A

Project Report

On

STUDY OF SAFETY AT PUBLIC PLACES AND ROADS

Submitted by

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In partial fulfillment of the requirements for the degree in
Bachelor of Technology in Civil Engineering

Under the guidance of

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CERTIFICATE

It is certified that the work contained in the thesis entitled ***"Study of safety at public places and roads"*** submitted by ***Mr.Sambit Kumar Sial (Roll No.109CE0063)***, has been carried out under my supervision and this work has not been submitted elsewhere for a degree.

Date: 10-05-2013

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I would like to thank **NIT Rourkela** for giving me the opportunity to use their resources and work in such a challenging environment.

First and foremost I take this opportunity to express my deepest sense of gratitude to my guide ***Prof. U. Chattaraj*** for his able guidance during my project work. This project would not have been possible without his help and the valuable time that he has given me amidst his busy schedule.

I would also like to extend my gratitude to ***Prof. N. Roy***, *Head, Department of Civil Engineering* and ***Prof. R. Jha***, *Department of Civil Engineering,* for their constant encouragement, support and valuable tips throughout my work.

Last but not the least I would like to thank all my friends who have been very cooperative with me and have helped me in completing my project.

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ABSTRACT

Safety is generally divided into two categories i.e. safety at public places and safety at roads.Safety at public places are further subdivided into safety at Hall e.g. Shopping mall, Movie Theatre.Public place can vary through the course of the day which can be used by different groups of people at different times. It may be busy at certain times and sometimes not busy and those differences can have a very different impact on the way you feel when you are in them. So a good planning from an early stage will help to run every event safely. In this model I have studied how the time of evacuation from a hall gets affected due to the width of the door.Road safety refers to measures and methods for reducing the risk of a person using the road network being killed or seriously injured. In this model I have studied how road accident gets affected due to road factors. Road factors generally refers to the Geometric features of the road(Horizontal radius,Vertical curve and superelevation), and the manmade features.Manmade features refers to the features made by man (Roadway obstacles,Adjacent structurs which are present very nearer to the road and the posters present along the road)

To demonstrate the developed model by regression, empirical data is used.

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CHAPTER-1
INTRODUCTION

1. Safety is generally divided into 2 categories.Safety at public places & safety at roads.Safety at public places are further subdivided into safety at Hall e.g. Shopping mall, Movie Theatre and in case of roads 2 factors are mainly responsible for accidents I.e., road factor and human factor.

<u>Safety at Public place</u>

Malls generally face substantial public liability exposure for a host of risks, including slip and falls, assault if a customer is incorrectly detained by mall security, and even biological and physical attack.These risks include fires which is not stranger to the shopping mall. In 1977, a part of the Westgate Mall in Pennsylvania burnt and another Pennsylvania shopping center was destroyed by on Christmas Eve, 1981. More recently, in November 2006, a fire near the Willow Grove Park mall in Pennsylvania just outside of Philadelphia, forced the evacuation of more than 6000 people though no injuries were reported. Another fire, in April 2008, at a Milford in New Zealand shopping mall also caused hundreds of people to be evacuated from the smoke-filled structure.and three months earlier in January, a 10 hour fire in the Galleria Baclaran Shopping Mall in Pasay City, outside Manila, The Philippines, resulted in damages estimated at $1.8 million dollars. Luckily, none of these conflagrations resulted in loss of life. However, on Christmas Day 2006, a 7 hour fire in the Unitop General Merchandising Store in the Ormoc Mall in Manila, claimed the lives of 31 people.

Public place can vary through the course of the day. It can be used by different groups of people at different times. It may be busy at certain times.These differences can have a very different impact on the way you feel when you are in them. So a good planning from an early stage will help to run every event safely.

2. Accident at road causes due to 2 factors i.e. human factor and road factor.

<u>Human Factor(Driver)</u>

e.g.- aggressive, conservative nature, illness, addiction, physical problems like colour blindness, night blindness.Could not collect data on human psychology, so in this study work on this area is not done

<u>Road Factor</u>

A. . **Road geometry**

Horizontal curve

Vertical curve

Superelevation

B. **Manmade features**

- How a driver reacts to the action of other drivers

2(A)Road geometry

- **Horizontal Curves**

A horizontal highway curve is a plan to provide a change in direction in the centerlene of the road.When a vehicle goes along a horizontal curve,a force called as centrifugal force acts horizontally outwards through out the centre of gravity of the vehicle.More the horizontal curve,lesser will be the chances of accidents. Accidents on horizontal curves are a cause for concern in all countries, whatever the level of development of their road system. A recent study has found that in Denmark, about 20% of all personal injury accidents and 13% of all fatal accidents occur on curves in rural areas; and in France, over 20% of fatal accidents occur on dangerous curves in rural areas (Herrstedt and Greibe, 2001). Accidents on bends are undoubtedly a major problem in many developing countries, although the proportion of such accidents is dependent upon both the topography and demography of each country.

Accidents on horizontal curves tend to be of two main types: 'Running off the road and hitting an object' and 'Lost control and Rolled over'. There can also be a significant number of Head On and Sideswipe accidents at higher traffic volumes. The apparent cause of these accidents is usually the driver entering the bend at too high a speed; and the reason for this can be because the driver was wilfully travelling at a high speed, was paying insufficient attention or because he misjudged the severity of the bend. Such misjudgements can be caused because of the bend's visual configuration, poor delineation or because it was unexpectedly sharp after a series of gentle curves or after a long straight (tangent) section. Another major problem can occur when drivers sometimes ignore the 'no-overtaking' enforcement. When travelling around bends, the higher forces put on the road surface by the side thrust of the tyre frequently cause the surface aggregate on bends to polish more quickly than the rest of the road, thus aggravating the problem of safety. There can also be underlying problems in the geometric design of the curve because the basic assumptions are not applicable to the design (e.g. a high proportion of drivers exceed the design speed). On gravel roads in particular, the loss of super-elevation in the cross-sectional profile through lack of maintenance may result in the effects of a horizontal curve being more severe than as designed.

