

# Construction Phase Road Safety Audit of Kottayam Ettumanoor MC Road (SH 01)

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**Abstract**—The nation's highways are in need of extensive maintenance and reconstruction work. High traffic demand requires state and local transportation agencies to consider practical strategies for minimizing a work zones impacts on the travelling public and construction workers. Work zone safety audit is a proactive tool to serve the purpose. The procedure of road safety audit (RSA), can be incorporated in the framework of designing, constructing, and operating road infrastructure as a means for preventing accidents. This paper presents the guidelines for the highway work zone safety audit of Kottayam-Ettumanoor MC road at its construction stage. The construction activities being carried out there resulted in significant road safety issues essentially increase in number of road accidents. A Road Safety Audit was conducted for 11 km in the Kottayam - Ettumanoor road stretch and four black spots were identified. The major problems that challenge the safety aspect of the road were identified by a negative response survey and an switching response survey. On the basis of the results of Road Safety Audit, suitable rectification measures were also suggested.

**Keywords**— Safety Audit, Black Spot, Accident Data, Accident Analysis

## INTRODUCTION

Road Safety Audit (RSA) is an evaluation of a highway improvement scheme during design, at the end of construction and post-construction, to identify road safety problems and to suggest measures to eliminate or mitigate any concerns. RSA is an important tool for road safety engineering, which has the potential to make a significant contribution to highway safety. In this thesis the RSA during the construction stage is performed. Several safety problems were identified by the accident analysis and site inspections. The remedies were also suggested based on that.

Main Central Road is the arterial state highway of south Kerala, designated as SH1. Chengannur to Ettumanoor 47km highway modernization work of MC road is being carried out as part of Kerala Road Transport Project (KSTP) Phase 2. The road will have a total width of 10 meters and will facilitate two-lane traffic. The road will also have a 7 meter carriage way and sealed shoulder, having width of 1.5 meters. At the urban sections of the road stretch there will be additional footpaths of 2.5m each on either sides of the road. The project also features protection walls and adequate drainage facilities. The construction of several bridges is also being carried out as

part of the project. This includes the construction of bridge at Neelimangalam, Manipuzha, Pannikkuzhi, Arattukadavu, Illimala, Thondara and Kallissery. The work is expected to cost 293.58 crore when it is completed.

The MC road is one of the busiest road stretches in Kottayam district. The traffic growth, unsatisfactory condition of the road and increased accident rates demanded widening of the stretch. The construction activities being carried out there resulted in significant road safety issues essentially increase in number of road accidents. A Road Safety Audit was conducted for 11 km in the Kottayam – Ettumanoor MC Road. The major problems that challenge the safety aspect of the road were identified by a negative response survey and negative response survey of bus drivers.

## DATA COLLECTION AND ANALYSIS

Kottayam Ettumanoor MC Road is the study section of the state highway 01 where the road improvement works are in progress. The data collection included in the thesis work is: The cross sectional drawings obtained from the Kerala Public Works Department (PWD). The accident data of Kottayam District was collected from the Kerala State Crime Recording Bureau. The spot speed was measured using Radar speed gun. Both manual counting and video graphic method was used to find the traffic volume of the road stretch.



Fig 1. Study Stretch  
ACCIDENT DATA COLLECTION

The accident data for the 2010, 2011, 2012, 2013, 2014, and 2015 and till March 2016 were collected from Kerala State Crime Recording Bureau. The accident data during and before the road construction are compared in the analysis. By the comparison efficiency of providing safety in the construction

site can be evaluated. The analysis comprises of accident analysis, traffic volume analysis and Road Safety Audit

### VARIATION OF ACCIDENTS

The accident analyses were done based on annual variation, hourly variation, vehicles involved in accidents. The number of accidents in each spots was identified. From accident analysis, four black spots were identified for the Road safety audit.

