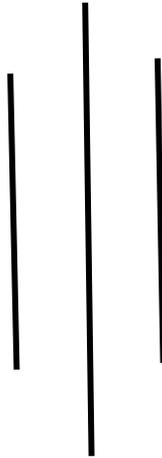TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

PULCHOWK CAMPUS

DEPARTMENT OF CIVIL ENGINEERING

TRANSPORTAION ENGINEERING II

LAB REPORT

SUBMITTED TO

DEPARTMENT OF CIVIL ENGINEERING

PULCHOWK CAMPUS

PULCHOWK,LALITPUR

SUBMITTED BY

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078BCE178

TRAFFIC VOLUME STUDY NEAR LABIM MALL

OBJECTIVES
→ To determine the number and types of vehicles passing a point on a road.
→ To classify vehicles into different vehicle categories.
→ To compute Peak Hour volume, vehicle composition, and Traffic flow variation.

THEORY
Traffic volume study is a fundamental part of traffic engineering that involves the quantitative measurement of vehicular flow at a specific location over a given period. It provides vital data used in the planning, design, and operation of road ways.

Manual counting method:
In Manual counting method, observer physically counts and classify vehicles into predefined categories during a set observation period. This method is cost-effective, simple and especially useful where:
- Traffic is not heavy
- Classification is important
- Automatic counters are unavailable.

However,
- It is labor-intensive and time-consuming
- Prone to human error. or fatigue
- Less suitable for 24-hour or high-speed studies.

PCU (Passenger car unit) is a standard measure used to express heterogenous traffic (mixed traffic with different vehicle type) in a common unit equivalent to a passenger car. Different vehicles occupy different space, have varying speeds and interact differently in traffic.

As per IRC:106:1990:

vehicle type		PCU value
Car/Jeep/Van	→	1.0
Cycle/Motorcycle/scooter	→	0.5
Heavy Truck/Buses	→	3.0
Light truck	→	1.5
Tractor with trailer	→	4.5

- Peak Hour Factor (PHF)
  ↳ Indicates how uniformly the traffic is distributed within the peak hour.

$$PHF = \frac{Total\ hourly\ volume}{4 * Highest\ 15\text{-}min\ volume}$$

$PHF = 1 \rightarrow$ Uniform flow (ideal)

- Peak Rate of Flow (PRF) for 15-minutes period

$$PRF = 4 * volume\ during\ peak\ 15\text{-}minute\ period.$$

PROCEDURE
1. Divided observers to cover each approach direction of the intersection.
2. Manual data sheets (tally charts) was prepared to record vehicle counts for every 15-minute interval over a 1.5-hour period with each vehicle categorization.
3. Number of vehicles in each category from each direction during every 15-minute interval was recorded on data sheet.
4. Multiplying number of vehicles in each class by respective PCU values to compute 15-minute PCU value.
   Hourly PCU = summing four consecutive 15-minute PCU
5. Identified 15-minute period with highest volume & highest hourly PCU to find PHF and PRF.
6. Analysed vehicle composition, direction-wise flow and peak characteristics to evaluate traffic behaviour at the intersection.

Jawalakhel

Labim Mall

Shree marg

Patan Dhoka ②

A
B

③

D

④ Jhamsikhel

C

①
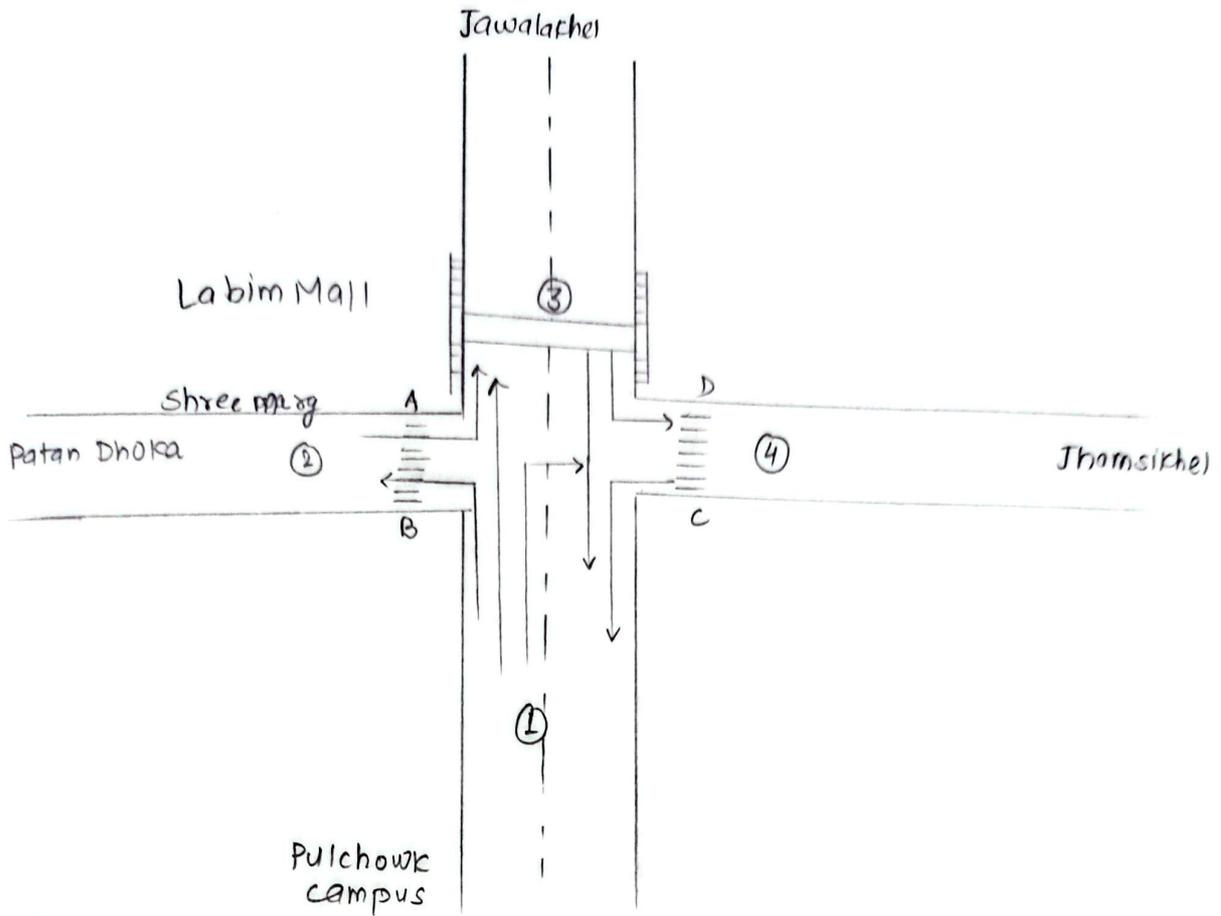
Pulchowk campus

* Calculation Table (Traffic volume count)

Approach: Pulchowk campus to Jawalakhel (1-3) [Through]

(1) Time (PM)	(2) Motorcycle/ Scooter	(3) Tempo	(4) Car/ Taxi/ Jeep	(5) Buses	(6) Light Truck	(7) Cycles	(8) Pederstain	(9) PCU	(10) Hourly PCU
2:45-3:00	319	18	127	11	18	2		365.5	
3:00-3:15	393	8	102	10	14	5		360	
3:15-3:30	363	13	93	13	19	0		355	
3:30-3:45	397	7	121	8	15	1		373.5	1484
3:45-4:00	403	16	107	10	14	3		377	1465.5
4:00-4:15	415	12	115	11	9	2		382	1487.5] Max

Note: PCU (9) = (2) *0.5 + (3) *1 + (4)*1 + (5) *3 + (6) *1.5 + (7) *0.5

Approach: Jawalakhel to Pulchowk Campus (3-1) [Through]

Time (PM)	Motorcycle/Scooter	Tempo	Car/Taxi/Jeep	Buses	Light Truck	Cycles	Pedestrian	PCU	Hourly PCU
2:45-3:00	255	7	148	22	7	3	7	360.5	
3:00-3:15	327	11	187	15	12	0		424.5	
3:15-3:30	260	8	160	20	10	2		374	
3:30-3:45	272	10	171	18	8	6		386	1545
3:45-4:00	314	12	165	24	15	4		430.5	1615
4:00-4:15	335	10	158	27	18	1		444	1634.5] Max

Approach: Jawalakhel to Jhamsikhel (3-4)

Time (PM)	Motorcycle/Scooter	Tempo	Car/Taxi/Jeep	Buses	Light Truck	Cycles	Pedestrian	PCU	Hourly PCU
2:45-3:00	96	0	15	0	0	0	75	63	
3:00-3:15	76	0	10	0	0	5	66	50.5	
3:15-3:30	87	0	9	0	0	2	53	53.5	
3:30-3:45	77	0	18	0	0	3	87	58	225
3:45-4:00	103	0	15	0	0	0	77	66.5	228.5
4:00-4:15	93	0	17	0	0	6	73	66.5	244.5] Max

Approach: Jhamsikhel to Pulchowk Campus (4-1)

Time (PCU)	Motorcycle/Scooter	Tempo	Car/Taxi/Jeep	Buses	Light Truck	Cycles	Pedestrian	PCU	Hourly PCU
2:45-3:00	124		48	2	2	3		120.5	
3:00-3:15	137		41	3	0	5		121	
3:15-3:30	130		52	2	1	4		126.5	
3:30-3:45	143		55	1	1	6		134	502
3:45-4:00	151		49	2	0	2		131.5	513] Max
4:00-4:15	129		43	3	2	3		121	513

Approach: Patan Dhoka to Jawalakhel (2-3)

Time (PM)	Motorcycle/scooter	Tempo	Car/Jeep/Taxi	Buses	Light Truck	cycles	PCU Relation	Hourly PCU	Hourly Pedestrian
2:45-3:00	19		9			2	19.5	8	91
3:00-3:15	20		14			3	25.5		58
3:15-3:30	16		12			4	22		60
3:30-3:45	18		10			1	19.5	86.5	72
3:45-4:00	19		13			3	24	91	65
4:00-4:15	16		15			5	25.5	91]Max	93

Approach: Pulchowk Campus to Patan Dhoka (1-2)

Time (PM)	Motorcycle/scooter	Tempo	Car/Jeep/Taxi	Buses	Light Truck	cycles	Pedestrian	PCU	Hourly PCU
2:45-3:00	12		6			3		13.5	
3:00-3:15	18		8			2		18	
3:15-3:30	15		5			5		15	
3:30-3:45	16		7			3		16.5	63
3:45-4:00	21		9			4		23.5	71
4:00-4:15	18		13			6		25	78]Max

