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THE STUDY OF ROAD WIDTH ON PASSENGER CAR UNITS (PCU) OF VEHICLES UNDER HETEROGENEOUS TRAFFIC CONDITIONS

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Abstract: Passenger car units (PCU) are used to represent the effects of varying mixed vehicle types on traffic stream. In this paper the required data is collected at eight sections of main highways of Nepal using a digital video recorder which eventually analyzed the traffic characteristics and PCU values was calculated. The study found traffic composition of Bus, Truck, LCV and Car are increasing with the increase in carriageway width but the composition of volume is found to be highest in smaller carriageway width. The speeds of all categorized vehicles are increasing linearly with the increase in carriageway width. It is found that PCU values obtained for motor cycle from all sections are smaller than the values given in NRS and for Bus, Truck, LCV found higher than the value given in NRS 2070 .This study has shown the impact of lane width on the PCU for different categories of vehicles on a Highways. It is found that the PCU for a vehicle type increases with increasing carriageway width.

Keywords: Traffic composition, Speed, Passenger Car Units

I. INTRODUCTION

Nepal road traffic is heterogeneous in nature consisting of vehicles of wide ranging physical dimensions, weight and power sharing the same lane. It is not feasible to improve the standard of road by very small increments and it is standard practice to design and construct new roads and improvement works to withstand the estimated traffic at some future date. In Nepal this forward period (perspective period) shall be 20 years, i.e. roads shall be designed with a capacity sufficient to cater for the estimated traffic volume 20 years after the date of completion of the works.

Different types of vehicles take up differing amounts of road space and have different speeds (For geometric design) and impose differing loads on the road structure (For structural design. It is, therefore, necessary to adopt a standard traffic unit to which other types of vehicles may be related. For geometric design of roads this standard is the 'Passenger Car Unit (PCU)' which is that of a normal car (passenger car), light van or pick-up. Other types of vehicles are taken into account by multiplying by the following equivalency factors (Nepal Road Standard 2070).

In Nepal, Nepal Road Standard 2070 and Nepal Rural Road Standard 2071 has specified PCU values for different ehicle types also such as car, truck, trailer tractors, handcarts, motor cycle, rickshaws, bullock carts etc. and these values are adopted from Indian road standards for rural and urban roads. The present study was undertaken to identify the effect of width of the carriageway as the lane concept is not strictly followed in Nepal and vehicles tend to move abreast. The term carriageway is used in Nepal for the total width of paved surface of a road excluding its shoulders on the capacity of a two-lane road under mixed traffic conditions.

II. MATERIALS AND METHODS

The key step by step procedures for applying methodology for determining PCU and its relationship with lane width for the study area are:

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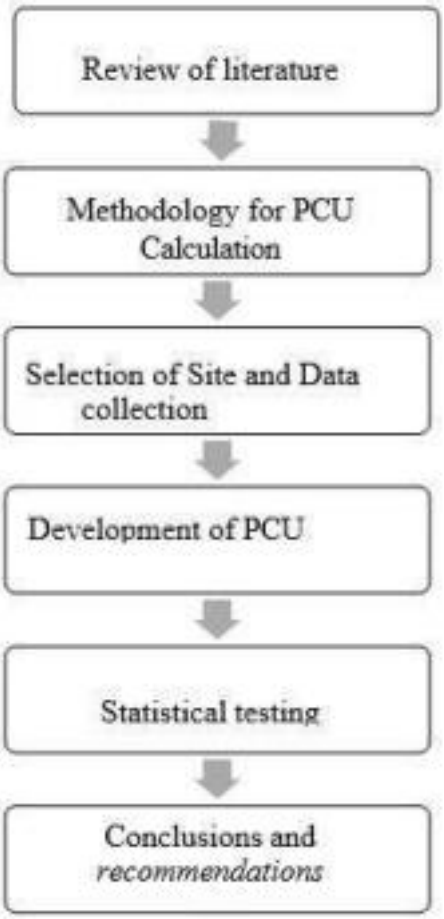

Source of Data

Primary data collected for this study. All the required information is collected from the required section via video-graphic recording. The necessary data were extracted manually via video replaying. Other useful information was recorded on field sheets. No any secondary data was used during the study.

Site Selection

The sites were selected so as to satisfy the following requirements:

1. There is flow of traffic all classified vehicles required for our study and of variable road width section.
2. It is away from bus stops and other facilities, which may cause the traffic flow to halt.
3. The section is straight and level.
4. An attempt was made to collect data at sites where the directional split of traffic was in the narrow range of 50 – 55%.
5. Data for this study was collected at eight different locations on highways in Nepal.

Location1: Dharke, Naubise

It is a section of Prithvi highway that is having a road width of 6.8 m with a good paved surface and both side shoulder of width 0.8m which is graveled surface. It is free from any encroachment and obstructions.

