Asphalt Recycling and Materials Re-use in Asphalt Pavements

L'Aquila, Italy, 27 – 29 June 2007

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Contents

- Introduction – outline of current recycling position in UK;
- Experience with re-use of two materials in asphalt:
  - Binder additive; and
  - Aggregate replacement
- Functionality
- Challenges

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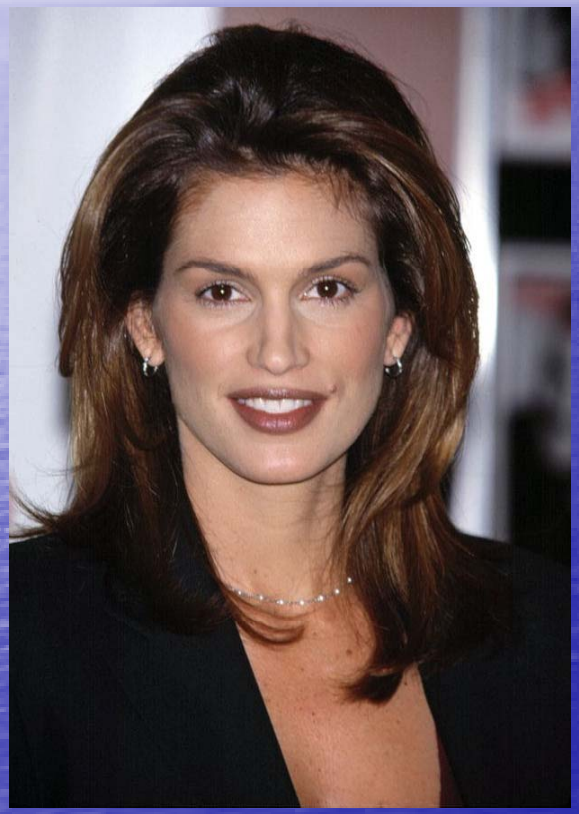
Recycling – Is it all worth it?



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Introduction

- In the UK, asphalt recycling is common, encouraged and is specified by national standards.
  - In-situ recycling comprises three processes:
    - Repaving
    - Remixing

    } Hot – Wirtgen Machine

    - Retread – Cold (may adopt emulsion or foam bitumen)

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Introduction

- Plant recycling (off-site)
  - Hot recycled materials in modified batch plants have been used. More recently, cold recycled materials have evolved using bitumen emulsion or foam.

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Provisions for use of secondary and recycled materials in UK pavements

Application and Series ▶	Capping	Unbound Mixtures for Sub-base	Hydraulically Bound Mixtures for Sub-base and Base	Bitumen Bound Layers
Material ▼	600	800	800	900
Blast furnace Slag	✓	✓	✓	✓
Burnt Colliery Spoil	✓	✓	✓	x
China Clay Sand/Stent	✓	✓	✓	✓
Coal Fly Ash/Pulverised Fuel Ash (CFA/PFA)	✓	x	✓	✓
Foundry Sand	✓	✓	✓	✓
Furnace Bottom Ash (FBA)	✓	x	✓	x
Incinerator Bottom Ash Aggregate (IBAA)	✓	✓	✓	✓
Phosphoric Slag	✓	✓	✓	✓
Recycled Aggregate	✓	✓	✓	✓
Recycled Asphalt	✓	✓	✓	✓
Recycled Concrete	✓	✓	✓	✓
Recycled Glass	✓	✓	✓	✓
Slate Aggregate	✓	✓	✓	✓
Spent Oil Shale/Blaise	✓	✓	✓	x
Steel Slag	✓	✓	✓	✓
Unburnt Colliery Spoil	x	x	✓	x

Recent and current research on materials re-use in asphalt pavements

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Recycled rubber (wet process)

