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Traffic Analysis and Pavement Evaluation along SH-200 (for Mhaisang-Asara Section) in Maharashtra

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Abstract: ***The globalization, rapid industrialization and urbanization leading for the continual increase in the traffic movement from last decade and the same calls for the properly designed interconnected road network. As such, in the arena of the Traffic Analysis, Pavement Design and Construction, there is an urgent need of economical and innovative Technology that provides sufficient strength and durability to pavement. Pavement gets damaged due to environmental effect and traffic movement.***
In this study, the following road project is selected for Traffic Analysis and Pavement Design/Evaluation:
"Two-Ianing of improvement to SH-200, Akola-Aapatapa-Mhaisang-Aasara Road (Mhaisang to Aasara From Km. 25/000 to 65/200) in Akola District" through Public Private Partnership on Hybrid Annuity basis under Maharashtra Road Improvement Programme (MRIP)".
Keywords: Traffic survey, Characteristic of traffic, ADT, AADT, OD survey, economic appraisal, predictions, flexible pavement design, pavement distress, IRC 37, CBR, Axle load etc.

I. INTRODUCTION

Government of India aims to improve transport efficiency of the National/State Road network, which will contribute to expansion of economic opportunities and poverty reduction. This will be realized by (i) improving the National/state highway network, (ii) facilitating safe and appropriate road usage, (iii) increasing efficiency of transport services and (iv) enhancing Government capacity for road asset development and management.

To achieve the above objectives, Government has decided to upgrade the entire single lane/intermediate lane National /State Highways to at least two-lane standards largely in consistent to Indian Road Congress (IRC) guidelines. As part of this endeavor, PWD-Government of Maharashtra has decided to undertake two-Ianing of "Improvement to SH-200, Akola-Aapatapa-Mhaisang-Aasara Road (Mhaisang to Aasara From Km. 25/000 to 65/200) in Akola District" through Public Private Partnership on Hybrid Annuity basis under Maharashtra Road Improvement Programme (MRIP).

II. REVIEW OF LITERATURE

KDM Engineers (India) Pvt Ltd (KDM) (2018) prepared the report for Traffic Study and Pavement Structural Strength survey for Saalipet Road, Near Poranki, Vijayawada, Andhra Pradesh. The report displays Composition of the commercial vehicles from the traffic count, VDF from the axle load survey and Projected MSA for the designed life of 15 years.

PradnyaMawale& Raju Narwade (2017) discusses about the Pavement Management System for Traffic Study & Analysis of SH-93. The paper presented the base year traffic data, its projections, lane capacity calculations based on LOS, and capacity augmentation requirements.

Kathleen T. Hall, et.al(2001) discussed the Rehabilitation Strategies for Highway Pavements. The report provides a step-by-step process and practical guidance for project-level evaluation and rehabilitation strategy selection for in-service pavements. Pavement rehabilitation is defined for the purposes of this Guide as a structural or functional enhancement of a pavement which produces a substantial extension in service life, by substantially improving pavement condition and ride quality. A review of the pavement rehabilitation practices of State DOTs, and the literature available on pavement evaluation, rehabilitation techniques, and selection of rehabilitation strategies, was conducted for the project.

Pranshul Shahua & Ritesh Kamble (2017) discussed that the thickness of pavement varies with the change in the value of C.B.R. With higher value of C.B.R. the pavement thickness is less and vice versa. Following are the important highlights from their study:

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1) From their experimental results it has been observed that the soil SC-SM with 10% fly ash is suitable for the construction purpose for soil subgrade in comparison with only soil, soil with 5% fly ash and soil with 15% fly ash on the basis of higher values of CBR.
2) Due to the saving in Pavement thickness is less quantity of material will be applicable so that, huge amount of money can be saved.
3) Due to the higher value of CBR for 10% fly ash with soil will be more durable compared to 5% and 15% of fly ash with soil and also with only soil.
4) Further this Research work can be carried with different materials to improve CBR values and also with different Soaking Conditions.

