

**LISBOA 2010**  
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# Laboratory Investigation of the Properties of Asphaltic Mixtures and its Antioxidant Modifier Subjected To Ageing

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# INTRODUCTION

- /// Transportation facilities are required for the economic development of a country.
- /// Population growth and economic development result extensive development of asphalt-paved roadways.
- /// The level of performance of asphaltic concrete has a close relationship with the properties of bitumen in the mixture .
- /// Its properties changes as it ages in bulk storage , transport and storage on site.

## Two Phenomena Exist on Pavements

### 1. High temperatures

- Can soften the bitumen and consequently
- Reduce the stiffness of asphaltic concrete making the mix more susceptible to rutting.

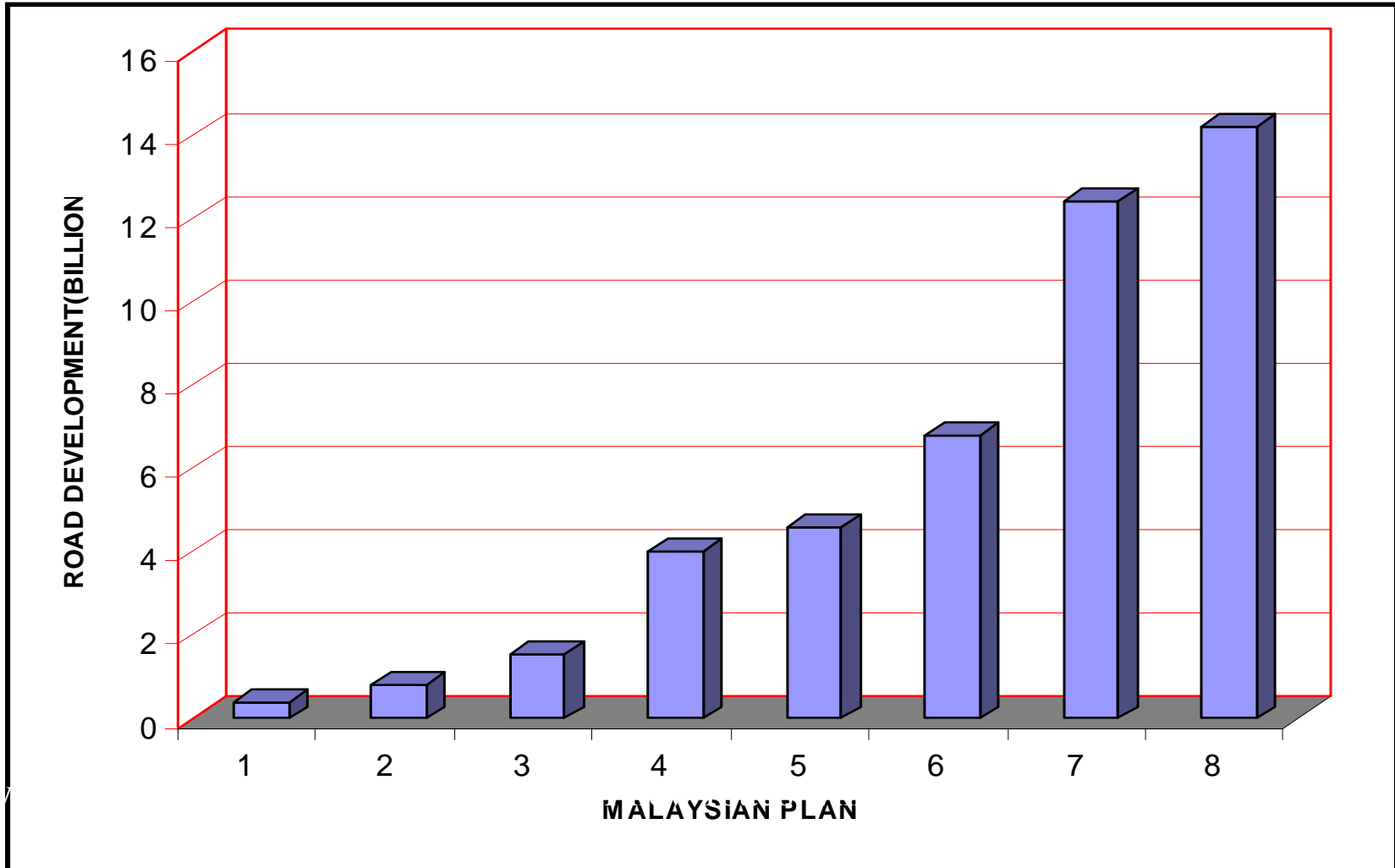
### 2. Low temperature

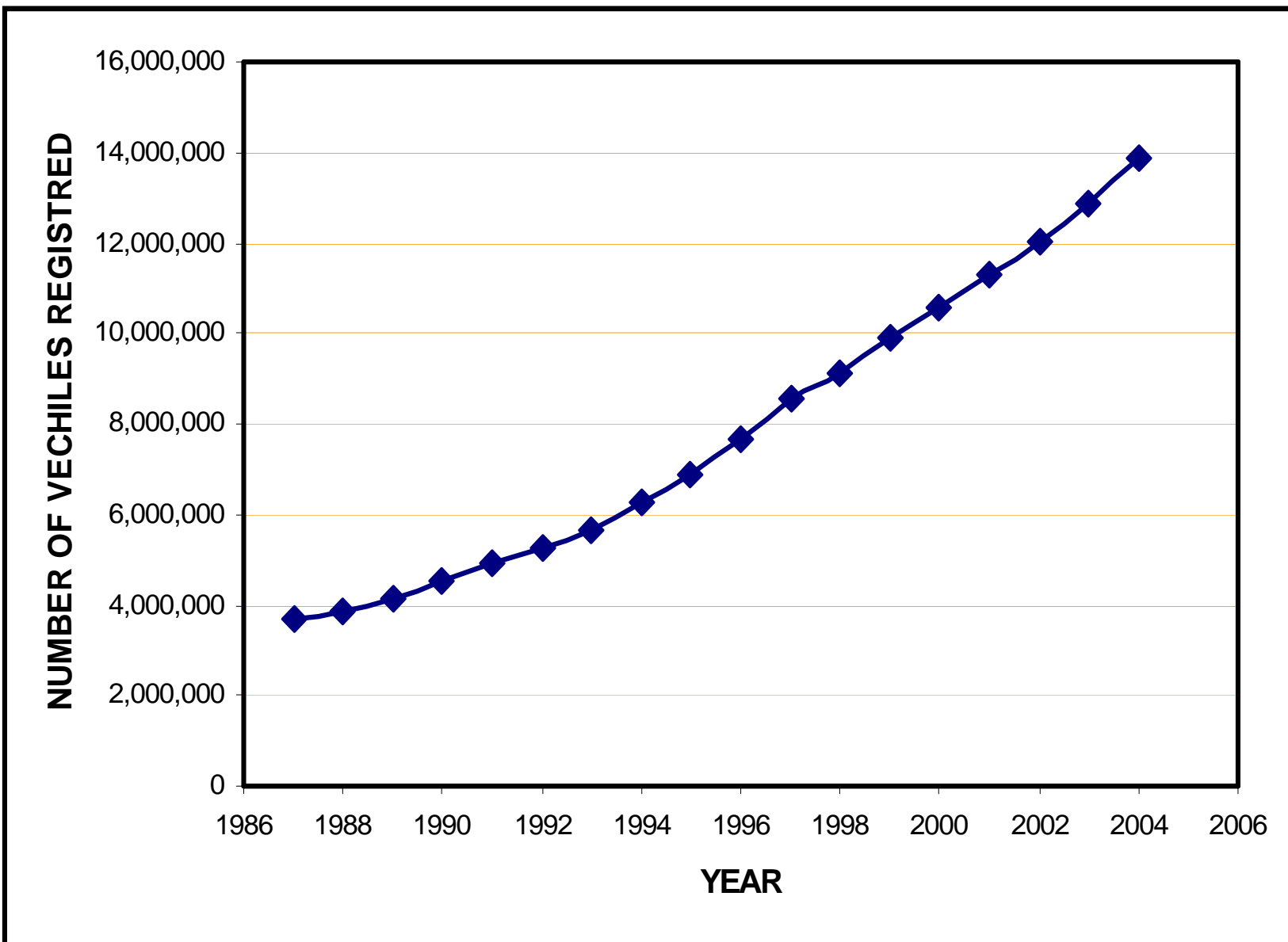
- Increase the stiffness of bitumen and
- Reduce the flexibility of the asphaltic concrete.



