

CONSTRUCTION AND QUALITY CONTROL OF FLEXIBLE AND RIGID PAVEMENTS

TEST ON EMULSIONS AND CUTBACKS

National Rural Infrastructure
Development Agency



Ministry of Rural Development

National Institute of
Technology



Warangal, Hyderabad

Lecture-9

TEST ON EMULSIONS AND CUTBACKS

Bituminous Binders

- Bitumen

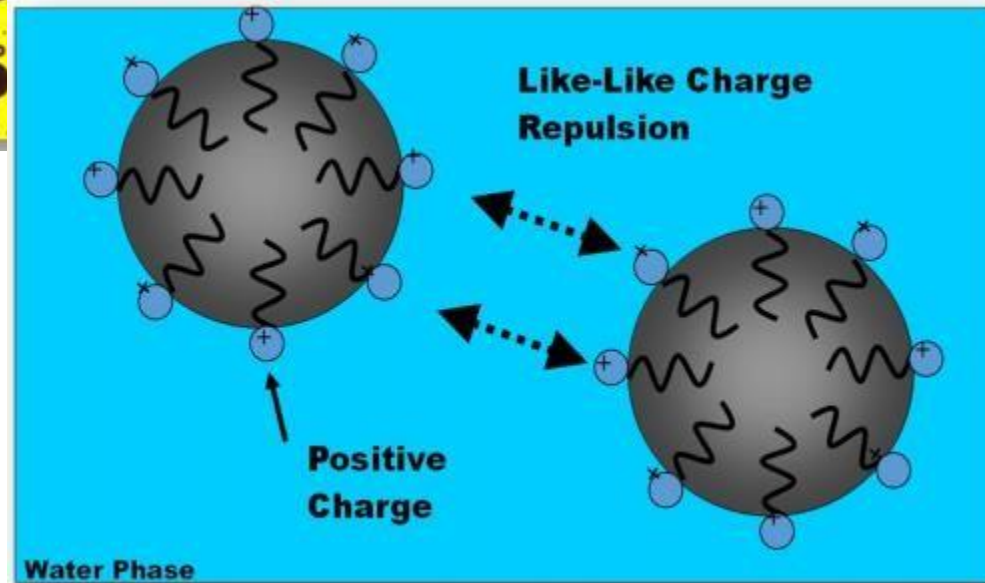
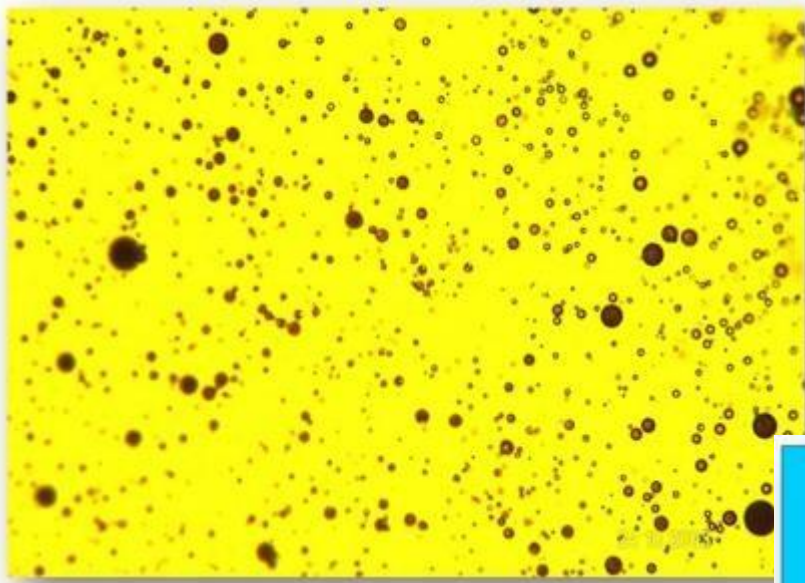
- Tar
- Cutback
- Emulsions
- Modified binders



