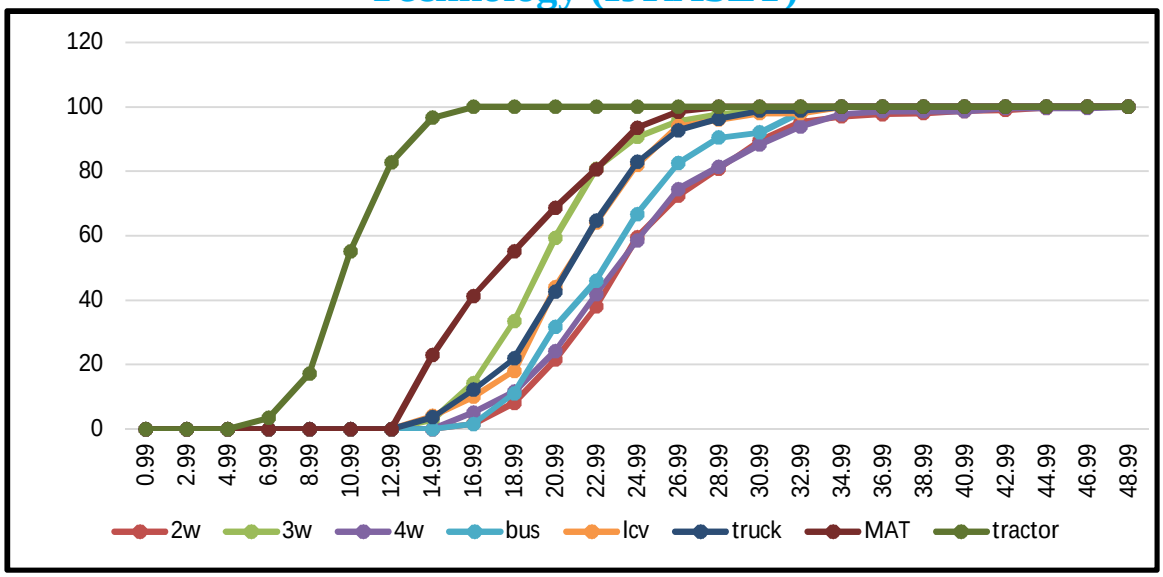

Fig 12: cumulative frequency distribution curve for Dakor to Umreth road

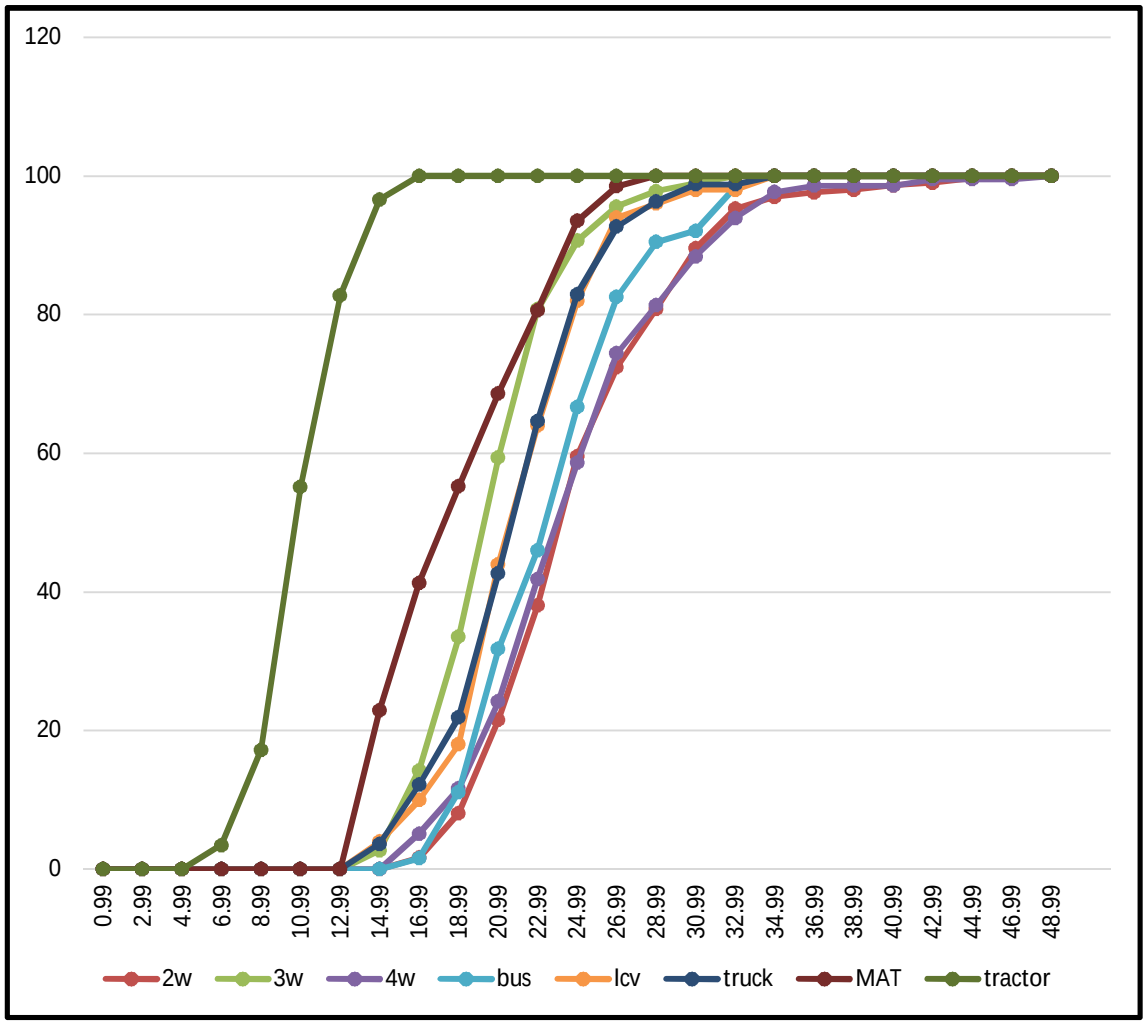

Fig 13: cumulative frequency distribution curve for Dakor to Maudha road