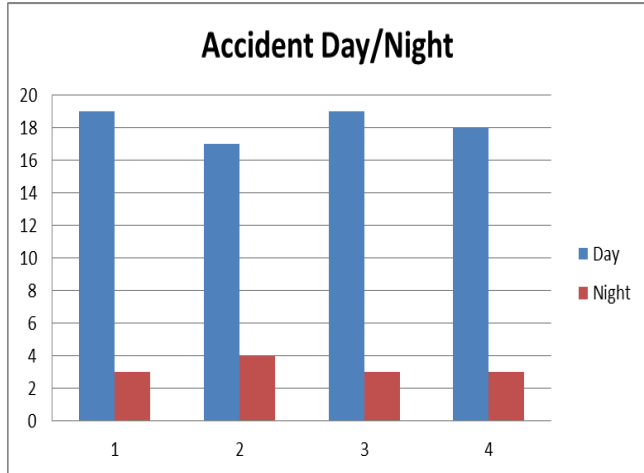


Figure.2 Number of accidents day night variation

In 2010 the major and minor injuries were very less, but next year the rate of injuries was increased and reached at the peak and then it declined continuously. Reasons for the fluctuation of the variation is identified as if traffic volume is increased rigorously, speed of the vehicles will decrease and hence number of accidents occurred will decrease. But if we widen the existing two lanes to four lanes the speed will increase and there may be a considerable increase in the accidents. This situation should be given importance and various precautions should be taken care for this.

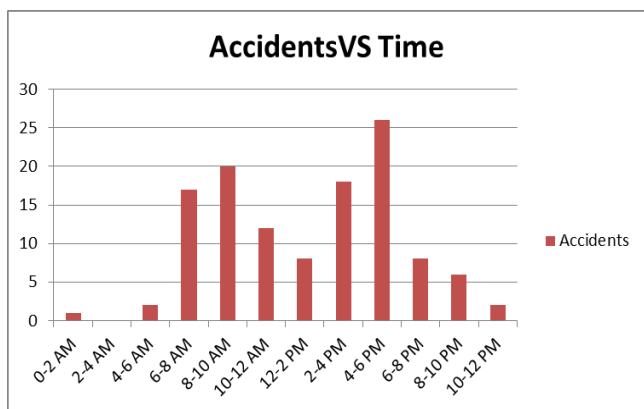


Fig 3. Number of accident vs. time period

It is found that during 10.00PM-08.00AM accidents occurred is very less. Peak time of accident occurring is during 06.00AM-10.00AM and 04.00PM-06.00 PM. it is found that total 89 accidents were occurred at the selected black spots during the period 2014 to 2016. Out of it 89 accidents 73 accidents occurred during the day time.

### VEHICLES INVOLVED IN ACCIDENTS

Two wheelers and pedestrians are involved in the most of the accidents. The average number of two wheelers involved in the accidents for last 3 years is 53.66%. The average pedestrians involved accidents in last 5 years is 18.42%.

### SPOT SPEED

VEHICLE TYPE	MANGALAM	ADICHIRA	THELLAKOM	CARITAS
Two wheeler (50)	43.22	29.51	25.65	32.14
Three wheeler (50)	37.25	25.95	27.65	29.35
LMV (50)	39.45	27.35	24.45	30.18
Heavy (50)	39.05	23.2	23.65	25.1

From the spot speed survey It was observed that the spot speed of vehicles at Mangalam, Adichira, Thellakom and Caritas were between 25 and 30 km/hr which is higher than the specified speed limit of 20 km/hour. There were no speed control devices or police inspections to reduce the speed of vehicles. Proper enforcement of traffic regulations are necessary to control rash and negligible driving through the construction zones in which both the construction workers and road user lives are in danger.

### BLACK SPOTS

By the accident analysis the number of accidents occurred at each black spots were identified. The Table 1 shows that the number of accidents occurred at the different black spots in different years from 2010 to 2015.

TABLE 1: NO OF ACCIDENTS IN DIFFERENT BLACK SPOTS

Sl No	Black Spots	2010	2011	2012	2013	2014	2015
1	Mangalam	2	1	2	1	12	7
2	Adichira	0	7	2	9	11	9
3	Thellakom	13	9	7	11	7	13
4	Caritas	3	2	2	1	8	11

### ROAD SAFETY AUDIT

The road safety audit can be done during different stages of road construction such as planning, design and construction etc. IRC SP 88:2010 specified different checklist which should be followed at different stages of construction. The road safety auditor must follow this checklist during the Road safety audit. The checklists are the questions related to road condition. The road safety audit on these black spot is executed with the help of this these checklist of IRC SP 88:2010