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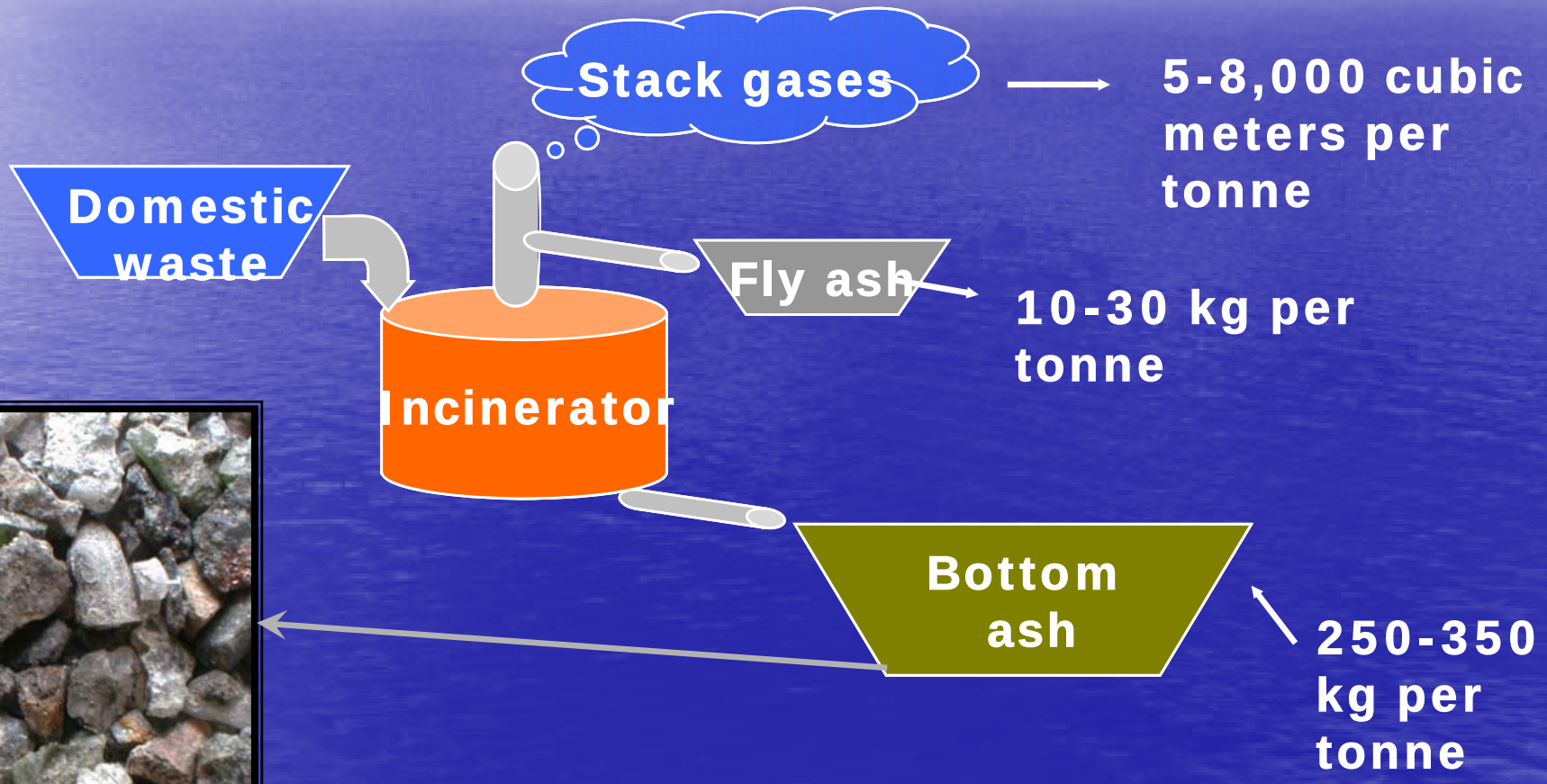
Incinerator Bottom Ash Aggregate (IBAA)



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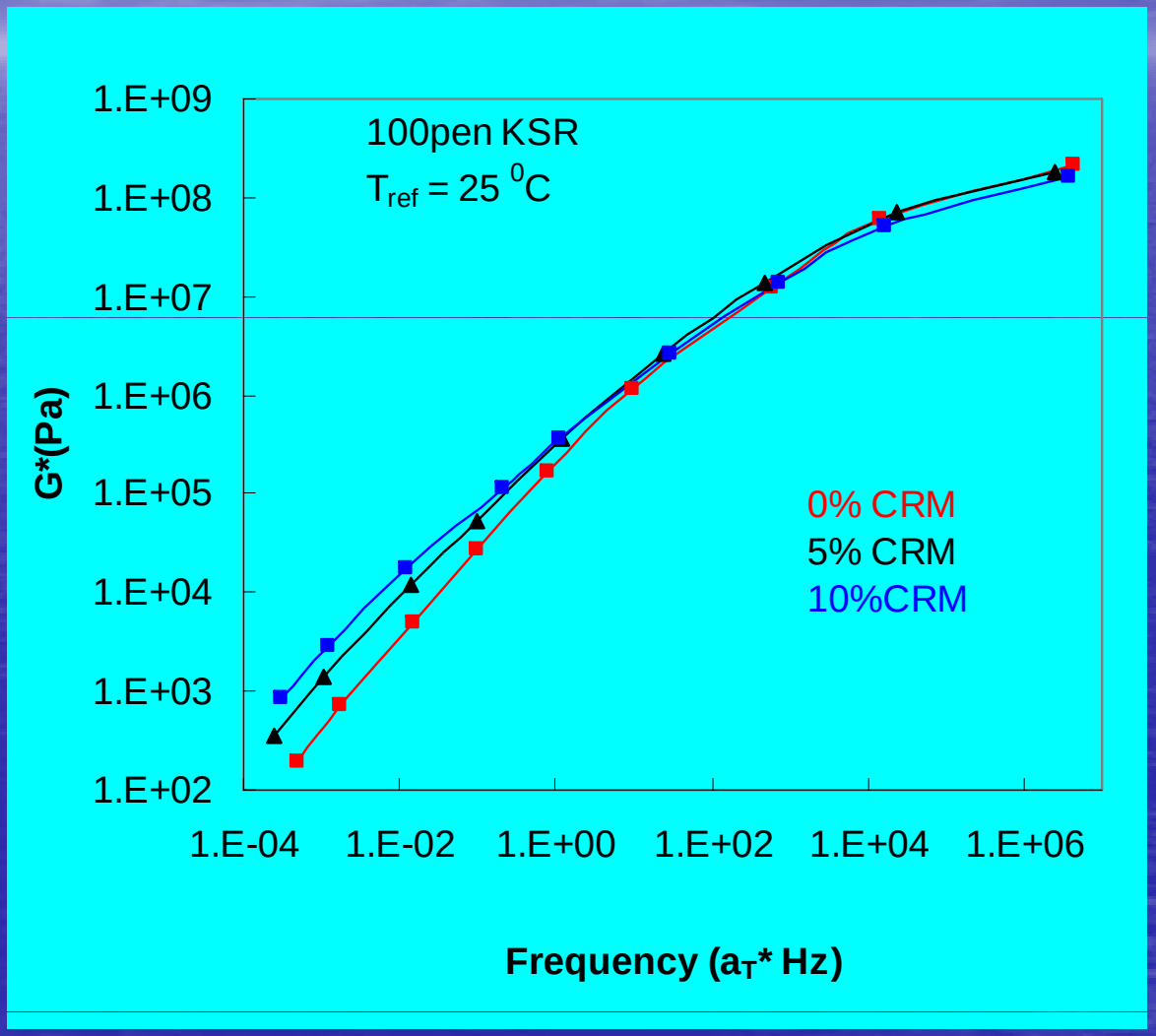
Crumb tyre rubber - rheology



