SECTION 95 – BITUMINOUS GROTING (PENETRATION MACADAM)

2216. **General**. Bituminous grouting, although extravagant in binder is a quick and easy method of laying a strong, durable surface, but a sound and well compacted base is essential because, in the event of failure the surface cannot be restored by scarifying and reworking. Either hot binder or emulsion can be used. Two proccesses are available-semi-grout and full grout.

TABLE 22.1 – SURFACE DRESSING WITH HOT BINDERS RECOMMENDED GRADES

Serial No	Type of dressing	Recommended grade*				
		Temperate climates			Tropical or sub tropical climates	
		Bitumen		Road tar	Bitumen	
		UK grades	US grades	Type	UK grades	US grades
(a)	(b)	(c)	(d)	(e)	(f)	(g)
1.	First of double dressing (waterbound macadam and similar) (Serial No 6 and 9 in Table 56	20/30 secs at 40°c or 100/200 secs at 25°c	MC 3 MC 4	24-29°c EVT	50/700 secs at 25°c or 150/300 PEN	RC 2, 3, 4 and 5 MC 3, 4 and 5
2.	Normal dressing (Serial No 1,2,3,5 and 8 in Table 56)	20/60 secs at 40°c or 100/400 secs at 25°c	RC 2 2, 4 ,5 MC 2, 3, 4, 5	29-40°c EVT	50/700 secs at 25°c or 800/300 PEN	RC 2, 3, 4 and 5 MC 3, 4 and 5
3.	Soil priming coat	-	MC 0 MC 1	13-20°c EVT	-	MC 0, 1 and 2
4.	Normal soil dressings (Serial No 4,7 and 10 in Table 56)	20/60 secs at 40°c or 100/400 secs at 25°c	MC 3 MC 4	25-35°c EVT	100/700 secs at 25°c or 150/300 PEN	MC 3 MC 4

*Use lower limits of viscosity for winter laying and whenever using small chippings.
Use upper limits of viscosity for summer laying and whenever using large chippings.

TABLE 22.2-SURFACE DRESSING WITH HOT BINDERS-RECOMMENDED SPRAYING TEMPREATURES

Serial No	Ride	Spraying temperature		Grade	Spraying temperature	
		°F	°C		°F	°C
(a)	(b)	(c)	(d)	(e)	(f)	(g)
	US cut-backs-			straight-run bitumen		
				280/320 OPEN	300-350	150-175
1	MC 0	100 150	35 65	180/200 OPEN	310-360	155-185
2	MC 1	130 175	55 80	80/100 OPEN	330-380	165-195
3	MC 2 RC 2	150 225	65 105			
4	MC 3 RC 3	175 275	80 120			
5	MC 4 RC 4	200 275	95 135			
6	MC 5 RC 5	225 300	105 150			
7	UK cut-backs			UK type A road tars-		

8	20/10 sacs at 40°C	200-250	95-100	13 to 20°C EVT	110-140	45-60
9	40/60 sacs at 40°C	225-275	105-135	20 to 27°C EVT	140-160	60-71
10	50/100 to 00/150 sacs at 25°C	200-250	95-120	27 to 34°C EVT	160-200	71-93
11	150/200 to 200/300 sacs at 25°C	225-275	105-135	34 to 41°C EVT	200-240	93-115
12	300/400 to 500/700 sacs at 25°C	250-300	120-150			

Notes:

1. RC cut-backs should be heated to lower limits.
2. All bitumen's should be heated to lower limits for hand spraying and ie upper limit for tank spraying.
3. Road tar temperatures given are for hand spraying from open tar boilers. If tank spraying is used, temperature for all viscosities should be within the range of 220-280° F (105-140°C).