Bituminous Emulsions

- Bituminous emulsion is a two phase system consisting of bitumen, water and one or more additives (emulsifiers)
- Bitumen is dispersed throughout the water phase in the form of fine globules (0.1 to 5 microns)
- The bitumen globules are held in suspension and prevented from settling by electrostatic forces provided by the emulsifiers

Bituminous Emulsions



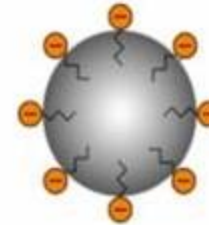
Bituminous Emulsions

- Typically contains 50-75% Bitumen, 0.1-2% emulsifying agent
- These components are introduced into a colloidal mill which shears the bitumen into tiny droplets
- The emulsifier ion orients itself on to the bitumen particles and provides electrostatic charges
- The emulsifiers keep the bitumen particles in suspension, controls breaking and aids in adhesion of bitumen particles on to the aggregate surface

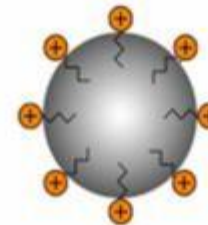
Bituminous Emulsion - Classification

- On the basis of the electrical charge surrounding the bitumen globules, bitumen is classified as
 - Cationic - suitable for Silicious aggregates like quartzite, sandstone, granite
 - Anionic - suitable for Calcareous aggregates such as limestone and dolomite
 - Neutral - non ionic, rarely used in road construction

Negative Charge = Anionic Emulsion



Positive Charge = Cationic Emulsion



Bitumen Emulsion classification

- On the basis of how quickly emulsion reverts to bitumen
- ## Cationic Emulsions
- RS - Rapid Setting (suitable for surface dressing and patch repair)
 - MS- Medium Setting (suitable for premix with less fines)
 - SS - Slow Setting (suitable for premixes with larger percentage of fines)

Bitumen Emulsion classification (BIS 8887)

- **Bituminous emulsions are further classified into RS-1, RS- 2,MS, SS-1, SS-2**
 - RS-1 used as tack coat
 - RS-2 used for surface dressing
 - MS is used in open graded premix carpet
 - SS1 used for priming, fog seal, crack seal, sand seal application (large fines)
 - SS2 used for slurry sealing, seal coat, BSM mixes

Breaking and curing of emulsion

- Emulsions have to ultimately serve as binder
- The separation of water from emulsions is called as breaking
 - Electrochemical phenomena
 - Evaporation
- RS emulsions will have 1 to 5 minutes of breaking time
- Medium or Slow setting emulsions take considerably large time
- Type and concentration of emulsifiers control the breaking time
- Complete loss of water and formation of cohesive film

Selection of a grade of emulsion

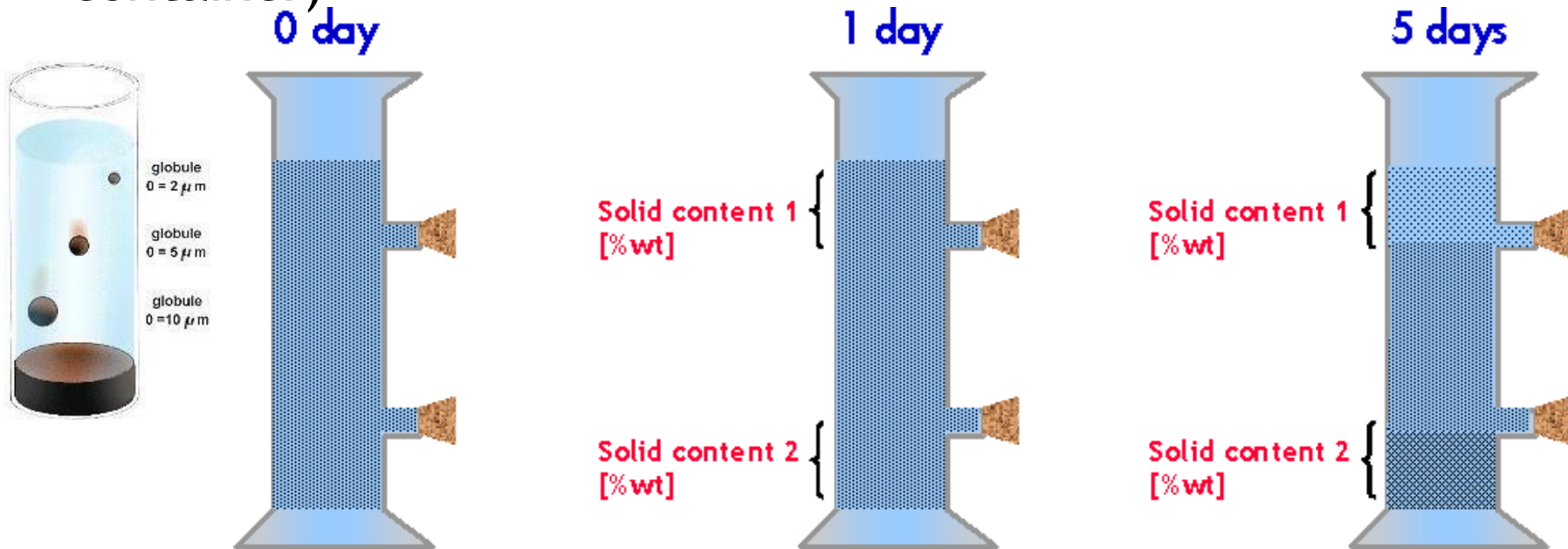
- Climatic conditions during construction
- Aggregate type and gradation
- Construction equipment
- Traffic control