- **Vertical Curve**

A parabolic curve that is applied to make a smooth and safe transition between two grades on a roadway or a highway.
Vertical curves are generally applied

- At an intersection of two slopes on a highway or a roadway
- To provide a safe and comfort ride for vehicles on a roadway.

There are three main effects of vertical road alignments, which are closely associated with the occurrences of traffic accidents. These are excessive speeds and out-of-control vehicles on down grades, differential speed between vehicles created on both down and up grades, and low range of visibility that often occurs in the immediate vicinity of steep grades at the crest of vertical curves. It may be difficult for driver to appreciate the sight distance available on crust curve and he may overtake when it is insufficient for him to do so safely. This can be extremely expensive to provide safe overtaking sight distances on crust curves. However, a complete ban on overtaking would be difficult to enforce because of the presence of very slow moving vehicles, the lack of driver discipline in selecting places, poor maintenance of road marking and signs. Successive short vertical curves on straight section of road may produce misleading forward visibility. Berehanu summarized the effects of vertical curve in such a way that steep grades have higher accident rates than mild ones. He extends that grades of less than 6 per cent have little effect, but grades steeper than this are associated with higher accident rates. Down grades are greater problems, particularly for truck safety than upgrades. A combination of horizontal curve under 450m and grades more than 4 per cent are not recommended. Weak conditions of the horizontal and vertical alignments of a road can result in visual effects, which can cause accidents and are detrimental to the appearance of the road.

- **Superelevation**

Superelevation is the rotation of the pavement on the approach to and through a horizontal radius. Superelevation is made to assist the driver by counteracting the lateral acceleration produced by moving across the curve. Superelevation is expressed as a decimal point, representing the ratio of the pavement slope to width, varying from 0 to 0.12 foot/feet. The adopted criteria allow for the use of maximum superelevation rates from a range of 0.04 to 0.12. Maximum superelevation rates for design are established by policy by each State.

Selection of a maximum superelevation rate is based on several variables, such as terrain, weather, highway location (urban vs. rural), and frequency of very slow-moving vehicles. e.g, northern States that experience ice and snow conditions may establish maximums for superelevation than States that do not experience these conditions. Use of lower maximum value of superelevation rates by policy is made to address the perceived problem created by vehicles sliding transversely when traveling at very low speeds when weather conditions are poor.

2(B)Manmade Features

* I have studied here how a driver gets disturbed due to the presence of some unwanted things on the road/vicinity of the road.
* The term “manmade features” mainly refers to any object on the side of the road that, by virtue of its placement and structure, results in or is likely to cause, a maximum probability of vehicular damage, occupant injury or fatality.
* In my case I have considered three features such as roadway obstacles, obstacles very near to road and posters though it will not cause obstruction, but it can affect human’s mind).
* Our main aim is to consider these factors and analyze it using some video data and and then analyzed it through regression.

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Regression model

A regression model is to be fitted for all the 3 experiments I have done.

CHAPTER-2

Literature Review

In the past few decades a large number of deterministic and/or stochastic models have been developed to solve complex traffic and transportation engineering problems. These mathematical models use different formulae and equations to solve such problems.

1.

Ethel Graat, Cees Midden, Paul Bockholts (1999): Ethel Graat, Cees Midden and Paul Bockholts concerned with the concept of building evacuation and the factors which affects the emergency egress time.They divided the evacuation time into three components i.e. the time to understand a dangerous situation, the time to be decided for evacuation and the time for the movement towards safety. They had discussed the advantages of the use of a mean value over the use of a maximum value, and thus of the use of average value over a minimum egress time.

Yarali, A. ; Ahsant, B. ; Rahman, S.(2009): These peoples have studied a paper which provided a background on technology requirements for emergency and public safety communications systems and addressed some of the technical influences of wireless mesh networks. The article also described the capabilities and architecture of the man-portable, interoperable, tactical operations center communication system which was funded by the U.S. Department of Homeland Security. Infact It is a modern mobile communications infrastructure which is well suited for public safety and disaster recovery applications.

Xuan Xu (2010): He had studied a paper on the risk early-warning method of passenger flow in business district from four aspects parts i.e regional density, flow rate of the section, bidirectional flow ratio of the section and mean velocity and compared the advantages and shortcomings of these methods. All of these factors are significant in preventing such accident and constituting to the emergency response.

Xiaoge Wei (2011):He studied a paper which chose a hospital as the object of study and reset the velocity of pedestrians in a software i.e.,FDS+Evac by means of collecting data which are related to real velocities of different pedestrian groups in hospital, and investigated how the parameters such as velocity and exit familiarity influence the evacuation results. The results showed that large velocity difference leads to intermittent flow.

2(A).

Yulong Pei ; Ji Ma:These people had studied the effect of road conditions to accidents should be given much attention to. With large numbers of actual traffic accidents of Shenda Freeway, Liaoning Province and Harbin City in China, the parameters and effect along the accidents of horizontal curve, vertical graden , cross section and intersection were studied systematically, and the analysis of the effect was presented. The critical value and the suitable range of curve radius and angle of deflection was put forward in view of road safety. The safe grade value and the proposed critical grade were raised in vertical grade design. The effect which number of lanes, cross section of the road, height and gradient of subgrade that influenced the traffic accidents were analyzed deeply.

Chunyan Li, Jun Chen(2009): They have studied that as the traffic accident forecast result is not only affected by the present factors, but the past ones, it needs to know the past values of traffic accident and its affected factors. Basing on the statistic analysis of affected factors values in the past years, it was found that they have obvious increase tendency and fluctuating characters which established the relationship between traffic dead people and the other factors which can be called affected factors. Time series and random event values being independent variables and volume of dead people being dependent variable, a dynamic regression model is established.

2(B).

Zhuanglin MA, Chunfu SHAO(2010): This paper tells about how to evaluate the association between accident severity and possible contributory factors. The nature of the dependent variable that facilitates the application of binary logistic regression for which the probability of an extra serious or major accident against an ordinary or minor accident was estimated by maximum likelihood method. Binary logistic regression was used in this. The probability that an extra serious or major accident will occur or not was modelled as logistic distribution.