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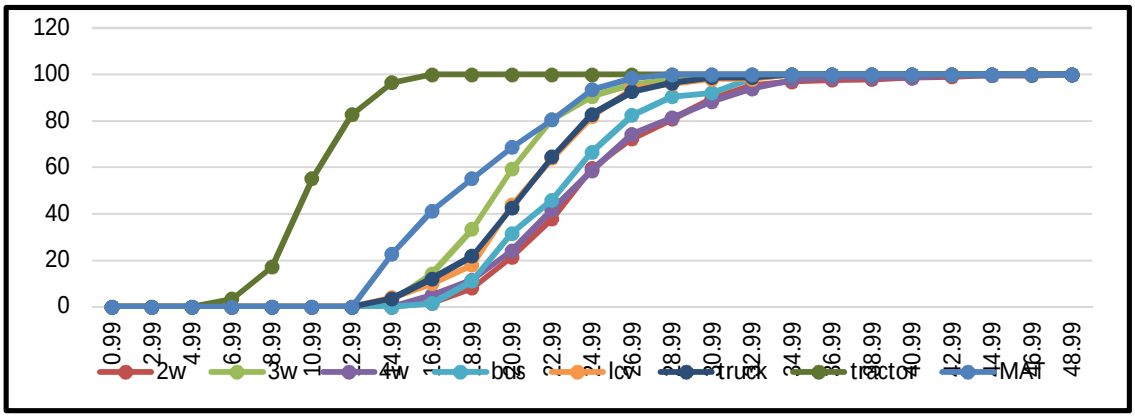

Fig 14: cumulative frequency distribution curve for Maudha to Dakor road

Table 5: Percentile speed of Different class of vehicle on Umreth to Dakor road (in kmph)

