

A
PROJECT REPORT
ON
“STUDY ON ERROR IN SPACE SPEED PREDICTION ”

SUBMITTED BY

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(ROLL.NO-110CE0039)

IN PARTIAL FULLFILLMENT OF THE REQUIREMENTS FOR THE DEGREE IN
BACHELOR OF TECHNOLOGY

IN
CIVIL ENGINEERING

UNDER
THE GUIDANCE OF
DR. UJJAL CHATTARAJ



NATIONAL INSTITUTE OF TECHNOLOGY
DEPARTMENT OF CIVIL ENGINEERING
ROURKELA, 2014



CERTIFICATE

It is certified that the work contained in this thesis entitled “**study on error in space speed prediction**” submitted by **Mr. Bishwa Bhusan Hansdah, Roll.no-110ce0039** in partial fulfilment of the requirements for the bachelor degree in civil engineering at National institute of technology Rourkela. The work has been done under my supervision and the work has not been submitted elsewhere for a degree.

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ABSTRACT

In the “study on error in space speed prediction” data are collected from different road section of the Rourkela steel city, Odisha. Radar gun is used for the determination of the time mean speed. Video camera analysis is done for the determination of the space mean speed where time mean speed is observed. Road sections are taken from 20m to 2m with an interval of 2m for the space mean speed. Datas are analyzed by the keeping the time mean speed constant then error in space mean speed with respect to time mean speed is observed along the road section from 2m to 20m with an interval of 2m. It is observed that error is larger in short distance but it decreases with increase in distance.

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CHAPTER-1

INTRODUCTION

1. Speed is one of the basic parameters of traffic engineering like volume, density etc. It is considered as a quality measurement of travel as a result drivers and passenger will more concern about the speed of journey and design aspect of traffic. Speed is defined as the distance travelled by the vehicle per unit time. Suppose a vehicle covers a distance from X_1 position to X_2 position during time interval from t_1 to t_2 . Mathematically speed is defined as

$$v = \frac{X}{t}$$

$$= \frac{X_2 - X_1}{t_2 - t_1}$$

Where v =velocity of the vehicle in m/sec or km/hr

X = total distance covered by the vehicle in m or km

$$= X_2 - X_1$$

X_1 = starting position of vehicle in m or km

X_2 = Ending position of vehicle in m or km

t = time taken by the vehicle to cover X distance

$$= t_2 - t_1$$

t_1 = initial position of vehicle in sec or hour

t_2 = final position of vehicle in sec or hour

1.1 Speed is dependent on two factors i.e. time and space. Time related speeds are spot speed, time mean speed. Space related speeds are space speed, space mean speed, journey speed and running speed.

