

**GEOMETRIC DESIGN CONSIDERATION IN
REHABILITATION OF URBAN ARTERIAL ROADS
(CASE STUDY B084, HORANA - COLOMBO ROAD)**

Kotta Kankanamge Darshana Dhananjaya

209568V

Degree of Master of Engineering

Department of Civil Engineering

University of Moratuwa

Sri Lanka

June 2024

**GEOMETRIC DESIGN CONSIDERATION IN
REHABILITATION OF URBAN ARTERIAL ROADS
(CASE STUDY B084, HORANA - COLOMBO ROAD)**

Kotta Kankanamge Darshana Dhananjaya

209568V

Thesis submitted in partial fulfillment of the requirements for the degree M.Eng in
Highway and Traffic Engineering

Department of Civil Engineering

University of Moratuwa

Sri Lanka

June 2024

DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature: Date: 01/06/2024

The above candidate has carried out research for the Masters thesis under my supervision. I confirm that the declaration made above by the student is true and correct.

Name of Supervisor: Prof. W.K.Mampearachchi

Signature of the Supervisor: Date: 01/06/2024

DEDICATION

I dedicate this dissertation to Prof.W.K. Mampearachchi, my supervisor, who encouraged me to conduct the study successfully, and to my parents and wife, who supported me throughout.

K.K.D. Dhananjaya

Department of Civil Engineering

University of Moratuwa

01.06.2024

ACKNOWLEDGEMENT

I want to express my gratitude to everyone who helped me during the research. First, I would like to thank my research supervisor, Prof. W.K.Mampearachchi, for teaching me the background of the research and providing the necessary guidance to initiate my study. And also, throughout the field works and analysis, he clarified my doubts and corrected my mistakes while obtaining the results.

Then I would like to express my gratitude to all the academic staff of the Department of Civil Engineering at the University of Moratuwa and all the non-academic staff of the University of Moratuwa. I'm thankful to Mr. Indika Dahanayaka, Mr. Mihiruk Jayasundara, and Prasanna Srinath Subhasinghe for assisting and helping me with the success of the research.

Finally, I would like to express my gratitude to all the other people who have given me support, courage, and guidance towards the success of the research.

ABSTRACT

Geometric improvement plays a significant part in urban arterial road rehabilitation by addressing social, environmental, and economic issues. The study selected the Horana - Colombo (B084) road rehabilitation project as the case study.

During the investigation, several issues related to the project scope, duration, and society were identified. In this study, priority weightages were systematically assigned through expert interviews. These weightages were readjusted using the known costs incurred for implementing solutions for several issues. Moreover, these issues were ranked according to the summation of the readjusted weightages. Further, a checklist with priority order was proposed based on the identified issues and the ranking.

The results show that drainage design issues are the most critical design consideration. The second most critical design consideration is geometric design at fuel stations. Third most critical issue is the vertical alignment design at areas with underlying rock areas and utility lines. Traffic count should be conducted at the junctions before implementing the geometric design. Access issues are a significant design consideration in the geometric design. Furthermore, coordinating with the authorities for the utility maintenance is necessary to minimise road damage. Following design and construction sequences is necessary for minimizing line drain construction issues. Pavement design optimization saves cost and the time of construction. The existing horizontal and vertical alignment should be harmonised during the geometric design. Incorporating this checklist with priority order in the geometric design of rehabilitation of urban arterial roads will ensure that the road is constructed safely, efficiently, and cost-effectively.

Keywords: Geometric design, urban arterial roads, horizontal alignment, vertical alignment, hydrology design

TABLE OF CONTENTS

DECLARATION	i
DEDICATION	ii
ACKNOWLEDGEMENT	iii
ABSTRACT	iv
TABLE OF CONTENTS	v
LIST OF FIGURES	viii
LIST OF TABLES	x
LIST OF ABBREVIATIONS	x
LIST OF APPENDICES	xi
01. INTRODUCTION	1
1.1 Background	1
1.2 Pavement design considerations	1
1.3 Environmental considerations	1
1.4 Geographic and topological considerations	1
1.5 Social considerations	1
1.6 Geotechnical considerations	2
1.7 Hydraulic consideration	2
1.8 Economic consideration	2
1.9 General design parameters	2
1.10 Scope of the rehabilitation work at Horana - Colombo (B084) road	3
1.11 Land use of the study area	6
1.12 Problem statement	7
1.13 Objectives	8
1.14 Scope of the research	9
2 LITERATURE REVIEW	10
2.1 Introduction	10
2.2 Rehabilitation of Horana - Colombo (B084) Road	10
2.3 Issues identified during the rehabilitation of B084 road	12
2.3.1 Impacts of land acquisition	13

