Part 1

Introduction

Terminology

Surface course, usually max 40mm thick

Binder course, usually max 60mm thick

Base, thickness designed and depends on anticipated traffic loadings, up to 300mm thick

Sub-base, thickness depends on soil strength but min. 150mm

Either existing soil, ie “Formation” or a capping layer of cheapest stone, up to 600mm thick

Types of pavement

1 Prehistoric tracks	6 Telford type
2 Roman Roads	**7 Evolved**
3 Unpaved roads	**8 Designed**
4 Stone causeways	**9 Concrete (reflective cracking only)**
5 Macadam type	10 Block paved

Pavement construction – **Evolved**. (thinner, variable and <u>can be very flexible</u>)

Surface course (asphalt)
Binder course (asphalt)
Road base ????? Several layers of surface dressing, mixed with tarmacadam / bit.mac/ broken brick????
Sub-base?? , incinerator ash or sand/gravel or old lane
Formation (existing soil)

Evolved road, riding on water-bound macadam

There was virtually no asphalt in the UK until the early 1900's

Interior View of an Asphalte Mine at the Working Face.
(Courtesy: Val de Travers Asphalte Paving CO. Ltd.)

An evolved rural road, damaged by flooding

New LA road being built, UK in 1947, Telford's system, large rock

There was no such material as
DBM or HRA road base until 1960.
The base in UK roads built before the 60's
will be……..,

dry stone, crusher-run or 50mm single size

or perhaps "wetmix"

or "lean-mix", a **very** weak concrete

or a VERY lean bit. emulsion mix (2% bit)

Roads built since the 1960's years

are usually very uniform in construction

with a thick asphalt base and they

are usually very strong.

We now call these "Designed Roads"

Designed roads, mainly built or improved since the 1960's

Surface course (40mm asphalt)
Binder course (60mm asphalt)
Base (asphalt) at least 200mm thick
Sub-base (crushed stone) plus Capping layer perhaps
Formation (existing soil)

Carriageway construction types, left to right

- **Flexible**
- Composite
- Rigid
- Modular (paving blocks)

DRY soil is strong.

WET soil is weak, especially if clayey.

It is **MOST** important to keep the soil beneath the road DRY

If it gets wet, it will weaken

and eventually the road pavement will fail

Remoulded clay,
increasing moisture content, left to right

It is essential to keep water and air (oxygen)

out of asphalt pavement layers

if at all possible.

Road drainage systems need to be well

maintained and NOT forgotten

Many **Evolved** roads are very flexible relative to **Designed** roads.

They are usually unsuitable for most BBA/HAPAS “thin surfacings” and “UK SMA’s”

The French have known this for 30 years

All asphalts are made with bitumen and aggregate. In the UK we have plenty of good aggregate.

Commercially, the most valuable is that which does not polish easily, ie with a high polished stone value

We call this high psv aggregate. This is used in surface courses to give us

good skid resistance.

High psv aggregate eventually polishes but can be recycled into other road layers.

All the aggregate used in asphalts is virtually indestructible and can be recycled indefinitely.