Percentile speed	2w	3w	Car	bus	lcv	Truck	MAT	Tractor
98th	44.08	37.89	43.90	36.86	43.90	32.14	35.88	22.59
85th	40.67	31.83	38.57	33.33	40.15	31.03	32.14	19.15
50th	34.19	27.60	26.67	30.17	37.89	27.27	25.81	16.67
15th	29.83	23.63	25	27.91	25.53	23.13	22.18	14.23

Table 6: Percentile speed of Different class of vehicle on Dakor to Umreth road (in kmph)

Percentile speed	2w	3w	Car	bus	Lcv	Truck	MAT	Tractor
98th	47.38	37.24	45.38	34.07	44.08	33.23	37.34	23.53
85th	41.96	32.73	38.85	33.64	40.45	31.3	33.64	20.22
50th	34.12	27.69	26.87	30.34	37.79	27.57	25.96	16.77
15th	29.88	23.68	25	27.75	25.73	23.23	22.54	14.67

Table 7: Percentile speed of Different class of vehicle on Dakor to Maudha road (in kmph)

Percentile speed	2w	3w	Car	bus	lcv	Truck	MAT	Tractor
98th	41.42	30.25	37.37	33.75	31.03	30.59	27.98	17.14
85th	30.51	24.60	30.95	28.42	26.21	26.41	24.66	15
50th	25.17	21.09	24.94	24.27	22.22	22.74	19.50	11.63
15th	21.09	18.15	20.38	20.34	19.60	18.31	17.09	9.89

Table 8: Percentile speed of Different class of vehicle on Maudha to Dakor road (in kmph)

Percentile speed	2w	3w	Car	bus	lcv	Truck	MAT	Tractor
98th	41.22	30.51	37.37	33.13	31.30	32.24	28.50	17.09
85th	30.68	24.60	31.03	28.62	26.02	26.41	24.44	14.90
50th	25.06	21.12	24.85	24.36	22.12	22.24	19.12	11.43
15th	21.59	18.65	20.85	20.34	19.69	18.42	15.56	9.59

Above table shows the 98th percentile, 85th percentile, 50th percentile and 15th percentile speed of different class of vehicle on

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selected stretch of Dakor to Umreth and Dakor to Maudha road.

D. Speed-flow relationship

Speed-flow function have been developed by several transportation experts to predict speed on the road network. From the gathered speed and flow data the relationship between speed and flow is observed. The speed-flow graph is plotted with average of space mean speed of all class of vehicle and hourly flow of vehicle in terms of PCU. The results for the Dakor to Umreth road and dark to Maudha road is given below.

The value of R^2 is ranges between 0.33 to 0.40 which are lower which means it requires more numbers of observation and more variables to be added for analysis.