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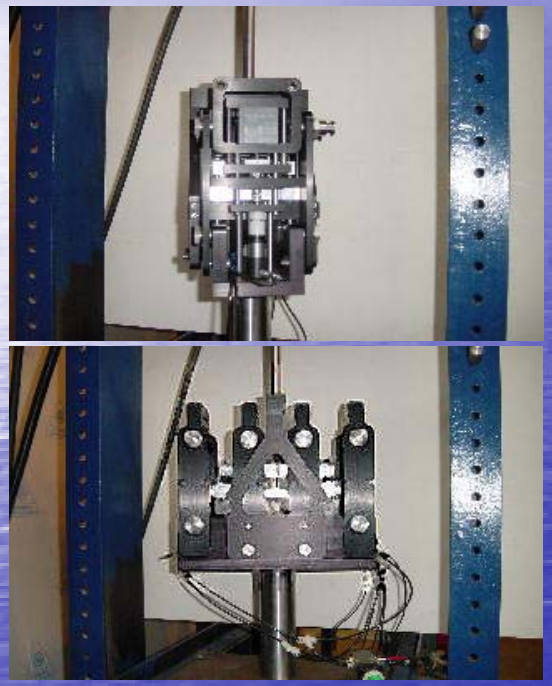
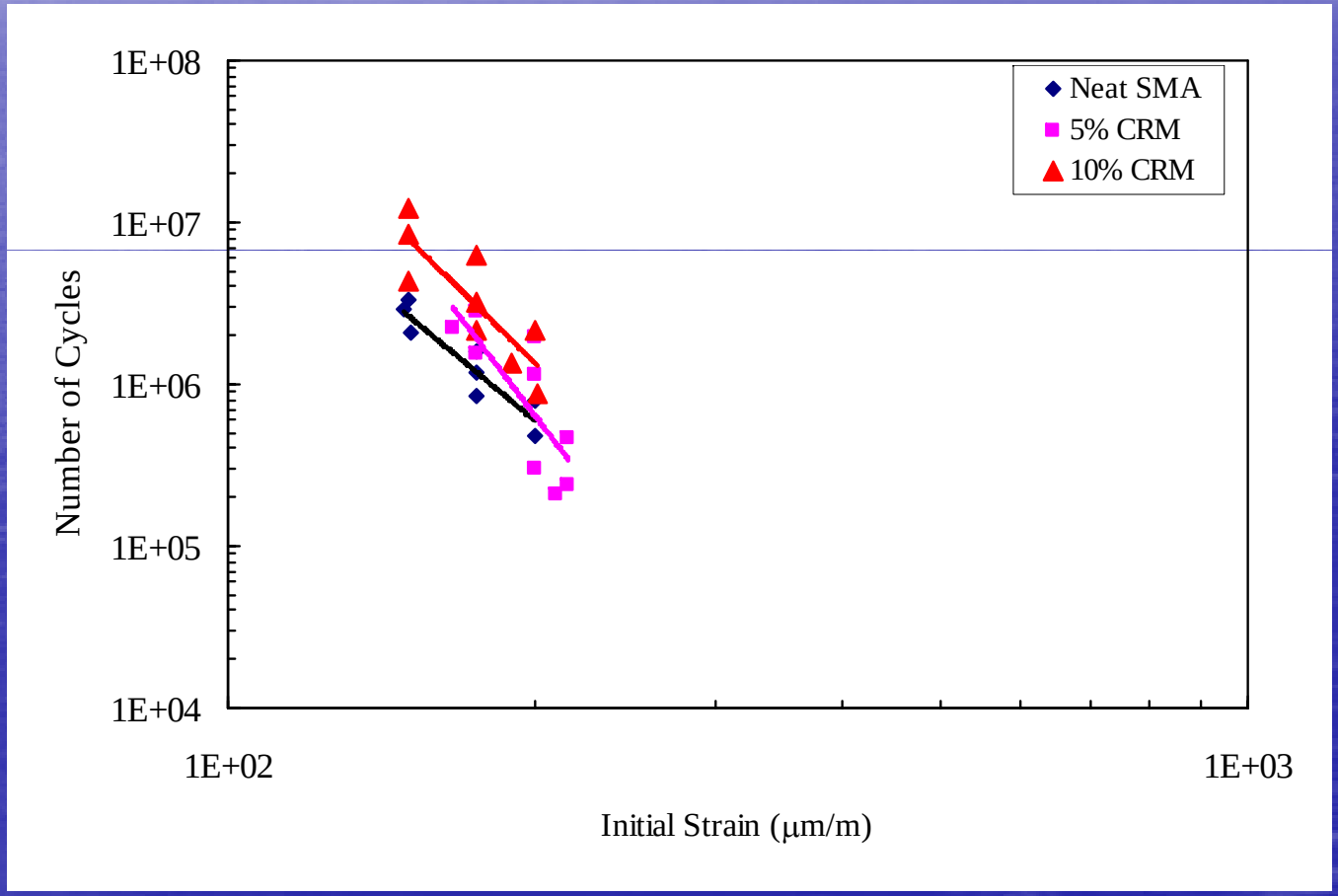
Crumb tyre rubber - fatigue





