

174354

D
19/07/2004

B.3000f

**A STUDY OF INCORPORATION OF GROUND
RUBBER TYRE INTO BITUMEN FOR ROAD
APPLICATION**

BY

PEDURU HEWA SARATH KUMARA

174354

MSc IN POLYMER SCIENCE AND TECHNOLOGY

SEPTEMBER 2003

ABSTRACT

Ground Rubber Tyre (GRT) is one of the modifiers used for the modification of bitumen. The main application of bitumen is for road construction as a binder. There are two advantages if GRT can be used on a large scale for the modification of this binder. Since GRT is very much cheaper than any other polymer modifier, cost of modification is minimal. On the other hand if this becomes an outlet for waste tyres, it would help to mitigate the environmental impact immensely.

Studies with GRT for this purpose have not been reported in Sri Lanka. Although some studies have been carried out in the country using latex on modification of bitumen, none of the Sri Lankan roads has so far been rubberised. Rubberisation of roads is not a new concept and research in this area has been carried out for one and a half centuries. This study is an initial step in investigating the methods of incorporation of GRT into bitumen to improve the desirable properties of bitumen mainly for road applications with the aim of rubberisation of roads in Sri Lanka. Various polymer materials have been tried for modification of properties of bitumen. It has been established that rubberisation of roads improves the road performance and also the service life.

In this research work, some properties of bitumen modified with GRT at different levels under different mixing conditions were studied to ascertain the optimum level and the best mixing conditions of incorporation of GRT into bitumen to achieve the optimum properties for application in road construction.

Out of the 3 characteristics tested, 2 of the vital properties namely softening point and penetration were found to be substantially improved by incorporation of GRT into bitumen. However, strength properties of modified bitumen were found to be affected by GRT due to the failure of ductility and therefore further research has to be carried out to improve these properties.

TABLE OF CONTENTS

SECTION	PAGE
List of Tables	I
List of figures	II
Definitions	III
Abbreviations	V
Acknowledgments	VI
Abstract	VII
1.0 INTRODUCTION	
1.1 Concept of incorporation of rubbery materials into bitumen and rubberisation of roads	1
1.2 Early developments with rubberisation of roads	1
1.3 History of evolution of roads and highways	2
1.3.1 Roads and highways	2
1.3.2 Origin of roads	3
1.3.3 Roads in Pre-Roman times	3
1.3.4 Roman roads	3
1.3.5 Roads after the fall of Rome	4
1.3.6 Modern highways	4
1.4 Materials for road construction	5
1.4.1 Aggregates	5
1.4.1.1 Evaluation of aggregates	6
1.4.1.2 Sieve analysis of aggregates	8

SECTION	PAGE
1.4.2 Asphalt cement	9
1.4.2.1 Bitumen vs. Tar vs. Asphalt	11
1.4.2.2 ASTM definition of bitumen	11
1.4.2.3 Cutback asphalt and emulsified asphalt	12
1.4.2.4 Chemistry of asphalt	12
1.4.2.5 Characterisation of asphalt	14
1.4.2.6 Specifications for asphalt cement	20
1.4.2.7 Classification of asphalt	20
1.5 Asphalt concrete	22
1.6 Asphalt pavements for vehicular traffic	22
1.6.1 Properties and function of asphalt wearing surface	24
1.6.2 Function of base and sub-base	24
1.6.3 Distresses of asphalt pavements	25
1.6.3.1 Rutting	26
1.6.3.2 Thermal cracking	27
1.6.3.3 Load associated fatigue cracking	27
1.6.3.4 Stripping and ageing	27
1.7 Modification of bitumen with polymer materials	27
1.7.1 Categorisation of polymers used for asphalt modification	33
1.7.2 Ground rubber tyre (GRT)	34
1.7.2.1 Manufacture of GRT	34
1.7.2.2 Characterisation of GRT	36
1.7.3 Mechanism of incorporation of elastomeric polymer in asphalt	36
1.7.4 Property improvement of bitumen by polymer incorporation	39



SECTION	PAGE
1.7.5 Methods for determining polymer modification	41
1.7.5.1 Ductility tests	41
1.7.5.2 Spectroscopic methods	43
1.7.5.3 Toughness and tenacity tests	43
1.7.5.4 Torsional recovery tests	44
1.7.5.5 Effective rubber content	46
1.8 Asphalt rubber	46
1.9 Road surfacing with rubbery polymer	46
1.10 Availability of polymeric materials in Sri Lanka for modification of bitumen	47
1.11 Problem of waste tyre disposal around the globe	48
1.12 Tyre industry in Sri Lanka and the problem of waste tyre disposal	49
1.13 Objectives of the study	50
 2.0 MATERIALS AND METHODS 	
2.1 Materials	51
2.1.1 Ground rubber tyre (GRT)	51
2.1.2 Bitumen	51
2.1.3 Aggregates	52
2.1.4 Filler	52
2.2 Equipment	52
2.2.1 Mechanical stirrer	52
2.2.2 Reactor vessel	52
2.2.3 Sieve	54