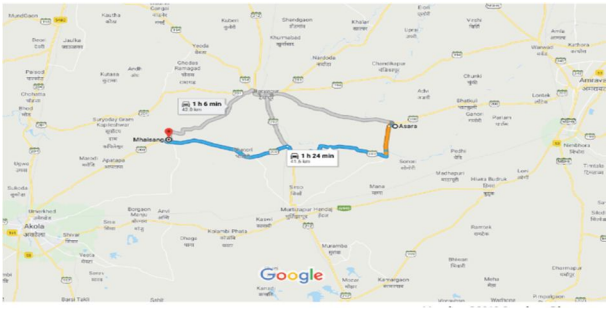
III. METHODOLOGY

To fulfil the objective of the scope the work was divided in three parts, viz. count, O & D and axle load.The methodology adopted for the same is enumerated below:

1) Area Survey
2) Physical Traffic Count
3) Origin & Destination Sample Study
4) Axle Load Survey
5) Development Study of the service area
6) Observations
7) Correlation to Data
8) Traffic Projections

A. *Area Survey*

The team jointly visited the site with Authority (PWD Officials) and subsequently commenced the reconnaissance survey and secondary data collection to carry out the study of project site and service area. The project road stretch under consideration from Mhaisang to Asara (Km 25/000 to Km 65/2000) is part of SH 280, in Murtijapur Tal. of Akola District.



The classified traffic volume count surveys have been carried out for 7 days (continuous, direction-wise) at the selected survey stations indicated below. Keeping in view the vehicle classification system given in IRC codes (IRC: 9, IRC SP: 19), the following generalized classification system has been used recording the classified volume count.