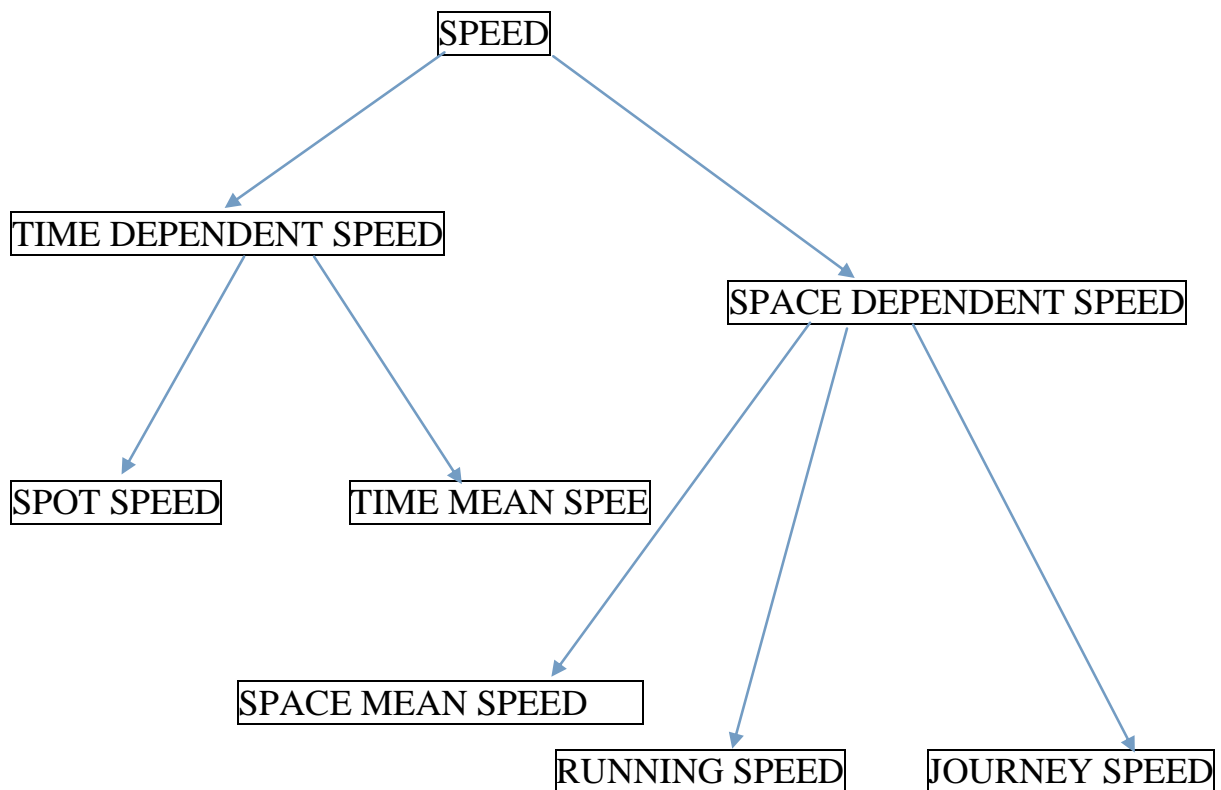


Figure-A types of speed in traffic engineering

1.2 Spot speed

Spot speed is defined as the instantaneous speed i.e.; it is a speed at very negligible time interval.

Time interval tends to zero at spot speed.

$$V_{spot} = \lim_{\Delta t \rightarrow 0} \frac{\Delta x}{\Delta t}$$

Where, V_{spot} = spot speed

Δx = distance covered at spot speed

Δt = time duration at spot speed

Spot helps in speed limits, no passing zone etc.

1.3 Time mean speed

Time mean speed is defined as the mean of all the spot speed.

Mathematically it is expressed as

$$V_{tms} = \frac{1}{n} \sum_{i=1}^n V_i$$

Where V_{tms} = time mean speed

V_i = spot speed of the i^{th} vehicle

n= no of vehicles

1.4 Space mean speed

Space mean speed is defined as the distance divided by the mean of time duration of the vehicles at fixed distance.

$$V_{\text{sms}} = \frac{L}{\frac{\sum_{N=1}^N t_i}{N}}$$

Where V_{sms} = space mean speed

L=length of the road section

N=no of vehicles

t_i =time taken by the i^{th} vehicles to cross the length of L

$t_i = (t_i)_{\text{exit}} - (t_i)_{\text{enter}}$

where $(t_i)_{\text{exit}}$ = time at exit of road section of the i^{th} vehicle

$(t_i)_{\text{enter}}$ = time at enter of road section of i^{th} vehicle

1.5 Running speed

Running speed is defined as the average speed of the vehicle during running position, no stopping time is considered. Only running time is considered for determination of speed.

1.6 Journey speed

Journey speed is defined as the average speed of the vehicle during journey position. Here, stopping time is also considered for determination of speed.

1.1.1 Factors affecting speed

Factors affecting speed are given below

- 1) Geometric features of the road
- 2) Traffic
- 3) Time
- 4) Place
- 5) Weather
- 6) Behavior of driver
- 7) Design of vehicle

1.1.2 Geometric features of road

The geometric designs are superelevation, curvature of road, width of the road section, terrain, humps, gradient of the road section etc. which are responsible for the variation of the speed.

1.1.3 Traffic

Speed depends upon the traffic volume, traffic density, traffic jam etc.

1.1.4 Time

Speed depends upon the time when speed of the vehicle is observed. During school time, office time speed of the vehicles are less compared to the other time.

1.1.5 Place

Place is also one of the factors upon which speed is dependent. Speed is more on empty area compared to the crowded area.

1.1.6 Weather

Weather of the place effect the speed of the vehicle .During summer speed of the vehicle is more compared to the winter.

1.1.7 Behavior of driver

Speed depend on the physical and psychological behavior of driver. Somebody drives more or less it depends upon his mood.

1.1.8 Design of vehicle

Vehicles are designed up to some speed it cannot exceed that speed. If vehicle is very old its speed is less.

1.1.1.1 Term related with speed

Term related with speed are given below

1)average speed

2)modal speed

3)Median speed

4)Percentile speed

5)pace

1.1.1.2 Average speed

Average speed is defined as the average of all the speed of the vehicle.