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Crumb tyre rubber - rutting

Binder Content (%)	CRM Content (%)	Temperature (°C)			
		45		60	
		Rut Depth (mm)	Rutting Rate (mm/hr)	Rut Depth (mm)	Rutting Rate (mm/hr)
5.5	0	1.9	0.53	2.5	0.65
5.5	5	1.2	0.46	2.2	0.62
6	10	1.0	0.21	1.9	0.11

14mm SMA including 50 Pen binder

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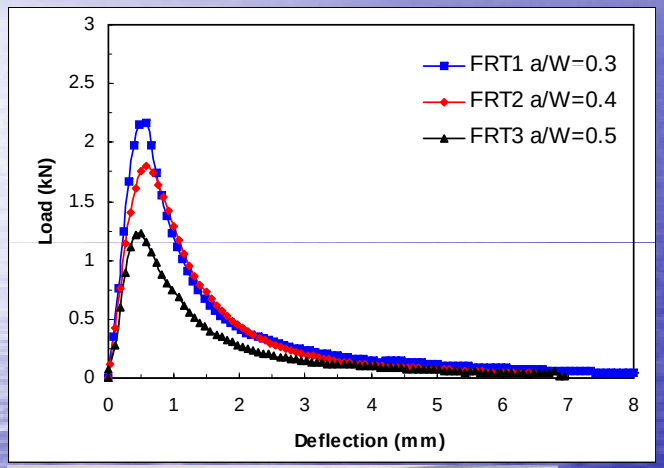
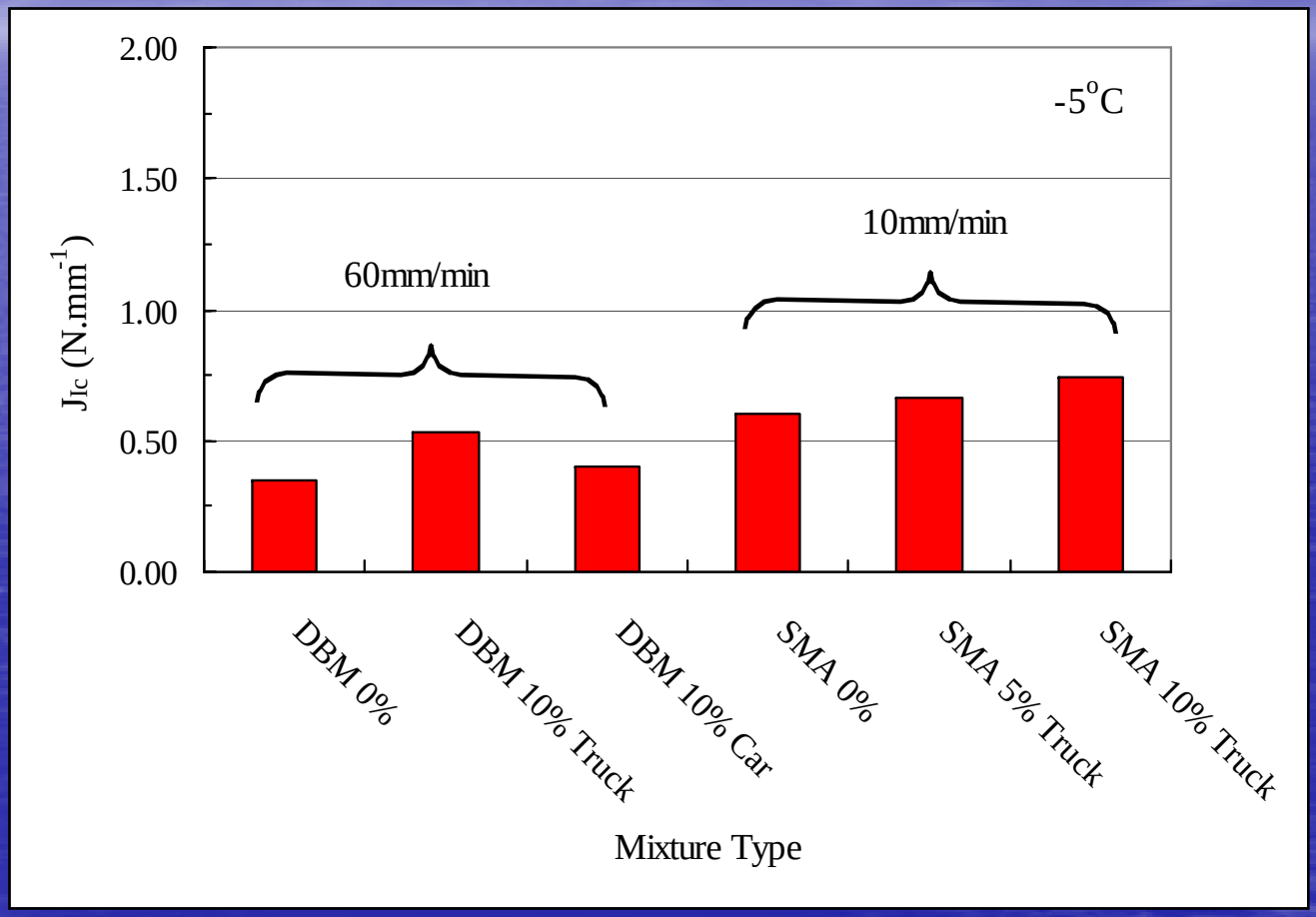
Crumb tyre rubber - cracking resistance