Cai Wenxue1, Wang Hengpeng2(2011): This paper tells about the improvement of the traditional hazardous material road transportation accident rate analysis model through a careful analysis based on the use of historical data, to achieve a more accurate accident rate. They found Hazardous material road transportation routing based on risk analysis was one of the key methods which can achieve the reduction of hazardous material transportation risks and accident damages. Historical data proved that the improved model results can get results more close to the actual situation.

CHAPTER-3

Empirical Calculations

1. EVACUATION FROM A HALL

STUDY AREA

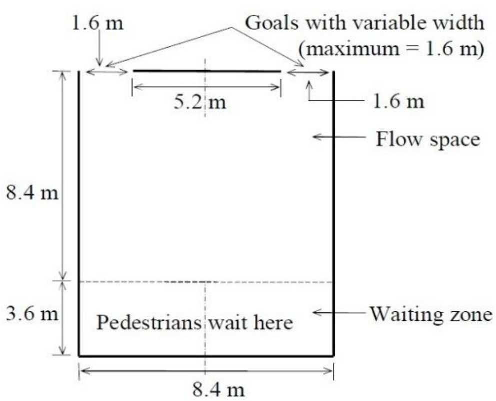
- To observe the evacuation of peoples from a hall and to understand their impact of exits and the geometry of the flow space on pedestrian flow with different conditions.

- Here experiments on evacuation from a hall are conducted to understand the impact of exits and the geometry of the flow space on pedestrian flow. The width of the door openings as well as number, shape, size and positioning of obstacles are varied to change the nature of the goals and the geometry of the flow space. It had shown how evacuation time from an enclosed space varies with number of persons inside the flow space and nature of exits present in the flow space as well as geometry of the space.

The different conditions are

- (i)Both doors are fully open; no obstacle present in the flow space
- (ii) Left door is fully open and right door is half open; no obstacle present in the flow space
- (iii) Both doors are half open; no obstacle present in the flow space
- (iv) Left door is fully open and right door is closed; no obstacle present in the flow space
- (v) Left door is half open and right door is closed; no obstacle present in the flow space
- (vi) Both doors are fully open; a rectangular obstacle in the form of a barrier
- (vii) Both doors are fully open; an obstacle near the initial position of the pedestrians
- (viii) Both doors are fully open; a rectangular obstacle near the left door

(ACTUAL VIEW OF THE HALL WITH FOUR CONDITIONS
BOTH THE DOORS OPEN **FIGURE 1**)



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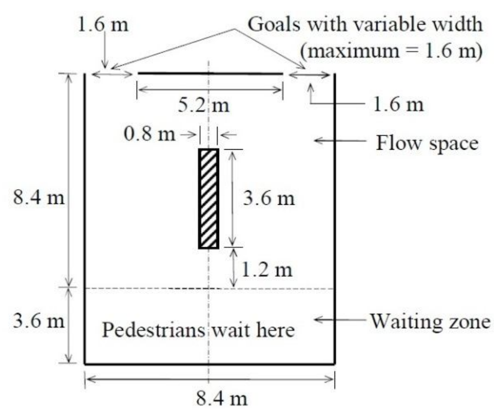
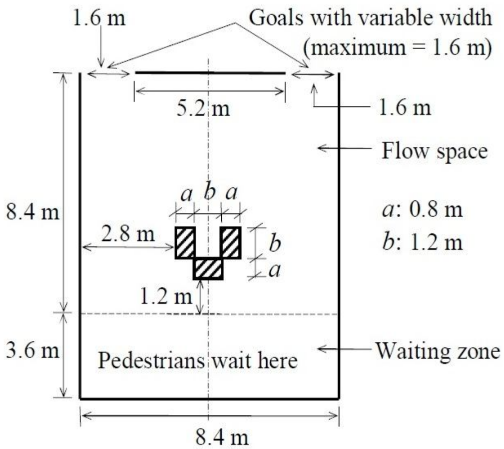


(a)



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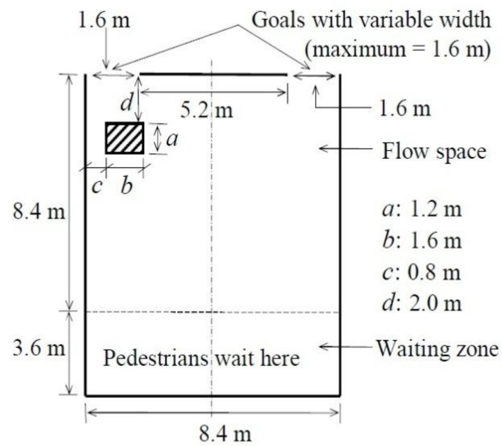


(c)

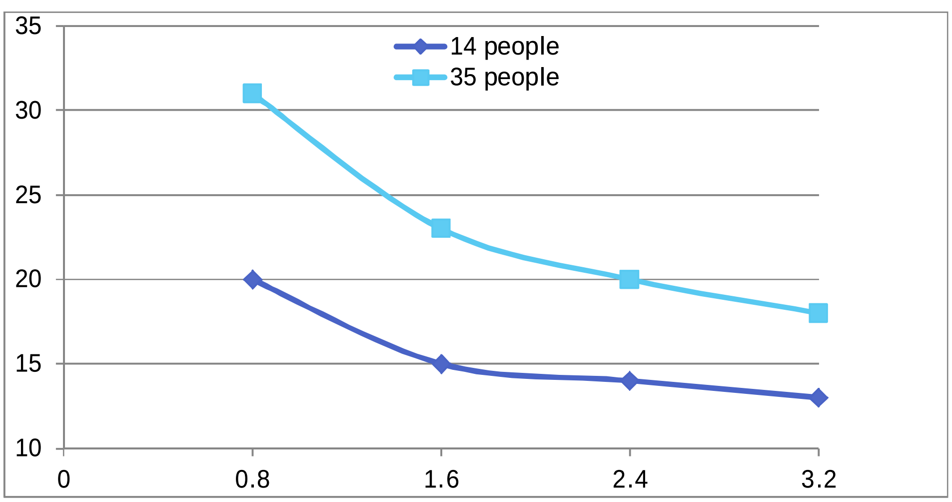
<u>All the figures adapted from Chattaraj et al</u>

FIGURE 2-No obstacles present

FIGURE 3-A rectangular object present which acts as a barrier

FIGURE 4- an obstacle near the initial position of the pedestrians

FIGURE 5- a rectangular obstacle near the left door



This is the graph between the total evacuation time versus width of door opening plot for 35 persons and 14 persons.

