

CHART W  
Temperature weighting curve

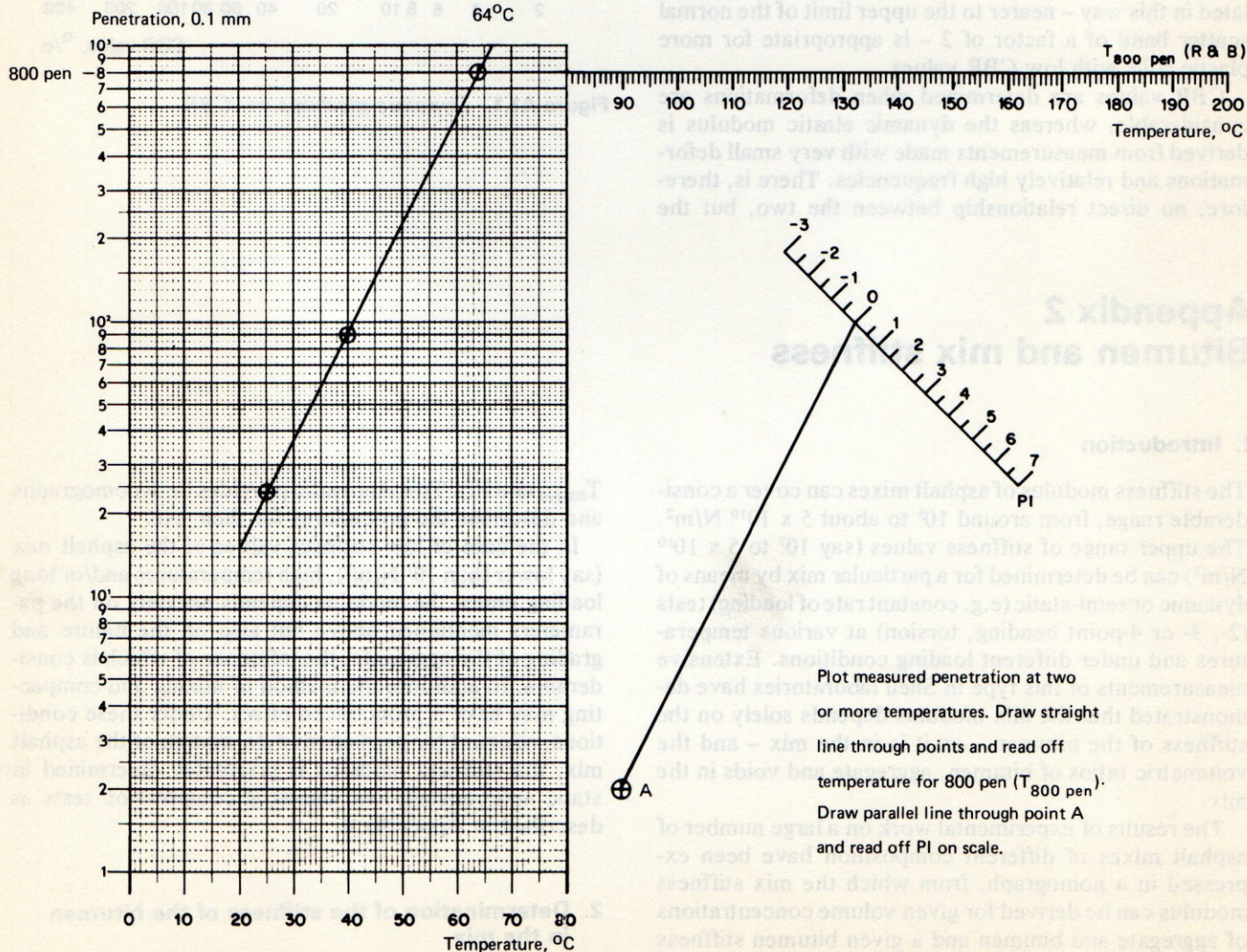


Figure A2.2. Determination of  $T_{800 \text{ pen}}$  and PI

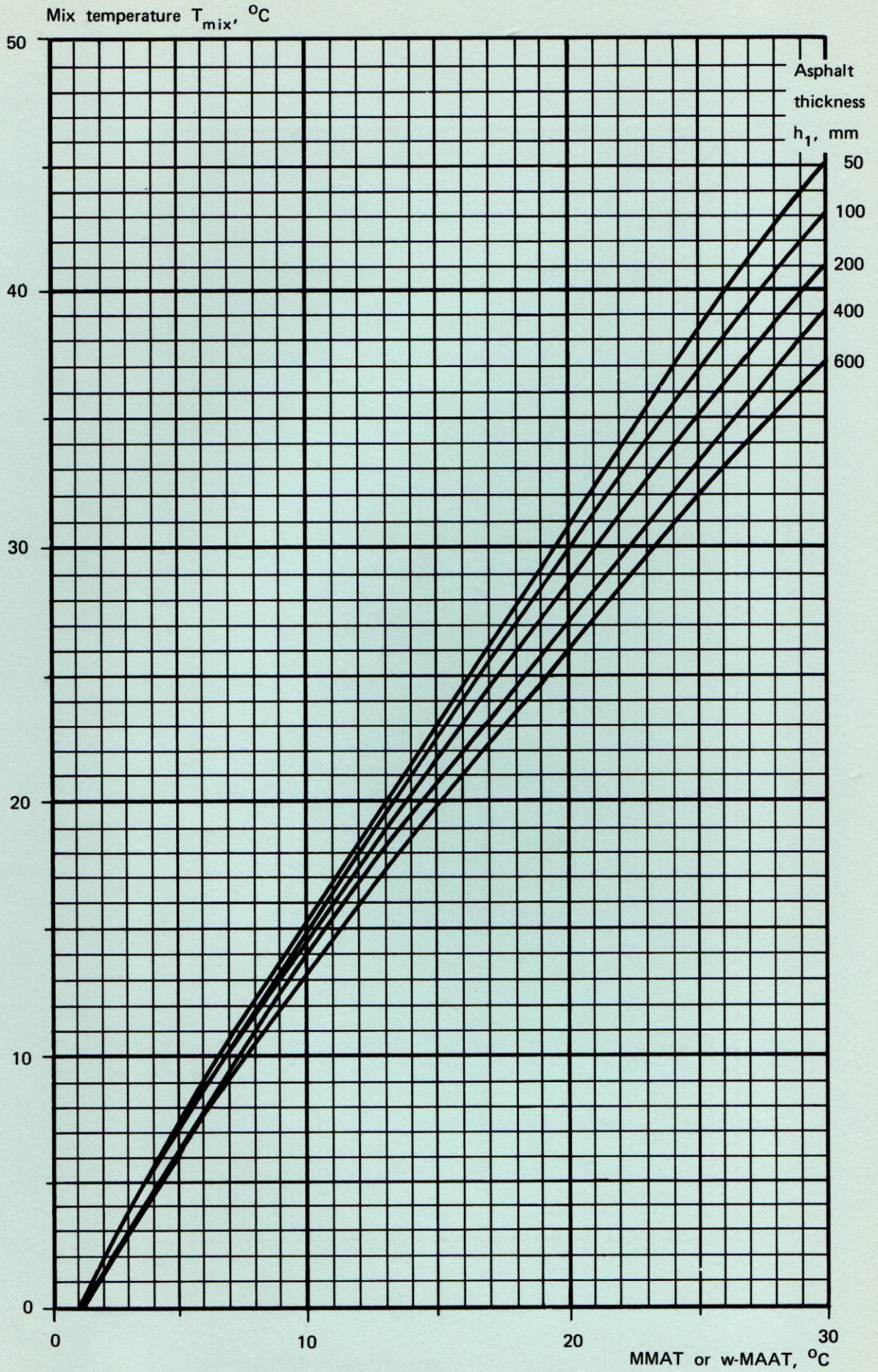
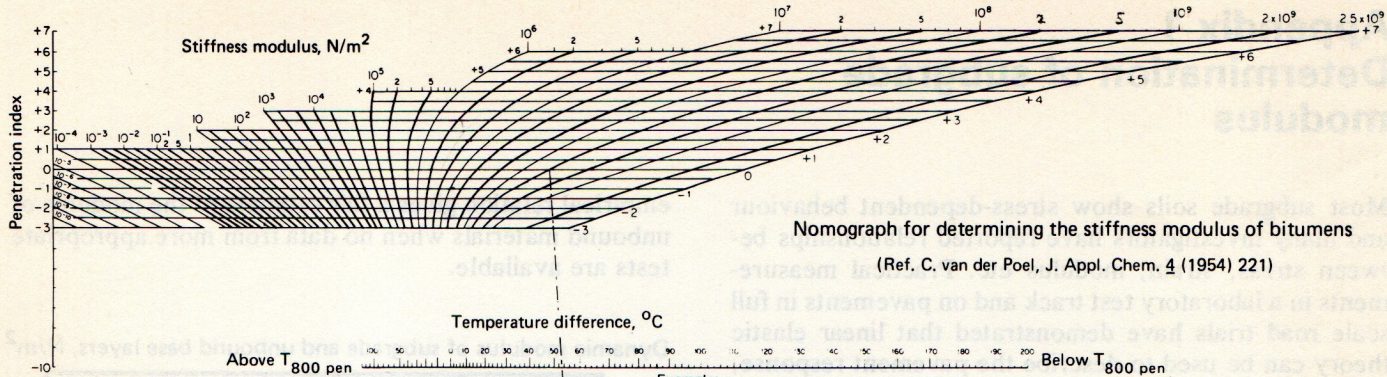