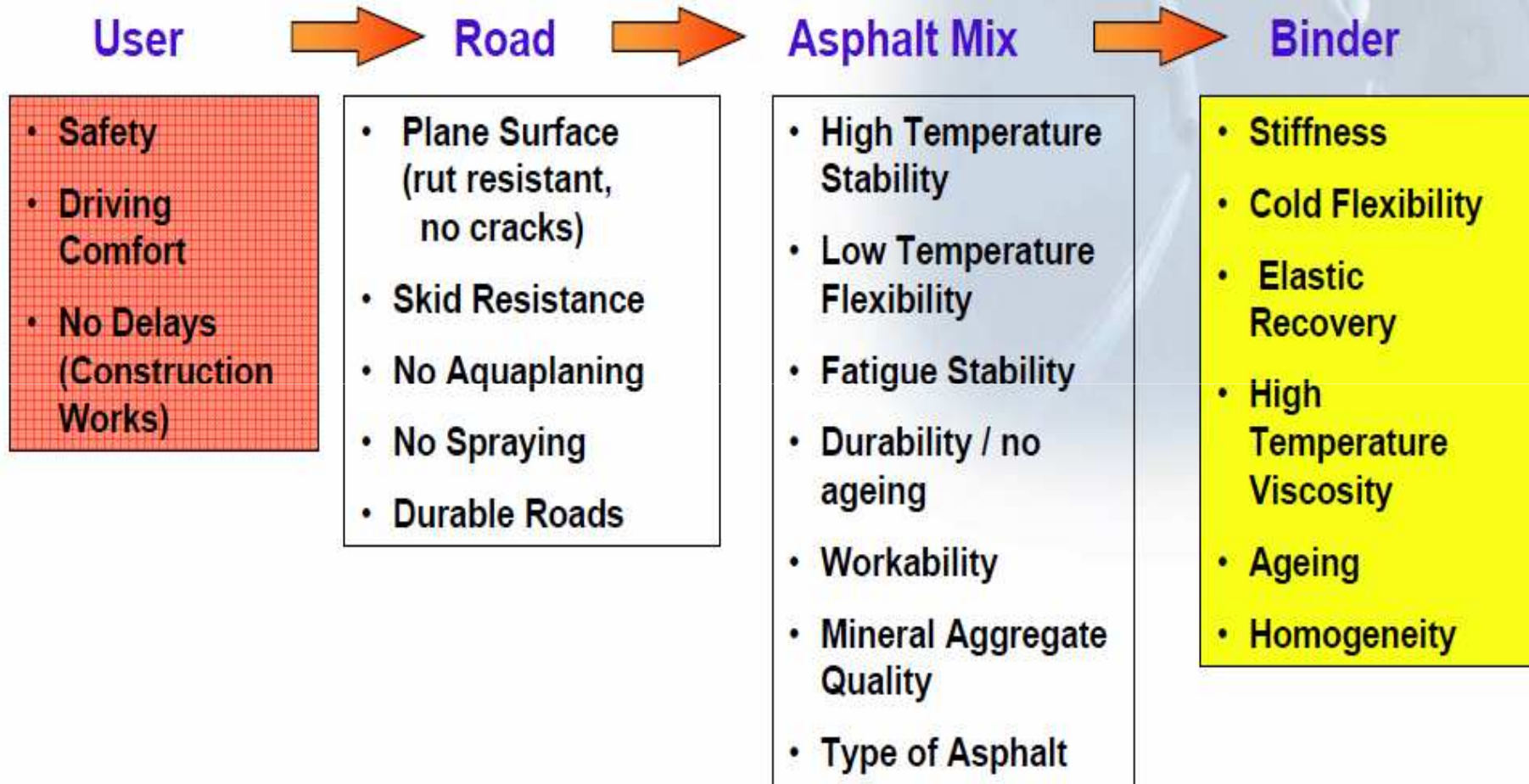
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# From user need to specifications