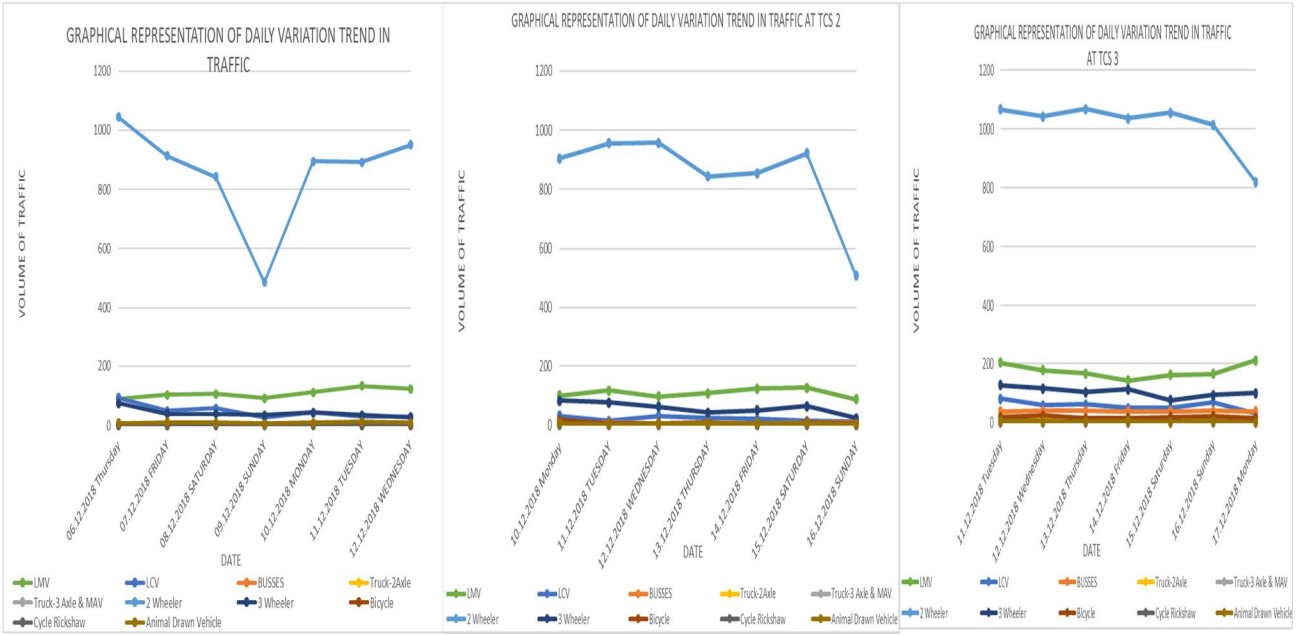
Classified Volume Count

Motorized Traffic			Non-Motorized Traffic
2-Wheeler			Bi-Cycle
3-Wheeler			Cycle-Rickshaw
Passenger Car			Animal Drawn Vehicle (ADV)
Utility Vehicle (Jeep, Van, etc.)			Hand Cart
			Other Non-Motorized Vehicle
Bus	Mini Bus, Standard Bus		
LCV	Passenger	Freight	
Truck	MCV: 2-Axle Rigid Chassis		
	HCV: 3-Axle Rigid Chassis		
	MAV	Semi Articulated	
		Articulated	

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B. Daily Traffic Vriation

Daily variation of traffic volume of Seven days at count stations on the project corridor is presented graphically in following Figure at the respective count stations.



C. Origin & Destination Survey

Sample O & D survey is carried out to determine the traffic flow pattern which helps in understanding –

1) The likely utilization of the proposed project facility
2) The extent of the service area
3) The business linkages and
4) Assessment of material composition of the traffic and the sustainability of the same.

The information collected in O&D survey using questioning technique included the state in which the vehicle is registered, origin of journey, destination, kind of material, knowledge of the driver regarding alternate route(s) and if so and his specific choice to follow this route.

Zone wise Distribution of Traffic

Zone No.	ZONE	TOTAL VEHICLES	% CONTRIBUTION
1	Akot, Daryapur, Kholapur, Runmochan	8	38.10%
2	Bhatkuli, Hendaj, HiwaraBudruk, Loni, Nimbhora	5	23.81%
3	Anbhora, Ganoja, Mana, Murtijapur, Sonori	8	38.10%
	TOTAL	**20**	**100%**

D. Analysis Of Axle Load Survey

Traffic loading has a significant impact on pavement performance and design because the damage that vehicles cause to a road depends on several factors such as gross load, tyre pressure, type of load, number of wheels and type of wheel configuration, number of repetitions, sub grade properties, climatic conditions and type of material used in pavement. Knowledge of axle loading and the spectrum of axle loads of vehicles using a highway system are necessary in the development and application of realistic pavement design and maintenance procedures. The maximum number of goods vehicles and buses, travelling in both the directions was intercepted to record their load using electronically operated Axle Load Pads.

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E. Traffic Projections

As stated above the ADT figures for short duration surveys are applied with the correction factor to arrive at the base figures. On applying other correction factors and the growth rates as stated above the traffic figures are projected for the concession period (10, 15, 20, 25 & 30 years) for all the TCSs & homogenous sections.

8.70% growth rate adopted for all the type of vehicles. The growth was estimated on an unconstrained capacity scenario in order to assess the maximum extent of traffic flow in the corridors under consideration.

IV. DATA ANALYSIS AND RESULTS

The collected data have been corroborated and arranged for processing.

A. Factors for AADT

1) Seasonal variation and pilgrimage factor

2) Based on APMC DATA

Based on the above data and its analysis, the Correction Factors for AADT calculated as given below:

Sr. No.	Category	Correction factor
1	LMVs	1.00
2	LCVs	1.05
3	BUSES	1.00
4	Trucks-2Axle	1.05
5	TRUCKs-3Axle & MAVs	1.05
6	2 Wheelers	1.00
7	3 Wheelers	1.00
8	NON-MOTORIZED VEHICLES	1.00

B. Traffic Demand and Forecasting

In general, the factors which influence the growth of traffic are:

- Economic (Gross National Product / Gross Domestic Product, Agricultural Output, Industrial Output)
- Demographic (Population, Rural / Urban mix of population, Income)

To establish the future traffic growth rates, following approaches have been explored:

- Past trends in Traffic growth over Project Road.
- Growth of registered motor vehicles.
- Region Vehicle Growth Criteria method
- National Standard Growth Rates
- Transport demand elasticity approach (IRC 108)
- Growth Rate Projected by Research Organization:

The outcome from the above is given in the table below:

S.N	Method of Traffic Forecasting	2-Wheelers	Cars/Jeeps /Taxis	Bus	Goods Vehicles
1	Time Trend analysis	11.69	12.91	5.23	9.54
2	National Standard Growth Rate	8.20	11.10	6.60	7.50
3	As per IRC-108, NSDP Method	8.70	8.70	8.70	8.70
4	Based on Research Organization	11.87	9.31	5.93	5.47

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C. Pavement Design

The Pavement Design for New Flexible Pavement carried out considering the parameters such as -

1) CVPD,
2) Traffic Growth Rate,
3) VDF,
4) Lane Distribution Factor (Lane width vis-à-vis guidelines provided under respective IRC Code),
5) Design Life,
6) CBR of the subgrade soil.