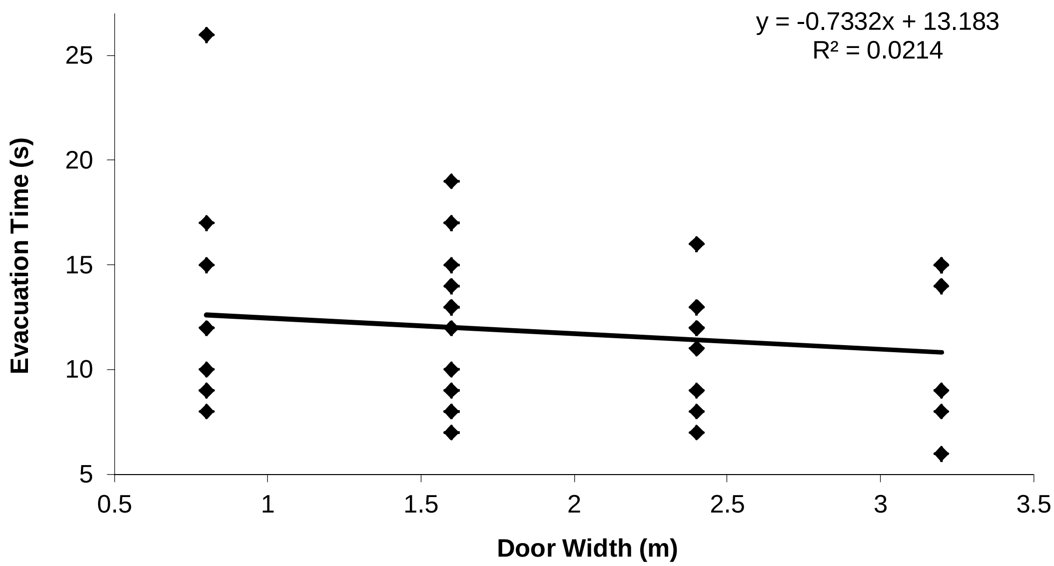
Results of the expt. TABLE-1

	A	B	C	D	E	F
1	**No. of Persons**	**Run**	**Name of Exp.**	**door width (m)**	**Evac. Time (s)**	
2	**14 persons**	**1st**	1 half door open	0.8	9	
3			2 half door open	1.6	8	
4			1 full door open	1.6	8	
5			1 full 1 half door open	2.4	7	
6			2 full door open	3.2	6	
7		**2nd**	1 half door open	0.8	8	
8			2 half door open	1.6	7	
9			1 full door open	1.6	9	
10			1 full 1 half door open	2.4	9	
11			2 full door open	3.2	9	
12		**3rd**	1 half door open	0.8	10	
13			2 half door open	1.6	7	
14			1 full door open	1.6	9	
15			1 full 1 half door open	2.4	8	
16			2 full door open	3.2	8	
17		**4th**	1 half door open	0.8	15	
18			2 half door open	1.6	8	
19			1 full door open	1.6	10	
20			1 full 1 half door open	2.4	11	
21			2 full door open	3.2	9	
22	**35 persons**	**1st**	1 half door open	0.8	9	
23			2 half door open	1.6	12	
24			1 full door open	1.6	13	
25			1 full 1 half door open	2.4	12	
26			2 full door open	3.2	14	
27		**2nd**	1 half door open	0.8	12	
28			2 half door open	1.6	14	
29			1 full door open	1.6	15	
30			1 full 1 half door open	2.4	13	
31			2 full door open	3.2	15	
32		**3rd**	1 half door open	0.8	17	
33			2 half door open	1.6	13	
34			1 full door open	1.6	17	
35			1 full 1 half door open	2.4	12	
36			2 full door open	3.2	15	
37		**4th**	1 half door open	0.8	26	
38			2 half door open	1.6	17	
39			1 full door open	1.6	19	
40			1 full 1 half door open	2.4	16	
41			2 full door open	3.2	15	

A regression model was fitted considering door width (x_1) as independent variables and evacuation time as dependent variable (y)

The equation of the model is given by

Y= C1*X1 + C2 Where C1,C2 are constants



So the equation of the regression line was found out to be

y = -0.7332x + 13.183

2(A) ROAD GEOMETRY

Here a study was conducted to find out how the accident rate is affected due to geometric features of the road such as horizontal radius,vertical grade, and superelevation.

INSTRUMENTS USED FOR ROAD GEOMETRY

The topographic survey was done with high precision engineering survey instruments such as

a. **Differential Global Positioning System (DGPS)**

b. **Total Station**

DGPS is a ground-based modern technology instrument which is used for positioning things on precise scale. This is used for measuring the real position (Latitude, Longitude) in the globe and this works with satellites and ground based computer technology.

TOTAL STATION is used for measuring distance, angle, and coordinates with relative to the known position. Total station stores the digital data in internal memory card and then download into a CAD programmed through some application software to visualize the surveying data.

ROAD GEOMETRY

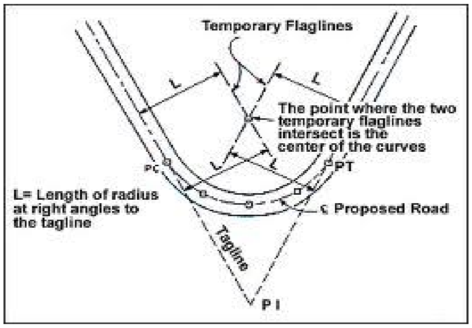
Here studies have been conducted on how the rate of accident is affected by the radius of horizontal curve(R_H),vertical curve(R_V),superelevation(e).

Rate of accident is the ratio of "total no. of accidents" and the "total no. of vehicles" passed on a particular road during the same period of time.