(Source: Shell Bitumen)

REFERENCE	AGEING METHOD	EVALUATION METHOD
Dow (1903)	18, 24 hrs, 325°F (163°C) Mixture aged for 30 min, 149°C	Change in weight, penetration of residue Recovered asphalt - change in penetration
Lang & Thomas, (1939)	Ottawa Sand mixture, aging oven, outdoor exposure	Change in mix properties, abrasion, strength
Shattuck (1940)	Mixture oven aging 30 min 163°C	Recovered asphalt - penetration, ductility, softening point
Lewis & Halstead (1946)	1/8-in.film oven test 5 hr, 163°C	Change in Weight, penetration, and ductility
Pauls & Wellborn (1952)	Ottawa Sand mixture oven aged 163°C TFOT	Compressive strength, recovered asphalt TFOT residue.
Vallerga, Monismith & Granthem (1957)	Ultraviolet and infrared Weathering	Penetration, Softening point Ductility

This paper describes results from a laboratory investigation of properties its mixtures modified with mixtures containing a new product known as CRABit (CR30 and CR50) which is a combination of Crumb Rubber Modified with Zinc Dithiocarbamate crumb.



# AGEING MECHANISMS

Complex process based on chemical composition pavement structure and climate.

Bitumen must be resistant to change in properties over time

Based on hardening or stiffening of asphalt material

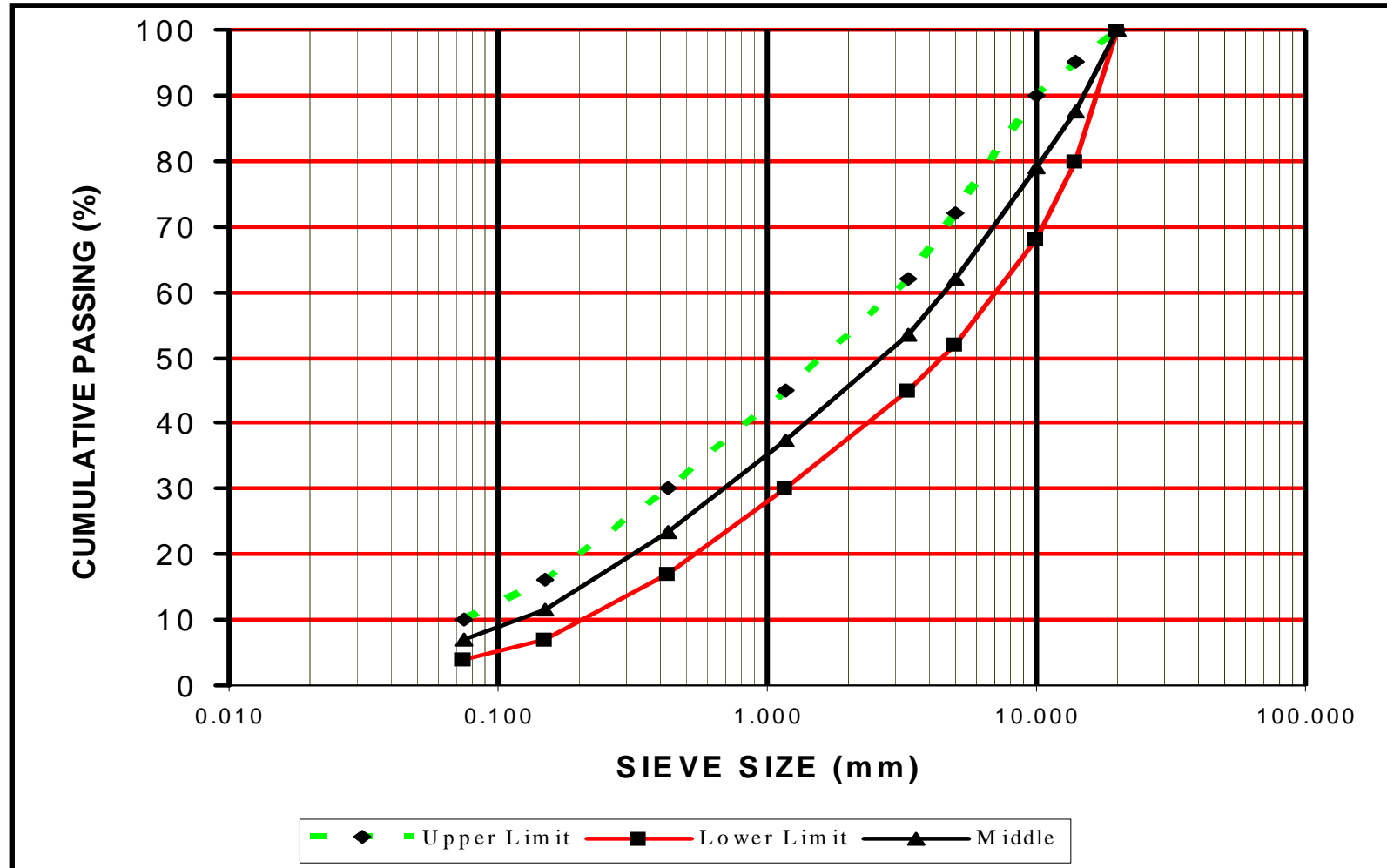
- Short-term ageing.
- Long-term ageing.