1.1.1.3 Modal Speed

Modal speed is defined as the speed at which maximum no of vehicles travel.

1.1.1.4 Median speed

Median speed is defined as the speed at which 50 percent vehicle travel.

1.1.1.5 Percentile speed

X percentile speed is the speed at which x percent of vehicle travel.

1.1.1.6 Pace

Pace is the range of the speed where maximum no of speed is observed.

CHAPTER-2

LITERATURE VIEW

Studied on speed has been done by many reasearcher.They gave the many ideas about speed. Speed is an important parameter for traffic engineer.Control of speed decreases accidents.

Mohd.Azahar bin Awang,Leong Lee Lien et.al(2010) studied the comparison of space mean speed by car chasing method and moving vehicle method.These methods were done on two lane highway in Malaysia. Based on volume in vph, means of space mean speed were different but based on volume in pcu/h were not different so significantly, they differed at 95% confidence interval.

(Xio-lang Ma) (In 2007) analyzed on time space diagram. They were analysis on speed, flow rate and density, time and space headway, distribution $v(t,x)$,stationary measurement by fixed station, stationary measurement by aerial photos, stationary flow.

Bumchul cho (1999) studied the spot speed of the vehicle at short term time interval as 5, 10 and 15 minute respectively.Imaage processing detectors were used for the collection of data at urban roadway and these are not so accurate. The accurate results were obtained by the model of kalman filtering and neural networks.

Victor knoop,Serge Hoogendoorn ,Henk Van Zuylen et.al studied on the empirical difference between the time mean speed and space mean speed. They observed that two mean speeds are varied up to a factor of 4.

Rajurekha Sen, Andrew Cross, Aditya Vashita, Venkata N. Pdmanabhan, Edward Cutrell, William Thies et al. studied on accurate speed and density measurement for road traffic in India in Bengaluru. 11% average error for density and speed compared to manually observed data were obtained by this study.

Ridwan B.A. Quaium (2010) studied the variations of speed at rural horizontal curves at day and night time. He observed that difference in speed taken at two times are basically same.

Wardrop first derived the relation between time mean speed and space mean speed from fundamental theory of traffic flow.

Sonu Agrawal (2013) studied about comparison of speed at two different cities Madras and Rourkela. He observed that speed at two different cities were different.

Krishna Prasad Shrestha (2010) studied the speed zones in rural highway a place located at Nepal in Nevada State. He observed that about 63% road accidents were occurred at normal condition. 87%, 70%, 60% road accidents were observed in dry condition, in clear weather condition, day light condition respectively.

CHAPTER-3

PRESENT STUDY

3.1 DATA COLLECTION SITE

Data are collected from different sections of the Rourkela city Odisha. They are given below.

- Sector-2 road section
- Rourkela market road section
- Sector-1 road section
- Sector-6 road section
- Sector-5 road section
- Fertilizer road section
- Hanuman vatika road section
- Panposh road section

3.2 DATA COLLECTION METHODOLOGY

Data are taken by two methods. They are radar gun method and video camera analysis.

3.2.1 Radar Gun METHOD

Radar gun method is used for the determination of the spot speed and time mean speed. Radar gun measures the speed of the moving object at instant.

3.2.1.2 APPARATUS

Radar gun

3.2.1.3 Principle

It is based on Doppler's effect principle. Speed is measured by the Doppler's formula.

3.2.1.4 Doppler's formula

$$v = \frac{\Delta f}{f} \times \frac{c}{2}$$

Where v =velocity of moving vehicle

Δf =difference in frequency between radio waves

f= emitted frequency of radio waves

c=velocity of light

A radio wave is transmitted by the radar gun towards the moving object. The radio wave is reflected by the metal of the object. The reflected

Wave is received by the receiver. The wave is converted in to electrical energy. According to the principle of Doppler's effect ,speed is displayed.

3.2.1.5 PROCEDURE

Spot speed of the 50 vehicles are measured with the help of radar gun at particular road section where video camera analysis has to be done. Then time mean speed is calculated as the mean of 50 vehicles. Speed of cycle, rickshaw, bike and non metallic vehicle should not be taken as radar gun does not give any accurate result. Radar gun should be hold at 30 degree to avoid cosine error effect.

3.2.2 VIDEO CAMERA ANALYSIS

Video camera analysis is done for the determination of the determination of the space mean speed.