In this case I have collected the road accident data of NH 200(from Bhojpur 131+150 to Telimunda Village 183+980) and at the accidents between these two site I had taken all the values using the DGPS and total station for the calculation of horizontal curve,vertical grade and superelevation.

CALCULATION OF R_H,R_V,e

The data obtained from the total station was plotted in AutoCAD using the X,Y,Z co-ordinates.



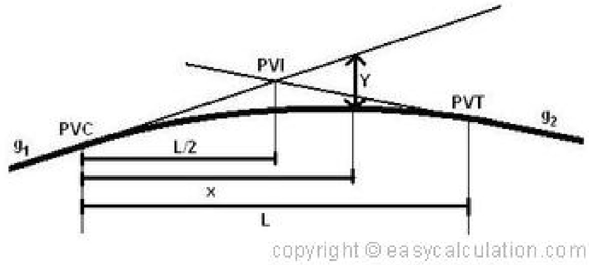


FIGURE 6 –Calculation of Horizontal Curve

FIGURE 7- Calculation of Vertical grade and super elevation

For the calculation of horizontal radius all the measurements were taken and it was plotted in Autocad software.Then the curved portions of the roads were extended to meet at a point.then by using the fillet command in autocad the radius which satisfied the curve was noted down as the horizontal curve radius.

R_H =Radius of the fillet satisfying the curve

MX-Road software was used to determine the vertical grade.

For the calculation of vertical grade the height difference between the end of the road and at the middle of the road was calculated.

Rv=Height difference/total distance covered

Measurement of superelevation is same as that of vertical grade.

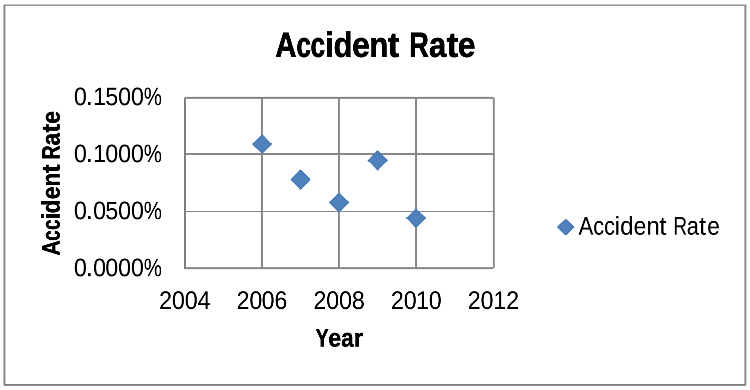
ACCIDENT DATA OF NH 200

Source of Data- Mohit Mohan Garnaik (M.Tech Research student)

on-going M.Tech. thesis

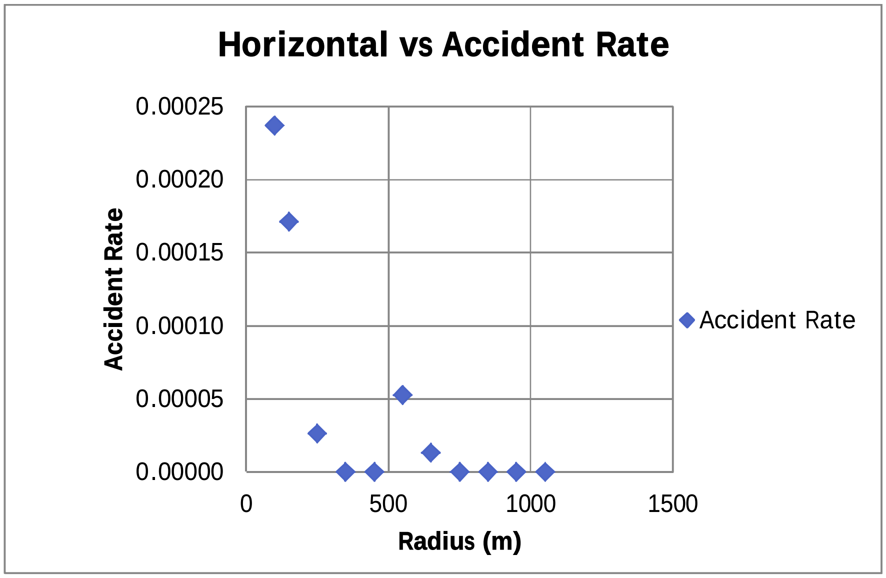
Total Accident
TABLE 2

Year	No. of Accident	Accident Rate
2006	13	0.1095%
2007	10	0.0783%
2008	8	0.0583%
2009	14	0.0949%
2010	7	0.0441%
Total	**52**	



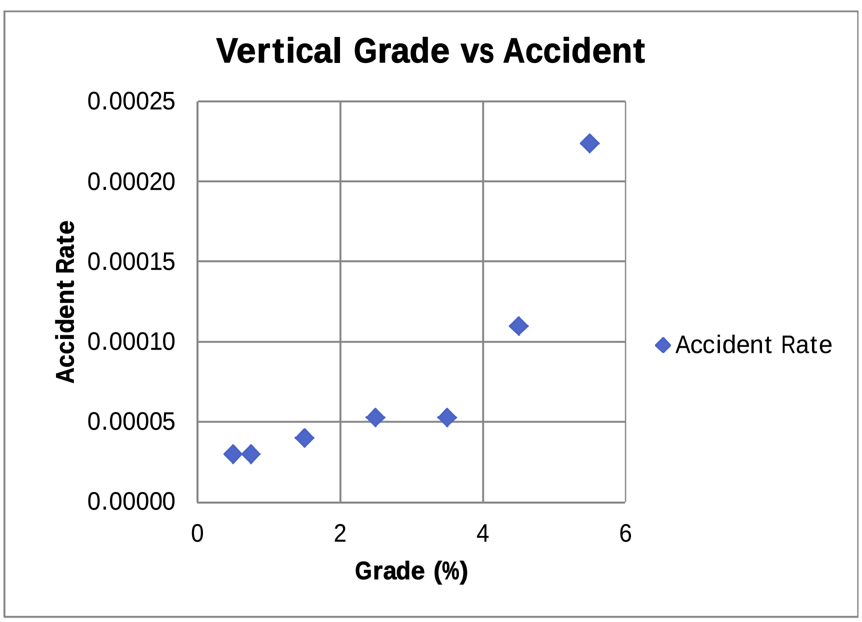
Horizontal
TABLE 3

Radius	Median	No. of Accident	Accident Rate
<100	100	18	0.00027
100-200	150	13	0.00019
200-300	250	2	0.00003
300-400	350	0	0.00000
400-500	450	0	0.00000
500-600	550	4	0.00006
600-700	650	1	0.00001
700-800	750	0	0.00000
800-900	850	0	0.00000
900-1000	950	0	0.00000
>1000	1050	0	0.00000
Total		**38**	