Problems with road surfaces

are often due to the condition of the

BITUMEN component of the asphalt

BITUMEN

Is characterised by 2 tests

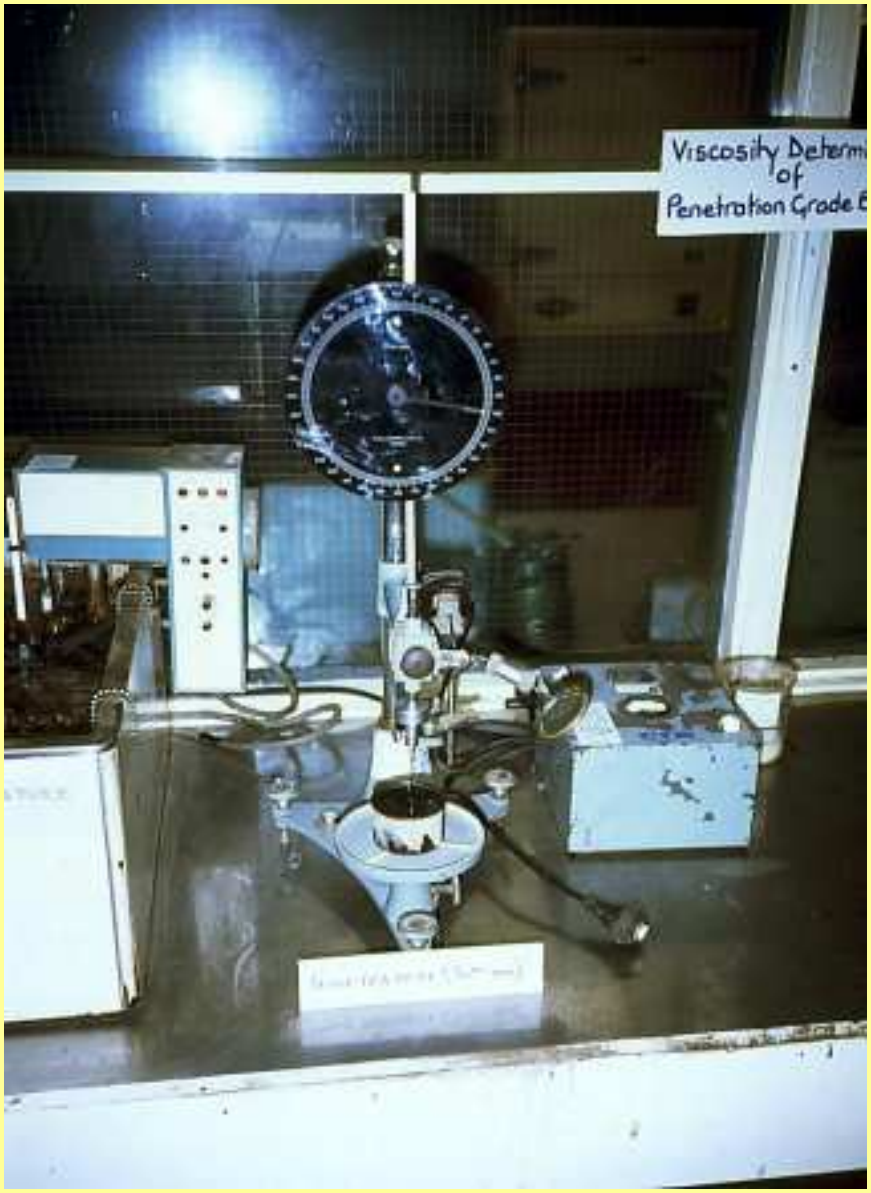
"**Penetration**" and

"**Softening point**"