3.2.2.1 APPARATUS

- 1) Video camera
- 2) Meter tape

3.2.2.2 PROCEDURE

- 1.) First two end points are to be marked at 20m section with the help of meter tape and marking should be done by two bricks.
- 2) Same procedure is done for 18m, 16m, 14m, 12m, 10m, 8m, 6m, 4m, 2m etc.
- 3) 18m, 16m, 14m, 12m, 10m, 8m, 6m, 4m, 2m should be the part of the 20m road section.
- 4) Then vehicles passing through the section should be recorded by video camera
- 5) Same procedure is done for 18m, 16m, 14m, 12m, 10m, 8m, 6m, 4m, 2m etc.

6) Then, by video camera analysis, duration of vehicles passes through camera is recorded.

7) Distance divided by duration gives the space mean speed.

8) For my desired purpose I have analyzed the 10 no of vehicles for each

distance

9) Video camera analysis should be done on decreasing order from 20m to 2m.

10) For better video analysis marking should be visible to the camera.

3.3 DATA OBTAINED AT SITE

Following the above method field data are collected at 8 different section of the Rourkela.

They are given below.

3.3.1 Result obtained at sector-2 road section

Time mean speed was obtained 37.74km/hr.

Table-1 Space mean speed data obtained at sector-2 road section

Distance (in metres)	Space mean speed (in km/hr)
2	40
4	39.34
6	39.27
8	36.5

10	36.51
12	36.73
14	36.81
16	36.87
18	36.92
20	36.92

3.3.2 Result obtained at Rourkela market road section

Time mean speed obtained was 37.98km/hr.

Table-2 Space mean speed data obtained at Rourkela market road section

Distance (in metres)	Space mean speed (in km/hr)
2	40.22
4	39.38
6	36.54
8	36.59
10	36.62

12	36.73
14	39.16
16	36.85
18	39.05
20	39.04

3.3.3 Result obtained at sector-1 road section

Time mean speed obtained was 37.86 km/hr.

Table-3 Space mean speed data obtained at sector-1 road section

Distance (in metres)	Space mean speed (in km/hr)
2	40.22
4	39.37
6	36.48
8	36.5
10	36.51
12	39.09

14	36.81
16	36.82
18	36.92
20	36.96

3.3.4 Result obtained at sector-6 road section

Time mean speed obtained was 36.66km/hr.

Table-4 Space mean speed data obtained at sector-6 road section

Distance (in Metres)	Space mean speed (in km/hr)
2	40.44
4	39.34
6	39.27
8	39.18
10	38.87
12	38.67
14	37.95

16	37.94
18	37.93
20	37.91

3.3.5 Result obtained at sector-5 road section

Time mean speed was obtained 37.56km/hr.

Table-5 Space mean speed data obtained at sector-5 road section

Distance (in metres)	Space mean speed (in km/hr)
2	40.67
4	39.88
6	39.2
8	36.4
10	36.47
12	36.48
14	36.6
16	36.85
18	36.9
20	36.96

3.3.6 RESULTS OBTAINED AT FERTILIZER ROAD SECTION

Time mean speed was obtained 39.42 km/hr.

Table-6 Space mean speed data obtained at fertilizer road section.

Distance (in metres)	Space mean speed (in km/hr)
2	36.92
4	37.5
6	37.63
8	38.09
10	38.29
12	40.26
14	40.25
16	40.22
18	40.17
20	40.17

3.3.7 Results obtained at hanuman vatika road section

Time mean speed was obtained 38.88km/hr.

Table-7 Space mean speed data obtained at hanuman vatika road section

Distance (in metres)	Space mean speed (in km/hr)
2	43.11

4	37.11
6	40.29
8	37.74
10	37.77
12	37.86
14	37.95
16	37.96
18	39.05
20	39.04

3.3.8 Results obtained at panposh road section

Time mean speed was obtained 38.42 km/hr.

Table-8 Space mean speed data obtained at panposh road section

Distance (in m)	Space mean speed (in km/hr)
2	36.36
4	36.64
6	37.5
8	37.64
10	37.69

12	37.72
14	37.83
16	37.86
18	37.93
20	37.95

3.4 DATA ANALYSIS AND METHODOLOGY

Time mean speed should be kept constant. Then error in space mean speed with respect to time mean speed is calculated by the formula given below.

$$error = \frac{|tms - sms_x|}{tms} \times 100$$

Where tms=time mean speed

Sms_x = space mean speed at x metre road section

The above formula is used to analyzed the data at 8 different collection site of Rourkela and a graph is drawn between error vs distance.