Advantages of Emulsions

- Do not require a petroleum solvent to make it to a liquid
- Emulsions can be used without additional heat
- These factors reduce energy consumption /little or no hydrocarbon emission

Tests on Emulsions

- Storage stability - Settled for 24 hours (difference in bitumen contents in the top and bottom portions of the container)



Test on Emulsions

- Residue on 600 micron sieve - To determine the amount of bitumen that has formed into bigger globules (Complement to storage stability test)
- Binder content - By distillation / evaporation

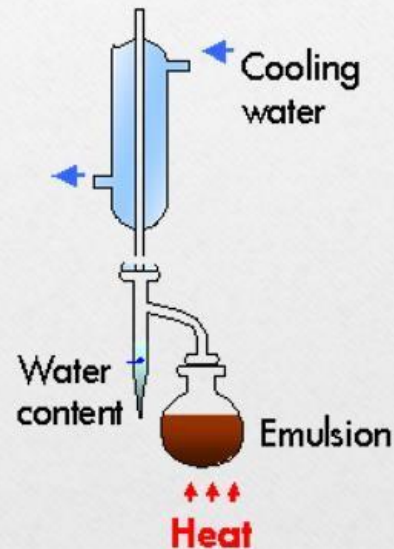
Evaporation method



Oven

50 g / 3 hours @ 163C

Distillation method



Test on Emulsions

- **Miscibility with water: Examine for coagulation**

Significance:

To identify the types of bitumen emulsion i.e. Bitumen in water or water in bitumen.

Principle:

150 ml of distilled water is mixed in 50 ml of bitumen emulsion with constant stirring at room temperature. The mixture is allowed to stand for 2h and examine it for any appreciable coagulation of the bitumen content of the emulsion.

Test on Emulsions

- Particle charge - To determine the nature of emulsions



- Emulsion viscosity - using Saybolt Fural viscometer (25 and 50 degC)



Test on Emulsions

- Test on residue - Penetration test



- Test on residue - Ductility test



BIS 8887 – 2018: Bitumen Emulsions for roads

भारतीय मानक
Indian Standard

IS 8887 : 2018

सड़कों के लिए बिटूमेन पायस
(धनायिक टाईप) — विशिष्टि
(तीसरा पुनरीक्षण)