Further, the analysis and design for provision of Overlay on the existing road is based on the parameters such as

a) BBD Survey Test results for characteristic deflection,
b) Guidelines provided by IRC 81 for thickness of overlay

D. New Flexible Pavement Design

In accordance with IRC: 37, more than 3 tones laden weight vehicles are considered for design. The following vehicles are considered in commercial vehicle category for design calculations:

- ***Light Commercial Vehicle, Bus, Two Axle Truck, Three Axle Trucks, Multi Axle Trucks***

The summarized statement of CVPD to be used for pavement design is as given below:

TRAFFIC COUNT STATION	CVPD				
	LCV	BUS	TRUCK 2 AXLE	TRUCK 3 AXLE & MAV	TOTAL
TCS 1 @ village Mhaisang	48	4	2	1	55
TCS 2 @ village Shelu Bonde	21	8	1	0	31
TCS 3 @ village Shelu Bazar	57	39	16	3	115

E. Traffic Growth Rate

As per the guidelines given under clause no 4.2.2.2 of IRC 37, the average annual rate of increase in traffic to be considered as 5.0 %. However, based on the traffic surrey and analysis report, the growth projection based on IRC 108, the growth rate of 8.7% for all the TCSs adopted for pavement design.

F. Axle Load Survey and Vehicle Damage Factor

The guidelines used for Vehicle Damage Factor (VDF) in estimation of cumulative msa for thickness design of pavements. The Vehicle Damage Factor (VDF) is a multiplier to convert the number of commercial vehicles of different axle loads and axle configuration into the number of repetitions of standard axle load of magnitude 80 kN. It is defined as equivalent number of standard axles per commercial vehicle. The VDF varies with the vehicle axle configuration and axle loading.

Axle load survey was carried out to get the spectrum of loading pattern, which affect the pavement, and also to arrive at Vehicle Damage Factor (VDF) for the design of pavement.

For Pavement design, the VDF of 3.5 is adopted.

G. Lane distribution Factor

The design shall be based on 50% of the total number of commercial vehicles in both directions.

H. Design Life

The design life shall be considered as 15 years.

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I. Material Investigation for Pavement Design

The main objective of material investigation is to determine the strength of the existing Sub soil/subgrade of the road pavements structure along the alignments. The objective for investigation on existing crust materials is to ascertain the suitability of the material as a fill for additional crust and use as existing subgrade or new subgrade with selected material and also to ensure that adequate quantity of material is available in the identified areas.

By considering existing available compacted subsoil the effective CBR 8% is considered for further design process.

J. Design of Overlay

1) The deflections measured by BBD are influenced by the Pavement temperature, seasonal variation in climate.

2) Correction for Temperature: The corrections for temperature vis-à-vis standard temperature of 35^0C are applied. Correction for temperature variation on deflection values measured at pavement temperature other than 35^0C should be 0.01 mm for each degree centigrade change from the Standard temperature of 35^0C. The correction will be positive for the pavement temperature less than 35^0C and negative for pavement temperature more than 35^0C.

3) Correction for seasonal variation: Correction for seasonal variation shall depend on the type of subgrade soil, its field moisture content (at the time of deflection survey) and average annual rainfall in the area.

- The subgrade soil test results given shows that the soil is **"Clayey with high plasticity (PI > 15)"**.
- From the information collected, the Average Annual Rainfall in the area is 859 mm (@ 33 inch). Thus, it comes under "Low Rainfall Area".

4) Overlay design for a given section is based not on individual deflection values but on a statical analysis of all the measurements in the section corrected for temperature and seasonal variations.