CHART RT

Relationship between effective asphalt temperature and MMAT or w-MAAT



Nomograph for determining the stiffness modulus of bitumens

(Ref. C. van der Poel, J. Appl. Chem. 4 (1954) 221)

The stiffness modulus, defined as the ratio  $\sigma/\epsilon = \text{stress/strain}$ , is a function of time of loading (frequency), temperature difference with  $T_{800 \text{ pen}}$  and PI.

$T_{800 \text{ pen}}$  is the temperature at which the penetration would be 800.

This is obtained by extrapolating the experimental log penetration versus temperature line to the penetration value 800.

At low temperatures and/or high frequencies the stiffness modulus of all bitumens asymptotes to a limit of approx.  $3 \times 10^9 \text{ N/m}^2$

Units:

$$1 \text{ N/m}^2 = 10 \text{ dyn/cm}^2 = 1.02 \times 10^{-5} \text{ kgf/cm}^2 = 1.45 \times 10^{-4} \text{ lb/sq. in.}$$

$$1 \text{ N s/m}^2 = 10 \text{ P}$$

Example:

Operating conditions

Temperature : 11 °C

Loading time : 0.02 seconds

Characteristics of the bitumen in the mix

$T_{800 \text{ pen}}$  temperature at which the penetration

is 800 0.1 mm : 64 °C

PI, penetration index : 0

Connect 0.02 s on time scale with temperature

difference  $64 - 11$  °C on temperature scale.

Record stiffness on grid at PI = 0

The stiffness of the bitumen determined with this nomograph is

$$S_{\text{bit}} = 2.0 \times 10^8 \text{ N/m}^2$$

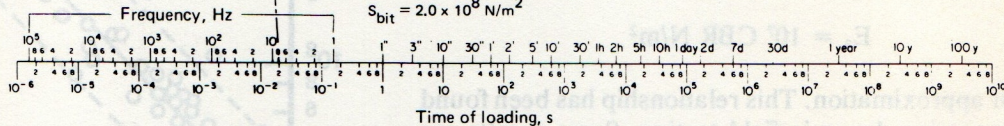
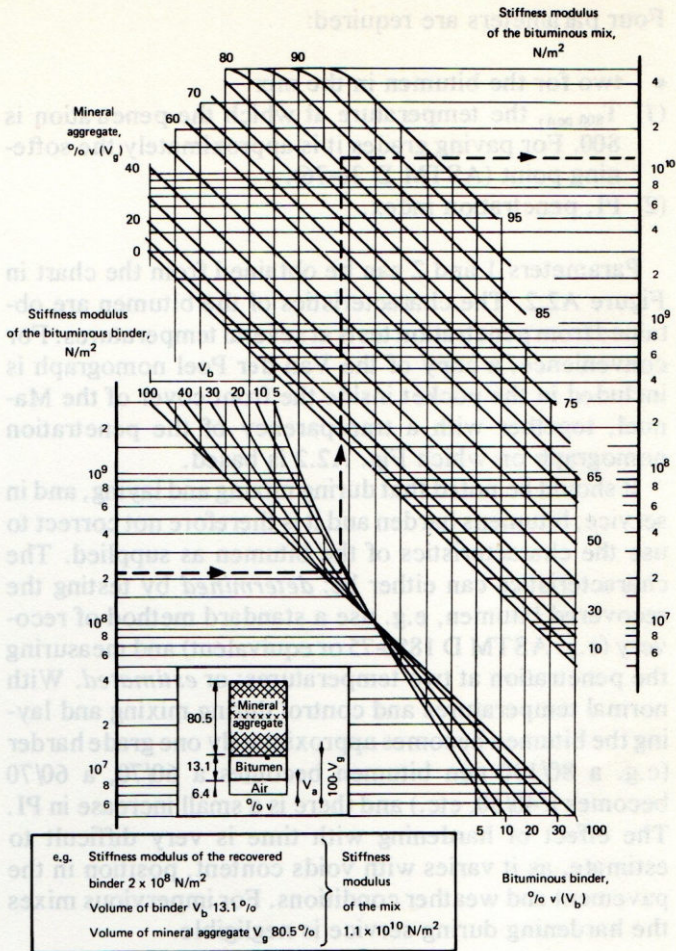


