The analytical design of bituminous pavements

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Mr D. J. Gregg, *Middlesex Polytechnic*

For the purpose of setting equitable taxation charges for heavy lorries, consideration of local temperatures and seasonal usage patterns could indicate certain circumstances in which a general average assessment is extremely unfair. For example, tippers operated by beet farmers in the Central Zone (who are intensively active in the winter months) might, in principle, expect to be less heavily taxed than similar vehicles operated by the construction industry in the Southern Zone. If the relative severity of road damage were to be taken into consideration by the Courts in overloading cases,⁴⁹ the offence of overloading would be treated less severely in winter than in summer.

Mr R. C. Koole, *Shell International Petroleum Company Limited, London*, and
Mr A. H. Gerritsen, *Koninklijke/Shell Laboratorium, Amsterdam*

Results of pavement designs on the basis of procedures described in this Paper are compared with, among others, those of the Shell Pavement Design Manual (SPDM),⁹ published in 1978. The Authors note that SPDM designs tend to require much thinner asphalt thicknesses than either a 'Road Note No. 29' design or an ANPAD design.

64. In this respect, it is of interest to report that, over the past eighteen months, Shell Research has carried out a review of the Shell Pavement Design Manual. In this review, the results of numerous analytical pavement evaluations on the basis of dynamic deflection measurements have played an important role. The main conclusions of this review are that the design charts in the SPDM are entirely valid, provided that the entry parameters (climate, traffic loading, sub-base and subgrade moduli, asphalt stiffness and fatigue characterization) are valid. However, the design charts are based on average relationships for the subgrade strain criterion and the sub-base modulus. Experience has shown that conservatism in this respect may be appropriate to obtain higher confidence levels in respect of service-life expectancy.

65. Later this year, Shell will publish an Addendum to the SPDM of 1978. This Addendum, which will be mailed to past and future recipients of the SPDM, will give explicit information on how to introduce this higher confidence level in the design charts. Furthermore, publications are currently being prepared that will report relevant background information.

66. To give an indication of the effect which the procedures recommended in the Addendum will have on SPDM designs, Table 8 of the Paper by Brown *et al.* is reproduced as Table 9, with additional data in respect of designs based on the SPDM with 50% (a straightforward SPDM design), 85% and 95% confidence levels.

Table 9. Comparison of required base thickness for each design method

Subgrade CBR, %	Life, msa	Sub-base thickness, mm	Total asphalt thickness, mm								
			Road Note No. 29		ANPAD		Shell Pavement Design Manual				
							S1-F2-50	S1-F2-100	S2-F2-50	S2-F2-100	Confidence level, %
5	1	210	HRA base 150	DBM base 160	HRA base 150	DBM base 170	100 130 140	130 170 190	150 190	170 210	50 85 95
	10	260	220	240	220	310	160 190 210	200 240 260	240 280	250 300	50 85 95
	100	310	320	370	310	490	230 260	280 330	320 360	350 430	50 85
2.5	1	380	150	160	160	180	110 140 160	150 180 230	190 230	210 240	50 85 95
	10	460	220	240	240	320	170 200 230	230 260 310	270 310	300 330	50 85 95
	100	540	320	370	350	510	250 300	310 350	370 400	400 440	50 85 95

67. Emphasis is placed on the asphalt mix characterization S1 and F2 which, as mentioned in the Paper, best characterize the HRA and DBM.

Professor Brown, Dr Brunton and Dr Stock

We were interested to note the comments made by *Mr D. J. Gregg* concerning the adjustment of taxation charges for heavy vehicles and court fines for overloading offences to take account of local temperatures and seasonal uses. However, we consider that as other factors—such as speed of loading, pavement construction, materials and thicknesses—also effect the relative damage occurring, it seems unreasonable to make adjustments only for temperature.

69. With regard to the level of confidence in the service life expectancy, we appreciate the useful additional information provided in Table 9 of the discussion by *Mr R. C. Koole* and *Mr A. H. Gerritsen*. While we note the differences in base thickness generated by the range of confidence levels, we believe that the design methods can still best be compared for the 50% confidence level. Road Note 29 was for an approximately 60% confidence level and ANPAD for 50–60%. One reason for our designs requiring additional base thicknesses may be that, in the Shell Design Manual, the weighted mean annual air temperature recommended for London (12°C) is too low. The Nottingham designs, used in the comparison, adopted pavement design temperatures of 14°C and 18·2°C for deformation and fatigue respectively; while the new methods for pavement design, proposed by the TRRL in LR 1132,⁵⁰ recommend a pavement design temperature of 20°C as appropriate for the UK.

70. We are particularly pleased to note that Shell, in the recent review of their design manual, have shown that the latter gives valid designs, provided that the entry parameters are valid. However, the main problem in using their manual in the UK remains the classification (S1 or S2 and F1 or F2) of typical British materials.

References

49. GREGG D. J. Tonnes of trouble: why the highway authorities want tougher weight enforcement. *Justice of the Peace*, 1982, **146**, March 13, No. 11, 162.
50. POWELL W. D. *et al.* The structural design of bituminous roads. Transport and Road Research Laboratory, Crowthorne, 1984, LR 1132.