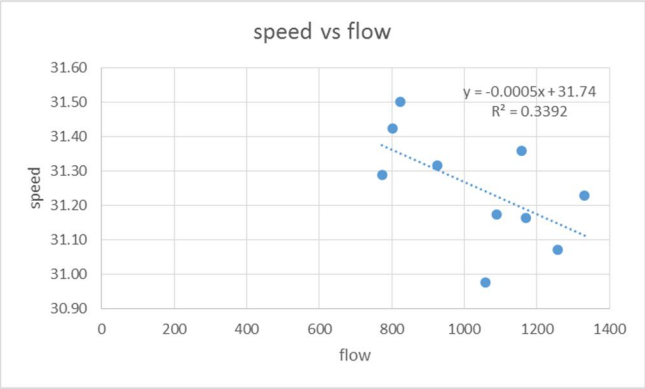

Fig 15: space mean speed vs hourly traffic flow at Dakor to Umreth road section

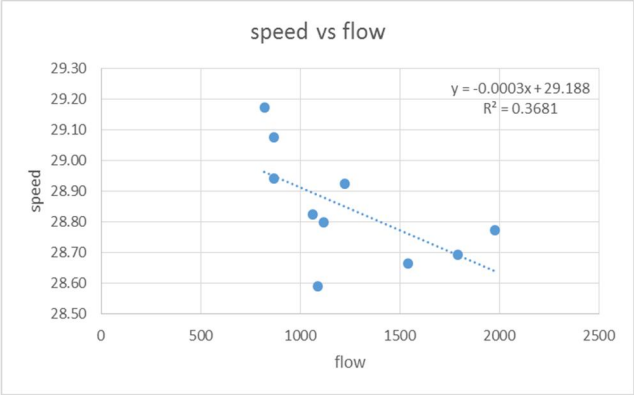

Fig 16: space mean speed vs hourly traffic flow at Umreth to Dakor road section

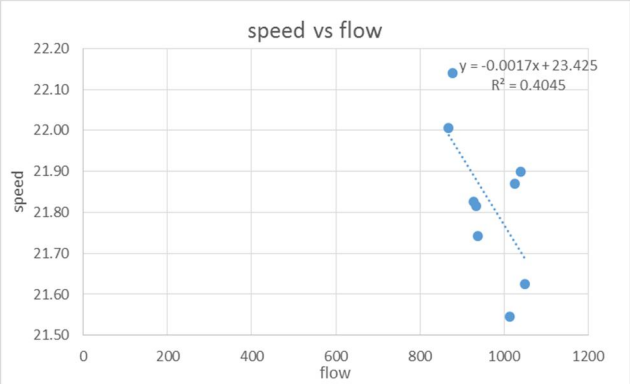

Fig 17: space mean speed vs hourly traffic flow at Dakor to Maudha road section

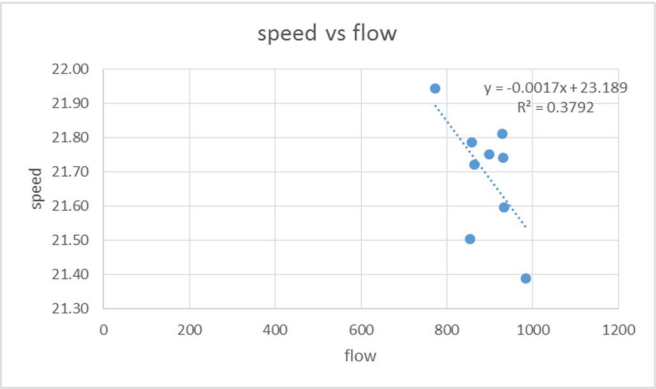

Fig 18: space mean speed vs hourly traffic flow at Maudha to Dakor road section

V. CAPACITY AND LEVEL OF SERVICE

As per IRC: 64-1990 the recommended design service volume for two lane road for plain terrain is 15000 PCU/day. From the traffic volume data the maximum flow is 1339 PCU/hr and 1722 PCU/hr on Dakor to Umreth road and Dakor to Maudha road respectively. By calculating the average v/c ratio of morning and evening peak hour for Dakor to Maudha road section is 0.93 which determines the LOS-E and same LOS is obtain for Maudha to Dakor as its v/c ratio is 0.92. Similarly for Dakor to Umreth the average v/c ratio of morning and evening peak hour is 0.87 indicating LOS D and same LOS is obtain for Umreth to Dakor as its v/c ratio is 0.86.

VI. CONCLUSION

A. After the analyzing the speed and flow rate of traffic on the road stretch it is concluded that present road on which study is conducted caters very heavy traffic but existing condition of the road is not suitable for such a heavy traffic.

B. On the Dakor to Maudha road and Dakor to Umreth road the R^2 value ranges 0.33 to 0.40 which are lesser than 0.5 which indicates poor relationship thus other several parameters should be taken into consideration like drivar's behavior, road width,

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number of lane etc.

C. LOS can be determine using v/c ratio and operating speed of vehicles. Here on Dakor to Maudha road v/c ratio comes to 0.9 and its vehicle speed is comes under the 15 percentile thus it has LOS E while comparatively on Dakor to Umreth road v/c ratio comes to 0.85 and here also vehicles are running with 15 percentile speed thus it comes under LOS D. Looking to the situation of both stretches, road should be widen to increase the capacity and improve the level of service because PCU of Dakor to Maudha road is 1722 pcu/hr while of Dakor to Umreth road is 1339 pcu/hr.