Figure A2.1. Van der Poel nomograph for bitumen stiffness



**Figure A2.3.** *Nomograph for mix stiffness*

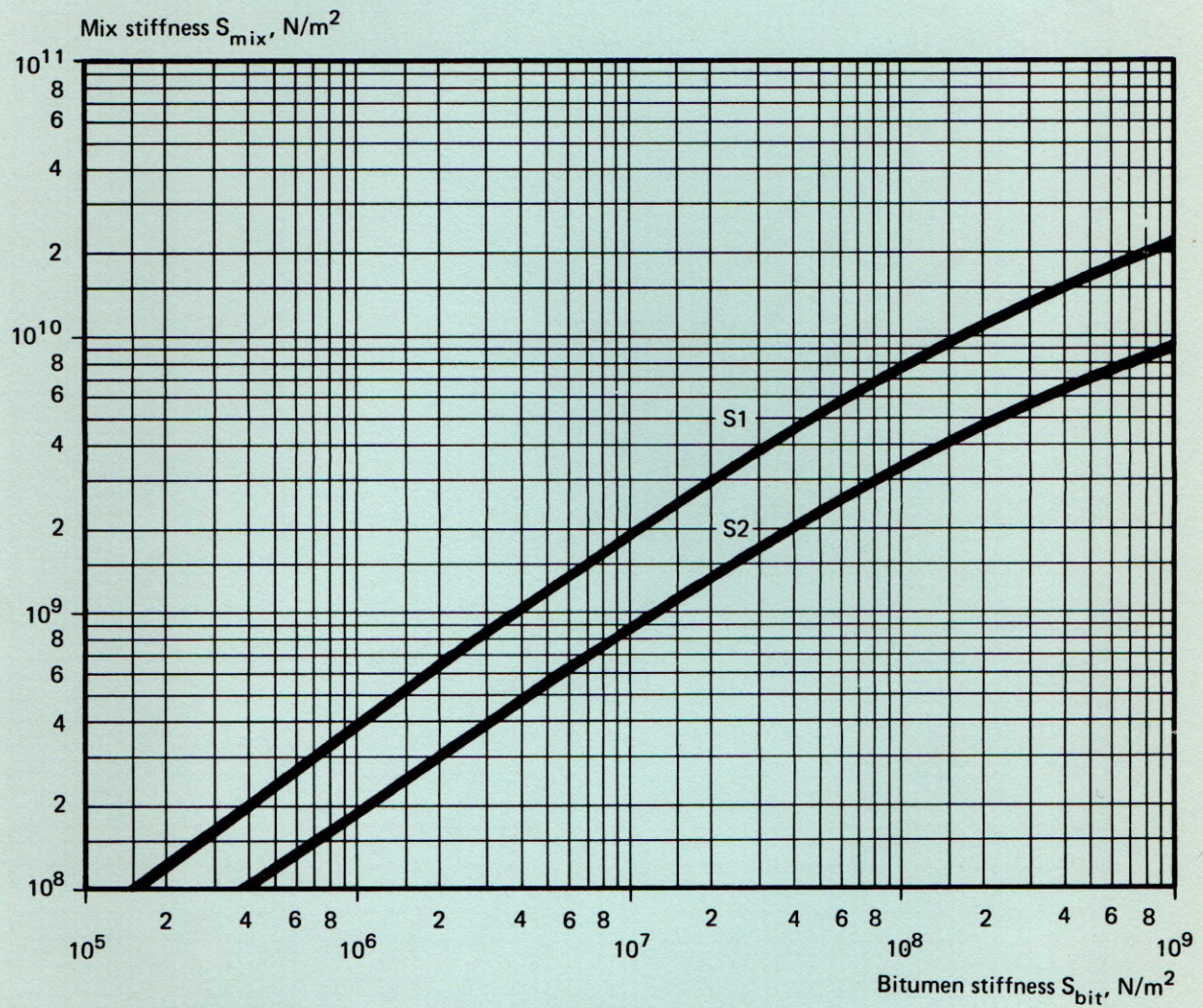


CHART M-1