TABLE 22.3-SURFACE DRESSING (HOT BINDER)-RATES OF APPLICATION

Serial No	chipping		Rate of application of binder			
	Nominal size	Rate of spread	Angular chippings (crushed rock)		Rounded Chippings (gravel)	
	(Ins)	(sq yds/ton)	(sq yds/gal)	(gals/sq yd)	(sq yds/ g-1)	(gals/sq yd)
(a)	(b)	(c)	(d)	(e)	(f)	(g)
	Road tars					
1.	$\frac{3}{4}$	70-80	$3\frac{1}{2}$ -$4\frac{1}{2}$	0.30-0.22	3-4	0.33-0.25
2.	$\frac{1}{2}$	90-100	$4\frac{1}{2}$ -6	0.22-0.17	$3\frac{1}{2}$ -5	0.29-0.20
3.	$\frac{3}{8}$	100-120	$5\frac{1}{2}$ -7	0.18-0.14	$4\frac{1}{2}$ -6	0.22-0.17
4.	$\frac{1}{4}$	140-170	$6\frac{1}{2}$ -8	0.15-0.12	6-5	0.17-0.14
	Bitumen's-					
5.	$\frac{3}{4}$	45-50	3.4	0.33-0.25	$2\frac{1}{2}$ -$3\frac{1}{2}$	0.40-0.30
6.	$\frac{1}{2}$	60-70	$4.5\frac{1}{2}$	0.25-0.18	3-$4\frac{1}{2}$	0.33-0.22
7.	$\frac{3}{8}$	75-95	$4\frac{1}{2}$ -6	0.22-0.17	$3\frac{1}{2}$ -5	0.28-0.20
8.	$\frac{1}{4}$	100-120	5-7	0.20-0.14	$4\frac{1}{2}$ -6	0.22-0.17

Notes –

1. Road tars. In general, the lower limit of binder quantity applies to an existing surface rich in binder: the upper limit to a lean surface.
2. Bitumen's. In general, the lower limits apply to existing bituminous surfaces: the upper limits to untreated surfaces.
3. The use of rounded chippings with a bitumen binder should be avoided if possible.

TABLE 22.4-SURFACE DRESSING (COLD BINDER)- RATES OF APPLICATION

Serial No	chipping		Rate of application of binder			
	Nominal size	Rate of spread	Angular chippings (crushed rock)		Rounded Chippings (gravel)	
	(Ins)	(sq yds/ton)	(sq yds/gal)	(gals/sq yd)	(sq yds/ g-1)	(gals/sq yd)
(a)	(b)	(c)	(d)	(e)	(f)	(g)
	Road tars					
1.	$\frac{1}{2}$	80-110	$3\frac{1}{2}$ -$4\frac{1}{2}$	0.29-0.22	$2\frac{1}{2}$ -$3\frac{1}{2}$	0.40-0.30
2.		120-150		0.25-0.20		0.33-0.25
3.	$\frac{3}{8}$	150-190	3.4	0.20-0.17	3.4	0.25-0.20
4.		180-220	4.5	0.17-0.14	4.5	0.20-0.17
	$\frac{1}{4}$		5-6		5-6	
	$\frac{1}{8}$					

Notes –

1. The emulsion used for this work should be class 1A or 1B Labile. In general class 1A is more suitable for open textured surfaces and for use with the larger chipping.

2. The use of rounded chippings should be avoided if possible.

TABLE 22.5-SURFACE DRESSING-SIZE OF CHIPPINGS

Serial No	Type of surface to which applied	Nominal size of chipping	
		Using hot binders	Using cold emulsion
(a)	(b)	(c)	(d)
1.	Bituminous surface (heavy traffic)-Single surface dressing of second of double dressing	$\frac{3}{4}$-in	$\frac{1}{2}$-in
2.	Bituminous surface (medium traffic)-Single surface dressing of second of double dressing	$\frac{1}{2}$-in	$\frac{3}{8}$-in or $\frac{1}{2}$
3.	Water-bound macadam or concrete-second of double dressing	ditto	ditto
4.	Natural compacted soil-single dressing of second of double dressing		ditto
5.	Bituminous surface (light traffic)	$\frac{3}{8}$-in or $\frac{1}{4}$	$\frac{3}{8}$-in or $\frac{1}{4}$
6.	Water-bound macadam-First dressing	ditto	ditto
7.	Natural compacted soil-First of double dressing	ditto	ditto
8.	Bituminous surface (medium and heavy traffic) open textured surface-First of double dressing	$\frac{1}{4}$	ditto

9.	Concrete-First dressing	ditto	$\frac{1}{8}$ - in
10.	Stabilized soil	ditto	$\frac{1}{8}$ - in or $\frac{1}{4}$

*For roads carrying heavy traffic and using cold emulsion as a binder, two dressings should be carried out using $\frac{1}{2}$ in chippings. An interval of 2 to 3 months should elapse between dressings.

