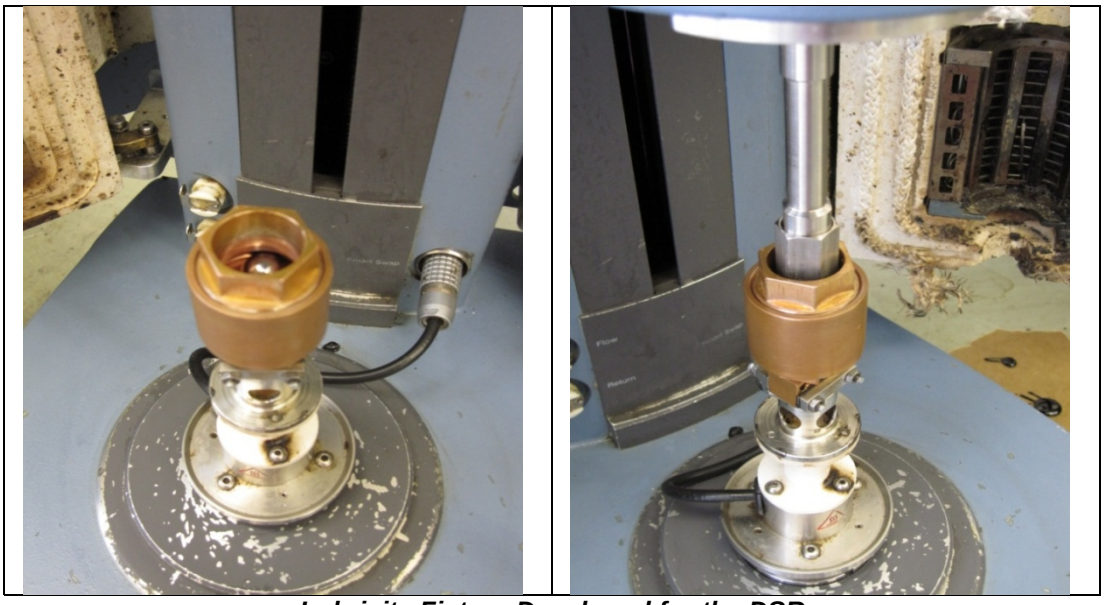
Asphalt Lubricity Test

Environmental initiatives and a renewed focus on sustainability have prompted continued development of warm mix asphalt (WMA) technologies involving additives and processes. The success of field trials has prompted the development of mix design procedures and specifications to allow state agencies to take advantage of these technologies. A major impediment to the implementation of WMA is the lack of procedures to evaluate the impacts of WMA technologies on asphalt binder and mixture workability.

Specifically, the effects of WMA additives on asphalt binder viscosity were not consistent with the enhanced workability observed in the field. This observation led to the concept that the WMA additives promoted compaction at lower temperatures by enhancing the lubricating properties of the asphalt binder.

After an extensive literature review, a new test methodology for measuring the internal friction coefficient of the asphalt using a specially developed fixture in the DSR was introduced. The test is based on a standard method provided in ASTM D5183-05 meant for evaluating the friction and wear properties of lubricating oils. In application to asphalt, the concept is that at production temperatures the asphalt acts as a lubricant and that measuring internal friction coefficient (lubricity) allows assessment of the lubricating effects of warm mix additives.



Lubricity Fixture Developed for the DSR

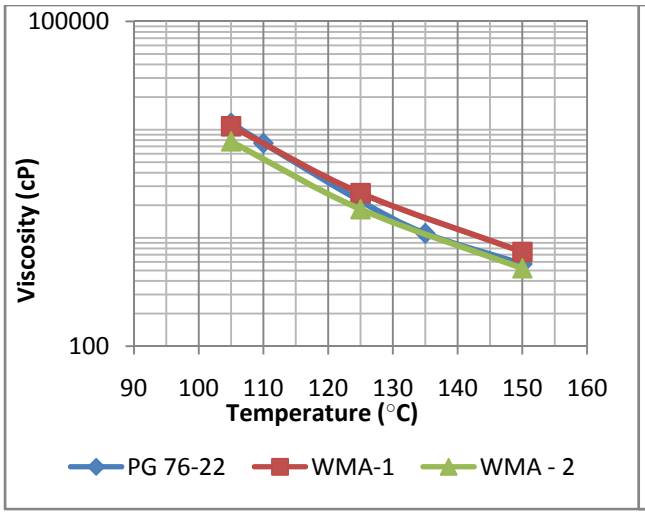
The apparatus consists of three lower balls clamped in a cup; a fourth ball held in a chuck is loaded against them, a sufficient amount of lubricant is added to produce a film between the chuck and clamped assembly. The chuck is rotated in one direction with resistance provided by the fixed balls in the cup below. Testing is conducted at temperatures from 90℃ – 135℃. The selection of this range was based on conventional compaction temperatures for HMA and WMA. Before the test, the distance between the surface of the clamped balls and chuck is decreased until a normal force of 15 Newton's is established. During the test, the normal force and torque required to rotate the chuck are monitored under constant speed and temperature. The coefficient of friction is then calculated using the relationship between the normal force, applied torque, and a constant related to the geometry of the apparatus.