Approach: Pulchowk campus to Jhamsikhel (1-4)

Time (PM)	Motorcycle/scooter	Tempo	Car/Taxi/Jeep	Buses	Light Truck	cycles	Pedestrian	PCU	Hourly PCU
2:45-3:00	26		15		0	2		29	
3:00-3:15	31		16		2	3		36	
3:15-3:30	23		18		0	0		29.5	
3:30-3:45	27		13		1	2		29	123.5
3:45-4:00	36		22		0	1		40.5	135]Max
4:00-4:15	25		17		0	3		31	130

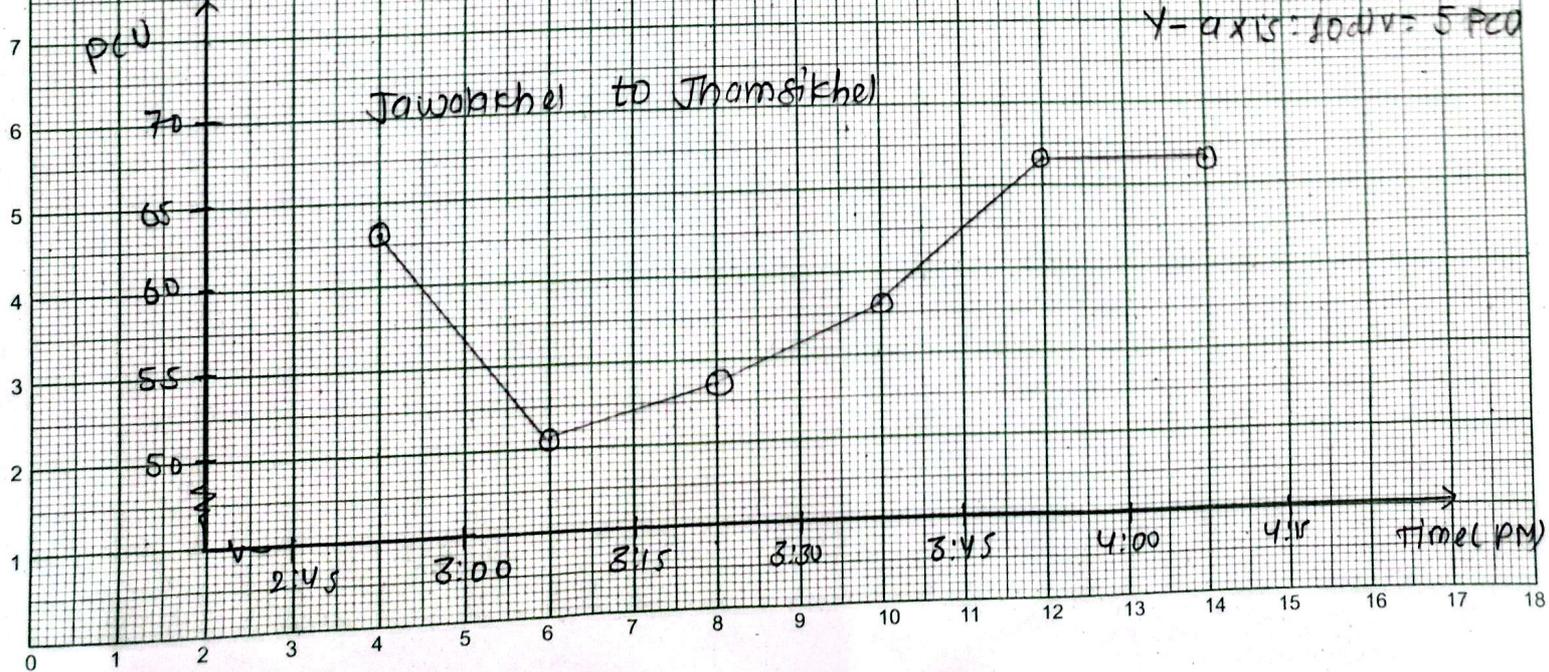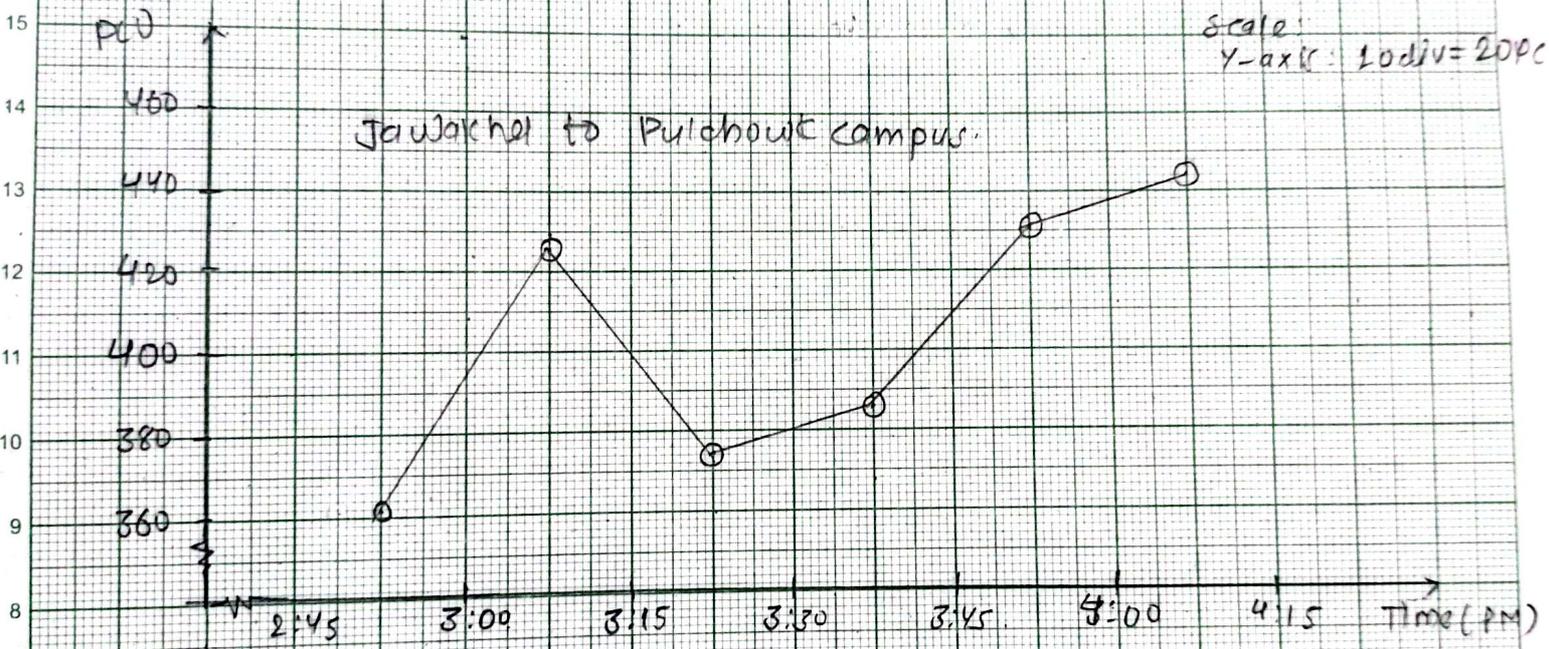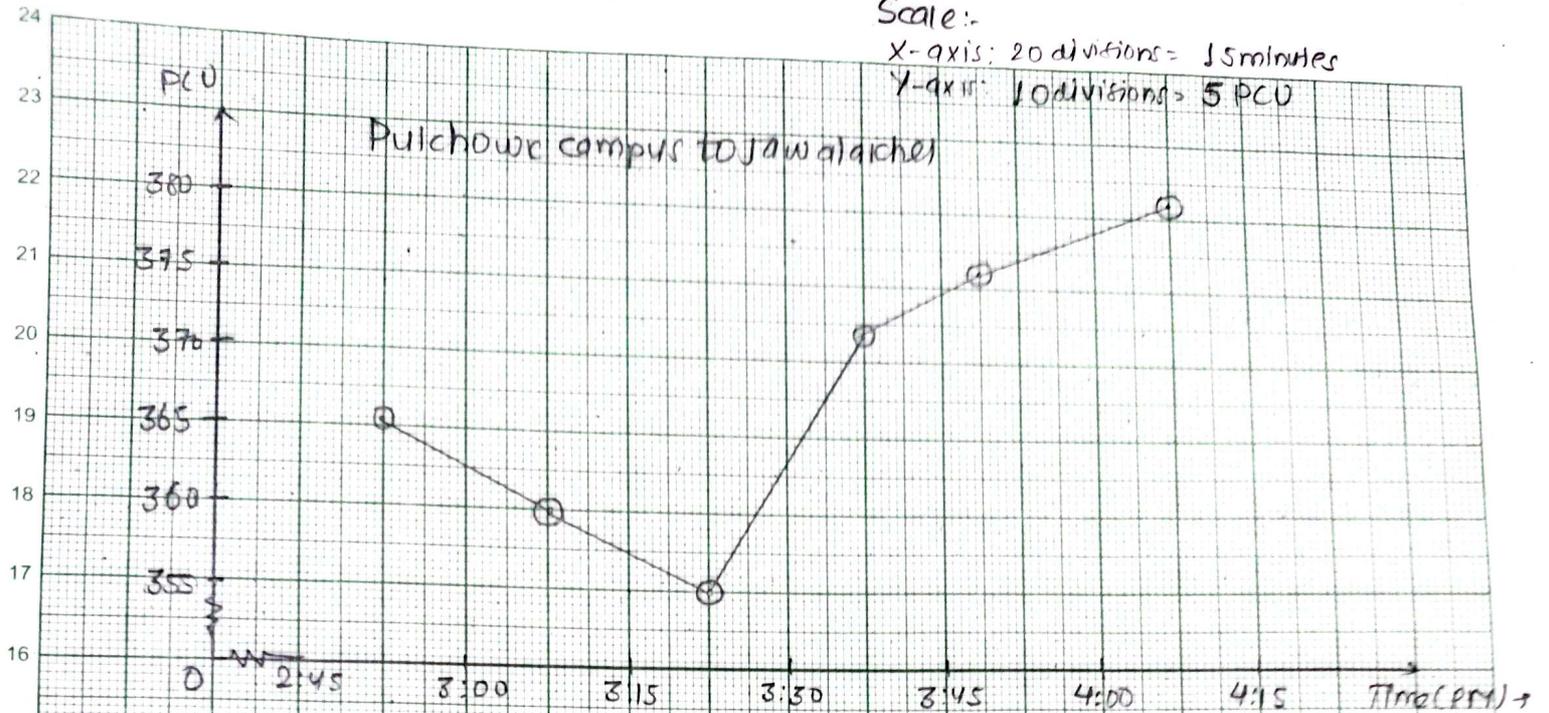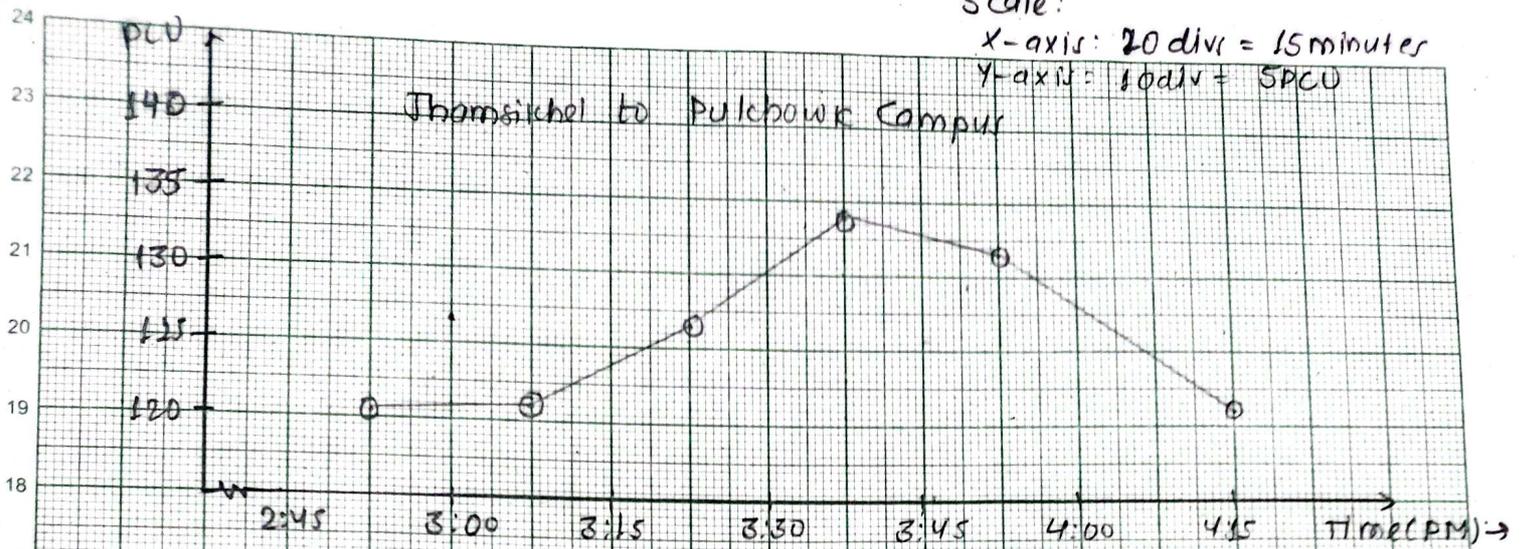# PCU vs Time