TABLE 22.6-SURFACE DRASSING-PROCEDURE

Serial No	Operation	Normal method, using hot binder	Cold process, using emulsion	Remark
(a)	(b)	(c)	(d)	(e)
1.	Preparation of site	Reshape irregularities and repair potholes. Sweep off organic matter and loose stones. On stabilized or compacted soil apply in correct proportions	As in column (c). A very dry surface may have to be "damped" to ensure proper penetration	

2.	Preparation of material	Heat binder of appropriate grade to correct temperature (see Table 22.2). Use dry chippings of correct size (see Table 22.5). Organize regular supply in correct proportions.	Binder does not require heating. Dampness of chippings does not affect results.	See Para 501 for use of coating agents with damp stone (hot binder method)
3.	Application of binder	Tanker sprayers give more even distribution and better output than hand spraying. Rates of application are given in Table 22.3. Check rate of spread over a measured area.	Vacuum or pressure pumps give excellent results, but mechanical pumping causes premature breaking. I hand spreading. Pour emulsion direct from containers or cans and brush in one direction only. Rates of application are given in Table 22.4.	See Para 502 for notes on control of spraying.
4.	Application of chipping	Spread as evenly as possible immediately after applying binder. Time lag should not exceed 10 mins in temperate climates. Rates of application are given in Table 22.3.	(a) Normal chippings ($\frac{1}{4}$ - in and up).-Spread before emulsion starts to break) (b) Coarse sand, or chippings with a high proportion of fines.-Allow	

			braking to start before spreading. Rates of application are given in Table 22.4	
5.	Rolling	Aim is to press chippings into binder without crushing them. Use smooth wheel or pneumatic-tired roller of not more than 6 tons weight. Consolidation by traffic is also possible after initial adhesion has occurred, but acceleration and sharp braking must be prevented	As in column (c). Roll as soon as possible after breaking of emulsion is complete	

2217. Tools and plant. - Work can be done with a minimum of tools and plant; especially if emulsion is used. Requirements are: -

a. Bitumen heater (hot binder process only).
b. Binder sprayer, either mechanical or hand-operated. If necessary, watering cans can be used.
c. Water sprayer (semi-grout process only).
d. Smooth-wheel roller, 6 to 10 tons.
e. Shovels, stone forks, rakes.

2218. Specifications. - The effects of correct and incorrect penetration are illustrated in Figure 45.

Recommended aggregate grading and application for binder are summarized in Table 58. Recommended types and viscosities of binder are given in Table 59.

2219. Semi-grout process. -The procedure is:

a. Spread a $\frac{1}{2}$ inch layer of sand or stone dust over the base.
b. Spread aggregate to the required thickness and camber allowing for compaction.
c. Roll to produce water bound bottom layer in the surfacing applying enough water to enable the fine material on the base to form a slurry and to work up into the interstices in the aggregate. They should be filled to within $\frac{1}{3}$ 1 inch from the top surface.
d. Make good any depressions.
e. When the surface is firm, apply binder at the required rate, either by pressure sprayer of from watering cans. If a hot binder is used the aggregate must be allowed to dry out. A wet surface is preferable when using emulsion.
f. Immediately after applying the binder, blind the surface with chippings.
g. Complete compaction.
h. When the surface has cured and hardened, apply a sealing coat or surface dressing.

2220. Full grout process. - The procedure is exactly the same as for the semi-grout process, except that no water is used and that the initial rolling (see Para 507 (c)) Is limited to one or two passes. As the grout has to penetrate the full

depth of the surfacing a more fluid binder is desirable and a greater quantity is required. Emulsion is commonly used. In this process the function of the $\frac{1}{2}$ inch layer of fine material on the base is to prevent the bind escaping into the base.