Preliminary results indicate that the test method is repeatable and sensitive enough to detect changes in binder type or the presence of WMA additives. Relative to the conventional binder evaluated, the WMA additives demonstrate significantly reduced temperature sensitivity and enhanced lubrication at lower temperatures. These findings are consistent with mixture workability taken from data collected during gyratory compaction on a fine graded mixture. Conversely, the conventional asphalt binder viscosity test is unable to differentiate between conventional binders and those containing WMA. Although additional testing on a wider range of materials is needed, these initial results confirm that the lubricity of the asphalt binder is an additional mechanism by which the asphalt binder promotes mixture workability.

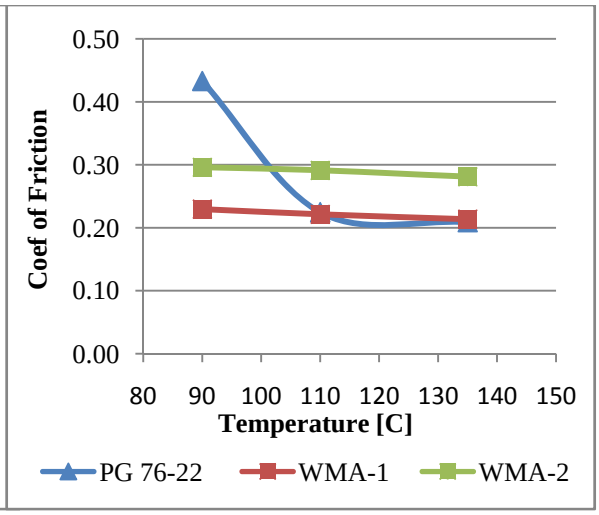
"Viscosity reduction is not the only mechanism by which warm mix additives allow for compaction at reduced temperatures. Internal coefficient of friction is a key mechanism that contributes to the effects of WMA additives on mixture workability."

Andrew Hanz, Task Leader for Warm Mix work element E1c-1

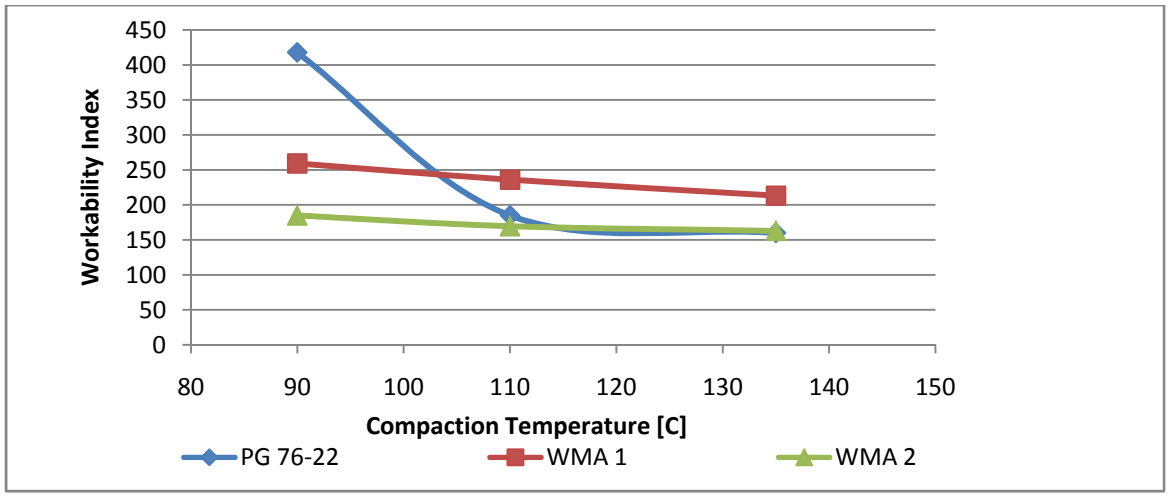
Conventional Test – Binder Viscosity



Proposed Lubricity Test



Comparison to Mixture Workability



The final objective of this research is to provide a standard test method to assess the lubricating properties of asphalt binders. Developing the final procedure involves defining both the appropriate speeds and temperatures at which to run the test and establishing its repeatability and reproducibility according to ASTM guidelines. The final procedure will be used to evaluate the effects of WMA additives in more detail; specifically, a wider range of WMA additives will be incorporated and the experimental matrix expanded to include evaluation of the effects of concentration and aging.