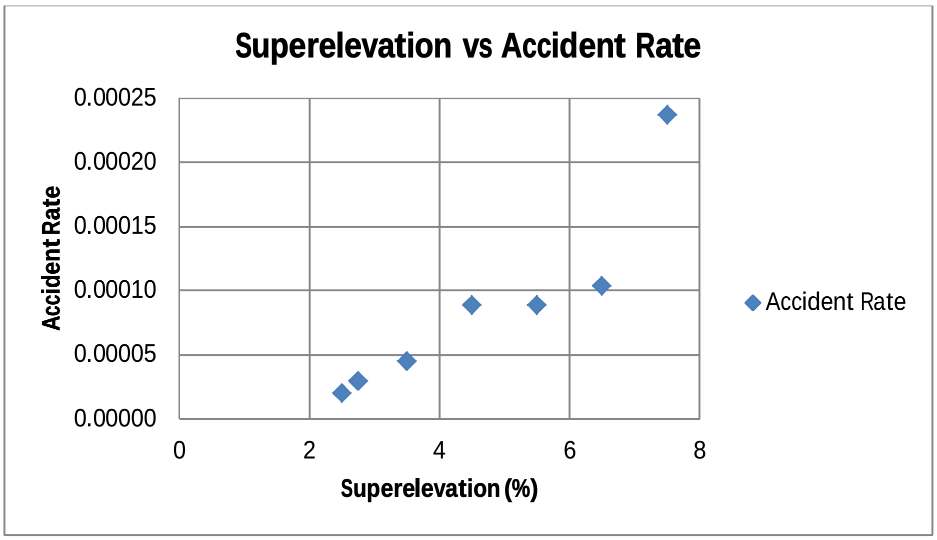
Vertical TABLE 4

Grade (%)	Median	No. of Accident	Accident Rate
<0.5	0.5	9	0.00002
0.5 - 1.0	0.75	13	0.00003
1.0 - 2.0	1.5	4	0.00004
2.0 - 3.0	2.5	4	0.00006
3.0 - 4.0	3.5	4	0.00006
4.0 - 5.0	4.5	1	0.00011
>5.0	5.5	17	0.00025
Total		**52**	



Superelevation
TABLE 5

e%	Median	No. of Accident	Accident Rate
Normal Crown (>2.5%)	2.5	14	0.00002
2.5 - 3.0	2.75	2	0.00003
3.0 - 4.0	3.5	1	0.00005
4.0 - 5.0	4.5	6	0.00009
5.0 - 6.0	5.5	6	0.00009
6.0 - 7.0	6.5	7	0.00010
=>7	7.5	16	0.00024
Total		**52**	



Aim of this study was to model the scenario.

In this case $y=f(R_V,R_H,e)$

objective function y, denotes TA**, i.e., the** total no. of accidents at that point.

decision variables: denoted by $\mathbf{R_V, R_H, e}$

Where

$\mathbf{R_V}$**=** Radius of the vertical curve

$\mathbf{R_H}$=Radius of the horizontal curve

e=superelevation

The equation of the model is given by

$$\mathbf{TA = C1{*}R_H + C2{*}R_V + C3{*}e + C4}$$

The aim is to estimate C_1 , C_2, C_3 and C_4 from the data collected through *multi-variable linear regression analysis*.

	A	B	C	D
1	No. of accidents	HR	SE	VG
2	4	600	4.4	16667
3	1	65	5.62	1410
4	2	700	3.13	1149
5	2	200	6.84	16667
6	2	200	2.85	1500
7	2	55	8.8	0
8	3	25	7.73	0
9	6	40	5.8	0
10	3	30	6.42	0
11	2	150	9.3	488
12	2	170	7.1	0

<u>ACCIDENT DATA OF NH 200 TABLE-6</u>

The regression equation using excel was found out to be
$Y= -0.00121X_1 - 0.12507X_2 + 2.99x10^{-5}X_3 + 3.552$

2(B) MANMADE FEATURES

I have studied here how a driver gets disturbed due to the presence of some unwanted things on the road/vicinity of the road.

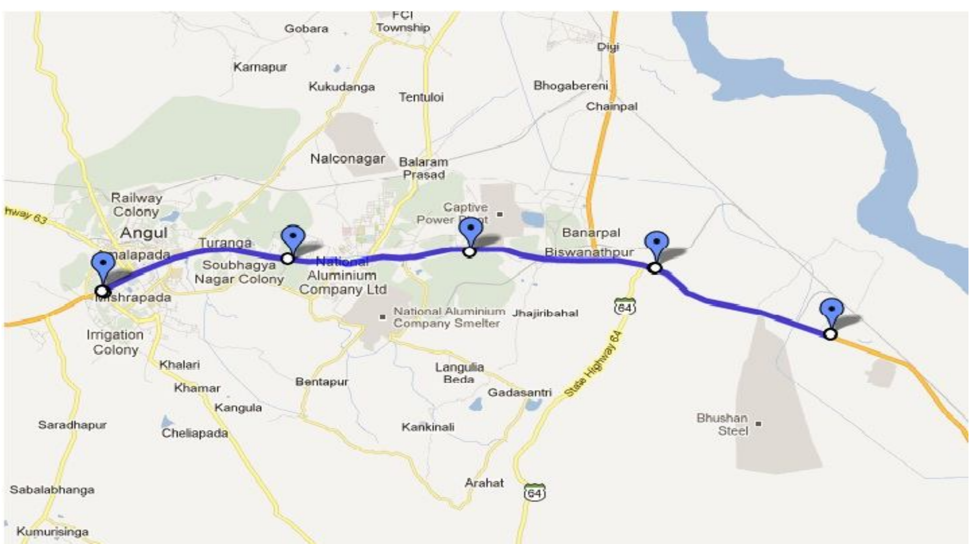
The term “manmade features” mainly refers to any object on the side of the road that, by virtue of its placement and structure, results in or is likely to cause, a maximum probability of vehicular damage, occupant injury or fatality.