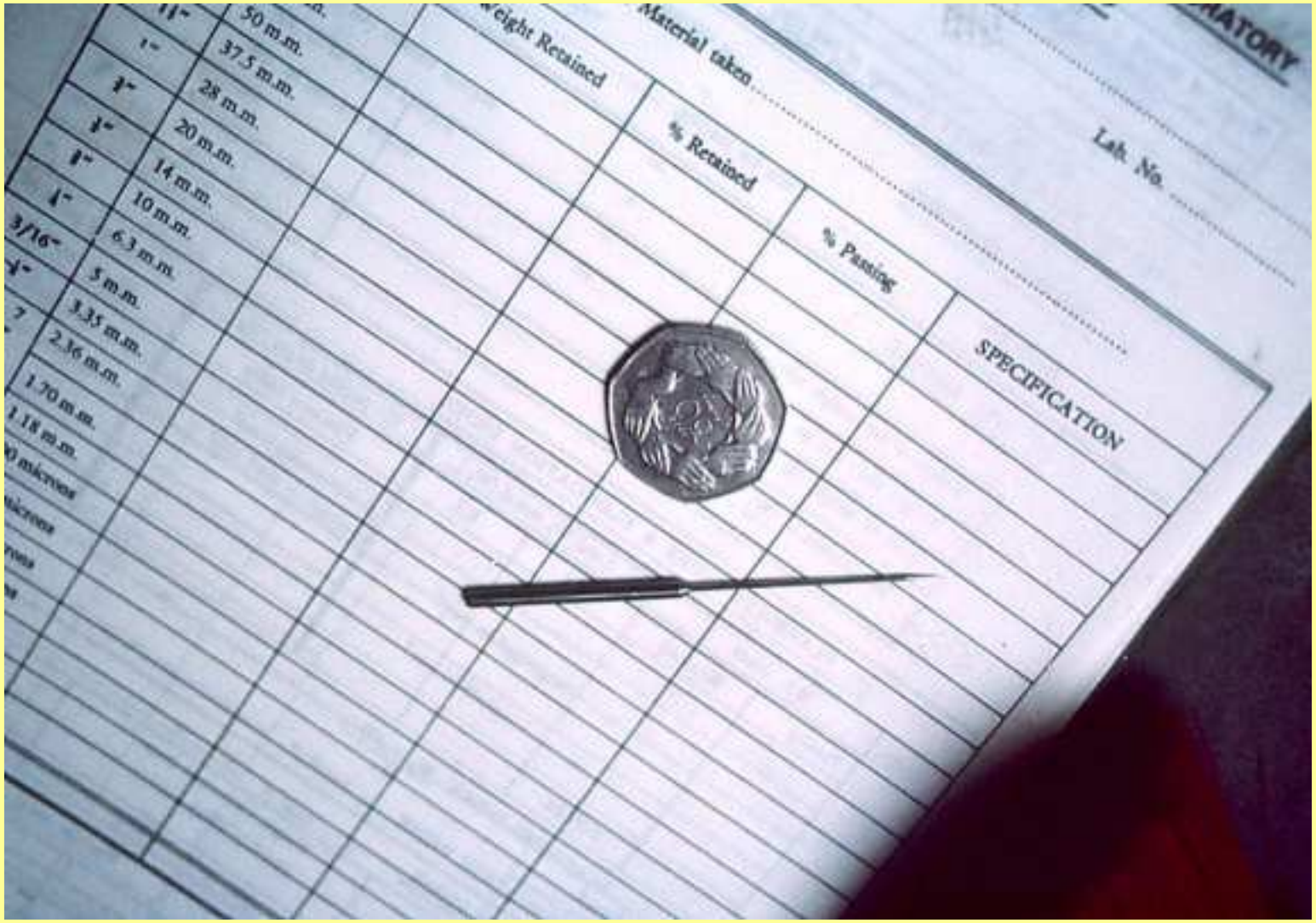
Nearly all the photographs of asphalts you will see on this course were all produced as hot mixes.

We shall look briefly at mixes made at lower temperatures later

The penetration test apparatus



The penetration test needle



Examples:-

5mm penetration of the test needle = 50pen
(now correctly referred to as grade 40/60)

19mm penetration of the test needle = 190pen
(now correctly referred to as grade 170/210)

