

# MANUAL INSPECTION AND ASSESSMENT METHOD OF HIGHWAY BRIDGES

Karthika.M

(09/8082)



University of Moratuwa, Sri Lanka.  
Electronic Theses & Dissertations  
Degree of Master of Science  
[www.lib.mru.ac.lk](http://www.lib.mru.ac.lk)

Department of Civil Engineering

University of Moratuwa  
Sri Lanka

February 2011

# DECLARATION

I hereby, declare, that the work included in this thesis in part or whole,  
has not been submitted for any other academic qualification at any institution.

.....  
Karthika. M  
(Author)



University of Moratuwa, Sri Lanka.  
Electronic Theses & Dissertations  
[www.lib.mrt.ac.lk](http://www.lib.mrt.ac.lk)

Certified by

.....  
Dr. Baskaran. K  
Supervisor/ Senior Lecturer  
Division of Building & Structural Engineering  
Department of Civil Engineering  
University of Moratuwa  
Sri Lanka

## ABSTRACT

“**Inspection and Assessment of bridges**” plays an important role, because the resources being spent in keeping existing bridges functioning to the standards for which they were designed are no longer sufficient. There is serious risk of reducing the investment necessary for rebuilding these structures. Since maintenance budgets are always limited, this involves setting priorities and defining maintenance strategies based on real condition of each bridge determined by periodic and proper inspection and assessment.

In Sri Lanka we can see several types of bridges. Some of them are more than hundred years old. To decide whether the bridges need to be demolished or used for next few years, proper inspection methods and assessment techniques are needed. Based on the results maintenance can be carried out effectively. Not only for old bridges but new coming bridges also have to be inspected and evaluated on a regular basis and should be maintained to reduce the major repair cost.

Current methods of inspection performed by Road Development Authority (RDA) of Sri Lanka are only visual inspection and it depends only on the personnel and it leads to some misjudgment.

So, this research is made to improve the existing manual inspection method, with guideline and manual and propose new assessment method.

The improvements on the newly developed manual inspection method consists new inspection sheets for condition inspection of concrete and steel bridges and guideline and manual for the manual inspection. This is basically an independent inspection method while comparing the existing method.

The new assessment method for the condition assessment technique deals with equations to assess the component of bridges and main part of the bridges separately and overall assessment of the bridges. For the strength assessment of concrete deck slab “YIELD” software is validated. As there is no guideline for the assessment of bridges, assessment guideline also discussed.

It is also recommended to carry on some additional work along the lines of present study.

## **ACKNOWLEDGEMENT**

Giving guidance, making advices and correcting through comments are valuable things and very important for a researcher. Therefore I must thank all the people who involved in this research project.

First of all I would like to express my gratitude and deep appreciation to my supervisor **Dr. K. Baskaran**, Department of Civil Engineering, University of Moratuwa, the project supervisor who always motivated and kept me on the right track. He gave me an excellent guidance during my research, sacrificing his valuable time.

Also I want to offer my thanks to **Prof. R. A. Weerasekara**, the examiner, **Prof. J.M.S.T. Bandara** the research coordinator for their guidance on my research and also the **Senate Research Committee of University of Moratuwa** should be thanked for supporting and financing my research.

Then my thanks are due to the **staffs working at Road Development Authority of Sri Lanka**, who helped me in several ways to carry out my research project.

Finally my sincere and kind gratitude to our staff of the Department of Civil Engineering and to my friends who provide all the facilities and help for me to successfully complete this research.

# CONTENTS

CHAPTER 01 .....	1
<i>INTRODUCTION</i> .....	1
1.1 Overview .....	1
1.2 Objective .....	2
1.3 Outline of the report .....	2
CHAPTER 02 .....	3
<i>LITERATURE SURVEY</i> .....	3
2.1 Introduction .....	3
2.2 Inspection method of Highway Bridges .....	3
2.3 Assessment methods of highway bridges.....	8
2.3.1 Analysis types for the Strength Assessment of Bridges .....	11
2.3.2 Yield line analysis .....	12
CHAPTER 03 .....	14
<i>METHODOLOGY</i> .....	14
3.1 Introduction .....	14
3.2 Understanding the current manual inspection method used by Road Development Authority (RDA) of Sri Lanka.....	14
3.3 Identifying the problems relating to the existing method .....	16
3.4 Proposed improvements on the current manual inspection method for concrete and steel bridges. ....	20
3.4.1 Bridge Guideline and Manual .....	20
3.4.1.1 Bridge inspection policy .....	20
A. Routine Maintenance Inspection .....	20
B. Bridge Condition Inspection.....	21
C. Detailed Engineering Inspections and analysis .....	22
3.4.1.2 Identification of common defects found in Reinforced Concrete Bridges due to material .....	23
3.4.1.3 Identification of common defects found in Steel Bridges due to material .....	26
3.4.1.4 Causes of deterioration not related to bridge material .....	29