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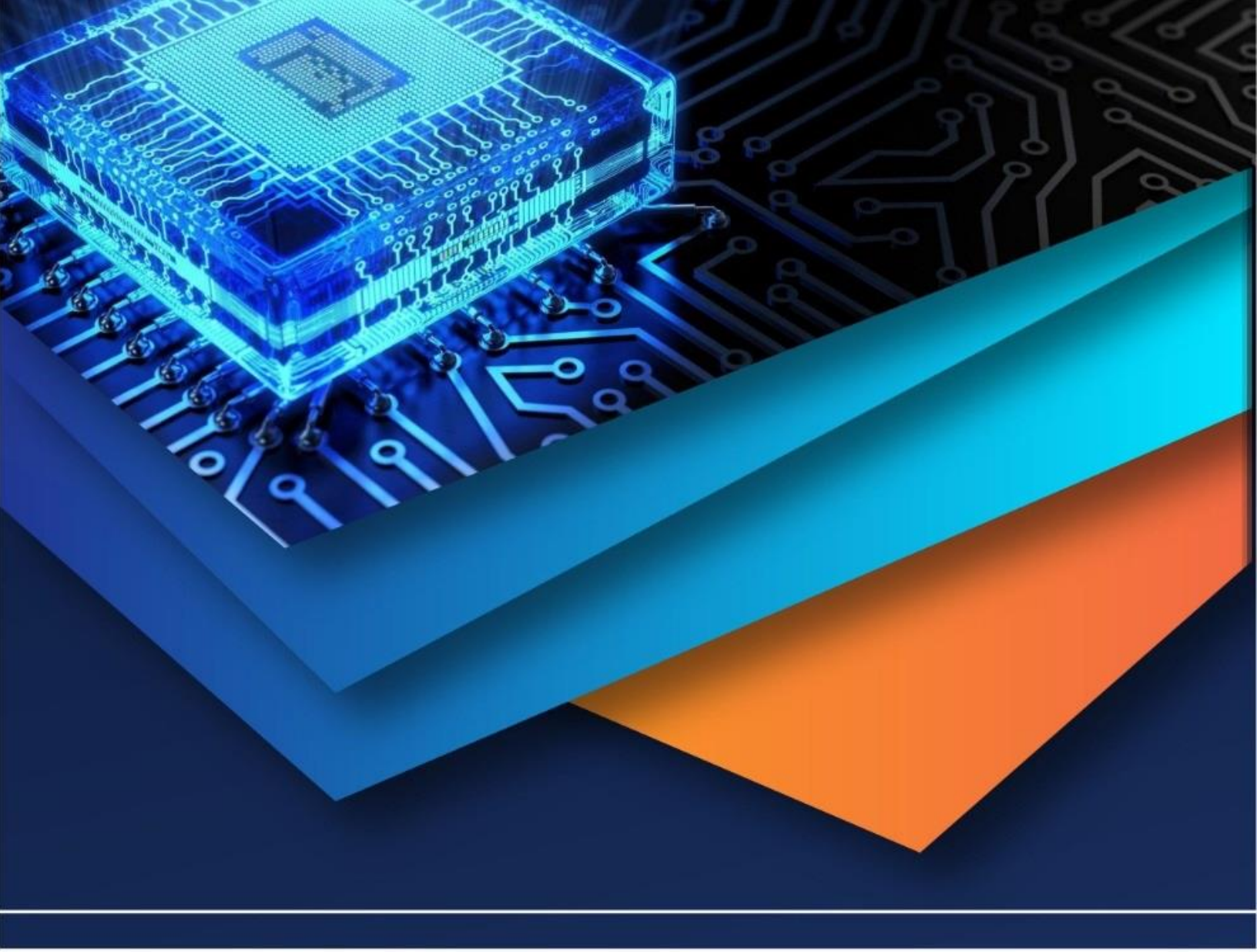

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