Notched prismatic beam specimen

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Crumb tyre rubber – site trial

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Rubber asphalt - Challenges

- No cross-linking between rubber and bitumen – storage problems
- Long-term performance – ageing
- Potential for recycling - recyclability
- Cost implications – legislation/tax-relief

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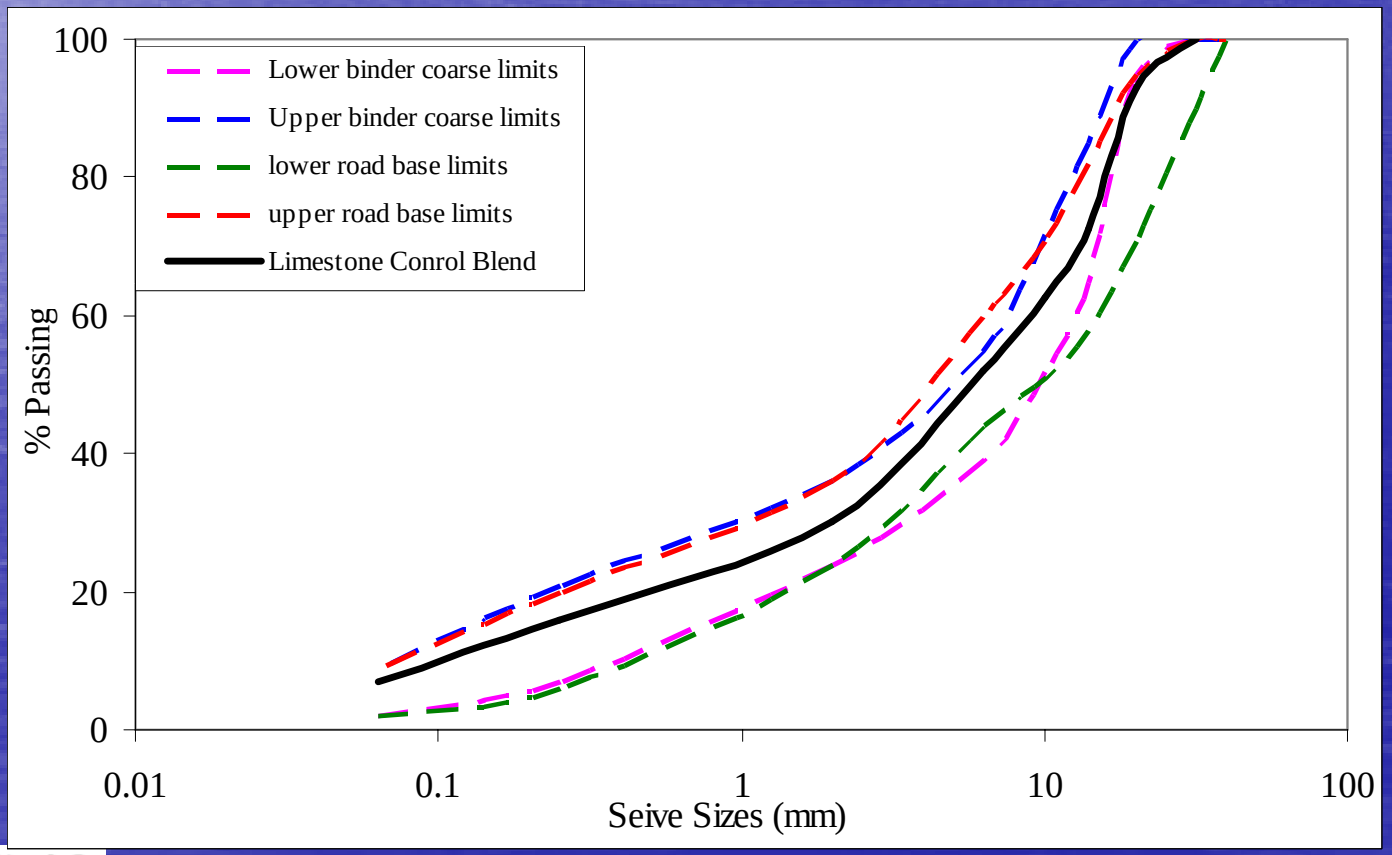
IBAA in asphalt