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Figure 1: Dharke Site

Location 2: Manhari, Hetauda

It is a section of E-W highway that is having a road width of 6.7m with a good paved surface and both side shoulder of width 0.8m which is graveled surface. It is free from any encroachment and obstructions.

Figure 2: Manhari, Hetauda Site

Location3: Sanga

It is a section of Araniko highway that is having a road width of 6.6m with a good paved surface and both side shoulder of width 0.5 m which is graveled surface. It is also free from any encroachment and obstructions.

Figure 3: Sanga Site

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Location 4: Budol, Kavre

It is a section of Araniko highway that is having a road width of 6.5 m with a good paved surface and both side shoulder of width 0.3 m which is graveled surface**.**

Figure 4: Budol Site

Location 5: Pashupatinagar, Hetauda

It is a section of E-W highway that is having a road width of 6.4 m with a good paved surface and both side shoulder of width 0.8 m which is graveled surface**.**

Figure 5: Pashupatinagar, Hetauda Site

Location 6: Panchkhal

It is a section of Araniko highway that is having a road width of 6.1m with a good paved surface and both side shoulder of width 0.8 m which is graveled surface**.**

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Figure 6: Panchkhal Site

Location 7: Jhallari

It is a section of Jhallari, Mahendranagar section of East-West Highway having a road width of 5.8 m with a good paved surface and both side shoulder of width 0.7 m which is graveled surface**.**

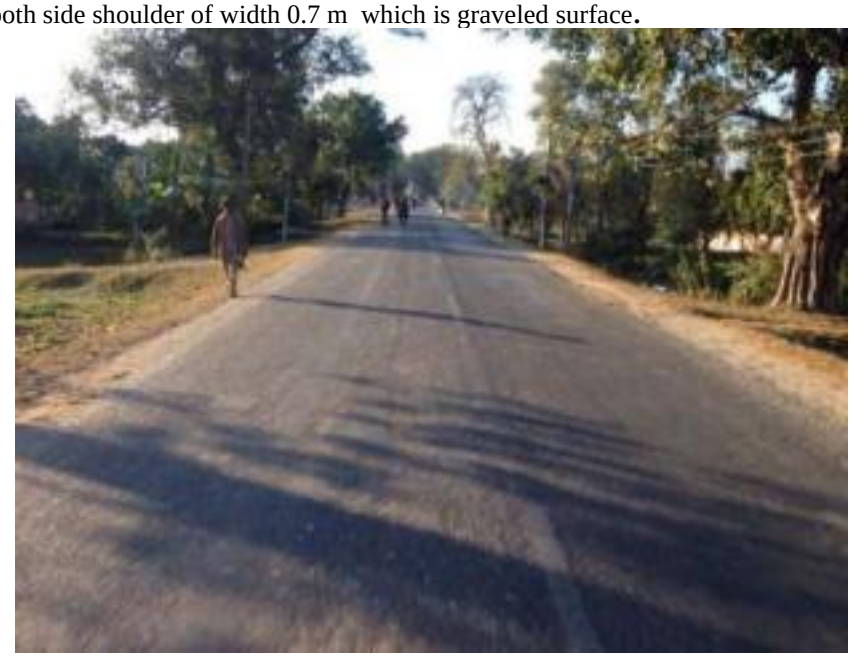

Figure 7: Jhallari Site

Location 7: Kolfutar, Nuwakot

It is a section of roadway between Galchhi, Dhading to Bidur, Nuwakot having a road width of 5.1 m with a good paved surface and both side shoulder of width 0.3 m which is graveled surface.

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Figure 8: Kolfutar Site

Data Collection and Extraction

- ·The video recording technique was used to collect the data. A longitudinal trap of 20 m was made on the carriageway for the measurement of speed.
- The video camera was mounted on the stand and placed sufficiently high so as to cover the total trap length with some margin on either side. The timer in the camera was switched on and the recording was done for about 4 – 5 hrs on a typical weekday.
- These data were supplemented with manually collected data on the road width, shoulder width, and shoulder condition. The details for these recorded data at each section selected for study is included in Annex-I.
- The recorded film was played on a large screen television and the desired information has been extracted. To make the analysis meaningful, the vehicles were divided into five different categories as shown in Table 3.1. The average dimensions of each vehicle category were measured either by actual field measurements or from the data available on supplier websites in Nepal. Average dimensions and projected rectangular areas as per survey of each type of vehicle category are also given in Table 3.1.
- The average time taken by each vehicle type to travel the trap length was measured by the time displayed on the screen with an accuracy of 0.1 s. This time has been noted to calculate the speed of a vehicle passing through the section and minimum 300 data of each type of vehicle were extracted from every site.