Scale:-
X-axis: 20 divisions = 15 minutes
Y-axis: 10 divisions = 5 PCU

Pulchowk campus to Jawalakhel

Scale:
Y-axis: 10 div = 20 PCU

Jawakhel to Pulchowk campus

Y-axis: 10 div = 5 PCU

Jawalakhel to Jhamsikhel

PCU vs Time

Scale:
X-axis: 20 divi = 15 minutes
Y-axis: 10 div = 5PCU

Thomsichel to Pulchowk Campus

Patan Dhoica to Jawalakhel

Pulchowk Campus to Patan Dhoica

Pulchowk Campus to Thomsichel
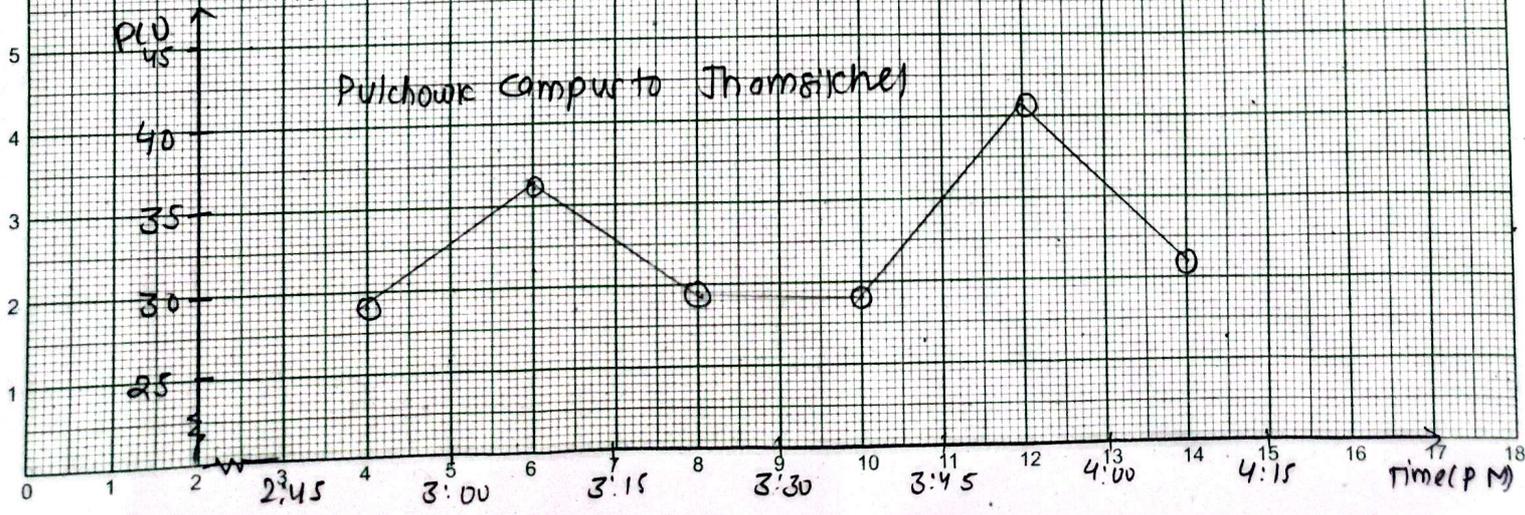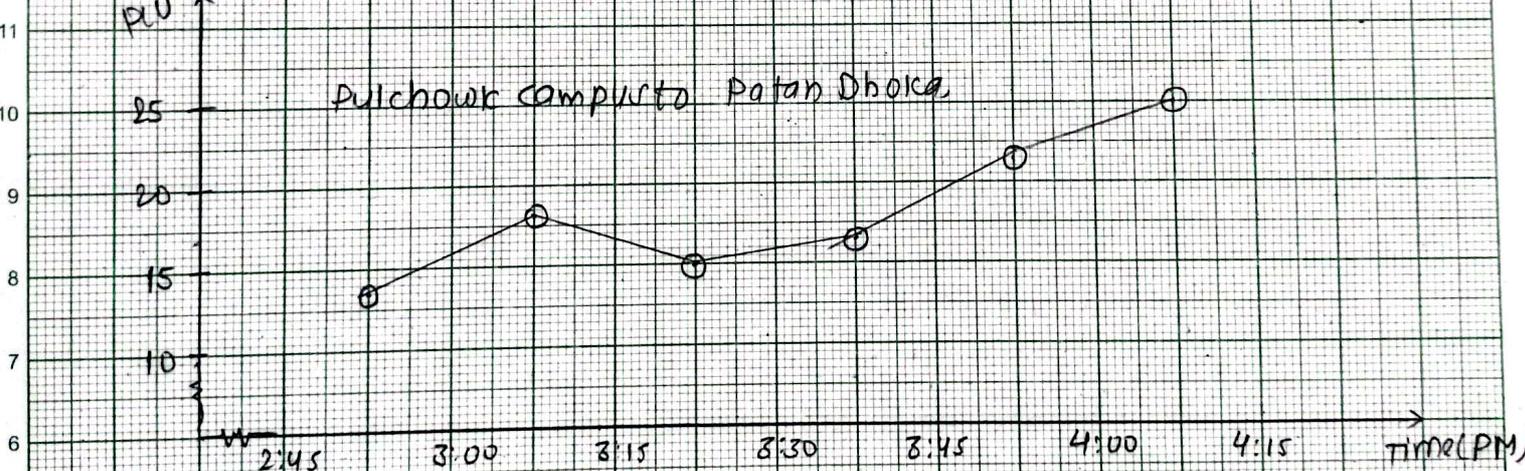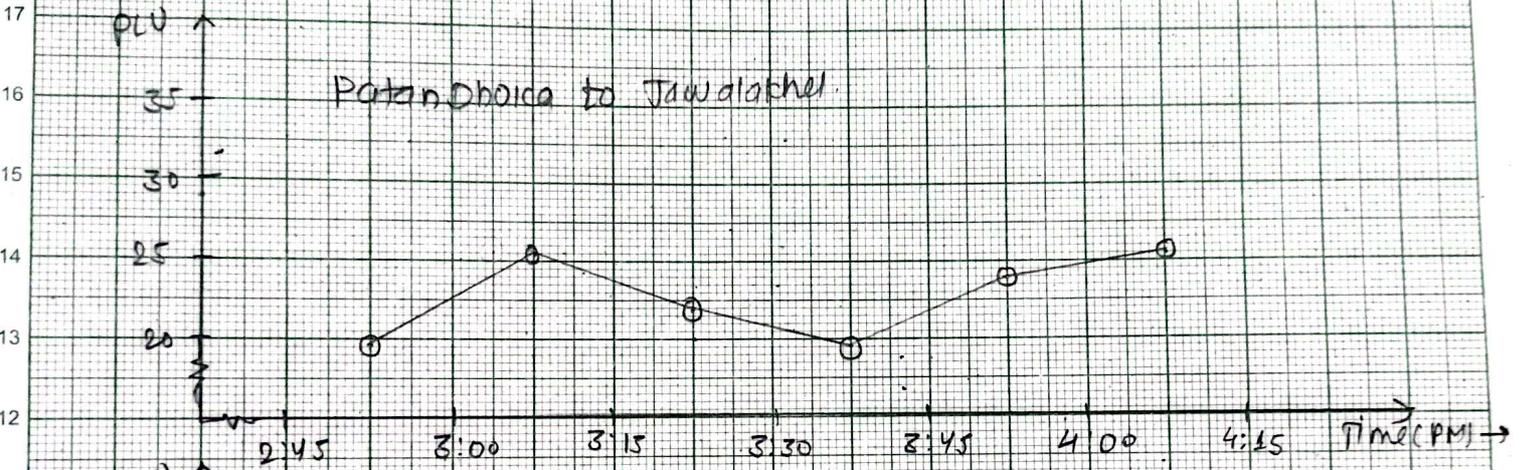
* Analysis:

(1) Approach 1-3: Pulchowk campus to Jawalakhel

Peak hour = 3:15 - 4:15 PM

Peak hourly volume = 1487.5 PCU/hr

Peak hour factor (PHF) (for 15 min period) $= \dfrac{1487.5}{382 \times 4} = 0.973$

Peak rate of flow (for 15 min period) $= 382 \times 4 = 1528\ PCU$

(2) Approach 3-1: Jawalakhel to Pulchowk campus

Peak hour = 3:15 - 4:15 PM

Peak hourly volume = 1634.5 PCU/hr

$(PHF)_{15\,min} = \dfrac{1634.5}{444 \times 4} = 0.920$

Peak rate of flow (for 15 min) $= 444 \times 4 = 1776\ PCU$

(3) Approach 3-4: Jawalakhel to Jhamsikhel

Peak hour = 3:15 - 4:15 PM

Peak hourly volume = 244.5 PCU/hr.

