

# Performance improvements in bituminous binders modified by the addition of TonerPlas®

## Introduction

This report demonstrates the potential for improved asphalt performance via the addition of TonerPlas®. Close the Loop, the manufacturer of TonerPlas, have developed significant libraries of data including hundreds of DSR (Dynamic Shear Rheometer) scans that demonstrate improved stiffness and elasticity characteristics of a wide variety of bituminous binders.

Binder performance has a direct impact on asphalt performance and this discussion is not meant to mitigate the need for testing of asphalt performance with the addition of TonerPlas®

## Background

TonerPlas is a polymer compound that increases asphalt longevity. It is used as a dry mix additive and will melt, extend and modify the bituminous binder. TonerPlas is designed to rapidly melt and blend during the asphalt mix process. An additive that is dry mix processable is convenient and does not add processing cost, compared to wet mix processing utilised by conventional PMB technology.

TonerPlas will improve the mechanical properties of asphalt, by reducing flow and deformation and imparting elasticity in the bituminous binder mastic.

Asphalt binder properties directly influence asphalt performance, and the DSR is a powerful tool in characterising binder (viscoelastic) properties.

The DSR is used to measure a binders stiffness (modulus) and elasticity, across a wide service temperature range.

Mixtures of various binders with TonerPlas can be characterised by the DSR, in terms of improvements to stiffness at high service temperatures and improved elasticity.

When a DSR scan comparison is made between standard unmodified binder and TonerPlas modified binder, the improvements can be measured.

### Stiffness / Modulus

The high temperature (40-80°C range) stiffness of a binder relates to wheel tracking performance. Higher stiffness at high service temperatures will directly translate to improved wheel tracking performance associated with asphalt flow and deformation.

### Elasticity / Phase angle

The elasticity of a binder (at average service temperatures, around 20°C) will directly influence asphalt fatigue life performance. Higher elasticity (**lower phase angle on the DSR graph**) will provide better asphalt fatigue life (repetitive cycles of loading and unloading)

*Improved binder properties will lead to improved asphalt properties.*



## Testing Protocol

Samples of the various binder grades are collected from partner asphalt companies.

TonerPlas is added and blended at 160°C under medium shear stirring.

A sample of the binder / TonerPlas blend is tested on the DSR.

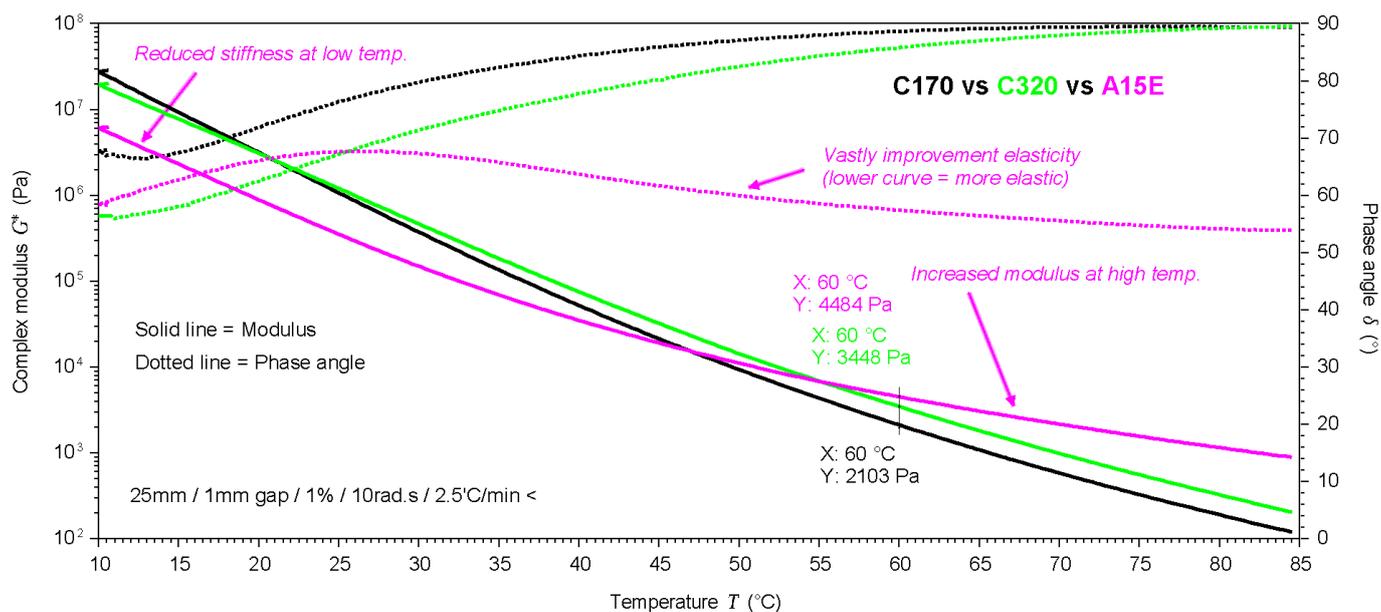
The rheological profile (from DSR) of TonerPlas modified binder is compared to the standard binder.