Thus, the data corroborated was analyzed for calculation of mean deflection, standard deviation and characteristic deflection.

Based on the results of the Characteristic Deflection (Dc) values obtained as per Clause 2.4 of (B) above and the designed traffic in terms of cumulative number of standard axles (MSA) computed as per clause 7 of (A) above, the minimum overlay thickness (in terms of bituminous macadam) is calculated.

As per IRC, the equivalency factors for converting the BM shall be given as:

1 cm of BM = 1.5 cm of WBM/WMM/BUSG
1 cm of BM = 0.7 cm of DBM/AC/SDC.

V. RESULT

1) Summary of Projected Total Traffic Volume for First Traffic Volume Count Survey:

Sr. No.	Year	Mhaisang		Shelu Bonde		Shelu Bazar	
		AADT	PCU	AADT	PCU	AADT	PCU
1	2018 Base Year	1080	816	1059	716	1433	1089
2	2019	1174	886	1151	777	1558	1183
3	2024	1775	1337	1746	1174	2363	1795
4	2029	2689	2024	2644	1775	3582	2722
5	2034	4075	3066	4011	2686	5432	4133
6	2039	6180	4652	6087	4073	8240	6275
7	2044	9373	7056	9236	6173	12501	9526
8	2048	13081	9849	12896	8613	17448	13300

As per the traffic projection, the Daily Traffic volume will be below 15000 PCUs upto 2048 in the entire length of the corridor. The two lanning would thus be sufficient for this section upto the year 2048 or even beyond.

2) Pavement Design – New Crust / Reconstruction/Widening portion

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Design Life - 15 Years
Traffic MSA – 5 MSA
CBR of soil - 8%
Carriageway - Two Lane/Intermediate Lane Undivided

Design Layers (New Pavement = 975mm)
Subgrade - 500 mm (CBR 8 % Min)
Granular Sub Base (GSB) - 150 mm
Wet Mix Macadam (WMM) - 250 mm
Dense Bituminous Macadam (DBM) - 50 mm
Bituminous Concrete (BC) - 30 mm

3) Pavement Design – Overlay portion

Overlay design for a given section is based not on individual deflection values but on a statistical analysis of all the measurements in the section corrected for temperature and seasonal variations.

Thus, the data corroborated was analyzed for calculation of mean deflection, standard deviation and characteristic deflection.

Based on the results of the Characteristic Deflection (Dc) values obtained as per Clause 2.4 of (B) as 2.14mm. and the designed traffic in terms of cumulative number of standard axles (MSA) -5 MSA computed as per clause 7 of (A) above, the minimum overlay thickness (in terms of bituminous macadam) is calculated as below:

As per IRC, the equivalency factors for converting the BM shall be applied.

Thus, Overlay Crust composition for this shall be:

FOR SECTION 25+000 TO 35+980

BC	25	MM
DBM	50	MM

V. CONCLUSION

1) Traffic indicates that the traffic is largely of local nature.
2) The graph of daily variation indicates that the traffic is almost uniform in volume for all days of the week pursuant to the vehicular composition. On Sunday it dips slightly. This is a typical characteristic of traffic with local component overweighing the composition.
3) Since the traffic is governed by intra district & State factors to a large extent the sustainability of the traffic is assured.
4) The probable diversion factor would be nil as the project road acts as the linkage for the 27 villages situated along the stretch.
5) Result of O & D survey Shelu Bazar shows that the traffic on the stretch is largely of local nature.
6) For calculating the growth rate, NSDP of Maharashtra State from the Statistical Department of India and Elasticity factors as per the guidelines of ADB are adopted.
7) Pavement Design for New Crust/Reconstruction/Widening portion:

Design Traffic (MSA) 15 Years	CBR of Subgrade (%)	Proposed Minimum Pavement Thickness (mm)				
		BC	DBM	WMM	GSB	Total
5	8	25	50	250	150	475

8) Pavement Design for Overlay:

Description	BC	DBM
For Stretches proposed for overlay only	25 mm	50 mm

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VI. RECOMMENDATIONS FOR FUTURE WORK