3.4.1 DATA ANALYZED AT SECTOR-2 ROAD SECTION

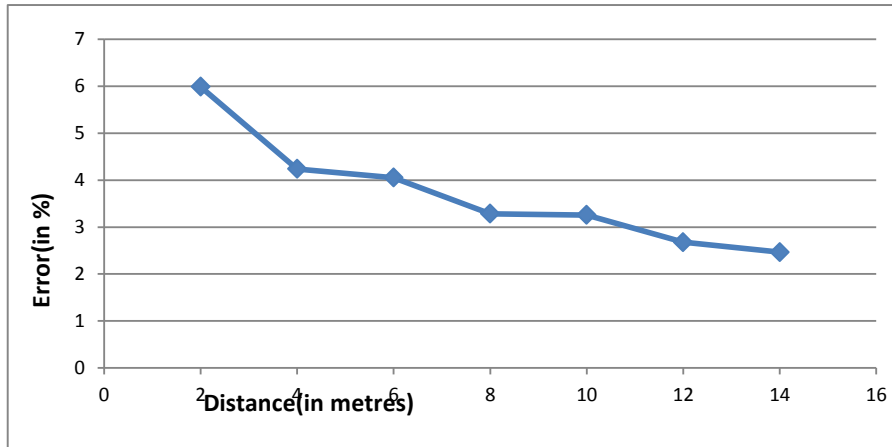


FIGURE-1 error Vs distance graph at sector -2 road section

TABLE-9 ERROR IN SPACE SPEED WITH RESPECT TO DISTANCE AT SECTOR-2 ROAD SECTION

Distance (in metres)	Error (In %)
2	5.9883
4	4.2395
6	4.0540
8	3.2856
10	3.2591
12	2.6762
14	2.4642
16	2.3052
18	2.1727
20	2.1727

3.4.2 DATA ANALYZED AT ROURKELA MARKET ROAD SECTION

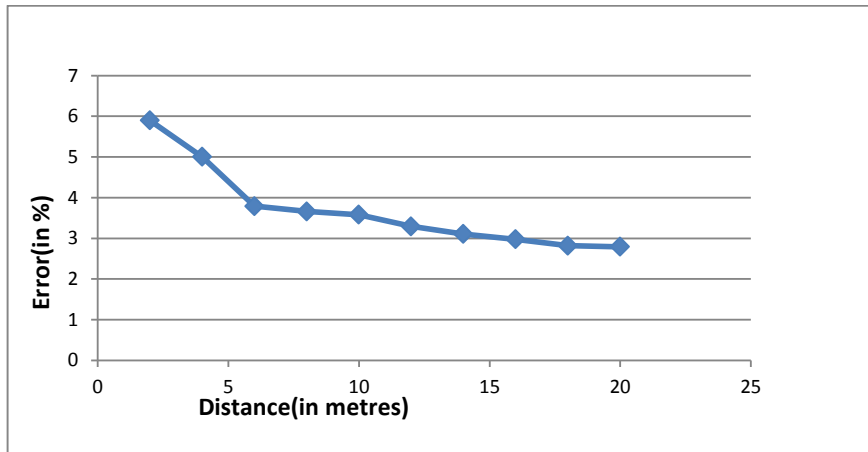


FIGURE-2 error Vs distance graph at Rourkela market road section

Table-10 error in space speed with respect to distance at Rourkela market road section

Distance (in metres)	Error (in %)
2	5.8978
4	5.0026
6	3.7914
8	3.6598
10	3.5808
12	3.2912
14	3.1068
16	2.9752
18	2.8172
20	2.7909