## Test Results

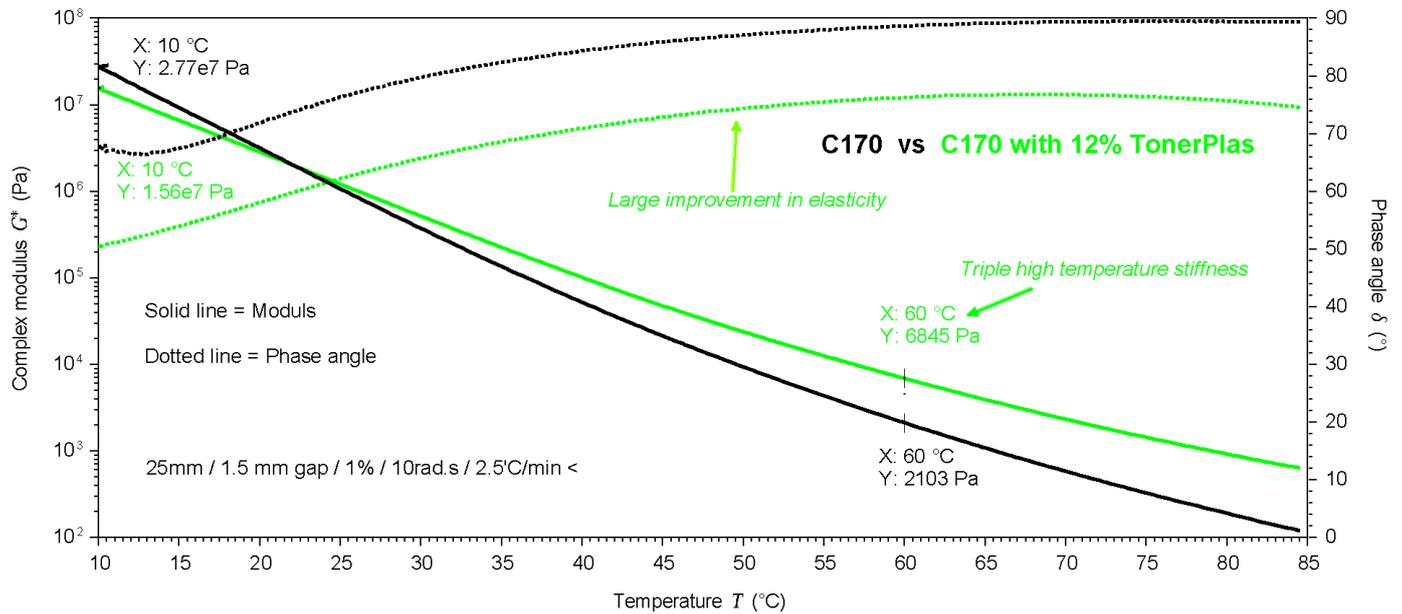
### C170 vs C320 vs A15E

A comparison of three binders – two of the most common un-modified bitumen's (C170 & C320) and one PMB (A15E). This overlay graph allows one to appreciate the differences in stiffness and elasticity of standard bitumen compared to a highly elastic PMB. It shows the properties that make a PMB a *performance binder* – increased stiffness at high temperatures, reduced stiffness at low temperatures and high elasticity.