Characteristic relationships between mix stiffness and bitumen stiffness

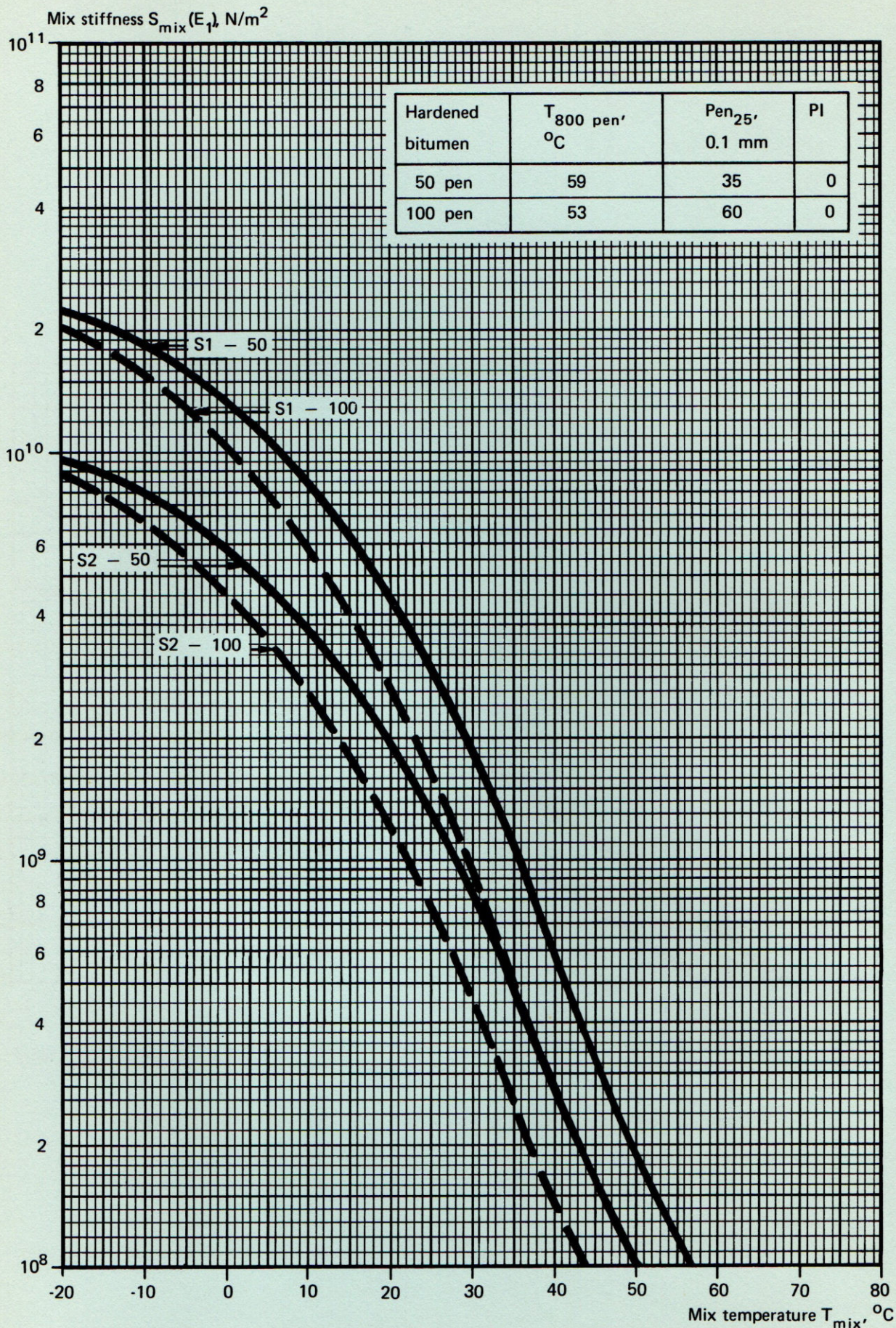
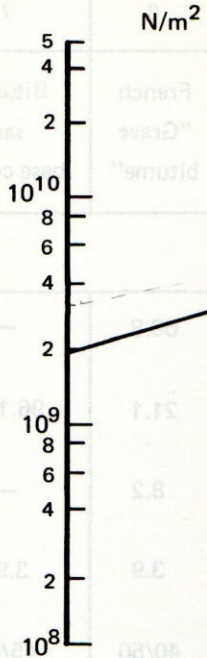