TABLE 2:IRC CHECKLIST FOR SEVERITY DURING CONSTRUCTION

Sl No	Questions during construction	Severity response	
1	Whether the width of road satisfactory for the traffic passing the works area?	YES-A	NO-B
2	Is there sufficient shoulder width?	YES-A	NO-B
3	Is proper care and attention given for pedestrian and non-motorized traffic at construction site?	YES-A	NO-B
4	Construction workers provided with protective clothing, reflective jackets, hard hats, gloves etc.	YES-A	NO-B
5	Whether the Vehicles travel with the speed limit of 20km/hr?	YES-A	NO-B
6	Whether information regarding construction zone approaching has been provided well in advance?	YES-A	NO-B
7	Whether sight and stopping distances adequate?	YES-A	NO-B
8	Is there any provision of marked lanes for clear view of traffic lanes?	YES-A	NO-B
9	Whether warning signs clearly visible?	YES-A	NO-B
10	Whether bus stops located with adequate clearance from traffic lanes?	YES-A	NO-B
11	Whether adequate street lights provided?	YES-A	NO-B
12	Whether pedestrians safe while crossing the road?	YES-A	NO-B
13	Whether suitable speed reducing measures provided?	YES-A	NO-B
14	Whether construction vehicles and equipments stocked away from traffic lanes?	YES-A	NO-B
15	Whether adequate barricades and flashing lights provided?	YES-A	NO-B

**SEVERITY PREDICTION**

There are lots of safety issues detected in each black spot during the road safety audit. The severity prediction for the each safety issue was a difficult task. For predicting the severity, there are 15 question prepared related to road conditions. The severity of a safety issue is measured by answering the checklists. There are 15 questions which is prepared for expressing the conditions of road. These questions are answered in such a way that the positive

response is expressed as ‘A’ and negative response as ‘B’. If the negative responses (B) are more than 10 out of 15, it is termed as severity HIGH. If B is less than 10 and higher than 5 it is termed as severity MEDIUM. If B is less than 5, it is termed as severity LOW. Table 5.2 shows the 15 checklists which are used for predated the severity and the table 5.3 shows the severity response prediction.

**INTERPRETATION FROM THE ROAD SAFETY AUDIT IN BLACKSPOTS**

Several interpretations were generated from the result of RSA of four black spots.

1. Interpretation from the severity response.
2. Interpretation based on switching response survey.

**INTERPRETATION FROM THE SEVERITY RESPONSE**

The interpretation of safety issues were generated from the severity response. It is based on the number of negative response generated with the safety issue.

The severity of each issue in black spots has been explained by the help of severity response checklists. All the safety issue in the black spot was correlated with the below mentioned 15 checklist questions for construction stage. The 15 questions were answered as A or B for expressing the severity of that safety issue. The positive response of question is noted as A and negative response as B. if the negative response of 15 questions of a severity issue is greater than ten, it is denoted as severity high. If the response is in 5 – 9, and less than 5 is denoted as severity medium and low respectively.

BLACK SPOT	SEVERITY RESPONSE	SEVERITY
MANGALAM	9	MEDIUM
ADICHIRA	14	HIGH
THELLAKOM	14	HIGH
CARITAS	13	HIGH

**INTERPRETATION FROM THE RSA AT MANGALAM DURING CONSTRUCTION STAGE**

*Major deficiencies in Mangalam*

1. Negligence of the safety of workers
2. Improper placing of barricades, sign boards and absence of reflectors
3. Open drainages without proper safety barriers
4. Construction materials are improperly placed on the carriage way.
5. No proper speed reduction measures
6. Inadequacy of street lights
7. Bus stops hindering traffic flow

*Remedial Suggestions*

- Safety of workers is found to be a major challenge at Mangalam. Workers were not equipped with safety jackets and other such features. Provide appropriate safety equipments to construction workers.
- Sign boards and barricades should be given in necessary locations.
- Proper drainage facilities should be properly given and construction materials should be stacked without hindering the traffic movement.
- Bus stops should be away from traffic lanes.
- Proper speed reduction measures should be provides.
- Adequate street lights must be provided.
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INTERPRETATIONS FROM RSA OF ADICHIRA

*Major deficiencies in Adichira*

1. Improper placing of barricades, sign boards, and absence of reflectors
2. Inadequate road width
3. Inadequate lighting
4. Construction materials are improperly placed
5. Bad condition of road surface
6. Lack of speed reduction measures
7. Construction workers not provided safety equipments
8. Lack of safety barriers at high edge drops and construction areas