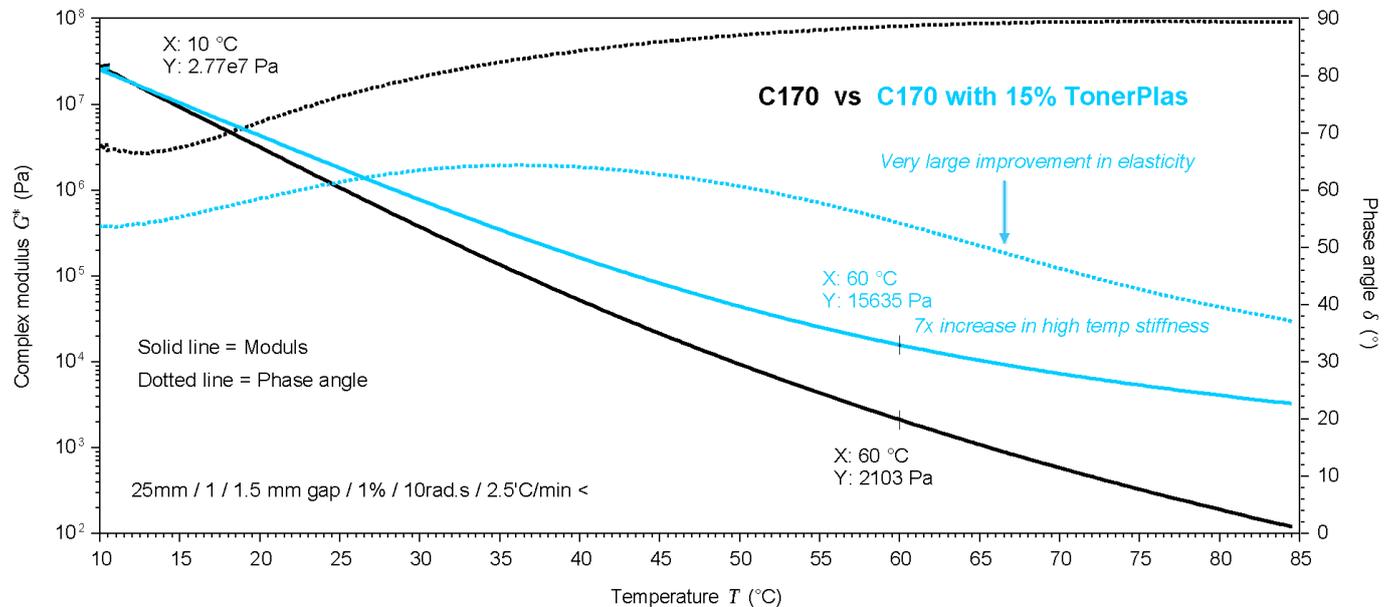
### C170 vs C170 with 12% TonerPlas

The addition of 12% TonerPlas to C170 demonstrates a significant improvement in binder elasticity (relating to fatigue life performance) and a tripling of high temperature modulus (relating to wheel tracking performance). These improvements in binder properties have been demonstrated in asphalt, with significant fatigue life improvement coupled with an 80% decrease in wheel tracking depth.