**Bitumen Emulsion for Roads
(Cationic Type) — Specification**
(*Third Revision*)

ICS 75.140; 93.080.20

Specifications for Bituminous Emulsions

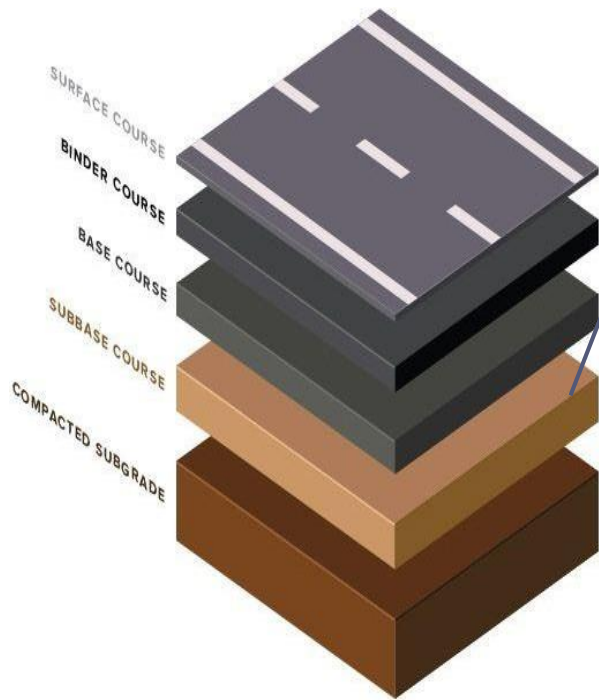
Table 5.1 Physical and Chemical Requirements of Bitumen Emulsion (Cationic Type)
(Clauses 4.2 and 6.2)

Sl No.	Characteristics	Grade of Emulsion					Method of Test	
		RS-1	RS-2	MS	SS-1	SS-2	IS No.	Annex
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	Residue on 600 micron IS Sieve, percent by mass, <i>Max</i>	0.05	0.05	0.05	0.05	0.05	—	B
ii)	Viscosity by saybolt furol viscometer, seconds						3117	—
	1) At 25°C	—	—	—	20-100	30-150		
	2) At 50°C	20-100	100-300	50-300	—	—		
iii)	Coagulation of emulsion at low temperature ¹⁾	Nil	Nil	Nil	Nil	Nil	—	C
iv)	Storage stability after 24 h, percent, <i>Max</i>	2	1	1	2	2	—	D
v)	Particle charge	Positive	Positive	Positive	—	Positive	—	E
vi)	Coating ability and water resistance:						—	F
	1) Coating, dry aggregate	—	—	Good	—	—		
	2) Coating, after spraying	—	—	Fair	—	—		
	3) Coating, wet aggregate	—	—	Fair	—	—		
	4) Coating, after spraying	—	—	Fair	—	—		
vii)	Stability to mixing with cement (% coagulation), <i>Max</i>	—	—	—	—	2	—	G
viii)	Miscibility with water	No Coagulation	No Coagulation	No Coagulation	Immiscible	No Coagulation	—	H
ix)	Tests on residue:							
	1) Residue by evaporation, percent, <i>Min</i>	60	67	65	—	60	—	J
	2) Penetration 25°C/100g/5 sec	80-150	80-150	60-150	—	60-120	1203	—
	3) Ductility 27°C/cm, <i>Min</i>	50	50	50	—	50	1208	—
	4) Solubility I trichloroethylene, percent by mass, <i>Min</i>	98	98	98	98 ²⁾	98	1216	
x)	Distillation in percent volume of distillate recovered at 360°C at						1213	—
	1) 190°C	—	—	—	20-55	—		
	2) 225°C	—	—	—	30-75	—		
	3) 260°C	—	—	—	40-90	—		
	4) 316°C	—	—	—	60-100	—		
	5) Residue at 360°C, percent, <i>Min</i>	—	—	—	50	—		
xi)	Water content, percent by mass, <i>Max</i>	—	—	—	20	—	1211	—

¹⁾ This requirement shall be applicable only under situations where the ambient temperature is below 15°C.