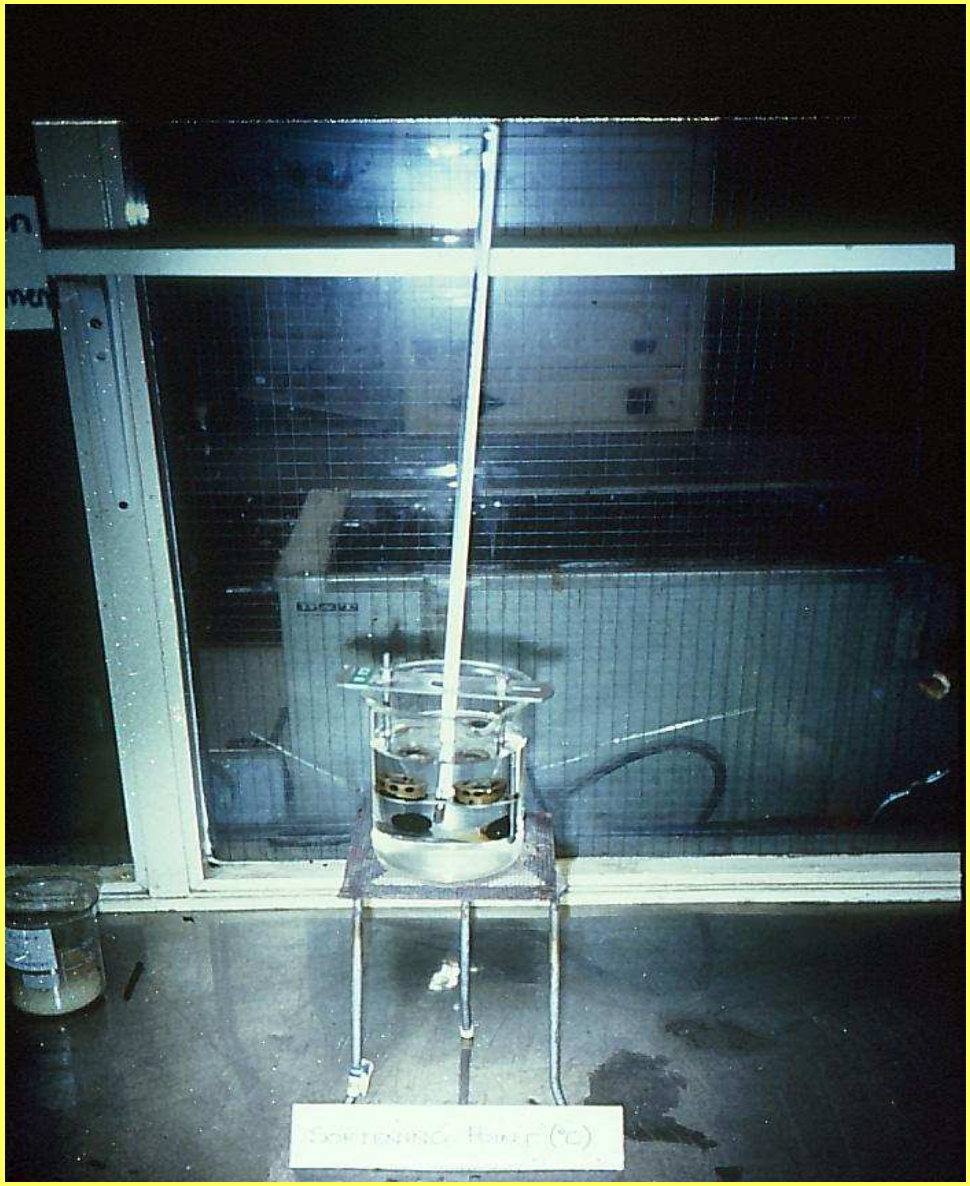
ie softer bitumen has a larger pen number.

Softening Point test

Two samples of bitumen, each loaded with a steel ball, are immersed in
water, which is heated at 5^0C / minute. until the bitumen softens and can no longer carry the weight of the steel balls.

This temperature is the bitumen's softening point (max 70C for RAP)

The softening point test apparatus



TRL research on bitumen durability

New bitumen added to mixer,	50* pen
After mixing, 12 pen hardening,	38* pen
After laying, 4 pen hardening,	34* pen

(*actual measured pen values)

Rule of thumb,
after mixing, pen drops by about 1/3

Bitumen continues to harden
in service, mainly due to its reaction with
atmospheric oxygen

The bitumen's reaction with oxygen is called **OXIDATION**

How fast it oxidises depends on the **air void** content of the mix

The greater the air voids, the faster the bitumen oxidises

Once a bitumen has oxidised

down to about 15 pen,

it is useless.