3.4.3 DATA ANALYZED AT SECTOR-1 ROAD SECTION

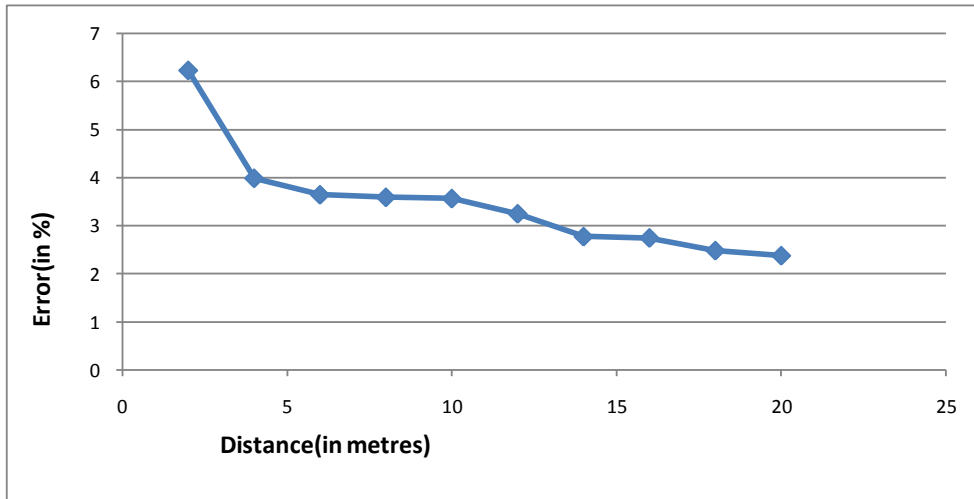


FIGURE-3 error Vs distance graph at sector -1 road section

Table-11 error in space speed with respect to distance at sector-1 road section

Distance (in metres)	Error (in %)
2	6.2334
4	3.9883
6	3.6450
8	3.5921
10	3.5657
12	3.2488
14	2.7733
16	2.7469
18	2.4828
20	2.3771

3.4.4 DATA ANALYZED AT SECTOR-6 ROAD SECTION

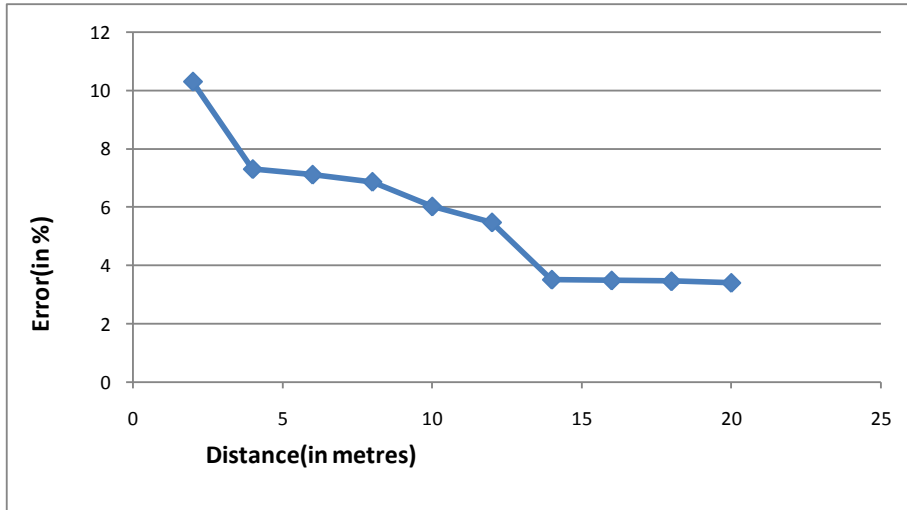


FIGURE-4 error Vs distance graph at sector -6 road section

Table-12 error in space speed with respect to distance at sector-6 road section

Distance (in metres)	Error (in %)
2	10.3109
4	7.3104
6	7.1194
8	6.8739
10	6.0283
12	5.4828
14	3.5188
16	3.4915
18	3.4642
20	3.4097