$(PHF)_{15\,min} = \dfrac{244.5}{66.5 \times 4} = 0.916$

Peak rate of flow (for 15 min) $= 66.5 \times 4 = 266\ PCU$

(4) Approach 4-1: Jhamsikhel to Pulchowk campus

Peak hour = ~~2:45~~ 3:00 - 4:00 PM / 3:15 - 4:15 PM

Peak hourly volume = 513 PCU/hr.

$(PHF)_{15\,min} = \dfrac{513}{131.5 \times 4} = 0.975$

Peak rate of flow $= 131.5 \times 4 = 526\ PCU$

(5) Approach 2-3: Patan Dhoka to Jawalakhel

Peak hour = 3:15 - 4:15 PM / 3:00 - 4:00 PM

Peak hourly volume = 91 PCU/hr

$(PHF)_{15\,min} = \dfrac{91}{25.5 \times 4} = 0.892$

Peak rate of flow $= 25.5 \times 4 = 102\ PCU$

(6) Approach 1-2: Pulchowk campus to Jhamsikhel

Peak hour = 3:15-4:15PM

Peak hourly volume = 135 PCU/hr

$(PHF)_{15min} = \dfrac{135}{4 \times 40.5} = 0.833$

Peak rate of flow = $4 \times 40.5 = 162$ PCU

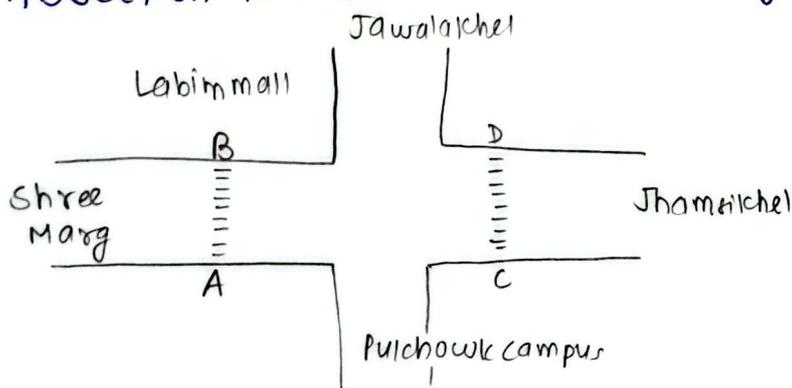(7) Approach 1-4: Pulchowk campus to Patan Dhoka

Peak hour = 3:15 - 4:15 PM

Peak hourly volume = 78 PCU/hr

$(PHF)_{15min} = \dfrac{78}{4 \times 25} = 0.78$

Peak rate of flow = $4 \times 25 = 100$ PCU

* Pedestrian volume Analysis

→ AB section is choosen in Shree Marg a (Beside Labim Mall)

Peak hour = 3:15-4:15PM

Peak hourly volume = 290 Pedestrians/hour

peak rate of flow = $4 \times 93 = 372$ Pedestrians

$(PHF)_{15min} = \dfrac{290}{372} = 0.779.$

→ CD section in Jham silchel marga

Peak hour. 3:15-4:15PM

Peak Hourly volume = 290 Pedestrions/hour

Peak rate of flow = $4 \times 87 = 348$ Pedestrions
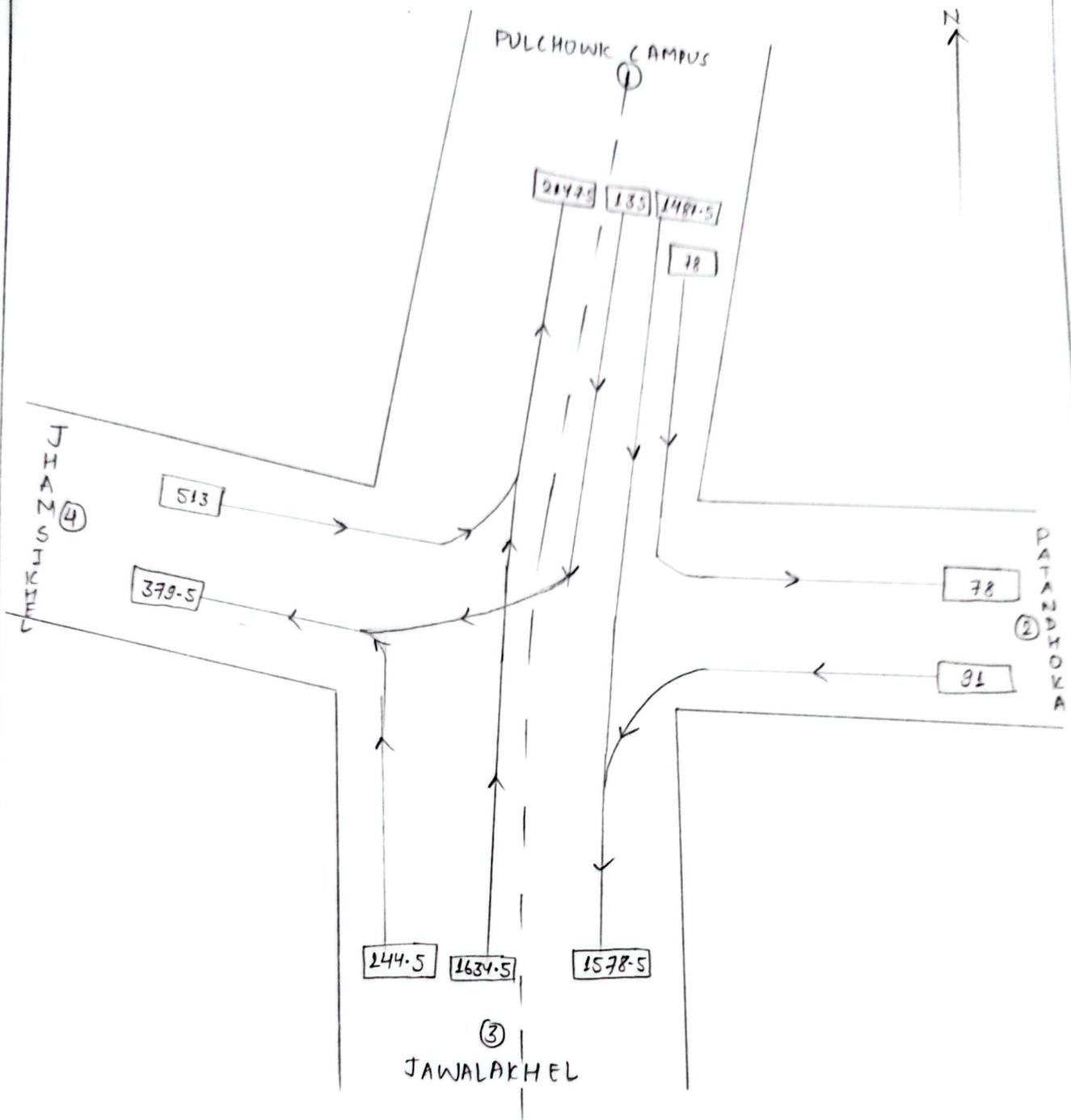
$(PHF)_{15min} = \dfrac{290}{348} = 0.833.$

Fig: Intersection vehicle flow Diagram.

* DISCUSSION

A manual traffic volume study was conducted using the direct method, with hand-tally counts for vehicles and pedestrians. The results indicated peak-hour traffic volumes of approximately 2100 PCU on Jawalakhel to Pulchowk campus route and 290 pedestrians on both of the crossings in Shree Marg and Jhamsilchel marga. While this method provided valuable data for flow analysis and intersection diagrams, potential manual errors - such as miscounting or observational inaccuracies - could have influenced the results. Nevertheless, the findings remain useful for cross-verifying traffic data obtained through automated or indirect methods.

CONCLUSION

In summary, the traffic volume study at Pulchowk campus-Jawalakhel - Jhamsikhel - Patan Dholka intersection successfully determined peak-hour metrics, including peak hour volume, peak rate of flow, and peak hour factor. The findings offer a foundational dataset for further traffic management analyses.

SPOT SPEED STUDY

OBJECTIVE:

To conduct a spot speed study, develop a cumulative frequency distribution curve and calculate various statistical measures.

EQUIPMENT AND FACILITIES REQUIRED

1. Stopwatch
2. Observation sheets.

THEORY

A spot speed study is conducted to measure the instantaneous speed of a vehicles at a specific location or spot on a roadway. Unlike Journey or running speed studies, it does not consider the travel time over a stretch of road but instead focuses on how fast vehicles are moving at a particular point. This study is essential for understanding traffic flow characteristics, speed behaviour of drivers, and for evaluating the effectiveness of speed regulations or roadway geometry.

Methods of spot speed measurements

1. Stopwatch Method.
2. Radar Gun
3. Inductive Loop detector/ sensor
4. Video Analysis

Speed characteristics:

- Mean speed (v): Average speed of all vehicles
- Upper safe speed = 85th percentile speed
- Design speed = 98th percentile speed
- Median speed = 50th percentile speed
- Lower safe speed = 15th percentile speed.
- Modal speed = Most frequently observed speeds.