2.3.2	Realignment of the existing road	13
2.3.3	Economic activities in the project influence area.....	14
2.3.4	Tree removal for geometric improvements.....	14
2.3.5	Hydrology design.....	15
2.3.6	Social impacts	15
2.3.7	Parking	15
2.3.8	Grade separations and interchanges.....	16
2.3.9	Design exceptions.....	16
2.4	3R Projects	16
2.4.1	3R Project evaluation	17
2.5	Pavement evaluation	17
2.5.1	Pavement condition survey	18
2.5.2	Geotechnical investigation.....	18
2.6	Checklist for geometric design considerations	18
2.6.1	Land clearance	19
2.6.2	Access to the properties	19
2.6.3	Provision for utilities.....	19
2.6.4	Drainage control measures.....	19
2.6.5	Topographycal maps	19
2.6.6	Geotechnical investigation reports.....	20
2.6.7	Urban design guidelines.....	20
2.6.8	Economic analysis.....	20
2.7	Checklist for geometric design for operations	20
2.7.1	Managing non-recurring congestion	20
2.7.2	Managing High Occupancy Vehicles (HOVs).....	20
2.7.3	Impacts to adjacent accesses	20
2.7.4	Performance measures and operational objectives	21
2.8	Summary of the chapter	21
3	IDENTIFYING SOCIAL, ENVIRONMENTAL AND ECONOMIC ISSUES OF THE PROJECT	23
3.1	Proposed Methodology	23
3.1.1	Field visits.....	23
3.1.2	Identifying issues	23

3.1.3	Analyzing the issues.....	23
3.1.4	Preparation of the checklist with priority order	23
3.2	Identifying social social issues of the project	24
3.2.1	Drainage issues	24
3.2.2	Access issues.....	25
3.2.3	Land acquisition issue at Ch.11+425-11+600 km.....	28
3.2.4	Utility posts at the edge of the road pavement	28
3.2.5	Fuel station access issue from Ch.11+990 to Ch.12+120 km	29
3.2.6	Increasing the vehicle queue length at the adjacent junction	30
3.2.7	Parking spaces issues	30
3.2.8	Parking on the cycle lane	31
3.2.9	Surface runoff discharge into paddy fields	31
3.3	Identifying economic issues of the project.....	32
3.3.1	Pavement design issues.....	32
3.3.2	Wearing course was not laid in the Piliyandala town area.....	36
3.3.3	Vertical alignment change at Ch.26+400 km.....	36
3.3.4	Base layer was higher than the line drains top level	38
3.3.5	Using Aggregate Base Course (ABC) material as sub base material	39
3.3.6	Road pavement excavation by National Water Supply and Drainage Board (NWS&DB) at Ch.12+900 RHS	39
3.4	Environmental issues	40
3.4.1	Flooding issue	40
3.4.2	Blocking the lead-away drains at Ch.11+770 km (LHS), Ch.11+900 km	40
3.4.3	Hydrology design issues	42
3.4.4	Bo tree located in the carriageway at Ch.22+900 km (RHS).....	42
3.5	Issues identified during rehabilitation of A11 road from Maradankadawala to Habarana	44
4	IDENTIFYING THE IMPACTS DUE TO THE ISSUES, ASSIGNING WEIGHTAGES AND RANKING	46
5	IDENTIFYING CHECKLIST WITH PRIORITY ORDER FOR GEOMETRIC DESIGN OF REHABILITATION OF URBAN ARTERIAL ROADS	55
6	CONCLUSION.....	58
	REFERENCES.....	60