All the glue-like parts have disappeared

and the blacktop **will fall apart**

Terminally oxidised surface course

Burned in the mixer, HRA binder course

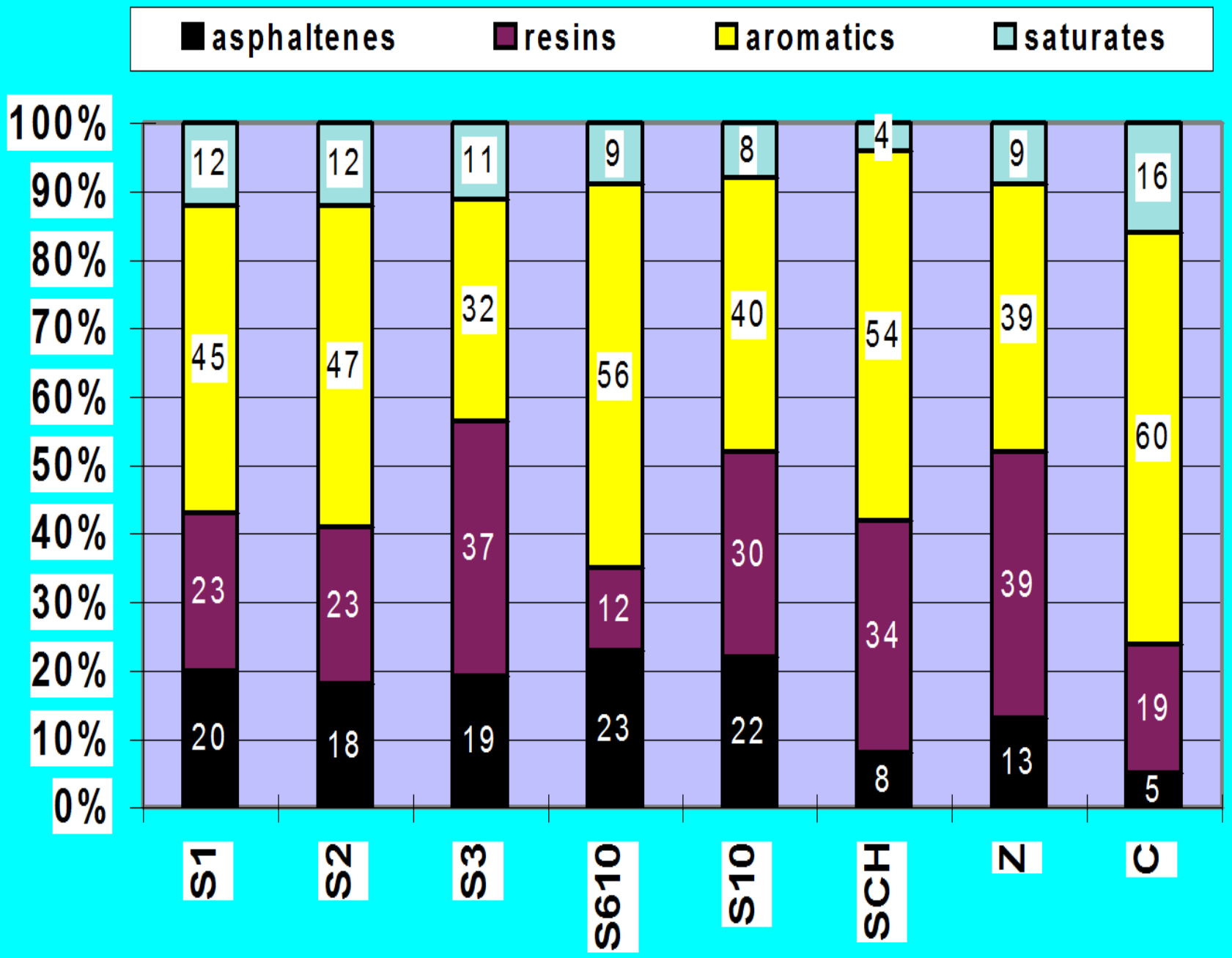
The SARA concept

Saturates
Similar to oils, give “fluid” properties

Aromatics
Give adhesive properties

Resins
Stabilisers - hold everything together

Asphaltenes
Give stiffness, rigidity


asphaltenes
resins
aromatics
saturates
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
12
45
23
20
12
47
23
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Modified Bitumens

Larger volumes of traffic and heavier vehicle axle loadings sometimes require modified bitumens to be used in asphalt production

The bitumens need modifiers which are compatible with their own chemistry or the resulting improvement in performance does not happen.