In my case I have considered three features such as roadway obstacles, obstacles very near to road and posters though it will not cause obstruction, but it can affect human’s mind).

Our main aim is to consider these factors and analyze it using some video data and and then analyzed it through regression.

Study Area NH-55

(ANGUL-BHUSHAN STEEL   FIGURE 8)



In this case I have collected the 10 years accident data of NH 55 and analyzed it to model the equation.I had divided the 20 km road into 10 strips.So under one strip 2km came and under this one strip, I had calculated the total no. of accidents for each month and stored it in a table.

Source of Data- Achuta Dehuri (M.Tech student)

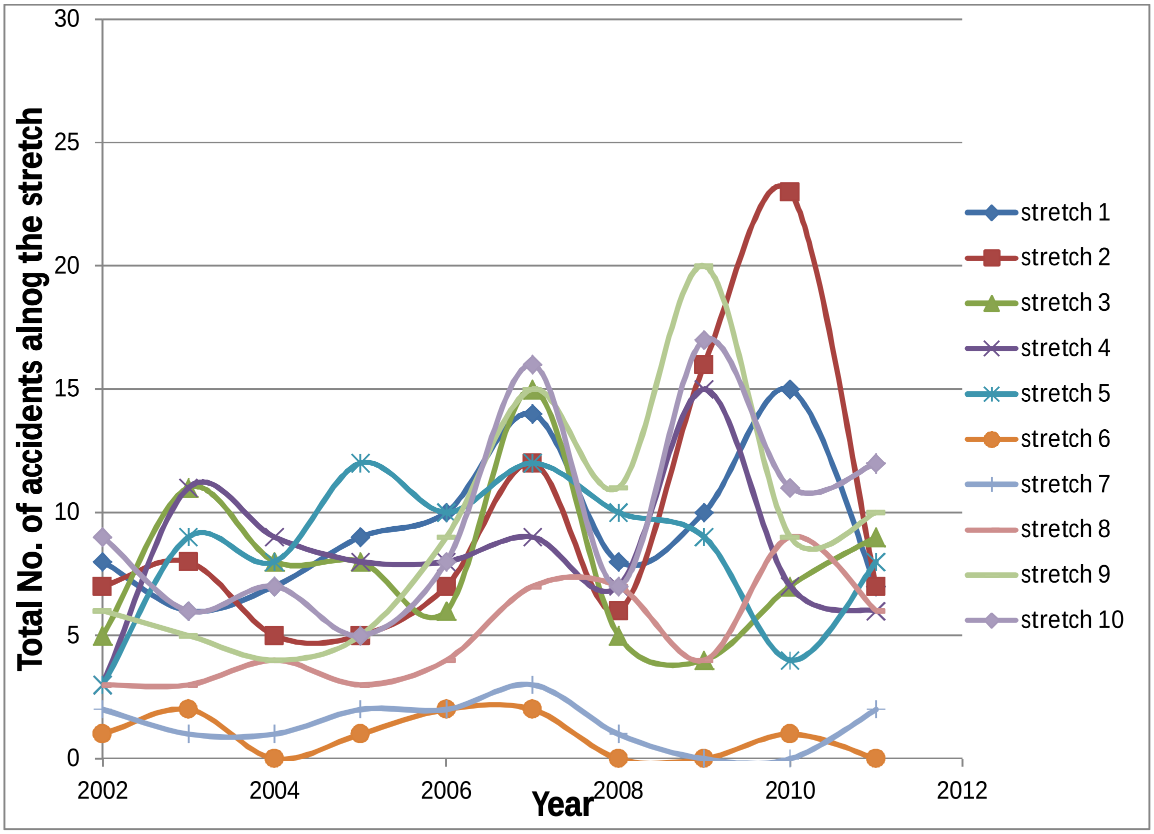
on-going M.Tech. thesis

TABLE-7

Distance(km)	(0-2)km	(2-4)km	(4-6)km	(6-8)km	(8-10)km	(10-12)km	(12-14)km	(14-16)km	(16-18)km	(18-20)km	Total
year											
2002	8	7	5	3	3	1	2	3	6	9	47
2003	6	8	11	11	9	2	1	3	5	6	62
2004	7	5	8	9	8	0	1	4	4	7	53
2005	9	5	8	8	12	1	2	3	5	5	58
2006	10	7	6	8	10	2	2	4	9	8	66
2007	14	12	15	9	12	2	3	7	15	16	105
2008	8	6	5	7	10	0	1	7	11	7	62
2009	10	16	4	15	9	0	0	4	20	17	95
2010	15	23	7	7	4	1	0	9	9	11	86
2011	7	7	9	6	8	0	2	6	10	12	67
	94	96	78	83	85	9	14	50	94	98	

Then a graph was plotted between each year and the no. of aciidents that have occurred imn that year.

From the stretch 6(10-12km) and stretch 7(12-14km),we can easily conculde that there are very obstcles in that road as the no. of accidents that have occurred in that road is low comared to the other stretches.