Average speed of traffic stream (kmph)		Base length (meter)
< 40	→	27
40 – 65	→	54
> 65	→	81
Observer 2		Observer 1

Study Length

Approaching vehicle

End Timing

Start Timing

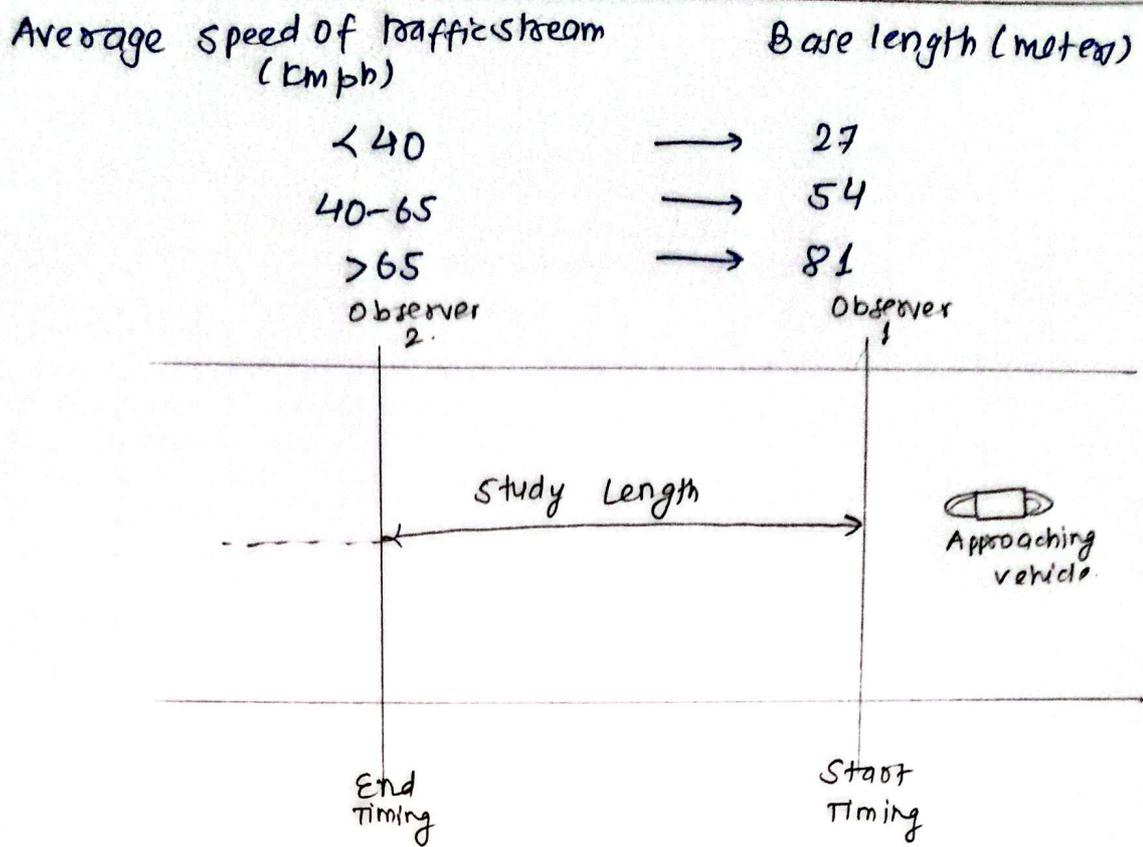Fig: Trap length for conducting a speed study.

PROCEDURE:

1. The site was selected as per guideline and then, appropriate trap length was obtained.

2. Observations on spot speed were recorded on data entry from unidirectional readings were taken.

3. As the front of the vehicle crossed the starting section of the study length, the observer 1 signalled the observer of the end of the section to start stopwatch. The stopwatch was stopped when the vehicle reached the end station. Therefore, the time elapsed between 2 sections was obtained.

4. The vehicle speeds were checked for corresponding time range.

5. Frequency distribution curve and cumulative frequency distribution curve were generated.

6. Various statistical parameters were calculated.

* CALCULATION

SN	Speed range (kmph)	Mid value (v_i) (kmph)	total vehicles in given range	Frequency, %of (f_i)	cumulative frequency, % cf
1	0-3	1.5	0	0	0
2	3-6	4.5	0	0	0
3	6-9	7.5	0	0	0
4	9-12	10.5	0	0	0
5	12-15	13.5	1	0.82	0.82
6	15-18	16.5	5	$\frac{5}{122} \times 100 = 4.10$	4.92
7	18-21	19.5	12	$\frac{12}{122} \times 100 = 9.84$	14.75
8	21-24	22.5	15	12.30	27.05
9	24-27	25.5	20	16.39	43.44
10	27-30	28.5	17	13.93	57.38
11	30-33	31.5	13	10.66	68.03
12	33-36	34.5	12	9.84	77.87
13	36-39	37.5	10	8.20	86.07
14	39-42	40.5	7	5.74	91.80
15	42-45	43.5	6	4.92	96.72
16	45-48	46.5	4	3.28	100.00

$$\Sigma = 122 \qquad \Sigma = 100\%$$

* ANALYSIS OF DATA

From cumulative Frequency Distribution Graph,

Design speed = 98th percentile speed = 44.3 kmph

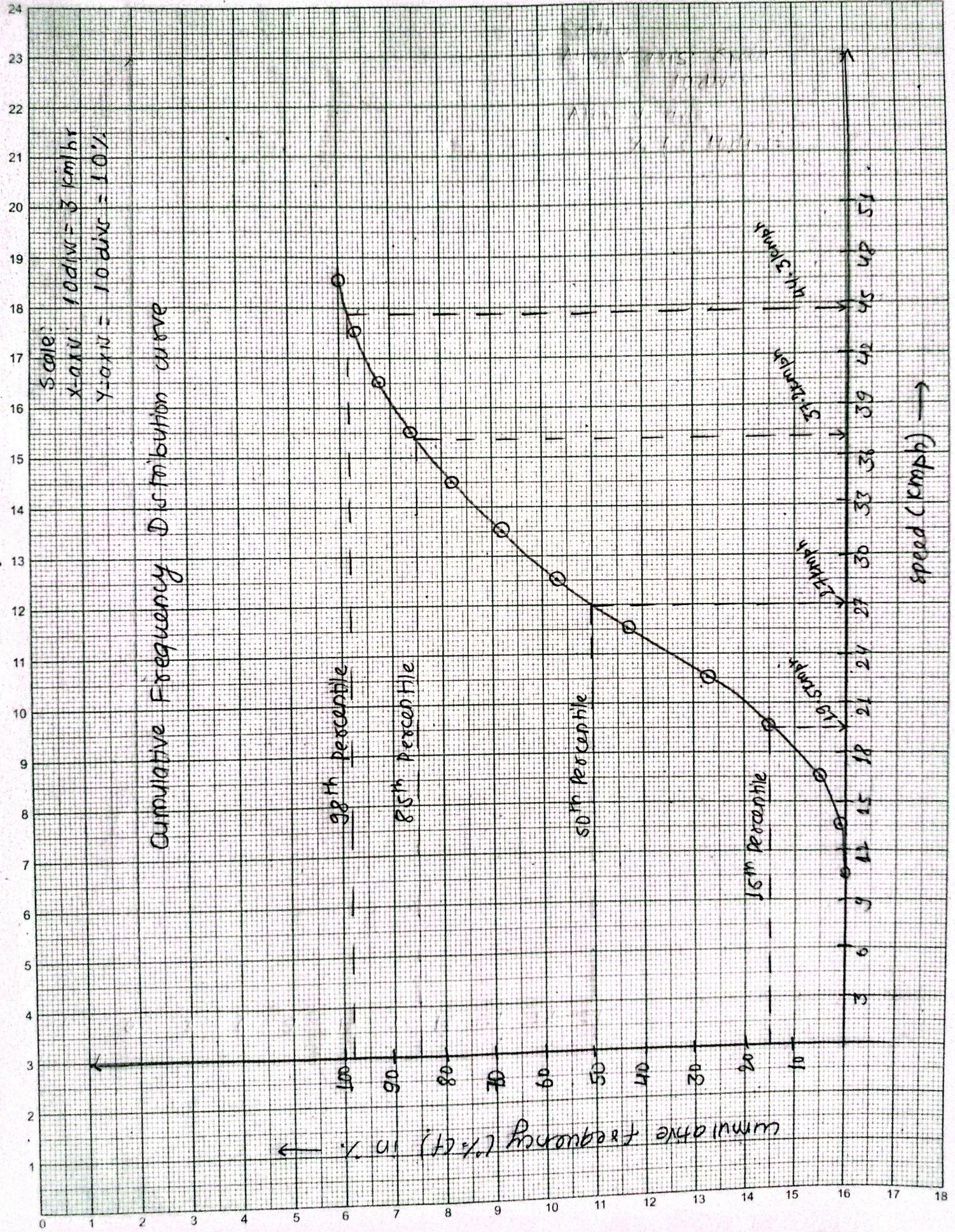Upper safe speed = 85th percentile speed = 37.2 kmph

Median speed = 50th percentile speed = 27 kmph

Lower safe speed = 15th percentile speed = 19.5 kmph

Statistical Analysis

Mean speed = $\frac{\Sigma v_i f_i}{\Sigma f_i}$ (v_m)