The main mechanisms of aging of bitumen are oxidation and loss of volatiles.



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# METHODS AND MATERIALS USED IN THIS STUDY



ACW14 Aggregate Gradation Used in this Study  
 (Source: PWD, 1988).

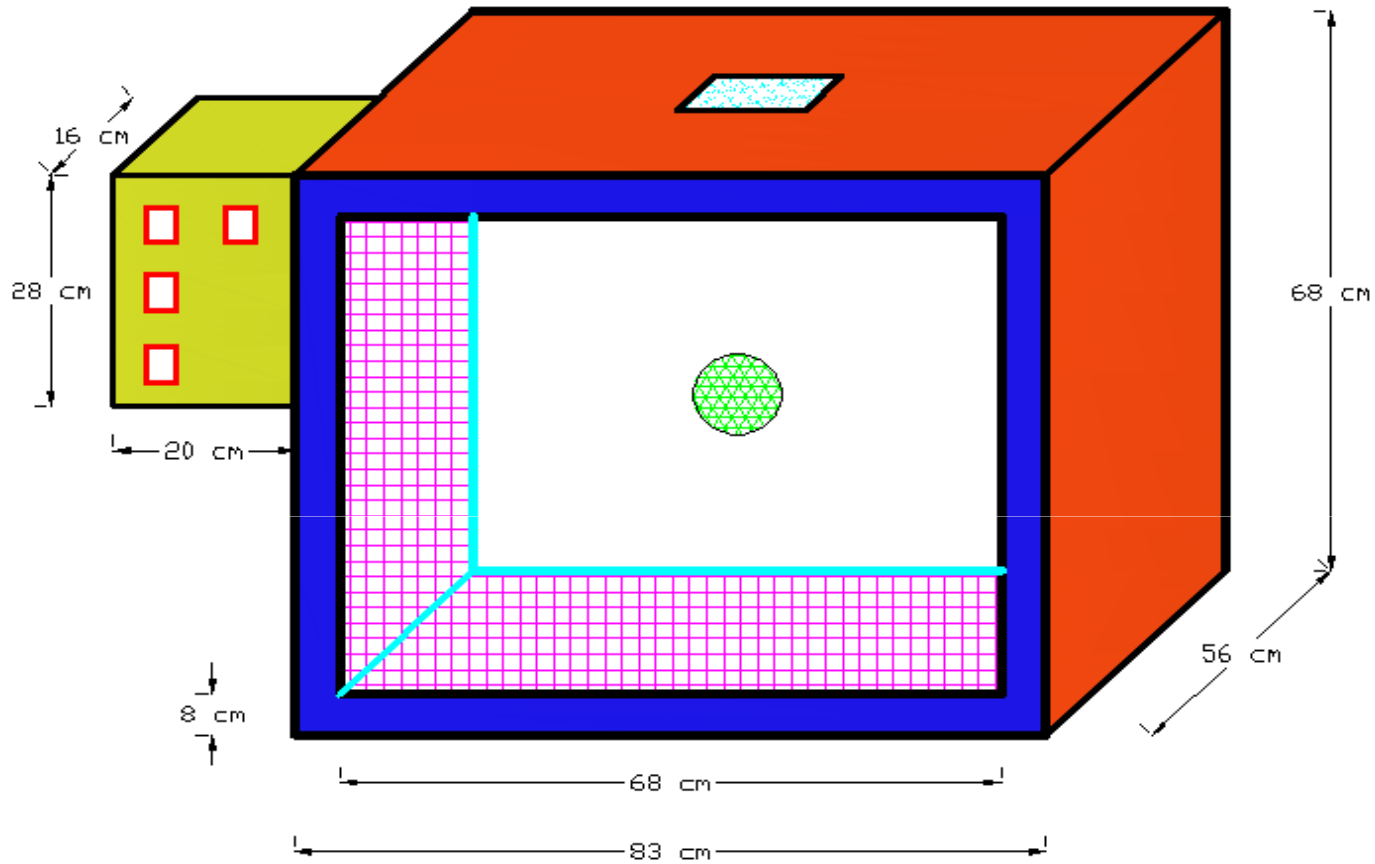


Table : Composition of CR30 and CR50

DESIGNATION	COMPOSITION		
	Crumb Rubber (%)	Zinc Dithiocarbamate (%)	Accelerator (%)
CR30	30	55	15
CR50	50	40	10

## Properties of Materials used

Property	Measured Parameter	Value
Bitumen (80/100)	Relative Density	1.02
	Softening Point (°C)	44.0
	Penetration at 25°C (dmm)	83
	Ductility (cm) at 25°C	> 100
Aggregate	Specific Gravity	2.681
Crumb rubber	Specific Gravity	1.03
Cement	Specific Gravity	3.018



Diagrammatic Sketch of an Oven Designed for Ageing Samples



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## Results LTA Aged without Ultraviolet Evaluated at 20°C

Mixture Type	Resilient Modulus (MPa)		LTA % increase
	Unaged Samples	LTA	
1%CR30	3766	4782	27.0
2%CR30	3284	4200	27.9
3%CR30	3104	4095	31.9
1%CR50	2990	4353	45.6
2%CR50	2625	3928	49.6
3%CR50	2603	3941	51.4
80/100	2605	4420	69.7
DAMA	3605	4750	31.8
SBS	3241	3977	22.7

## Results LTA Aged without Ultraviolet Evaluated at 40°C

Mixture Type	Resilient Modulus (MPa)		LTA % increase
	Unaged Samples	LTA	
1%CR30	298	420	40.9
2%CR30	249	356	43.0
3%CR30	257	327	27.2
1%CR50	261	354	35.6
2%CR50	199	356	78.9
3%CR50	213	300	40.8
80/100	240	473	97.1
DAMA	394	650	65.4
SBS	318	480	50.9