3.4.5 DATA ANALYZED AT SECTOR-5 ROAD SECTION

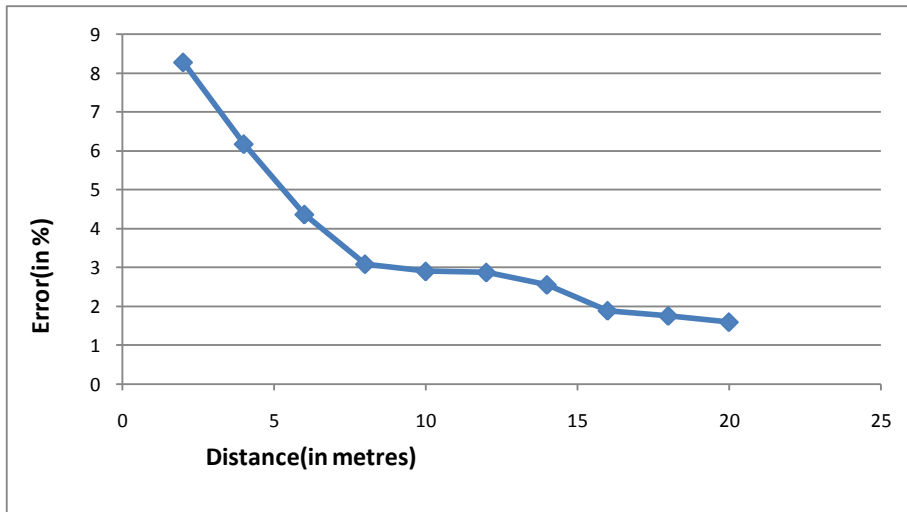


FIGURE-6 error Vs distance graph at sector -5 road section

Table-13 error in space speed with respect to distance at sector-5 road section

Distance (in metres)	Error (In %)
2	8.28
4	6.1767
6	4.3663
8	3.0883
10	2.902
12	2.8753
14	2.5559
16	1.8903
18	1.7571
20	1.5974

3.4.6 DATA ANALYZED AT FERTILIZER ROAD SECTION

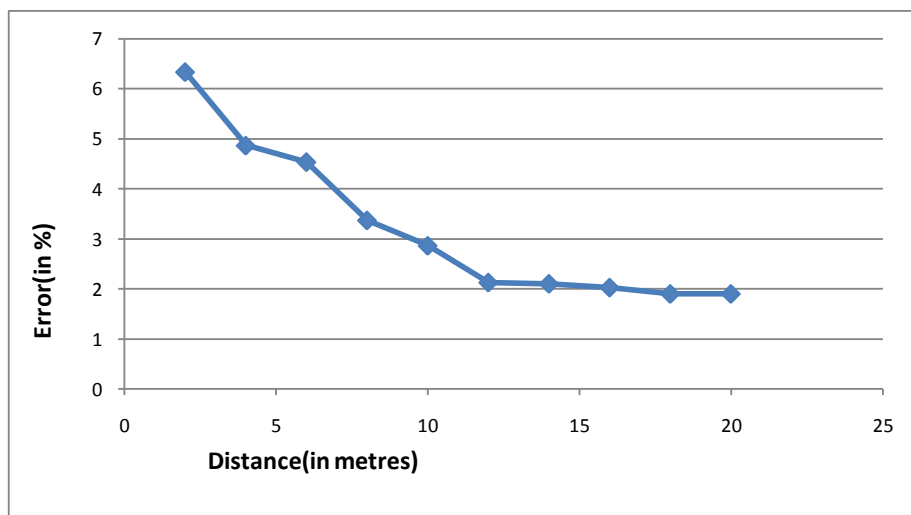


FIGURE-6 error Vs distance graph at Fertilizer road section

Table-14 error in space speed with respect to distance at fertilizer road section

Distance (in metres)	Error (in %)
2	6.3419
4	4.8706
6	4.5408
8	3.3739
10	2.8665
12	2.1308
14	2.1055
16	2.0294
18	1.9025
20	1.9025

3.4.7 DATA ANALYZED AT HANUMANVATIKA ROAD SECTION

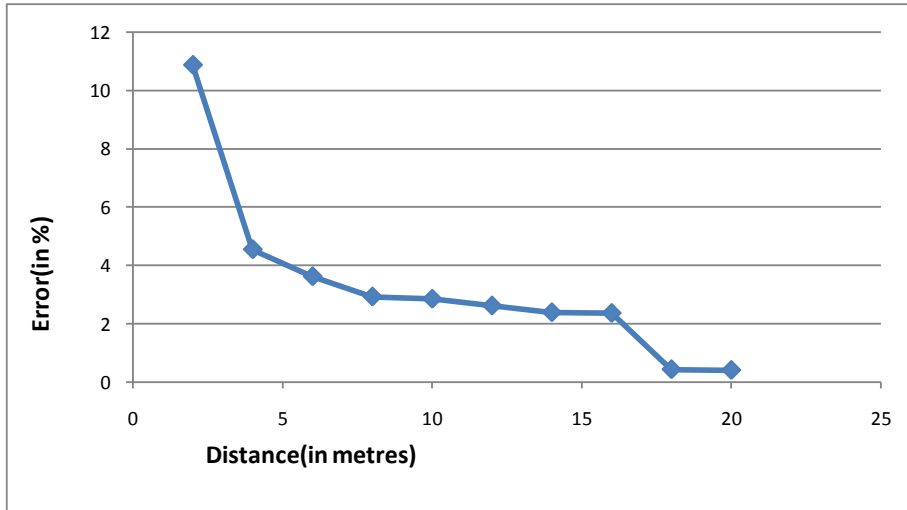


FIGURE-7 error Vs distance graph at hanuman vatika road section

Table-15 error in space speed with respect to distance at hanuman vatika road section