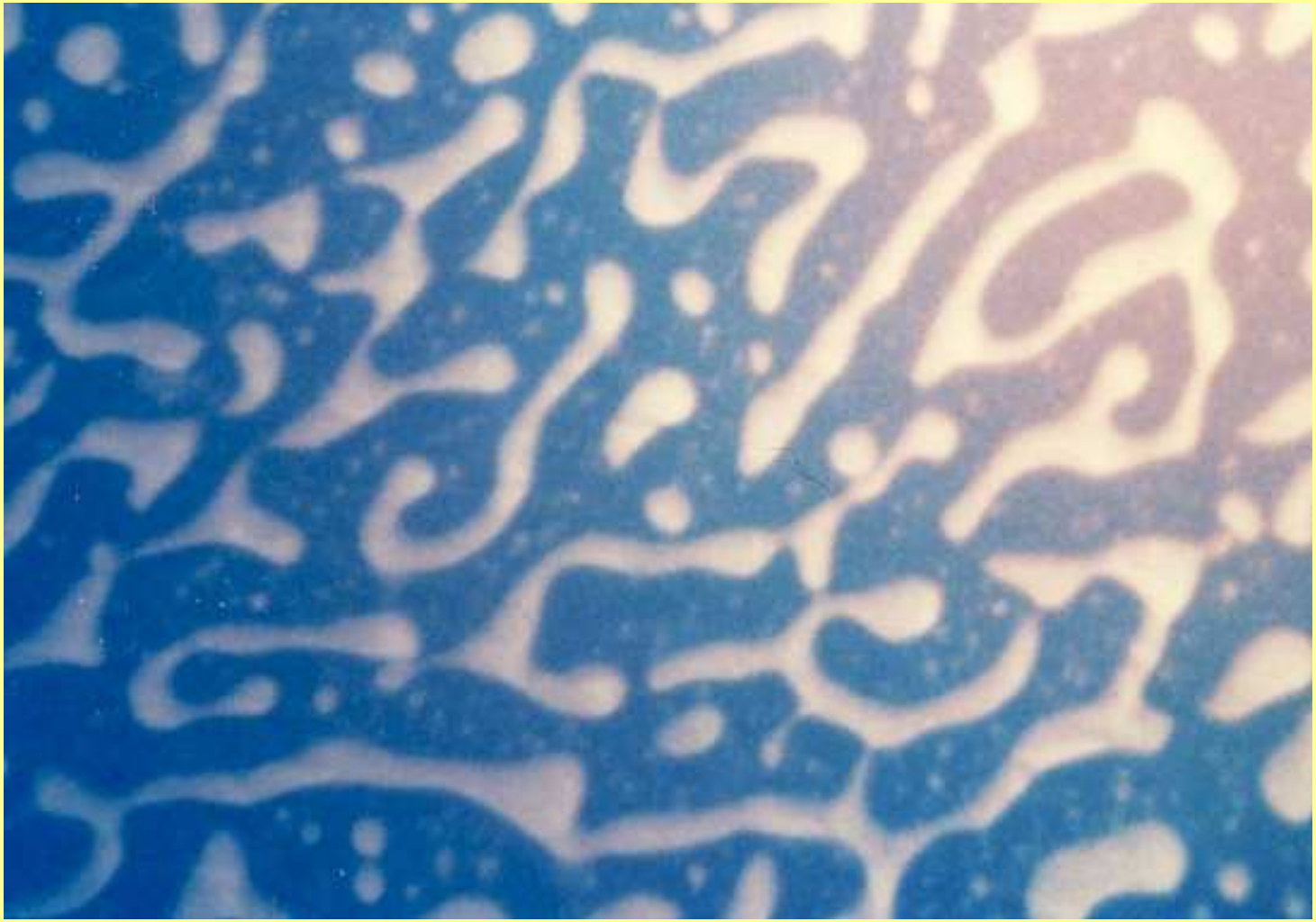
The most usual modifiers in the UK

SBS, an elastomer, a form of artificial rubber, which improves an asphalt's resistance to both reflective cracking and wheel-tracking deformation

