In the case of the 35/50 bitumen, the differences in behavior have been made noticeable at lower rates with an elastomer polymer. Most of the modified binders have been made through cross-linking (Styeder) but some equivalent simple physical blends (PB) have also been made. All the binder tests reported in the text have been obtained on unaged binders. A closer insight into the impact of aging is presented in §4.13.

Experimental results – modified bitumen

TSRST versus «binder failure tests»

The Fraass test seems unable to reflect the differences evidenced by TSRST between bitumen of the same penetration grade (35/50) but of different origins. Although results were only available for origins A and C, the ABCD failure temperatures tend to be better in line with the TSRST fracture temperatures.

The ABCD test conditions being as close as possible to those applied in the TSRST, it is quite encouraging to find a certain relationship between both tests. Also the fact that ABCD failure temperatures tend to be more “optimalistic” than TSRST failure temperatures seems logical considering the much thinner and more heterogeneous distributed binder film in the asphalt test sample, leading to higher stress concentrations at micro-level than in the ABCD test sample. The cooling rate in the Fraass test (1°C/min) is much quicker than in the TSRST and ABCD tests (10°C/h). The test is also performed on a thin film which is expectedly friable (fatigue component) and failure not always coincides with crack initiation whereas in TSRST and ABCD there is a certain crack propagation time. These considerations could explain why Fraass breaking temperatures are much higher and not well correlated to TSRST and ABCD failure temperatures.

TSRST versus BBR characteristics

When modifying with a cross-linked elastomer, the Tfraass,10°C, temperature changes in a monotonous way with increasing polymer content (in general at a slower rate than the corresponding TSRST temperature). The BBR test did thus not reflect the optimum value at 3.5% polymer content obtained in the TSRST. As in TSRST, BBR data do not show any improvement over the base bitumen for the physical blends at 3.5% polymer. With regard to Tfraass,10°C there is almost no impact of polymer addition on the measured values that, at least for the investigated binders, this criterion seems to be essentially controlled by the base bitumen.

These different evolutions of the TSRST and BBR critical temperatures explain that there cannot be a unique correlation between these two characteristics. At the best, such correlations are “families of products” such as, in the case of this study, the family of cross-linked binders at 3.5% of polymer content (although this correlation seems to be relatively poor). The fact that (the “family” of) cross-linked binders at 5% polymer content happens to be on the same line as the pure bitumen is only a coincidence due to the fact that Tfraass,10°C continuously decreases with polymer content while the TSRST fracture temperatures rise after the minimum at 3.5% polymer content. Considering the small evolution of m-values with polymer content, there is of course no likelihood to find a relation between Tfraass,10°C and TSRST fracture temperatures obtained at different polymer contents.

Conclusions

○ The stiffness characteristics measured by the BBR test can only be related to TSRST performance through correlation. Such a relationship can however not be universal and has to established per group of products showing a similar behaviour, such as for instance pure bitumen or modified bitumen of a same “family”.

○ Although Fraass measures a failure characteristic, it appears as being particularly severe and thus prone to eliminate binders which show a satisfactory TSRST behaviour. Its known lack of precision and difficult operating (in particular with modified binders) is a further handicap for this method.

○ The ABCD test seems more reliable from an operational point of view. Contrarily to Fraass, it tends however to be too optimistic and, also here, the relationship to TSRST is dependent on the type of binder.