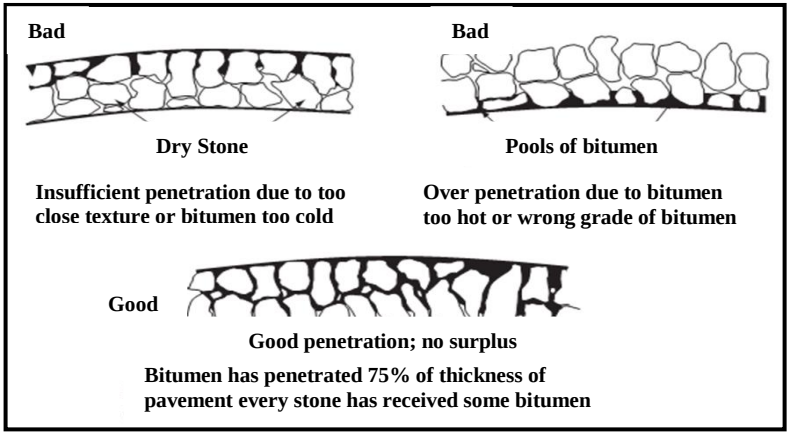

Figure 22-2: Correct and Incorrect Grouting

TABLE 22.7 BITUMINOUS GROUTING-GRADING AND RATES OF APPLICATON

Serial no	Thickness of surfacing	Aggregate grading		Rate of application of binder		Rate of application of sealing coat		
		Sieve size	Percentage by weight passing	Semi grout (gals/ sq yd)	Full Grout (gals/ sq yd)	Chippings		Binder
						Nominal size (ins)	Rate (sq yds/ tion)	Rate (sq yds/ gal)
1.	Hot binders -							
	3 ins	2 in	100	1 to 1 ½	1 ½ to 2	¾	120 to 180	4 to 6
		1 ½ in	40			½	100 to 150	3 to 5
		¾ in	10					
2.	2 ½ ins	2 in	100	¾ to	1 ¼	¾	120	4 to 6

				1 ¼	to 1 ¾		to 180	
		1 ½ in	40			½	100 to 150	3 to 5
		¾ in	10					
3.	2 ins	1 ½ in	100	½ to 1	1 to 1 ½	¾	120 to 180	4 to 6
		1 in	40			½	100 to 150	3 to 5
		1/3 in	10					
Cold binder (bitumen emulsion)								
4.	3 ins	2 in	60	1 to 1½	1 ½ to 2	½	120 to 150	4 to 5
		1 ½ in	30				80 to 110	3 ½ to 4 ½
		¾ in	10					
5.	2 ½ ins	2 in	60	¾ to 1 ¼	1 to 1 ¼	3/8	120 to 150	4 to 5
		1 ½ in	30			½	80 to 110	3 ½ to 4 ½
		¾ in	10					
6.	2 ½ ins	2 in	60	½ to 1	1 ¼ to 1 ¾	3/8	120 to 150	4 to 5
		1in	30			½	80 to 110	3 ½ to 4 ½
		1/3 in	10					
		¾ in						

Notes: (i) All bitumen's should be heated to lower limits for hand spraying and to upper limits for tank spraying.

(ii) RC cut-backs should be heated to lower limits.

(iii) For hand spraying from open tar boilers. If tank spraying is used, temperatures for all viscosities should be within the range of 220-280 F (105-140 C).

TABLE-22.8- BINDER FOR BITUMINOUS GROUTING

Sarial No	Climatic conditions	Season	Bitumen (i)					Road tar			Bitumen emulsion	
			UK grades Available in UK STV at 40 0C	Avallable abroad STV at 250C	US grades Desig-nation	Straight run PEN at 25^0C	Tempe-ratute of applica-tion (i), (ii)	Type	Visco-sity	Temper-ature of application (iii)	Type	Grade
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(k)	(l)	(m)	(n)
1	Moderate climates-NW Europe, etc	Winter	20/60	100/400	MC 4	-	110-125^{0}C (230-257^{0}F	A	27-30^{0}C EVT	75-95^{0}C (167-203^{0}F)	Not recom-mended	-
2	ditto	Summer	80/240	500/1125	MC-5	-	110-125^{0}C (230-	A	33-35^{0}C EVT	75-95^{0}C (167-203^{0}F)	Labile	

							257^{0}F					
						100/500	170-190^{0}C (338-374^{0}F					Class IA or Class IB
3.	Extreme con-ditions-Northern Europe, etc	Winter	20/30	100/150	RC 4	-	110-125^{0}C (230-275^{0}F	A if avail-able	27-30^{0}C EVT	75-95^{0}C (167-203^{0}F)	No reco-mmen-ded	-
4	ditto	Summer	-	-	-	40/70	170-190^{0}C (338-374^{0}F	A if avail-able	40-50^{0}C EVT	100-110^{0}C (112-203^{0}F)	Labile	Class IA Class IB

5	Tropical and sud-tropical areas-Middle and Far East, etc	All Year	-	300/1125	MC-5	-	110-125^{0}C (230-257^{0}F	A if avail-able	40-50^{0}C EVT	100-110^{0}C (212-230^{0}E)	Labile	Class IA
						30/100	170-190^{0}C (338-374^{0}F					Class IB

Notes :- (i) All bitumens should be heated to lower Iimits for hand spraying, and to upper limits for tank spraying.
(ii) RC cut-backs should be heated to lower limits.
(iii) For hand spraying from open tar boilers, If tank spraying is used, temperatures for all viscosities should be within the range of 220-280^{0}F (105-140^{0}C)