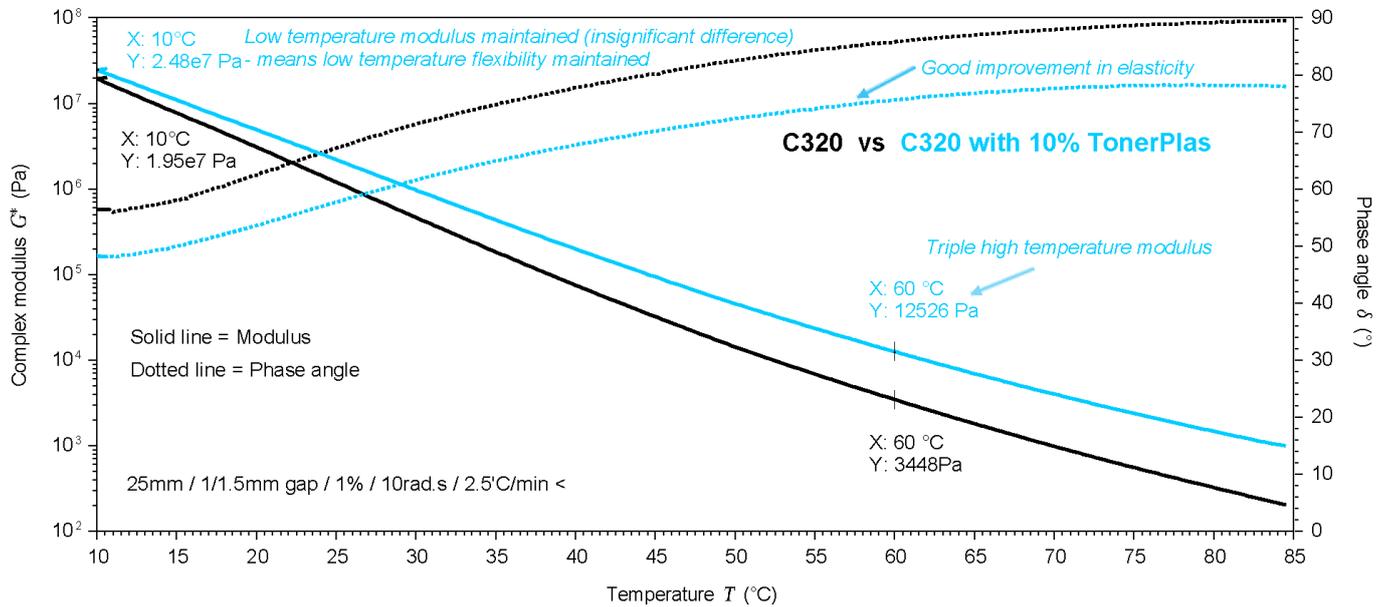
### C170 vs 15% TonerPlas

The addition rate effect on binder properties is not linear – from 12% to 15% shows a far greater enhancement in stiffness and elasticity



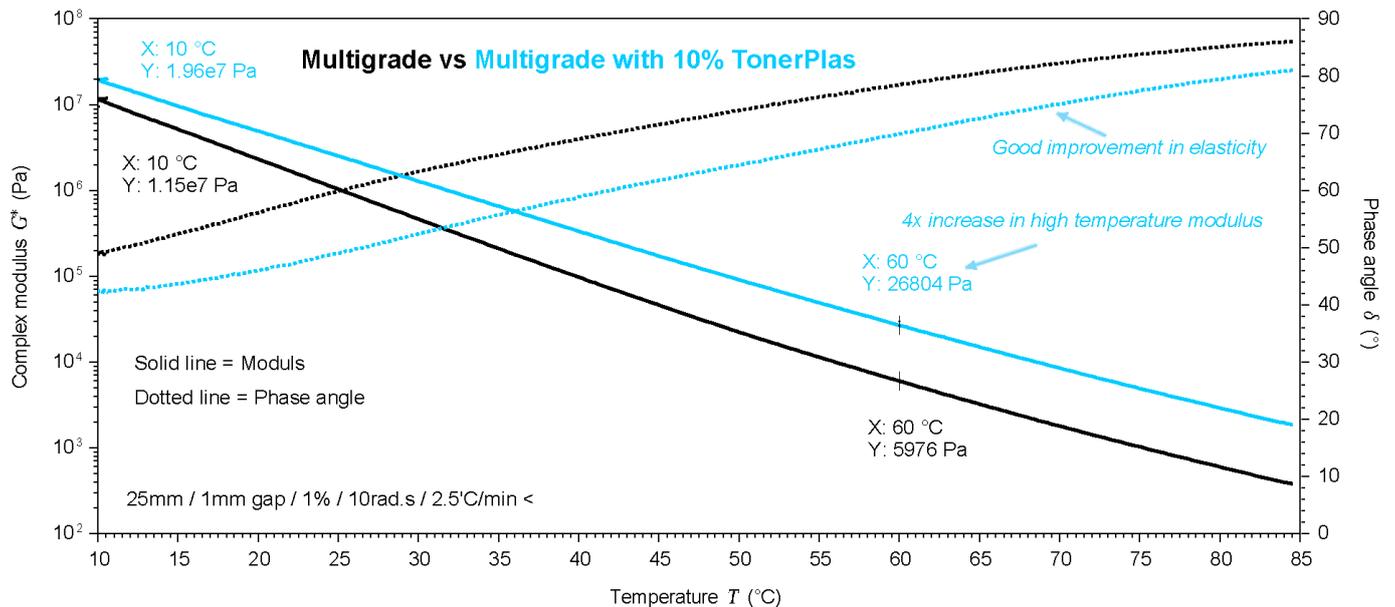
## C320 vs 10% TonerPlas

Similarly to C170, the addition of 10% TonerPlas to C320 demonstrates a significant improvement in binder elasticity (relating to fatigue life performance) and a tripling of high temperature modulus (relating to wheel tracking performance). The other important aspect is that the stiffness is preserved at low pavement temperatures, which is important for low temperature flexibility.