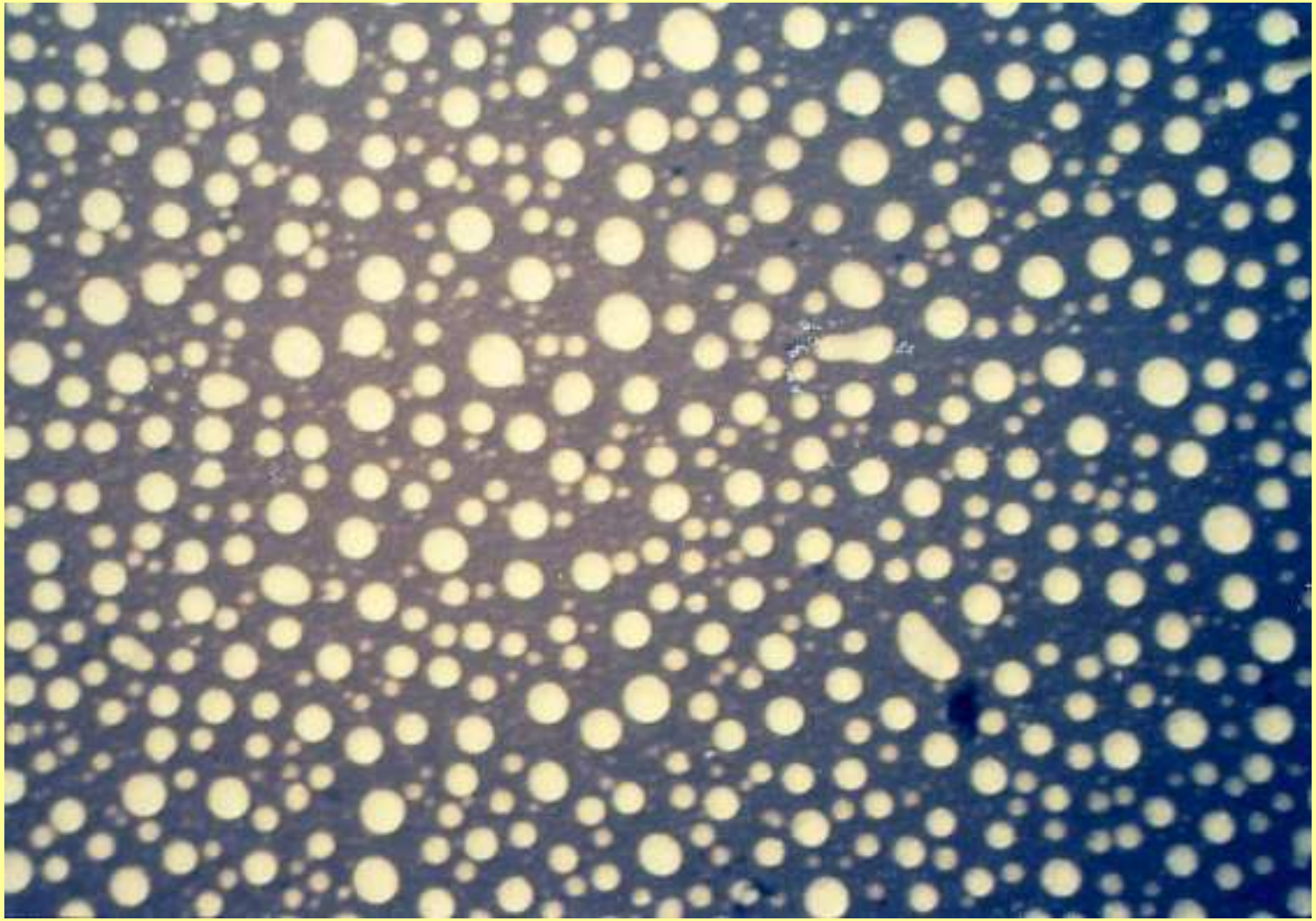
EVA, a polymer, which enhances the toughness of the asphalt so improves both asphalt's resistance to wheel-tracking and point loading. *(Not reflective cracking)*

modifier	Wheel tracking	Thermal cracking	Fatigue cracking	Moisture damage	ageing
Plastomer, Eg EVA	yes				
Elastomer Eg SBS	yes	yes	yes		yes
Rubber Eg tyre crumb		yes	yes		
Carbon black	yes				yes
Lime				yes	yes
Polypropylene fibres			yes		
Sulphur	yes				
Epoxy resin	yes	yes	yes		
Antistripping additives					yes