Accident /year/km and Frequency TABLE-8

Name of stretch	Length	No of accidents in a year		
		Sum of 10 year	Accident/ yr/km	Total Cumulative frequency
Angul P.S-Prasanti Hotel	2km	94	4.7	13.41
P.H-petrol pump	2km	96	4.8	27.10
P.P-SBI atm	2km	78	3.9	38.23

SBI atm-ME school	2km	83	4.15	50.07
ME school-CRP sqr	2km	85	4.25	62.19
CRP sqr-Jagannath temple	2km	9	0.45	63.48
J.temple-Asha talkies	2km	14	0.7	65.48
Asha talkies	2km	50	2.5	72.61
-SBI	2km	94	4.7	86.02
SBI-Bhushan steel	2km	98	4.9	100

Then a video was taken along this 20km road to find out all the road factors along that road and was tabulated and finally it was modelled by multi linear regression.I had considered three road factors such as

Roadway problems(which includes mainly the total length of the dividers along the road)

Obstacles which are present very nearer to the road(mainly the telephone poles,electric poles)

All the Posters which are present along the road

DISTANCE	ADJACENT STRUCTURES	ROADWAY PROBLEMS	POSTER	Accident /yr/km
(0-2)km	65	0	18	4.7
(2-4)km	22	0	15	4.8
(4-6)km	40	0	9	3.9
(6-8)km	69	28	7	4.2
(8-10)km	56	0	5	4.3
(10-12)km	41	0	3	0.45
(12-14)km	15	0	2	0.7
(14-16)km	8	29.33	4	2.5
(16-18)km	14	0	3	4.7
(18-20)km	14	0	1	4.9

TABLE-9

Aim of this study was to model the scenario.

In this case $y=f(X1,X2,X3)$

objective function y, denotes accident /year /km

decision variables: denoted by X_1, X_2, X_3

Where

X_1=no. of adjacent structures

X_2= total no. of roadway problems length

X_3 = no. of poster

The equation of the model is given by

$$\mathbf{AYM = C1*X_1 + C2*X_2 + C3*X_3}$$

The first aim is to estimate C_1, C_2, and C_3 from the data collected through *multi-variable linear regression analysis*.

The regression equation was found out to be
$Y = -0.000461X_1 - 0.000838X_2 + 0.1032 X_3 + 2.646$

CONCLUSIONS AND DISCUSSIONS

1.

- The total evacuation time versus width of door opening plot for 35 persons is above that for 14persons.
- The total evacuation time rises sharply when the width of door opening reduces beyond a certain value (from the figure the value seems to be around 1.6 m).
- As expected the rise is sharper when more number of persons participating in the experiment.
- The width of 1.6 m is obtained in two ways; in one case only one door is fully open and in the other case both doors are half open; the results show there is not much change in the total evacuation time.

2(A)

- With increase in horizontal curve,the accident rate decreases.
- With increase in vertical grade, the accident rate increases.
- With increase in superelevation,the accident rate increases

2(B)

The graph plotted between year and the total no. accidents clearly suggests that there is no such obstacles along the road,stretch 6(10-12km) and stretch 7(12-14km), which will cause the accident.

REFERENCES

1.

* Chattaraj Ujjal, Chakroborty Partha and Seyfried Armin (*to appear*) "*Some Empirical Studies on Evacuation from Halls*", **Proceedings of the 9th Conference on Traffic and Granular Flow,** held on 28th September - 1st October, 2011at Moscow, Russia
* Hankin BD, Wright RA (1958) Passenger Flow in Subways. Operational Research Quarterly, Vol 9,No 2, pp 81–88
* Mori M, Tsukaguchi H (1987) A New Method for Evaluation of Level of Service in Pedestrian Facilities. Transportation Research A, Vol 21 A, No 3, pp 223–234
* Navin FPD, Wheeler RJ (1969) Pedestrian Flow Characteristics. Traffic Engineering, Vol 39, pp30–36
* Seyfried A, Passon O, Steffen B, Boltes M, Rupprecht T, Klingsch W (2009) New Insights into Pedestrian Flow Through Bottlenecks. Transportation Science, Vol 43, No 3, pp 395–406
* Young SB (1999) Evaluation of Pedestrian Walking Speeds in Airport Terminals. Transportation Research Record 1674, pp 20–26

2.(A & B)

* A.F. Iyinam, S. Iyinam and M. Ergun (1997) "*Analysis of Relationship Between Highway Safety and Road Geometric Design Elements: Turkish Case*," Online Publication, Technical University of Istanbul.
* Alan Nicholsonl et al. (1998) "*Superelevation, Side Friction, and Roadway Consistency*," Journal of Transportation Engineering (ASCE), Vol. 124, No.5, Paper No. 15158.
* Y. Hassan and S. M. Easa (2003) "*Effect of Vertical Alignment on Driver Perception of Horizontal Curves*," Journal of Transportation Engineering (ASCE), Vol. 129, No. 4.
* Yulong Pei and Ji Ma (2003) "*Countermeasures for Traffic Accidents Due to Road Conditions in China*," Journal of IEEE.
* Darren J. Torbic, Douglas W. Harwood and David K. Gilmore (2004) "*A Guide for Reducing Collisions on Horizontal Curves*," Transportation Research Board, Volume 7- Nchrp Report 500.
* L. Richl and T. Sayed (2006) "*Evaluating the Safety Risk of Narrow Medians Using Reliability Analysis*," Journal of Transportation Engineering (ASCE), Vol. 132, No. 5.

* Zhang Yingxue et al. (2009) "*Analysis the Relation between Highway Horizontal Curve and Traffic Safety*," Journal of IEEE.
* Anthony P. Voigt and Raymond A. Krammes (2009) "*An operational and safety evaluation of alternate horizontal curve design approaches on rural Two-Lane highways*," Texas Transportation Institute, Online Journal.
* Eric T. Donnell, Francis Gross, Brandon P. Stodart and Kenneth S. Opiela (2009) "*Appraisal of the Interactive Highway Safety Design Model's Crash Prediction and Design Consistency Modules: Case Studies from Pennsylvania*," Journal of Transportation Engineering (ASCE), Vol. 135, No. 2.
* Ali Aram et al. (2010) "*Effective Safety Factors on Horizontal Curves of Two-lane Highway*," Journal of Applied Science, 2010, ISSN 1812-5654.
* Kay Fitzpatrick, Dominique Lord and Byung-Jung Park (2010) "*Horizontal Curve Accident Modification Factor with Consideration of Driveway Density on Rural Four-Lane Highways in Texas*," Journal of Transportation Engineering (ASCE), Vol. 136, No. 9.