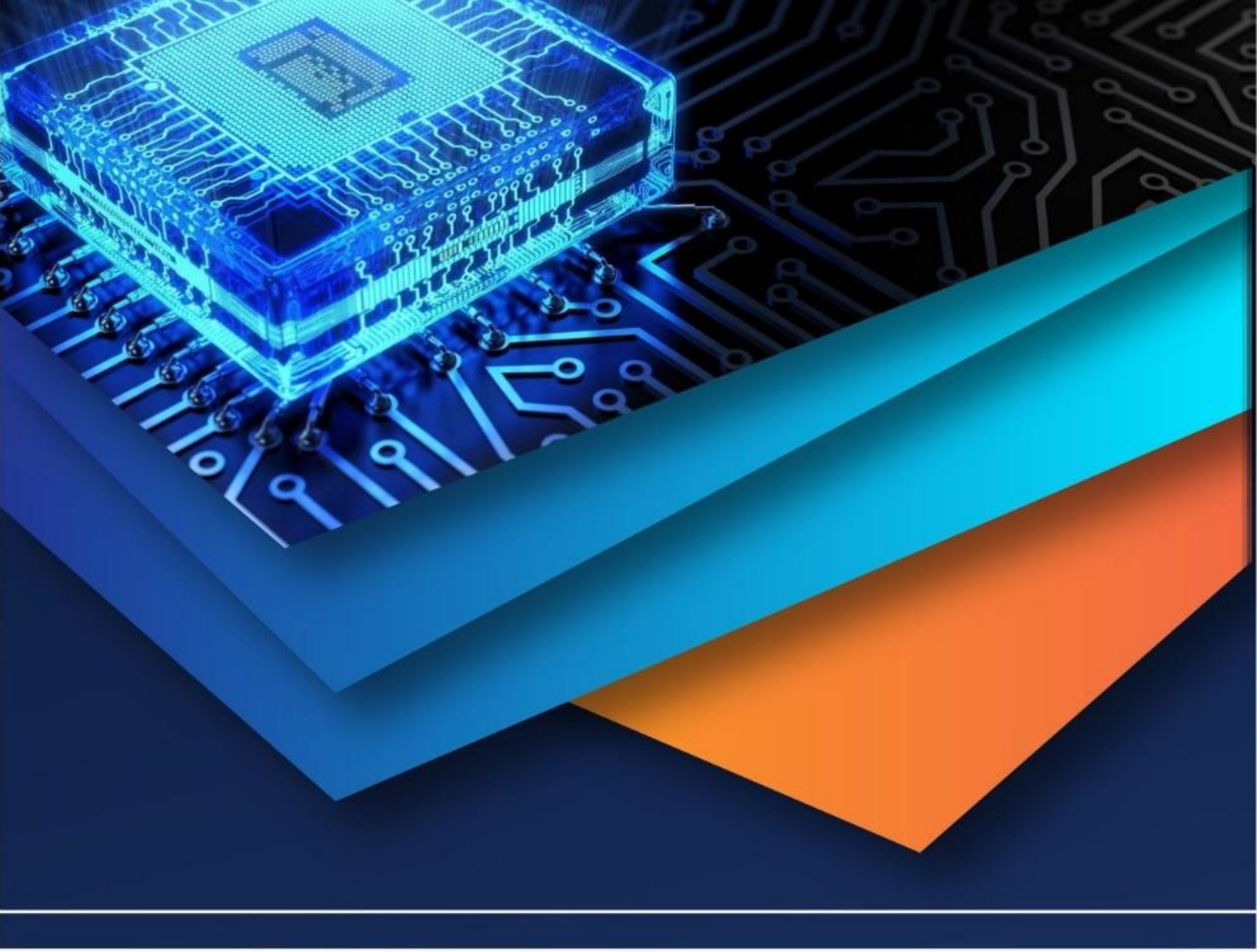
A. The vehicle counting operations carried by Manual methods generally not provide accurate results. The counting by mechanical means will give accurate results. The same need to be adopted.

B. The geometrical improvement proposal for the project is subjected to FUND ALLOTED for the work. As such, many parameters need to be curtailed out for implementing the project. As such, proper allocation of the FUND to be ensured.

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