Poor bitumen /modifier blend, the required properties will not be achieved



Good bitumen /modifier blend, the required properties will be achieved



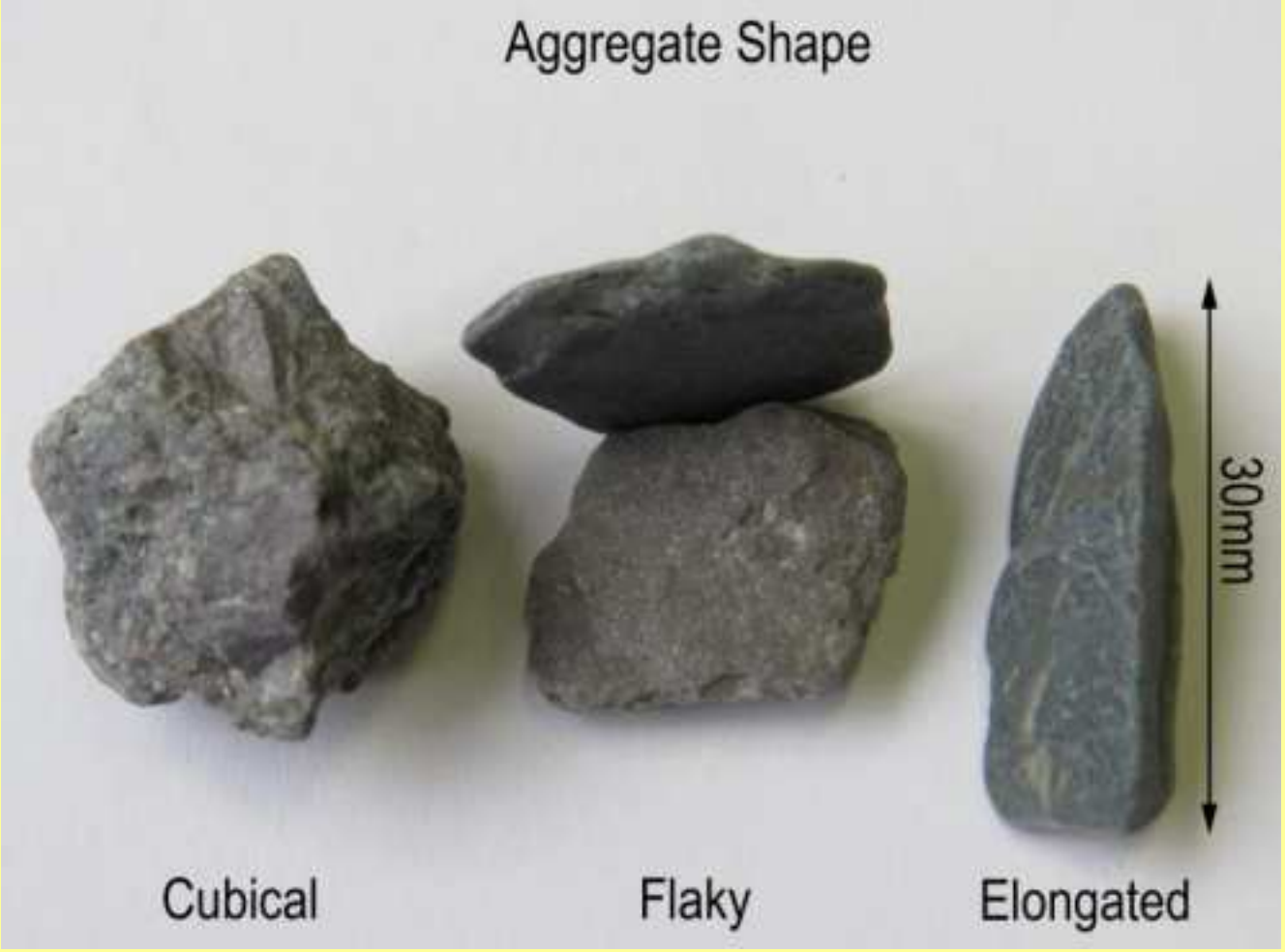
The dynamic shear rheometer used to monitor modified bitumens. Pen and SP no use.

Aggregate is the largest constituent in asphalt, typically 92-96% by mass; the type of aggregate, its mineralogy, physical and chemical properties will have a significant impact on asphalt performance.

The Specification for Highway Works (SHW) requires that they should be .....

"*clean, hard and durable and shall comply with BS EN 13043.*"

Quarries aim to produce aggregates which are roughly cubical since these readily interlock and make dense asphalts



The last thing we want in **any asphalt** is **Flaky** aggregate which has a thickness of less than half its nominal size. We have a Flakiness Index *(FI) the %age of a sample which is flaky*

Good cubical shaped aggregates would have an *Fl* value of 20 or less.

We also need rock which resists fragmentation so check with the Los Angeles Test (Sample in drum with 11 no 47mm steel balls, then check %age broken to lesser size which is the LA value. LA_{30} or less is good)

For surface course aggregates, we need those with a high resistance to polishing, ie a high polished stone value (psv)

< psv machine

TRL portable skid tester >

The course notes have more information about aggregates

In general, since asphalt has been produced in the UK for more than a century, we have very few problems with aggregates

The two enemies of asphalt, air and water

Any questions?