CHART M-2

Characteristic relationships between mix stiffness and mix temperature

Loading time 0.02 s

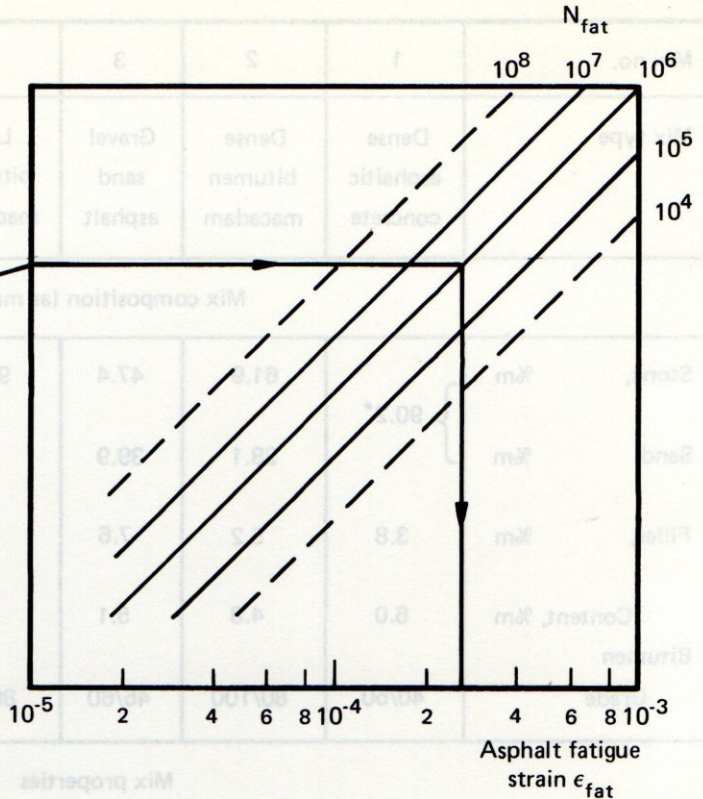
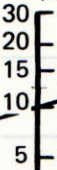
Stiffness modulus of the mix  $S_{mix}$



Volume of bitumen

in mix  $V_b$ , %

o/o



Example: If  $S_{mix} = 2 \times 10^9$  N/m<sup>2</sup>  
 $V_b = 10\%$   
 $N = 10^6$   
 then  $\epsilon_{fat} = 2.7 \times 10^{-4}$