3.4.1.5	Problems relating to the main components of Concrete bridges.....	32
3.4.1.6	Problems relating to the main components of Steel bridges .....	36
3.4.2	Inspection sheets for concrete and steel bridges. ....	37
3.5	Evaluation on New Inspection Method.....	39
3.6	Bridge Assessment Based on the Condition inspection.....	40
3.7	Proposed strength assessment method of Reinforced Concrete bridge decks based on the detailed inspection.....	42
3.7.1	Methodology of assessment .....	42
3.7.2	YIELD Software .....	43
3.7.2.1	Validation of this program .....	44
3.7.2.2	Data collection in detail inspection .....	50
3.7.2.3	Assessment guidance.....	52
1.	Material Properties .....	52
2.	Load Calculation .....	53
3.	Modelling .....	62
4.	Analysis and Assessment for the reinforced concrete bridges	
	University of Moratuwa, Sri Lanka.	
	63	
	Electronic Theses & Dissertations	
	www.lib.mrt.ac.lk	
CHAPTER 04.....		66
<i>FUTURE DEVELOPMENTS</i> .....		66
4.1 Future Developments in Manual Inspection Method.....		66
CHAPTER 05 .....		68
<i>CONCLUSION</i> .....		68
REFERENCES.....		70
ANNEX-A		
ANNEX-B		

## **LIST OF FIGURES**

Figure 2.1:	Condition rating statistics as reported by inspectors for a reinforced Concrete bridge.....	06
Figure 3.1:	Toppling of abutment.....	17
Figure 3.2:	Major vertical cracks at abutment through weep holes.....	17
Figure 3.3:	Demolition of abutment due to misjudgement.....	17
Figure 3.4:	Ruwanwella steel bridge.....	18
Figure 3.5:	Failure of deck due to overlays without assessment.....	19
Figure 3.6:	Scaling of concrete.....	23
Figure 3.7:	Cracking of concrete.....	24
Figure 3.8:	Spalling.....	25
Figure 3.9:	Corrosion of reinforcement.....	26
Figure 3.10:	Corrosion of steel.....	27
Figure 3.11:	Loose connection.....	28
Figure 3.12:	Damage due to inefficient drainage.....	30
Figure 3.13:	Excessive growth of vegetation on an abutment .....	30
Figure 3.14:	Input menu.....	44
Figure 3.15:	One way slab details.....	45
Figure 3.16:	Slab Test 1 Program results.....	46
Figure 3.17:	End Condition for the tested slab –Fixed.....	46
Figure 3.18:	Two way slab details.....	47
Figure 3.19:	Slab arrangement.....	48
Figure 3.20:	Loading.....	48
Figure 3.21:	Cracking Pattern.....	48
Figure 3.22:	Yield line.....	48
Figure 3.23:	Program results of Slab test -2.....	49
Figure 3.24:	Core cut for tested slab.....	50
Figure 3.25:	Cover meter test.....	51
Figure 3.26:	HA Loading - UDL Load.....	57
Figure 3.27:	Overlay Asphalt Concrete.....	61

**LIST OF TABLES**

Table 3.1:	Rating criteria used by RDA in the inspection of bridge components .....	15
Table 3.2:	Weighted factor used by RDA in the overall evaluation of bridge Components.....	16
Table 3.3:	Description about Variables.....	40
Table 3.4:	Values of $\Upsilon_{fL}$ .....	54
Table 3.5:	Number of Notional lanes.....	55
Table 3.6:	Single Axle Load.....	60
Table 3.7:	Single Wheel Load.....	60



University of Moratuwa, Sri Lanka.  
Electronic Theses & Dissertations  
[www.lib.mrt.ac.lk](http://www.lib.mrt.ac.lk)