## Results Short Term Aged Mixtures Evaluated at 40°C

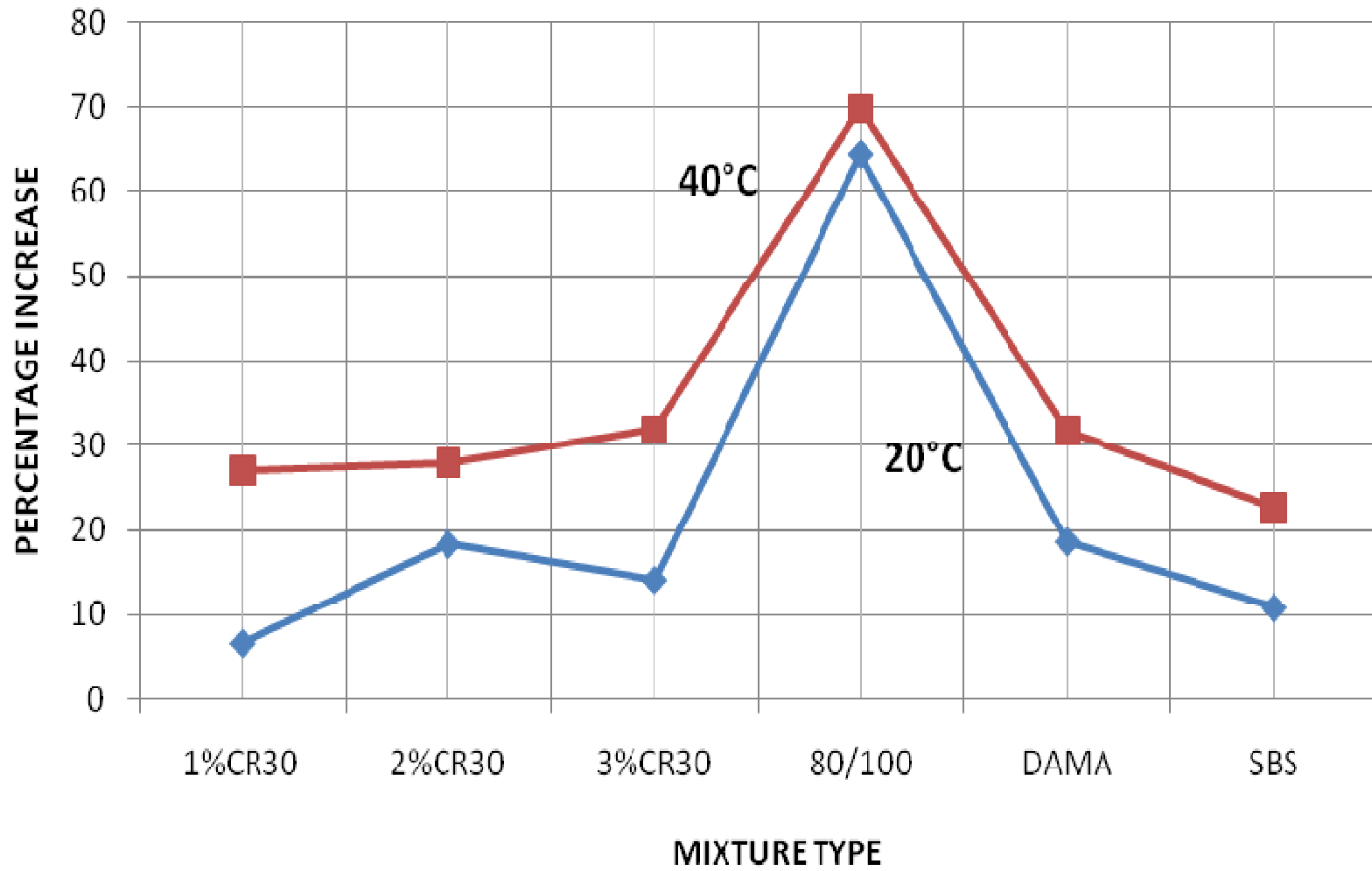
Mixture Type	Resilient Modulus (MPa)		STA % Increase
	Unaged	STA	
<b>1%CR30</b>	<b>298</b>	<b>319</b>	<b>7.0</b>
2%CR30	249	294	18.1
3%CR30	257	286	11.3
1%CR50	261	298	14.2
2%CR50	200	280	40.0
3%CR50	213	253	18.8
<b>80/100</b>	<b>240</b>	<b>416</b>	<b>73.3</b>
DAMA	394	543	37.8
SBS	318	390	22.6