$= \dfrac{\begin{array}{l} 13.5 \times 0.82 + 16.5 \times 4.10 + 19.5 \times 9.84 + 22.5 \times 12.30 \\ + 25.5 \times 16.39 + 28.5 \times 13.93 + 31.5 \times 10.66 \\ + 34.5 \times 9.84 + 37.5 \times 8.20 + 40.5 \times 5.74 \\ + 43.5 \times 4.92 + 46.5 \times 3.28 \end{array}}{100}$
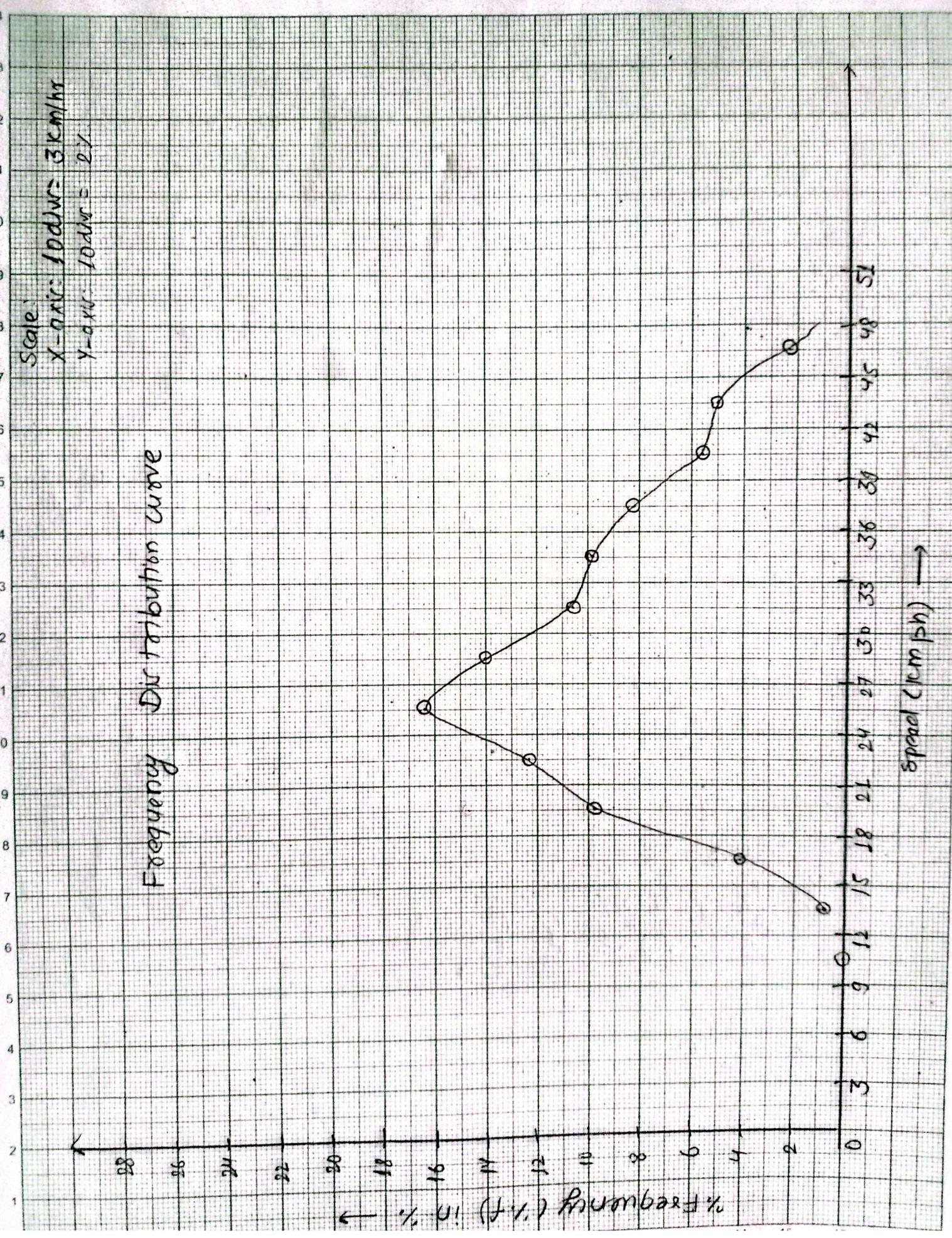
$= 29.43 \text{ kmph}.$

Cumulative Frequency Distribution curve

Scale:
x-axis: 1.0 div = 3 km/hr
y-axis: 1.0 div = 10%

98th Percentile
85th Percentile
50th Percentile
15th Percentile

44.3kmph
37.5kmph
27kmph
17.5kmph

speed (kmph) ⟶

cumulative Frequency (∑(f)) in %

Standard Deviation, $\sigma_S = 1$

Scale:
X-axis: 10div = 3km/hr
Y-axis: 10div = 2%

Frequency Distribution Curve

% Frequency (%f) in %

Speed (km/hr) ⟶

Modal Speed = 25.5 km/hr (Frequency = 16.39%)

$$\text{Standard Deviation, } \sigma_s = \sqrt{\frac{f_i(v_i - v_m)^2}{n-1}} = \sqrt{\frac{6183.178}{100-1}}$$

$$= 7.90 \text{ kmph.}$$

RESULT:

The design speed, upper safe speed, median speed and lower safe speed was found to be 44.3 km/hr, 37.2 km/hr, 27 km/hr and 19.5 km/hr respectively. While, Modal speed and Average speed of 25.5 km/hr and 29.43 km/hr respectively with standard deviation of 7.90 kmph is found.

DISCUSSION

The spot speed study employed manual data collection to analyze vehicle speeds, revealing a modal speed of 25.5 km/hr (frequency = 16.39%) and a median speed of 27 kmph

with standard deviation of 7.90 kmph. The frequency distribution graph adhered to a Normal distribution, while cumulative frequency curve followed an S-shape, enabling derivation of key parameters like design speed and safe speeds. Although manual methods introduced potential errors (e.g., stopwatch precision, signaling delays), the graphs effectively captured the speed distribution trends.

CONCLUSION:
The study successfully analyzed vehicle speeds using frequency and cumulative distribution curves. Key outcomes include the determination of median speed, design speed, and safe speed limits, providing essential data for road safety assessments and traffic management strategies.

CALIFORNIA BEARING RATIO (CBR) TEST

OBJECTIVE

→ To determine the bearing capacity and strength of subgrade soil.

THEORY

The CBR test is a penetration test developed by the California state Highway Department. It measures the resistance of a soil sample to the penetration of a standard plunger (50 mm diameter) under controlled density and moisture conditions. The pressure required to penetrate the soil is compared with that required for standard crushed stone. The result is expressed as a percentage - known as the CBR value.

- $$CBR = \frac{\text{Measured Load at a given penetration}}{\text{Standard load at same penetration}} * 100$$

- Standard Loads (as per IS code):
  - At 2.5mm penetration → 1370 kg (or 13.24 kN)
  - At 5mm penetration → 2055 kg (or 20.09 kN)

- Correction for concave curve (if needed)
  If the initial part of the load-penetration curve is concave, correct it by drawing a tangent from the steepest part of the curve to the origin.

- Typical CBR values:
  Subgrade soil : 2-10%
  Granular sub-base : 20-50%
  WBM base course : 80% or More

- The higher of the CBR values at 2.5mm or 5mm is reported.

PROCEDURE

A. Sample Preparation

→ Prepare a soil specimen (either undisturbed or remoulded) in a CBR mould with collar and base plate.

→ Compact the soil in three equal layers. by tamping 25 blows from 310mm height with 2.6kg rammer.

→ Remove the collar and cut extra soil using knife.

B. CBR Testing.

→ Place the mould in the CBR testing machine.

→ Apply load through the standard plunger at a constant rate of 1.25mm/min.

→ Record the load values at different penetrations

→ Plot the load vs. penetration curve and determine the corrected load values.
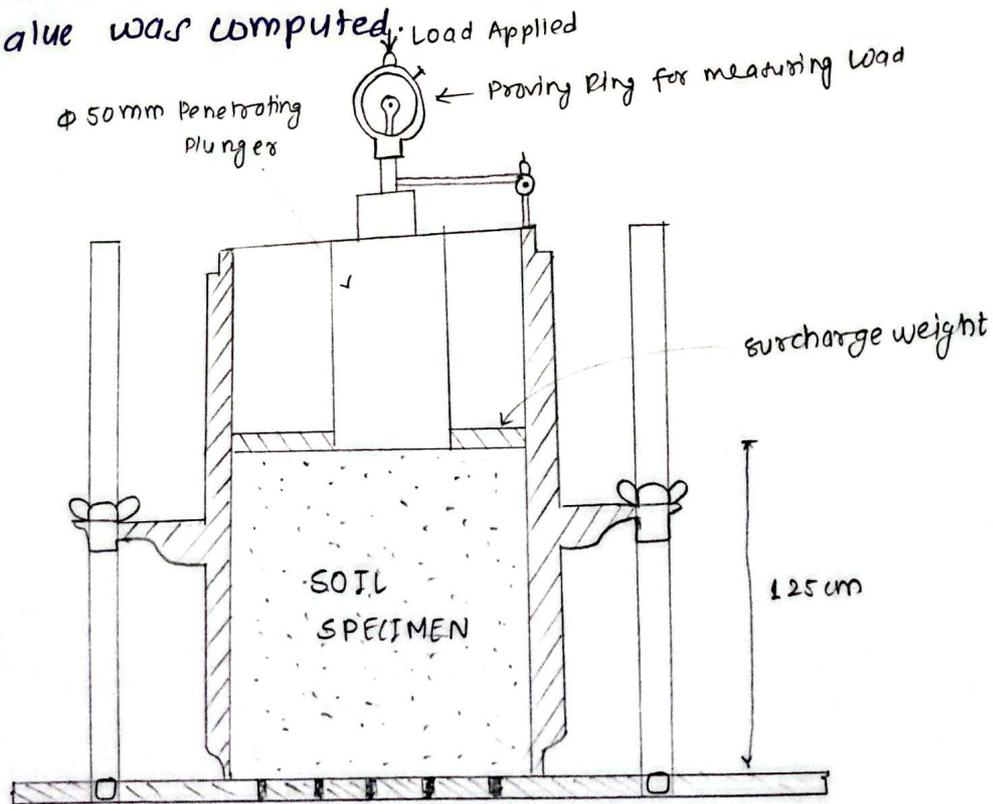
C. Calculations.

→ CBR value was computed.

Fig:- California Bearing Ratio Test Loading.