Figure A3.1. Fatigue nomograph based on  $S_{mix}$  and  $V_b$



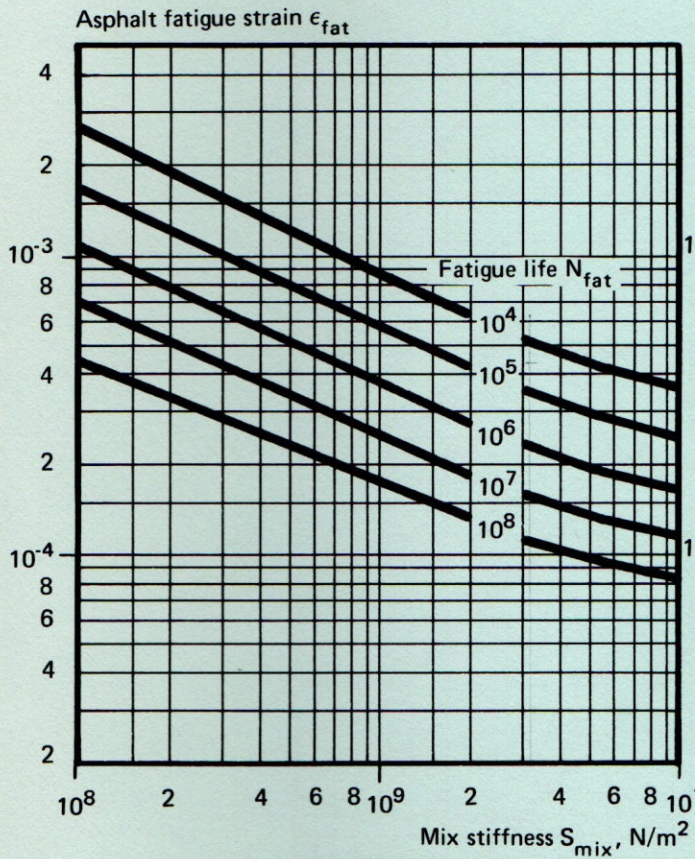


CHART M-3

Asphalt fatigue characteristics F1

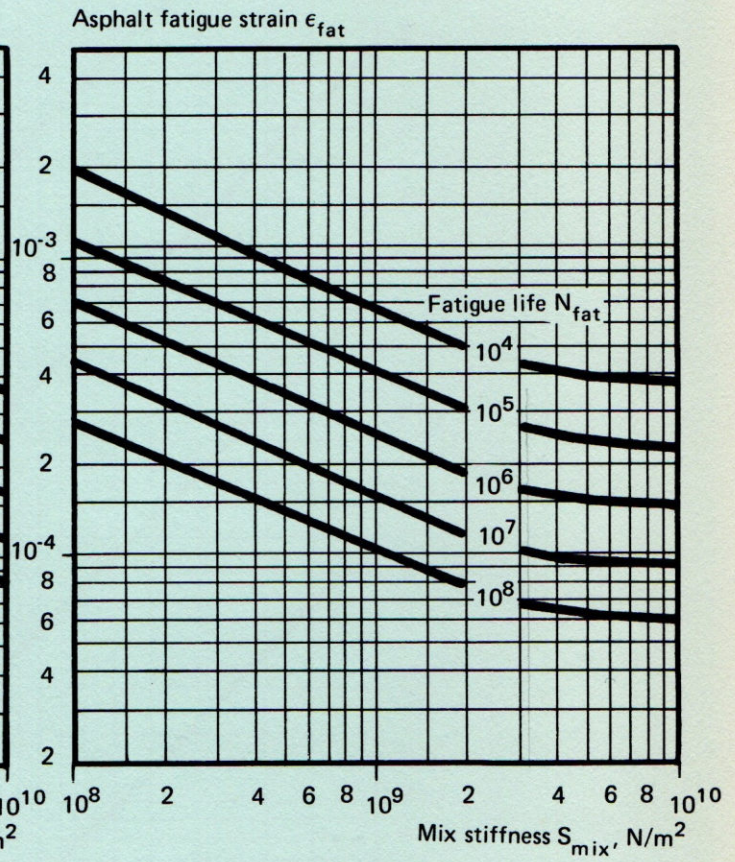


CHART M-4

Asphalt fatigue characteristics F2

# Index to Charts HN

$h_1$  versus  $h_2$ : variable N

Subgrade modulus $E_3$ ,  $N/m^2$	w-MAAT,  $^{\circ}C$	Mix code							
		50 pen Bitumen				100 pen Bitumen			
		S1 - F1 - 50	S1 - F2 - 50	S2 - F1 - 50	S2 - F2 - 50	S1 - F1 - 100	S1 - F2 - 100	S2 - F1 - 100	S2 - F2 - 100
$2.5 \times 10^7$	4	1	2	3	4	5	6	7	8
	12	9	10	11	12	13	14	15	16
	20	17	18	19	20	21	22	23	24
	28	25	26	27	28	29	30	31	32
$5 \times 10^7$	4	33	34	35	36	37	38	39	40
	12	41	42	43	44	45	46	47	48
	20	49	50	51	52	53	54	55	56
	28	57	58	59	60	61	62	63	64
$10^8$	4	65	66	67	68	69	70	71	72
	12	73	74	75	76	77	78	79	80
	20	81	82	83	84	85	86	87	88
	28	89	90	91	92	93	94	95	96
$2 \times 10^8$	4	97	98	99	100	101	102	103	104
	12	105	106	107	108	109	110	111	112
	20	113	114	115	116	117	118	119	120
	28	121	122	123	124	125	126	127	128