²⁾ The value of solubility is determined on distillation residue at 360°C

Application - Prime coat



**SS1
(Prime)**

Dosage: 0.7 to 0.9 kg/m²

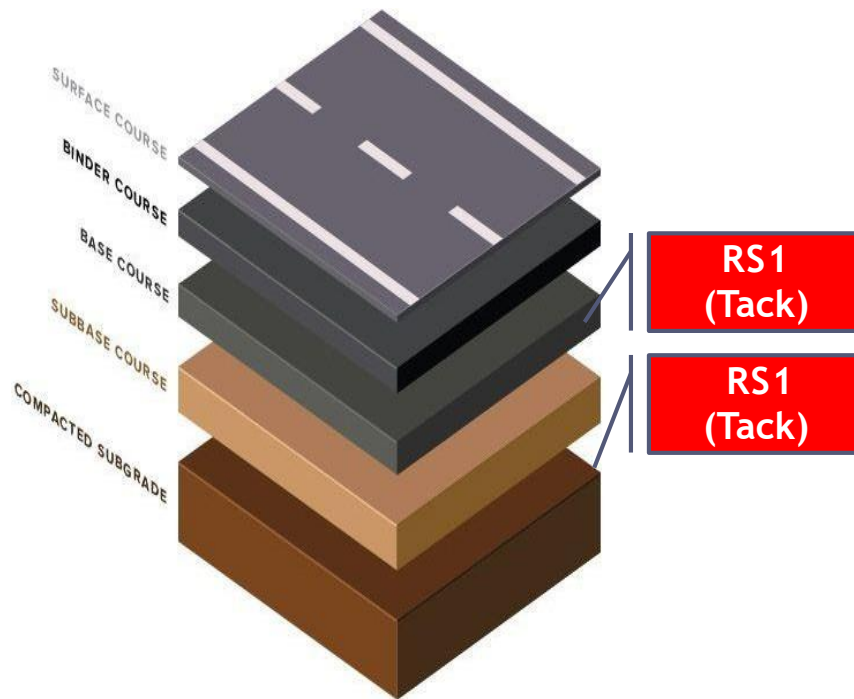


Penetration depth of a
prime coat material

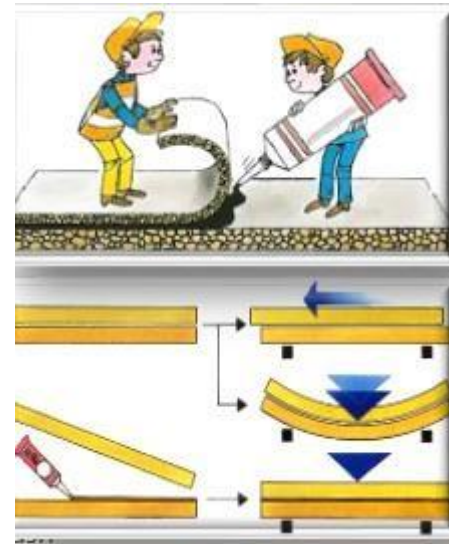


Interfacial bond
strength

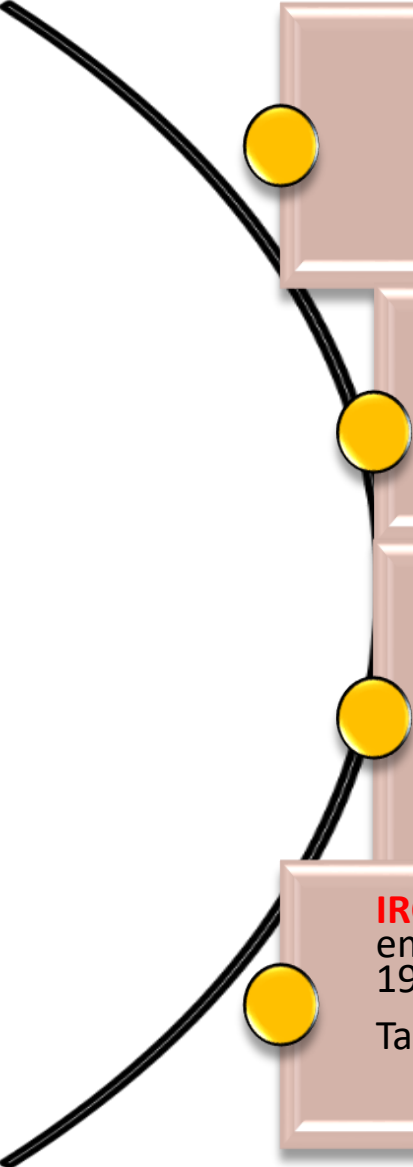
Applications - Tack coat



www.falconsurfacing.co.uk



Dosage: 0.23 - 0.35 kg/m²



MoRTH Section 500, Clause 502: Prime Coat: The primer shall be cationic bitumen emulsion SS1 grade conforming to IS:8887 or medium curing cutback bitumen conforming to IS:217 or as specified in the Contract.