OBSERVATION AND CALCULATION

Deflection Reading	Deflection(mm), Reading $\times 0.01'' \times \frac{2.54}{10}$	Load Reading	Load kg, 1 div=10kg
50	1.27	1	10
100	2.54	2.5	25
150	3.81	6	60
200	5.08	8	80
250	6.35	9	90
300	7.62	10	100
350	8.89	12	120
400	10.16	13	130
450	11.43	15	150
500	12.7	16	160
600	15.24	23	230
700	17.78	24	240
800	20.32	29	290

From graph,

$$\text{Load}_{2.5mm} = 46 \text{ kg}$$

$$\text{Load}_{5mm} = 88 \text{ kg}$$

Now,

$$CBR_{2.5mm} = \frac{46}{1370} \times 100\% = 3.36\%$$

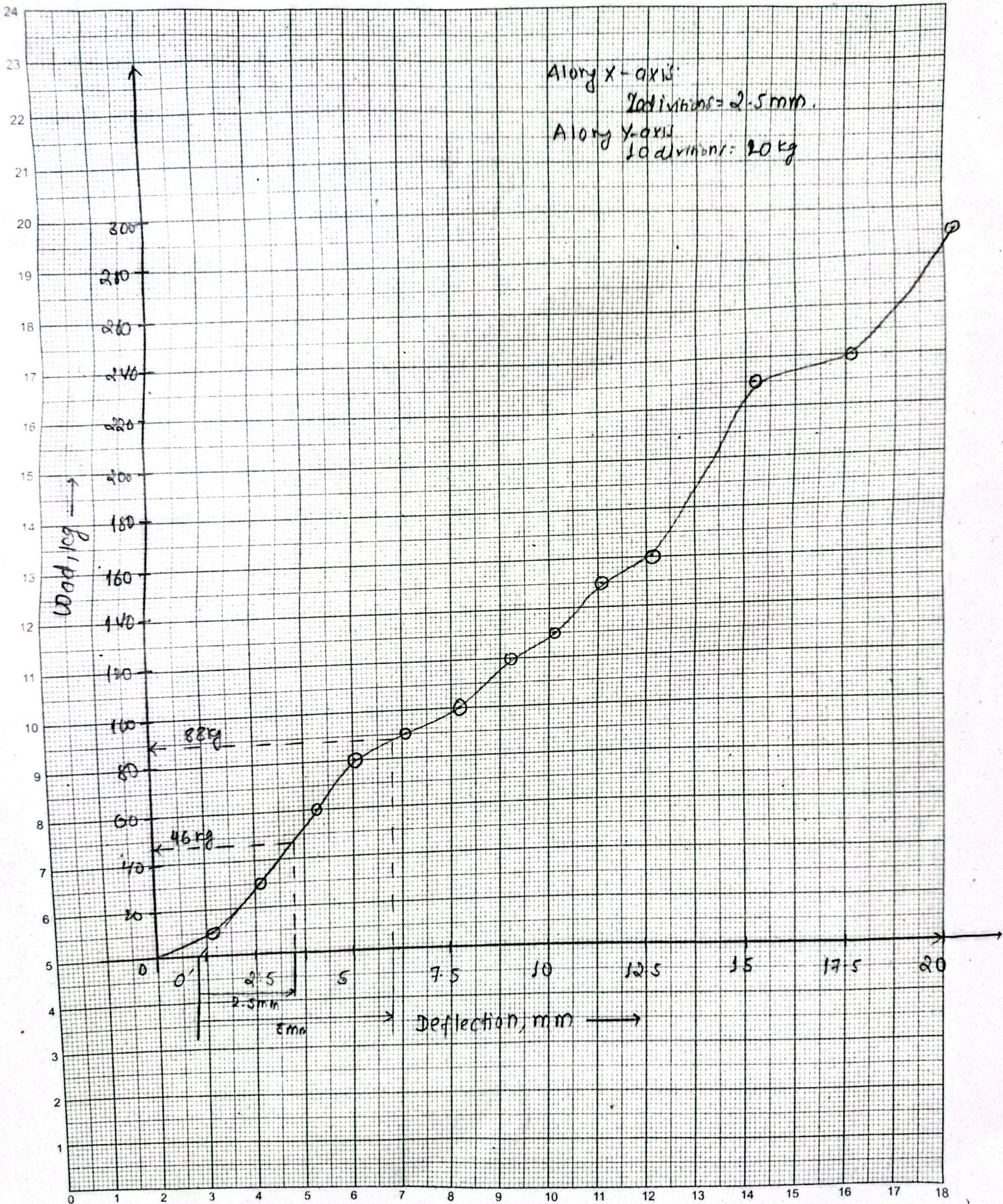$$CBR_{5mm} = \frac{88}{2055} \times 100\% = 4.28\%$$

Generally, $CBR_{2.5mm} > CBR_{5mm}$. But, here $CBR_{5mm} > CBR_{2.5mm}$

As it is taken from given data (experiment could not be repeated) So, [CBR = 4.28%]

Load v/s Penetration

Along X-axis:
20 divisions = 2.5 mm.

Along Y-axis
10 divisions = 20 kg

DISCUSSION

In lab experiment from the graph plotted between load v/s penetration, CBR value is computed. From results CBR at 2.5mm penetration was found to be lesser than CBR at 5mm penetration which means that experiment to be repeated again, but as we could not do that CBR at 5mm is taken as actual CBR value which is 4.28%.

It may be due to anamolies in given data and faulty measurements

BENKELMAN BEAM TEST

OBJECTIVES:

To determine the rebound deflection of a pavement under a standard wheel load and tyre pressure, with or without deflection, i.e. evaluation of structural capacity of existing pavement and estimation of overlay if required.

EQUIPMENTS REQUIRED:-

1. Benkelman Beam
2. Loaded Truck (Usually dual wheel load ~8.2 tonnes as per IRC)
3. Tyre pressure measuring Gauge
4. Thermometer (0-50°c) with 1° division (IRC 81:1997)
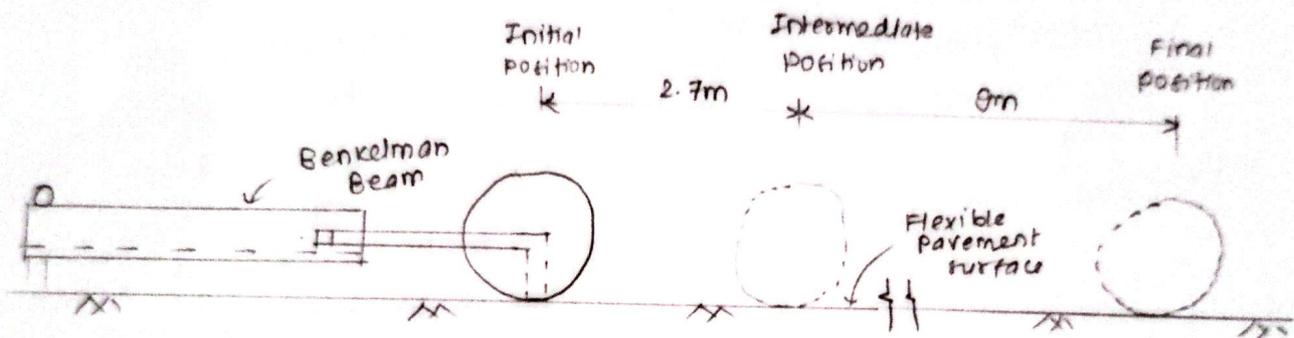5. Measuring Tape.

Fig. Benkelman Beam Experiment

THEORY

Benkelman Beam is used to evaluate the structural capacity and pavement deflection of flexible pavements under wheel loads, particularly for overlay design and maintenance planning. When a standard truck wheel passes over a flexible pavement, the pavement deflects. The Benkelman beam measures this rebound deflection after the wheel moves away.

It is based on cantilever principles. i.e. beam amplifies pavement deflection to be measured on a dial gauge.

It is developed by U.S. Army corps of Engineer and later standardized by IRC 81:1997 in India.

It is widely used in Highway maintenance, overlay thickness design and structural evaluation.

PROCEDURE (AS per IRC 81:1997)

1. Initial setup
→ Select a test point on the flexible pavement.
→ Place tip of Benkelman beam between the dual rear wheels of the loaded truck, so it rests exactly on the test point.
→ Ensure the dial gauge is set to zero or note initial reading.

2. Initial Loading
→ Keep the truck stationary over the test point for a few seconds to allow full pavement deflection under load.
→ Note the initial dial gauge reading (R_0).

3. Truck Move
→ Slowly move the truck forward 2.7 m from the test point.
→ Observe the dial gauge as the pavement begins to rebound.
→ Record the intermediate reading (R_1) from the dial gauge (when rebound starts to stabilize but not complete)
→ Then continue moving the truck forward to 9m from the test point.
→ Record the final dial gauge reading (R_2) - this represents the full rebound deflection.

ANALYSIS OF DATA

→ If $(R_0 - R_2)$ is less than $0.025mm$ ($2.5 div$)
$$R = 0.02 (R_0 - R_2), \text{ where } R \text{ in divisions}$$
$$(1 div = 0.01 mm)$$

→ If $(R_0 - R_2)$ is more than $0.025mm$ ($2.5 div$)
$$R = [0.02 (R_0 - R_2) + 0.0582 (R_0 - R_2)]$$
$$\text{where, } R \text{ in divisions } (1 div = 0.01 mm)$$

→ Mean deflection, $\bar{R} = \dfrac{\Sigma R}{n}$

→ Standard deviation, $\sigma = \sqrt{\dfrac{\Sigma(\bar{R} - R)^2}{n-1}}$

→ Characteristic deflection,
  • $R_c = \bar{R} + 2\sigma$ for important roads to cover 97.7% deflection values.

  • $R_c = \bar{R} + \sigma$ for low traffic roads, to cover 84.1% deflection values

OBSERVATION AND CALCULATION

S-No.	Location	Position	Dial Gauge Reading (Least count 0.01) Initial (R0)	Intermediate (R1)	Final (R2)	R0-R1	R0-R2	Check: (R0-R1)-(R0-R2)	Deflection(mm) D
1	0+000	Left	111	72	71	39	40	1 <2.5	0.02*40 = 0.8
2	0+100	Right	145	84	82	61	63	2 <2.5	0.02*63 = 1.26
3	0+200	Left	120	88	87	32	33	1 <2.5	0.02*33 = 0.66
4	0+300	Right	144	107	106	37	38	1 <2.5	0.02*38 = 0.76
5	0+400	Left	115	65	62	50	53	3 >2.5	0.02*53+0.058*3=1.235
6	0+500	Right	114	81	79	33	35	2 <2.5	0.02*35 = 0.70
7	0+600	Left	137	100	100	37	37	0 <2.5	0.02*37 = 0.74
8	0+700	Right	114	74	72	40	42	2 <2.5	0.02*42 = 0.84
9	0+800	Left	112	50	48	62	64	2 <2.5	0.02*64 = 1.28
10	0+900	Right	152	96	94	56	58	2 <2.5	0.02*58 = 1.16
11	1+000	Left	130	69	68	61	62	1 <2.5	0.02*62 = 1.24
12	1+100	Right	103	64	62	39	41	2 <2.5	0.01*41 = 0.82
13	1+200	Left	79	36	36	43	43	0 <2.5	0.02*43 = 0.88
14	1+300	Right	55	5	3	50	52	2 <2.5	0.02*52 = 1.04
15	1+400	Left	86	54	53	42	43	1 <2.5	0.02*43 = 0.86
16	1+500	Right	80	45	40	35	40	5 >2.5	0.02*40+0.058*5=1.031
17	1+600	Left	111	52	50	59	61	2 <2.5	0.01*61 = 1.22
18	1+700	Right	112	71	70	41	42	1 <2.5	0.02*42 = 0.84
19	1+800	Left	95	26	25	69	70	1 <2.5	0.02*70 = 85.4
20	1+900	Right	78	21	20	57	59	1 <2.5	0.02*59 = 1.16

ΣD = 19.966mm

→ Mean deflection, $\bar{D} = \dfrac{\sum D}{n} = \dfrac{19.366}{20} = 0.998$

→ $\sigma = 0.336$

→ Characteristic deflection
$$= 0.998 + 1 \times 0.336$$
$$= 1.45\,mm$$

Let us consider pavement is designed to support medium traffic (i.e. 450-1500 vpd). So, $D_a = 1.95$

Now,

Overlay Thickness , $h_o = 550 \log_{10}\left(\dfrac{1.95}{1.95}\right) = 30.19 \approx 33\,mm$

Thickness in term of DBM/AC $= \dfrac{33}{2} = 16.5\,mm$

CONCLUSION

The Benkelman Beam Deflection Test was conducted to evaluate the rebound deflection of flexible pavement at 20 locations. The maximum deflection was observed to be 1.4 mm at chainage 1+800. The magnitude of deflection varied across locations, suggesting non-uniform structural performance along the road stretch. The calculated deflections were used for deciding type and thickness of overlay as 33mm for pavement maintenance and rehabilitation.