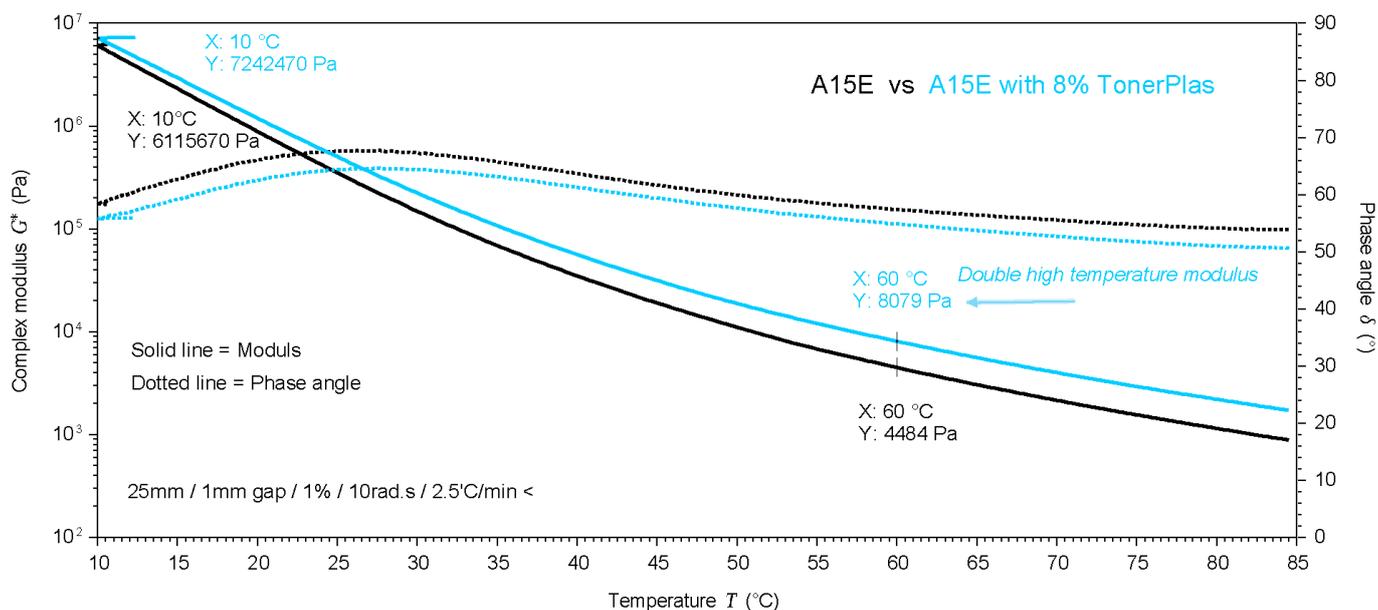
## Multigrade vs 10% TonerPlas

TonerPlas will also enhance the stiffness and elasticity of Multigrade bitumen. High temperature stiffness is increased by over a factor of 4.



## A15E vs 8% TonerPlas

TonerPlas will also enhance the stiffness and elasticity of highly elastic PMBs. High temperature stiffness is doubled, and elasticity preserved.



## Conclusions

The addition of small amounts of TonerPlas directly to an asphalt mix improves the performance of a wide range of Australian binders as shown on the DSR graphs above.

TonerPlas is a convenient and cost effective method of polymer modifying asphalt for improved durability.

## About TonerPlas

TonerPlas is a patented Australian technology, more than 8 years in the making.

TonerPlas is made from 100% post consumer recycled materials, mainly waste plastics, but only plastics with very specific performance characteristics related to melt point, elasticity, and stiffness.

Close the Loop has developed an advanced manufacturing process to take waste plastics in, clean, purify, blend, melt, homogenise, extrude, pelletise, cool and pack.

*CONSIDER – Not all waste plastics improve the performance of asphalt. Please make sure you are shown evidence of rigorous testing and improved performance before accepting asphalt modified with plastic. If the plastics being promoted are not specifically re-processed for use in asphalt modification, be cautious.*

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