LIST OF FIGURES

Figure 1.1: Layout of B084, Horana - Colombo road.....	4
Figure 1.2: Project Location Map	5
Figure 1.3: Typical cross section of a 4-lane road section.....	5
Figure 1.4: Weligampitiya area.....	6
Figure 1.5: Business premises at Pokunuwita area	6
Figure 1.6: Kahathuduwa interchange	7
Figure 2.1: Commercial activities in the project influence area	14
Figure 2.2: Status of planted trees at crusher and batching plant site Kubuka, Pokunuwita.....	15
Figure 3.1: Access to be reconstructed to match the road finish levels	24
Figure 3.2: Dish drain constructed for drainage.....	25
Figure 3.3: Supermarket access.....	25
Figure 3.4: Raised location of the supermarket access	26
Figure 3.5: Access is higher than the road level	26
Figure 3.6: House access issue in the Weligampitiya area	27
Figure 3.7: House access issue at the Weligampitiya area.....	27
Figure 3.8: House access issue in the Weligampitiya area	27
Figure 3.9: Structures in the ROW.....	28
Figure 3.10: Electrical poles located at the edge of the road pavement.....	29
Figure 3.11: Fuel station, which was disturbed due to the construction	29
Figure 3.12: Kerb line after shifting to LHS	30

Figure 3.13: Footwalk near the Puwakgas junction	30
Figure 3.14: Cycle Lane	31
Figure 3.15: Parking on the cycle lane.....	31
Figure 3.16: Surface runoff discharge through concrete drains	32
Figure 3.17: Surface runoff discharge through concrete drains	32
Figure 3.18: Access at Ch.26+400 km	37
Figure 3.19: Excavation due to initial design	37
Figure 3.20: Rock outcrop area	37
Figure 3.21: Rock outcrop area	38
Figure 3.22: Current condition of the road section	38
Figure 3.23: Line drain construction issue	38
Figure 3.24: ABC laying	39
Figure 3.25: Excavated carriageway area	40
Figure 3.26: Lead away drains covered by the commercial buildings.....	40
Figure 3.27: Culvert at downstream.....	41
Figure 3.28: Lead-away drain was blocked by the residents	41
Figure 3.29: Area was flooded during a slight rain due to the lead-away blockage ..	41
Figure 3.30: Bo tree.....	42
Figure 3.31: Bo tree location after construction.....	42
Figure 3.32: Foot path is constructed on a separate structure	43
Figure 3.33: Sacred Bo tree located at 3+500 km.....	44

LIST OF TABLES

Table 2.1: Types of complaints recorded, cumulative	12
Table 2.2: Pavement Condition Classification based on PQI	18
Table 3.1: Pavement design for section from 0+500-1+100 km.....	33
Table 3.2: Pavement design for section from 10+500-10+450 km.....	33
Table 3.3: Pavement design for section from 23+400-28+400 km.....	33
Table 3.4: Pavement design of A11 road	34
Table 3.5: 4 - day soaked CBR data -A11 road	35
Table 3.6: Pavement design parameters for 21+000-23+000 km section.....	36
Table 3.7: Complaint and non-complaint areas	43
Table 4.1: Initial weightages and ranking	47
Table 4.2: Identifying the impacts due to the issues and ranking	51
Table 4.3: Summary of issues and ranking	54
Table 5.1: Checklist for geometric design consideration in rehabilitation of urban arterial roads.....	55

LIST OF ABBREVIATIONS

ABC	- Aggregate Base Course
ADB	- Asian Development Bank
BOQ	- Bill of Quantities
CEB	- Ceylon Electricity Board
Ch.	- Chainage
DCP	- Dynamic Cone Penetration test
LHS	- Left Hand Side
SLDC	- Sri Lanka Land Development Corporation

NWS&DB	- National Water Supply and Drainage Board
PD	- Pavement Design
RDA	- Road Development Authority
RHS	- Right Hand Side
ROW	- Right of Way
SIA	- Social Impact Assessment
SRCP	- Southern Road Connectivity Project
USA	- United States of America

LIST OF APPENDICES

Appendix A: Fuel station issue – Additional cost.....	63
Appendix B: Vehicle queue length at junction – Additional cost.....	64
Appendix C: Line drain construction issue – Additional cost	65