- IBAA has been used to replace virgin (limestone) aggregate in an asphalt mixture suitable for base or binder course



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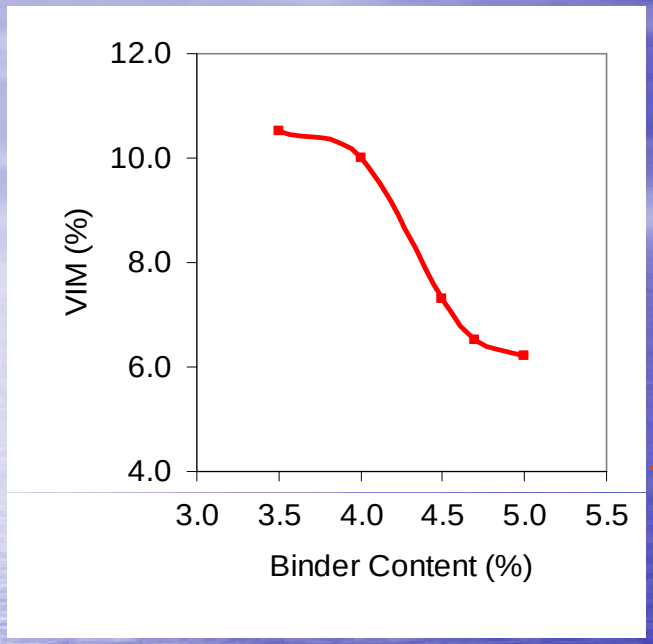
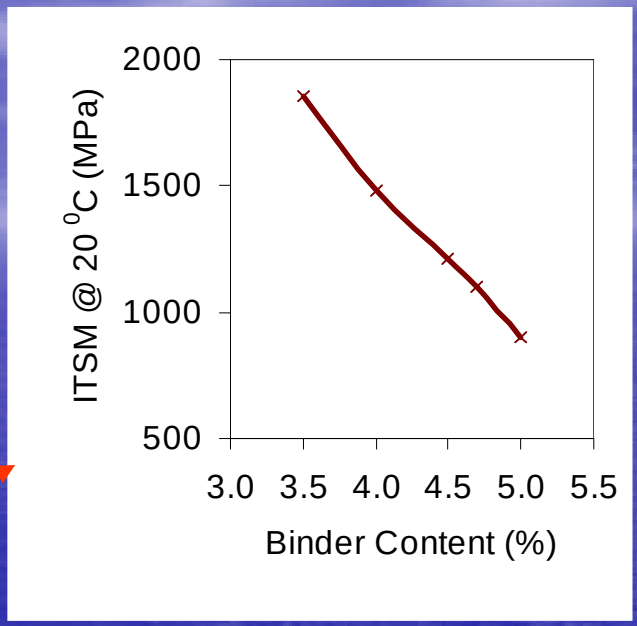
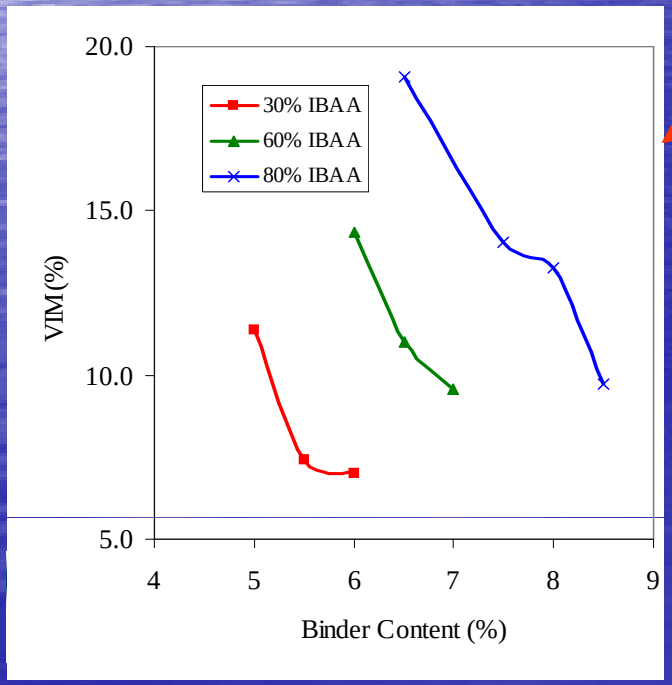
Mix design – (HMA)