*Remedial Suggestions*

- Workers should be provided with adequate safety equipment (like reflecting jackets, helmets etc ;)
- Sign boards and barricades should be properly placed and reflectors should be given to obstructing objects
- Proper lighting should be given for night time visibility
- Construction materials should be stocked away from carriage way

- Adequate carriageway width and proper maintenance of the road surface should be done
- Speed reduction measures should be provided
- Safety barricades must be provided at appropriate locations

INTERPRETATIONS FROM RSA AT THELLAKOM

Improper placing of barricades, sign boards, and absence of reflectors

1. Inadequate road width
2. Inadequate lighting
3. Construction materials are improperly placed
4. Bad condition of road surface
5. Lack of speed reduction measures
6. Construction workers not provided safety equipments
7. Lack of safety barriers at high edge drops and construction areas

*Major deficiencies in Thellakom*

*Remedial Suggestions*

- Workers should be provided with adequate safety equipment (like reflecting jackets, helmets etc ;)
- Sign boards and barricades should be properly placed and reflectors should be given to obstructing objects
- Proper lighting should be given for night time visibility
- Construction materials should be stocked away from carriage way
- Adequate carriageway width and proper maintenance of the road surface should be done
- Speed reduction measures should be provided
- Safety barricades must be provided at appropriate locations

INTERPRETATIONS FROM RSA OF CARITAS

*Major deficiencies in Caritas*

1. High edge drop
2. High traffic congestion
3. Insufficient parking facilities
4. Less carriage way and shoulder width
5. Inadequate signs and signals

*Remedial Suggestions*

- Adequate shoulder width should be provided and paved
- Proper signs and signal should be installed and maintained at proper places
- Edge drop should be minimized.
- Adequate carriage way width and shoulder width should be provided.
- Adequate parking facility should be provided.

SEVERITY RESPONSE SURVEY OF BUS DRIVERS

The major safety issues of the road stretch were identified also with the help of severity response survey conducted among 25 bus drivers whom regularly travel through the work site. The bus drivers answered the different safety issues from 1 - 15 responsible for accidents and they are requested to give their responses according to their perspective. All the safety issue in the black spot was correlated with the above mentioned 15 checklist questions for construction stage. The 15 questions were answered as A or B for expressing the severity of that safety issue. The positive response of question is noted as A and negative response as B. if the negative response of 15 questions of a severity issue is greater than ten, it is denoted as severity high. If the response is in 5 – 9, and less than 5 is denoted as severity medium and low respectively.

RESULTS OF SEVERITY RESPONSE SURVEY

By analyzing the results it is clear that according to the road users, Insufficient Road width, Lack of warning signs, poor road surface condition, high edge drop and lack of street lights are the major safety measures to be prioritized in construction stage.

BLACK SPOT	NUMBER OF PARTICIPANTS RATED SEVERITY(25)		
	LOW	MEDIUM	HIGH
MANGALAM	5	14	6
ADICHIRA	0	5	20
THELLAKOM	0	7	18
CARITAS	0	9	16

SUMMARY AND CONCLUSION

The road safety audit found out 4 major areas namely Mangalam, Adichira, Thellakom and Caritas were identified as black spots. Hence it is necessary to check the challenges to the road safety of these spots. IRC specifies speed limit between 20 Kmph for the vehicles in a road stretch when it is under construction stage. A spot speed study was conducted by which it is found that vehicles violates the speed limit which can be said to be a challenge to the safety aspect of that stretch

The major defects and problems other than speed limit were studied by a Road Safety Audit using checklist 4 (RSA on road under construction) of IRC SP88. The results of the audit showed that there are a number of factors which results in the unsafe condition of the road. These include uncovered and unsafe drainages, lack of proper warning signs, construction materials stack along the road sides which reduces usable shoulder width, pot holes and electric and telephone posts on carriageway, signs boards placed closer to the road, lack of proper carriageway width for two way traffic, bus bays affecting traffic flow, lack of proper safety barricades etc. These factors were identified based on negative response survey and switching response survey. It is found that following factors seemed to be most important in the road stretch under construction stage.

1. Lack of information regarding construction zone approaching Lack of warning signs
2. Lack of adequate parking facilities
3. Insufficient road width
4. Lack of street lights
5. High edge drops
6. Poor road surface condition
7. Lack of street lights

Suitable remedial measures were also proposed for the above mentioned problems which are found to be relevant in the safety aspects of the road stretch. Thus the proper

implementation of the suggested remedial measures may help bring down the accident rates.

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