Table 1: Vehicle Categories and their Average Dimensions

Category	Vehicles included	Average dimension		Projected Area on Ground (m^2)
		Length (m)	Width (m)	
Bus	Buses	11.12	2.49	27.74
Truck	Truck	7.5	2.35	17.62
Lcv	Minibus,mini truck, micro bus	6.10	2.10	12.81

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Cars	Car, jeep, van	3.74	1.44	5.39
Two-wheeler	Scooters, motorcycles	1.87	0.64	1.2

III. RESULTS AND DISCUSSION

The proportion of vehicles in a traffic stream is very important parameter for geometric and structural design of any pavement. Analysis of traffic composition gives the idea of proportion of wide variety of vehicles. The study shows that two wheeler i.e. Motor cycles have the highest percentage in the traffic stream and truck, light commercial vehicle has the lowest percentage in the traffic stream and percentage of car shows slightly variation in volume of traffic. All these traffic distributions at different locations are presented through Table4.1.This study
Shows that two wheelers traffic is predominant at all the locations and the percentage shares of other vehicles are also given.

Table 2 Traffic Distribution at Different Locations

Section Name	**Traffic Distribution of different vehicle (%)**				
	Bus	**Truck**	**LCV**	**Car**	**Two-wheeler**
Dharke	13.3	2.7	7.3	17.1	59.6
Manhari	12.8	2.5	7.0	16.9	60.8
Sanga	10.5	2.1	6.7	16.5	64.2
Budol	13.5	1.8	5.8	16.2	62.7
Pashupatinagar	7.5	1.75	5.1	15.8	69.85
Panchkhal	6.6	1.6	4.8	14.2	72.8
Jhallari	15.8	1.4	4.5	14.1	64.2
Kolfutar	15.1	1.2	3.9	13.7	66.1

Speed Distributions

The PCU factor is based on the mean speed values of different vehicle classes. This is calculated by dividing the mean speed value of passenger cars by the mean speed value of any vehicle class. Therefore, a longitudinal trap of 20 m was made on the carriageway for the measurement of speed. The video was recorded and recorded film was played on a large screen television and the data was extracted. The average time
Taken by each vehicle type to travel the trap length was measured by the time displayed on the screen with an accuracy of 0.1 s with the help of stop watch. This time was used to calculate the speed of a vehicle passing through the section. The average speed of different vehicle at different section of highways is illustrated in Table 4.2 below.

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Table 3: Average Speed of Vehicles at Different Locations

Section Name	Speed of different vehicle (km/hr)				
	Bus	Truck	LCV	Car	Two-wheeler
Dharke	62.32	58.10	60.03	65.95	53.73
Manhari	61.68	57.27	59.37	64.98	53.47
Sanga	60.29	56.68	58.14	63.40	52.50
Budol	59.45	55.96	57.44	62.40	51.80
Pashupatinagar	59.16	54.99	56.69	61.12	51.06
Panchkhal	57.92	53.38	55.13	59.23	50.06
Jhallari	55.68	51.43	55.00	56.35	48.76
Kolfutar	51.88	49.85	49.39	50.45	48.21

The study shows that speed of all categories vehicles are increasing with the increasing linearly with the increase in carriageway width. The analysis carried out showing the effect of carriageway width on the speed of vehicles, resulting in development of following relationship**:**

IV. CONCLUSION

The analysis is based on the field studies conducted on eight different locations of Highway of Nepal considering four classes of vehicles which are Bus, Truck, LCV and Two-Wheeler commonly found in Nepal. The study shows that traffic composition of two-wheeler are found predominant in all locations and the volume of vehicles types such as Bus, Truck, LCV and Car are linearly increasing with the increasing in carriageway width where as volume of Two-Wheeler are found to be highest at smaller lane carriageway width. The speed of all types vehicle is found to be increasing with the increase in carriageway width having linear relationship between carriageway width and speed. The study also shows that traffic composition has also effect on PCU values of respective vehicle types and has linear relationship between them. The PCU values for these categories of vehicle are determined at all locations of Highway separately. The range of PCU values as obtained from the study for Bus is 5.466 to 5.005, Truck PCU value is 3.711 to 3.708, LCV PCU is 2.611 to 2.428 and Two Wheeler PCU is 0.273 to 0.233 with carriageway width varying from 6.8 to 5.1. The study shows the PCU values are not constant and depend on lane width and PCU for a vehicle type increases with increasing lane width. The regression equation and its statically testing show significance relationship exists between lane width and PCU values of vehicles. Impact of highway lane width on the PCU is apparently linear. The New PCU values obtained from site are quite different from the values given in NRS standard. It is found that PCU values obtained for motor cycle from all sections are smaller than the values given in NRS 2070 and for Bus, Truck; LCV found higher than the value given in NRS 2070.

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