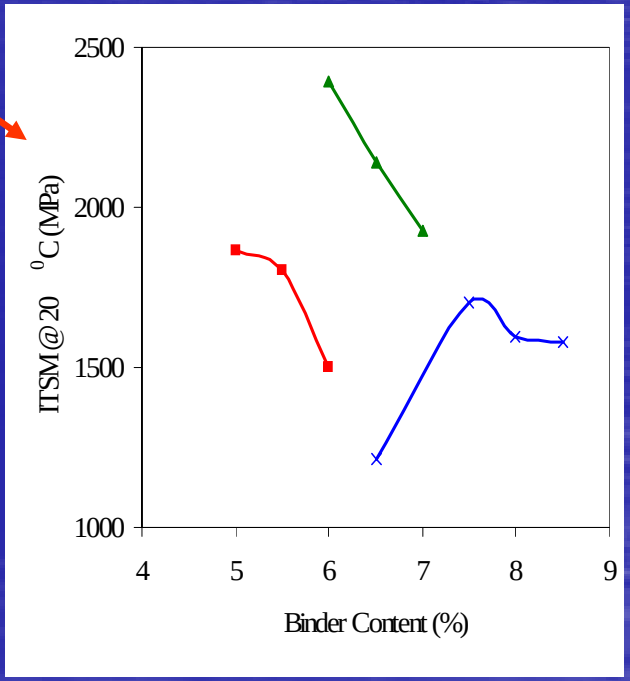
Limestone control mixture



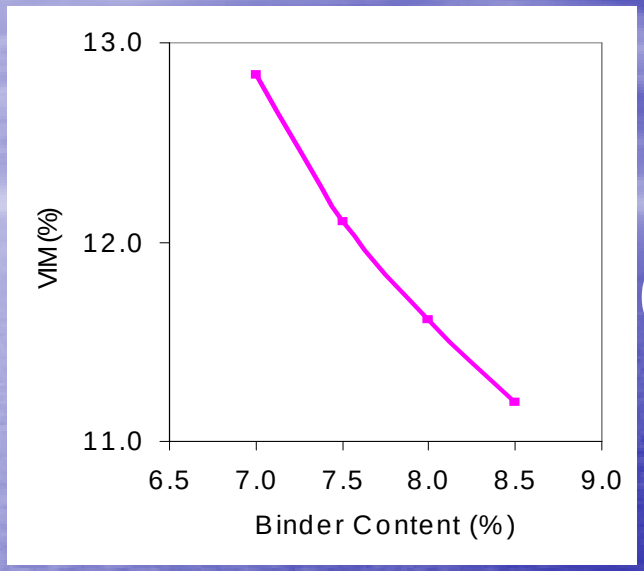
100 Pen binder



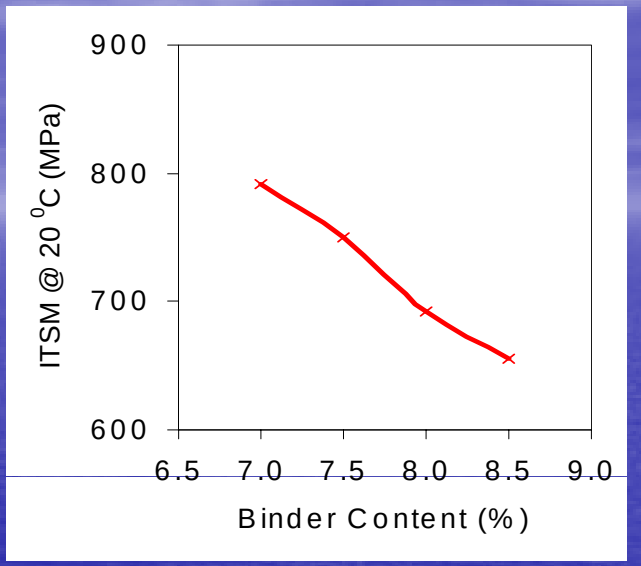
IBAA replacement at different levels

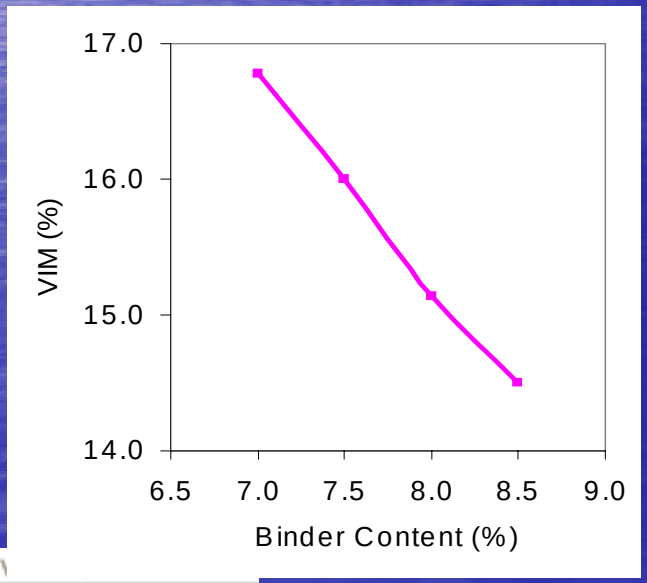


Mix design – cold asphalt

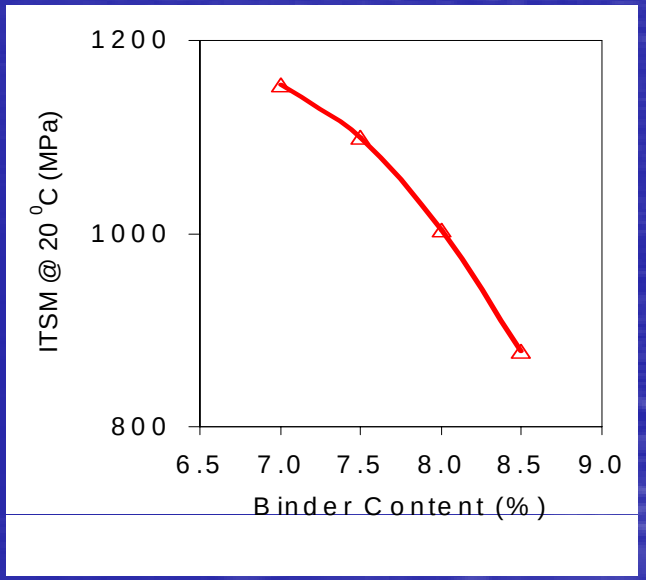


60% IBAA





80% IBAA



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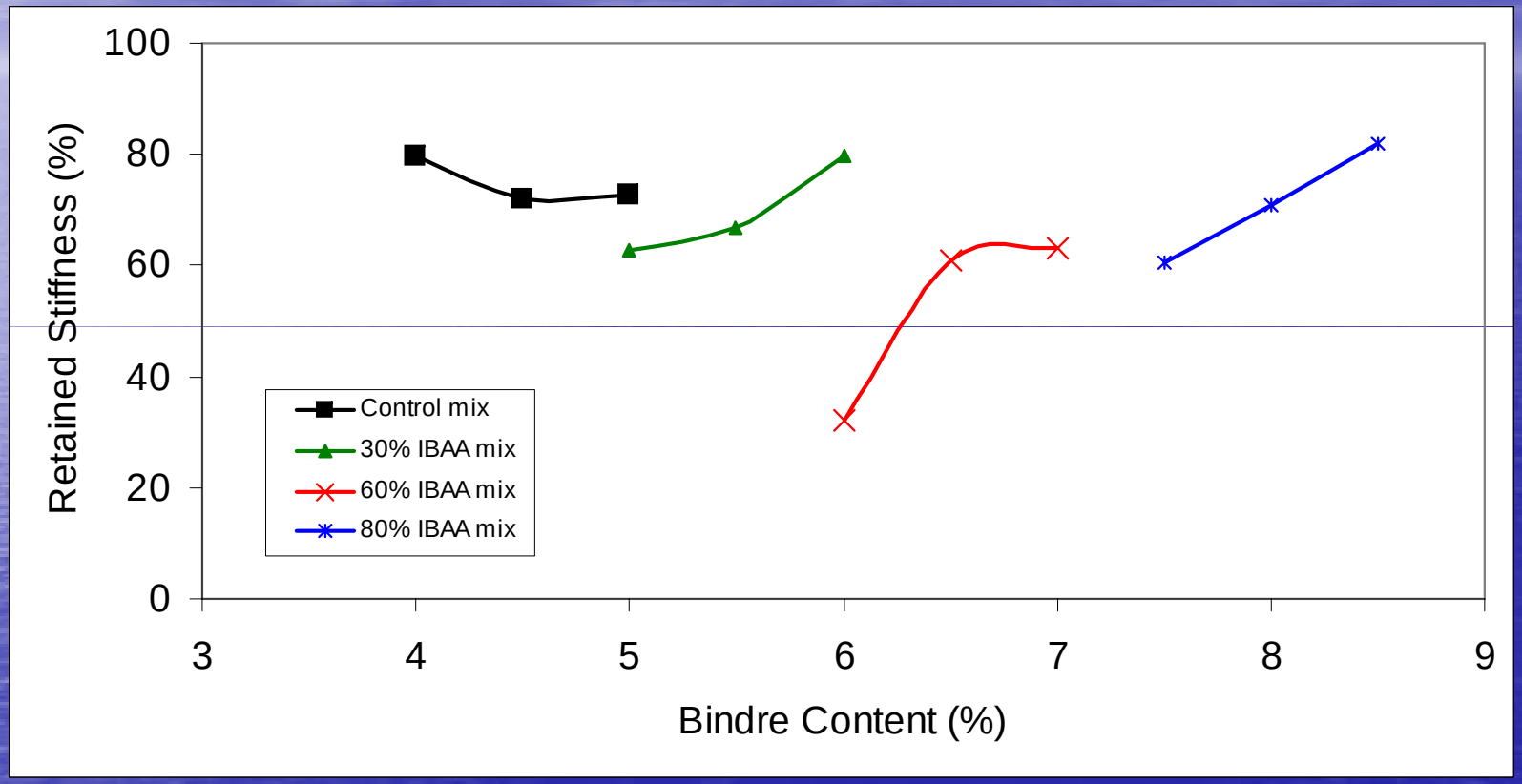
Moisture sensitivity (durability)



Mixtures saturated, immersed in water at 60°C for 6 hrs, then in water at 5°C for 16 hrs – 3 cycles

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Challenges - problems

- Viability of IBAA mixtures;
- Durability.

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Grazie per vostra attenzione

Thank you for your attention

Merci pour votre attention

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