MoRTH Section 500, Clause 503: Tack Coat: The binder used for tack coat shall be either Cationic bitumen emulsion (RS 1) complying with IS:8887

IRC 16 : STANDARD SPECIFICATIONS AND CODE OF PRACTICE FOR PRIME AND TACK COAT The bituminous material to be used as primer should be such that it can penetrate deep into base course (**about 10 mm depth**). Cationic bitumen emulsion **SS-1** grade conforming to IS:8887 shall be used as primer. The binder used for tack coat shall be either Cationic Bitumen Emulsion (**RS- 1**) conforming to IS: 8887

IRC SP 20: Rural Roads Manual: The primer shall be a slow setting bitumen emulsion complying with IS:8887, or medium curing cut-back as per IS:217-1983

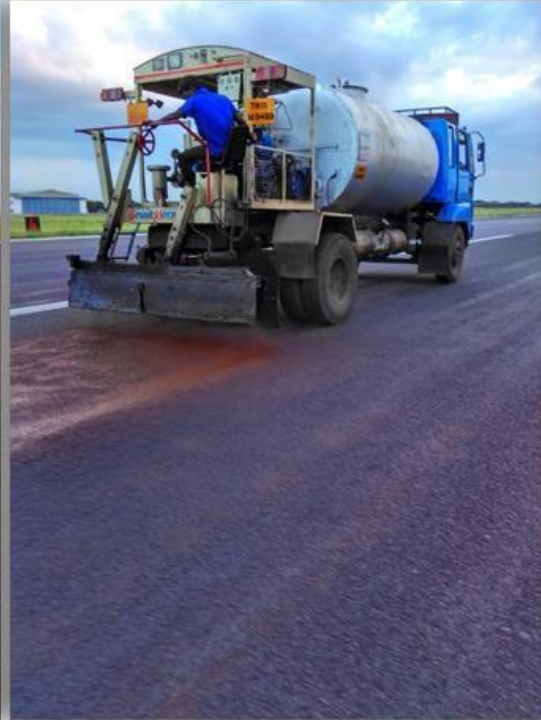
Tack Coat : Rapid or medium or slow setting type emulsion (IS: 8887- 1 995

Applications - Fog seal

Airport References



MES Airport, Jammu
BIAL, Bangalore
DIAL, Delhi



MES Airport, Gwalior
MES Airport, Jodhpur
MES Airport, Kutch



MES Airport, Jalandher
MES Airport, Arakkonam
MIAL & HIAL Airports

Application - Bitumen Stabilized bases



CutBacks

- Cutbacks are low viscosity bitumen
- Viscosity is lowered by means of adding a volatile solvent
- After application the volatile matter escapes away, leaving the required amount of bitumen

Types of cutbacks

- **Depending on the solvent**
 - Rapid Curing (RC)
Naphtha or gasoline as solvent
 - Medium Curing (MC)
Kerosene as solvent
 - Slow curing (SC)
Diesel or lubricating oil as solvent

Classification of Cutbacks

- Depending on initial viscosity of cutbacks (BIS217:1988) at 60 degC, cutbacks are further classified as

Rapid Curing

RC70, RC250, RC800 and RC3000

Medium Curing

MC30, MC70, MC250, MC800 and MC3000

Slow Curing

SC70, SC250, SC800

Application of Cutback

- Rapid curing - with mixes containing no fines
- Medium curing - with aggregates with less than 20% fines
- Slow curing - with aggregates with more than 20% fines

Application of cutbacks is restricted because of environmental reasons