Distance (in metres)	Error (in %)
2	10.8796
4	4.5524
6	3.6265
8	2.932
10	2.8549
12	2.6234
14	2.3919
16	2.3662
18	0.4372
20	0.4115

3.4.8 DATA ANALYZED AT PANPOSH ROAD SECTION

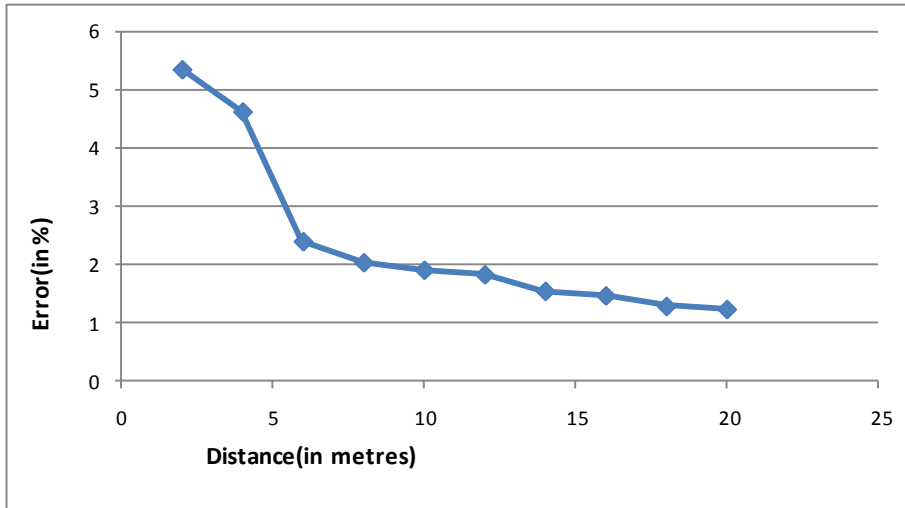


FIGURE-8 error Vs distance graph at panposh road section

Table-16 error in space speed with respect to distance at panposh road section

Distance (in metres)	Error (in %)
2	5.3617
4	4.633
6	2.3945
8	2.0301
10	1.9
12	1.8219
14	1.5356
16	1.4575
18	1.2753
20	1.2233

3.4.9 AVERAGE

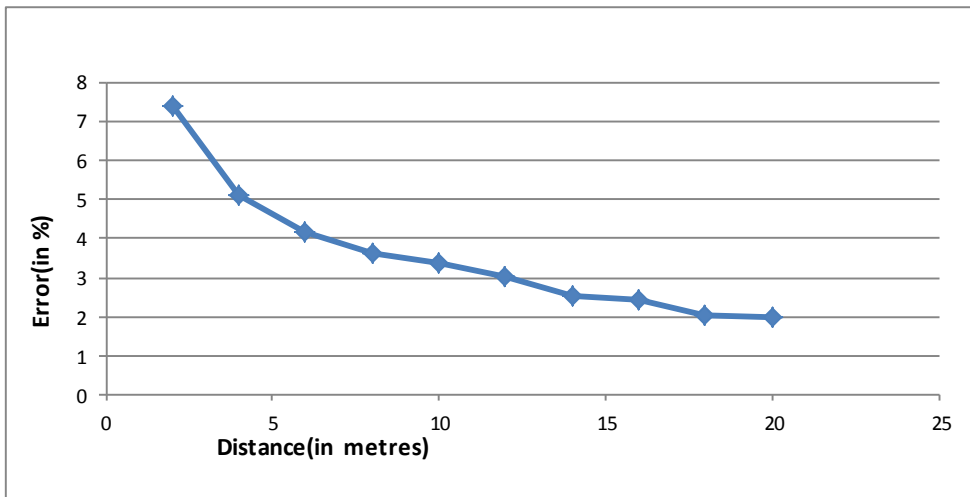


FIGURE-9 error Vs distance graph on average

Table-17 error in space speed with respect to distance on average

Distance (in metres)	Error (in %)
2	7.4117
4	5.0966
6	4.1922
8	3.6044
10	3.3696
12	3.0188
14	2.5565
16	2.4077
18	2.0386
20	1.9856

CHAPTER-4

CONCLUSION

Error in space mean speed with respect to time mean speed was found to be more when distance is short .Error was decreased with increase of distance. Rate of error was first decreased more with increase of distance,then decreased very less amount.

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