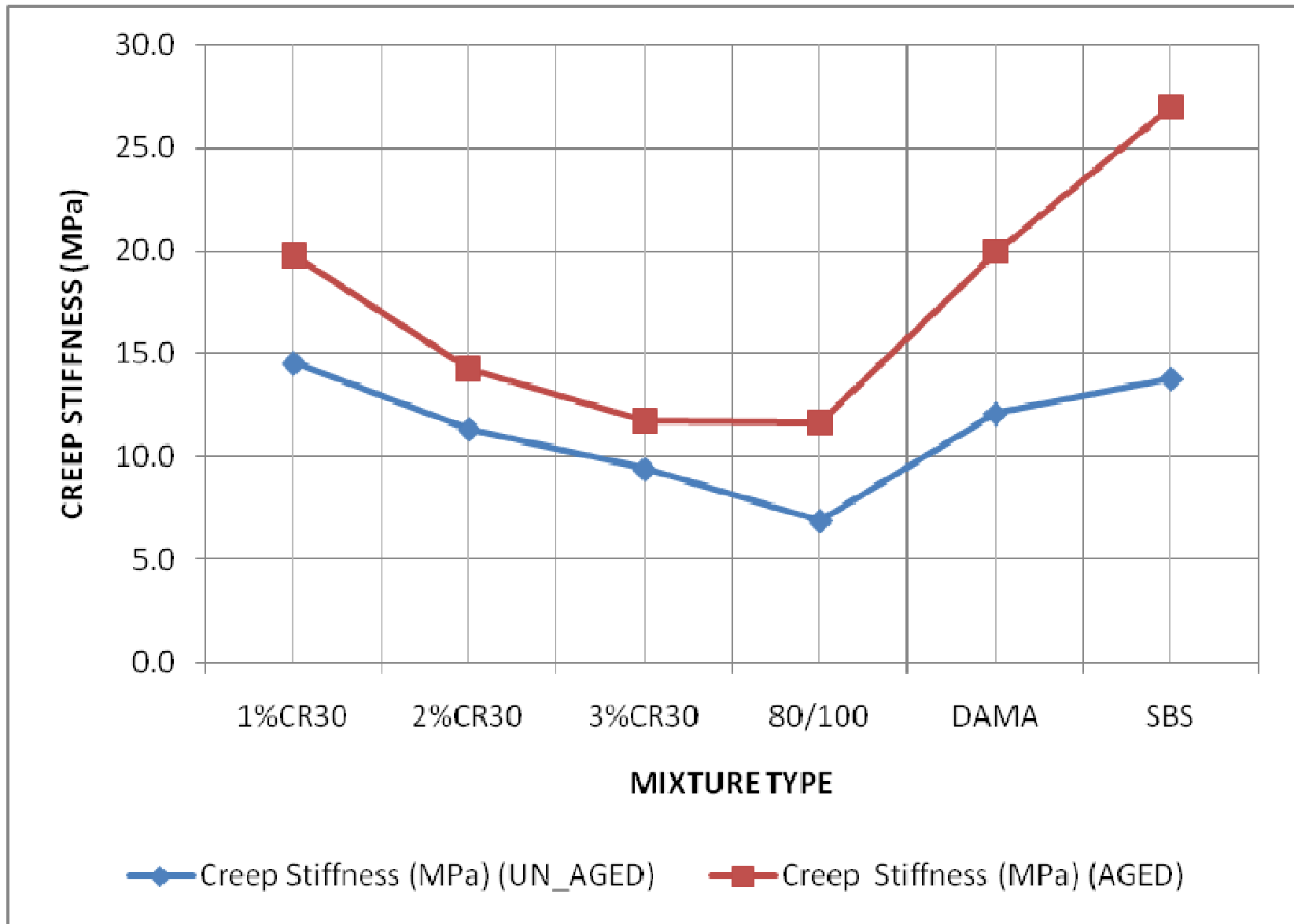
# Results of Short Term Ageing Tested at 20°C

Mixture Type	Resilient Modulus (MPa)		STA % Increase
	Unaged	STA	
1%CR30	3766	4016	6.6
2%CR30	3284	3885	18.3
3%CR30	3104	3542	14.1
1%CR50	2990	3802	27.2
2%CR50	2625	3409	29.9
3%CR50	2603	3653	40.3
80/100	2605	4283	64.4
DAMA	3605	4275	18.6
SBS	3241	3590	10.8



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# Conclusion

The results of this study suggest the beneficial effects of using CR30 in bituminous mixes..

1. The resultant mix properties conformed to the JKR requirements. All the modified and unmodified mixtures have undergone an increase in resilient modulus after subjected to ageing.
2. The increase in the resilient modulus indicates the relative effects of binder ageing on the asphalt paving mixtures.
3. The resilient modulus results indicate that short term ageing caused the resilient modulus of unmodified mixes increase by 64.4% higher compared to unaged samples.
4. This indicates CR30 are less severely affected by oxidative aging compared to normal binders. The results of modified mixtures showed good permanent deformation characteristics compared to the conventional unmodified mixture.
5. Modification of binder using crumb rubber not only improves bituminous mixtures but can also aid in conservation of the environment.