SKID RESISTANCE TESTS OF HIGHWAYS USING BRITISH PENDULUM TEST.

OBJECTIVES
To measure the surface frictional properties using the British Pendulum Skid Resistance Tester.

APPARATUS REQUIRED
(i) British Pendulum Tester
(ii) Slider
(iii) Accessories

TEST SPECIMEN
1. Field: Field test surface shall be free of loose particles and flushed with clean water

2. Laboratory:
   Lab test panels shall be clean and free of loose particles and shall be held rigidly so as not to be moved by the fall of pendulum.

THEORY:
The friction or skid resistance between vehicle tyre and pavement surface is one of the factors determining the operating system speed and the minimum distance required for stopping the vehicle.
The head of pendulum is loaded firmly, the fitting handle is raised and spacer are removed.
The full scale tire friction test is also called loaded wheel tester. This method uses a loaded wheel skidding along the tested surface to measure friction resistance.

TEST:
(i) Sufficient water was applied to cover the test area throughly. 1 swing was executed but the reading was not recorded. The pendulum was caught during the early position of its return swing.

(ii) While returning the pendulum to its starting position, the slider was raised to avoid contact between slider and test surfaces.

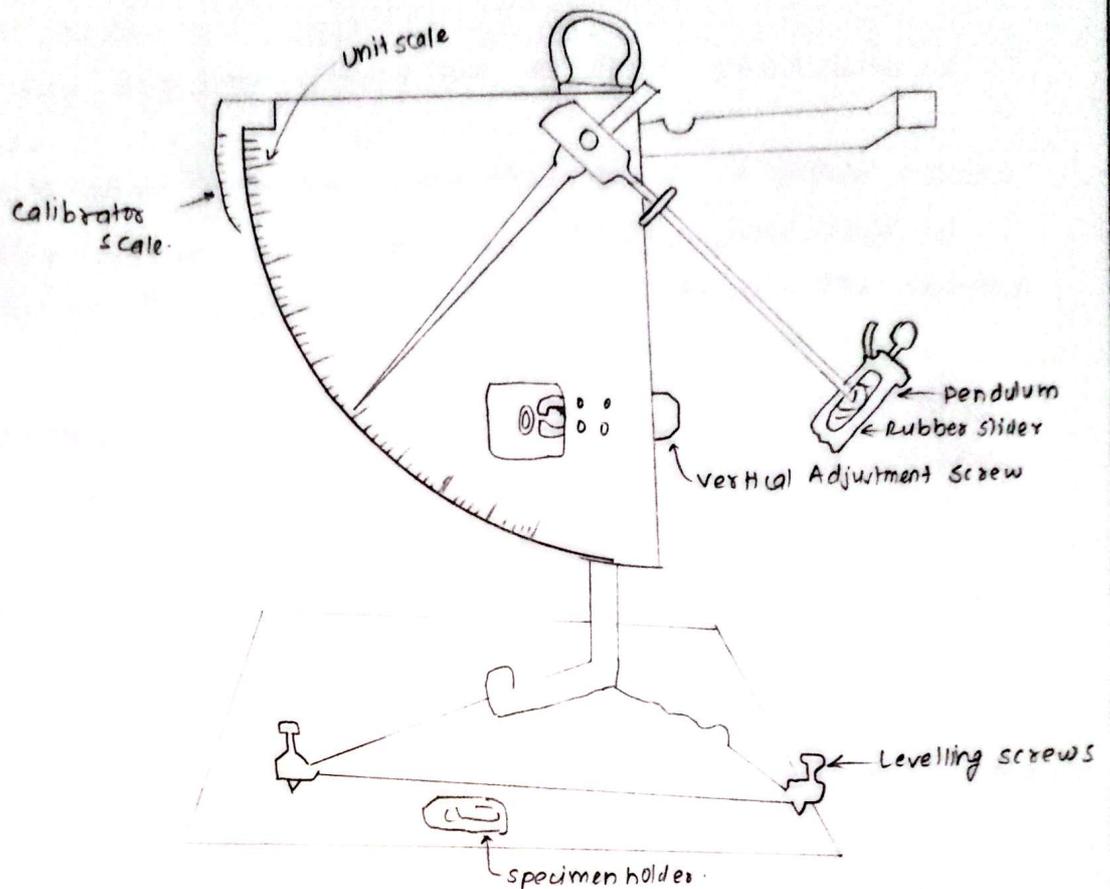(iii) Without delay, swings were made, rewetting the test area each time and recording the result.

Fig: Schematic diagram of British Test Apparatus.

OBSERVATION:

Temperature of test surface = 25°C
Type = Bituminous pavement
Condition = Average
Texture = Fine Rough.

Site	Observatn No.	Initial Reading	Final Reading	Coeff. of Friction	Average.
A	1	0°	48	0.48	
	2	0	50	0.50	0.51
	3	0	56	0.56	
B	1	0	48	0.48	
	2	0	51	0.51	0.50
	3	0	52	0.52	
C	1	0	47	0.47	
	2	0	44	0.44	0.46
	3	0	46	0.46	

PRECAUTION

1. Levelling of instrument should be done accurately by turning levelling screws until the bubble is centred in the spirit level.
2. The pointer reading should be 0 when pendulum is released.
3. With pendulum hanging free, the space is placed under adjusting screws of lifting handle. The pendulum is lowered so that edge of slides just touches the surface.

AS,
Skid Resistance value (SRV) 'or' Pendulum test value (PTV) in each site was in range of 45-55 indicating acceptable SRV for most roads.

CONCLUSION

The British Pendulum Test effectively assessed the skid resistance of the tested pavement surface. The obtained SRV falls within acceptable range for road safety standards. This implies that the pavement offers sufficient friction to prevent skidding under wet conditions.
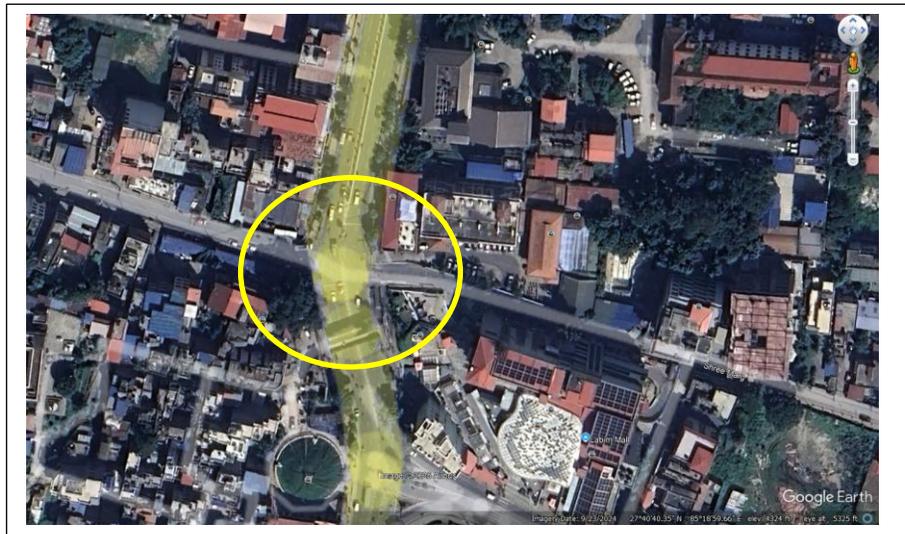
SPOT SPEED STUDY

(IN FRONT OF DEAN OFFICE)
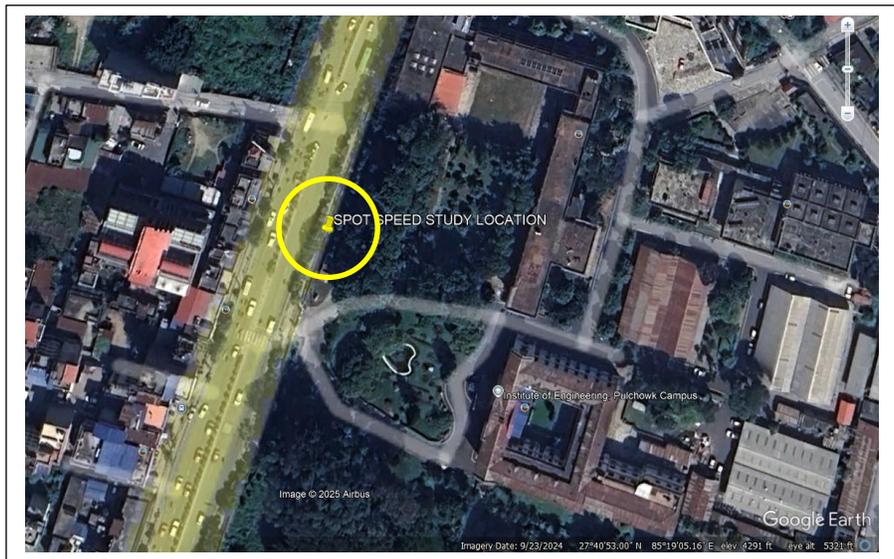
LOCATION

TRAFFIC VOLUME STUDY

(BESIDE LABIM MALL)

LOCATION